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(402+ Presentations in ICWS/SCC/CLOUD/SERVICES 2010)
# Program Overview

## July 5, 2010 (Monday)

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<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>7:00-8:00</td>
<td>Breakfast (Conference Registration Area)</td>
</tr>
<tr>
<td>7:00-18:00</td>
<td>On-Site Registration (Hibiscus B)</td>
</tr>
<tr>
<td>8:00-18:00</td>
<td>IEEE Body of Knowledge on Services Computing Initiative (Presentation Recording) Gardenia ABC</td>
</tr>
<tr>
<td>8:00-18:00</td>
<td>Internet Access Room (Prefunction Area) // IEEE Office (Azalea AB)</td>
</tr>
<tr>
<td>8:30-9:30</td>
<td>- Conference Opening (ICWS/SCC/SERVICES/CLOUD 2010): General Chairs</td>
</tr>
<tr>
<td></td>
<td>- Program Overview: Program Chairs</td>
</tr>
<tr>
<td></td>
<td>- Summer School Opening Talk: A Reference Model for Master Degree Programs of Services Computing (Liang-Jie Zhang, IBM T.J. Watson Research Center, USA) Room: Ashe Auditorium (Third Floor)</td>
</tr>
<tr>
<td>9:30-11:00</td>
<td>Room: Brickell North Summer School Tutorial 1</td>
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<td>Room: Brickell South Summer School Tutorial 3</td>
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<tr>
<td></td>
<td>Room: Tuttle North Summer School Tutorial 5</td>
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<tr>
<td></td>
<td>Room: Tuttle South SWF 2010 Workshop</td>
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<tr>
<td></td>
<td>Room: Orchid AB WebX 2010 Workshop</td>
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<td></td>
<td>Room: Orchid CD NCSE 2010 Workshop</td>
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<tr>
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<td>Room: Tuttle Center SEASS 2010 Workshop</td>
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<tr>
<td>11:00-11:30</td>
<td>AM Break with Refreshments (outside conference halls)</td>
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<tr>
<td>11:30-13:00</td>
<td>Summer School Tutorial 1</td>
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<td>Summer School Tutorial 3</td>
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<td>WebX 2010 Workshop</td>
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<td>SEASS 2010 Workshop</td>
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<td>14:00-15:30</td>
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<td>SWF 2010 Workshop</td>
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<td>WebX 2010 Workshop</td>
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<td>WebX 2010 Workshop</td>
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<td>NCSE 2010 Workshop</td>
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<tr>
<td>18:30-20:30</td>
<td>No Planned Activities for Conference Participants. (Posters can be setup and kept in Jasmine and Hibiscus A)</td>
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<tr>
<td>Time</td>
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<td>7:00-8:00</td>
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<td>7:00-18:00</td>
<td>On-Site Registration (Hibiscus B)</td>
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<td>8:00-18:00</td>
<td>IEEE Body of Knowledge on Services Computing Initiative (Presentation Recording) Gardenia ABC</td>
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<tr>
<td>8:00-18:00</td>
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**Room**

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<thead>
<tr>
<th>Room</th>
<th>Brickell North</th>
<th>Brickell South</th>
<th>Tuttle North</th>
<th>Tuttle South</th>
<th>Orchid AB</th>
<th>Orchid CD</th>
<th>Tuttle Center</th>
<th>Brickell Center</th>
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<tbody>
<tr>
<td>8:00-9:30</td>
<td>ICWS Research Session 1</td>
<td>ICWS Application &amp; Industry Session 1</td>
<td>SCC Research Session 1</td>
<td>SCC Application &amp; Industry Session 1</td>
<td>CLOUD Research Session 1</td>
<td>CLOUD Application &amp; Industry Session 1</td>
<td>Ph.D. Symp. Session 1</td>
<td>ICWS Research Session 3</td>
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<tr>
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<td>10:00-11:30</td>
<td>ICWS Research Session 2</td>
<td>ICWS Application &amp; Industry Session 2</td>
<td>SCC Research Session 2</td>
<td>SCC Application &amp; Industry Session 2</td>
<td>CLOUD Research Session 2</td>
<td>CLOUD Application &amp; Industry Session 2</td>
<td>Ph.D. Symp. Session 2</td>
<td>SCC Research Session 3</td>
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<td>11:30-12:30</td>
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<td>12:30-14:00</td>
<td>Welcome Message from the IEEE Computer Society</td>
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<td></td>
<td>Panel 1: Cloud Computing Standards</td>
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<td>Chair: Stephen L. Diamond, Chair of IEEE Cloud Computing Initiative</td>
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<td>14:00-14:15</td>
<td>PM Break</td>
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<td>14:15-15:45</td>
<td>Keynote 1: Cloud Computing in an Outcome Centric World</td>
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<td>Chung-Sheng Li, IBM T.J. Watson Research Center</td>
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<td>15:45-16:30</td>
<td>PM Break with Refreshments (outside conference halls)</td>
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<tr>
<td>16:30-20:30</td>
<td>IEEE Plenary Poster and Innovation Showcase Session (with Refreshments)</td>
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<td>Room: Jasmine, Hibiscus A, and Promenade Lower Hallway</td>
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### July 7, 2010 (Wednesday)

<table>
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<th>Time</th>
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<tbody>
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<td>7:00-08:00</td>
<td>Breakfast (Conference Registration Area)</td>
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<tr>
<td>7:00-18:00</td>
<td>On-Site Registration (Hibiscus B)</td>
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<tr>
<td>8:00-18:00</td>
<td>IEEE Body of Knowledge on Services Computing Initiative (Presentation Recording) Gardenia ABC</td>
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<tr>
<td>8:00-18:00</td>
<td>Internet Access Room (Prefunction Area) // IEEE Office (Azalea AB)</td>
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<tr>
<td>Room</td>
<td>Brickell North</td>
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<tr>
<td>8:00-9:30</td>
<td>ICWS Research Session 4</td>
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<tr>
<td>9:30-10:00</td>
<td>AM Break with Refreshments (outside conference halls)</td>
</tr>
</tbody>
</table>
| 10:00-11:30| **Keynote Panel:** Trends of Services and Cloud Computing  
Chair: Stephen S. Yau, Arizona State University  
Room: James L. Knight Center (Third Floor) |
| 11:30-12:30| Lunch (Not Included)                                                    |
| 12:30-14:00| ICWS Research Session 5  | ICWS Application & Industry Session 5  | SCC Research Session 5  | SCC Application & Industry Session 5  | CLOUD Research Session 5  | CLOUD Application & Industry Session 5  | CLOUD Research Session 5  | SERVICES Research Session 1 |
| 14:00-14:15| PM Break                                                               |
| 14:15-15:45| ICWS Research Session 6  | ICWS Application & Industry Session 6  | SCC Research Session 6  | SCC Application & Industry Session 6  | CLOUD Research Session 6  | CLOUD Application & Industry Session 6  | CLOUD Application & Industry Session 6  | SOA Industry Summit Session 2 |
| 15:45-16:30| PM Break with Refreshments (outside conference halls)                  |
| 16:30-18:00| Panel 2: Killer Applications in the Cloud: Challenges and Opportunities  
Moderator: Ling Liu, Georgia Institute of Technology  
Room: Jasmine                                           |
| 18:30-21:00| IEEE Congress Banquet (ICWS/SCC/SERVICES/CLOUD 2010)  
Riverfront Hall (Second Floor)                           |
### July 8, 2010 (Thursday)

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>7:00-8:00</td>
<td>Breakfast (Conference Registration Area)</td>
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<tr>
<td>7:00-18:00</td>
<td>On-Site Registration (Hibiscus B)</td>
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<tr>
<td>8:00-18:00</td>
<td>IEEE Body of Knowledge on Services Computing Initiative (Presentation Recording) Gardenia ABC</td>
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<tr>
<td>8:00-18:00</td>
<td>Internet Access Room (Prefunction Area) // IEEE Office (Azalea AB)</td>
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<tr>
<td>8:00-9:30</td>
<td><strong>Keynote 3:</strong> Securing Data in the Cloud – Challenges and Research Directions</td>
</tr>
<tr>
<td></td>
<td>Elisa Bertino, Purdue University</td>
</tr>
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<td></td>
<td>Room: Ashe Auditorium (Third Floor)</td>
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<tr>
<td>9:30-10:00</td>
<td>AM Break with Refreshments (outside conference halls)</td>
</tr>
</tbody>
</table>

#### Room

<table>
<thead>
<tr>
<th>Time</th>
<th>Sessions</th>
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<tbody>
<tr>
<td>10:00-11:30</td>
<td>ICWS Research Session 8&lt;br&gt;ICWS Application &amp; Industry Session 8&lt;br&gt;SCC Research Session 8&lt;br&gt;SCC Application &amp; Industry Session 8&lt;br&gt;CLOUD Research Session 8&lt;br&gt;CLOUD Application &amp; Industry Session 8&lt;br&gt;CLOUD Research Session 10&lt;br&gt;SERVICES Research Session 3</td>
</tr>
<tr>
<td>11:30-12:30</td>
<td>Business Lunch (Ashe Auditorium (Third Floor))&lt;br&gt;Overview and Planning of Services Computing Community’s Professional Activities&lt;br&gt;(Host: IEEE TC-SVC Executive Committee and Conference Chairs)</td>
</tr>
<tr>
<td>12:30-14:00</td>
<td>ICWS Research Session 9&lt;br&gt;ICWS Application &amp; Industry Session 9&lt;br&gt;SCC Research Session 9&lt;br&gt;SCC Application &amp; Industry Session 9&lt;br&gt;CLOUD Research Session 9&lt;br&gt;CLOUD Application &amp; Industry Session 9&lt;br&gt;CLOUD Application &amp; Industry Session 10&lt;br&gt;SERVICES Research Session 4</td>
</tr>
<tr>
<td>14:00-14:15</td>
<td>PM Break</td>
</tr>
<tr>
<td>14:15-15:45</td>
<td>ICWS Research Session 10&lt;br&gt;ICWS Application &amp; Industry Session 10&lt;br&gt;SCC Research Session 10&lt;br&gt;SCC Application &amp; Industry Session 10&lt;br&gt;CLOUD Research Session 3&lt;br&gt;ICWS Application &amp; Industry Session 3&lt;br&gt;CLOUD Application &amp; Industry Session 3&lt;br&gt;SCC Application &amp; Industry Session 3</td>
</tr>
<tr>
<td>15:45-16:30</td>
<td>PM Break with Refreshments (outside conference halls)</td>
</tr>
<tr>
<td>16:30-18:00</td>
<td>ICWS Research Session 11&lt;br&gt;ICWS Application &amp; Industry Session 11&lt;br&gt;SCC Research Session 11&lt;br&gt;SCC Application &amp; Industry Session 12</td>
</tr>
<tr>
<td>18:30-20:30</td>
<td>No planned activities for conference participants (Enjoy Your Stay in Miami)&lt;br&gt;(All posters are kept and open in Jasmine and Hibiscus A)</td>
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<tr>
<td>Time</td>
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<td>7:00-8:00</td>
<td>Breakfast (Conference Registration Area)</td>
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<td>7:00-18:00</td>
<td>On-Site Registration (Hibiscus B)</td>
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<tr>
<td>8:00-18:00</td>
<td>IEEE Body of Knowledge on Services Computing Initiative (Presentation Recording) Gardenia ABC</td>
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<tr>
<td>8:00-18:00</td>
<td>Internet Access Room (Prefunction Area) // IEEE Office (Azalea AB)</td>
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</tbody>
</table>
| 8:00-9:30     | **Keynote 4:** Thinking Outside the Box: How Cloud, Grid, and Services Can Make Us Smarter?  
                      Ian Foster, Argonne National Laboratory and University of Chicago  
                      Room: Ashe Auditorium (Third Floor)                                 |
| 9:30-10:00    | AM Break with Refreshments (outside conference halls)                  |
| 10:00-11:30   | Room: Brickell North, Brickell South, Tuttle North, Tuttle South, Orchid AB, Orchid CD, Tuttle Center, Brickell Center  
                      ICWS Research Session 12, ICWS WIP Session 1, SCC Application & Industry Session 13, SCC WIP Session 1, CLOUD Application & Industry Session 11, CLOUD WIP Session 1, Full-Day SERVICES CUP Evaluation, Social Networking |
| 11:30-12:30   | Lunch (Not Included)                                                  |
| 12:30-14:00   | Room: Brickell North, Brickell South, Tuttle North, Tuttle South, Orchid AB, Orchid CD, Tuttle Center, Brickell Center  
                      ICWS Research Session 13, ICWS WIP Session 2, SCC Application & Industry Session 14, SCC WIP Session 2, CLOUD Application & Industry Session 12, CLOUD WIP Session 2, Full-Day SERVICES CUP Evaluation, Social Networking |
| 14:00-14:15   | PM Break                                                              |
| 14:15-15:45   | Room: Brickell North, Brickell South, Tuttle North, Tuttle South, Orchid AB, Orchid CD, Tuttle Center, Brickell Center  
                      ICWS Application & Industry Session 12, ICWS WIP Session 3, SCC Application & Industry Session 15, SCC WIP Session 3, CLOUD WIP Session 3, SCCI Course Dev Session, Full-Day SERVICES CUP Evaluation, Social Networking |
| 15:45-16:30   | PM Break with Refreshments (outside conference halls)                 |
| 16:30-18:00   | Room: Brickell North, Brickell South, Tuttle North, Orchid AB, Orchid CD, Tuttle Center, Brickell Center  
                      ICWS WIP Session 4, ICWS WIP Session 5, ICWS WIP Session 6, SCC WIP Session 4, ICWS WIP Session 7, SCCI Course Dev Session, Full-Day SERVICES CUP Evaluation, Social Networking |
| 18:30-20:30   | No planned activities for conference participants (Enjoy Your Stay in Miami).  
                      (All posters are kept and open in Jasmine and Hibiscus A)  
                      Organizing Committee Meeting (Invitation Only)               |
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
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<td>Conference Registration Area</td>
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<tr>
<td>7:00-18:00</td>
<td>On-Site Registration (Hibiscus B)</td>
<td>Hibiscus B</td>
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<tr>
<td>8:00-18:00</td>
<td>IEEE Body of Knowledge on Services Computing Initiative (Gardenia ABC)</td>
<td>Gardenia ABC</td>
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<tr>
<td>8:00-18:00</td>
<td>Internet Access Room (Prefunction Area) // IEEE Office (Azalea AB)</td>
<td>Azalea AB</td>
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<tr>
<td>8:00-9:30</td>
<td>HIS 2010 Workshop</td>
<td>Brickell North</td>
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<td>RTSOAA 2010 Workshop</td>
<td>Brickell South</td>
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<tr>
<td></td>
<td>WS-CS-Testing 2010 Workshop</td>
<td>Tuttle North</td>
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<tr>
<td></td>
<td>SC4B2B &amp; WSBPS Workshop</td>
<td>Tuttle South</td>
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<tr>
<td></td>
<td>Ph.D. Symposium Session 3</td>
<td>Orchid AB</td>
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<td>Internet Room</td>
<td>Orchid CD</td>
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<td>Social Networking</td>
<td>Tuttle Center</td>
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<td>9:30-10:00</td>
<td>AM Break with Refreshments (outside conference halls)</td>
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<tr>
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<td>HIS 2010 Workshop</td>
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<td>RTSOAA 2010 Workshop</td>
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<td>WS-CS-Testing 2010 Workshop</td>
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<td>SC4B2B &amp; WSBPS Workshop</td>
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<td>ICWS Application &amp; Industry Session 13</td>
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<td>Social Networking</td>
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<td>11:30-12:30</td>
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<td>EMSOS 2010 Workshop</td>
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<td>RTSOAA 2010 Workshop</td>
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<td>WS-CS-Testing 2010 Workshop</td>
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<td>SOCMAS 2010 Workshop</td>
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<td>Internet Room</td>
<td>Orchid CD</td>
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<td>Social Networking</td>
<td>Tuttle Center</td>
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<tr>
<td>14:00-14:20</td>
<td>PM Break</td>
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<td>14:20-15:50</td>
<td>EMSOS 2010 Workshop</td>
<td>Brickell North</td>
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<td>RTSOAA 2010 Workshop</td>
<td>Brickell South</td>
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<td>WS-CS-Testing 2010 Workshop</td>
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<tr>
<td></td>
<td>SOCMAS 2010 Workshop</td>
<td>Tuttle South</td>
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ICWS/SCC/CLOUD/SERVICES 2010 Keynotes

Keynote 1: Cloud Computing in an Outcome Centric World
Chung-Sheng Li
Director of Commercial Systems, IBM T.J. Watson Research Center, USA

Abstract:
Delivering business outcome is augmenting and/or replacing traditional fee-for-service business model and has become increasingly prevalent in areas such as strategic outsourcing, smarter planet solutions, crowd sourcing, knowledge marketplace, internet advertisements, and healthcare. As an example, outcome-based strategic outsourcing contracts are expected to grow from ~5% this year (2010) to ~50% by 2015. The primary challenge faced by outcome based business model is the difficulties in providing a transparent and verifiable way for measuring the business outcome between the producer and the consumer without having to reveal too much proprietary information. The rapid penetration of cloud computing is fundamentally changing this landscape as cloud computing facilitated the standardization of service delivery and pricing.

This talk will focus on the technology implications on cloud computing from an outcome centric world: (1) Risk adjusted cost performance, which captures the variation of outcome, for system level metrics will receive increasing focus. This metric will either augment or subsume the traditional cost performance metric. (2) Fine-grained resource provisioning: Both resource provisioning and runtime management for system cluster, private & public clouds will be optimized for the heterogeneous workloads generated by vertically integrated solution platforms that will become increasingly outcome centric. (3) Emergence of cloud OS: Outcome centric management of datacenter resources requires capability for elastic partitioning computing resources among on-premise computing clusters, private and public clouds, resulting in the emergence of cloud hypervisor or OS. (4) Proactive Platforms: Outcome centric platforms and system management requires the system platform to be more situational and context aware of the environment and business requirements. Increase use of behavior models of the system platforms and the environment enables the HW/SW platforms to be increasingly proactive in responding to potential future events.

About the Speaker:
Chung-Sheng Li received the BSEE degree from National Taiwan University, Taiwan, R.O.C., in 1984, and the MS and PhD degrees in electrical engineering and computer science from the University of California, Berkeley, in 1989 and 1991, respectively. He has been with IBM T.J. Watson Research Center as a research staff member since Sept. 1991, and became the Director of the Security, Information Analytics, and Business Integrity department since 2006 and has been the Director of the Commercial Systems since March 2010.

Keynote 2 (Panel): Trends of Services and Cloud Computing
Chair: Stephen S. Yau, Arizona State University, USA
Panelists: Jun-Liang Chen, Beijing University of Post and Telecommunications, China
Andrzej Goscinski, Deakin University, Australia
Hermant K. Jain, University of Wisconsin at Milwaukee, USA
Min Luo, IBM Software Group, USA

About the Moderator:
Stephen S. Yau is currently a professor of computer science and engineering and the Director of Information Assurance Center at Arizona State University (ASU), Tempe. He served as the president of the IEEE Computer Society, a member of the IEEE Board of Directors, and the Board of Directors of Computing Research Association. He also served as the editor-in-chief of IEEE \textit{COMPUTER} magazine, and organized many international major conferences. He is the general co-chairs of the collocated conferences ICWS, SCC, SERVICES, and CLOUD in 2010. He is a fellow of the IEEE and The American Association for the Advancement of Science. His current research interests include service and cloud computing, information assurance and security.

About the Panelists:
Jun-Liang Chen is a professor at Beijing University of Post and Telecommunications, China. He is an acadeian of both Chinese Academy of Sciences and Chinese Academy of Engineering. His current research interests include web services communication.
Andrzej Goscinski, professor in computing at Deakin University, Australia. His research is in service, cloud and autonomic computing, including security.
Hermant K. Jain is Wisconsin Distinguished Professor and Tata Consulting Services Professor, Management Information Systems at University of Wisconsin at Milwaukee. His research is in information system agility through web services, service-oriented architecture and component based development.
Min Luo is an Executive Architect, Strategy and Technology, IBM Software Group, Atlanta. He served as Chief Architect of the Global Business Solution Center -GCG, IBM IGS, and also Executive Architect in IBM Software Group’s Industry Solution Group. He contributed to the development and adoption of SOA and led the design and development of a number of major systems.
Keynote 3: Securing Data in the Cloud - Challenges and Research Directions
Elisa Bertino
Professor of Computer Science and Research Director of Center for Information Research in Information Assurance and Security
Purdue University, USA
(SERVICES2010-5003)

ABSTRACT:
Managing data is arguably one of the reasons for adopting cloud technologies. These technologies are very promising with respect to enhancing scalability, reducing costs, and rapidly adapting to changes in application demands. However the adoption of these technologies is not without risks. Data stored in a cloud would be accessible to a large variety of individuals, like the IT staff of the cloud providers. The cloud providers may in turn outsource data management functions to other providers. Data integrity and availability are critical issues. Physical protection, crucial for data security, may be difficult to assess for the organization owning the data as data may be stored in different countries, which makes difficult making inspections to the data storage location. In some cases, even being able to control the location of the data may be difficult. However, making sure that data is stored or not stored in certain locations is crucial for compliance. Data segregation is essential in the context of multi-tenant contexts in which data owned by different organizations may reside on the same systems. Support for disaster recovery, and accountability are also critical requirements. In the talk we will first elaborate on these issues. We will then present an overview of the MASK system, able to support fine-grained encryption of data while at the same time supporting identity-based privacy-preserving access control on encrypted data. We will conclude the presentation with a discussion about the notion of accountability policies and tools for managing security policies.

About the Speaker:
Elisa Bertino is professor of computer science at Purdue University and Research Director of the Center for Information and Research in Information Assurance and Security (CERIAS). Prior to joining Purdue, she was a professor and department head at the Department of Computer Science and Communication of the University of Milan. She has been a visiting researcher at the IBM Research Laboratory (now Almaden) in San Jose, at the Microelectronics and Computer Technology Corporation, at Rutgers University, at Telcordia Technologies. Her recent research focuses on database security, digital identity management, policy systems, and security for web services. She is a fellow of ACM and of IEEE. She a member of the editorial board of IEEE Transactions on Dependable and Secure Computing, and IEEE Security & Privacy. She is currently serving as chair of the ACM Special Interest Group on Security, Audit and Control (ACM SIGSAC).

Keynote 4: Thinking Outside the Box:
How Cloud, Grid, and Services can Make Us Smarter
Ian Foster
Director, Argonne National Laboratory and Professor of Computer Science, University of Chicago, USA
(SERVICES2010-5004)

ABSTRACT:
Whitehead observed that "civilization advances by extending the number of important operations which we can perform without thinking about them." Thanks to Moore's Law, these operations can nowadays involve increasingly complex information manipulation and computation. The outsourcing of computing via approaches such as utility computing, on-demand computing, grid computing, software as a service, and cloud computing can further enhance human capabilities, by freeing computer applications from the limiting confines of a single computer. Software that thus runs "outside the box" can be more powerful (Google, TeraGrid), dynamic (Animoto, calBIG), and collaborative (FaceBook, my Experiment). It can also be cheaper, due to economies of scale in hardware and software. Simultaneously, service-oriented architectures make it easier to integrate data and software from many sources. The combination of new functionality and new economics inspires new applications, reduces barriers to entry for application providers, and in general disrupts the computing ecosystem. I discuss new applications that outside-the-box computing enables; the hardware and software architectures that make these new applications possible; and the social dimensions of outside-the-box computing.

About the Speaker:
Ian Foster is Director of the Computation Institute, a joint institute of the University of Chicago and Argonne National Laboratory, where he is also the Arthur Holly Compton Distinguished Service Professor of Computer Science and an Argonne Distinguished Fellow. He received a BSc (Hons I) degree from the University of Canterbury, New Zealand, and a PhD from Imperial College, United Kingdom, both in computer science. His research deals with distributed, parallel, and data-intensive computing technologies, and innovative applications of those technologies to scientific problems. Methods and software he has developed underpin many large national and international cyber infrastructures. He is a fellow of the American Association for the Advancement of Science, the Association for Computing Machinery, and the British Computer Society. His awards include the British Computer Society's award for technical innovation, the Global Information Infrastructure (GII) Next Generation award, the British Computer Society's Lovelace Medal, R&D Magazine's Innovator of the Year, and an honorary doctorate from the University of Canterbury. He was a co-founder of Univa UD, Inc., a company established to deliver high-quality grid and cloud computing solutions.
Panel 1: Cloud Computing Standards

Moderator: Stephen L. Diamond, Chair, IEEE Cloud Computing Initiative, and General Manager, Industry Standards, EMC Corporation, USA (SERVICES2010-5005)

Theme:
Given the importance of standards to the development of cloud computing, this panel on cloud computing standards will share the latest information on IEEE cloud computing standards study group (see http://www.computer.org/portal/web/standards/cloud), a new cloud computing initiative under the IEEE NIC, as well as other industry standard initiatives.

About the Moderator:
Stephen L. Diamond is General Manager of Industry Standards at EMC Corporation. He chairs the IEEE Cloud Computing Standards Study Group and the IEEE Cloud Computing Initiative. Steve has 30 years of senior management, marketing, business development, M&A, and engineering experience in semiconductors, software, systems, and standards. Prior to EMC, he was Director of Product Management for Intercloud Computing at Cisco Systems. Steve has authored more than 20 technical publications on cloud computing, memory and microprocessor technology, signal processing, expert systems, and computer graphics. He is a member of the IEEE Board of Directors and was the 2003 President of IEEE Computer Society.

Panel 2: Killer Applications in the Cloud: Challenges and Opportunities

Moderator: Ling Liu, Professor, College of Computing, Georgia Institute of Technology, USA (SERVICES2010-5006)

Theme:
Cloud Computing is becoming a scalable services delivery platform for applications in various industries. Examples range from Healthcare industry, Energy and Utilities industry, Transportation industry, Biotechnology industry, to Internet and Web industry and Telecommunication industry.

This panel is organized to discuss and debate on the following topics:
- What kinds of applications can best leverage Cloud Computing platform?
- How to shape the industry solutions in the cloud computing platform?
- Which industries have the potential to offer the best killer applications?
- What are the research and development challenges and opportunities?

The panelists will present their statements in response to these questions and articulate their viewpoint in terms of a particular industry that they believe to hold the high promise as one of the best killer applications for Cloud.

About the Moderator:
Ling Liu is a Professor in the College of Computing at Georgia Institute of Technology. There she directs the research programs in Distributed Data Intensive Systems Lab (DiSL), examining performance, security, privacy, and data management issues in building large scale distributed computing systems. Dr. Liu and the DiSL research group have been working on various aspects of distributed data intensive systems, ranging from decentralized overlay networks, mobile computing and location based services, sensor network and event stream processing, to service oriented computing and architectures.

Panel 3: SOA and Cloud Computing: Synergy, Interlock and Transition

Moderator: Tony Shan, Keane Inc., USA (SERVICES2010-5007)

Theme:
Cloud Computing has been gaining momentum to steal the limelight away from SOA, which has recently faded out of the mainstream, particularly after the infamous declaration of “SOA is dead” early last year. It is worth taking a retrospective look at how SOA has evolved in a bumpy journey and what can be learned from its success as well as underperformance. In this panel session, we invite business and technology thought leaders from both industry and academic worlds to discuss the interplay between SOA and Cloud Computing, and then explore the convergence and divergence of these two solutions. The panelists of practitioners and researchers will share their insightful perspectives and real-world experience on how Cloud Computing will mature, what is the best approach of transformation, and where SOA and Cloud Computing can play in tandem. Selected subjects and issues will be examined in depth in the discussion, such as what Cloud Computing can do what SOA did not or could not do.

About the Moderator:
Tony Shan is a chief architect at Keane Inc.

About the Panelists:
Ian Foster is Director of the Computation Institute, a joint institute of the University of Chicago and Argonne National Laboratory, where he is also the Arthur Holly Compton Distinguished Service Professor of Computer Science and an Argonne Distinguished Fellow.

Melvin Greer is Chief Strategist, Cloud Computing and the Director SOA Competency Center, Lockheed Martin, Advanced Technologies Office. With over 25 years of systems and software engineering experience, he is a recognized expert in Service Oriented Architecture and Cloud Computing. He functions as a principal investigator in advanced research studies. He significantly advances the body of knowledge in basic research and critical, highly advanced engineering and scientific disciplines.
Summer School Opening Talk: A Reference Model for Master Degree Programs of Services Computing

Liang-Jie Zhang, IBM T. J. Watson Research Center, USA (SERVICES2010-5008)

Summary: Services Computing has become an increasingly important area in the IT and business sectors. In particular, Services now account for more than half of the economy in the United States and other countries. Numerous Services Computing-related degree programs and accreditation processes are being created. However, very few systematic guidelines exist for building graduate programs for Services Computing. This talk presents a reference model of the Masters Program in Services Computing for academic institutions and accreditation agencies as a relevant curriculum guideline. Specifically, the core and elective courses are introduced to help build the reference program. The interconnections between core and elective courses are also illustrated to help create concentration programs based on the introducing sequences of the courses. Some practices of delivering Services Computing related courses and conducting accreditation application process are presented in this talk to help others more rapidly initiate the adoption process of the Services Computing curriculum.

About the Speaker: Liang-Jie Zhang (LJ) is a research staff member (RSM) and program manager of application architectures and realization at IBM T.J. Watson Research Center. He leads R&D of the custom solution engagement cloud for the IBM Global Business Services. He is also the worldwide leader of IBM’s SOMA Modeling Environment (SOMA-ME). He published the Cloud Computing Open Architecture (CCOA) in 2009. From 2004 to 2005, he was the Chief Architect of Industrial Standards at IBM Software Group, where he was responsible for defining the strategic direction of service-oriented business solutions and standards. He has received many awards from IBM, an Outstanding Achievement Award from the World Academy of Sciences, and an Innovation Leadership Award from Chinese Institute of Electronics. He has many research papers and patents. He received his Ph.D. of Pattern Recognition and Intelligent Control from Tsinghua University. He completed both IBM Services Business Leadership Today (SBLT) Program and IBM Research’s MicroMBA Program in 2006. He is an ACM Distinguished Scientist and Senior Member of IEEE. He currently serves as the Editor-in-Chief of IEEE Transactions on Services Computing (TSC) and chairs the 2010 IEEE 3rd International Conference on Cloud Computing (CLOUD 2010).

ICWS/SCC/CLOUD/SERVICES 2010 Tutorials

Tutorial 1: Enterprise Architecture (EA)

Min Luo, Executive Architect, Strategy and Technology, IBM SWG, USA (SERVICES2010-5009)

Abstract:
One of the fundamental problems with not-so-attractive IT Return of Investment (ROI) is that most enterprise systems and applications have been built in an ad hoc way for the past several decades, and that is also why those systems are very difficult and expensive to enhance or integrate so they could never adapt to the ever-changing business requirements. The proposed MS in Service Computing will make a conscientious effort to introduce “architecture” as the cornerstone for the program that aims at helping students and practitioners fully understand the importance of establishing a sound architectural foundation for enterprise systems and applications, how to address concerns of various key stakeholders of their specific perspectives or interests using various architecture views, how Services Computing would become an effective mechanism to facilitate an architecture-centric process for the whole lifecycle of system development. This tutorial will overview what is enterprise architecture, its scope and addressed issues, the foundation, and several prevailing EA framework, the evolving standardization and language to formalize EA, EA consulting best of practice and some case studies.

About the Speaker:
Min Luo is currently an Executive Architect, Strategy and Technology, IBM Software Group. He served as Chief Architect of the Global Business Solution Center -GCC, IBM IGS, and also Executive Architect in IBM SWG’s Industry solution group. For more than 6 years as a Senior Certified Architect of the Center of Excellence – Enterprise Architecture and also of SOA, he had led several large scale projects in social services. He contributed to the development and adoption of SOA in IBM, led the design and development of one of the first operational Enterprise Service Bus, and conducted many IT/business consulting and alignment with SOA and Enterprise Architecture. He has 18+ years of industry experience with 12+ years of managing the whole life cycle of software application design, development and deployment. He has been serving on the organizing committee for IEEE’s ICWS and SCS/CC Conferences, presented several tutorials on SOA and its best practice.

Tutorial 2: Advanced Transaction Models for e-Services

Kamalakar Karlapalem, International Institute of Information Technology, Hyderabad, India
K. Vidyasankar, Memorial University, St. John’s, Canada
P. Rudha Krishna, Infosys Technologies Limited, Hyderabad, India (SERVICES2010-5010)

Abstract:
The concept of transactions has been fundamental for providing fault tolerance, reliability and robustness for database applications. The idea then is to extend the same transactional guarantees to new and evolving paradigms. A transaction is an execution of a program. It is committed when the execution is complete and successful. Otherwise, it is aborted and partial execution, if any, is rolled back. Thus, a transaction is an atomic unit. Each transaction, when executed alone, is assumed to be correct. A concurrent execution of several transactions is taken to be correct when the execution is equivalent to some serial execution of the same transactions.

The advancements in database systems impacted transaction executions in various ways. Some examples are the following.
(i) In distributed database systems, the data and hence operations on them are distributed among different sites and both site and network failures need to be taken into account; (ii) In heterogeneous distributed database systems, the sites are autonomous and so the rollback mechanism needs to be changed from undo to compensation; (iii) In mobile database systems, sites are disconnected from the network often and hence the execution and commitment strategies need to be changed; (iv) Some transactions tend to be long-running and the correctness criteria for concurrent executions need to be refined allowing increased interleaving of the transaction operations; Advanced transaction models were designed to accommodate these requirements;

- Services Computing paradigm has different execution characteristics.
- The (atomic database) operations are replaced by (not necessarily atomic) activities and services;
- Interdependencies develop among the executions of the activities and they affect the commitment of the transactions;
- The activities and services span multiple autonomous and heterogeneous organizations and they need cross-organizational transaction support;
- Very much like nested transactions, multi-level hierarchical compositions of activities and services come into picture.

These characteristics necessitate new transaction models that relax the transactional properties differently.

This tutorial covers the necessary background on advanced transaction models and Services Computing paradigm that includes Web services, e-contracts and cloud computing. Various aspects of e-services such as loose coupling, interaction, commitment and closure, composability, orchestration, interoperability, and business objectives and their influence on the design of transaction models will be discussed.

**About the Speakers:**

Kamal Karlapalem is a Professor at International Institute of Information Technology (IIIT), Hyderabad, India. He received his PhD from College of Computing, Georgia Tech in 1992. He has been working in the area of workflow management systems (WFMS), dealing with frameworks for building WFMSs, meta-modeling issues, support for handling exceptions in WFMSs, and security aspects of WFMSs. Currently, his research interest is to model and deploy electronic contracts derived from contract documents.

Krishnamurthy Vidyasankar is a Professor of Computer Science, Memorial University, St. John’s, Newfoundland, Canada. His research areas include transactional aspects in database and information systems including services computing and e-contracts, transactional memory, and shared variable constructions and mutual and group mutual exclusion algorithms in distributed computing. He has published several articles in reputed journals and conferences.

Radha Krishna is a Principal Research Scientist at Software Engineering and Technology Labs, Infosys Technologies Limited, Hyderabad, India. He received his Ph.D. from Osmania University in 1996. He is currently associated with research projects leading to futuristic information management and knowledge engineering solutions. His research interests include data warehousing, data mining, and electronic contracts and services.

**Tutorial 3: Risk Analysis on Service Outsourcing**

Yudistira Asnar, Fabio Massacci (University of Trento), Wendy Hui (University of Nottingham Ningbo, China), and Patrick C.K. Hung (University of Ontario Institute of Technology, Canada) (SERVICES2010-5012)

**Abstract:**

Risk is a well-known security concept in any business activity, and is considered a critical component in making business decisions. In recent years, the trend of service outsourcing introduces a new class of risk modeling and requirements. This tutorial presents basic notions of risk and explains how they are related to business-oriented Web services. Risk issues related to service outsourcing are becoming the major focus of this tutorial. This tutorial introduces the SI* framework to analyze IT risks in an outsourcing environment. Essentially, the framework is composed of a modeling framework, analysis techniques and methodology. SI* is developed to analyze security and trust issues in an organizational setting. This tutorial presents how SI* assists business analysts in analyzing service outsourcing initiatives. The tutorial begins by capturing business objectives from each stakeholder (actor) in the organization, and relating uncertain events that might compromise them. Relevant regulatory compliance and trust among actors are critical aspects that need to be captured and analyzed. This tutorial continues by analyzing the business objectives and services to be outsourced using automated reasoner in the SI* tool. Business analysts can assess the risk level and evaluate whether they need to employ more countermeasures in such an environment. This tutorial also covers several industry-specific scenarios to illustrate the usage of the framework using SI* tools, and open to the possibility to work on the case study proposed by attendees.

**About the Speakers:**

Yudistira Asnar (http://yudis.asnar.net) received B. Eng. from Bandung Institute of Technology (ITB) in 2002 and PhD in Computer Science and Information Engineering at University of Trento, Italy in 2010. His research interests include the areas of requirement engineering, agent systems, security-dependability risk management, and information assurance. The main focus of his research is on modeling and analyzing governance, risk and compliance of IT services.

Fabio Massacci (http://www.massacci.org) received a Ph.D. in Computer Science and Engineering at University of Rome La Sapienza in 1998. He joined University of Siena as an Assistant Professor in 1999, was a visiting researcher at IRIT Toulouse in 2000, and joined Trento in 2001 where he is now a professor. His research interests are in security requirements engineering, formal methods and computer security. He is currently a scientific coordinator of multimillion Euros industry R&D European projects on security and compliance.

Wendy Hui (http://www.nottingham.edu.cn/staffF.php?s=131) holds a Ph.D. in Information Systems from the Hong Kong University of Science and Technology (HKUST). She is currently a Lecturer at University of Nottingham Ningbo China. Her research interests include Economics of Information Systems, Information Security, and Technology-Assisted Learning. Her work has been accepted by the Journal of Management Information Systems (JMIS), Decision Support Systems (DSS), IEEE Transactions on Systems, Man and Cybernetics, Part A (IEEE SMCA), and Communication of the AIS (CAIS).

Patrick C. K. Hung (http://www.hrl.uoit.ca/~ckphung) is an Associate Professor at the Faculty of Business and Information Technology from the University of Ontario Institute of Technology and an Adjunct Faculty Member at the Department of Electrical and Computer Engineering in the University of Waterloo, Canada. He is also a Guest Professor at the Institute of Computer Science in University of Innsbruck, Austria. Recently Patrick Hung has founded a startup company BeaconWall Limited located at Hong Kong Science and Technology Park with Prof. Jay Tashiro from Wolfsongs Informatics, USA.
Tutorial 4: Services Computing in Biomedical Science
Wei Tan, Ravi Madduri
Computation Institute, University of Chicago and Argonne National Laboratory, USA, wtan@mcs.anl.gov, madduri@mcs.anl.gov
(SERVICES2010-5013)

Abstract:
Service-oriented Science (SOS) represents a SOA approach to federating data access and analysis across different institutional and disciplinary sources, thus facilitating large scale scientific collaboration. The US National Cancer Institute’s Biomedical Information Grid (a.k.a., caBIG) program seeks to create both a service computing infrastructure (caGrid) and a suite of data and analytical services. Workflow tools in caGrid facilitate both the use and creation of services by accelerating service discovery, composition and orchestration tasks.
This tutorial uses caGrid as a case of service computing in biomedical science and includes a combination of research and engineering effort made by our team. The following aspects are to be covered: 1) the motivation of SOS and an overview of state-of-the-art; we will highlight some examples in biomedical and bioinformatics field; 2) caGrid architecture, the service creation and management tools it offers and the services it hosts; 3) Taverna workbench as the workflow solution of caGrid, and how we enhance it to fulfill the requirements from caGrid community; 4) the challenges we are facing and the research opportunities.

About the Speakers:
Wei Tan is a research professional associate at the Computation Institute, University of Chicago and Argonne National Laboratory. He is the core developer of caBIG workflow system, and has received Teamwork Award and Outstanding Poster Award from US National Institute of Health in recognition of his contribution in this effort. His research interests include business and scientific workflows, grid and service-oriented computing (especially the applications in health-informatics), and Petri nets. He is now involved in multiple health-informatics-related projects, providing scientific workflow solutions for domain users. Find more from his homepage at http://www.mcs.anl.gov/~wtan/.

Ravi Madduri is a fellow at the Computation Institute, University of Chicago. He is one of three key contributors to the National Institutes of Health $100M Cancer Bio-Informatics Grid (caBIG), which links 60 NIH-funded cancer centers and clinical sites engaged in cancer research. For his efforts in project management, tool development, and collaboration, Ravi received several Outstanding Achievement Awards from NIH in recognition of his work on caBIG project management, tool development, and collaboration. He is a lead architect on the scientific workflow design and implementation project under the caGrid toolkit.

Tutorial 5: Security in Web Services: State-of-the-art and Research Opportunities
Júlio Cezar Estrella, Kalinka Castelo Branco, University of São Paulo, Brazil
Marco Vieira, University of Coimbra, Portugal
jcezar@icmc.usp.br, kalinka@icmc.usp.br, mvieira@dei.uc.pt (SERVICES2010-5014)

Abstract:
Web services are the cornerstone of Service Oriented Architectures (SOA). As business critical components, web services must provide high security. However, deploying secure web services is a difficult task. In fact, several studies show that a large number of web services are deployed with security flaws that range from code vulnerabilities (e.g., code injection vulnerabilities) to the incorrect use of security standards and protocols. In this tutorial we will present different techniques and tools for the deployment of secure web services, including:
−Standards and protocols to deploy secure services: standards such as XML, SOAP, UDDI, WSDL approach the basic concepts of interoperable services, but for secure web services other rules must be added. In this sense it is essential to study the main security specifications for Web Services, which include cryptographic algorithms and techniques that implement digital signatures. In the tutorial we will identify and map the main security requirements in Web Services aiming at defining ways to apply security specifications such as: WS-Security, WSC-Conversation, XML-Signature, XML-Encryption, XACML, SAML, and others.
−Security assessment techniques and tools: software defects are a major source of vulnerabilities. Interface and communication faults, related to problems in the interaction among software components/modules, are particularly relevant in service-oriented environments, as services must provide a secure interface to the client applications, even in the presence of malicious inputs. In the tutorial we will overview different security assessment approaches and experiment several tools for vulnerability detection.

The tutorial will address both current research topics and industry practice. Several case studies will be presented and used to demonstrate the effectiveness of existing tools and techniques. Future research opportunities will be identified and discussed.

About the Speakers:
Júlio Cezar Estrella, is currently a Ph.D. student at the Computer Systems Department of the University of São Paulo, and is about to defend his Ph.D. thesis. He has a strong background on web services implementation and practitioner experience in performance evaluation of SOA frameworks and tools and also has been working in distributed systems, service oriented architectures, computer networks, security, performance evaluation and processes scheduling.

Kalinka Regina Lucas Jaquie Castelo Branco is an Assistant Professor of the Institute of Mathematics and Computer Science - ICMC – USP. She has worked in distributed systems, computer networks, security, performance evaluation and processes scheduling.

Marco Vieira is an Assistant Professor at the University of Coimbra, Portugal, and an Adjunct Associate Teaching Professor at the Carnegie Mellon University. His research interests include dependability benchmarking, security assessment, robustness assessment and improvement, fault injection, and software quality assurance.

Tutorial 6: A3S: Accountability as a Service
Chen Wang and Shiping Chen, CSIRO ICT Centre, Australia, (SERVICES2010-5015)

Abstract:
Accountability in Service Oriented Architecture (SOA) is a capability of making business processes across all participants (services, applications
and people) accountable in terms of both business logic and Quality of Services (QoS). While accountability is a critical mechanism to enhance trust between collaborative services, there is the lack of standard accountability support in the current SOA infrastructure. For example, it is difficult with the existing technologies/infrastructure to resolve a dispute between two (web) services if some interactions between the two services go wrong; there is also little existing accountability support for a service consumer to collect quantity evidences to complain a service provider, who fails to meet its Service Level Agreement (SLA). As the increasing real-world activities are performed through the Internet connected services, we envision that there will be growing requirements for making the behaviors of both service providers and consumers accountable.

In the business world, one may be reluctant to transact directly with a stranger. But a mutually trusted middleman can be used to facilitate transactions and resolve possible disputes. In this tutorial, we will share our observations and research results on building accountability into SOA. First, we will review related work on accountability in traditional distributed systems, ranging from Internet protocols and network file systems to outsourced database management systems. We will examine what methods embodied in these work can fit service computing in Internet scale and what cannot. Then we will present our research work on middleware-based approach to delivering accountability as a service, including our recent research results. This tutorial will focus on the major technical challenges of enabling SOA accountable and our solutions to these challenges. Finally, we will demonstrate our solutions using a collaborative services scenario deployed in Amazon EC2 cloud. The goal of this tutorial is to provide detailed understanding of accountability issues and related technologies in SOA with in-depth related work discussions, recent research outcomes and a deployed accountability service prototype.

About the Speakers:
Chen Wang received his PhD from Nanjing University. He is a research scientist in CSIRO (The Commonwealth Scientific and Industrial Research Organisation) ICT Centre, Australia. His research interest is primarily in distributed, parallel and trustworthy systems. His current work focuses on accountable distributed systems and smart grids. He developed a high-throughput event system and a medical image archive system, which are used by many hospitals and medical centres. His detailed research information can be found at www.ict.csiro.au/staff/chen.wang

Shiping Chen is a senior research scientist of CSIRO ICT Centre, Australia. He received his PhD in Computer Science from University of New South Wales. Since joining in CSIRO in 1999, he has worked on a number of middleware-related research and consultant projects. His current research interests include web services and SOA, data storage and trust computing. His detailed research information can be found at www.ict.csiro.au/staff/shiping.chen

2010 IEEE 8th International Conference on Web Services (ICWS 2010)

Research Track

Research Track 1 – Services Selection (Session Chair: Umesh Bellur, Indian Institute of Tech (IIT) Bombay)

Service Selection based on Customer Rating of Quality of Service Attributes (ICWS2010-1001)
Abhishek Srivastava, Paul Sorenson (University of Alberta, Canada)

Selecting the optimal service from a set of functionally equivalent services is non-trivial. Previous research has addressed this issue making use of Quality of Service (QoS) attributes of the candidate services. In doing this, researchers have however assumed that the customers’ preference of the various QoS attributes varies linearly with the actual attribute values. In this work, we put forward a technique that overcomes this restriction and compares functionally equivalent services on the basis of the customers’ perception of the QoS attributes rather than the actual attribute values. We utilize the ‘mid-level splitting’ method to track the customer’s preference vis-a-vis the actual attribute values. Further, we utilize the ‘Hypothetical Equivalents and Inequivalents Method’ to assign weights, reflecting the importance, to the attributes on the basis of the customer preference. The whole procedure is demonstrated using a simple running example.

RegionKNN: A Scalable Hybrid Collaborative Filtering Algorithm for Personalized Web Service Recommendation (ICWS2010-1002)
Xi Chen, Xuadong Liu, Zicheng Huang, and Huilong Sun (Beihang University, China)

Several approaches to web service selection and recommendation via collaborative filtering have been studied, but seldom have these studies considered the difference between web service recommendation and product recommendation used in e-commerce sites. In this paper, we present RegionKNN, a novel hybrid collaborative filtering algorithm that is designed for large scale web service recommendation. Different from other approaches, this method employs the characteristics of QoS by building an efficient region model. Based on this model, web service recommendations will be generated quickly by using modified memory-based collaborative filtering algorithm. Experimental results demonstrate that apart from being highly scalable, RegionKNN provides considerable improvement on the recommendation accuracy by comparing with other well-known collaborative filtering algorithms.

HyperService: Linking and Exploring Services on the Web (ICWS2010-1003)
Chenting Zhao, Chun’e Ma, Jing Zhang, Jun Zhang, Li Yi, Xinxheng Mao (IBM China Development Laboratory, China)

Web is becoming a programmable platform, with countless services blooming everyday in various forms like Feeds, REST APIs and Widgets, etc. Although the existing technologies, such as Mashups, have reduced the challenges to build new applications by composing these services, it’s still far from enabling the non-technical users to solve their situational problems by correlating and consuming these services. In this paper, we present our HyperService technology, which empowers a much more flexible way to link and explore existing services for solving various situational problems. In HyperService, the service metadata, service linkages and user behaviors are indexed and managed; Based on the user’s input keywords and navigation context, a group of relevant services are dynamically searched, ranked and recommended for facilitating future navigations; the service navigation is smoothed by a web2.0 style exploratory user interface. A prototype system is also presented to demonstrate the effectiveness of our HyperService research work.

Research Track 2 – QoS-aware Services Composition (Session Chair: Louise Moser, University of California, Santa Barbara, USA)
and significantly improves the accuracy of the search results. Evaluations show that, compared to the state of the art, QSynth achieves superior implementation of QoS objectives of service requests as the search directives. This approach effectively prunes the search space approaches suffer from serious limitations in scalability and accuracy when addressing both requirements simultaneously. We have designed and correct work plans from thousands of services but also satisfy the quality requirements of the users. Our observation is that conventional Web Services Challenge 2010.

abstract process templates; iii) an optimization process that maximizes the overall quality of final compositions. Finally, we compare the AI parametric-design techniques using a multi agent approach to configure and adapt services processes, heavily relying on the latter set of regulations, security or temporal requirements and others. Then, it allows for instantiating, verifying and executing the composition design and for monitoring the process while in execution. The effect of run-time violations can also be calculated and a set of recovery actions can be taken, allowing for the self-healing Web services composition.

QSynth: A Tool for QoS-aware Automatic Service Composition (ICWS2010-1006)
Wei Jiang, Charles Zhang, Zhenqiu Huang, Mingwen Chen, Songlin Hu, and Zhiyong Liu (Chinese Academy of Sciences; The Hong Kong University of Science and Technology, China)

With the proliferation of Web services, service engineers demand good automatic service composition algorithms that not only synthesize the correct work plans from thousands of services but also satisfy the quality requirements of the users. Our observation is that conventional approaches suffer from serious limitations in scalability and accuracy when addressing both requirements simultaneously. We have designed and implemented a tool QSynth to use QoS objectives of service requests as the search directives. This approach effectively prunes the search space and significantly improves the accuracy of the search results. Evaluations show that, compared to the state of the art, QSynth achieves superior scalability and accuracy with respect to a large variety of composition scenarios. Our design of QSynth won the performance championship of the Web Services Challenge 2010.

Research Track 3 – Services Composition (Session Chair: M. Brian Blake, University of Notre Dame, USA)

Policy-Driven Service Composition with Information Flow Control (ICWS2010-1007)
Wei She, I-Ling Yen, Bhavani Thuraisingham, and Elisa Bertino (University of Texas at Dallas; Purdue University, USA)

Ensuring secure information flow is a critical task for service composition in multi-domain systems. Research in security-aware service composition provides some preliminary solutions to this problem, but there are still issues to be addressed. In this paper, we develop a service composition mechanism specifically focusing on the secure information flow control issues. We first introduce a general model for information flow control in service chains, considering the transformation factors of services and security classes of data resources in a service chain. Then, we develop general rules to guide service composition satisfying secure information flow requirements. Finally, to achieve efficient service composition, we develop a three-phase protocol to allow rapid filtering of candidate compositions that are unlikely to satisfy the information flow constraints and thorough evaluation of highly promising candidates. Our approach can achieve effective and efficient service composition considering secure information flow.

SOA4All: An Innovative Integrated Approach to Services Composition (ICWS2010-1008)
Freddy Lécué, Yous Gorronogóitia, Rafael Gonzalez, Mateusz Radzinski, and Matteo Villa (The University of Manchester, UK; ATOS Research, Spain; TXT e-Solutions SpA, Italy)

Automated web service composition has been tackled from different directions and to different purposes. In addition, most of the approaches address the composition problem with underspecified requirements, returning compositions models that do not necessarily satisfy and fulfill end-users objectives. Satisfying the latter objectives is a difficult problem, especially from scratch, which requires stronger requirements and a further step of integration with service-based components in order to make service oriented computing and service composition a reality. In this work, we address this issue by presenting an innovative and integrated approach to service composition which consists of i) an automatic template process generator, that is able to generate abstract process templates and their hierarchy from past exceptions; ii) a novel and scalable approach to AI parametric-design techniques using a multi agent joint approach to configure and adapt services processes, heavily relying on the latter step of abstract process templates; iii) an optimization process that maximizes the overall quality of final compositions. Finally, we compare the scalability of these components with some experiments.

Detecting Data Inconsistency Failure of Composite Web Services through Parametric Stateful Aspect (ICWS2010-1009)
Guoquan Wu, Jian Wei, Chuyang Ye, Hua Zhong, Tao Huang (Academy of Sciences, China)

Runtime monitoring of Web service compositions with WS-BPEL has been widely acknowledged as a significant approach to understand and guarantee the quality of services. However, most existing monitoring technologies only track patterns related to the execution of an individual process. As a result, the possible inconsistency failure caused by implicit interactions among concurrent process instances cannot be detected. To address this issue, this paper proposes an approach to specify the behavior properties related to shared resources for web service compositions and verify their consistency with the aid of a parametric stateful aspect extension to WS-BPEL. Parameters are introduced in pattern specification, which allows monitoring not only events but also their values bound to the parameters at runtime to keep track of data flow among concurrent process instances. An efficient implementation is also provided to reduce the runtime overhead of monitoring and event observation. Our experiments show that the proposed approach is promising.

Research Track 4 – Runtime Services Evaluation (Session Chair: João Eduardo Ferreira, University of São Paulo, Brazil)

Automated Runtime Verification for Web Services (ICWS2010-1010)
Tien-Dung Cao, Trung-Tien Phan-Quang, Patrick Felix, and Richard Castanet (University of Bordeaux, France)
This paper presents a methodology to perform passive testing of behavioural conformance for the web services based on the security rule. The proposed methodology can be used either to check a trace (offline checking) or to runtime verification (online checking) with timing constraints, including future and past time. In order to perform this: firstly, we use the Nomad language to define the security rules. Secondly, we propose an algorithm that can check simultaneously multi instances. Afterwards, with each security rule, we propose a graphical statistics, with some fixed properties, that helps the tester to easily assess about the service. In addition to the theoretical framework we have developed a software tool, called RV4WS (Runtime Verification engine for Web Service), that helps in the automation of our passive testing approach. In particular the algorithm presented in this paper is fully implemented in the tool. We also present a mechanism to collect the observable trace in this paper.

**Distributed QoS Evaluation for Real-World Web Services** (ICWS2010-1011)
Zhibin Zheng, Yilei Zhang, Michael R. Lyu (The Chinese University of Hong Kong, China)
Quality-of-Service (QoS) is widely employed for describing non-functional characteristics of Web services. Although QoS of Web services has been investigated in a lot of previous works, there is a lack of real-world Web service QoS datasets for validating new QoS-based techniques and models of Web services. To study the performance of real-world Web services as well as provide reusable research datasets for promoting the research of QoS-driven Web services, we conduct several large-scale evaluations on real-world Web services. Firstly, addresses of 21,358 Web services are obtained from the Internet. Then, invocation failure probability performance of 150 Web services is assessed by 100 distributed service users. After that, response time and throughput performance of 5,825 Web services are evaluated by 339 distributed service users. Detailed experimental results are presented in this paper and comprehensive Web service QoS datasets are publicly released for future research.

**WSExpress: A QoS-Aware Search Engine for Web Services** (ICWS2010-1012)
Yilei Zhang, Zhibin Zheng, Michael R. Lyu (The Chinese University of Hong Kong, China)
Web services are becoming prevalent nowadays. Finding desired Web services is becoming an emergent and challenging research problem. In this paper, we present WSExpress (Web Service Express), a novel Web service search engine to expressively find expected Web services. WSExpress ranks the publicly available Web services not only by functional similarities to users’ queries, but also by nonfunctional QoS characteristics of Web services. WSExpress provides three searching styles, which can adapt to the scenario of finding an appropriate Web service and the scenario of automatically replacing a failed Web service with a suitable one. WSExpress is implemented by Java language and large-scale experiments employing real-world Web services are conducted. Totally, 3,738 Web services (15,811 operations) from 69 countries are involved in our experiments. The experimental results show that our search engine can find Web services with the desired functional and non-functional requirements. Extensive experimental studies are also conducted on a well known benchmark dataset consisting of 1,000 Web service operations to show the recall and precision performance of our search engine.

**Research Track 5 – QoS-aware Services Orchestration** (Session Chair: Jia Zhang, Northern Illinois University, USA)

**Variability Modeling and QoS Analysis of Web Services Orchestrations** (ICWS2010-1013)
Ajay Kattepur, Sagar Sen, Benoît Baudry, Albert Benveniste, and Claude Jard (Campus Universitaire de Beaulieu; Université e Européenne de Bretagne, France)
The ever-growing choice in diverse services is making service orchestration variability an essential aspect of a composite web service. Influence of this variation on the Quality of Service (QoS) of a composite service is critical and the focus of our work. In this paper, we present a methodology to first model orchestration variability using a feature diagram (FD). The FD specifies a product line of orchestrations represented as configurations of invoked/rejected atomic services. Second, due to the potentially large set of configurations we employ combinatorial testing techniques to automatically generate configurations covering all valid pairwise interactions between services. Third, we analyze QoS variation for each configuration using probabilistic models of QoS. Using a crisis management system case study we experimentally show that pairwise generation covers all QoS outliers and eliminates analysis of > 75% of all possible configurations. The QoS analysis of the pairwise configurations reveals unsafe/ineffective configurations, helps determine realistic Service Level Agreements (SLAs), and provides valuable feedback to help remodel an orchestration.

**Towards Data-Aware QoS-driven Adaptation for Service Orchestrations** (ICWS2010-1014)
Dragan Ivanovic, Manuel Carro, and Manuel Hermenegildo (Universidad Politecnica de Madrid (UPM)/Madrid; UPM/Fund IMDEA Software/Madrid, Spain)
Several activities in service oriented computing can benefit from the knowledge of properties of a given service composition ahead of time. We will focus here on properties related to computational cost and resource usage, in a wide sense, which can be linked to QoS characteristics. In order to attain more accuracy, we formulate computational cost resource usage as functions on input data (or appropriate abstractions thereof) and show how these functions can be used to make more informed decisions when performing composition, proactive adaptation, and predictive monitoring. We present an approach to, on one hand, automatically synthesize these functions from orchestrations and, on the other hand, to effectively use them to increase the quality of nontrivial service-based systems with data-dependent behavior. We validate our approach by means of simulations with runtime selection of services and adaptation due to service failure.

**Web Services Selection in Support of Reliable Web Service Choreography** (ICWS2010-1015)
Sun-Yih Hwang, Wen-Po Liao, and Chien-Hsiang Lee (National Sun Yat-Sen University)
There are two approaches to specifying the composition of Web services: orchestration and choreography. Previous works in Web services selection are mostly based on the orchestration model which focuses on the interactions with a single party. However, in many application scenarios, business goals are achieved by a number of pair-wise interactions among a set of Web services, and there does not exist a single entity that is in charge of selecting Web services for all tasks. Each Web service will autonomously perform Web services selection. In such a choreographic environment, we study the kind of information that each Web service should provide to its partner Web services and how each Web service should perform Web service selection so as to maximize the chance of successfully accomplishing a business goal. The proposed approach is evaluated by simulation, and the experimental results show that our proposed method is close to centralized method and better than the other two distributed Web services selection methods.

**Research Track 6 – Services Composition Management** (Session Chair: Manuel Carro, Technical University of Madrid, Spain)

**Highly Scalable Web Service Composition using Binary Tree-based Parallelization** (ICWS2010-1016)
Data intensive applications, e.g. in life sciences, pose new efficiency challenges to the service composition problem. Since today computing power is mainly increased by multiplication of CPU cores, algorithms have to be redesigned to benefit from this evolution. In this paper we present a framework for parallelizing service composition algorithms investigating how to partition the composition problem into multiple parallel threads. But in contrast to intuition, the straightforward parallelization techniques do not lead to superior performance as our baseline evaluation reveals. To harness the full power of multi-core architectures, we propose two novel approaches to evenly distribute the workload in a sophisticated fashion. In fact, our extensive experiments on practical life science data resulted in an impressive speedup of over 300% using only 4 cores. Moreover, we show that our techniques can also benefit from all advanced pruning heuristics used in sequential algorithms.

**Formal Specification and Verification of Data-Centric Service Composition (ICWS2010-1017)**  
Iman Saleh, Gregory Kiczynski, M. Brian Blake (Virginia Polytechnic Institute and State University; University of Notre Dame, USA)

Service-oriented architecture (SOA) promotes a paradigm where ad-hoc applications are built by dynamically linking service-based software capabilities. Service providers follow specification standards to advertise their services’ capabilities and to enable loosely coupled integration between their services and other businesses over the Web. A major challenge in this domain is interpreting the data that must be marshaled between consumer and producer systems. We propose a framework to support formal modeling and contracts for data-centric Web services. We demonstrate how this framework can be used to verify correctness properties for composition of services.

**Decentralized Approach for Execution of Composite Web Services Using the Chemical Paradigm (ICWS2010-1018)**  
Héctor Fernández, Thierry Priol, and Cédric Tedeschi (Campus Universitaire de Beaulieu, France)

Nowadays, executions of composite Web services are typically conducted by heavyweight centralized engines. A centralized is a potential processing and communication bottleneck as well as a central point of failure, and its cost of deployment is usually too high for a large number of small businesses or end-users. In addition, it presents some weaknesses dealing with privacy issues. These drawbacks, and requirements such as loose coupling, are pushing service infrastructures toward more decentralized and dynamic interaction schemes. In this paper, we propose a decentralized alternative system for the execution of Web Services based on the chemical analogy. The chemical paradigm provides a high-level execution model that allows executing composite services in a fully decentralized manner. Our architecture is composed by nodes communicating through a shared space containing both control and data flows, allowing to distribute the composition among nodes without the need for any centralized coordination.

**Research Track 7 – Web Services Discovery**  
(Session Chair: Martin Necasky, Charles University in Prague, Czech Republic)

**Clustering WSDL Documents to Bootstrap the Discovery of Web Services (ICWS2010-1019)**  
Khalid Elgazzar, Ahmed E. Hassan, and Patrick Martin (Queen’s University, Canada)

The increasing use of the Web for everyday tasks is making Web services an essential part of the Internet customer’s daily life. Users query the Internet for a required Web service and get back a set of Web services that may or may not satisfy their request. To get the most relevant Web services that fulfill the user’s request, the user has to construct the request using the keywords that best describe the user’s objective and match correctly with the Web Service name or location. Clustering Web services based on function similarities would greatly boost the ability of Web services search engines to retrieve the most relevant Web services. This paper proposes a novel technique to mine Web Service Description Language (WSDL) documents and cluster them into functionally similar Web service groups. The application of our approach to real Web services description files has shown good performance for clustering Web services based on function similarity, as a predecessor step to retrieving the relevant Web services for a user request by search engines.

**Measuring Similarity of Web Services Based on WSDL (ICWS2010-1020)**  
Fangfang Liu, Xuliang Shi, Jie Yu, Tianhong Wang, and Jingzhe Wu (Shanghai University; Shandong University, China)

Web service has already been an important paradigm for web applications. Growing number of services need efficiently locating the desired web services. The similarity metric of web services plays an important role in service search and classification. The very small text fragments in WSDL of web services are unsuitable for applying the traditional IR techniques. We describe our approach which supports the similarity search and classification of service operations. The approach firstly employs the external knowledge to compute the semantic distance of terms from two compared services. The similarity of services is measured upon these distances. Previous researches treat terms within the same WSDL documents as the isolated words and neglect the semantic association among them, hence lower down the accuracy of the similarity metric. We provide our method which tries to reflect the underlying semantics of web services by utilizing the terms within WSDL fully. The experiments show that our method works well on both service classification and query.

**An Approach for Context-Aware Service Discovery and Recommendation (ICWS2010-1021)**  
Hua Xiao, Ying Zou, Joanne Ng, and Leho Nigul (Queen’s University, Canada)

Given the large amount of existing services and the diversified needs nowadays, it is time-consuming for end-users to find appropriate services. To help end-users obtain their desired services, context-aware systems provide a promising way to automatically search and recommend services using a user’s context. However, existing context-aware techniques have limited support for dynamic adaption to newly added context types (e.g., location, time and activity). Due to the diversity of user’s environment, the available context types may change over time. It is challenging to anticipate a complete set of context types while we design a context aware system. In this paper, we propose a context modeling approach which can dynamically handle various context types and values. More specifically, we use ontologies to enhance the meaning of a user’s context values and automatically indentify the relations among different context values. Based on these relations among context values, we capture the potential services which the user might need. A case study is conducted to evaluate the effectiveness of our approach. The results show that our approach can use contexts to find users’ needs and recommend their desired services with high precision and recall.

**Research Track 8 – Services Scalability**  
(Session Chair: Guido Wirtz, Bamberg University, Germany)

**Enhancing Scalability and Performance of Mashups through Merging and Operator Reordering (ICWS2010-1022)**  
Osama Al-Haj Hassan, Lakshmin Rameswamy, and John A. Miller (University of Georgia, USA)

Recently, mashups are gaining tremendous popularity as an important Web 2.0 application. Mashups provide end-users with an opportunity to create personalized Web services which aggregate and manipulate data from multiple diverse sources distributed across the Web. However, this increase in personalization also results in new scalability and performance challenges. Surprisingly, there are very few studies on the performance
aspect of mashups. In this paper, we propose two novel techniques to enhance the scalability and performance of mashup platforms. The first is an efficient mashup merging scheme that avoids duplicate computations and unnecessary data retrievals by detecting common operator sequences in different mashups and executing them together. Second, we propose a canonical form-based mashup reordering scheme that not only transforms individual mashups to their most efficient forms but also increases the effectiveness of mashup merging. This paper also reports a number of experiments studying the benefits and costs of the proposed techniques.

Scalable and Reliable IPTV Service through Collaborative Request Dispatching (ICWS2010-1023)
Shicong Meng, Ling Liu, and Jianwei Yin (Georgia Institute of Technology, USA; Zhejiang University, China)
IPTV has emerged as the future standard of television and drawn enormous attention from both industry and research communities. Among different IPTV services, on-demand services are the most popular ones due to their convenience and rich content. However, supporting scalable and reliable on-demand IPTV services remains to be an important challenge. Existing IPTV architecture dedicates a centralized regional station to serve subscribers in the respective region regardless of temporal and spatial dynamics in service demand. As a result, it may cause significant imbalance of resource utilization and service provisioning delay at different stations, especially with increasing subscribers and video content. In this paper, we propose to allow IPTV stations of different regions to collaboratively serve user requests for delivering scalable and reliable IPTV services. One key challenge in achieving this station-wise collaboration is to route service requests to appropriate stations according to cost-effectiveness and load distribution in a fully distributed manner. We devise a novel request dispatching protocol which runs on each IPTV station, and yet forms a collaborative dispatching strategy that avoids hot spots and reduces service delivery cost at the same time. Our experiment results suggest that our service request dispatching algorithm significantly improves the scalability of on-demand IPTV services for the existing IPTV architecture.

EDS: An Elastic Data-Service for Situational Applications (ICWS2010-1024)
Avraham Jeff, James Rayfield (IBM T.J. Watson Research Center, USA)
Developers of situational applications—applications created by a small group of users/developers to satisfy the specific needs of the group—require two things from their software stack. First, they require support for their rapidly changing designs; second, they require semantics that are close to their domain of expertise. For example, developers of situational applications prefer to use scripting languages because the “duck typing” style of programming language allows them to ignore issues related to class inheritance or interface implementation. In comparison to strongly-typed languages, developers can begin programming more quickly, and can modify their program more rapidly in response to changing requirements. In this paper we explore whether middleware services can similarly provide developers of situational applications with these desired software characteristics. Specifically, we present EDS, an Extensible Data-Service designed to support applications whose design changes rapidly and with semantics that are closer to the domain expertise of situational application developers. We present the features of EDS, contrast it to other data services and APIs, and discuss the EDS implementation.

Research Track 9 – Services Testing (Session Chair: Jinping Wei, Florida International University, USA)
Script-Based Generation of Dynamic Testbeds for SOA (ICWS2010-1025)
Lukasz Jazczuk, Schahram Dustdar (Vienna University of Technology, Austria)
This paper addresses one of the major problems of SOA software development: the lack of support for testing complex service-oriented systems. The research community has developed various means for checking individual Web services but has not come up with satisfactory solutions for testing systems that operate in service-based environments and, therefore, need realistic testbeds for evaluating their quality. We regard this as an unnecessary burden for SOA engineers. As a proposed solution for this issue, we present the Genesis2 testbed generator framework. Genesis2 supports engineers in modeling testbeds and programming their behavior. Out of these models it generates running instances of Web services, clients, registries, and other entities in order to emulate realistic SOA environments. By generating real testbeds, our approach assists engineers in testing systems that operate in service-based environments and, therefore, need realistic testbeds for evaluating their quality.

Benchmarking Vulnerability Detection Tools for Web Services (ICWS2010-1026)
Nuno Antunes, Marco Vieira (University of Coimbra – Portugal)
Vulnerability detection tools are frequently considered the silver-bullet for detecting vulnerabilities in web services. However, research shows that the effectiveness of most of those tools is very low and that using the wrong tool may lead to the deployment of services with undetected vulnerabilities. In this paper we propose a benchmarking approach to assess and compare the effectiveness of vulnerability detection tools in web services environments. This approach was used to define a concrete benchmark for SQL Injection vulnerability detection tools. This benchmark is demonstrated by a real example of benchmarking several widely used tools, including four penetration-testers, three static code analyzers, and one anomaly detector. Results show that the benchmark accurately portrays the effectiveness of vulnerability detection tools and suggest that the proposed approach can be applied in the field.

Taking Advantage of Service Selection: A Study on the Testing of Location-Based Web Services through Test Case Prioritization (ICWS2010-1027)
Ke Zhai, Bo Jiang, W.K. Chan, T.H. Tse (The University of Hong Kong)
Dynamic service compositions pose new verification and validation challenges such as uncertainty in service membership. Moreover, applying an entire test suite to loosely coupled services one after another in the same composition can be too rigid and restrictive. In this paper, we investigate the impact of service selection on service-centric testing techniques. Specifically, we propose to incorporate service selection in executing a test suite and develop a suite of metrics and test case prioritization techniques for the testing of location-aware services. A case study shows that a test case prioritization technique that incorporates service selection can outperform their traditional counterpart — the impact of service selection is noticeable on software engineering techniques in general and on test case prioritization techniques in particular. Furthermore, we find that points-of-interest-aware techniques can be significantly more effective than input-guided techniques in terms of the number of invocations required to expose the first failure of a service composition.

Research Track 10 – Business Process Monitoring and Modeling (Session Chair: Christopher P. Fowler, Queen's University Belfast, UK)
Context-awareness and adaptability are important and desirable properties of service-based processes designed to provide personalized services. Most of the existing approaches focus on the adaptation at the process instance level [1] which involves extending the standard Business Process Execution Language (BPEL) and its engine or creating their own process languages (e.g. [2]). However, the approach proposed here aims to apply an adaptation to processes modeled or developed without any adaptation possibility in mind and independently of specific usage contexts. In addition, most of the existing approaches tackle the adaptation on the process instance or definition levels by explicitly specifying some form of variation points. This, however, leads to a contradiction between how the architect logically views and interprets differences in the process family and the actual modeling constructs through which the logical differences must be expressed. We introduce the notion of an evolution fragment and evolution primitive to capture the variability in a more logical and independent way. Finally, the proposed approach intends to support the viewpoint of context-aware adaptation as a crosscutting concern with respect to the core “business logic” of the process. In this way, the design of the process core can be decoupled from the design of the adaptation logic. To this end, we leverage ideas from the domain of model-driven development (MDD) and generative programming.

**QoS-based Late-Binding of Service Invocations in Adaptive Business Processes** *(ICWS2010-1029)*  
Pierre Châtel, Jacques Malenfant, and Isis Truck (Thales Communications; Université Pierre et Marie Curie/LIP6; Université Paris 8/LIASC)  
Computing has reached the time of distributed applications everywhere. Service-oriented architectures are more and more used to organize such complex and highly dynamic applications into business processes calling services discovered in registries at load-time. In this context, Quality of Service (QoS) and agility in business processes become key issues. Instead of binding business processes to services at load-time, this paper presents a caching architecture for web services and an adaptive pre-fetching algorithm. The key characteristics of our approach are the compatibility with major mobile browsers and the independence of the caching proxy from the frontend application and the back-end services. We evaluate our approach on realistic traces of web service calls in an IT service management scenario. The traces were generated from handling real incidents according to the ITIL (ISO 20000) processes. The results confirm that using our approach, the latency perceived by the user is reduced by 24%.

**Reducing User Perceived Latency in Mobile Processes** *(ICWS2010-1030)*  
Daniel Schreiber, Erwin Aitenbichler, Andreas Goeb, and Max Mühlhäuser (TU Darmstadt; SAPResearch, Germany)  
Employees are increasingly participating in business processes using mobile devices. Often, this is supported by a mobile web application, which accesses various web services in the back-end. The high latency of the mobile network (e.g., EDGE) is perceived by the user each time a web service is called, in addition to the time needed to invoke the service itself. This high latency may lead to low usability, low acceptance rate, and finally compromises the overall process quality. To reduce the latency perceived by the user, we present a caching architecture for web services and an adaptive pre-fetching algorithm. The key characteristics of our approach are the compatibility with major mobile browsers and the independence of the caching proxy from the frontend application and the back-end services. We evaluate our approach on realistic traces of web service calls in an IT service management scenario. The traces were generated from handling real incidents according to the ITIL (ISO 20000) processes. The results confirm that using our approach, the latency perceived by the user is reduced by 24%.

**Research Track 11 – Service Security and Trust** *(Session Chair: Yuhong Yan, Concordia University, Canada)*

**A Pattern-Driven Generation of Security Policies for Service-Oriented Architectures** *(ICWS2010-1031)*  
Michael Menzel, Robert Warschofsky, and Christoph Meinel (Hasso-Plattner-Institute, Germany)  
Service-oriented Architectures support the provision, discovery, and usage of services in different application contexts. The Web Service specifications provide a technical foundation to implement this paradigm. Moreover, mechanisms are provided to face the new security challenges raised by SOA. To enable the seamless usage of services, security requirements can be expressed as security policies (e.g. WS-Policy and WS-SecurityPolicy) that enable the negotiation of these requirements between clients and services. However, the condition of security policies is a difficult and error-prone task due to the complexity of the Web Service specifications. In this paper, we introduce our model-driven approach that facilitates the transformation of architecture models annotated with simple security intentions to security policies. This transformation is driven by security configuration patterns that provide expert knowledge on Web Service security. Therefore, we will introduce a formalized pattern structure and a domain-specific language to specify these patterns.

**A Trust and Reputation Model Based on Bayesian Network for Web Services** *(ICWS2010-1032)*  
Hien Trang Nguyen, Weiliang Zhao, and Jian Yang (Macquarie University, Sydney, Australia)  
Trust and reputation for web services emerges as an important research issue in web service selection. Current web service trust models either do not integrate different important sources of trust (subjective and objective for example) or do not focus on satisfying different user’s requirements about different quality of service (QoS) attributes such as performance, availability etc. In this paper, we propose a Bayesian network trust and reputation model for web services that can overcome such limitations by considering several factors when assessing web services’ trust: direct opinion from the trusting user, user rating (subjective view) and QoS monitoring information (objective view). Our comprehensive approach also addresses the problems of users’ preferences and multiple QoS-based trust by specifying different conditions for the Bayesian network and targets at building a reasonable credibility model for the raters of web services.

**Message Correlation and Web Service Protocol Mining from Inaccurate Logs** *(ICWS2010-1033)*  
Kreshnik Musa, Tetsuya Yoshida, Florian Daniel, Mohand-Said Hadid, Fabio Casati, and Boualem Benatallah (Universite de Lyon, Villeurbanne, France; Hokkaido University, Japan; University of Trento, Trento, Italy; University of New South Wales, Sydney, Australia)  
Business process management, service-oriented architectures and software back-engineering heavily rely on the fundamental processes of mining of processes and web service business protocols from log files. Model extraction and mining aim at the (re)discovery of the behavior of a running model implementation using solely its interaction and activity traces, and no a priori information on the target model. This paper presents an approach for correlating messages and extracting the business protocol of a web service in the realistic scenario in which correlation information is entirely absent from interaction and activity logs. Correlation is achieved through deterministic computations that result in an extremely efficient method whose extensive experiments have shown its solid reliability, robustness when dealing with complex structures, and very high performance and scalability. This approach and the underlying algorithms extend what is actually possible to achieve in the web service business...
protocol mining domain using incomplete and noisy data logs, and opens new horizons in back-engineering of web services. The theoretical and experimental results clearly show the leap forward achieved herein.

**Research Track 12 – Services Adaptation** (Session Chair: Luís Ferreira Pires, University of Twente, the Netherlands)

**Semantic Support for Adaptive Long Term Composed Services** (ICWS2010-1034)

Vikram Chauhan, Manoj Rege, Athman Bouguettaya (Rochester Institute of Technology, USA)

We propose an integrated framework that manages changes in long term composed services. The main problem of change reaction is presented. One of the most challenging research issues of change management is how to automate the process of change reaction. To address this issue, we propose a semantic support, which centers around a tree-structured Web service ontology. The ontology is expected to provide sufficient semantic for change reaction. We propose a set of algorithms for efficiently querying semantics from the ontology. We conduct a set of experiments to evaluate the performance of the proposed algorithms.

**From Specification to Adaptation: An Integrated QoS-driven Approach for Dynamic Adaptation of Web Service Compositions** (ICWS2010-1035)

Vikas Agarwall and Pankaj Jalote (IBM Research – India; Indraprastha Institute of Information Technology, India)

Web services composition environment is highly dynamic with new services being deployed, existing ones becoming unavailable or their QoS and other non-functional properties (cost, availability, etc.) changing dynamically. However, current approaches for web services composition and execution, such as WS-BPEL, can neither tailor the execution automatically as per the required QoS nor can they adapt to the highly dynamic environment. Though there have been some recent efforts in this direction they are piecemeal and insufficient. They either do not take user’s non-functional requirements (NFRs) into consideration for adaptation, or there is no standard way of specifying these requirements for a BPEL process. In this paper, we propose an integrated approach for dynamically adapting web service compositions based on NFRs. We will give a specification for representing NFRs for each partner service of a BPEL process, and then describe a system that dynamically adapts the BPEL process based on these requirements by selecting suitable services at runtime. The selected services only need to be semantically equivalent and the system automatically takes care of the syntactical differences between their interfaces. We integrated our system in an existing BPEL engine using aspect oriented approach and demonstrate via experiments that it has very little performance overhead even at high loads.

**On Service Community Learning: A Co-clustering Approach** (ICWS2010-1036)

Qi Yu, Manoj Rege (Rochester Institute of Technology, USA)

Efficient and accurate discovery of user desired Web services is a key component for achieving the full potential of service computing. However, service discovery is a non-trivial task considering the large and fast growing service space. Meanwhile, Web services are typically autonomous and a priori unknown. This further complicates the service discovery problem. We propose a service community learning algorithm that can generate homogeneous communities from the heterogeneous service space. This can greatly facilitate the service discovery process as the users only need to search within their desired service communities. A key ingredient of the community learning algorithms is a co-clustering scheme that leverages the duality relationship between services and operations. Experimental results on both synthetic and real Web services demonstrate the effectiveness of the proposed service community learning algorithm.

**Research Track 13 – Services Modeling** (Session Chair: Janaka Balasooriya, Arizona State University, USA)

**Document based modeling of Web services choreographies using Active XML** (ICWS2010-1037)

Loïc Hélouët and Albert Benveniste(INRIA-Rennes, France)

This paper proposes a document based framework for the modeling of web-based choreographies involving a tight combination of workflow and data management. Our starting point is Active XML proposed by S. Abiteboul — AXML documents are XML documents with embedded service calls. We enhance Active XML with a rich notion of interface and we propose an effective technique to decide if provided services and needs of callers (defined as interfaces) are compatible. We also explicitly take distribution into account and allow for the composition of distributed AXML systems.

**From Representational State Transfer to Accountable State Transfer** (ICWS2010-1038)

Joe Zou, Jing Mei, and Yan Wang(IBM Australia Macquarie University; IBM Research, China; Macquarie University, Australia)

Since Representational State Transfer (REST) architecture was proposed by Fielding in early 1990s for distributed hypermedia systems, it has become a popular architectural style of choice in various computing environments. However, REST was not originally designed to support enterprise requirements, in particular the accountability requirements that are crucial for the business services offered through the Software as a Service (SaaS) and Cloud Computing environments. In this paper, we propose an Accountable State Transfer (AST) architecture to bridge the accountability gap in REST. With AST, service participants can be held accountable for each representational state transfer during service consumption. A formal service contract model with a hybrid reasoning mechanism and a novel accountable state transfer protocol are designed as the mechanisms underpinning the AST architecture. Moreover, we implement a Credit Check service prototype based on AST, demonstrating the practicality of such architecture. Inheriting REST’s scalability, AST architecture provides the much needed accountability capabilities for the virtual service delivery environment.

**Semi-automatic Integration of Web Service Interfaces** (ICWS2010-1039)

Jakub Klínek and Martin Vecask(Charles University, Prague)

Modern information systems may exploit numerous web services for communication. Each web service may exploit its own XML format for data representation which causes problems with their integration and evolution. Manual integration and management of evolution of the XML formats may be very hard. In this paper, we present a novel method which exploits a conceptual diagram. We introduce an algorithm which helps a domain expert to map the XML formats to the conceptual diagram. It measures similarities between the XML formats and the diagram and adjusts them on the base of the input from the expert. The result is a precise mapping. The diagram then integrates the XML formats and facilitates their evolution - a change can be made only once in the diagram and propagated to the XML formats.
Adaptive Goals for Self-Adaptive Service Compositions

Mohamad EL Falou, Maroua Bouzid, Abdel-Illah Mouaddib, Thierry Vidal (University of Caen, Basse-Normandie; Ecole Nationale d’Ingénieurs de Tarbes)

The ability to automatically answer a request that requires the composition of a set of web services has received much interest in the last decade, as it supports B2B applications. Planning techniques are used widely in the literature to describe the web services composition problem but they don’t scale up well. This weakness is due to the search space explosion caused by the large ranges of data exchanged among services. In addition, it is more interesting to use a decentralised planner because the nature of the problem is distributed. In this paper, we consider a set of web service agents where each agent has a set of services organized in a graph. To respond to a request, agents propose their best local partial plans which are partial paths in the graph. They then coordinate their partial plans to provide the global plan for the submitted request using an algorithm based on a distributed heuristic function. This function ensures the optimality and the completeness of the algorithm. Indeed, it is based not only on the agent capabilities to respond to a request, but also taking into account the plans proposed by other agents. The complexity of the algorithm is polynomial. The experiments show the ability of our approach to find the optimal solutions for automated web services composition taking into account the dependencies between the agents.

QoS Aware Semantic Web Service Composition Approach Considering Pre/Postconditions

Peter Bartalos and Mariá Bieliková (Slovak University of Technology in Bratislava)

Web service composition is a topic bringing several issues to be resolved. Our work deals with the effectiveness and scalability of service composition. During composition we consider QoS and pre-/post-conditions of single services to create a composite service satisfying the user needs the best. Regarding pre-/post-conditions we propose an approach to fast determination of which services produce results expected by the user, i.e. the post-condition of which services implicates the desired condition defined in the user goal. This paper proposes also an approach to restriction on the service space which provided a dramatic improvement in terms of composition time.

Adaptive Goals for Self-Adaptive Service Compositions

Luciano Baresi and Liliana Pasquale (DEI - Dipartimento di Elettronica e Informazione, Italy)

Service compositions need to continuously self-adapt to cope with unexpected failures. In this context adaptation becomes a fundamental requirement that must be elicited along with the other functional and non functional requirements. Beside modelling, effective adaptation also demands means to trigger it at runtime as soon as the actual behavior of the composition deviates from stated requirements. This paper extends traditional goal models with adaptive goals to support continuous adaptation. Goals become live, runtime entities whose satisfaction level is dynamically updated. Furthermore, boundary infringement triggers adaptation capabilities. The paper also provides a methodology to trace goals onto the underlying composition, assess goals satisfaction at runtime, and activate adaptation consequently. All the key elements are demonstrated on the definition of the process to control an advanced washing machine.

Towards a Formal Verification Approach for Business Process Coordination

Min Yuan, Zhiqiu Huang, Xiang Li, and Yan Yan (Nanjing University of Aeronautics and Astronautics, China)
BPEL (Business Process Execution Language) enacts a process-oriented web service orchestration, and multi-business processes can be regarded as BPEL composition. A business process can be regarded as a complex set of interactions among Web services to achieve a defined goal. The achievement of distributed agreement among multiple-participant services is an orthogonal problem outside the scope of BPEL, so the rationality for distributed coordination of multi-business processes is an urgent issue to study. The definition of the message exchanges that take place between the process and each one of its partners lack the precise definition which is required for performing a formal analysis and reasoning. An integrated approach supporting a formal verification of multi-business interactions is proposed. This paper first examines a rigorous approach for the formalization of the execution semantics of business process in the Pi-calculus. Then transforms the Pi-calculus expressions into equivalent SMV code and verifies the system whether a process satisfies given properties automatically using the NuSMV model checker, and the approach is illustrated using a concrete case study subsequently. The approach supports creating robust multi-business processes which are distributed or span multiple vendors and platforms.

Monitoring, Prediction and Prevention of SLA Violations in Composite Services (ICWS2010-1047)
Philipp Leitner, Anton Michlmayr, Florian Rosenberg, and Schahram Dustdar (Vienna University of Technology; CSIRO ICT Centre)

We propose the PREvent framework, which is a system that integrates event-based monitoring, prediction, detection of SLA violations using machine learning techniques, and automated runtime prevention of those violations by triggering adaptation actions in service compositions. PREvent improves on related work in that it can be used to prevent violations ex ante, before they have negatively impacted the provider’s SLAs. We explain PREvent in detail and show the impact on SLA violations based on a case study.

WebMov: A Dedicated Framework for the Modelling and Testing of Web Services Composition (ICWS2010-1048)
Ana Cavalli, Tien-Dung Cao, Wissam Mallouli, Eliane Martins, Andrey Sadovykh, Sebastien Salva, and Fatih Zaidi (TELECOM SudParis, France; Univ. of Bordeaux; SOFTEAM; Univ. d’Auvergne; France)

This paper presents a methodology and a set of tools for the modelling, validation and testing of Web service composition, conceived and developed within the French national project WebMov. This methodology includes several modelling techniques, based mainly on some variations of Timed Extended Finite State Machines (TEFSM) formalism, which provide a formal model of the BPEL description of Web services composition. These models are used as a reference for the application of different test generation and passive testing techniques for conformance and robustness checking. The whole WebMov methodology is integrated within a dedicated framework, composed by a set of tools that implement the model representation, the test generation and passive testing algorithms. This framework also permits the interaction of these tools to achieve specific modelling and testing activities in a complementary way. A case study based on a real service, a Travel Reservation Web Service, is presented as well as the results of the application of the proposed WebMov methodology and tools.

Application and Industry Session 4 – Services Adaptation (Session Chair: Xiaodong Liu, Edinburgh Napier University, UK)

Towards Integrated Service Adaptation—A New Approach Combining Message and Control Flow Adaptation (ICWS2010-1049)
Zhe Shan, Akhil Kumar, and Paul Grefen (Penn State University, USA; Eindhoven University, Netherlands)

Current approaches for service adaptation focus on either the message interface aspect or the control flow interface aspect separately. Our work recognizes that message adaptation may affect control flow adaptation and vice versa in complex ways. Hence an integrated approach is necessary. We propose a framework for integration and identify a set of extendible message adaptation patterns to solve typical message mismatches. In addition we give an algorithm for generating new message adapter on the fly so as to integrate control flow considerations into message adaptation. Finally we show how these individual patterns can be combined by another algorithm to create a complete adapter for two processes. The advantages of our method are illustrated with a case study. We present the design of a prototype and show XSLT code for implementing the message transformation.

A Feature-Oriented Approach for Web Service Customization (ICWS2010-1050)
Tuan Nguyen and Alan Colman (Swinburne University, Australia)

This paper proposes a feature-oriented approach for Web services customization that can address three key challenges: reducing complexity, automated validation and dynamic deployment. We exploit techniques from Software Product Line (SPL) domain, particularly feature modeling techniques, to design our framework. Feature modeling allows to abstract variability in consumers’ requirements to simplify customization processes, while automated analysis on feature models helps to validate customizations. The use of feature models at runtime enables dynamic deployment of a business process as a result of a service customization. We propose the use of feature models as service description artifacts to facilitate service customizations. The framework builds on a Model-Driven Development (MDD) approach to automate large parts of its operation.

A MVC Framework for Policy-Based Adaptation of Workflow Processes: A Case Study on Confidentiality (ICWS2010-1051)
Kristof Geebelen, Eryk Kułkowski, Eddy Truyen, and Wouter Joosen (IBBT-DistriNet, Belgium)

Most work on adaptive workflows offers insufficient flexibility to enforce complex policies regarding dynamic, evolvable and robust workflows. In addition, many proposed approaches require customized workflow engines. This paper presents a portable framework for realistic enforcement of dynamic adaptation policies in business processes. The framework is based on the Model-View-Controller (MVC) pattern, commonly used for adding dynamism to web pages. To enhance reusability, our approach supports separation of adaptation logic from the functional workflow and modularization of workflow tasks in reusable aspects. The main idea is to design a workflow process as a template, where tasks can be specified on an abstract level. Concrete implementations of the tasks, modeled as aspects, are then selected from a library according to a policy-based adaptation logic. This logic is implemented using a general purpose language that offers an extensible and flexible solution to enforce any type of policy. We evaluate by means of a case study on workflow confidentiality to what extent an approach using standards-based technologies allows application-specific adaptation of running workflow instances.

Application and Industry Session 5 – Services Replacement (Session Chair: Rama Akkiraju, IBM Research, USA)

Checking Compatibility and Replaceability in Web Services Business Protocols with Access Control (ICWS2010-1052)
Emaid Elabd, Emmanuel Coquery, and Mohand-Said Hacid (Université de Lyon Université Claude Bernard, France)
Recently, most enterprises adapt Web services technologies for designing and building complex inter-enterprise business applications. These applications are built by the coordination between set of Web services. Therefore, checking the compatibility between two services to guarantee that they can interact correctly is an important issue. In case of service update or replacement, there is a need for checking the replaceability to ensure that the new service is compatible with all the services which were compatible with the replaced one. These two type of checking are based on the services descriptions. Enriching services descriptions by including their behaviours is becoming more and more important. This behaviour can be described by business protocols representing the possible sequences of message exchanges. Since a lot of Web services use access control policies to restrict the access to authorized consumers, these policies should be a part of the service description. Checking compatibility and replaceability between Web services by analyzing their business protocols after assigning the access control policies is the main contribution of this work. Access control policies will be presented using ontology.

Generating Minimal Protocol Adaptors for Loosely Coupled Services (ICWS2010-1053) 
R. Seguel, R. Eshuis, and P. Grefen(Eindhoven University, Netherlands)
In dynamic e-business, organizations collaborate in a just-in-time fashion using loosely coupled services. To ensure interoperability of the services, behavioral mismatches between their protocols need to be resolved in a fast and efficient way, which can be done with protocol adaptors. We present an efficient, automated method to construct (if possible) a minimal protocol adaptor with parallelism for two asynchronously communicating business protocols. A minimal adaptor only processes those messages that cause the mismatch, and has less message overhead at run-time than a nonminimal adaptor. Existing methods only build adaptors that are sequential, synchronous, or non-minimal. We show that the proposed method increases the efficiency of service adaption both at run-time and design-time.

An Effective Heuristic for On-line Tenant Placement Problem in SaaS (ICWS2010-1054) 
Yi Zhang, Zhihu Wang, Bo Gao, Changjie Guo, Wei Sun, and Xiaoping Li(Southeast University; IBM Research,China;Ministry of Education)
As one of the key characteristics of Software as a Service (SaaS), multi-tenancy aims to support massive customers by sharing application instances and databases. To achieve the high economies of scale, one of the most issues needing to be solved in the real industry is that, given a fixed number of nodes, how to optimally place on-boarding tenants to maximize the total supported number of tenants without violating their SLA requirements. This paper focuses on this problem, which is called On-line Tenant Placement Problem (OTPP). In order to calculate the resource consumption of on-boarding tenants, a novel resource consumption estimation model for multi-tenant pattern is proposed in this paper. Based on this model, we explore the complexity of OTPP. A robust heuristic is proposed for the OTPP. The simulation experimental results show the high effectiveness and the good efficiency of our algorithm.

Application and Industry Session 6 – Services Analysis (Session Chair: Wenbing Zhao, Cleveland State University, USA)
Estimating the Cost of Developing Customizations to Packaged Application Software Using Service Oriented Architecture (ICWS2010-1055) 
Rama Akkiraju and Hendrik van Geel (IBM T.J. Watson Research Center; IBM Global Business Services,USA)
Service-oriented way of building customizations to packaged applications is an emerging alternative to the traditional way of modifying the package application directly to implement customizations. Estimating the effort at an early stage (before detailed design) in the services engagement is important to reduce the perceived risk of the new approach and to demonstrate the potential cost efficiencies. In this paper we present a method to estimate the effort and cost involved in developing customizations to packaged application software(such as SAP and Oracle ERP software) using service-oriented architecture/design (SOA) style. Taking only a description of business processes to be customized, we estimate the effort and costs of implementing those customizations. We use novel artifact-centric and linguistic analysis approaches to estimate the business object count which lies at the center of our cost estimation model. The model is currently being piloted at a large IT services organization involved in implementing packaged application software for clients. Initial experiments reveal that the cost and effort estimates are within 10% range of the benchmark estimates developed after requirements gathering and detailed design.

Analyzing Behavioral Substitution of Web Services Based on Pi-calculus (ICWS2010-1056) 
Li Kuang, Yingjie Xia, Shuiguang Deng, and Jian Wu (Hangzhou Normal University; Zhejiang University, China)
The behavioral analysis for Web services provides a priori detection of errors to ensure successful interactions in services invocation and composition, and the behavioral substitution of Web services is one of the most important issues in such analysis. In this paper, we propose to formalize the behavior of a Web service by π-calculus. Based on the formalization, we introduce two notions of behavioral substitution of Web services namely strong and weak simulation. Furthermore, we propose a derivative approach to analyzing the behavioral substitution of services according to the given notions, which is implemented based on an existing tool of π-calculus. The proposed approach takes advantage of formalization and theory of π-calculus, so that the formalized services can be naturally analyzed and the behavioral substitution of them can be easily determined.

Semantic Annotations for WS-Policy (ICWS2010-1057) 
Sebastian Speiser (Karlsruhe Service Research Institute, Germany)
WS-Policy is a standard to express requirements and capabilities in Web service systems. Policies are based on domain-specific assertions. In this paper we present a lightweight approach to semantic annotations of policy assertions. The approach allows matching of requirements and capabilities based not only on the syntactical representation of their corresponding assertions but also on their semantic meaning. Besides vocabulary mismatches our approach can also handle granularity mismatches, e.g. if two capabilities in combination satisfy a single requirement. We present a validation of our approach consisting of a performance evaluation and the realization of a use case, both based on our implementation of the semantic policy matching algorithm. We furthermore show the advantages of our approach compared to existing related work.

Performance Evaluation for SOAP and RFC in SAP Netweaver Platform (ICWS2010-1058) 
Zhibin Cao, Raghav Jandhyala, and Shiva Koduvayur (SAP Labs, USA)
SAP Netweaver Application Server (AS) provides two communication protocols to connect SAP ABAP (Advanced Business Application Programming) systems with external systems: Simple Object Access Protocol (SOAP) and Remote Function Call (RFC). RFC is the standard SAP interface for communication between SAP systems. SOAP is widely used in web service solutions for its nature cross-platform characteristic. It uses platform independent eXtensible Markup Language (XML) but it introduces more latency tags to represent the data. Thus, SOAP might
need more memory and transferring time. This paper studies and compares their performance characteristic with introducing an evaluation model and then evaluates them for different use cases. This work gives a practical conclusion for protocol selection in special case.

**Application and Industry Session 7 – Services Applications** (Session Chair: Luvai Motiwalla, University of Mass Lowell, USA)

**User Experience in Added Value Location-Based Mobile Music Service** (ICWS2010-1059)
Timo Koskela, Sari Jarvinen, Meirong Liu, and Mika Vlantisila(University of Oulu; VTT Technical Research Centre of Finland)

In this paper, the user experience in added value location-based mobile music service called the City Night Life (CNL) is evaluated and analyzed. The CNL service provides recommendations about entertainment premises in the proximity by matching their music styles with the user’s personal music preferences. Entertainment premises are shown on a map interface and are marked with colors according to their match. The paper presents the components of the CNL service, the music profile, matching algorithm and the map-based user interface in a web browser. The user evaluation with 53 test users assessed the feasibility and business potential of the CNL service. Data was collected with both quantitative questionnaires and short interviews. The results indicate that the CNL service will be most useful in relatively large, unfamiliar cities. Furthermore, the matching algorithm was perceived to perform quite well.

**Use Cases to Process Specifications in Business Process Modeling Notation** (ICWS2010-1060)
Avik Sinha and Amit Paradkar(IBM T J Watson Research Center, USA)

Use cases are a key technique to elicit software requirements from the point of view of the user of a system. Their prevalence is noticeable ever since the onset of agile programming techniques. Within SOA projects however, business process models are used for capability analysis and gap detection. Business process models present a global view of the system and hence are more suited for gap detection. Therefore, in practice both these forms of requirements continue to be useful and coexist. Often in big software projects and in distributed development environment such coexisting requirement specifications can grow out of synch. We present here a technique to semi-automatically transform use cases into business processes and to create mapping between them. By preserving the mapping between these forms one can enforce consistency between the two forms of requirements.

**Computing Service Skylines over Sets of Services** (ICWS2010-1061)
Qi Yu and Atithan Bouguetayya (Rochester Institute of Technology, USA; CSIRO ICT Center, Australia)

We propose a skyline computation approach that enables service users to optimally access sets of services as an integrated service package. We first present a one pass algorithm based on the observation that a multi-service skyline is completely determined by single service skylines. The skyline is returned after an enumeration on a significantly reduced candidate space. We then develop a dual progressive algorithm that is able to progressively report the skyline. We conduct an experimental study to assess the performance of the skyline computation approaches.

**Application and Industry Session 8 – Services Brokering** (Session Chair: Freddy Lecue, University of Manchester, UK)

**DISCE: A Declarative Inter-ESB Service-Connectivity Configuration Engine** (ICWS2010-1062)
Kristijan Dragicevic, Luis Garcia-Erice, and Daniel Bauer (IBM Research Zurich Laboratory, Switzerland)

The service-oriented architecture (SOA) has been successfully applied in enterprise environments. Due to decentralized set-ups, mergers and acquisitions and organizational boundaries, many enterprises today operate multiple, fragmented and heterogeneous service infrastructures that are administered by different organizational units. This fragmented infrastructure causes service duplication and unnecessary redundancy. This paper proposes an approach of cross-domain service integration through an automated federation of Enterprise Service Buses (ESBs). ESBs are the mediation centers within a service domain that enable service interaction across technological and organizational boundaries by using service proxies. We present DISCE, a configuration engine prototype that enables an operator to configure service connectivity in such an environment in a declarative form, by specifying simple rules. The engine produces a configuration consisting of a set of proxies interconnecting clients and services.

**Two-Staged Approach for Semantically Annotating and Brokering TV-related Services** (ICWS2010-1063)
Hong QIng Ya, Neil Benn, Stefan Dietze, Carlos Pedrinaci, Dong Liu, John Domingue, and Ronald Siebes(The Open University, UK; Vrije Universiteit Amsterdam, The Netherlands)

Nowadays, more and more distributed digital TV and TV-related resources are published on the Web, such as Electronic Personal TV Guide (EPG) data. To enable applications to access these resources easily, the TV resource data is commonly provided by Web service technologies. The huge variety of data related to the TV domain and the wide range of services that provide it, raises the need to have a broker to discover, select and orchestrate services to satisfy the runtime requirements of applications that invoke these services. The variety of data and heterogeneous nature of the service capabilities makes it a challenging domain for automated web-service discovery and composition. To overcome these issues, we propose a two-stage service annotation approach, which is resolved by integrating Linked Services and IRS-III semantic web services framework, to complete the lifecycle of service annotating, publishing, deploying, discovering, orchestration and dynamic invocation. This approach satisfies both developer’s and application’s requirements to use Semantic Web Services (SWS) technologies manually and automatically.

**Designing a Broker for QoS-driven Runtime Adaptation of SOA Applications** (ICWS2010-1064)
Valeria Cardellini and Stefano Iannucci(University of Roma “Tor Vergata”, Italy)

One of the major current trends in service oriented systems is the emphasis given to the need of introducing runtime adaptation features, so that the system can meet its QoS requirements in a volatile operating environment. In this paper we present the design and implementation of a service broker that supports the QoS-driven runtime adaptation of SOA applications offered as composite services to users. We describe the functionalities provided by the broker components and present their design and implementation according to two different versions we have developed and that are both based on open source products. The components of the first version have been developed in Java as Web services, while the second version takes advantage of OpenESB. Since the broker needs to sustain a traffic of requests generated by several concurrent users, we also present the replicated architectures of the two broker versions. We discuss the design tradeoffs and the lessons we have learned in developing the broker.
Design Patterns for RESTful Communication Web Services (ICWS2010-1065)

Li Li, Wu Chou (Avaya Labs Research, Avaya Inc., USA)

In recent years, REST (Representational State Transfer) has received much attention for designing scalable web services in various domains. There is an increasing interest on its application to real-time communication web services. Based on a case study of CSTA services, we found that communication services exhibit a combination of complex message exchange and stateful behavior patterns, including multi-states, twoway interaction, event-driven, multi-resources, multiresponses and session management, that need to be modeled properly within the framework of REST. To address these challenges, we propose three REST design patterns: session, event subscription and relationship using REST Web.

Towards Improved Data Dissemination of Publish-Subscribe Systems (ICWS2010-1066)

Ramith Jayasinghe, Dinesh Gamage, and Srinath Perera (Lanka Software Foundation)

With the proliferation of internet technologies, publish/subscribe systems have gained wide usage as a middleware. However for this model, catering large number of publishers and subscribers while retaining acceptable performance is still a challenge. Therefore, this paper presents two parallelization strategies to improve message delivery of such systems. Furthermore, we discuss other techniques which can be adopted to increase the performance of the middleware. Finally, we conclude with an empirical study, which establishes the comparative merit of those two parallelization strategies in contrast to serial implementations. Keywords: publish-subscribe system; parallelization strategies in contrast to serial implementations.

An Aspect-Oriented Approach to Consistency-Preserving Caching and Compression of Web Service Response Messages (ICWS2010-1067)

Wubin Li, Johan Tordsson, and Erik Elmroth (Umea University, Sweden)

Web Services communicate through XML encoded messages and suffer from substantial overhead due to verbose encoding of transferred messages and extensive (de)serialization at the end-points. We demonstrate that response caching is an effective approach to reduce Internet latency and server load. Our Tantivy middleware layer reduces the volume of data transmitted without semantic interpretation of service requests or responses and thus improves the service response time. Tantivy achieves this reduction through the combined use of caching of recent responses and data compression techniques to decrease the data representation size. These benefits do not compromise the strict consistency semantics. Tantivy also decreases the overhead of message parsing via storage of application-level data objects rather than XML representations. Furthermore, we demonstrate how the use of aspect-oriented programming techniques provides modularity and transparency in the implementation. Experimental evaluations based on the WSTest benchmark suite demonstrate that our Tantivy system gives significant performance improvements compared to non-caching techniques.

Application and Industry Session 9 – Services Patterns (Session Chair: Sattanathan Subramanian, Uni BCCS, Bergen, Norway)

Application and Industry Session 10 – Services Selection (Session Chair: Michael Maximilien, IBM Research – Almaden, USA)

Automating QoS Based Service Selection (ICWS2010-1068)

Manish Godse, Umesh Bellur, and Rajendra Sonar (Indian Institute of Technology Bombay, India)

The presence of multiple services sharing a common functional interface necessitates differentiating between them on the basis of their performance. However advertised quality of service (QoS) alone cannot paint the true picture of how the service has performed so far and how it will continue to function in the near future. This information is crucial for service selection. In this paper, we outline a method of monitoring and extrapolating service performance and using the same for automated service selection process.

Utility-Based Optimal Service Selection for Business Processes in Service Oriented Architectures (ICWS2010-1069)

Vinod K. Dubey and Daniel A. Menasce (Booz Allen Hamilton and George Mason University, USA)

Service Oriented Architectures enable markets of functionally equivalent service providers delivering services at different Quality of Service (QoS) and cost levels. Under these circumstances, there is a need for mechanisms to optimally select service providers at run-time to support a business process execution so that a utility function for the business process is maximized subject to QoS and cost constraints. This is an NP-hard problem. This paper investigates this problem when the utility function is expressed in terms of multiple QoS metrics. An efficient optimal algorithm is presented, which eliminates the need to exhaustively search the state space. This algorithm can be used for small to medium size problems. A very efficient heuristic solution is also presented and scientifically evaluated against the optimal solution on a large set of randomly generated business processes.

Business Process Personalization through Web Widgets (ICWS2010-1070)

Nassim Laga, Emmanuel Bertin, and Noel Crespi (Orange Labs; Institut Telecom, France)

Widget aggregators such as iGoogle and Netvibes are broadly adopted by the mass market. They enable endusers to personalize their environment with their preferred services (Widgets). However, the usage in an enterprise context is not yet investigated. In this paper, we firstly show that in addition to personalization capability, the integration of business processes should be considered. Secondly, we propose a new Widget aggregator that enables the end-user to personalize a business process by chaining Widgets according to his/her needs and habits. Thirdly, we introduce a new approach for specifying an end-user process; an approach which enables even ordinary end-users, without computing skills, to define their processes. Finally, we validate these concepts by implementing and testing a prototype. As a consequence, this work does not only impact Widget aggregators, but it also innovates in end-user service creation research by proposing an intuitive tool, understandable even by ordinary end-users, for specifying their processes (composite services).

Application and Industry Session 11 – Services-based Workflows (Session Chair: Donghui Lin, NICT, Japan)

Mashing-Up Rich User Interfaces for Human-Interaction in WS-BPEL (ICWS2010-1071)

Qi Zhao, Xuanzhe Liu, Dawei Sun, Tiancheng Liu, Ying Li, and Gang Huang (Ministry of Education; Peking University; IBM Research – China)
Services computing paradigm together with Web services have significantly promoted the automation of business process in enterprise. Prevalent service composition technologies, such as WS-BPEL and WSCI, provide promising means to deal with machine-to-machine communication. Traditionally, in the phase of business process modeling, there usually require some human-involved tasks. Recent new technologies such as BPEL/People and Human Task begin to consider involving human interaction in business process. However, such approaches still have some limitations. On one hand, they exactly require some extensions of current BPEL standards. As a result, the existing business processes have to be rewritten and redeployed. On the other hand, they yet lack of the development and deployment supports of flexible and reusable user interfaces in business process. In this paper, we address these issues by enabling human interaction in business process with rich web applications. Our approach models human tasks as services, and can be seamlessly integrated to current BPEL without any modifications to existing engine and processes. We further support building human task presentations from service-oriented rich user interfaces. During the process execution, the corresponding task stakeholders can select, configure and compose these reusable and rich UI components according to their own application context.

A Collectional Data Model for Scientific Workflow Composition (ICWS2010-1072)
Xubo Fei, Shiyong Lu (Wayne State University, USA)

Modern scientific computations are usually data intensive, involving large-scale, heterogeneous and structured scientific datasets. Modeling, organizing, and processing scientific data have become key challenges for scientific workflow management systems (SWFMSs). In contrast to business data, which is usually relational and stored in databases, scientific data is often hierarchically organized and collection oriented. Although several data models have been proposed for SWFMSs, none of them provides a formal data model with a set of well-defined operators. In this paper, we take a first step towards formalizing a collection-oriented data model, called collectional data model, to model hierarchical collection-oriented scientific data, and a set of well-defined operators to manipulate and query such data. We then apply the collectional data model to VIEW, a dataflow-based scientific workflow composition framework, whose workflow constructs are extended to support collections. We implement our techniques and validate them by a case study in a biological simulation project.

Confucius: A Scientific Collaboration System Using Collaborative Scientific Workflows (ICWS2010-1073)
Jia Zhang, Daniel Kue, Shiyong Lu (Northern Illinois University, USA; Wayne State University, USA)

Large-scale scientific data management and analysis usually relies on many distributed scientists with diverse expertise. In recent years, such a collaborative effort is often composed and automated into a dataflow-oriented process, a so-called scientific workflow. However, existing scientific workflow tools are single user-oriented and do not support collaborative scientific workflow composition, execution, and management among multiple distributed scientists. In this paper, we report our study of collaboration protocols towards building a tool supporting collaborative scientific workflow composition. Based on a scientific collaboration ontology, we propose a collaboration model supported by a set of collaboration primitives and patterns. The collaboration protocols are then applied to support effective concurrency control in the process of collaborative workflow composition.

Application and Industry Session 12 – Services QoS Modeling (Session Chair: Qi Yu, Rochester Institute of Technology, USA)

An Insurance Model for Guaranteeing Service Assurance, Integrity and QoS in Cloud Computing (ICWS2010-1074)
Min Luo, Liang-Jie Zhang, and Fengyan Lei (IBM, IBM T.J. Watson Research Center, USA; Beijing University of Chemical Technology, China)

SOA and cloud computing have brought new opportunities for the long expected agility, reuse and the adaptive capability of IT to the ever changing business requirements and environments. But due to the immature nature of the rapidly evolving technologies, especially in the areas of security, service or information integrity, privacy, quality of service and their possible detrimental consequences, many enterprises have been hesitating to make the shift. This paper adopts the concept of insurance and establishes a framework and the supporting reference model for cloud computing. We utilize the value-at-risk (VAR) approach to establish several appropriate mechanisms, and use a set of measurable metrics. Those quantitative or qualitative metrics can be applied as the basis for the business value and risk assessment, and eventually for insurance premium and compensation calculation for the failures of the services offered in Cloud environment. This model can also establish a potential new innovative market branch for the insurance industry.

Timed Extended Invariants for the Passive Testing of Web Services (ICWS2010-1075)
Gerardo Morales, Stephane Maag, Ana Cavalli, Wissam Mallouli, Edgardo Montes de Oca, and Bachar Wehbi (Télécom Sud; Montimage EURL, France)

The service-oriented approach is becoming more and more popular to integrate highly heterogeneous systems. Web services are the natural evolution of conventional middleware technologies to support Web-based and enterprise level integration. Formal testing of such Web-based technology is a key point to guarantee its reliability. In this paper, we choose a non-intrusive approach based on monitoring to propose a conformance passive testing methodology to check that a composed Web service respects its functional requirements. This methodology is based on a set of formal invariants representing properties to be tested including data and time constraints. Passive testing of an industrial system (that uses a composition of Web services) is briefly presented to demonstrate the effectiveness of the proposed approach.

A Hybrid Scheme for Controlling Transactional Composite Services (ICWS2010-1076)
Xinfeng Ye, Yi Chen (Auckland University, New Zealand)

This paper proposes a hybrid concurrency control scheme for transactional composite services. The scheme uses the information gathered from the workflow specifications of the composite services to reduce the overhead in detecting cycles in the serialization graph. The scheme carries out runtime analysis of the SQL statements used by the composite services to determine whether the clients that execute composite services depend on each other more accurately. As a result, it reduces the response time to some users. The proposed scheme also tackles the repeated rollback problem facing many concurrency control schemes.

Application and Industry Session 13 – Services Quality and Policy (Session Chair: Yu Chen Zhou, IBM Software Development Lab, China)

Context Model Based SOA Policy Framework (ICWS2010-1077)
With the popularity of SOA, SOA policy becomes one of the core technical enablers for SOA governance and management. Different in several aspects from traditional policy for distributed system management, policy applied in SOA solutions needs to take into account various policy types and enforcement points in different layers of SOA solution stack and different phases of SOA lifecycle. As well, it has the unique requirements on compliance to match existing SOA technologies and characteristics, as simplicity, standardization, high performance, etc. In this paper, a novel context model based SOA policy management framework by innovatively extending W3C Service Modeling Language (SML) and ISO Schematron is introduced. Firstly, a common context model distilled from SOA policy types typically including service policy, service governance policy, application policy and business policy, is presented. Then, the core components - context model based policy engine and definition tool are described. Finally, it is illustrated how the unified definition tools and policy engine are manipulated within the context model based SOA policy framework to manage and enforce policies in typical scenarios as service meta-data management, service match making and business process management. Based on the project, we participated in the works for defining W3C SML V1.1 working draft and proposed the works introduced in this paper to W3C SML Working Group. This paper demonstrates how these technologies and architectures significantly enhance the capability of SOA governance and management throughout whole SOA lifecycle and spanning the layers of SOA solution stack.

**Extending BPMN for Supporting Customer-Facing Service Quality Requirements** (ICWS2010-1078)

Kawther Saeedi, Liping Zhao, and Pedro R. Falcone Sampaio (The University of Manchester, UK)

Service-oriented computing promises to create flexible business processes and applications on demand by dynamically assembling loosely coupled services within and across organizations. Quality requirements play a central role in service sourcing and, together with Service Level Agreements, facilitate service selection and measurement of service delivery effectiveness. This empowers customers to make better decisions when faced with multiple service offerings and varying service costs. However, existing business process modeling languages provide little support for quality requirements annotation and specification. This paper argues that quality requirements are a central aspect of business process modeling specification, and thus proposes to incorporate time, cost and reliability quality requirements as extensions to the Business Process Modeling Notation (BPMN). These quality requirements are evaluated based on analytical model using reduction rules. An example of online purchasing business process is illustrated to demonstrate the applicability of the proposed approach.

**Work-in-Progress Track**

**Work-in-Progress Session 1 – Services Composition**

*Survey of the Tools for Automating Service Composition* (ICWS2010-1079)

Riina Maigre (Tallinn University of Technology (Estonia))

This paper presents the results of a brief survey of tools for increasing the level of automation of service composition. Our main emphasis in this paper is on tools for building compound services. Tools for both non-semantic and semantic services are considered.

*Compose Real Web Services with Context* (ICWS2010-1080)

Sen Luo, Bin Xu, and Kewu Sun (Tsinghua University, China)

Web service composition is to integrate existing web services to provide a compound service which satisfies specified requirement. However, traditional web service compositions fail to provide different compound services under various scenarios. In this paper, we propose an approach to compose services with context. A context ontology is defined to describe the scenario for user. An abstract service description is defined to describe current three kinds of services including WSDL/Restful/Web API. The goal is to correlate context and service composition to improve the quality of the compound service from real services.

*Agile Service Oriented Architecture with Adaptive Processes Using Semantically Annotated Workflow Templates* (ICWS2010-1081)

Wolfgang Halb, Hervwig Zeiner, Bernhard Jandl, Harald Lembefj, and Christian Derler (Joanneum Research, Austria)

Although WS-BPEL is a widely used language for modeling executable business processes in service oriented architectures it is almost impossible to dynamically bind services at runtime taking complex constraints and optimization goals into account. The approach presented in this paper uses semantically annotated workflow templates and extensions to introduce adaptability which enables agile service oriented architectures. The technological solution will be validated in a critical infrastructure environment where resilience and security play an important role.

*Seamless Cross-Domain Connectivity for Enabling Domain Autonomy in a Federated SOA* (ICWS2010-1082)

Ignacio Silva-Lepe, Isabelle Rouvellou, Rahul Akolkar, and Arun Iyengar (IBM T.J. Watson Research Center, USA)

To tackle SOA projects that span across various boundaries, enterprises are adopting a federated SOA approach in order to manage reuse across service domains [1, 3]. A service domain, as used in this paper, is a collection of services that reflects the underlying organizational, geographical or governance structure of an enterprise. Managing service reuse involves sharing a subset of the services that are provided within a domain and fulfilling references to services required by applications or other services in a domain. While this is a major goal, it is also important for a federated enterprise to enable the autonomy of its multiple service domains. For the purposes of this paper, we consider as domain autonomy the ability to (1) decide what domain provided services to share and how, without the need for a central federation authority, and (2) reuse required services without the need for explicit domain membership knowledge or the existence of a federation architecture to fulfill required references. This paper proposes an approach for cross-domain connectivity that enables domain autonomy and that preserves across domains properties such as location transparency, dynamic selection, and asynchronous connectivity, that are taken for granted by services within a domain. We introduce a cross-domain connectivity capability and show how this capability allows for services to be shared and reused without the need for an federation architect, and how it preserves intra-domain properties, thus enabling domain autonomy in a federation.

**Work-in-Progress Session 2 – Services-based Processes**

*An A BPEL Observability Enhancement Method* (ICWS2010-1083)

Sébastien Salva and I saam Rabbi (Campus des C’zeaux,Aubi’ere, FRANCE)

WS-BPEL processes are usually overlapped in large Business applications composed of several Web Services. Such
applications are more and more developed with respect of quality processes. Testability is an important quality degree, which evaluates the fault detection coverage during the testing process and the testing cost. In this paper, we focus on a well-known testability criterion called observability, which evaluates if enough distinguishable events can be observed while testing. We study the observability of ABPEL (Abstract-BPEL) specifications and we describe some ABPEL observability degradation properties. From these, we propose some observability enhancement methods which detect observability issues in ABPEL specifications and semi-automatically update the ABPEL code.

Development of a Novel Software Architecture for Active Internet Applications Based on Fusion of Mobile Agent, Web Services and BPEL Technologies (ICWS2010-1084)
Venkatesan Pillai (Anna University, India)
Mobile agent technology has been evolving since late 1990s and its development is essentially independent of developments in distributed computing technology such as SOA, Semantic web and Web services. Incorporating mobile agents bring undeniable benefits to a distributed application. Present mobile agent technology fails to leverage the interoperable web infrastructure developed in a standard compliant manner. Here we fuse Workflow, Web 2.0, SOA and WS-BPEL and create a distributed computing environment (ACtive E-commerce Framework called ACEF) that permit creation of inter operable, infrastructure leveraging migratable code for design of active internet application.

OWL-S Process Model Matchmaking (ICWS2010-1085)
Ahmed Gater, Daniela Grigori, and Mokrane Bouzeghoub (Université de Versailles Saint-Quentin en Yvelines, France)
In this paper, we propose an approach for approximate matching of OWL-S process model. We also propose a similarity measure that captures structural and semantic differences between two process models. To do so, we reduce the process matching to a graph matching problem and we adapt existing algorithms for this purpose.

A Web 2.0-Based Scientific Application Framework (ICWS2010-1086)
Weijie Chu, Frank Tung, and Zhonghai Wu (Peking University, China)
A significant obstacle to building usable, web-based interfaces for computational science in a Grid environment is how to deploy scientific applications on computational resources and expose these applications as web services. To streamline the development of these interfaces, we propose a new application framework that can deliver user-defined scientific workflows as both web services and OpenSocial gadgets. Through this application framework, scientists can focus on defining computational workflows using domainspecific applications and can use the software tools in the framework to quickly generate gadgets for running the applications and visualizing the output from workflow executions. By assembling these domain-specific gadgets and some common gadgets predefined in the framework for workflow management, scientists can easily set up a customized computational workspace to meet their requirements.

Work-in-Progress Session 3 – Services Security and Adaptation (Session Chair: Janaka Balasooriya, Arizona State University, USA)
A Tripartite Security Model for Dynamic Service-Oriented Systems Using DynaSOAr (ICWS2010-1087)
Chris Fowler, Paul Watson (The Queen’s University, Northern Ireland; Newcastle University, UK)
The DynaSOAr framework presents a wholly service-oriented approach to grid and Internet-based computing that makes a clear and explicit separation of concerns between service-provision and resource-provision for each service invocation. The separation allows the dynamic deployment of code at runtime, in the form of a service implementation, between a service provider and an explicit resource provider. This paper presents work in progress towards an integrated tripartite security model and framework that enables the security constraints of each engaging party to be expressed, propagated, unified and enforced as part of a DynaSOAr service invocation.

A Framework for Delivering Rigorously Trusted Services (ICWS2010-1088)
Dongxi Liu, John Zic (Information Engineering Lab, Marsfield, Australia)
Rigorously trusted services depend on reliable evidences to describe and check service behaviors. In this paper, we propose the pi-SOA framework, which delivers mutually trusted services in a rigorous way. The framework allows clients to verify service behaviors remotely according to their trust policies and uniquely identify the verified service at all times during its executions. On the other hand, service providers in this framework can check that clients have agreed with the service behaviors before using the service.

Self-Adaptive Service Composition through Graphplan Repair (ICWS2010-1089)
Yuhong Yan, Pascal Poizat, and Ludeng Zhao (Concordia University, Canada; University of Evry Val d’Essonne, France)
Service composition is nowadays mainly seen as a once-for-all activity. Supporting a dynamic service world, where both available services and needs may change, requires runtime adaptive features for service composition. In this paper we propose a repair technique for internal composition adaptation, as opposed to external adaptation. Moreover, setting up our proposal in the planning framework, we compare our repair technique with reference to re-composition, that is re-planning.

Work-in-Progress Session 4 – Services Modeling (Session Chair: Zhibin Cao, SAP Labs, USA)
A Uniform Device Information Access for Context-Aware Middleware (ICWS2010-1090)
Weiping Li, Weijie Chu, Frank Tung, and Zhonghai Wu (Peking University, China)
This paper presents a middleware for building context-aware applications. One of the main components, Device Information Access (DIA), is discussed in detail. Since many kinds of devices (e.g., RFID, GPS, Bluetooth, etc.) can be used to collect the context information, the middleware defines the Device Information Access component to communicate with different devices. A set of interfaces are devised in DIA, and the common functions such as getting and setting a data element are defined in the interfaces. For each device, we shall provide an implementation of the interfaces to communicate with the corresponding servers or software agents. DIA can communicate with the software agents or servers using various protocols such as RMI, Web Services, and REST. In this way the access to the hardware are encapsulated by the middleware and virtualized to the end-point applications. The architecture of the middleware and the functions of DIA are discussed, and an empirical application is also developed to validate our design.

Implementing Attribute-Based Encryption in Web Services (ICWS2010-1091)
Web services are now widely used in web-based applications. To protect the information in web services, many security specifications have been proposed. Attribute-based Encryption (ABE) provides us a brand new cryptographic primitive for access control. This paper sets out to examine an unexplored area to date – how attribute-based encryption might be used to provide privacy and security for web services. We try to implement ABE in web services. The implementation and performance evaluation demonstrate that ABE is efficient and feasible in web services.

Enabling Publish/Subscribe with COTS Web Services across Heterogeneous Networks (ICWS2010-1092)
Espen Skjervold, Trude Hafse, Frank T. Johnsen, and Ketil Lund (Norwegian Defence Research Establishment, Norway)

In scenarios such as search-and-rescue operations, it may be required to transmit information across multiple, heterogeneous networks, often experiencing unreliable connections and limited bandwidths. Typically, there will be traffic within and across radio networks, as well as back to a central infrastructure (e.g., a police command post) when a reach-back link is available. This implies that using Publish/Subscribe is advantageous in order to reduce network traffic, and that store-and-forward capabilities are required to handle the instability of radio networks. At the same time, it is desirable to use commercial software based on standards as far as possible, in order to reduce cost and development time, and to ease interconnection of systems from different organizations. We therefore propose using SOA based on Web services in such scenarios. Indeed, Web services are targeted at stable, high-speed networks, but our work shows that such usage is feasible. In this paper, we add Publish/Subscribe functionality to standard, unmodified Web services through the use of our prototype middleware solution called the Delay and Disruption Tolerant SOAP Proxy (DSProxy). In addition to the ability to make Web services delay and disruption tolerant, the DSProxy enables SOAs in scenarios as described above. The DSProxy has been tested in field trials, with promising results.

Compatibility and Reparation of Web Service Processes (ICWS2010-1093)
Yuhong Yan, Ali Ait-Bachir, Min Chen, and Kai Zhang (Concordia University, Canada; University of Grenoble, France; Huazhong Normal University, China)

When two Web services work together, they exchange messages in a predefined interface process. Two interface processes should be compatible when they can work properly. Our idea to fix incompatibility problem in service processes is to change an incompatible process so that the new process can simulate a compatible process. We consider not only the control flow but also the data flow in modeling the processes into FSMs. We present a technique that not only detects the incompatibility, but also provides resolution strategies to generate the new process.

A Novel Cloud-Oriented WS-Management-Based Resource Management Model (ICWS2010-1096)
ZhiHui Lu, Jie Wu, and WeiMing Fu (Fudan University, China)

Cloud computing environment requires a more open and loosely-coupled service and resource management model. Web Services for Management specification (WSManagement), as an initiative of DMTF organization, can help to manage IT resources cross multiple domains in cloud environment. In this paper, we propose a novel WSManagement-based Cloud-oriented resource management model. We describe the main components of this model. And then, we discuss our management model verification experimental scheme focusing on DASH resource. Finally, we present conclusion and future work.

An Approach for Mining Web Service Composition Patterns from Execution Logs (ICWS2010-1097)
Run Tang and Ying Zou (Queen’s University, Canada)

A service-oriented application is composed of several web services to provide complex functionality that a single web service cannot provide. A set of services along with their control flows can be frequently used in multiple applications. Such services form a service composition pattern which is well tested in the numerous adoptions. Reusing service composition patterns in service composition provides an efficient way to improve the quality of new applications. To facilitate the documentation of service composition patterns, we propose an approach to automatically recognize service composition patterns from various applications. We identify service composition patterns by locating a set of associated services commonly used by different applications and recovering the control flows among the set of associated services.

Distributed Web Services Discovery Middleware for Edges of Internet (ICWS2010-1098)
Abdul Haseeb, Mikhail Matskin, and Peep Küngas (KTH Royal Institute of Technology, Sweden; University of Tartu, Estonia)

The advent of mobile computing devices and development of wireless and ad-hoc networking technologies has led to growth of infrastructure-less environments. Mostly, these environments lie at the edges of Internet i.e. they are disconnected/sparsely connected to rest of the world. In order to exploit the access to such edges of Internet, we propose and experimentally evaluate an interoperability middleware that synergizes P2P technology, message queuing support and a passive distributed UDDI for Web services discovery and invocation.
Recommendation on Uncertain Services (ICWS2010-1099)
Liang Chen, Jian Wu, Ru Jia, Shiguang Deng, and Ying Li (Zhejiang University, China)
In this paper, we propose a time-sensitive probability skyline (TPS) approach to recommend services with uncertainty. We project services to n-dimensional data space and recommend services in TPS. Experimental evaluation on real data shows the great performance of TPS in service recommendation by comparing the experiment result with results of other approaches.

Optimizing the Data-Traffic of Centrally Coordinated Scientific Workflow Systems (ICWS2010-1100)
Sattanathan Subramanian, Pål Punterrøl, and Pawel Stromwasser (Uni BCCS, Norway)
Scientific workflow systems facilitate scientific experiments by integrating and coordinating geographically distributed data and algorithmic services in a loosely coupled manner. Most scientific workflow-engines use centralized coordination as the choice of approach for executing workflows, requiring the coordinator (i.e., workflow-engine) to send and receive all input and output data of component services. Such indirect data communication between the component services increases the data-traffic of the coordinator and weakens the performance of the workflow. To optimize this, we propose an approach where data-flow is dynamically delegated from the coordinator to the component services, with direct transportation of data between the component services.

Everett: Providing Branch-Isolation for a Data Evolution Service (ICWS2010-1101)
Avraham Leff and James T. Rayfield (IBM T.J. Watson Research Center, USA)
One benefit of Software-as-a-Service (SaaS) is the ability to rapidly deploy iterative improvements without requiring users to upgrade the application on their machine. However, the need to rapidly “develop and test” different versions of an application implies that developers need branch isolation to protect the system from local changes to both data and meta-data in the same way that they traditionally use branch-isolation to protect the system from source code changes. Providing branch-isolation for source-code changes has well-known solutions, but these solutions do not extend well to providing isolation for changes to data and meta-data. EVERETT provides developers the ability to safely – and concurrently – change database values with new business logic or evolve data schema in various ways while sharing the same database.

Work-in-Progress Session 7 – NFR and Applications (Session Chair: Jicheng Fu, University of Central Oklahoma, USA)
jGASW: A Service-Oriented Framework Supporting HTC and Non-functional Concerns (ICWS2010-1102)
Javier Rojas Balderama, Johan Montagnat, and Diane Lingrand (University of Nice-Sophia Antipolis, France)
Although Service-Oriented principles have been widely adopted by High Throughput Computing infrastructure designers, the integration between SOA and HTC is made difficult by legacy. jGASW is a framework for wrapping legacy scientific applications as Web Services and integrating them into an intensive computing-aware SOA framework. It maps complex I/O data structures to command lines and enables dynamic allocation of computing resources; including execution on local hosts or on grid infrastructures; data transfer management and support of non-functional concerns.

Design and Implementation for Communication Component Based Open Multimedia Conferencing Web Service over IP (ICWS2010-1103)
Cheng Bo, Zhang Yang, Hu Xiaosiao, Zhang Shicheng, and Chen Junliang (Beijing University of Posts & Telecommunications, China)
This paper provides an appropriate implementation to deliver the multimedia conferencing communication components as Web services over IP networks. And mainly focus on the design of the multimedia conferencing components and Web service model, messages adaptor between Web service and components. Finally, we give a scenario to create a conference by the chairman.

2010 IEEE 7th International Conference on Services Computing (SCC 2010)

Research Track

Research Track 1 – Choreography of Business Process Management (Session Chair: Geetika T Lakshmanan, IBM T.J. Watson Research Center, USA)
A Model for Visual Specification of E-contracts (SCC2010-2001)..........................Enrique Martínez, Gregorio D’az, M. Emilia Cambronero, and Gerardo Schneider (University of Castilla - La Mancha Albacete, Spain; University of Gothenburg, Sweden; University of Oslo, Norway)
In a web service composition, an electronic contract (e-contract) regulates how the services participating in the composition should behave, including the restrictions that these services must fulfill, such as real-time constraints. In this work we present a visual model that allows us to specify e-contracts in a user friendly way, including conditional behavior and real-time constraints. A case study is presented to illustrate how this visual model defines e-contracts and a preliminary evaluation of the model is also done.

Preserving Data Flow Correctness in Process Adaptation (SCC2010-2002)..........................Wei Song, Xiaoxing Ma, S. C. Cheung, Hao Hu, and Jian Lv (Nanjing University; HKUST, China)
In services and cloud computing, processes need to be continually adapted to changing environments and requirements. Undisciplined process adaptation could easily lead to data flow anomalies, e.g., input missing for some activities in the process. In this paper, we study the problem of data-flow-correctness-preserving adaptation and propose three important criteria that can maintain the data flow correctness in process adaptation. We demonstrate our approach by using a typical process adaptation scenario in BPEL.

Process Trace Identification from Unstructured Execution Logs (SCC2010-2003)..........................
Many real world business processes are executed without explicit orchestration and hence do not generate structured execution logs. This is particularly true for the class of business processes which are executed in service delivery centers in emerging markets where rapid changes in processes and in the people executing the processes are common. In such environments, the process execution logs are usually natural language descriptions of actions performed and hence are noisy. Despite the lack of structured logs, it is crucial to know the trace of activities as they happen on the ground. Without such a visibility into the ground activities, regulatory compliance audit, process optimization, and best practices standardization are severely disabled. Process monitoring on top of unstructured execution logs has been a relatively unexplored research area. This paper proposes an approach for process trace identification from unstructured logs that applies state-of-the-art text mining techniques. It applies this approach on logs of real-world business process used in a service delivery center and shows that individual process activities are correctly identified 90% of the time. Also, 65% of the activity traces were identified with zero errors and an additional 24% with a single error. This approach is generic and applicable to wide array of business processes.

**Research Track 2 - Modeling and Abstraction of Services Process** (Session Chair: Marvin Ferber, University of Bayreuth, Germany)

Dynamic Service Invocation Control in Service Composition Environments (SCC2010-2004)

Donghai Lin, Yohei Murakami, and Masahiro Tanaka (NICT Japan)

Service composition environments enable people to create, manage, share services, and compose atomic services for their own requirements. Since users and service entity hosts are always distributed in locations in such environments, service responses might be very slow if users invoke services that are physically far from them, which is even slower for invoking composite services. However, those problems cannot be solved using traditional caching technologies in the areas of contents delivery network because service providers in service composition environments always have their own policies about service license issues, and do not allow their service entities to be copied on all service entity hosts. In this paper, we propose the approach of dynamically switching availability of services among service entity hosts based on the invocation request from users, and design several dynamic invocation control mechanisms to improve the response performance of services considering the service license constraints by service providers. Our proposed mechanisms are evaluated by simulation in service composition environments.

BPEL Remote Objects: Integrating BPEL Processes into Object-Oriented Applications (SCC2010-2005)

Marvin Ferber, Thomas Rauber, and Sascha Hunold (University of Bayreuth, Germany; International Computer Science Institute Berkeley, USA)

Service-orientation and object-oriented design are common practice in the field of business application development. Business process execution languages help to facilitate the orchestration of Web services in service-oriented architectures (SOA). However, using business processes from within object-oriented and event-driven applications is difficult as asynchronous event handling is missing in workflow-based business process modeling languages. The present article presents an approach for integrating BPEL business processes into object-oriented applications. We propose BPEL remote objects (BPELROs) that can be accessed asynchronously in an object-oriented business processes can be implemented using BPELROs. It is shown how to apply BPELROs for software modernization tasks and we also evaluate the performance of BPELROs on different BPEL engines.

Co-Taverna: A Tool Supporting Collaborative Scientific Workflows (SCC2010-2006)

Jia Zhang (Northern Illinois University, USA)

Scientific workflows have become an important instrument for domain scientists to synergistically integrate distributed computations and data to accelerate scientific discoveries. Existing scientific workflow tools, however, only support single scientists to compose scientific workflows in a desktop application. Nowadays, many scientific research projects are becoming increasingly larger scale, requiring that multiple research partners with different expertise collaborate from distributed organizations. Therefore, there is a critical need of a collaborative scientific workflow tool that supports domain scientists to cooperatively design, compose, annotate, execute, monitor, and manage scientific workflows over the Internet in both synchronous and asynchronous modes. This research reports the design and development of our preliminary version of a collaborative scientific workflow tool based on an open-source, single-user tool Taverna. We present our study of the role-organization-based access control technique over collaborative scientific workflow composition.

**Research Session 3 – Business Oriented and Enabled SOA** (Session Chair: Massimo Maresca, University of Padova, Italy)

Business Driven Consolidation of SOA Implementations (SCC2010-2007)

Biplav Srivastava and Pietro Mazzoleni (IBM Research, India; IBM, USA)

Changes are continuously happening in enterprises and they impact the IT landscape. The most drastic among them are mergers and acquisitions, but recent trends like globalization and recession also lead companies to adopt new business consolidation strategies. Today, very limited support is provided to companies undergoing consolidation; the business to IT alignment is implicit, the task of identifying major IT changes compared to minor ones is pain-staking, and the ability to provide insights of the IT system as result of one strategy over another is impossible. In this paper, we are interested in precise methods that can characterize the impact of business consolidations on the companies’ SOA based IT implementation, wherein the service interfaces are explicitly exposed. Our solution is to model the business to SOA dependencies and use the model to analyze IT consolidation choices when triggered by business consolidation decisions.

Detection of Semantically Equivalent Fragments for Business Process Model Change Management (SCC2010-2008)

Christian Gerth, Markus Luckey, Jochen M. Kuster, and Gregor Engels (IBM Research - Zurich, Switzerland; University of Paderborn, Germany)

Modern business process modeling environments support distributed development by means of model version control, i.e. comparison and merging of two different model versions. This is a challenging task since most modeling languages support an almost arbitrary creation of process models. Thus, in multi-developer environments, process models or parts of them are often syntactically very different but semantically equivalent. Hence, the comparison of business process models must be performed on a semantic level rather than on a syntactic level. For the domain of business process modeling, this problem is yet unsolved. This paper describes an approach that allows the semantic comparison of different business process models using a normal form. For that purpose, the process models are fully automatically translated into process model terms.
and normalized using a term rewriting system. The resulting normal forms can be efficiently compared and easily be used for reconciliation. Our approach enables the semantic comparison of business process models ignoring syntactic redundancies.

A Novel Approach to Improving the Efficiency of Storing and Accessing Small Files on Hadoop: A Case Study by PowerPoint Files (SCC2010-2010)

Bo Dong, Jie Qiu, Qinghua Zheng, Xiao Zhang, Jingwei Li, and Ying Li (Xian Jiaotong University, China)

Hadoop distributed file system (HDFS) becomes a representative cloud storage platform, benefiting from its reliable, scalable and low-cost storage capability. HDFS has been utilized in BlueSky, one of the most prevalent e-Learning resource sharing systems in China, to store and share courseware majorly in the form of PowerPoint (PPT) files and video clips. Unfortunately, HDFS does not perform well for massive small files since huge numbers of small files imposed heavy burden on NameNode of HDFS, correlations between files were not considered for data placement, and no prefetching mechanism was provided to improve I/O performance. This paper introduces a novel approach to improve the efficiency of storing and accessing small files on HDFS. Characteristics of file correlations and access locality remaining among small files in the context of courseware are well considered for storing and accessing them. Firstly, all correlated small files of a PPT courseware are merged into a larger file to reduce the metadata burden on NameNode. Secondly, a two-level prefetching mechanism is introduced to improve the efficiency of accessing small files. The experimental results indicate that the proposed approach is able to effectively mitigate the load of NameNode and to improve the efficiency of storing and accessing massive small files on HDFS.

Research Session 4 – Cloud Services (Session Chair: Dharanipragada Janakiram, Indian Institute of Technology, Madras)

Graph-Based Cloud Service Placement (SCC2010-2010)

Anca Sailer, Michael R. Head, Andrzej Kochut, and Hidayatullah Shaiikh (IBM T.J. Watson Research Center, USA)

The emerging IT clouds as the future of datacenters enable considerable opportunities for the services creation, deployment, management and usability. Users all over the world, from individuals to businesses have been taking advantage of the new cloud services automation and scalability benefits. However, the services creation and business support are still dominated by intensive manual labor. Offerings with similar infrastructure requirements and dependencies are mainly built from scratch as separated entities, making the service development inefficient and error prone. We propose a graph based solution for semi-automated service creation, which expresses the mapping between a business support system and an operations support system. We first identify and expose, at the leaf level of our graph, the meaningful IT operations in the form of basic services. Then, we extend our graph by representing existing services offerings in terms of these operation level service definitions as well as simpler services offerings. At service creation time, an offering manager can re-combine existing building blocks to define new services, besides implementing new blocks down to the operations support system. Our solution takes into consideration the constraints and costs of the service offering sub-components as far as their mapping down to datacenter resources for optimizing the service placement into data-centers. We present a study of the Desktop Service use case.

A Formal Service Contract Model for Accountable SaaS and Cloud Services (SCC2010-2011)

Joe Zou, Yan Wang, and Kwei-Jay Lin (IBM Australia, Macquarie University, Australia; University of California, USA)

Enabled by Service-Oriented Architecture (SOA), recently Software as a Service (SaaS) and Cloud computing are gaining momentum in the industry. A key open issue is how to enable accountability in business services offered through Internet. Traditionally a contract is an effective means to uphold accountability in business transactions. In this paper, we propose a novel service contract model called OWL-SC for e-Services. Based on OWL-DL and SWRL, OWL-SC model can be used to disclose obligations of both e-Services consumer and e-Services provider. More importantly, the model allows service participants to monitor the service contract execution and keep track of obligation fulfillment for each party during service delivery. We also propose a graphical model SC-CPN based on Colored Petri-Nets (CPN) to formally model contract obligations and their interdependencies. SC-CPN can also be used to validate the correctness of obligations in OWL-SC through simulation and state space analysis. Finally, we use the Congo Book Service as an example to illustrate how to use OWL-SC and SC-CPN to build a service contract model.

Accountability as a Service for the Cloud (SCC2010-2012)

Jinhui Yao, Shiping Chen, Chen Wang, David Levy, and John Zic (University of Sydney; Networking Technologies Laboratory CSIRO ICT Centre Australia)

Computing resource provisioning through the use of the Cloud computing paradigm has triggered revolutions in modern day computing. It is a new paradigm for deploying services on rented machines. On the other hand, Service Oriented Architecture (SOA) has gained wide adoption among organizations due to the importance of collaborations and outsourcing. Therefore the Cloud’s enormous capacity with comparable low cost makes it an ideal platform for SOA deployment. The overall correctness of the SOA deployed in the Cloud depends on the correctness of all individual participants. As the SOA usually spans multiple administration domains, concluding the faulty service and making the provider responsible become a challenging task. In this paper, we propose a novel design to achieve Trustworthy Service Oriented Architecture (TSOA) in the Cloud through enforcing strong accountability. In such system not only the root of a fault can always be concluded to the guilty participant(s), each conclusion is supported with non-disputable evidence. We also implemented a demonstrative system to show its effectiveness in real practice. Our testing figure indicates the cost of incorporating our design to SOA in the cloud is acceptable.

Research Session 5 – QoS and Services Composition (Session Chair: Michael Menzel, Hasso Plattner Institute for Software Systems Engineering, Germany)

Metaheuristic Optimization of Large-Scale QoS-Aware Service Compositions (SCC2010-2013)

Florian Rosenberg, Max Benjamin Mueller, Philipp Letzner, Anton Michlmayr, Athman Bouguettaya, and Schahram Dustdar (CSIRO ICT Centre; University of Technology, Australia)

We present an optimization approach for service compositions in large-scale service-oriented systems that are subject to Quality of Service (QoS) constraints. In particular, we leverage a composition model that allows a flexible specification of QoS constraints by using constraint hierarchies. We propose an extensible metaheuristic framework for optimizing such compositions. It provides coherent implementation of common metaheuristic functionalities, such as the objective function, improved mutation or neighbor generation. We implement three metaheuristic algorithms that leverage these improved operations. The experiments show the efficiency of these implementations and the improved convergence behavior compared to purely randomized metaheuristic operators.

Xi-Calculus: A Calculus for Service Interactions (SCC2010-2014)

Joe Zou, Yan Wang, and Kwei-Jay Lin (IBM Australia, Macquarie University, Australia; University of California, USA)
The paper proposes xi-calculus, a formalism for describing interactions in Service Oriented Architectures. The calculus treats interactions between services as a core concept to capture important architectural characteristics of the system. The focus of xi-calculus is on the higher level abstraction rather than on the lower level details like parameter passing, use of stacks, closures etc. And hence it can be used to specify, study, and compare different service oriented systems from an architectural point of view. The paper also introduces a notion of interaction types suitable for the level of abstraction under consideration. These types are used to describe the type system of the calculus. The paper introduces a notion of design time non-functional capabilities and also present the application of the calculus in a real business scenario.

A Service-Oriented Framework for GNU Octave-Based Performance Prediction (SCC2010-2015)

George Koussiouris, Dimosthenis Kyriazis, Kleopatra Konstanteli, Spyridon Gogouvitis, Gregory Katsaros, and Theodora Varvarigou (National Technical University of Athens, Athens)

Cloud/Grid environments are characterized by a diverse set of technologies used for communication, execution and management. Service Providers, in this context, need to be equipped with an automated process in order to optimize service provisioning through advanced performance prediction methods. Furthermore, existing software solutions such as GNU Octave offer a wide range of possibilities for implementing these methods. However, their automated use as services in the distributed computing paradigm includes a number of challenges from a design and implementation point of view. In this paper, a loosely coupled service-oriented implementation is presented, for taking advantage of software like Octave in the process of creating and using prediction models during the service lifecycle of a SOI. In this framework, every method is applied as an Octave script in a plug-in fashion. The design and implementation of the approach is validated through a case study application which involves the transcoding of raw video to MPEG4.

Research Session 6 - QoS Selection and Matchmaking (Session Chair: Mark Yampolskiy, German Research Network, Germany)

QoS Analysis and Service Selection for Composite Services (SCC2010-2016)

Huiyuan Zheng, Jian Yang, and Weiliang Zhao (Macquarie University, Australia)

A composite service can be constructed with the arbitrary combination of sequential, parallel, loop, and conditional structures. In this paper, we propose a general solution to calculate the QoS for composite services with complex structures. We also show QoS-based service selection can be conducted based on the proposed QoS calculation method. An application example is given to show the effectiveness of the method.

A Heuristic Algorithm for Trust-Oriented Service Provider Selection in Complex Social Networks (SCC2010-2017)

Guanfeng Liu, Yan Wang, Mehmet A. Orgun, and Ee-Peng Lim (Macquarie University, Australia; Singapore Management University, Singapore)

In a service-oriented online social network consisting of service providers and consumers, a service consumer can search trustworthy service providers via the social network. This requires the evaluation of the trustworthiness of a service provider along a certain social trust path from the service consumer to the service provider. However, there are usually many social trust paths between participants in social networks. Thus, a challenging problem is which social trust path is the optimal one that can yield the most trustworthy evaluation result. In this paper, we first present a novel complex social network structure and a new concept, Quality of Trust (QoT). We then model the optimal social trust path selection with multiple end-to-end QoT constraints as a Multi-Constrained Optimal Path (MCOP) selection problem which is NP-Complete. For solving this challenging problem, we propose an efficient heuristic algorithm, HOSTP. The results of our experiments conducted on a large real dataset of online social networks illustrate that our proposed algorithm significantly outperforms existing approaches.

An information Model for the Provisioning of Network Connections Enabling Customer-Specific End-to-End QoS Guarantees (SCC2010-2018)

Mark Yampolskiy, Wolfgang Hommel, Patricia Marcu, and Matthias K. Hamm (DFN; LRZ; MNM)

The growing significance of international collaborations in research, education, and business fields has raised the demand for the assurance of the quality of the network connections which the projects and applications are realized upon. A large spectrum of examples with diverse requirements is found in areas such as GRID- and Cloud computing, eLearning, and video-conferencing. The consequences of these diverse project and application requirements culminate in the urgent necessity to provide an End-to-End (E2E) guarantee for any customer-specific or user-tailored combination of service-specific Quality of Service (QoS) parameters. The quality of the overall network connections provided to users obviously directly depends on the quality of the involved connection parts. This means that already during the setup negotiation process the quality of the available connection parts has to be considered. Especially for international connections it is common that multiple independent service providers (SPs) realize different connection segments. This means in turn, that during the information exchange about available connection parts not only the technical challenges have to be solved, but also preferences and restrictions of the involved provider domains must be considered. In this paper we present a novel information model for the description of such connections. In the proposed model, a multi-domain view is derived from the single-domain perspectives of each considered SP. This model serves as a pro-found basis for an end-to-end routing algorithm which considers multiple user specific QoS parameters in parallel. The proposed model also accounts for the typically very restrictive SP information policies.

Research Session 7 – Design and Modeling of SOA (Session Chair: Yudistira Dwi Wardhana Asnar, Trento University, Italy)

SecureSOA – Modelling Security Requirements for Service-Oriented Architectures (SCC2010-2019)

Michael Menzel and Christoph Meinel (Hasso-Platner-Institute, Germany)

Service-oriented Architectures (SOA) facilitate the provision and orchestration of business services to enable a faster adoption to changing business demands. Web Services provide a technical foundation to realize this paradigm and support a variety of different security mechanisms and approaches. Security requirements are codified in Web Service policies that control the service’s behavior in terms of secure interactions with other participants in an SOA. To facilitate and simplify the generation of enforceable security policies, we foster a model-driven approach based on the modeling of security requirements in system design models. This paper introduces our security design language SecureSOA that enables the description of these security requirements. We present the abstract syntax and notation of SecureSOA and describe a schema to integrate SecureSOA in any system design language for service-based systems. Moreover, we will demonstrate the integration of SecureSOA in Fundamental Modelling Concepts (FMC) Block Diagrams.
Service-oriented collective intelligence, which creates new value by combining services provided by various organizations via services computing technologies, has been gaining in importance with the development of services computing technologies. Because collective intelligence needs many participants, it is crucial to build a framework where a wide variety of policies of service providers are satisfied. In this paper, we propose an architecture which handles a comprehensive process of service selection, adaptation, and coordination to satisfy policies of service providers. First the system selects services, and then adapts the services to the given policies if any of available services cannot satisfy the policies. To achieve this, we formalized this problem as an extension of constraint satisfaction problem and showed a solution. Moreover, the system often needs to force a composite service to follow protocols given by service providers. Therefore we proposed a method which uses meta-level control functions for composite services in order to change order of service execution.

Research Session 8 – Semantic Web Services  
(Chair: Adeel Talib, Swinburne University of Technology, Australia)

Meta-Modeling of Semantic Web Services (SCC2010-2021)

Roberto De Virgilio (Automazione Universita di Roma Tre, Italy)

Web Services Description Language (WSDL) allows a structured way to standardize the description of Web Services, exploiting XML for the exchange of structured information. Nevertheless XML supports little interoperability between services, expected when WSDL documents have to be combined. In this context, the Semantic Web has become a promising research field. Semantic Models (e.g. RDF or OWL) allow knowledge from many different sources to be easily combined so that unexpected data connections can be used. In this paper we provide a description of WSDL documents into a metamodel representation of Semantic Models. It allows interoperability at different levels of abstraction. A Datalog rule based system queries both service description and associated semantic annotations. Such is built on top of traditional database technology to guarantee an efficient management of Semantic Web Services Descriptions. Finally we present experiments on a real dataset to test the feasibility of the modeling approach.

Improve Service Interface Adaptation Using Sub-ontology Extraction (SCC2010-2022)

Lu Jin, Jian Wu, Jianwei Yin, Yin Li, and Shiguang Deng (Zhejiang University, China)

Interface mismatches are common among web services interactions. It happens when the interacting services have different message signatures. Semantic Web technologies are proposed to address this problem. If services are annotated with shared ontologies, an interface adapter may be generated by connecting messages that annotated with same or similar concepts. Unfortunately, services are usually annotated with different ontologies. As a result, different ontologies need to be aligned before adaptation. Aligning large ontologies can be time-consuming and inaccurate, which leads to inefficient and unsuccessful web service adaptation. In this paper, we tackle the problem by proposing a sub-ontology extraction method to generate Representation Ontology for each service. The Representation Ontologies can significantly increase alignment speed and accuracy, which consequently improve the process of interface adapter generation. Related tests are conducted to evaluate our work.

Distributed Storage and Querying Techniques for a Semantic Web of Scientific Workflow Provenance (SCC2010-2023)

John Abraham, Pearl Brazier, Artem Cheboiko, Jaime Navarro, and Anthony Piazzia (University of Texas - Pan American, USA)

In scientific workflow environments, scientific discovery reproducibility, result interpretation, and problem diagnosis primarily depend on provenance, which records the history of an in-silico experiment. Resource Description Framework is frequently used to represent provenance based on vocabularies such as the Open Provenance Model. For complex scientific workflows that generate large amounts of RDF triples, single-machine provenance management becomes inadequate over time. In this paper, we research how HBase Bigtablelike capabilities can be leveraged for distributed storage and querying of provenance data represented in RDF. In particular, we architect the ProvBase system that incorporates an HBase/Hadoop backend, propose a storage schema to hold provenance triples, and design querying algorithms to evaluate SPARQL queries in the system. Using the Third Provenance Challenge queries, we conduct an experimental study to show the feasibility of our approach.

Research Session 9 – Service Discovery and Delivery  
(Chair: Nianjun Zhou (Joe), IBM T.J. Watson Research Center, USA)

Discovering Shared Services from Cross-Organizational Software Specifications (SCC2010-2024)

Alexander Yale-Loehr, Ian D. Schlesinger, Aubrey J. Rembert, and M. Brian Blake (Georgetown University; IBM T.J. Watson Center; University of Notre Dame, USA)

During a standard software development process, organizations create text-based documents that describe software requirements, design, and implementation. These text-based specifications describe the functionality of future applications as they relate to an existing IT infrastructure. We suggest that these documents also implicitly describe core underlying service-based capabilities of the organization. In this paper, we describe an approach that (when provided with software specifications from multiple organizations) can recommend services shared by the multiple organizations represented. These approaches leverage the syntactic similarity of the specification text and semantic information as inferred from WordNet. Experiments show the effectiveness of this approach when processing real software requirements specifications in operational environments.

Analyzing Communities vs. Single Agent-Based Web Services: Trust Perspectives (SCC2010-2025)

Bubak Khosrovifar, Jamal Benatour, Ahmad Moazin, Zikariat Magamur, and Philippe Thiran (Concordia University, Canada; Zayed University, UAE; University of Namur, Belgium)

Gathering functionally similar agent-based Web services into communities has been proposed and promoted on many occasions. In this paper, we compare the performance of these communities with self-managed, single agent-based Web services from trust perspective. To this end, we deploy a reputation model that ranks communities and Web services with respect to different reputation parameters. By relating the parameters, we extend our discussion to analyze the beneficial cases and incentives for a single Web service to join a community even if this joining could negatively impact other parameters. Besides theoretical discussions of this analysis, we discuss the system implementation along with simulations that depict diverse parameters and system performance.

A Service Packaging Platform for Delivering Services (SCC2010-2026)
For a service to be used in a commercial setting, certain service delivery functions such as monitoring, billing, authentication, etc need to be packaged with the service. Because of the growing number of available services and the diversity in their offerings, predefined service delivery functions like that offered by existing service brokers (e.g. StrikeIron or Salesforce) cannot be easily adapted and plugged in with the core service from a third party provider. The need is to have a lightweight service packaging platform that offers service providers the ability to create reusable service packages by assembling existing service delivery functions or creating new ones. In this paper we introduce the notion of service packages and a pattern-based approach to service packaging. We highlight what is required from a platform to have such service packaging capabilities, and detail a prototype platform that we have developed to meet these requirements.

**Research Session 10 - Service Composition, Coordination and Management** (Session Chair: Wei Tan, University of Chicago and Argonne National Lab, USA)

**A Value-Driven Approach for the Determination of Global Optimization Objective of Service Composition (SCC2010-2027)**

Zhongjie Wang, Xiaofei Xu, Dianhui Chu, and Chao Ma (ICES, Harbin Institute of Technology, China)

We present a value-driven approach capable of determining the global optimization objective of service composition to satisfy high-level value expectations. In traditional service composition methods, global and local QoS requirements and constraints are directly raised by customers, then a set of service components (web services) are selected to achieve the optimized QoS. Yet in practice, there is no mechanism helping customers accurately and comprehensively determine their QoS desires. In our approach, a customer’s initial expectations of high-level global values are first put forward, and then five types of dependencies between service values are analyzed. Because values are realized under the facilitation of specific service components, value expectations and value dependencies are transformed into the objective and constraints of service selection and composition, respectively. Another feature of our approach is that, besides web services, other generalized service components such as human activity and physical resources are considered as potential components for fulfilling value expectations. The effectiveness of our approach is demonstrated in a case study of ocean transportation service (OTS).

**Applying Bargaining Game Theory to Web Services Negotiation (SCC2010-2028)**

Xianrong Zheng, Patrick Martin, Wendy Powley, and Kathryn Brohman (Queen’s University, Canada)

Service Level Agreements (SLAs) have obvious value for Service-Oriented Computing and have received attention from both academics and industry. However, SLAs still lack a theoretical basis and effective techniques to facilitate automatic SLA establishment. In this paper, we classify negotiations into four types, and focus on the 1-to-1 Web services negotiation between a single service provider and a single service consumer. We make three contributions. Firstly, we represent the 1-to-1 Web services negotiation as a bargaining game. Here, we are interested in a bargain that takes into account the interests of both a service provider and a service consumer, in other words, a fair solution. Secondly, we determine a Nash equilibrium that can be regarded as the fair solution to a two-player bargaining game. We also determine the fair solution to the 1-to-1 Web services negotiation. Finally, we discuss issues that may arise with the 1-to-1 Web services negotiation under credible threats, incomplete information, time constraints, and multiple attributes.

**A Continuous Long Running Batch Orchestration Model for Workflow Instance Migration (SCC2010-2029)**

David Frank, Lianna Fong, and Linh Lam (IBM T. J. Watson Research Center, USA)

Workflow engines which require process instances to run to completion against their creation model are limited in their ability to adapt to model changes. The technique of process instance migration can be used to migrate instances to a new process model, but at any given time only a fraction of instances may be in a state which is compatible with the new model. We propose a continuous batch approach for migration which treats migration itself as a long running problem. The continuous migration approach schedules and orchestrates the evaluation and migration of long running processes over time, controlled by configurable policies while maintaining continuous process availability. We have built a long running process migration simulation to test our approach, looking at both migration success and cost. The simulation confirms the need for a long running migration approach and yields some interesting suggestions for tuning the configuration of the migration system.

**Application and Industry Track**

**Application & Industry Session 1 – Services Composition Methodology** (Session Chair: Florian Rosenberg,CSIRO Australia)

**Describing and Verifying Web Service Composition Using TLA Reasoning (SCC2010-2030)**

Hongbing Wang, Qianzhao Zhou, and Yanqi Shi (Southeast University, China)

Web service composition is the process of integrating multiple independent Web Services into a coherent system that performs complex functions. This paper proposes an effective method for performing Web service composition and verification. We use Temporal Logic of Actions (TLA) to model Web services, composition patterns and users’ requests. Based on the models, composition can be created by conducting TLA reasoning. The correctness of composition result can also be verified by checking whether the resulted TLA formula implements a user’s request. A case study was conducted to illustrate the correctness of our approach.

**Dynamic Composition of Services in Sensor Networks (SCC2010-2031)**

Sahin Cem Geyik, Boleslaw K. Szymanski, Petros Zerfos, and Dinesh Verma (Rensselaer Polytechnic Institute; IBM T.J. Watson Research Center, USA)

Service modeling and composition is a fundamental method for offering advanced functionality by combining a set of primitive services provided by the system. Unlike in the case of web services for which there is an abundance of reliable resources, in sensor networks, the resources are constrained and communication among nodes is error-prone and unreliable. Such a dynamic environment requires a continuous adaptation of the composition of services. In this paper, we first propose a graph-based model of sensor services that maps to the operational model of sensor networks and is amenable to analysis. Based on this model, we formulate the process of sensor service composition as a cost-optimization
problem, which is NP-complete. We then propose two heuristic methods for its solution, the top-down and the bottom-up, and discuss their centralized and distributed implementations. Using simulations, we evaluate their performance.

**Discovering Business Process Model from Unstructured Activity Logs (SCC2010-2032)**
Rahul Kumar, Chiranjib Bhattacharyya, and Virendra Varshneya (Indian Institute of Science; IBM Research, India)

Many real-world business processes are executed without explicit orchestration and hence do not generate structured execution logs. This is particularly true for the class of business processes which are executed in service delivery centers in emerging markets where rapid changes in processes and in the people executing the processes are common. In such environments, the process execution logs are usually a mix of human entered activity log of actions performed and the auto-generated logs by various tools used during the process execution. Process discovery from unstructured execution logs has been a relatively unexplored research area. In this paper, we propose an approach for process discovery from unstructured logs using gaussian mixture models and hidden markov models. We apply this approach to the logs generated by a real-world business process used in a delivery center and demonstrate that the results obtained are comparable to an approach of manually labeling the logs followed by a best known process discovery algorithm in literature. The approach proposed is generic and applicable to a wide range of business process execution settings.

**Application & Industry Session 2 – Services Selection and Matchmaking**
(Session Chair: Boleslaw Szymanski, Rensselaer Polytechnic Institute, USA)

**Utilizing the Waiting-Time Criterion for Selecting Services in a Composition Scenario (SCC2010-2033)**
Abhishek Srivastava and Paul G. Sorenson (Department of Computing Science University of Alberta, Canada)

Service composition is an effective practice to perform complex tasks through varied configurations of simple services. An issue that often arises in such a set-up is the selection of the best service from a group of functionally equivalent ones to cater to each of the various functionalities of the composite application. Previous effort in this direction incorporates utilizing the Quality of Service (QoS) attributes of the services to pick out the best one of the lot. This paper presents a technique to select the optimal service for composition using the average waiting time attribute of the services. The service selected is the one that has the smallest value of the average waiting time. Concepts from queueing theory have been borrowed and customized to estimate the waiting time values of the candidate services. Experiments have been performed wherein selection results using the proposed technique are compared with the selections that are made by simulating an actual scenario and computing the waiting time by observation.

**ViPen: A Model Supporting Knowledge Provenance for Exploratory Service Composition (SCC2010-2034)**
Weilong Ding, Jing Wang, and Yanzhi Han (Chinese Academy of Sciences; Graduate University of Chinese Academy of Sciences, China)

In current service composition efforts, the intermediate products such as data and related process fragments are neglected in many cases when the deviation occurs from predefined composition. The lack of adequate provenance support makes it not convenient when building the composition in an exploratory fashion. In this paper, we present ViPen model, and illustrate its operations to enhance the provenance for flexible deviation in composition service. Meanwhile, a partially ordered relation “derivation” is formed which guarantees the new derived processes can reuse previous knowledge effectively. A case study of one bioinformatics experiment is explained to verify our work.

**A QoS Query Language for User-Centric Web Service Selection (SCC2010-2035)**
Delnavaz Mobedpour, Chen Ding, and Chi-Hung Chi (Ryerson University, Canada; Tsinghua University, China)

One of the prerequisites for the success of a QoS-based web service selection process is an accurately formulated QoS query. It is usually not an easy task for users to formulate an accurate query considering the complexity of many current QoS languages and users’ lack of knowledge on realistic QoS values. It would be very helpful if the system can provide some assistance to users during the whole process. Nonetheless, not many research works put user support to the center of their system design. In this paper, we want to tackle this issue by proposing a QoS query language which is expressive while not so complicated, together with a comprehensive user support mechanism to guide users through the query formulation process. A few unique features of the language include its time dimension, user-defined relaxation order which could be different from the preference order, and the support for the mixed fuzzy and range requirement. How to handle these new features is also discussed as case studies in the paper.

**Application & Industry Session 3 – Policy Driven Business Process Generation**
(Session Chair: Anthony Hock-koon, University of Nantes, France)

**Analyst-Mediated Contextualization of Regulatory Policies (SCC2010-2036)**
George Koliadis, Nirmrit V. Desai, Nanjungad C. Narendra, and Aditya K. Ghose (University of Wollongong, Australia; IBM Research India)

Increasing legislative and regulatory concerns have fueled an interest in effective and efficient tools for managing business process compliance within organizations. In particular, the key challenge is to understand high-level compliance policies in natural language, and interpret them for a particular usage context. These interpreted policies can then be represented in a formal language, and used to (for example) automatically verify compliance of business process executions against these policies. In this paper, we focus on the first part of this problem: interpreting regulatory policies — called contextualization. We employ a natural language parser to extract key phrases from the natural language statements and generate possible interpretations from predefined templates. An analyst chooses interpretations according to the organizational context. These interpretations are then grounded further and represented in a formal language. Via a prototype, we demonstrate our approach on real-life security compliance obligations used within IBM’s IT service delivery units.

**Measuring Compliance and Deviations in a Template-Based Service Contract Development Process (SCC2010-2037)**
Vijil Chenthamarakshan, Rafah A. Hoss, Shajith Rhal, Nanda Kambhatha, Debapriyo Majumdar, and Soumitra Sarkar (IBM T.J. Watson Research Center, USA; IBM Research – India)

Asset-based approaches, involving the use of standardized reusable components (as opposed to building custom solutions), are increasingly being adopted by IT service industries to achieve higher standardization, quality and cost reduction goals. In this paper, we address issues related to the use of an asset-based approach for authoring service contracts, where standard templates are defined for each type of service offered. The success of such an approach relies on a compliance checking system. We focus on three key components of such a system. The first measures how well
Towards A Novel Web Services Standard-Supported CDN-P2P Loosely-Coupled Hybrid and Management Model (SCC2010-2038)

ZhiiHui Lu, Jie Wu, Weiming Fu (Fudan University, China)

In recent years, some researchers have begun to focus on researching CDN-P2P-hybrid architecture, but most hybrid architectures belong to tightly-coupled hybrid model. Cloud computing era calls for a more open content service mode. In order to construct open service relationship, we propose one novel CDN-P2P loosely-coupled SLA negotiation model. CDN first needs to provide an open and standard-based agreement interface for the P2P and other applications to negotiate with it. Therefore, we use Web Services Agreement Specification (WS-Agreement) for establishing agreement between two CDN and P2P. This scheme also allows CDN easily integrated with other application. The loosely-coupled CDN-P2P-SLA establishment needs to link with SLA performance monitoring, we design WSDM based CDN-P2P loosely coupled SLA monitoring scheme. The prototype system experiments have proved the feasibility of this model and scheme. Finally, we conclude this paper and analyze the prospective research direction.

Application & Industry Session 4 – Trust Management (Session Chair: ZhiiHui Lu, Fudan University, China)

Universal Identity Management Model Based on Anonymous Credentials (SCC2010-2039)

Yang Zhang and Jun-Liang Chen (Beijing University of Posts & Telecommunications, China)

The relationship-focused and credential-focused identity management are both user-centric notions in Service-oriented architecture (SOA). For composite services, pure user-centric identity management is inefficient because each sub-service may authenticate and authorize users and users need participate in every identity provisioning transaction. If the above two paradigms are unified into the universal identity management model where identity information and privileges are delegatable, user-centricity will be more feasible in SOA. This paper aims to extend WS-Federation to build a universal identity management model based on anonymous credentials, which provides the delegation of anonymous credentials and combines identity metasystem to support easy-to-use, consistent experience and transparent security. In addition, the concept of self-generated pseudonym is introduced to construct efficient anonymous delegation model.

A Trust Ontology for Semantic Services (SCC2010-2040)

Wanita Sherchan, Surya Nepal, Jonathon Hunklinger, and Athman Bouguettaya (CSIRO ICT Centre, Australia)

We propose a novel semantic service trust organization that uses an ontological approach to model service trust. In particular, our ontology-based organization supports various trust phases including trust bootstrapping, atomic service trust, trust composition and trust propagation. We describe the implementation of the proposed trust organization.

Constructing an Authentication Token to Access External Services in Service Aggregation (SCC2010-2041)

Peishun Wang, Yi Mu, Willy Sasilo, and Jun Yan (University of Wollongong, Australia)

Service aggregation is becoming a cost-effective and time-efficient way for a business to develop new applications and services. While it creates tremendous opportunities in various industry sectors, its cross-organization nature raises serious challenges in the security domains for authentication. In this paper we formulate a formal definition of authentication in service aggregation and a security model for it, and propose two authentication protocols. One is a one-way protocol and another is an interactive one. In particular, the constructed authentication tokens are anonymous to verifiers. We prove their security, show how to choose optimal system parameters, and analyze the efficiency.

Application & Industry Session 5 – Semantic Web and Pattern (Session Chair: Christian Gerth, University of Paderborn, Germany)

Discovering Hierarchical Patterns in Event-Based Systems (SCC2010-2042)

Hannes Obweger, Josef Schiefer, Peter Kepplering, and Martin Santtinger (UC4 Sensative, Austria)

Expressive and powerful event-pattern rules are key to successful applications of Complex Event Processing (CEP). However, the definition of complex pattern-detection logic may place heavy demands on business users. In this work we present a model for hierarchical event-patterns, allowing users to compose complex patterns from encapsulated, fullyabstrated sub-pattern definitions with a visual decision graph. Pattern definitions can be reused across business scenarios, thereby encouraging the creation of pattern libraries. In the course of this paper we give a brief overview of the event-based system SARI and describe a number of extensions to its ruling model. We present an algorithm for evaluating hierarchical ruling logic and demonstrate our approach with a use case from the fraud-detection domain.

Alternative Approaches for Workflow Similarity (SCC2010-2043)

Andreas Wombacher and Chen Li (University of Twente, the Netherlands)

Service discovery of state dependent services has to take workflow aspects into account. To increase the usability of a service discovery, the result list of services should be ordered with regard to the relevance of the services. Means of ordering a list of workflows is a similarity measure of the workflow and a query. In this paper different similarity measures facilitating structured workflows and higher level change operations are presented and evaluated based on a pilot of an empirical study. In particular the different measures are compared with the study results. It turns out that the quality of the different measures differ significantly. The best results can be achieved by facilitating n-gram multisets as a workflow as a basis for the similarity measure calculations.

A Knowledge Acquisition Method for Improving Data Quality in Services Engagements (SCC2010-2044)

Mohan N. Dani, Tanveer A. Faruque, Rishabh Garg, Govind Kohari, Mukes K. Mohania, K. Hima Prasad, L. Venkata Subramanian, and Varsha N. Swamy (IBM India Software Labs; IBM Research India; Indian Institute of Technology)

Poor Data Quality is a serious problem affecting enterprises. Enterprise databases are large and manual data cleansing is not feasible. For such large databases it is logical to attempt to cleanse the data in an automated way. This has led to the development of commercial tools for automatic
and a WS-BPEL orchestrator engine. The feasibility for mobile settings introduces new challenging issues to face with, such as reduced capabilities. This prevents them from being used in mobile scenarios, such as emergency management. ROME4EU is based on a mobile Web service middleware. To our knowledge, all existing PAISs are equipped with an engine meant to run only on laptop/desktop. And this limits their mobility to only equipped with smart devices, such as PDAs. This paper illustrates ROME4EU, a fully-fledged PAIS that can be entirely developed on smartphones, tablets, and laptops.

Defining Metrics for Loose Coupling in Service Composition

Anthony Hock-koon and Mourad Oussalah (University of Nantes, France)

Service Oriented Architectures (SOA) mainly rely on the service composition mechanism which supports the reusability. Numerous researches focus on this thematic in order to satisfy all the objectives of quality fixed by the SOA community. One of these objectives is the notion of loose coupling between the composition’s services. However, this notion is intuitively understood and tangible, its definition lacks formalism. This unclear picture of the loose coupling is reflected in limited metrics which do not allow for its quantitative and objective evaluation. In this paper, we propose a set of different metrics which are associated with a clear definition of the loose coupling notion. These metrics act as guidelines for architects to develop their composite service. They are gathered in a formula which allows for evaluating the global coupling of a composition of services. Moreover, they are also used as comparison criteria for classifying existing composition models.

Market-Based QoS Control for Voluntary Services

Yohei Murakami, Naoki Miyata, and Toru Ishida (National Institute of Information and Communications Technology (NICT); Kyoto University, Japan)

With the development of services computing technology, more and more voluntary services have been available on the Internet. When using voluntary services, users tend to demand higher QoS (e.g., throughput of the services) than they actually need because there is no cost. To control QoS of the voluntary services appropriately, it is necessary to design resource allocation mechanism using utilities on both service users and providers. Therefore, we have proposed market-oriented resource allocation where users and providers exchange system resources and QoS based on their utilities. In our proposed approach, service users obtain more utilities if higher QoS is allocated according to their preferences in using the services, while service providers get more utilities if their services are more effectively used by their preferred users. In order to validate the proposed method, we have compared market-based approach with demand-based approach by simulation. The simulation results show that our approach motivated users to give true demands more than demand-based approach.

Towards Green Business Process Management

Konstantin Hoesch-Klohe, Aditya Ghose, and Lam-Son Le (University of Wollongong, Australia)

There is a global consensus on the need to reduce our collective carbon footprint. While much research attention has focused on developing alternative energy sources, automotive technologies or waste disposal techniques, we often ignore the fact that the ability to optimize (existing) operations to reduce their emissions impact is fundamental to this exercise. We believe that by transforming the problem into the domain of Business Process Management (BPM) we can leverage the rich expertise in this field to address issues associated with identifying areas for improvement, understanding the implication and performing carbon footprint minimization. We will use the term “Green BPM” to describe a novel class of technologies that leverage and extend existing BPM technology to enable process design, analysis, execution, and monitoring in a manner informed by the carbon footprint of process designs and instances. This article describes the first steps in the development of this class of technologies.
Customer contact centers have to regularly and proactively evaluate and adapt their customer handling processes to support the business vision of their clients and to maintain a competitive differentiating edge. This work presents the contact collector tool developed at IBM that allows the contact center supervisors to record and analyze the behavior of various agent customer handling processes. The contact collector tool generates quantifiable insights to improve operational strengths and productivity as well as to enhance the quality of the overall interaction. The present work also discusses the advantages of automating the contact collector tool, technical challenges encountered in the automation process so far and performance of the automated components of the tool.

**Application & Industry Session 8 – Business Driven Services Composition**

**A Cost-Minimizing Service Composition Selection Algorithm Supporting Time-Sensitive Discounts (SCC2010-2051)**

Lei Xu and Brendan Jennings (FAME, Waterford Institute of Technology Waterford, Ireland)

An attractive business model for service brokers and aggregators is the creation of composite services built from services offered by third parties. These providers generate profits by charging their customers a premium above the charges they themselves pay to the third party providers. When multiple providers offer services with the same or similar functional and non-functional properties, selecting services with lowest associated costs is clearly beneficial. However, this is not a trivial task when, as is often the case, third party providers have complex service charging models incorporating discounts based on the context in which their service is used. This context can refer to, for example, which other services a service is composed with, or the time interval in which the service is invoked. We present a service selection algorithm that takes into account time-sensitive intra and inter provider discounts which serves to minimize the expected cost to the service aggregator of offering a composite service within a specified time interval.

**A Business Centric End-to-End Monitoring Approach for Service Composites (SCC2010-2052)**

Geetika T. Lakshmanan, Paul Keyser, Aleksander Slominski, Francisco Curbera, and Runia Khalaf (IBM T. J. Watson Research Center, USA)

Enterprise applications today are composed of multiple independently executing services and processes that collectively provide a solution to a business problem. These composite applications contain a heterogeneous collection of services that execute in a variety of runtimes making them difficult to manage while maintaining a business centric point of view, as opposed to a service point of view. This paper introduces a business centric monitoring framework to bridge the gap between the business and service levels in complex business applications. Our technical approach focuses on using business information invariants to define one or more monitor sets in order to relate service activity to business composite execution. We apply this framework to enable end-to-end monitoring of composite business applications. In this paper we present an initial prototype of our business centric monitoring approach using monitor sets for monitoring a simple loan application composite implemented on IBM’s WebSphere Business Modeler, Process Server and Business Monitor. Our prototype implementation demonstrates the convenience, effectiveness and ease of design and deployment of our monitoring solution to attain a single end-to-end business centric view of a collection of heterogeneous services executing together. Our work also exposes potential challenges as we extend this work to support more powerful end-to-end monitoring.

**Smarter Heuristics for Business-Driven Services Selection in Multi-Services P2P Grids (SCC2010-2053)**

Alvaro Coelho and Francisco Brasilheiro (Universidade Estadual de Santa Cruz; Universidade Federal de Campina Grande, Brazil)

In peer-to-peer (P2P) grids, peers act both as providers and consumers of the services offered in the system. In these systems, fair and efficient match of service request and service provision can be attained by using simple reciprocation based mechanisms. Under contention, a peer p gives priority to serve the requests of the peers that have the largest difference between the amount of service provided to p and the amount of service consumed from p in the past, i.e. the peers to whom p owes most. Taking a business-driven approach, peers have a cost for the provision of services, while gain utility for the consumption of services, and the peers’ profit is given by the difference between the overall utility attained and the overall cost incurred. It has been shown that if a peer may offer multiple services, then the profit that it can extract from the P2P grid is highly affected by the services that it chooses to offer. Thus, the services selection problem can be formulated as an optimisation problem that seeks to maximise the peers’ profit. Unfortunately, due to the many uncertainties that characterise this highly dynamic system, it is not feasible for a peer to deterministically decide what is the optimal selection of services that it should make. Thus, services selection algorithms must be based on heuristics. Some heuristics have been proposed, but although they perform well in a number of scenarios, there are many others in which they fall short. This is basically due to their inability to identify situations in which it would be better not to use their resources to provide services that will not yield any profit in the future. In this paper we use a hill-climbing approach to design smarter heuristics that can provide more profitable selections, when compared to previously proposed ones. Our simulation results show that, in the scenarios evaluated, the new heuristics proposed never perform worse than the best of the previously proposed ones, and can outperform the latter in as much as 281% in the most favourable settings when resources are plentiful.

**Application & Industry Session 9 – Software Tools for Services Computing**

**AHA: Asset Harvester Assistant (SCC2010-2054)**

Debdoott Mukherjee, Senthil Mani, Vibha Singhal Sinha, Rema Ananthanarayanan, Biplov Srivastava, Pankaj Dhoolia, and Prahlad Chowdhury (IBM Research; IBM Global Business Services, India)

Information assets in service enterprises are typically available as unstructured documents. There is an increasing need for unraveling information from these documents into a structured and semantic format. Structured data can be more effectively queried, which increases information reuse from asset repositories. This paper addresses the problem of extracting XML models, which follow a given target schema, from enterprise documents. We discuss why existing approaches for information extraction do not suffice for the enterprise documents created during service delivery. To address this limitation, we present the Asset Harvester Assistant (AHA), a tool that automatically extracts structured models from MS-Word documents, and supports manual refinement of the extracted models within an interactive environment. We present the results of empirical studies conducted using business process documents from real service-delivery engagements. Our results indicate that the AHA approach can be effective in extracting accurate models from unstructured documents and improving user productivity.

**A Link Obfuscation Service to Detect Webbots (SCC2010-2055)**
Web bot fraud activity currently accounts for a large number of web accesses. Current resistance methods such as CAPTCHA are not applicable for bot detection at the granularity of each click. In this paper, we propose a service that counters web bots which mimic human clicks by walking random links. We base our defense on systematically applying link obfuscation. The obfuscation is designed as a service that can be applied to websites without changes from web developers and without changing the behavior of human users. The service for resisting web bots is called Decoy Link Design Adaptation (DLDA) and works by transparently modifying every page of a protected website. The modifications are made such that walking web bots cannot traverse valid paths through the website. Specifically, DLDA modifies each original link on the page surrounding it with a group of invalid links. These obfuscated links are carefully styled to be unnoticed or avoided by human users; however, they require significant effort for programs (bots) to identify. Experiments show that DLDA has a very high detection rate for web bots and near zero false positives. DLDA can detect 80% of walking bots ending a session after one minute of inactivity (no clicks). The detection rate increases to 100% when the session is ended where multiple visits of the bots can be grouped into a single session.


Jin Zeng, Hailong Sun, Xiaodong Liu, Ting Deng, and Jianing Zou (Beihang University, China)

Process model improvement is one of the most important challenges to deal with in the field of evolving process-aware information systems. In this paper, we present, PRV, an approach to process model refactoring supporting automatic process model improvement, which enables PAIS to adapt to the varying business requirements. First, a set of change operations preserving soundness is defined to avoid complex verification. Second, an algorithm for process model refactoring based on variants is designed to restructure optimal models automatically. Finally, an extensive set of simulations are performed to show the feasibility and effectiveness of the proposed PRV algorithm.

**Application & Industry Session 10 – Information Systems for Business Processes** (Session Chair: Andreas Wombacher, University of Twente, The Netherlands)

**Prospective and Retrospective Provenance Collection in Scientific Workflow Environments** (SCC2010-2057)

Chunhyeok Lim, Shiyong Lu, Artem Chebotko, and Farshad Fotouhi (Wayne State University; University of Texas-Pan American, USA)

Provenance, a record of the derivation history of scientific results, is critical for scientific workflows to support reproducibility, result interpretation, and problem diagnosis. Both prospective provenance, which captures an abstract workflow specification as a recipe for future data derivation, and retrospective provenance, which captures past workflow execution and data derivation information, provide important contextual information for the analysis of scientific results. In this paper, we explore and design: i) a provenance model that models both prospective and retrospective provenance as an extension to the Open Provenance Model (OPM), which only models retrospective provenance; ii) a provenance collection framework to collect both prospective and retrospective provenance according to our model; iii) a relational provenance store to store, reason, and query prospective and retrospective provenance, which is captured via the proposed provenance collection framework. An experimental study is performed to show the performance of our provenance store using provenance queries for the Third Provenance Challenge. While most existing systems use an internal proprietary provenance model and develop an import/export facility to convert between the proprietary model and OPM, our provenance collection framework and provenance store feature the native support of OPM.

**Correcting Interaction Mismatches for Business Processes** (SCC2010-2058)

Shuai Gong, Jinhua Xiong, Zhiyong Liu, and Cheng Zhang (Chinese Academy of Sciences; Graduate University of Chinese Academy of Science)

Discovering and correcting interaction mismatches in inter-organizational business processes are important for service choreography. Automatic discovery mismatches and providing correcting plans will alleviate burdens on business modelers, however, three major challenges are: 1) by what cost model to evaluate multiple correcting plans; 2) how to avoid generating new mismatches when correcting processes; 3) how to effectively reduce the search space size. In this paper, we first extend our previous approaches to discover interaction mismatches, and present a cost model for evaluating correcting plans: second, we propose an independent modifying region-based method to obtain multiple correcting plans which can avoid generating new mismatches, and reduce the search space for finding out correcting plans. A running example is given to illustrate the validity.

**Using Complex Event Processing for Dynamic Business Process Adaptation** (SCC2010-2059)

Gabriel Hermosillo, Lionel Seinturier, and Laurence Duchien (INRIA Lille Nord Europe - University of Lille 1, France)

As the amount of data generated by today’s pervasive environments increases exponentially, there is a stronger need to decipher the important information that is hidden among it. By using complex event processing, we can obtain the information that really matters to our organization and use it to improve our processes. However, even when this information is retrieved, business processes remain static and cannot be changed dynamically to adapt to the actual scenario, diminishing the advantages that can be achieved. In this paper we present CEVICHE, a framework that combines the strengths of complex event processing and dynamic business process adaptation, which allows to respond to the needs of today’s rapidly changing environments. We use a simple car rental scenario to show how CEVICHE could be used to maintain the quality of service of a business process by adapting it according to the situation.

**Application & Industry Session 11 – Service Platform and Middleware** (Session Chair: Artem Chebotko, University of Texas - Pan American)

**Message-Based Service Brokering and Dynamic Composition in the SAI Middleware** (SCC2010-2060)

Federica Paganelli, David Parlanti, and Dino Giuli (National Interuniversity Consortium for Telecommunications (CNIT); University of Florence, Italy)

Service-Oriented Computing (SOC) is a wide and complex research area. Despite the huge effort in both industrial and academics initiatives, several challenges need to be addressed in order to effectively realize the SOC vision. One of the most relevant issues is the need of effective, flexible, reliable, low cost solutions for dynamic service brokering and composition. This paper presents results of an ongoing work on the design and development of a service- and message-oriented middleware for atomic and composite service brokering, named SAI middleware. The SAI middleware offers a set of features for service brokering and dynamic composition, while also guaranteeing loose coupling between service providers and consumers and relaxing the prerequisites for service providers to publish their capabilities in an interoperability domain. SAI dynamic composition is based on an Artificial Intelligence planning approach and on the adoption of an ontology-based functional profile encoding information for enabling automatic information extraction and combination in the service composition chain. Our main contribution...
consists in addressing these issues in a holistic way, as required to effectively support the SOA vision in real application scenarios, while not optimizing single aspects yet.

An Assessment of Middleware Platforms for Accessing Remote Services (SCC2010-2061) .........................................................
Young-Wei Kwon, Eli Tilevich, and William R. Cook (Virginia Tech; The University of Texas at Austin, USA)

Due to the shift from software-as-a-product (SaAP) to software-as-a-service (SaaS), software components that were developed to run in a single address space must increasingly be accessed remotely across the network. Distribution middleware is frequently used to facilitate this transition. Yet a range of middleware platforms exist, and there are few existing guidelines to help the programmer choose an appropriate middleware platform to achieve desired goals for performance, expressiveness, and reliability. To address this limitation, in this paper we describe a case study of transitioning an Open Service Gateway Initiative (OSGi) service from local to remote access. Our case study compares five remote versions of this service, constructed using different distribution middleware platforms. These platforms are implemented by widely-used commercial technologies or have been proposed as improvements on the state of the art. In particular, we implemented a service-oriented version of our own Remote Batch Invocation abstraction. We compare and contrast these implementations in terms of their respective performance, expressiveness, and reliability. Our results can help remote service programmers make informed decisions when choosing middleware platforms for their applications.

Extensible and General Service-Oriented Platform: Experience with the Service Abstract Machine (SCC2010-2062) ............
Eric Simon, Jacky Estublier, and Diana Moreno-Garcia (Laboratoire Informatique de Grenoble, France)

Services are successful for applications with high levels of dynamicity and interoperability. Ironically the actual Service-Oriented Computing (SOC) technologies are such that interoperability is problematic if different platforms are used simultaneously, and dedicated tools for the support of most engineering tasks are essentially missing. We address the interoperability issue through the definition of a Service Abstract Machine (SAM) that observes a set of heterogeneous service platforms running on different machines and dynamically builds a reliable and homogeneous model of the global state. Conversely, changes in the state model, through SAM API are dynamically translated into the corresponding action(s) in the actual underlying SOC platforms. Evolution, extensibility and engineering support are addressed by dedicated software engineering environments that fully rely on the state model, as if SAM were a real SOC platform.

Application & Industry Session 12 – Cloud Services (Session Chair: Philippe Thiran, University of Namur, Belgium)

Wukong: Toward a Cloud-Oriented File Service for Mobile Devices (SCC2010-2063) .................................................................
Huajian Mao, Nong Xiao, Weisong Shi, and Yutong Lu (National University of Defense Technology, China; Wayne State University, USA)

Along with the rapid growth of heterogeneous cloud services and network technologies, more mobile devices use cloud storage services to enlarge the capacity and share data in our daily lives. We commonly use cloud storage service clients in a straightforward fashion, since we may easily obtain most client-side software from many service providers. However, when more devices and users participate in heterogeneous services, the difficulty increases to manage these services efficiently and conveniently. In this paper we design and implement a novel cloud-oriented file service, Wukong, which provides a user-friendly and highly-available facilitative data access method for mobile devices in cloud settings. By using the innovative storage abstraction layer and a set of optimization strategies, Wukong supports heterogeneous services with a relatively high performance. By evaluating a prototype in a systematic way on the aspects of the supporting interface, system performance, and the system resource cost, we find that this easily operable file service has a high usability and extensibility. It costs about 50 to 150 lines of code to implement a new backend service supporting plugin. Wukong achieves an acceptable throughput of 179.11 KB/s in an ADSL environment and 80.68 KB/s under a country EVDO 3G network with negligible overhead.

X-RIME: Cloud-Based Large Scale Social Network Analysis (SCC2010-2064)
Wei Xue, JuWei Shi, and Bo Yang (IBM Research China)

As an important technique in modern sociology, social network analysis has gained a lot of attention from many disciplines, and been used as important complements to traditional statistics and data analysis. In order to make it affordable for analysts with massive and fast growing networks, we present X-RIME, a cloud-based library for large scale social network analysis. We propose an implementation-oriented classification of social network analysis structures and structure variables to guide the implementation of them over MapReduce parallel programming model. The layered architecture of the library is described along with design consideration of each layer. By sharing the same infrastructure and integrating with existing cloud-based data warehouse and data mining libraries and tools, more comprehensive and cost effective social network aware business intelligence solutions could be built. We present several case studies on an online community to illustrate the usage of X-RIME library. The performance of the library is evaluated with experiments, which demonstrates good scalability.

Online Self-reconfiguration with Performance Guarantee for Energy-Efficient Large-Scale Cloud Computing Data Centers (SCC2010-2065)
Haibo Mi, Huamin Wang, Gang Yin, Yangfan Zhou, Dianxi Shi, and Lin Yuan (National University of Defense Technology; The Chinese Univ. of Hong Kong; Information Engineering University, China)
In a typical large-scale data center, a set of applications are hosted over virtual machines (VMs) running on a large number of physical machines (PMs). Such a virtualization technique can be used for conserving power consumption by minimizing the number of PMs that should be turned on according to the application requirements to resource. However, the resource demands for VMs is dynamic in nature since the number of user requests the applications should handle is rapidly changing in practice. It is a great challenge to online reconfigure the VMs (i.e., optimize the number and the locations for the VMs) according to the dynamic resource demands. Especially for the emerging applications of large-scale data centers for cloud computing systems, existing approaches either fails to find a best configuration of VMs or cannot produce a result in an acceptable time. In this paper, we propose an online self-reconfiguration approach for reallocating VMs in large-scale data centers. It first accurately predicts the future workloads of the applications with Brown’s quadratic exponential smoothing. Based on such a prediction, it adopts a genetic algorithm to efficiently find the optimal reconfiguration policy. The resource utilization of large-scale cloud computing data centers can thus be improved and their energy consumption can be greatly conserved. We conduct extensive experiments and the results verify that our approach can effectively switch off more unnecessary running PMs comparing with current approaches without a performance degradation of the whole system.
**Application & Industry Session 13 – Cloud Computing**  (Session Chair: Patrick C.K. Hung, University of Ontario Institute of Technology, Canada)

**Resource Allocation and SLA Determination for Large Data Processing Services over Cloud (SCC2010-2066)**  
K. Hima Karanam, Tanveer A. Faruque, L. Venkata Subramaniam, Mukesha Mohania, and Girish Venkatachalliah (IBM Research India; IBM India Software Lab)

Data processing on the cloud is increasingly used for offering cost effective services. In this paper, we present a method for resource allocation for data processing services over the cloud taking into account not just the processing power and memory requirements, but the network speed, reliability and data throughput. We also present algorithms for prioritization data, for doing parallel block data transfer to achieve better throughput and allocated cloud resources. We also present methods for optimal pricing and determination of Service Level Agreements for a given data processing job. The usefulness of our approach is shown through experiments performed under different resource allocation conditions.

**Cross Enterprise Improvements Delivered via a Cloud Platform: A Game Changer for the Consumer Product and Retail Industry (SCC2010-2067)**  
Trieu Chieu, Shubir Kapoor, Ajay Mohindra, and Anees Shaikh (IBM T.J. Watson Research Center, USA)

Gaining visibility into their retail supply chain has become a top priority for the Consumer Product (CP) industry. However, taking a “do-it-yourself” approach to the problem is proving to be both expensive and complex. Cloud Computing, with its on-demand provisioning capability on shared resources, has emerged as a new paradigm to address the challenges of the CP industry. In this paper, we describe a framework for deployment of business analytic solutions on a Cloud platform. We illustrate the benefits of the approach in the context of the Demand Driven Business Analytic solution that provides demand signals to CP manufacturers.

**PeopleCloud Service for Enterprise Crowdsourcing (SCC2010-2068)**  
Mariana Lopez, Maja Vukovic, and Jim Laredo (Carnegie Mellon; IBM T.J. Watson Research Center)

Web 2.0 provides the technological foundations upon which the crowdsourcing paradigm evolves and operates, enabling enterprises, universities and eGovernments, to access scalable networks of knowledge experts on-line. However, there is no existing practice allowing for coordination of crowdsourcing tasks, and their integration with existing business processes and embedding these services into the Web fabric. In this paper, we examine two applications of enterprise crowdsourcing service in the domain of IT Service Delivery: 1) IT Inventory Management and 2) End-User Support. We illustrate how a) expert discovery mechanism, b) virtual team building capabilities, c) task management and d) provisioning of task-based services, enable enterprises to effectively build knowledge networks, which are able to execute complex and transformative knowledge-intensive tasks. Finally, based on the application analysis, we propose PeopleCloud, an on-demand service system, which spawns and manages scalable virtual teams of knowledge workers by either (1) building on the wisdom of crowds within an enterprise or across a value chain or (2) creating a marketplace for accessing specialists on-line.

**Application & Industry Session 14 – SOA Management and Coordination**  (Session Chair: Rong Chang, IBM T. J. Watson Research Center, USA)

**SOAC: A Conceptual Model for Managing Service-Oriented Authorization (SCC2010-2069)**  
Haoyang Sun, Weiliang Zhao, and Jian Yang (Macquarie University, Australia)

A web service can be composed of multiple com- ponent web services in a loosely-coupled environment. Traditional Role Based Access Control (RBAC) is in-adequate for the authorization management of compos-ite services since the administration of the component web services has not been taken into consideration. In this paper, we propose a novel conceptual model, named as Service Oriented Authorization Control (SOAC) to facilitate the administration and management for both service consumers and component web services. A set of administrative functions are also provided for managing the elements of SOAC. This research will be the rst step towards managing service-oriented authorization.

**Legacy Asset Analysis and Integration in Model-Driven SOA Solution (SCC2010-2070)**  
Nianjun Zhou, Liang-Jie Zhang, Yi-Min Chee, and Lei Chen (IBM T.J. Watson Research Center, USA)

In this paper, we study legacy asset reuse for SOA design. Typically, the cost of reusing legacy assets is much lower than the cost of creating new services from scratch. As an extension of our SOA service modeling, we use top-down approaches to identify business services, and use asset modeling for legacy asset identification to find potential reusable assets for those services. Using service capacity analysis, we evaluate the maturity of a legacy asset for transformation to a service. Finally, we provide a model transformation to convert a service model with legacy assets into an SOA reference architecture model. Our effort integrates asset reuse as a part of the overall SOA design cycle and increases the possibility of asset reuse. To help architects use our method in engineering practice, we have implemented our method in the SOMA-ME tooling environment.

**Towards a Variability Model for SOA-Based Solutions (SCC2010-2071)**  
Nanjugal C. Narendra, and Karthikkeyan Vonnalappa (IBM Research India)

The prevalent approach to developing business solutions is driven by requirements expressed as process models. This is essentially a top-down model-driven approach for building solutions from a given process model specification, from scratch. However, in order to enhance the reusability of such solutions, the emphasis has now shifted to defining business solutions via service-oriented architectures (SOAs) that compose software services to support business processes. This enables creating and reusing services and processes as software “assets” which is more scalable and profitable. In this context, the key to reusing assets is to support the right mechanisms to incrementally refine existing software services as well as business processes. Our earlier works, viz., Variation Oriented Engineering (VOE) and Variation Oriented Service Design (VOSD), proposed some mechanisms in this direction. But our experiences in developing and inducting VOE and VOSD into IBM’s business units motivated the need for a rigorous formal foundation for variability in SOA-based solutions. To that end, this paper proposes a Variability Model for SOA-based solutions, through which variations in a service can be modeled and maintained. Our Variability Model also clarifies the extent to which an existing service can be modified to suit a business process requirement, while ensuring that the overall integrity of the service is maintained. We also present an algorithm for determining whether a variant of a service is a legal variant, and we demonstrate our Variability Model on a realistic running example in the insurance domain, via a prototype built on IBM’s Rational Software Architect modeling tool.
Aligning IT Service Levels and Business Performance: A Case Study (SCC2010-2072)

Thiago Barroero, Giannario Motta, Giovanni Pignatelli, Mario Bochicchio, Antonella Longo, Alessandra Raffone, Maurizio Lombardi, and Massimo Manuelli (University of Pavia; University of Salento, Italy; TF5 S.p.A.)

TSF is an Italian IT service company, focused on logistics and transportation IT market segments. It is able to support customer’s business operations through a complex IT service chain, appraised by a Service Level Management (SLM) system. Due to the long term contractual relationship (10 years) with Italian Railways, TSF developed a symbiotic relationship with its main customer, becoming co-accountable for its business performance. This aspect has highlighted the necessity of the definition of an extended SLM model able to correlate the customer business performances with the delivered ICT service levels, in the perspective of an end-to-end service delivery chain. The paper illustrates the conceptual approach and the method adopted to overcome this problem in a pilot project.

Process as a Service - Distributed Multi-tenant Policy-Based Process Runtime Governance (SCC2010-2073)

Mingxue Wang, Kosala Yapa Bandara, and Claus Pahl (Dublin City University, Ireland)

With the emergence of Business Process Outsourcing and Cloud Computing, enterprises are looking for available business processes outside of their organizations to quickly adopt to new business requirements and also reduce process development and maintenance costs. The process execution needs to be governed as policy enforcement might differ between different clients. Since a process is deployed outside of the organizations and serves multiple process clients, distribution and multi-tenancy have become two requirements for runtime governance of service processes. We address this problem by introducing a policy-oriented aspectual business process framework. The runtime governance from process clients are integrated as aspects through dynamic weaving into process execution.

An Ontology to support Context-Aware B2B Services (SCC2010-2074)

P.S. Tan, A.E.S. Goh, S.S.G. Lee (Singapore Institute of Manufacturing Technology; Nanyang Technological University, Singapore)

In present day globalised trade, the ability to support collaboration through B2B (Business-to-Business) services is crucial. One of the key challenges is to pervasively connect partners across the entire value chain, with the appropriate service offerings. Thus, it is vital to quickly identify potential partners to form new B2B collaborations or to support formed collaborations with swift decision making abilities. This paper proposes the use of Description Logic (DL) based reasoning to ensure completeness and decidability in reasoning for context-aware B2B services. A B2B Context Model is realised through a DL-based representation language called OWL (Web Ontology Language). The expressivity of OWL was extended through the SWRL (Semantic Web Rule Language), to represent business rules identified in the model. The performance scalability of an ontology based knowledge base using OWL was then investigated. Results showed that such a knowledge base is not scalable.

Business-driven Trust Federation Management for Service Marketplaces (SCC2010-2075)

Ji Hu, Xiaoyi Fan, and Fischer Robin (SAP Research Center Karlsruhe; Forschungszentrum Informatik; Karlsruhe Institute of Technology, Germany)

In web service ecosystems, business participants, such as service consumers, service providers and service marketplaces are required to form temporary collaborations to support virtual and dynamic business value networks. This requires participants in the collaboration to establish ondemand trust relationships (i.e. a trust federation) between each other and hence enable service sharing or consumption between partners in a secure and trustworthy way. This paper proposes a business-driven approach that can effectively manage the lifecycle of a trust federation according to business decisions taking place in service marketplaces. By leveraging a federation management architecture, we can establish, enforce, update, or dissolve trust relationships required by business collaborations on demand, which greatly reduces the costs for complicated and error-prone trust configurations in individual enterprise domains.

Work-in-Progress Track

Work-in-Progress Session 1 – Implementation of Services Computing (Session Chair: Antoine Schlechter, Centre de Recherche Public – Gabriel Lippmann, Luxembourg)

Formal Passive Testing of Service-Oriented Systems (SCC2010-2076)

Cesar Andres, M. Emilia Cambronero, and Manuel Nunez (Universidad Complutense de Madrid; Universidad de Castilla-La Mancha, Spain)

This paper presents a formal framework to perform passive testing of service-oriented systems. Our approach uses the historical interaction files between web services to check the absence of faults. It uses a set of properties, that we call invariants, to represent the most relevant expected behaviour of the web services under test. Intuitively, an invariant expresses the fact that each time the system under test performs a given sequence of actions, it must exhibit a behavior reflected in the invariant. Invariants can be defined from a local point of view, that is, to check properties of isolated web services, and from a global point of view, that is, to check web service interaction properties. In order to increase applicability and adaption to a real environment, we assume that we do not have a global log. We show how to use local logs (recorded in each web service) in order to check local properties and how to combine them in order to check global properties.

A Service Identification Framework for Legacy System Migration into SOA (SCC2010-2077)

Saad Alahmari, Ed Zaluska, and David De Roure (University Southampton, UK)

Service-Oriented Architecture (SOA) enables the re-engineering and migration of legacy software systems into loosely-coupled and interoperable sets of services. Existing approaches focus mainly on defining coarse-grained services corresponding to the key business requirements. An improved migration of legacy systems onto SOA-based systems requires identifying the ‘optimal’ services with an appropriate level of granularity. This paper proposes a novel framework which identifies the key services effectively. The framework approach focuses on defining these services based on a Model-Driven Architecture approach supported by a SOA meta-model. Effective guidelines are proposed for identifying the optimal service granularity over a wide range of possible service types.

Towards a Foundation for Quantitative Service Analysis - An Approach from Business Process Models (SCC2010-2078)

Naveen Kulkarni, Deepthi Parachuri, and Shashank Trivedi (Infosys Technologies Ltd, India)

Recent advancements in process centric systems, the concept of Services have been adopted widely over business processes. Services which are discrete reusable functional blocks have become the choice to achieve highest order of reuse. However, key to having such services is to identify
them with right objectives. Current methods and techniques for service analysis are heuristic and rely heavily on the experience and intuition of the designer. We present the prerequisite formalism for service analysis from business process models and basic quantitative metrics.

Towards Self-Aware Performance and Resource Management in Modern Service-Oriented Systems (SCC2010-2079)  
Samuel Kounev, Fabian Brosig, Nikolaus Huber and Ralf Reussner (Karlsruhe Institute of Technology, Germany)

Modern service-oriented systems have increasingly complex loosely-coupled architectures that often exhibit poor performance and resource efficiency and have high operating costs. This is due to the inability to predict at runtime the effect of dynamic changes in the system environment (e.g., varying service workloads) and adapt the system configuration accordingly. In this paper, we describe a long-term vision and approach for designing systems with built-in self-aware performance and resource management capabilities. We advocate the use of architecture-level performance models extracted dynamically from the evolving system configuration and maintained automatically during operation. The models will be exploited at run-time to adapt the system to changes in the environment ensuring that resources are utilized efficiently and performance requirements are continuously satisfied.

Work-in-Progress Session 2 – Data Management in Services Computing (Session Chair: Nianjun Zhou (Joe), IBM T.J. Watson Research Center, USA)

Supporting Geosciences Web Services Metadata Management and Discovery (SCC2010-2080)  
Pearl Brazier, Artem Chebotko, Eric Gonzalez, Andrey Kashev, and Anthony Piazza (The University of Texas-Pan American, USA)

Geosciences Web portals are becoming increasingly important for supporting geoscientists in their research. The GEO-SEED portal is a repository of geosciences web services metadata, represented in Resource Description Framework (RDF), which supports management and discovery by machines and automated agents. This project uses SPARQL, the W3C standard for querying RDF, to support discovery of web services. SPARQL query performance becomes more critical as the amount of RDF metadata in the repository increases. Most existing RDF storage systems are based on relational database technology. The problem with most of these systems is that their query performance is limited by the use of fixed schema mapping strategies. In this paper, we present our system, called S2ST, which addresses this issue in the context of geosciences web services metadata management. Our experiments show that S2ST provides better SPARQL performance than existing relational RDF storage systems.

Utility Decomposition and Surplus Redistribution in Composite SLA Negotiation (SCC2010-2081)  
Jan Richter, Mohan Barnawal Chhetri, Ryszard Kowalczyk, Bao Quoc Vo, Muhammed Adeel Talib, and Alan Colman (Swinburne University of Technology, Australia)

The end-to-end QoS negotiation for SLA establishment for composite services involves multiparty negotiations in which the composite service provider concurrently negotiates with multiple candidates for each atomic service, selecting the ones that best satisfy the atomic service QoS preferences while ensuring that end-to-end QoS requirements are also fulfilled. In order to negotiate with potential candidates, it is necessary to derive the atomic utility boundaries from the global utility boundary. Additionally, there needs to be a mechanism to update these boundaries in subsequent negotiation rounds based upon the individual negotiation outcomes. In this paper, we propose an algorithm that addresses these requirements and evaluate it using an example scenario for composite service provisioning.

Functionality-Driven Clustering of Web Service Registries (SCC2010-2082)  
Mohamed Sellami, Walid Gaooud, and Samir Tata (Institut TELECOM, TELECOM SudParis, CNRS UMR Samovar, Evry, France)

Web service registries play an important role in service oriented applications. They constitute the market where service consumers and providers go to search and advertise Web services. With the proliferation of Web service registries, finding an adequate registry has become a complex task for a service requester. In this paper we propose a semantic model for Web services registry description (WSRD). WSRD descriptions depict the functionalities offered by services advertised by a given registry since they rely on these descriptions. We also propose a functionality-driven clustering approach for distributed Web service registries. This approach is based on a fuzzy clustering technique and allows structuring distributed registries based on their WSRD descriptions without any additional data. This clustering will be helpful for selecting an adequate registry for service requesters.

Work-in-Progress Session 3 – Management and Support of Services Computing (Session Chair: Karin Breitman, PUC-Rio)

Toward Consistent Combination of Service Selection Methods and Process Adaptation Methods (SCC2010-2083)  
Fayuki Ishikawa (GRACE Center National Institute of Informatics, Japan)

A variety of methods have been proposed for selection of service providers as well as adaptation of business processes to manage service providers. However, each method is discussed under a certain set of often implicit assumptions or expectations. It has thus not clearly discussed how selection methods and adaptation methods can be chosen and combined in a consistent way with each other and with the target business process. This paper provides an overview of our study toward an analysis, design and implementation framework to promote consistent use of service selection methods and process adaptation methods with different assumptions.

Task Exception Handling in the VIEW Scientific Workflow System (SCC2010-2084)  
Dong Ruan and Shiyong Lu (Wayne State University, USA)

Scientific workflows have been widely used by scientists to accelerate research experiments and achieve scientific discoveries. Due to the nature of science, scientific workflows often involve complex workflow design and distributed computation resources, so abnormal events are likely to happen and interrupt the normal execution of workflows. Restarting workflows is often too expensive and painful to do, especially for those long-running workflows. Thus, exception handling plays a significant role in the context of scientific workflows. In this paper, we present our ongoing work on exception handling in the VIEW scientific workflow management system.

A Framework for Shrink-Wrapping Security Services (SCC2010-2085)  
Gleneesha Johnson, Ashok Agrawala, and Elovej Billionnire (University of Maryland; Arizona State University, USA)

To achieve effective security in the increasingly dynamic computing environment of the mobile workforce our perspectives on security have to change, requiring the development of new approaches. We discuss a new security paradigm, shrink-wrapped security, in which security services are tightly coupled to a user’s situation, and present a framework to help enable its realization.

Enhancing Web Service Registries with Semantics and Context Information (SCC2010-2086)
With the increasing demand for dynamic web service composition, traditional web service registries are no longer adequate in providing precise service selection. To address this problem, the paper proposes a fine-grain structural concept for traditional service registries, called web service community. Efficient semantic-level service query and community management depend on context information. This paper investigates the issue of context modeling and proposes four categorizations of context information for service composition. Several design issues that relate to these context information are discussed, including community organization, context-aware management and semantic-level web service query.

**Work-in-Progress Session 4 – Services Delivery and Applications** *(Session Chair: Roberto De Virgilio, Universita’ Roma Tre, Italy)*

**Converged Service Delivery: Modeling and Engineering (SCC2010-2087)***

Noemie simoni, Chunyang Yin, Philippe Couto (TELECOM ParisTech; Société Française de Radiotéléphonie (SFR) – DRDS)

With the success of the network convergence, we have no more difficulty to transport most of contents and deliver any service. However, nowadays’ users desire to have their own services with a richer media as the content. As a result, it challenges to reconsider a new service paradigm and its delivery. Driven by the trend of different mobility and service ubiquity, the service convergence comes into sight as a promising solution facing the NGS context. Moreover, reengineering is needed for the delivery of the converged services. Existing solutions as IN, SOA and WS have not been able to completely cover all the converged service delivery needs. This paper proposes to redesign the service by modelling its structure and converged interfaces. We proposed a loose coupling between service elements (service composition) as well as a more flexible deployment of services (service aggregation) in order to meet converged service delivery.

**A Framework for Personalized Context-Aware Search of Ontology-Based Tagged Data (SCC2010-2088)***

Knarig Arbabshian (Alcatel-Lucent, Bell Labs Murray Hill, USA)

We describe a framework for personalized contextaware search of ontology-based tagged data. As more services are offered on the Web, it is becoming increasingly difficult for users to manage their context online. We propose a framework that performs context-aware search of tagged data using a tag ontology that includes context information in addition to tag keywords to present more meaningful search results to users. Keywords: ontologies, OWL, tag, folksonomy, contextaware computing

**A Novel Software Environment for Developing Migrating Internet Applications Based on Fusion of Mobile Agent, Web Services and BPEL Technologies (SCC2010-2089)***

J.M.Gnanasekar, Venkatesan D. Pillai (Anna University, India)

Incorporating code mobility to inter-operable internet enabled software applications improves efficiency, performance and network traffic reduction. Present mobile agent technology fails to leverage the interoperable web infrastructure developed in a standard compliant manner. Here we describe a development environment and technology that fuse Workflow, Web 2.0, SOA and WS-BPEL and create a distributed computing environment (ACtive E-commerce Framework called ACEF) that permit creation of inter operable, infrastructure leveraging migratable code for design of active internet applications.

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**Research Track**

**Research Track 1 – Data-centric Cloud** *(Session Chair: Louise Moser, University of California, Santa Barbara, USA)*

**Data Intensive Query Processing for Large RDF Graphs Using Cloud Computing Tools (CLOUD2010-3001)***

Mohammad Farhan Husain, Latifur Khan, Murat Kantarciglu, and Bhavani Thuraisingham (University of Texas at Dallas, USA)

Cloud computing is the newest paradigm in the IT world and hence the focus of new research. Companies hosting cloud computing services face the challenge of handling data intensive applications. Semantic web technologies can be an ideal candidate to be used together with cloud computing tools to provide a solution. These technologies have been standardized by the World Wide Web Consortium (W3C). One uch standard is the Resource Description Framework (RDF). With the explosion of semantic web technologies, large RDF graphs are common place. Current frameworks do not scale for large RDF graphs. In this paper, we describe a framework that we built using Hadoop, a popular open source framework for Cloud Computing, to store and retrieve large numbers of RDF triples. We describe a scheme to store RDF data in Hadoop Distributed File System. We present an algorithm to generate the best possible query plan to answer a SPARQL Protocol and RDF Query Language (SPARQL) query based on a cost model. We have implemented the Hadoop’s MapReduce framework to answer the queries. Our results show that we can store large RDF graphs in Hadoop clusters built with cheap commodity class hardware. Furthermore, we show that our framework is scalable and efficient and can easily handle billions of RDF triples, unlike traditional approaches.

**Model-Based Planning for State-Related Changes to Infrastructure and Software as a Service Instances in Large Data Centers (CLOUD2010-3002)***

Sebastian Hagen and Alfonso Kemper (Technical University Munich (TUM), Germany)

To deliver 3-tier applications as a Service in the Cloud state-related constraints crossing Infrastructure- and Software as a Service boundaries need to be managed. By automating the lifecycle of applications like databases, load balancers, and web application servers rich SaaS business services can be provided in the Cloud. We propose an object oriented planning approach based on state constraints to plan for changes of SaaS and IaaS components in the Cloud. We evaluate techniques for fast storing and restoring of large object oriented Configuration Management Databases and show that enforcing constraints in a procedural instead of a declarative way offers huge performance improvements. The
advantages of our approach lie within the tight integration of the planning algorithm with object oriented models frequently used for Configuration Management Databases. In addition to that, the algorithm scales to a large number of nodes and preserves its runtime even for large, heavily loaded data centers.

Using Cloud Technologies to Optimize Data-Intensive Service Applications (CLOUD2010-3003)

Dirk Habich, Wolfgang Lehner, Sebastian Richly, and Uwe Assmann (Dresden University of Technology, Germany)

The role of data analytics increases in several application domains to cope with the large amount of captured data. Generally, data analytics are data-intensive processes, whose efficient execution is a challenging task. Each process consists of a collection of related structured activities, where huge data sets have to be exchanged between several loosely coupled services. The implementation of such processes in a service-oriented environment offers some advantages, but the efficient realization of data flows is difficult. Therefore, we use this paper to propose a novel SOA-aware approach with a special focus on the data flow. The tight interaction of new cloud technologies with SOA technologies enables us to optimize the execution of data-intensive service applications by reducing the data exchange tasks to a minimum. Fundamentally, our core concept to optimize the data flows is found in data clouds: Moreover, we can exploit our approach to derive efficient process execution strategies regarding different optimization objectives for the data flows.

Research Track 2 – Cloud Architecture (Session Chair: Vasu Singh, IST Austria)

Enterprise Cloud Service Architecture (CLOUD2010-3004)

Longji Tang, Jing Dong, Yajing Zhao, and Liang-Jie Zhang (University of Texas at Dallas, IBM T.J. Watson Research Center, USA)

Cloud computing, a new paradigm of distributed computing, introduces many new ideas, concepts, principals, technologies and architectural styles into enterprise service-oriented computing. The enterprise service-oriented architecture (ESOA) style is an abstraction of concrete enterprise service-orientated architectures, which includes SOA architectural elements, service design patterns as well as SOA quality attributes. It can be extended to a new style for realizing enterprise cloud computing. Meanwhile, the principles and style of enterprise service-oriented computing facilitate the enterprise-wide adoption of cloud computing. This paper extends the ESOA style to a new hybrid architectural style, Enterprise Cloud Service Architecture (ECSA). The style is described by extending enterprise service-oriented formula for ESOA. We model the style through specifying each element in the formula with both service-oriented and cloud architectural styles.

Towards Living Landscape Models: Automated Integration of Infrastructure Cloud in Enterprise Architecture Management (CLOUD2010-3005)

Mathias Farwick, Berthold Agreiter, Ruth Breu, Matthias Häring, Karsten Voges, and Inge Hanschke (University of Innsbruck, Austria, iteratec GmbH Munich, Germany)

Enterprise Architecture Management (EAM), and in particular IT-landscape management try to model the IT and business elements of a company, in order to analyze its efficiency towards supporting business goals, optimize business-IT alignment, and to plan future IT-transformation as well as IT-standardization. A major challenge in this field is the elicitation of infrastructure information from run-time systems, e.g., to answer the question which servers provide services to a specific information system. Capturing this data is a time consuming manual task which leads to quickly outdated information. Similar to traditional hardware, cloud infrastructure needs to be documented in an EA model in order to gain insight on its relationships with business information systems and ultimately the business goals. The aim of our research in this area is the automatic integration of various runtime information sources into an EAM view. The overall goal is to minimize manual work to keep enterprise architecture information up-to-date. This enables enterprise architects to make timely and precise decisions. In this work we focus on how information on the cloud infrastructure can be seamlessly integrated into an EA view. Making the cloud visible for enterprise architects is especially important to meet legal (privacy) requirements, on the storage and processing location of data. We present a conceptual approach for the information integration problem, and introduce our prototypical implementation with the open-source infrastructure cloud implementation Eucalyptus, and the open-source enterprise architecture management tool iterplan.

A Review of Cloud Business Models and Sustainability (CLOUD2010-3006)

Victor Chang, Gary Wills, and David De Roure (University of Southampton, UK)

This paper reviews current cloud computing business models and presents proposals on how organisations can achieve sustainability by adopting appropriate models. Using the Jericho Forum’s Cloud Cube Model (CCM), we classify cloud computing business models into eight types: (1) Service Provider and Service Orientation; (2) Support and Services Contracts; (3) In-House Private Clouds; (4) All-In-One Enterprise Cloud; (5) One-Stop Resources and Services; (6) Government Funding; (7) Venture Capitals; and (8) Entertainment and Social Networking. We newly propose the Hexagon Model that includes six key elements for sustainability based on Sun Tzu’s Art of War and literature review, and the sixth factor is rated based on case studies and peer reviews. Areas occupied in the Hexagon can represent strengths and weaknesses of a cloud business, and several cases are presented with rationale explained. Apart from the qualitative approach, the quantitative approach we use is the Capital Asset Pricing Model and Modern Portfolio Theory, both of which aim computing organisational sustainability and predict how well an organisation can perform. The OMII-UK data is used to demonstrate sustainability and study the impact on cloud businesses, and is presented by statistical computation, 3D visualisation and the Hexagon Model. We believe that adopting an appropriate cloud computing business model will help organisations investing in this technology to stand firm at all times.

Research Track 3 – Cloud QoS (Session Chair: Ling Liu, Georgia Tech, USA)

Understanding Performance Interference of I/O Workload in Virtualized Cloud Environments (CLOUD2010-3007)

Xing Pu, Ling Liu, Yiduo Mei, Sankaran Sivathanu, Younggyun Koh, and Calton Pu (Georgia Institute of Technology, USA, Beijing Institute of Technology, Xi’an Jiaotong University, China)

Server virtualization offers the ability to slice large, underutilized physical servers into smaller, parallel virtual machines (VMs), enabling diverse applications to run in isolated environments on a shared hardware platform. Effective management of virtualized cloud environments introduces new and unique challenges, such as efficient CPU scheduling for virtual machines, effective allocation of virtual machines to handle both CPU intensive and I/O intensive workloads. Although a fair number of research projects have dedicated to measuring, scheduling, and resource management of virtual machines, there still lacks of in-depth understanding of the performance factors that can impact the efficiency and effectiveness of resource multiplexing and resource scheduling among virtual machines. In this paper, we present our experimental study on the performance interference in parallel processing of CPU and network intensive workloads in the Xen Virtual Machine Monitors (VMMs). We...
conduct extensive experiments to measure the performance interference among VMs running network I/O workloads that are either CPU bound or network bound. Based on our experiments and observations, we conclude with four key findings that are critical to effective management of virtualized cloud environments for both cloud service providers and cloud consumers. First, running network intensive workloads in isolated environments on a shared hardware platform can lead to high overheads due to extensive context switches and events in driver domain and VMM. Second, co-locating CPU intensive workloads in isolated environments on a shared hardware platform can incur high CPU contention due to the demand for fast memory pages exchanges in I/O channel. Third, running CPU intensive workloads and network-intensive workloads in conjunction incurs the least resource contention, delivering higher aggregate performance. Last but not the least, identifying factors that impact the total demand of the exchanged memory pages is critical to the in-depth understanding of the interference overheads in I/O channel in the driver domain and VMM.

Performance Measurements and Analysis of Network I/O Applications in Virtualized Cloud (CLOUD2010-3008)
Yiduo Mei, Ling Liu, Xing Pu, and Sankaran Sitaraman (Georgia Tech, USA, Xi an Jiaotong University; Beijing Institute of Technology, China)
Virtualization is a key technology for cloud based data centers to implement the vision of infrastructure as a service (IaaS) and to promote effective server consolidation and application consolidation. However, current implementation of virtual machine monitor does not provide sufficient performance isolation to guarantee the effectiveness of resource sharing, especially when the applications running on multiple virtual machines of the same physical machine are competing for computing and communication resources. In this paper, we present our performance measurement study of network I/O applications in virtualized cloud. We focus our measurement based analysis on performance impact of co-locating applications in a virtualized cloud in terms of throughput and resource sharing effectiveness, including the impact of idle instances on applications that are running concurrently on the same physical host. Our results show that by strategically co-locating network I/O applications, performance improvement for cloud consumers can be as high as 34%, and the cloud providers can achieve over 40% performance gain.

Fault Tolerance Middleware for Cloud Computing (CLOUD2010-3009)
Wenbing Zhao, P.M. Melliar-Smith, and I.E. Moser (Cleveland State University Cleveland, University of California, USA)
The Low Latency Fault Tolerance (LLFT) middleware provides fault tolerance for distributed applications deployed within a cloud computing or data center environment, using the leader/follower replication approach. The LLFT middleware consists of a Low Latency Messaging Protocol, a Leader-Determined Membership Protocol, and a Virtual Determinizer Framework. The LLFT middleware provides a fast reconfiguration and recovery service when a replica becomes faulty and when a replica joins or leaves a group. The Virtual Determinizer Framework captures ordering information at the primary replica and enforces the same ordering at the backup replicas for major sources of nondeterminism. The LLFT middleware maintains strong replica consistency, offers application transparency, and achieves low end-to-end latency.

Research Track 4 – Cloud Resource Management (Session Chair: Waltenegus Dargie, Technical University of Dresden, Germany)

Integrating Resource Consumption and Allocation for Infrastructure Resources On-Demand (CLOUD2010-3010)
Ying Zhang, Gang Huang, Xuanzhe Liu, and Hong Mei (Peking University, USA)
Infrastructure resources on-demand requires provision resource management (e.g., CPU and memory) to be both sufficient and necessary, which is the most important issue and a challenge in Cloud Computing. Platform as a service (PaaS) encapsulates a layer of software that includes middleware, and even development environment, and provides them as a service for building and deploying cloud applications. In PaaS, the issue of on-demand infrastructure resource management becomes more challenging due to the thousands of cloud applications that share and compete for resources simultaneously. The fundamental solution is to integrate and coordinate the resource consumption and allocation management of a cloud application. The difficulties of such a solution in PaaS are essentially how to maximize the resource utilization of an application, and how to allocate resources to guarantee adequate resource provision for the system. In this paper, we propose an approach to managing infrastructure resources in PaaS by leveraging two adaptive control loops: the resource consumption optimization loop and the resource allocation loop. The optimization loop improves the resource utilization of a cloud application via management functions provided by the corresponding middleware layers of PaaS. The allocation loop provides or reclaims appropriate amounts of resources to/from the application system while guaranteeing its performance. The two loops are integrated to run consecutively and repeatedly to provide infrastructure resources on-demand by first trying to improve resource utilization, and then allocating more resources when necessary. We implement a framework, SmartRod, to investigate our approach. The experiment on SmartRod proves its effectiveness on infrastructure resource management.
In computing clouds, it is desirable to avoid wasting resources as a result of under-utilization and to avoid lengthy response times as a result of over-utilization. In this paper, we propose a new approach for dynamic autonomous resource management in computing clouds. The main contribution of this work is two-fold. First, we adopt a distributed architecture where resource management is decomposed into independent tasks, each of which is performed by Autonomous Node Agents that are tightly coupled with the physical machines in a data center. Second, the Autonomous Node Agents carry out configurations in parallel through Multiple Criteria Decision Analysis using the PROMETHEE method. Simulation results show that the proposed approach is promising in terms of scalability, feasibility and flexibility.

**Research Track 5 – Cloud Applications**  
**Session Chair:** Feng Liu, Avaya Labs Research, Avaya, USA

**Social Cloud: Cloud Computing in Social Networks**  
Kyle Chard, Simon Eaton, Omer Rana, and Kris Babendorfer (Victoria University, New Zealand; Karlsruhe Institute of Technology, Germany; Cardiff University, UK)

With the increasingly ubiquitous nature of Social networks and Cloud computing, users are starting to explore new ways to interact with, and exploit these developing paradigms. Social networks are used to reflect real world relationships that allow users to share information and form connections between one another, essentially creating dynamic Virtual Organizations. We propose leveraging the pre-established trust formed through friend relationships within a Social network to form a dynamic “Social Cloud”, enabling friends to share resources within the context of a Social network. We believe that combining trust relationships with suitable incentive mechanisms (through financial payments or bartering) could provide much more sustainable resource sharing mechanisms. This paper outlines our vision of, and experiences with, creating a Social Storage Cloud, looking specifically at possible market mechanisms that could be used to create a dynamic Cloud infrastructure in a Social network environment.

**Mining Twitter in the Cloud: A Case Study**  
Pieter Noordhuis, Michiel Heijkoop, and Alexander Lazovik (University of Groningen, The Netherlands)

Mining and analyzing data from social networks can be difficult because of the large amounts of data involved. Such activities are usually very expensive, as they require a lot of computational resources. With the recent success of cloud computing, data analysis is going to be more accessible due to easier access to less expensive computational resources. In this work we propose to use cloud computing services as a possible solution for analysis of large amounts of data. As a source for a large data set, we propose to use Twitter, yielding a graph with 50 million nodes and 1.8 billion edges. In this paper, we use computation of PageRank on Twitter’s social graph to investigate whether or not cloud computing, and Amazon cloud services in particular, can make these tasks more feasible and, as a side effect, whether or not PageRank provides a good ranking of Twitter users.

**Cloud Computing: A Digital Libraries Perspective**  
Pradeep Teregowda, Bhuvan Urgaonkar, and C. Lee Giles (Pennsylvania State University, UK)

Provisioning and maintenance of infrastructure for Web based digital library search engines such as CiteSeerx present several challenges. CiteSeerx provides autonomous citation indexing, full text indexing, and extensive document metadata from documents crawled from the web across computer and information sciences and related fields. Infrastructure virtualization and cloud computing are particularly attractive choices for CiteSeerx, which is challenged by both growth in the size of the indexed document collection, new features and most prominently usage. In this paper, we discuss constraints and choices faced by information retrieval systems like CiteSeerx by exploring in detail aspects of placing CiteSeerx into current cloud infrastructure offerings. We also implement an ad-hoc virtualized storage system for experimenting with adoption of cloud infrastructure services. Our results show that a cloud implementation of CiteSeerx may be a feasible alternative for its continued operation and growth.

**Research Track 6 – Cloud Models**  
**Session Chair:** Li Li, Avaya Labs Research, Avaya, USA

**Characterizing Cloud Federation for Enhancing Providers’ Profit**  
Iñigo Goiri, Jordi Gutierrez, and Jordi Torres (Universitat Politecnica de Catalunya and Barcelona Supercomputing Center, Spain)

Cloud federation has been proposed as a new paradigm that allows providers to avoid the limitation of owning only a restricted amount of resources, which forces them to reject new customers when they have not enough local resources to fulfill their customers’ requirements. Federation allows a provider to dynamically outsource resources to other providers in response to demand variations. It also allows a provider that has underused resources to rent part of them to other providers. Both things could make the provider to get more profit when used adequately. This requires that the provider has a clear understanding of the potential of each federation decision, in order to choose the most convenient depending on the environment conditions. In this paper, we present a complete characterization of providers’ federation in the Cloud, including decision equations to outsource resources to other providers, rent free resources to other providers (i.e. insourcing), or shutdown unused nodes to save power, and we characterize these decisions as a function of several parameters. Then, we demonstrate in the evaluation section how a provider can enhance its profit by using the sequations to exploit federation, and how the different parameters influence which is the best decision on each situation.

**Maximizing Cloud Providers’ Revenues via Energy Aware Allocation Policies**  
Michele Mazzucco, Dmytro Dyachuk, and Ralph Deters (University of Cyprus, Cyprus; University of Saskatchewan, Canada; University of Tartu, Estonia)

Cloud providers, like Amazon, offer their data centers’ computational and storage capacities for lease to paying customers. High electricity consumption, associated with running a data center, not only reflects on its carbon footprint, but also increases the costs of running the data center itself. This paper addresses the problem of maximizing the revenues of Cloud providers by trimming down their electricity costs. As a solution allocation policies which are based on the dynamic powering servers on and off are introduced and evaluated. The policies aim at satisfying the conflicting goals of maximizing the users’ experience while minimizing the amount of consumed electricity. The results of numerical experiments and simulations are described, showing that the proposed scheme performs well under different traffic conditions.

**THEMIS: Towards Mutually Verifiable Billing Transactions in the Cloud Computing Environment**  
Ki-Woong Park, Sung Kyu Park, Jaesun Han, and Kya Ho Park (Korea Advanced Institute of Science and Technology; NexR Co.Ltd)
The ability to record and keep account of the usage of cloud resources in a credible and verifiable way is a precursor to widespread cloud deployment and availability because usage information is potentially sensitive and must be verifiably accurate. In an attempt to provide a mutually verifiable resource usage and billing mechanism, we found that the frequent asymmetric key operations of a digital signature lead to excessive computations and a bottleneck of billing transactions. As a remedy for these limitations, we propose a mutually verifiable billing system called THEMIS. The system, which introduces the concept of a cloud notary authority for the supervision of billing, makes billing more objective and acceptable to users and cloud service providers. THEMIS generates mutually verifiable binding information that can be used to resolve future disputes between a user and a cloud service provider. Because THEMIS does not require any asymmetric key operations of users and providers, it provides a level of security that is identical to that of a Public Key Infrastructure (PKI) and it minimizes the latency of billing transactions. This work has been undertaken on a real cloud computing service called iCube Cloud.

Research Track 7 – Cloud Migration (Session Chair: Claude Godart, University Henri Poincar, France)

Adaptive Data Migration in Multi-tiered Storage Based Cloud Environment (CLOUD2010-3019)
Gong Zhang, Lawrence Chiui, and Ling Liu (Georgia Institute of Technology; IBM Almaden Research Center, USA)

Multi-tiered storage systems today are integrating Solid State Disks (SSD) on top of traditional rotational hard disks for performance enhancement due to the significant I/O improvements in SSD technology. It is widely recognized that automated data migration between SSD and HDD plays a critical role in effective integration of SSD into multi-tiered storage systems. Furthermore, effective data migration has to take into account of application specific workload characteristics, deadlines, and I/O profiles. An important and interesting challenge for automated data migration in multi-tiered storage systems is how to fully release the power of data migration while guaranteeing the migration deadline is critical to maximizing the performance of SSD-enabled multi-tiered storage system. In this paper, we present an adaptive lookahead data migration model that can incorporate application specific characteristics and I/O profiles as well as workload deadlines. Our adaptive data migration model has three unique features. First, it incorporates a set of key factors that may impact on the performance of lookahead migration efficiency in our formal model develop. Second, our data migration model can adaptively determine the optimal lookahead window size, based on several parameters, to optimize the effectiveness of lookahead migration. Third, we formally and experimentally show that the adaptive data migration model can improve overall system performance and resource utilization while meeting workload deadlines. Through our trace driven experimental study, we compare the adaptive lookahead migration approach with the basic migration model and show that the adaptive migration model is effective and efficient for continuously improving and tuning of the performance and scalability of multi-tier storage systems.

Workload Migration into Clouds – Challenges, Experiences, Opportunities (CLOUD2010-3020)
C. Ward, N. Aravamudan, K. Bhattacharya, K. Cheng, R. Filepp, R. Kearney, B. Peterson, L. Shwartz, and C.C. Young (IBM, USA)

The steady drumbeat of Cloud as a disruptive influence for Infrastructure Service Providers (ISP’s) and the enabler vehicle for Software As A Service (SAAS) providers can be heard loud and clear in the industry today. In fact, Cloud is probably at the peak of the hype curve, and already there are identified challenges associated with effective deployment for business critical applications (so called Production Applications) in mature enterprises. One of these challenges is the smooth migration of workload from the previous environment to the new cloud enabled environment in a cost effective way, with minimal disruption and risk. In this paper we introduce extensions to an integrated automation capability called the Darwin framework that enables workload migration for this scenario and discuss the impact that automated migration has on the cost and risks normally associated with migration to clouds.

Towards Self-Assisted Troubleshooting for the Deployment of Private Clouds (CLOUD2010-3021)
Michael R. Head, Anca Sailer, Hidayatullah Shaikh, and Dennis Shea (IBM T. J. Watson Research Center, USA)

Acquiring a private computing cloud is the first step that an enterprise would choose to enable the cloud model and get its considerable benefits while keeping the control within the enterprise. The enterprise level applications that provide the infrastructure enabling cloud computing services are typically built by integrating inter-related complex software components. Critical challenges of these applications are the increasing level of inter-component dependencies and the customized growth, which make recurrent deployment of such applications, as the one required in private clouds, labor intensive and error prone. In this paper we investigate the type of issues faced when deploying a cloud computing management infrastructure and propose a solution to self-assist the deployment. We show how by leveraging virtual image technologies we can detect faulty installations and their signatures early in the deployment process. We also propose a methodology to capture in a shared repository and update these signatures for reuse in subsequent deployments in the form of two level signature patterns. We explore the perspective of our solution and criteria of analysis.

Research Track 8 – Cloud Security and Data Access (Session Chair: Anna C Squicciarini, Penn State University, USA)

Secure Virtual Machine Execution under an Untrusted Management OS (CLOUD2010-3022)
Chunxiao Li, Asand Raghunathan, and Niraj K. Jha (Princeton University; Purdue University, USA)

Virtualization is a rapidly evolving technology that can be used to provide a range of benefits to computing systems, including improved resource utilization, software portability, and reliability. For security-critical applications, it is highly desirable to have a small trusted computing base (TCB), since it minimizes the surface of attacks that could jeopardize the security of the entire system. In traditional virtualization architectures, the TCB for an application includes not only the hardware and the virtual machine monitor (VMM), but also the whole management operating system (OS) that contains the device drivers and virtual machine (VM) management functionality. For many applications, it is not acceptable to trust this management OS, due to its large code base and abundance of vulnerabilities. In this paper, we address the problem of providing a secure execution environment on a virtualized computing platform under the assumption of an untrusted management OS. We propose a secure virtualization architecture that provides a secure run-time environment, network interface, and secondary storage for a guest VM. The proposed architecture significantly reduces the TCB of security-critical guest VMs, leading to improved security in an untrusted management environment. We have implemented a prototype of the proposed approach using the Xen virtualization system, and demonstrated how it can be used to facilitate secure remote computing services. We evaluate the performance penalties incurred by the proposed architecture, and demonstrate that the penalties are minimal.

Flexible Data Access in a Cloud Based on Freshness Requirements (CLOUD2010-3023)
Laura Cristina Voicu, Heiko Schuld, Yuri Breithart, and Hans-Jürg Schek (University of Basel, Switzerland; Kent University, USA; ETH)
Data clouds are newly emerging environments in which commercial providers manage large volumes of data with individual quality of service (QoS) guarantees per customer. These guarantees mainly include keeping several replicas of each data item in different distributed data centers for availability purposes. However, as the cost of maintaining several updateable replicas per data object is very high, cloud providers rather offer only a limited number of synchronously updated replicas (i.e., replicas that are always up-to-date) together with several readonly replicas that are updated in a lazy way and thus might hold stale data. QoS agreements may also include the maintenance of dedicated archives (copies of data which are frozen at some point in time). Stale data allow cloud providers to offer a variety of read operations with different semantics, e.g., read the most recent data, read data not older than or not younger than some timestamp t, or read data produced between t1 and t2, or read data exactly as of t. These read operations can be supported by a read-only site using a stale replica. In this paper we present our approach to cloud data management, based on a recent protocol for data grids. We discuss in detail how the refresh of individual replicas is provided in a completely distributed way. Finally, we present the results of a performance evaluation in a data cloud setting.

Preventing Information Leakage from Indexing in the Cloud (CLOUD2010-3024)
Anna Spiggiarini, Smitha Sundareswaran, and Dan Lin (Penn State University; Missouri University of Science and Technology, USA)
Cloud computing enables highly scalable services to be easily consumed over the Internet on an as-needed basis. While cloud computing is expanding rapidly and used by many individuals and organizations internationally, data protection issues in the cloud have not been carefully addressed at current stage. Users’ fear of confidential data (particularly financial and health data) leakage and loss of privacy in the cloud may become a significant barrier to the wide adoption of cloud services. In this paper, we explore a newly emerging problem of information leakage caused by indexing in the cloud. We design a three-tier data protection architecture to accommodate various levels of privacy concerns by users. According to the architecture, we develop a novel portable data binding technique to ensure strong enforcement of users’ privacy requirements at server side.

Research Track 9 – Cloud Data Management (Session Chair: Yuqing Gao, IBM T.J. Watson Research, USA)

Data Flow Driven Scheduling of BPEL Workflows Using Cloud Resources (CLOUD2010-3025)
Tim Dörnemann, Ernst Juhnke, Thomas Noll, Dominik Seiler, and Bernd Freisleben (University of Marburg, Germany)
In this paper, an approach to assign BPEL workflow steps to available resources is presented. The approach takes data dependencies between workflow steps and the utilization of resources at runtime into account. The developed scheduling algorithm simulates whether the makespan of workflows could be reduced by providing additional resources from a Cloud infrastructure. If yes, Cloud resources are automatically set up and used to increase throughput. The proposed approach does not require any changes to the BPEL standard. An implementation based on the ActiveBPEL engine and Amazon’s Elastic Compute Cloud is presented. Experimental results for a real-life workflow from a medical application indicate that workflow execution times can be reduced significantly.

Storage Management in Virtualized Cloud Environment (CLOUD2010-3026)
Sankaran Sivathanu, Ling Liu, Mei Yiduo, and Xing Pu (Georgia Institute of Technology; Xi’an Jiaotong University; Beijing Institute of Technology, China)
With Cloud Computing gaining tremendous importance in the recent past, understanding low-level implications of the cloud infrastructure becomes necessary. One of the key technologies deployed in large Cloud infrastructures namely the Amazon EC2 for providing isolation and separate protection domains for multiple clients is virtualization. Therefore, identifying the performance bottlenecks in a virtualized setup and understanding the implications of workload combinations and resource configurations on the overall I/O performance helps both the cloud providers in managing their infrastructure efficiently and also their customers by means of better performance. In this paper we present the measurement results of detailed experiments conducted on a virtualized setup focusing on the storage I/O performance. We categorize our experimental evaluation into four components, each of which presenting some significant factors that affect storage I/O performance. Our experimental results can be useful for cloud application developers to tune their applications for better I/O performance and for the cloud service providers to make more effective decisions on resource provisioning and workload scheduling.

Metadata Partitioning for Large-Scale Distributed Storage Systems (CLOUD2010-3027)
Jan-Jan Wu, Pangfeng Liu, and Yi-Chien Chung (Research Center for Information Technology Innovation Academia Sinica, Taiwan; National Taiwan University)
With the emergence of large-scale storage systems that separate metadata management from file read/write operations, and with requests targeting metadata account for over 80% of the total number of I/O requests, metadata management has become an interesting research problem on its own. When designing a metadata server cluster, the partitioning of the metadata among the servers is of critical importance for maintaining efficient metadata operations and balanced load distribution across the cluster. We propose a dynamic programming method combined with binary search to solve the partitioning problem. With theoretical analysis and extensive experiments, we show that our algorithm finds the partitioning that minimizes load imbalance among servers and maximize efficiency of metadata operations.

Research Track 10 – Cloud Management (Session Chair: Stefano Ferretti, University of Bologna, Italy)

Autonomic Management of Cloud Service Centers with Availability Guarantees (CLOUD2010-3028)
Bernardetta Addis, Danilo Ardagna, Barbara Panicucci, and Li Zhang (Dipartimento di Elettronica Informazione, Italy; IBM T.J. Watson Research Center, USA)
Modern cloud infrastructures live in an open world, characterized by continuous changes in the environment and in the requirements they have to meet. Continuous changes occur autonomously and unpredictably, and they are out of control of the cloud provider. Therefore, advanced solutions have to be developed able to dynamically adapt the cloud infrastructure, while providing continuous service and performance guarantees. A number of autonomic computing solutions have been developed such that resources are dynamically allocated among running applications on the basis of short-term demand estimates. However, only performance and energy trade-off have been considered so far with a lower emphasis on the infrastructure dependability/availability which has been demonstrated to be the weakest link in the chain for early cloud providers. The aim of this paper is to fill this literature gap devising resource allocation policies for cloud virtualized environments able to identify performance and energy trade-offs, providing a priori availability guarantees for cloud end-users.

Cost-Optimal Scheduling in Hybrid IaaS Clouds for Deadline Constrained Workloads (CLOUD2010-3029)
With the recent emergence of public cloud offerings, surge computing – outsourcing tasks from an internal data center to a cloud provider in times of heavy load – has become more accessible to a wide range of consumers. Deciding which workloads to outsource to what cloud provider in such a setting, however, is far from trivial. The objective of this decision is to maximize the utilization of the internal data center and to minimize the cost of running the outsourced tasks in the cloud, while fulfilling the applications’ quality of service constraints. We examine this optimization problem in a multi-provider hybrid cloud setting with deadline-constrained and preemptible but non-provider-migratable workloads that are characterized by memory, CPU and data transmission requirements. Linear programming is a general technique to tackle such an optimization problem. At present, it is however unclear whether this technique is suitable for the problem at hand and what the performance implications of its use are. We therefore analyze and propose a binary integer program formulation of the scheduling problem and evaluate the computational costs of this technique with respect to the problem’s key parameters. We found out that this approach results in a tractable solution for scheduling applications in the public cloud, but that the same method becomes much less feasible in a hybrid cloud setting due to very high solve time variances.

**Reducing Costs of Spot Instances via Checkpointing in the Amazon Elastic Compute Cloud** (CLOUD2010-3030) Sangho Yi, Derrick Kondo, and Artur Andrzejak (INRIA Grenoble Rhône-Alpes, France; Zuse Institute Berlin (ZIB), Germany)
Recently introduced spot instances in the Amazon Elastic Compute Cloud (EC2) offer lower resource costs in exchange for reduced reliability: these instances can be revoked abruptly due to price and demand fluctuations. Mechanisms and tools that deal with the cost-reliability trade-offs under this schema are of great value for users seeking to lessen their costs while keeping reliability at a high level. We study how one such a mechanism, namely checkpointing, can be used to minimize the cost and volatility of resource provisioning. Based on the real price history of the spot instances we compare several adaptive checkpointing schemes in terms of monetary costs and improvement of job completion times. A trace-based simulation shows that our approach can reduce significantly both the price and the task completion time.

**Application and Industry Track**

**Application and Industry Session 1 – Cloud Architecture** (Session Chair: Vasu Singh, IST Austria)

**Compliant Cloud Computing (C3): Architecture and Language Support for User-Driven Compliance Management in Clouds** (CLOUD2010-3031)
Ivona Brandic, Schahram Dustdar, Tobias Anstett, David Schumann, Frank Leymann, and Ralf Konrad (Vienna University, Austria; University of Stuttgart, Germany; T-Systems International GmbH Frankfurt, Germany) Cloud computing represents a promising computing paradigm, where computational power is provided similar to utilities like water, electricity or gas. While most of the Cloud providers can guarantee some measurable non-functional performance metrics e.g., service availability or throughput, there is lack of adequate mechanisms for guaranteeing certifiable and auditable security, trust, and privacy of the applications and the data they process. This lack represents an obstacle for moving most business relevant applications into the Cloud. In this paper we devise a novel approach for compliance management in Clouds, which we termed Compliant Cloud Computing (C3). On one hand, we propose novel languages for specifying compliance requirements concerning security, privacy, and trust by leveraging domain specific languages and compliance level agreements. On the other hand, we propose the C3 middleware responsible for the deployment of certifiable and auditable applications, for provider selection in compliance with the user requirements, and for enactment and enforcement of compliance level agreements. We underpin our approach with a use case discussing various techniques necessary for achieving security, privacy, and trust in Clouds as for example data fragmentation among different protection domains or among different geographical regions.

**A Framework for Optimized Distribution of Tenants in Cloud Applications** (CLOUD2010-3032)
Christoph Fehling, Frank Leymann, and Ralph Mietzner (University of Stuttgart Universitatsstr Germany)
To be successful a cloud service provider has to target a preferably large customer group to leverage economies of scale. Therefore an application offered as a service in the cloud is often configurable regarding non-functional qualities, such as location or availability. Since many of these qualities depend on the resources on which the service is hosted, a large number of computing environments has to be managed by the service provider. This paper analyses the challenges arising from such a scenario and identifies several optimization opportunities originating from an intelligent distribution of users among the functionally equal resources with different quality of services. A framework enabling the development of distribution strategies exploiting these opportunities is defined. It allows modeling of resources, their deployment dependencies, and users with specific demands. An architecture and prototype of a management system is introduced to handle the required resource provisioning and user request routing. Several optimization strategies are defined and their performance is evaluated using statistical data of an existing cloud service provider.

He Huang, Luxiang Wang (University of Wyoming, USA)
Cloud computing paradigm contains many shared resources, such as infrastructures, data storage, various platforms and software. Resource monitoring involves collecting information of system resources to facilitate decision making by other components in Cloud environment. It is the foundation of many major Cloud computing operations. In this paper, we extend the prevailing monitoring methods in Grid computing, namely Pull model and Push model, to the paradigm of Cloud computing. In Grid computing, we find that in certain conditions, Push model has high consistency but low efficiency, while Pull model has low consistency but high efficiency. Based on complementary properties of the two models, we propose a user-oriented resource monitoring model named Push&Pull (P&P) for Cloud computing, which employs both the above two models, and switches the two models intelligently according to users’ requirements and monitored resources’ status. The experimental result shows that the P&P model decreases updating costs and satisfies various users’ requirements of consistency between monitoring components and monitored resources compared to the original models.

**Application and Industry Session 2 – Cloud Security & Accounting** (Session Chair: Min Luo, IBM, USA)

**Security Models and Requirements for Healthcare Application Clouds** (CLOUD2010-3034)
Rui Zhang and Ling Liu (Georgia Institute of Technology, USA; Beijing Jiaotong University, China)
With the widespread use of electronic health record (EHR), building a secure EHR sharing environment has attracted a lot of attention in both healthcare industry and academic community. Cloud computing paradigm is one of the popular health IT infrastructure for facilitating EHR sharing and EHR integration. In this paper we discuss important concepts related to EHR sharing and integration in healthcare clouds and analyze the arising security and privacy issues in access and management of EHRs. We describe an EHR security reference model for managing security issues in healthcare clouds, which highlights three important core components in securing an EHR cloud. We illustrate the development of the EHR security reference model through a use-case scenario and describe the corresponding security countermeasures and state of art security techniques that can be applied as basic security guards.

**Attack Surfaces: A Taxonomy for Attacks on Cloud Services** (CLOUD2010-3035)  
Nils Gruschka and Melko Jensen (NEC Europe Ltd. Heidelberg; IT-Security Ruhr University Bochum, Germany)

The new paradigm of cloud computing poses severe security risks to its adopters. In order to cope with these risks, appropriate taxonomies and classification criteria for attacks on cloud computing are required. In this work-in-progress paper we present one such taxonomy based on the notion of attack surfaces of the cloud computing scenario participants.

Prasad Saripalli and Ben Walters (Runaware Inc. USA)

A quantitative risk and impact assessment framework (QUIRC) is presented, to assess the security risks associated with cloud computing platforms. This framework, called QUIRC, defines risk as a combination of the Probability of a security threat event and its Severity, measured as its Impact. Six key Security Objectives (SO) are identified for cloud platforms, and it is proposed that most of the typical attack vectors and events map to one of these six categories. Wide-band Delphi method is proposed as a scientific means to collect the information necessary for assessing security risks. Risk assessment knowledge bases could be developed specific to each industry vertical, which then serve as inputs for security risk assessment of cloud computing platforms. QUIRC’s key advantage is its fully quantitative and iterative convergence approach, which enables stakeholders to comparatively assess the relative robustness of different cloud vendor offerings and approaches in a defensible manner.

**Application and Industry Session 3 – Cloud Evaluation** (Session Chair: Luís Ferreira Pires, University of Twente, the Netherlands)

**Toward Ease of Discovery, Selection and Use of Clusters within a Cloud** (CLOUD2010-3037)  
Michael Brock and Andrezj Gosinski (Deakin University, Australia)

While the emergence of clouds had lead to a significant paradigm shift in business and research, cloud computing is still in its infancy. Specifically, there is no effective publication and discovery service nor are cloud services easy to use. This paper presents a new technology for offering ease of discovery, selection and use of clusters hosted within clouds. By improving these services, cloud clusters become easily accessible to all clients, software services to noncomputing human users.

**Service Level Checking in the Cloud Computing Context** (CLOUD2010-3038)  
Antonin Chazalet (Orange Labs, FRANCE)

Cloud Computing raises numerous questions about the implementation and deployment of Service-Oriented Architecture (SOA) and virtualization. It also raises questions related to services contracts, their management and verification, independently of services migration within the Cloud(s). Issues and solutions related to the verification of contracts compliance are referred as Service Level Checking (SLC). Implementing SLC in the Cloud Computing context requires an innovating and functional architecture, in order to separate monitoring information collection concerns from contracts compliance verification concerns. Such contracts of Service Level Agreements (SLAs) apply to the target systems and services. In order to solve the separation of concerns issue, we have used the mediation approach. Our architecture and prototype have been implemented and validated in the context of the French ANR SemEUsE and European Celtic SERVERY cooperative research projects.

**An Evaluation of Distributed Datastores Using the AppScale Cloud Platform** (CLOUD2010-3039)  
Chris Bunch, Navraj Chohan, Chandra Krintz, Jovan Chohan, Jonathan Kupferman, Pancee Lakhiha, Yiming Li, Yoshishide Nomura (University of California, USA; Fujitsu Labs Ltd., Japan)

We present new cloud support that employs a single API – the Datastore API from Google App Engine (GAE) – to interface to different open source distributed database technologies. We employ this support to “plug in” these technologies to the API so that they can be used by web applications and services without modification. The system facilitates an empirical evaluation and comparison of these disparate systems by web software developers, and reduces the barrier to entry for their use by automating their configuration and deployment.

**Application and Industry Session 4 – Cloud QoS** (Session Chair: Sascha Hunold, ICSI Berkeley, USA)

**A Runtime Model Based Monitoring Approach for Cloud** (CLOUD2010-3040)  
Jin Shao, Hao Wei, Qianxiang Wang, Mei Hong (Peking University, China)

Monitoring plays a significant role in improving the quality of service in cloud computing. It helps clouds to scale resource utilization adaptively, to identify defects in services for service developers, and to discover usage patterns of numerous end users. However, due to the heterogeneity of components in clouds and the complexity arising from the wealth of runtime information, monitoring in clouds faces many new challenges. In this paper, we propose a runtime model for cloud monitoring (RMCN), which denotes an intuitive representation of a running cloud by focusing on common monitoring concerns. Raw monitoring data gathered by multiple monitoring techniques are processed by RMCN to present a more intuitive profile of a running cloud. We applied RMCN in the implementation of a flexible monitoring framework, which can achieve a balance between runtime overhead and monitoring capability via adaptive management of monitoring facilities. Our experience of utilizing the monitoring framework on a real cloud demonstrates the feasibility and effectiveness of our approach.

**QoS-Aware Clouds** (CLOUD2010-3041)  
Stefano Ferretti, Vittorio Ghini, Fabio Pancieri, Michele Pellegrini, Elisa Turirini (Computer Science University of Bologna Bologna, Italy)

In this paper we discuss the design and experimental evaluation of a middleware architecture that enables Service Level Agreement (SLA)-driven dynamic configuration, management and optimization of cloud resources and services. This architecture has been designed in order to respond effectively to the Quality of Service (QoS) requirements of the cloud customer applications. Typically, an application can be hosted in an...
execution platform constructed out of (real and virtual) cloud resources. In this context, the application QoS requirements can be specified in a SLA that binds the application to its hosting platform. Our architecture incorporates a load balancer that distributes the computational load across the platform resources, and monitors the QoS the platform delivers. If this deviates from that specified in the SLA, so as to violate it, the platform is reconfigured dynamically in order to incorporate additional resources from the cloud. In contrast, if the SLA is honored and platform resources result unused, platform reconfiguration occurs to release those unused resources.

**Performance and Power Management for Cloud Infrastructures (CLOUD2010-3042)**

Hien Nguyen Van, Frédéric Dang Tran, and Jean-Marc Menaud (Orange Labs; Mines de Nantes/INRIA, France)

A key issue for Cloud Computing data-centers is to maximize their profits by minimizing power consumption and SLA violations of hosted applications. In this paper, we propose a resource management framework combining a utility-based dynamic Virtual Machine provisioning manager and a dynamic VM placement manager. Both problems are modeled as constraint satisfaction problems. The VM provisioning process aims at maximizing a global utility capturing both the performance of the hosted applications with regard to their SLAs and the energy-related operational cost of the cloud computing infrastructure. We show several experiments how our system can be controlled through high level handles to make different trade-offs between application performance and energy consumption or to arbitrate resource allocations in case of contention.

**Application and Industry Session 5 – Scalable Cloud (Session Chair: Kenneth Hopkinson, Air Force Institute of Technology, USA)**

**How to Enhance Cloud Architectures to Enable Cross-Federation (CLOUD2010-3043)**

Antonio Celesti, Francesco Tusa, Massimo Villari, and Antonino Paliatto (Università di Studi di Messina, Italy)

The near future evolution of the cloud computing can be hypothesized in three subsequent stages: stage 1 “Monolithic” (now), cloud services are based on independent proprietary architectures; stage 2 “Vertical Supply Chain”, cloud providers will leverage cloud services from other providers; stage 3 “Horizontal Federation”; smaller, medium, and large cloud providers will federate themselves to gain economies of scale and an enlargement of their capabilities. Currently, the major clouds are planning the transition to the stage 2, but how to achieve the stage 3 is unclear because some architectural limitations have to be overcome. In this paper, considering a general cloud architecture, we highlight such limitations and propose some enhancements which add new federation capabilities. In order to address such concerns we propose a solution based on the Cross-Cloud Federation Manager, a new component placeable inside the cloud architectures, allowing a cloud to establish the federation with other clouds according to a three-phase model: discovery, match-making and authentication.

**Scalable Support for 3D Graphics Applications in Cloud (CLOUD2010-3044)**

Weidong Shi, Yang Lu, Zhu Li, and Jonathan Engelsma (VITie Inc.; Hong Kong Polytechnic University; Grand Valley State University)

Recent advances in virtualization technology and wide acceptance of the cloud computing model are having significant impact on the software service industry. Though cloud computing and virtualization technologies have been widely applied in supporting the information processing needs of conventional enterprise and business applications, there has been little success to-date in enabling real-time 3D virtual appliances in the cloud. This paper aims to address this deficiency by presenting SHARC, a solution for enabling scalable support of real-time 3D applications in a cloud computing environment. The solution uses a scalable pipelined processing infrastructure which consists of three processing networks according to the principle of division-of-labor, a virtualization server network for running 3D virtual appliances, a graphics rendering network for processing graphics rendering workload with load balancing, and a media streaming network for transcoding rendered frames into H.264/MPEG-4 media streams and streaming the media streams to a cloud user. The paper describes a prototype implementation of SHARC and reports test results that demonstrate the viability of this approach.

**LH*RE: A Scalable Distributed Data Structure with Recoverable Encryption (CLOUD2010-3045)**

Sushil Jajodia, Witold Litwin, and Thomas Schwarz (George Mason University; Université Paris Dauphine, France; Universidad Católica de Uruguay, Uruguay)

LH*RE is a new Scalable Distributed Data Structure (SDDS) for hash files stored in a cloud. The client-side symmetric encryption protects the data against the server-side disclosure. The encryption key(s) at the client are backed up in the file. The client may recover/revive any keys lost or stolen from its node. A trusted official can also do it on behalf of the client or of an authority, e.g., to imperatively access the data of a client missing or disabled. In contrast, with high assurance, e.g., 99%, the attacker of the cloud should not usually disclose any data, even if the intrusion succeeds over dozens or possibly thousands of servers for a larger file. Storage and primary key-based access performance of LH*RE should be about those of the well-known LH* SDDS. Two messages should typically suffice for a key-based search and four in the worst case, with the application data load factor of 70%, regardless of the file scale up. These features are among most efficient for a hash SDDS. LH*RE should be attractive with respect to the competition.

**Application and Industry Session 6 – Cloud Middleware (Session Chair: Hong Cai, IBM China Software Development Lab)**

**A Lifetime Supporting Framework for Cloud Applications (CLOUD2010-3046)**

Shigeru Hosono, He Huang, Tatsunori Hara, Yoshiaki Shimomura, and Tamio Arai (NEC Corporation, Japan; NEC Advanced Software Technology (Beijing) Co., Ltd., China; The University of Tokyo; Tokyo Metropolitan University, Japan)

This paper proposes a framework, which integrates the development and operation environments for cloud applications. Adopting perspectives on lifecycle management, the framework is equipped with tools and platforms, which seamlessly integrate lifetime phases: requirement analysis, architecture design, application implementation, operation and improvement. These are predicated on theories in design engineering, enabling identification of constraints arising in the development process and of dependencies among functional modules. A case study shows the feasibilities of the design principles, and indicates possibilities for the framework to be an Application Platform as a Service (APaaS), which can form an eco-system of datacenter operators, systems integrators and application providers.

**Dynamic Provisioning Modeling for Virtualized Multi-tier Applications in Cloud Data Center (CLOUD2010-3047)**

Jing Bi, Zhiliang Zhu, Ruixiong Tian, and Qingbo Wang (Northeastern University; IBM China Research Lab, China)

Dynamic provisioning is a useful technique for handling the virtualized multi-tier applications in cloud environment. Understanding the performance of virtualized multi-tier applications is crucial for efficient cloud infrastructure management. In this paper, we present a novel dynamic provisioning technique for a cluster-based virtualized multi-tier application that employ a flexible hybrid queueing model to determine
the number of virtual machines at each tier in a virtualized application. We present a cloud data center based on virtual machine to optimize resources provisioning. Using simulation experiments of three-tier application, we adopt an optimization model to minimize the total number of virtual machines while satisfying the customer average response time constraint and the request arrival rate constraint. Our experiments show that cloud data center resources can be allocated accurately with these techniques, and the extra cost can be effectively reduced.

**SciCumulus: A Lightweight Cloud Middleware to Explore Many Task Computing Paradigm in Scientific Workflows**  
*Daniel de Oliveira, Eduardo Ogassawara, Fernanda Baido, and Marta Matteoso (COPPE/UFRJ, NP2Tec/UNIRIO)*

Most of the large-scale scientific experiments modeled as scientific workflows produce a large amount of data and require workflow parallelism to reduce workflow execution time. Some of the existing Scientific Workflow Management Systems (SWfMS) explore parallelism techniques such as parameter sweep and data fragmentation. In those systems, several computing resources are used to accomplish many computational tasks in homogeneous environments, such as multiprocessor machines or cluster systems. Cloud computing has become a popular high performance computing model in which (virtualized) resources are provided as services over the Web. Some scientists are starting to adopt the cloud model in scientific domains and are moving their scientific workflows (programs and data) from local environments to the cloud. Nevertheless, it is still difficult for the scientist to express a parallel computing paradigm for the workflow on the cloud. Capturing distributed provenance data at the cloud is also an issue. Existing approaches for executing scientific workflows using parallel processing are mainly focused on homogeneous environments whereas, in the cloud, the scientist has to manage new aspects such as initialization of virtualized instances, scheduling over different cloud environments, impact of data transferring and management of instance images. In this paper we propose SciCumulus, a cloud middleware that explores parameter sweep and data fragmentation parallelism in scientific workflow activities (with provenance support). It works between the SWfMS and the cloud. SciCumulus is designed considering cloud specificities. We have evaluated our approach by executing simulated experiments to analyze the overhead imposed by clouds on the workflow execution time.

**Application and Industry Session 7 – Cloud Composition**  
*（Session Chair: Dirk Habich, Dresden University of Technology, Germany）*

**An Architecture for a Mashup Container in Virtualized Environments**  
*Michele Stecca and Massimo Maresca (DIST University of Genova; DEI University of Padova, Italy)*

This paper presents the architecture and the organization of a Mashup Container that supports the deployment and the execution of Event Driven Mashups (i.e., Composite Services in which the Services interact through events rather than through the classical Call-Response paradigm) following the Platform as a Service model in the Cloud Computing paradigm. We describe the two main modules of the container, namely the Deployment Module and the Service Execution Platform, and focus our attention on the performance on of the latter. In particular we discuss the results of an evaluation test that we run in a virtualized environment (VMware based) supporting scalability and fault tolerance.

**IC Cloud: A Design Space for Composable Cloud Computing**  
*Li Guo, Yike Guo, and Xiangchuan Tian (Imperial College London, UK)*

Cloud computing has attracted great interest from both academic and industrial communities. Different paradigms, architectures and applications have emerged. However, to the best of our knowledge, only few efforts have been devoted to study the architecture as well as implementation details for building up a cloud computing system. In this paper, we present our design and implementation of Imperial College Cloud (IC Cloud). The goal of IC Cloud is to provide a generic design space where various cloud computing architectures and implementation strategies can be systematically studied. The IC Cloud design strictly follows the SOA principle and incorporates a highly flexible system design approach.

**SaaS Integration for Software Cloud**  
*Feng Liu, Weiping Guo, Zhi Qiang Zhao, and Wu Chou (Avaya Labs Research, Avaya Inc., USA)*

Software as a Service (SaaS) has been adopted in a fast pace for applications and services on software clouds. However, the success of SaaS in software cloud cannot obscure the integration challenges faced by developers and enterprise infrastructure IT. Among those challenges, firewall/NAT traversal and security issues often pose a serious bottleneck as enterprises may not be entirely comfortable running mission critical applications outside the corporate firewall. On the other hand, SaaS applications in the cloud need to access enterprise on-premise applications for data exchange and on-premises services. The current approaches through opening special pin-holes on firewall or using dedicated VPNs have encountered a number of limitations and drawbacks. This paper presents a Proxy-based firewall/NAT traversal solution for SaaS integration (PASS). It allows SaaS applications to integrate with on-premise applications without firewall reconfiguration, while maintaining the security of on-premise applications. In addition, this approach is platform and application independent, making the SaaS integration seamless. Moreover, PASS is consistent with the enterprise web browsing infrastructure, and it requires little or no change to enterprise firewall/NAT configurations. In this paper we present the architecture of PASS and address SaaS integration challenges in software cloud, such as security/firewall, performance, and scalability. Experimental study based on our implemented system shows that the proposed approach of PASS is promising to resolve firewall/NAT traversal for SaaS integration with on-premise services.

**Application and Industry Session 8 – Cloud Resource Management**  
*（Session Chair: Xumin Liu, Rochester Institute of Technology, USA）*

**From Data Center Resource Allocation to Control Theory and Back**  
*Xavier Dutreilh, Nicolas Rivierre, Aurélien Moreau, Jacques Melenfant, Isis Truck (Orange Labs; Université Pierre et Marie Curie/LIP6; Université Paris 8/LIASD)*

Continuously adjusting the horizontal scaling of applications hosted by data centers appears as a good candidate to automatic control approaches allocating resources in closedloop given their current workload. Despite several attempts, real applications of these techniques in cloud computing infrastructures face some difficulties. Some of them essentially turn back to the core concepts of automatic control: controllability, inertia of the controlled system, gain and stability. In this paper, considering our recent work to build a management framework dedicated to automatic resource allocation in virtualized applications, we attempt to identify from experiments the sources of instabilities in the controlled systems. As examples, we analyze two types of policies: threshold-based and reinforcement learning techniques to dynamically scale resources. The experiments show that both approaches are tricky and that trying to implement a controller without looking at the way the controlled system reacts to actions, both in time and in amplitude, is doomed to fail. We discuss both lessons learned from the experiments in terms of simple yet key points to build good resource management policies, and longer term issues on which we are currently working to manage contracts and
reinforcement learning efficiently in cloud controllers.

**Optimal Resource Allocation in Clouds** (CLOUD2010-3053)

Fangzhe Chang, Jennifer Ren, Ramesh Viswanathan (Bell Labs, Alcatel-Lucent, USA)

Cloud platforms enable enterprises to lease computing power in the form of virtual machines. An important problem for such enterprise users is to understand how many and what kinds of virtual machines will be needed from clouds. We formulate demand for computing power and other resources as a resource allocation problem with multiplicity, where computations that have to be performed concurrently are represented as tasks and a later task can reuse resources released by an earlier task. We show that finding a minimized allocation is NP-complete. This paper presents an approximation algorithm with a proof of its approximation bound that can yield close to optimum solutions in polynomial time. Enterprise users can exploit the solution to reduce the leasing cost and amortize the administration overhead (e.g., setting up VPNs or configuring a cluster). Cloud providers may utilize the solution to share their resources among a larger number of users.

**HyperDealer: Reference-Pattern-Aware Instant Memory Balancing for Consolidated Virtual Machines** (CLOUD2010-3054)

Woomin Hwang, Yangwoo Roh, Youngwoo Park, Ki-Woong Park, Kya Ho Park (Korea Advanced Institute of Science and Technology)

Memory contention among consolidated virtual machines (VMs) creates the need for a memory balancing operation. In an attempt to provide a prompt memory balancing mechanism, we found problems with the retardation of memory transfer by the reclamation delay. The scheduling of the VMs generates the delay, and a conflict of two reclamation policies between the guest OS and the hypervisor deteriorates it. As a remedy to these problems, we propose HyperDealer, which selects the victim page by applying reference patterns, reclaims the pages with hypervisor-level paging, and transfers those pages with ballooning of the guest OS. Our scheme eliminates the involvement of the victim VM in memory balancing and extends the dwell time of reclaimed pages in the reclaimed state. Consequently, HyperDealer significantly reduces the time taken to transfer memory with a low overhead and enhances the value of additional memory for the recipient VM. The experimental results of our scheme show that the application performance in the recipient VM is 11% more time-efficient and has a penalty which is 50% less than previous approaches.

**Application and Industry Session 9 – Case Studies** (Session Chair: Chazalet Antonin, France Télécom R&D - Orange Labs)

**Is Server Consolidation Beneficial to MMORPG? A Case Study of World of Warcraft** (CLOUD2010-3055)

Yeng-Ting Lee, Kuang-Ta Chen (Institute of Information Science, Academia Sinica, Taiwan)

MMORPG is shown to be a killer application of Internet, with a global subscriber number increased to 17 millions in 2010. However, MMORPG servers tend to be overly provisioned because 1) such games do not have standard architectures thus dedicated hardware is assumed; 2) MMORPGs normally adopt a “sharded design” to resolve the scalability challenges of content production and workload distribution; and 3) a game is commonly deployed in geographically distributed data centers to protect gamers from excessive network latencies. Therefore, an operator needs to deploy dedicated hardware for each game in each data center, even though hardware utilization is low. In this paper, we propose a zone-based server consolidation strategy for MMORPGs, which exploits the unique spatial locality property of players’ interactions, to cut down the games’ considerable hardware requirement and energy use. We evaluate the effectiveness of our strategy based on a nine-month trace from a popular MMORPG World of Warcraft. The evaluation results show that, with a per-hour dynamic zone reallocation policy, the server number required can be reduced by 52% and the total energy consumption can be reduced by 62%, while the user-experienced latency remains ungraded.

**Open Source Cloud Computing Tools: A Case Study with a Weather Application** (CLOUD2010-3056)

Manuel Rodríguez-Martínez, Jaime Seguel, and Melvin Greer (University of Puerto Rico, Mayagüez; Lockheed Martin)

Cloud Computing is a promising paradigm designed to harness the power of networks of computers and communications in a more cost effective way. Clouds provide elastic capacity to serve a wide and constantly expanding range of information processing needs, including government, military, business and education. The Cloud Computing paradigm is maturing rapidly and is being considered for adoption in government and business platforms. Open source systems refer to software systems whose source code is available, allowing for immediate incorporation of improvements and adaptations of the system by its users. This paper reports on an evaluation of open source development tools for Cloud Computing. The main tools examined are Eucalyptus, Apache Hadoop, and the Django-Python stack. These tools were used at different layers in the construction of a notional application for managing weather data. The results of our experience are reported in terms of a capability matrix that grades nine different aspects associated with the use of these tools in the development and deployment of applications in open source Cloud Computing environments.

**Cloud Migration: A Case Study of Migrating an Enterprise IT System to IaaS** (CLOUD2010-3057)

Ali Khajeh-Hosseini, David Greenwood, and Ian Sommerville (University of St Andrews, UK)

This case study illustrates the potential benefits and risks associated with the migration of an IT system in the oil & gas industry from an in-house data center to Amazon EC2 from a broad variety of stakeholder perspectives across the enterprise, thus transcending the typical, yet narrow, financial and technical analysis offered by providers. Our results show that the system infrastructure in the case study would have cost 37% less over 5 years on EC2, and using cloud computing could have potentially eliminated 21% of the support calls for this system. These findings seem significant enough to call for a migration of the system to the cloud but our stakeholder impact analysis revealed that there are significant risks associated with this. Whilst the benefits of using the cloud are attractive, we argue that it is important that enterprise decision-makers consider the overall organizational implications of the changes brought about with cloud computing to avoid implementing local optimizations at the cost of organization-wide performance.

**Application and Industry Session 10 – Cloud Framework** (Session Chair: Vinod Dubey, Booz Allen Hamilton)

**Multi-tenant SOA Middleware for Cloud Computing** (CLOUD2010-3058)

Afkham Azeez, Srinath Perera, Dimutha Gunage, Rawan Linton, Prabhath Siriwardana, Dimuthu Leelaratne, Sanjiva Weerawarana, and Paul Freemont (WSO2 Inc., USA)

Enterprise IT infrastructure incurs many costs ranging from hardware costs and software licenses/maintenance costs to the costs of monitoring, managing, and maintaining IT infrastructure. The recent advent of cloud computing offers some tangible prospects of reducing some of those costs; however, abstractions provided by cloud computing are often inadequate to provide major cost savings across the IT infrastructure life-
cycle. Multi-tenancy, which allows a single application to emulate multiple application instances, has been proposed as a solution to this problem. By sharing one application across many tenants, multi-tenancy attempts to replace many small application instances with one or few large instances thus bringing down the overall cost of IT infrastructure. In this paper, we present an architecture for achieving multi-tenancy at the SOA level, which enables users to run their services and other SOA artifacts in a multi-tenant SOA framework as well as provides an environment to build multi-tenant applications. We discuss architecture, design decisions, and problems encountered, together with potential solutions when applicable. Primary contributions of this paper are motivating multi-tenancy, and the design and implementation of a multitenant SOA platform which allows users to run their current applications in a multi-tenant environment with minimal or no modifications.

A Conceptual Framework for Provisioning Context-Aware Mobile Cloud Services (CLOUD2010-3059)
Hyun Jung La, Soo Dong Kim (Sogonsil University)
We observe two of the recent trends in information technology. Cloud Computing (CC) is widely accepted as an effective reuse paradigm. Mobile Computing with Mobile Internet Device (MID) such as iPhones and Android devices becomes a convenient alternative to personal computers by integrating mobility, communication, software functionality, and entertainment. Due to the resource limitations of MIDs, cloud services become an ideal alternative to software installed on MIDs. A key feature of MIDs is the capability of sensing users’ contexts such as location, acceleration, longitude, latitude and movement. Hence, it is tempting to configure and provide cloud services for the specific context sensed, such as location-specific Map service. In this paper, we present a framework for enabling context-aware mobile services. The framework enables tasks of capturing context, determining what context-specific adaptation is needed, tailoring candidate services for the context, and running the adapted service. The net result of context-aware services is for consumers to receive better services which fit to the current context of the consumers.

Bridging the Gap between Desktop and the Cloud for eScience Applications (CLOUD2010-3060)
Yogesh Simmhan, Catharine van Ingen, Girish Subramanian, and Jie Li (Microsoft Research Los Angeles; Indiana University; University of Virginia, USA)
The widely discussed scientific data deluge creates a need to computationally scale out eScience applications beyond the local desktop and cope with variable loads over time. Cloud computing offers a scalable, economic, on-demand model well matched to these needs. Yet cloud computing creates gaps that must be crossed to move existing science applications to the cloud. In this article, we propose a Generic Worker framework to deploy and invoke science applications in the cloud with minimal user effort and predictable cost-effective performance. Our framework addresses three distinct challenges posed by the cloud: the complexity of application deployment, invocation of cloud applications from desktop clients, and efficient transparent data transfers across desktop and the cloud. We present an implementation of the Generic Worker for the Microsoft Azure Cloud and evaluate its use for a genomics application. Our evaluation shows that the user complexity to port and scale the application is substantially reduced while introducing a negligible performance overhead of < 5% for the genomics application when scaling to 20 VM instances.

Application and Industry Session 11 – Cloud Performance (Session Chair: Luis Garcés-Ericc, IBM Research-Zurich)
An Architecture for Distributed High Performance Video Processing in the Cloud (CLOUD2010-3061)
Rafael Pereira, Marcello Azumbuja, Karin Breitman, Markus Endler (Globo.com; PUC-Rio, Brazil)
Video processing applications are notably data intense, time, and resource consuming. Upfront infrastructure investment is usually high, specially when dealing with applications where time-to-market is a crucial requirement, e.g., breaking news and journalism. Such infrastructures are often inefficient, because due to demand variations, resources may end up idle a good portion of the time. In this paper, we propose the Split&Merge architecture for high performance video processing, a generalization of the MapReduce paradigm that rationalizes the use of resources by exploring on demand computing. To illustrate the approach, we discuss an implementation of the Split&Merge architecture, that reduces video encoding times to fixed duration, independently of the input size of the video file, by using dynamic resource provisioning in the Cloud.

Provisioning Web Services from Resource Constrained Mobile Devices (CLOUD2010-3062)
Mahbub Hassan, Wei Liang Zhao, Jian Yang (Macquarie University, Australia)
The increasing processing power, storage and support of multiple network interfaces are promising the mobile devices to host services and participate in service discovery network. A few efforts have been taken to facilitate provisioning mobile Web Services. However they have not addressed the issue about how to host heavy-duty services on mobile devices with limited computing resources in terms of processing power and memory. In this paper, we propose a framework which partitions the workload of complex services in a distributed environment and keeps the Web service interfaces on mobile devices. The mobile device is the integration point with the support of backend nodes and other Web services. The functions which require the resources of the mobile device and interaction with the mobile user are executed locally. The framework provides support for hosting mobile Web services involving complex business processes by partitioning the tasks and delegating the heavy-duty tasks to remote servers. We have analyzed the proposed framework using a sample prototype. The experimental results have shown a significant performance improvement by deploying the proposed framework in hosting mobile Web services.

An Economic Approach for Scalable and Highly-Available Distributed Applications (CLOUD2010-3063)
Nicolas Bonvin, Thanasis Papaioannou, Karl Aberer (Ecole Polytechnique F’ed’erale de Lausanne (EPFL) 1015 Lausanne, Switzerland)
Service-oriented architecture (SOA) paradigm for orchestrating large-scale distributed applications offers significant cost savings by reusing existing services. How-ever, the high irregularity of client requests and the distributed nature of the approach may deteriorate service response time and availability. Static replication of components in datacenters for accommodating load spikes requires proper resource planning and underutilizes the cloud infrastructure. Moreover, no service availability guarantees are offered in case of datacenter failures. In this paper, we propose a cost-efficient approach for dynamic and geographically-diverse replication of components in a cloud computing infrastructure that effectively adapts to load variations and offers service availability guarantees. In our virtual economy, components rent server resources and replicate, migrate or delete themselves according to self-optimizing strategies. We experimentally prove that such an approach outperforms in response time even full replication of the components in all servers, while offering service availability guarantees under failures.

Application and Industry Session 12 – Cloud NFR and Applications (Session Chair: Massimo Villari, University of Messina, Italy)
A Case for Consumer-Centric Resource Accounting Models (CLOUD2010-3064)
Ahmed Mihoob, Carlos Molina-Jimenez, Santosh Shrivastava (Newcastle University, UK)

A pay-per-use cloud service should be made available to consumers with an unambiguous resource accounting model that precisely describes all the factors that are taken into account in calculating resource consumption charges. The paper proposes the notion of consumer-centric resource accounting model such that consumers can compute their consumption charges of a remotely used service. In particular, the notion of strongly consumer-centric accounting model is proposed that requires that all the data needed for calculating billing charges can be collected independently by the consumer (or a trusted third party, TTP); in effect, this means that a consumer (or a TTP) should be in a position to run their own measurement service. Strongly consumer-centric accounting models have the desirable property of openness and transparency, since service users are in a position to verify the charges billed to them. To illustrate the ideas, the accounting model of a given cloud infrastructure service (simple storage service, S3 from Amazon) is evaluated. The exercise reveals some shortcomings which can be fixed as indicated in this paper to make Amazon’s model strongly consumer-centric. Service providers can learn from this evaluation study to re-examine their accounting models and perform any amendments.

An Architecture for Public and Open Submission Systems in the Cloud (CLOUD2010-3065)
Marcello A Czarniata, Rafael Pereira, Karin Breitman (Globo.com, PUC-Rio, Rio de Janeiro, Brazil)

The advent of the Internet poses great challenges to the design of public submission systems as it eliminates traditional barriers, such as geographical location and costs associated to physical media and mailing that helped keeping the number of submissions at bay. With open global access, it is very hard to estimate storage space and processing power required by this class of applications. In this paper, we argue in favor of a Cloud Computing solution, and propose a general architecture in which to build open access, public submission systems. Furthermore, we demonstrate the feasibility of our approach with a real video submission application, where candidates that want to take part in a nationwide reality show can register by submitting a personal video clip.

On-Demand Dynamic Security for Risk-Based Secure Collaboration in Clouds (CLOUD2010-3066)
Michael Boniface, Mike Surridge, Martin Hall-May, Stuart Bertram, Neil Briscoe (University of Southampton IT Innovation Centre, Qinetiq Ltd)

Industrial adoption of cloud computing for collaborative business processes is limited by their ability to meet inter-enterprise security requirements. Although some cloud offerings comply with security standards, no solution today allows businesses to assess security compliance of applications at the business level and dynamically link to security countermeasures on-demand. In this paper, we present a Platform-as-a-Service infrastructure that combines semantic security risk management tools with dynamic web service policy frameworks to support the mitigation of security threats throughout the lifecycle of a service-oriented application deployed within the cloud. The platform address the need to model security requirements, dynamically provision and configure security services and link operational security events to vulnerabilities and impact assessments at the business level. The Platform has been evaluated using a collaborative engineering design scenario and a proof-of-concept deployed at a multi-tenant cloud as part of the UK CFMS project. The work is being further enhanced in the European Funded SERSCIS project.

Work in Progress Track

Work-in-Progress Session 1 – Cloud Applications (Session Chair: Srinath Perera, Lanka Software Foundation)

Cloud Computing Infrastructure for Biological Echo-Systems (CLOUD2010-3067)
Janaka Balasooriya (Arizona State University, USA)

The biological applications such as Gene and Protein analysis integrate and analyze biological data for the research in many bioinformatics and other bio related fields. Such applications are used under many large scale scientific applications and help in computing, integrating data, execute the analysis, automate the process by using information retrieved by different tasks and computational procedures to assist the scientists in scientific discovery and data distribution. Grid based and/or web based scientific workflow tools are used for bioinformatics related complex research to make scientists’ and researchers’ work easier. On average, scientists spend about 80% of their time assembling data to prepare for analysis. This is due largely in part to the fact that many of these resources required for data processing must be gathered from an external source. The best of these resources, however, are scattered across the globe. They are hosted at universities, institutes, and laboratories throughout the world. To bring all of these resources together by hiding system, network, and application level heterogeneity issues are challenging.

IRain: A Personal Storage Cloud for Integrating Web Data Services (CLOUD2010-3068)
Jiangning Cui, Taoying Liu, Qian Chen, Hong Liu (Chinese Academy of Sciences, China)

In this paper, we design and implement IRain, a prototype of storage cloud for computer scientists and graduate students to manage personal data that spreads over the web. IRain (1) integrates personal data with various metainfo structures that comes from different web sites and personal computers; (2) provides a global, unified environment to users and supports user-defined file views via flexible combination of tags; (3) offers an easy way to integrate new web services via a VFS-like interface.

Organic Product Catalogs Towards an Architecture for Cloud-based Micro Enterprise E-Commerce (CLOUD2010-3069)
Robert Neumann, Andreas Schmietendorf, Reiner Dunke (Otto-von-Guericke University; FB II Berlin School of Economics and Law, Germany)

Nowadays, it seems like there is nothing that can not be procured online. Closer observations, however, reveal that especially micro businesses do not yet fully benefit from online exposing their products and services. Though micro enterprises play a significant role with respect to our daily shopping, we are still not able to electronically place orders or conduct business with them. In this article, we propose the concept of cloud-based organic product catalogs as an approach towards bringing e-commerce technology closer to micro enterprises.

Enrique Jiménez, Javier Torres, Angel Lagaes, Miguel Lagaes, Ricardo Colomo, Juan Miguel Gomez (Universidad Carlos III de Madrid Leganés, Madrid, Spain)

Cloud Computing is evolving from a mere “storage” technology to a new vehicle for Business Information Systems (BIS) to manage, organize
and provide added-value strategies to current business models. However, the underlying infrastructure for Software-as-a-Service (SaaS) to become a new platform for trading partners and transactions must rely on intelligent, flexible, context-aware Multi-Tenant Architectures.

In this paper, we present Cludio, a Cloud Computing-based metadata-powered Multi-Tenant Architecture, backed with a proof-of-concept J2EE implementation

**Work-in-Progress Session 2 – Business as A Service (Session Chair: Prasad Saripalli, Runawake, USA)**


Yu Chen Zhou, Xin Peng Liu, Xi Ning Wang, Liang Xue, Shuang Liang (IBM China Development Laboratory, China)

With the popularity of cloud computing, Platform-as-a-Service (PaaS) becomes one of the core technical enablers by enterprise to change the services to both customers and internal organizations. An application in an enterprise needs to take into account various specific requirements for hosting in private and hybrid cloud, with unique solution on rapid development, simplicity for deployment and management, integration with existing solution and compliance to industry standards, etc. In this paper, a novel business process centric PaaS model is introduced, which is targeted at supporting above requirements for cloud enabled industry solutions in an enterprise. Firstly, the emerging requirements of PaaS for cloud enabled industry solutions and the general features to meet such requirements are discussed. Then, the architecture and patterns for integrating with existing solutions are introduced. And the technologies to implement such PaaS model are presented including codeless developer workspace and automatic application generator. As well, to enable this PaaS model for “programmable SaaS”, BPM multi-tenancy is introduced. Based on the model and technologies, we designed and implemented cloud enabled industry solutions for Telecommunication, Chemical and Petroleum, Financial and Healthcare industries. This paper demonstrates how these technologies and architectures significantly enhance the capability of PaaS in the context of industry solutions and enterprise environments.


Kumiko Tatano, Masahiro Kawato, Fumiko Machida, Yoshishara Mueno (NEC Corporation Kawasaki, Japan)

In private clouds that host many enterprise applications, scalable security management has become an important issue. In our previous work, we had developed integrated access control manager that manages access permissions to a large number of various resources using resource information provided by a resource information service. To improve performance of the resource information service, we introduced a resource information cache and a proactive cache update control method. To avoid overload of the management server due to updating cached information, the proposed method selects a part of cached information by content priority as an update target. In this work, we evaluated the query response time of the resource information service in a third-party enterprise system using the search queries issued during system operations by an administrator. The proposed method reduced average query response time by 35% compared to a conventional reactive update control method.

**Towards an Anonymous Access Control and Accountability Scheme for Cloud Computing (CLOUD2010-3073)**

Meiko Jensen, Sven Schäfe, Jörg Schwenk (University Bochum, Germany)

An important aspect of trust in cloud computing consists in preventing the cloud provider from misusing the user’s data. In this work-in-progress paper, we propose the approach of data anonymization to solve this problem. As this directly leads to problems of cloud usage accounting, we also propose a solution for anonymous yet reliable access control and accountability based on ring and group signatures.

**Enterprise Architecture Frameworks for Enabling Cloud Computing (CLOUD2010-3074)**

Daniel Ebneter, Stella Gatziu Grivas, Tripathi Uttam Kumar, Holger Wache (University of Applied Sciences Northwestern Switzerland)

Cloud computing has emerged as a strong factor driving companies to remarkable business success. Far from just being an IT level support solution cloud computing is triggering changes in their core business models by making them more efficient and cost-effective. This has generated an interest for a lot of companies to try and adopt cloud computing for their existing and new business process. In this research we present an approach which a company can use to analyze if its operations can be positively impacted by moving to the cloud. Further we describe our approach using which the company can make that transition to the cloud.

**Work-in-Progress Session 3 – Cloud Management (Session Chair: Hong Cai, IBM China Software Development Lab)**

**Cloud Broker: Bringing Intelligence into the Cloud an Event-Based Approach (CLOUD2010-3075)**

Stella Gatziu Grivas, Tripathi Uttam Kumar, Holger Wache (University of Applied Sciences Northwestern Switzerland)

Handling changes of business processes, and making sure systems are up and running after a change in the business process with minimum downtime is something which has been of interest to researchers for long and there have been several approaches proposed for it. With Cloud computing becoming increasingly popular businesses require a strong system for cloud based implementations which can handle change management of processes. In this paper we propose a change management approach for cloud backed business process models.

**A Remote Swap Management Framework in a Virtual Machine Cluster (CLOUD2010-3076)**

Takeshi Okuda, Yotaro Nagai, Yoshishiro Okamoto, Eiji Kawai (Nara Institute, Japan; National Institute, Japan)

Virtual Machine Clusters tend to increase the amount of unused memory. We propose a remote swap management framework in a VM cluster which configures a remote swap dynamically to running VMs according to memory usage. We explain the functional requirements and the design of the framework, and demonstrate the effectiveness of the framework using prototype implementation.

**Seamless Support of Multimedia Distributed Applications through a Cloud (CLOUD2010-3077)**

Stefano Ferretti, Vittorio Ghini, Fabio Pandziere, Elisa Turruni (University of Bologna)

We describe a cross-layer architecture we are developing in order to offer mobility support to wireless devices executing multimedia applications which require seamless communications. This architecture is based on the use of pairs of proxies, which enable the adaptive and concurrent use of different network interfaces during the communications. A cloud computing environment is used as the infrastructure to set up (and release) dynamically the proxies on the server-side, in accordance with the pay-as-you-go principle of cloud based services.
Regular Research Papers

SERVICES Research Session 1 – Information Management and Delivery (Session Chair: Masoom Alam, SERG, Pakistan)

Enabling Integrated Information Framework as Cloud Services for Chemical and Petroleum Industry (SERVICES2010-4001)
Yu Chen Zhou, Xi Ning Wang, Xin Peng Liu, Liang Xue, Shuang Liang, and Chang Hua Sun (IBM China Development Laboratory)

Business agility is of vital importance to chemical and petroleum industry, especially in rapid response to diagnose and exchange of real-time information and other relevant data sources. From IT perspective, emerging delivery models such as cloud computing offer the possibility to build the elastic infrastructure and flexible computing platform, thus enable enterprises to focus on their core competences. In this paper we investigate how the new delivery models of cloud service achieve the improvement of the efficiency by means of Integrated Information Framework (IIF) of chemical and petroleum. In infrastructural level, the capabilities and implementation mechanism of cloud based IIF solution lifecycle management are presented. Based on such management foundation, a business process environment delivered in Platform-as-a-Service business model is provided for rapid development of business agility. Finally, IIF in public and enterprise SaaS models to enable the chemical and petroleum value chain and service market is discussed. This paper demonstrates how the cloud computing technologies and architecture patterns significantly enhance the capability and agility of not only chemical and petroleum using IIF, but also the enterprise with similar requirements, business models and IT architectures in other industries.

Service Storm: A Self-Service Telecommunication Service Delivery Platform with Platform-as-a-Service Technology (SERVICES2010-4002)
Yu Chen Zhou, Liang Xue, Xin Peng Liu, Xi Ning Wang, Xiao Xing Liang, and Chang Hua Sun (IBM China Development Laboratory)

To attract and serve an expanded customer base, telecommunication service providers need to provide more targeted, focused and personalized services, which brings challenges to both business model and technologies to development of value added services. In this paper, we introduce Service Storm, a novel self-service telecommunication Service Delivery Platform with Platform-as-a-Service technologies to support rapid and flexible construction and delivery of value added services in the cloud environment as an open developer community. Firstly, we analyze the characteristics of four categories of users including Individual User, Organization User, Telecommunication Operator, and Business Partner, and present the architecture of Service Storm to support new business model targeting at long tail applications as well as conventional business models. Then we highlight the key technologies including 1) Rapid assembly model and tools for codeless and off-premise integration of telecom services and application logic based on Web 2.0 technologies, 2) Cloud based resource isolation, management, capacity planning and scaling for dynamic topology deployment and elastic infrastructure support, and 3) Automatic deployment and monitoring in runtime. Finally we illustrate the sample of SMS and Web based mobile workflow for insurance order management to show the advantages of Service Storm. We demonstrate how these technologies and architectures enable the new business model for telecommunication operator and significantly enhance the diversity of value added services with lower cost and shorter time to market.

Improving the Usability of HL7 Information Models by Automatic Filtering (SERVICES2010-4003)
Antonio Villegas, Antoni Olivé, and Josep Vilalta (Universitat Politècnica de Catalunya; HL7 Education & e-Learning Services, Spain)

The amount of knowledge represented in the Health Level 7 International (HL7) information models is very large. The sheer size of those models makes them very useful for the communities for which they are developed. However, the size of the models and their overall organization makes it difficult to manually extract knowledge from them. We propose to extract that knowledge by using a novel filtering method that we have developed. Our method is based on the concept of class interest as a combination of class importance and class closeness. The application of our method automatically obtains a filtered information model of the whole HL7 models according to the user preferences. We show that the use of a prototype tool that implements that method and produces such filtered model improves the usability of the HL7 models due to its high precision and low computational time.

SERVICES Research Session 2 - Modeling and Abstraction of Services (Session Chair: San-Yih Hwang, National Sun Yat-sen University, Taiwan)

An Approach to Dynamic Provisioning of Social and Computational Services (SERVICES2010-4004)
Luiz Otávio Bonino da Silva Santos, Vikram Sorathia, Luis Ferreira Pires, and Marten van Sinderen (University of Twente, the Netherlands)

Service-Oriented Computing (SOC) builds upon the intuitive notion of service already known and used in our society for a long time. SOC-related approaches are based on computer-executable functional units that often represent automation of services that exist at the social level, i.e., services at the level of human or organizational interactions. With the increasing adoption of SOC, more complex scenarios mixing computational and social services are emerging, raising the need to better understand the relationship between social and computational services to specify and model them accordingly. In this paper we present our ontology-based approach to dynamic service provisioning. Our approach aims at improving the current state of the art by allowing an explicit distinction between social and computation services and dynamic service provisioning support for these two types of services. We illustrate the applicability of our approach with a use case scenario in the health care domain.

A Service Oriented E-Research Platform for Ocean Knowledge Management (SERVICES2010-4005)
Syed SR Abidi, Ashraf Abusharek, Ali Daniyal, Mei Kuan Wong, Farrukh Mehdi, Samina Abidi, Faisal Abbas, Philip Yeo, Farhan Jamal, and Reza Fathzadeh (Dalhousie University, Canada)

We present an E-Research platform for studying the impact of changes in the ecosystem on oceans and marine life. We have developed the Platform for Ocean Knowledge Management (POKM) that offers a suite of services for researchers to (a) access, share, integrate and
operationalize the data, models and knowledge resources available at multiple sites; (b) collaborate in joint scientific research experiments by sharing resources, results, expertise and models; and (c) form a virtual community of researchers. We take a knowledge management approach to establish conceptual, terminological and data level interoperability between ocean and marine life science communities so that they can collaborate to conduct complex experiments. POKM is supported by the CANARIE high bandwidth network that allows rapid sharing of high volume data from distributed repositories across the world.

A Transparent Approach of Enabling SaaS Multi-tenancy in the Cloud (SERVICES2010-4006)

Hong Cai, Ning Wang, and Ming-Jun Zhou (IBM China Software Development Laboratory)

It has become more and more obvious that in Cloud Computing, applications are key drivers to make Cloud business a success. Multi-tenancy is a critical technology to allow one instance of application serving multiple customers at the same time to share Cloud resources and achieve high operational efficiency. There are different options of realizing multi-tenancy, in this paper we describe a transparent approach of making existing Web applications to support multi-tenancy and run in the public Cloud. Our approach includes intercepting the Web requests and deriving the tenant context, carrying the tenant context with a thread in the Web container, manipulating the isolation points (application artifacts that need to be isolated) in a Web application, and propagating tenant context to remote Cloud resources (such as database server, and message queue server) when necessary. With this approach, volumes of existing Web applications could quickly be provisioned through a public Cloud platform without rewriting the original source code. We have also implement a real system based on the common multi-tenancy model that separate the concerns of application developer, SaaS operator, tenant administrator, and tenant user. We finally integrate the SaaS multi-tenancy technique with Cloud platform services.

SERVICES Research Session 3 – Services Security (Session Chair: Zhihui Lu, Fudan University, China)

Security Engineering Approach to Support Software Security (SERVICES2010-4007)

Francisco José Barreto Nunes, Arnaldo Dias Belchior, and Adriano Bessa Albuquerque (Universidade de Fortaleza, Brazil)

As information security and privacy become increasingly important to organizations, the demand grows for software development processes that assure information integrity, availability, and confidentiality. Unfortunately, despite the investments made in process improvement, there is still no guarantee that the developed software products are protected from attacks or do not present security vulnerabilities. As soon as software products continue to present security flaws and be compromised by attacks, the Systems Security Engineering – Capability Maturity Model (SE-CMM) becomes the de facto model to structure a software security approach. Moreover, security best practices, practical experience or international standards, like ISO/IEC 15408, should also be considered to support security engineering as they propose activities that can be adapted to enhance security in a software development process and contribute towards the overall software security. This paper proposes a security engineering approach to support software security through a specialized process that helps develop more secure software, entitled Process to Support Software Security (PSSS). In addition, one of PSSS’s subprocess, Model Security Threat, is explained in detail. This paper also presents the results of the case study when the PSSS was first applied in a software development project as well as the preliminary results of a large project implementation.


Masoom Alam, Xinwen Zhangy, Muhammad Nauman, Sohail Khan, and Quratulain Alam (Institute of Management Sciences, Pakistan; Samsung Information Systems America)

Mashups are a new breed of interactive web applications that aggregate and stitch together data retrieved from one or more sources to create an entirely new and innovative set of services. The paradigm is not limited to social networks and many enterprises are redesigning their business processes to create interactive systems in the form of mashups. However, protecting users’ private data from unauthorized access in mashups is a challenging security problem. Existing solutions for addressing the various authorization problems are limited due to all-or-nothing policy, third party dependence and scalability issues. In this paper, we present a general permission delegation model for mashups that is fine-grained, user centric and scalable. This contribution has the following objectives: We formally specify the dependency relationships among multiple web applications. Dependency relationships are categorized on the basis of specific data items. We present an extensible reference architecture for configuring multiple web applications and a session management protocol.

Value Added Privacy Services for Healthcare Data (SERVICES2010-4009)

Launzi Mootivalli and Xiaohui (Bob) Li (University of Massachusetts Lowell, USA)

The widespread use of digital data, storage and sharing for data mining has given data snoopers a big opportunity to collect and match records from multiple sources for identity theft and other privacy-invasion activities. While most healthcare organizations do a good job in protecting their data in their databases, very few organizations take enough precautions to protect data that is shared with third party organizations. This data is vulnerable to data hackers, snoopers and rogue employees that want to take advantage of the situation. Only recently has the regulatory environment (like HIPAA) tightened the laws to enforce data and privacy protection. The goal of this project was to explore use of value added software services to counter this invasion of privacy problem when data is shared with an external organization for data mining, statistical analysis or other purposes. Specifically, the goal of this service is to protect data without removing sensitive/non-sensitive attributes. Sophisticated data masking algorithms are used in these services to intelligently perturb and swap data fields making it extremely difficult for data snoopers to reveal personal identity, even after linking records with other data sources. Our software service provides value added data analysis with the masked dataset. Dataset-level properties and statistics remain approximately the same after data masking; however, individual record-level values are changed or perturbed to confuse the data snoopers.

SERVICES Research Session 4 – Services Education (Session Chair: Antoni Olivé, Universitat Politècnica de Catalunya, Spain)

A Reference Model for Master of Science Program in Services Computing (SERVICES2010-4010)

Liang-Jie Zhang, Zhiqiong Chen, Min Luo, Jia Zhang, and Patrick C.K. Hung (IBM T.J. Watson Research Center; Mercy College; IBM Software Group; Northern Illinois University, USA; University of Ontario Institute of Technology, Canada)

Services Computing has become an increasingly important area in the IT and business sectors. In particular, Services now account for more than half of the economy in the United States and other countries. Numerous Services Computing-related degree programs and accreditation processes are being created. However, very few systematic guidelines exist for building graduate programs for Services Computing. In this paper, we
present a reference model of the Masters Program in Services Computing for academic institutions and accreditation agencies as a relevant curriculum guideline. Specifically, the core and elective courses are introduced to help build the reference program. The interconnections between core and elective courses are also illustrated to help create concentration programs based on the introducing sequences of the courses. Some practices of delivering Services Computing related courses and conducting accreditation application process are presented in this paper to help others more rapidly initiate the adoption process of the Services Computing curriculum.

Case Study: Master of Science in Service Computing (Msc SC) (SERVICES2010-4011)
Mohamed Adel Serhani and Rachida Dssouli (College of Information Technology UAE University)
Service computing has become a very promising area of research and development for business-to-business integration, enterprise service migration and communication on the Internet. It provides the potential of communicating businesses online, and expands to become a large scale organization. Service market is growing continuously and need for service innovation is associated with demands for service research and education. Initiatives for service computing curriculum started in addressing/incorporating service courses within graduate programs for instance computer science, software engineering, and web engineering. Ideas for developing a program for service computing is in its initial state and some initiatives are ongoing. In this paper, we describe a case study of Master of Science in Service Computing proposal. We propose the curriculum structure that consists of key core courses, business process modeling and implementation courses, in addition to specialized key courses on service computing. We finally highlight the implementation of this curriculum and the possible issues that might be faced.

SERVICES Cup

REST-Based SOA Application in the Cloud: A Text Correction Service Case Study (SERVICES2010-4012)
Wubin Li and Petter Stvård (Umeå University, Sweden)
In this paper, we present a REST-based SOA system, Set It Right (SIR), where people can get feedback on and help with short texts. The rapid development of the SIR system, enabled by designing it as a set of services, and also leveraging commercially offered services, illustrates the strength of the SOA paradigm. Finally, we evaluate the Cloud Computing techniques and infrastructures used to deploy the system and how cloud technology can help shorten the time to market and lower the initial costs.

Accountability as a Service for the Cloud: From Concept to Implementation with BPEL (SERVICES2010-4013)
Jinhui Yao, Shiping Chen, Chen Wang, David Levy, John Zic (University of Sydney; CSIRO ICT Centre, Australia)
The emergence of computing resource provisioning known as the Cloud has revolutionized the modern day computing. It has provided a cheap and yet reliable alternative computing platform for whoever with huge needs for computing resources. Moreover, its charm has been further reinforced by the concept of Service Oriented Architecture (SOA), which allows your business processes conducted by services to be flexibly integrated with other collaborating services to form new value-added business products. In this sense, the enormous computing capability and transmission bandwidth of the Cloud make it an ideal platform to be a serviceful computing environment. However, the overall correctness of the SOA depends on the correctness of all participants. As systems like this usually span multiple administration domains, concluding the faulty service and making the provider responsible become a challenging task. In this paper, we propose a novel design to enforce strong accountability in the SOA deployed in the Cloud. With this accountability, not only faults can always be bound to their causes, this binding is always provable and undeniable. We have implemented a demonstrative system to show its effectiveness in real practice.

MapReduce for Scalable Neural Nets Training (SERVICES2010-4014)
Sebastian Richty, Georg Pueschel, Dirk Habich, and Sebastian Goetz (Dresden University of Technology, Germany)
The particular benefit of cloud computing is the simple scalability of large applications, and many companies have already decided to use the cloud for their infrastructures. An enterprise IT infrastructure often includes a workflow management system. In a cloud, various workflow engines can coexist, each with its specific functional responsibility. A central instance is in charge of distributing process fragments without causing high technical or economic costs. The derivation of cost functions, the determination of the fragments to be executed on the respective engines with minimal costs, is a complex issue, especially if various processes have to be executed simultaneously. This paper approaches the problem of delegating an entire process to a distributed infrastructure and shows how it can be solved efficiently with neural networks. To ensure computation performance when handling various neural networks, we use the MapReduce framework. The distributed computation capability of MapReduce can help process the mass of training data generated by system monitoring in the networks. So, the performance usage in the central instance is decreased and the entire system is able to scale with the growing infrastructure.

Moving Text Analysis Tools to the Cloud (SERVICES2010-4015)
Himanshu Vashisththa, Michael Smit, and Eleni Stroulia (University of Alberta, Canada)
Text analysis is an important computational task, as unstructured data including text abound and can potentially provide interesting information and knowledge in a variety of areas. In our collaboration with Digital Humanists, we have started to examine the opportunities that the cloud offers to improving the response times of text-analysis tools so that users can comparatively analyze large text corpora across a variety of dimensions. To that end, we have started migrating existing text analysis tools to the cloud, beginning with TAPOr, the Text Analysis Portal for Research. In this paper, we discuss our experience redesigning and re-implementing four basic TAPOr operations on Hadoop and we report on the performance improvements enabled by the migration.

The Service Security Lab: A Model-Driven Platform to Compose and Explore Services in the Cloud (SERVICES2010-4016)
Michael Menzel, Robert Warschofsky, Ivonne Thomas, Christian Willems, and Christoph Meinel (Hasso-Plattner-Institute, Germany)
Cloud computing enables the provisioning of dynamically scalable resources as a service. Next to cloud computing, the paradigm of Service-oriented Architectures emerged to facilitate the provisioning of functionality as services. While both concepts are complementary, their combination enables the flexible provisioning and consumption of independently scalable services. These approaches come along with new security risks that require the usage of identity and access management solutions and information protection. The requirements concerning security mechanisms, protocols and options are stated in security policies that configure the interaction between services and clients in a system. In this paper, we present our cloud-based Service Security Lab that supports the on-demand creation and orchestration of composed applications and services. Our cloud platform enables the testing, monitoring and analysis of Web Services regarding different security configurations,
The use of formal data contracts to decrease ambiguity about a service behavior, to fully verify a composition of services, and to guarantee data integrity within a composition of services. Since security policies are hard to understand and even harder to codify, we foster a model-driven approach to simplify the creation of security configurations. Our model-driven approach enables the definition of security requirements at the modelling layer and facilitates a transformation based on security configuration patterns.

**Ph.D. Symposium**

**Ph.D. Symposium Session 1** (Session Chair: Federica Paganelli, National Interuniversity Consortium for Telecommunications (CNIT), Italy)

**DataStorm - An Ontology-Driven Framework for Cloud-Based Data Analytic Systems** (SERVICES2010-4017)

Tomasz Wlodarczyk, Chunnong Ying, Baodong Jia, Laurentiu Cocanu, Csongor I. Nyulas, and Mark A. Musen (University of Stavanger, Norway; Stanford University, USA)

Cloud-based systems have proven to be a powerful technology for building data-intensive applications. However, the process of designing and deploying such applications is still primarily a manual one. There is a need for mechanisms and tools to help automate the required development steps. Using the Semantic Web ontology language OWL and the Hadoop platform we have developed a number of models and associated software tools that provide an end-to-end solution for designing and deploying cloud-based systems. This solution supports the construction of detailed models of data dependencies and their validation. It also enables generation and deployment of cloud-based data flows from those models. We illustrate its use for detecting alarm scenarios using data from vast underwater sensor-network.

**True Real-Time Change Data Capture with Web Service Database Encapsulation** (SERVICES2010-4018)

Mitchell J.Eccles, David J. Evans, Anthony J. Beaumont (Aston University, UK)

This research is investigating the claim that Change Data Capture (CDC) technologies capture data changes in real-time. Based on theory, our hypothesis states that real-time CDC is not achievable with traditional approaches (log scanning, triggers and timestamps). Traditional approaches to CDC require a resource to be polled, which prevents true real-time CDC. We propose an approach to CDC that encapsulates the data source with a set of web services. These web services will propagate the changes to the targets and eliminate the need for polling. Additionally we propose a framework for CDC technologies that allow changes to flow from source to target. This paper discusses current CDC technologies and presents the theory about why they are unable to deliver changes in real-time. Following, we discuss our web service approach to CDC and accompanying framework, explaining how they can produce real-time CDC. The paper concludes with a discussion on the research required to investigate the real-time capabilities of CDC technologies.

**Specification and Verification of Data-centric Web Services** (SERVICES2010-4019)

Iman Saleh (Virginia Polytechnic Institute and State University, USA)

Data-centric Web services are services whose behavior is determined by their interactions with a repository of stored data. The lack of data specification in current Web service standards potentially leads to erroneous use of these services by their consumers. In this work, we propose using formal data contracts to decrease ambiguity about a service behavior, to fully verify a composition of services, and to guarantee data integrity within a composition of services.

**Integrated Service Adaptation** (SERVICES2010-4021)

Zhe Shan (State University, USA)

With more automation in inter-organizational supply chains and proliferation of Web services technology, the need for organizations to link their business services and processes is becoming increasingly important. In some cases, we need adapter to reconcile the communication incompatibilities between two processes. My thesis proposes a new framework for integrated service adaptation. For the control flow adaptation, we propose a structural analysis of patterns which we show is more efficient than existing approaches. Furthermore, we propose an algorithm based message pair analysis and integer programming to create an optimal adapter. For message adaptation, we identify a set of extendible message adaptation patterns to solve typical message mismatches. In addition we give an algorithm for generating new message adapter on the fly so as to integrate control flow considerations into message adaptation. Finally we show another algorithm to integrate individual message adaptation patterns with control flow adapters to create a complete adapter for two processes. We implement all these algorithms in a Java-based prototype system and show the advantages of our methods by performance experiments.

**Ph.D. Symposium Session 3** (Session Chair: Zhihong Mao, University of Pittsburgh, USA)

**A Model for Business Process Automation in Service Oriented Systems with Knowledge Management Technologies** (SERVICES2010-4020)

Ana Sasa (University of Ljubljana)

Due to increasingly demanding requirements for business flexibility and agility, automation of end-to-end industrial processes has become an important topic. Business process execution needs to support automated tasks execution as well as human tasks. The topic of this doctoral work is to enable a higher degree of automation of business processes in service-oriented systems. The doctoral work shows that for certain types of human tasks it is relevant to consider their further automation. A service-oriented architectural framework for human task execution is proposed. It improves execution of human tasks by automating and semi-automating decision making based on ontologies and agent technology.

**SOA and Cloud Industry Summit**

**Industry Summit Session 1** (Session Chair: Shigeru Hosono, NEC Internet Systems Research Laboratories, Japan)

**FAST ROUTE to Cloudification** (SERVICES2010-4022)

Tony Shan, and Winnie Hua (Keane Inc.; CTS Inc., USA)
This paper presents a methodical approach to effectively designing real-world Cloud solutions that facilitate migration to a paradigm of a robust and industrialized Cloud ecosystem. To systemize the development of Cloud services and a federated fabric, a holistic framework is constructed, composed of Foundation, Applicability, Strategization, Transformation roadmapping, Reference models, Operationalization, Unification, Tooling, and Ecosystem (FAST ROUTE). This comprehensive method enables the pragmatic Cloudification of existing IT environments for a rightly-paced transformation, which accelerates the maturing of the Cloud technology to deliver faster, better, cheaper, and more secure Cloud services. Working examples and case studies are examined and demonstrated in the discussion.

**Version Management of BPEL Processes in SOA** (SERVICES2010-4023)

Matjaž B. Juric, and Ana Sasa (University of Maribor, FERI; University of Ljubljana, FRI)

Version management of WS-BPEL (Business Process Execution Language, BPEL) processes in SOA is not supported in a consistent way. Therefore, in this paper we propose specific extensions for BPEL to support versioning of processes and partner links. We introduce new activities and extends existing activities, including partner links, invoke, receive, import, and on-message activities. We propose version-related extensions to variables and introduces version handlers. The proposed extensions represent a complete solution for process-level and scope-level versioning at development, deployment, and run-time.

**CloudDB: One Size Fits All Revived** (SERVICES2010-4024)

Hakan Hacigumus, Junichi Tatamura, Wang-Pin Hsiang, Hyun Jin Moon, Oliver Po, Arsany Sawires, Yun Chi, and Hojjat Jafarpour (NEC Labs America)

**Industry Summit Session 2** (Session Chair: Tony Shan, Keane Inc., USA)

**Version Management of Service Interfaces in SOA** (SERVICES2010-4025)

Ana Sasa and Matjaž B. Juric (University of Ljubljana, FRI; Ljubljana; University of Maribor, FERI, Maribor)

Version management is an important aspect of SOA development, which has not been adequately addressed so far. In this article, we address version management of services and process in SOA. We propose extensions to WSDL. We address service-level and operation-level versioning, service endpoint mapping, and version sequencing. The proposed extensions represent a complete solution for service and process level versioning at development, deployment, and run-time.

**SLA-Aware Profit Optimization in Cloud Services via Resource Scheduling** (SERVICES2010-4026)

Hyun Jin Moon, Yun Chi, Hakan Hacigumus (NEC Labs America)

**Designing Resource Oriented Architecture in UML - A Case Study on Smart Grid Home Area Network (HAN)** (SERVICES2010-4027)

Shawn X.K. Hu, Tony C. Shan (Xtensible Solutions; Keane Inc., USA)

An UML approach to designing Resource Oriented Architecture (ROA) is described in this article along with a case study on Smart Grid Home Area Network (HAN). A set of UML diagrams is presented to illustrate steps from requirements collection, data flow, resource data modeling, to the interface model. The process provides an example on how to design ROA in a standardized way from a modeling perspective and how to link it to an existing Service Oriented Architecture (SOA) environment.

**Plenary Poster**

**Iterative Configuration Method: An Effective and Efficient Heuristic for Service Oriented Infrastructure Resource Allocation** (SERVICES2010-4028)

M. Brent Reynolds, Kenneth M. Hopkinson, Mark E. Oxley, and Barry E. Mullins (Air Force Institute of Technology, USA)

This work defines a heuristic to determine the most optimal configuration for a service oriented infrastructure by effectively and efficiently matching network nodes’ resource provisions to services’ resource demands. The heuristic is a numerical method that attempts to find the global minima of a configuration quality metric. The efficiency and effectiveness of the heuristic is compared to simulated annealing in a large scale simulation. In the large scale, the heuristic is an order of magnitude better in both effectiveness and efficiency.

**A Web Service Composition Algorithmic Method Based on TOPSIS Supporting Multiple Decision-Makers** (SERVICES2010-4029)

Hua Zou, Longchang Zhang, Fangchun Yang, and Yao Zhao (Beijing University, China)

This paper presents a novel Web service composition algorithm based on TOPSIS (WSC_TOPSIS) to solve the service composition difficulties with multiple decision-makers and heterogeneous QoS for the first time. It includes three main steps: normalizing decision matrix, evaluating alternatives synthetically and evaluating group alternatives synthetically. Experimental results show that the proposed algorithm can better support Web service composition with heterogeneous QoS data and multiple decision-makers.

**Collaborative Strategy Consulting Services Model and Framework for Small and Medium Business in Emerging Market** (SERVICES2010-4030)

Fan Jing Meng, Shun Xiang Yang, Peng Ji, and Zhi Hu Wang (IBM Research – China)

Strategy consulting services are a high-end knowledge-intensive business. Consulting service providers (CSPs) regard them as vital business because they can lead to additional business and sales opportunities. However, because of dramatic growth in the small and medium business (SMB) market in the emerging market and because of how labor intensive the current consulting services model is, it is becoming increasingly challenging to offer strategy consulting services. This paper proposes a collaborative consulting services model and framework in a service ecosystem consisting of CSPs, local business partners (BPs), and SMBs. This consulting service model is enabled by an Web-based consulting services platform. The integrated platform framework and key technical components are presented in the paper.

**Process Reservation for Service-Oriented Applications** (SERVICES2010-4031)
With an increasing use of services sustaining the resources which people need has become more important. In this paper, we propose an effective reservation method, called “BPSR” (Business Process Service Reservation), which aims for the process reservation which to the best of our knowledge has not been studied before. In particular we address for major jobs: service differentiation; service reservation; process reservation and QoS Control. We also describe a flexible policy-based reservation method which aims to increase the success rate of reservation and utilization of service resources. Experimental analysis shows that the BPSR reservation system achieves better results than other reservation methods.

**Service Registry with Advanced Search Capability** (SERVICES2010-4032)
Waseem Roshen, Sham Vaidya, and Sugandh Mehta (IBM, USA)

A new method is described which allow a service registry to return the intended service information even when the exact name or id of the service is not known to the user of the registry. The method comprises parsing the input service name into constituent words, constructing all equivalent service names by using synonyms of the constituent words, and returning the service information to the user when any one of the constructed names matches the name of a service in the registry.

**Generating Robust XPaths for Service Customization** (SERVICES2010-4033)
Takatoshi Kitano, Keiti Iguchi, and Kazuya Koyama (NEC Information and Media Processing Laboratories, Japan)

Since service customization is important for Saas, we aim to provide customizability to existing Web applications. To provide reliable customizations of existing applications externally, a method to analyze user interface is required. In this paper, we propose a new method for generating robust XPaths that provide reliable analysis of the user interfaces. The evaluation results show that the generated XPaths have reliable features that never fail in false positives, for the customization.

**Ensuring Resource-Level Quality for Services in Grids** (SERVICES2010-4034)
André Lage Freitas, Jean-Louis Picat, and Nikos Parlavantzas (INRIA / IRISA – MIRIADS Team, France)

Service-Oriented Architectures address the development of distributed and dynamic service-based applications. Due to the dynamics of their environments, services should be self-adaptable in order to maintain agreed resource-level qualities. To support building such services, this work proposes the Self-Adaptable Service Execution Manager (SASEM), responsible for monitoring and controlling the service execution on grid resources in order to prevent SLA violations. SASEM builds on the Dynaco adaptation model and on an enhanced grid monitoring and actuation system, implemented using the XtreamOS grid operating system.

**A New Ontology-Based Service Matching Algorithm** (SERVICES2010-4035)
Zhi Yang, Junliang Chen, and Budan Wu (Beijing University of Posts and Telecommunications, China)

Service discovery is the process of finding suitable services and selecting the best alternative for a given task, and service matching algorithm is the kernel technology of the step. Nowadays there are no quantity index of service Query Complete Rate (QCR) and Query Accuracy Rate (QAR), and the efficiency of service matching is low. This paper defines QCR and QAR, and provides a new ontology-based service matching algorithm that uses the theory of query rewriting from key-words to ontology to select suitable services.

**KASRA Framework: A Service Oriented Enterprise Architecture Framework (SOEAF)** (SERVICES2010-4036)
Elahi Najafi and Ahmad Baraani (SHBU University; Isfahan University, Iran)

Enterprise architecture (EA) is a new approach that organizations should practice to align their business strategic objectives with information and communication technology (ICT). Enterprise Architecture encompasses a collection of different views and aspects of the enterprise which constitute a comprehensive overview when put together. Such an overview cannot be well-organized regardless of incorporating a logical structure called Enterprise Architecture Framework (EAF). EAF presents a transparent and comprehensive map of an organization that shows how all organization elements (business and IT) work together to achieve defined business objectives. Several distinctive EAF have been proposed, but many organizations are struggling with using these frameworks. This article try to eliminate the challenges of common and famous EAF by using Service Oriented (SO) paradigm. This service oriented EAF (SOEAF) named KASRA1 EAF. KASRA EAF involves a SO Roadmap that is compatible with ITIL and a Classification Schema comprises four rows and six columns.

**The Design and Implementation of Service System for Cluster Supply Chain** (SERVICES2010-4037)
Xiao Xue, Tao Wang, and Biqing Huang (Henan Polytechnic University; Tsinghua University, China)

As a new type of management pattern, “cluster supply chain” (CSC) can help SMEs to face the global challenges through all kinds of collaboration. However, a major challenge in implementing CSC is the gap between theory and practice in the field. The recent rapid commercialization and adoption of “service” technologies has driven a process of transforming theory into practices. In an effort to provide a better understanding of this emerging phenomenon, this paper presents two key elements of cluster supply chain, including: an instantiated model for cluster supply chain alliance (CSA), and the architecture of service supporting system. Cluster supply chain has propelled a structural change in buyers-intermediaries-sellers relationships, and accelerated internationalization of small- and medium-sized enterprises.

**Review of Semantic Web Service Discovery Methods** (SERVICES2010-4038)
Le Do Ngan, Marcus Kirchberg, Rajaraman Kannanabairi (Institute for Infocomm Research, Singapore)

Discovering web services is the process of finding web services that satisfy specific requirements. Rich and formal representations of services and interactions are required for principled selection of services, context-aware analysis and satisfaction of requests, as well as dynamic interaction and negotiation with the service providers. Semantic technologies facilitate specialization and generalization of service needs as well as service composition. Thus, a higher degree of automation and more precise results can be achieved. In this paper, we provide a review of current Semantic Web Service (SWS) discovery approaches.

**SOI (Service Oriented Integration) and SIMM (Service Integration Maturity Model) - An Analysis** (SERVICES2010-4039)
Gandhi Sivakumar, Faried Abrahams, Kerard Hogg, John Hartley (IBM Australia; IBM USA)

The constellation of SOA entities encompasses a triplet of Service consumer/provider and an optional registry. In the normal style, the service provider (“Service”) is instantiated and the details are stored in a registry. Service consumers seeking the required service explore the registry, locate the Service end points, receive the service contracts (normally as WSDLs), comply with the established contracts in order to consume the
service. While this is an ideal scenario, in integration based environments the style differs where integration enablers as services are required to be built to aid integration. Thus Service Oriented integration (SOI) would mean the following depending on the type of players in the IT industry.

### Performance Optimization for Composite Services in Multiple Networks Environment

**SERVICES2010-4040**

**Shuai Zhang, Juanling Sun, Dongming Lu, Yuanhong Shen, and Aleksander J. Kavs (Zhejiang University, China; State Street Corporation, USA)**

With the prevalence of web services, services orchestration evolves from intra-enterprise integration to cross-domain integration and involves multiple networks. In traditional centralized SOA, the execution engine suffers from single point of failure and performance of composite services will be affected by the network conditions because of cross domain message transmissions. In this paper, we present a decentralized orchestration model for cross-domain multiple networks environment. Based on this model, we propose a Genetic Algorithm to find an optimization deployment solution for component services with minimum cross-domain network cost and thus increase the performance of composite services.

### Security Protocols in Service-Oriented Architecture

**SERVICES2010-4041**

**Abdelkader H. Ouda, David S. Allison, and Miriam A. M. Capretz (The University of Western Ontario London; Canada)**

In this paper, a comprehensive Quality of Security Service (QoSS) model for addressing security within a Service-Oriented Architecture (SOA) is proposed. We define a detailed SOA security model that supports and incorporates a number of networking security techniques and protocols. It utilizes symmetric keys, public keys and hash functions techniques, in order to provide different levels of QoS agreements to satisfy the requirements of both the services providers and requesters. These levels are based on core networking security requirements such as Mutual Authentication, Session keys, Anonymity, and Perfect forward Secrecy. In addition, the proposed model forms a strong line of defense against Replay, Man-in-the-Middle, and Denial-of-Services attacks.

### Moving from Saas Applications towards SOA Services

**SERVICES2010-4042**

**Ali Bou Nassif and Miriam A. M. Capretz (The University of Western Ontario London; Canada)**

This paper presents a brief introduction of Software as a Service (SaaS) and Service Oriented Architecture (SOA). Specifically, the paper introduces a five-step model to show how SaaS can be offered as SOA services. Furthermore, a real-life scenario is provided to demonstrate the benefits of using the proposed model.

### Trust in Web Services

**SERVICES2010-4043**

**Zainab M. Aljazzaf, Mark Perry, and Miriam A. M. Capretz (University of Western Ontario London; Canada)**

Trust is an important factor to predict the behaviour of a Web Service and as a criterion for Web Service selection. Although considerable research has been performed in the offline and online worlds, analysis of trust in the Web Services environment has been limited. Most trust studies in Web Services are focused on trust establishment without identifying and considering the main trust definition components and trust principles. Thus, this paper presents trust definition and trust principles based on the exploration of the trust literature in the offline and online worlds and Web Services. The trust definition and principles form a basis to establish trust in Web Services.

### Towards a Formal Definition of a Computing Cloud

**SERVICES2010-4044**

**Tyronne Grandison, E. Michael Maximilien, Sean Thorpe, and Alfredo Alba (IBM Services Research; IBM Almaden Services Research, USA; University of Technology, Jamaica)**

Cloud computing has been endorsed by the IT community as the new paradigm shift in the industry that charts the way forward. Unfortunately, the field is still on its path to rigor and robustness. This is epitomized by the numerous fuzzy articulations of “what is cloud computing”. This paper makes a first attempt at remedying this conundrum by providing a core technical specification of the model for cloud computing and demonstrating how current and future cloud deployments can use this to foster more productive technical discussion in future.

### Distributed Service Composition and Execution Framework in GloServ

**SERVICES2010-4045**

**Knarig Arabshian and Ankil Mehta (Alcatel-Lucent, Bell Labs Murray Hill; Columbia University, USA)**

We describe a framework for a distributed ontology based dynamic composition and execution of services. This paper describes an extension to GloServ, an ontology-based global service discovery system, which performs service composition with services described in OWL-S. It also analyzes the bottlenecks in using OWL-S for service composition and gives detailed results on the different types of ontology descriptions that work best for service composition.

### Server Hunt: Using Enterprise Social Networks for Knowledge Discovery in IT Inventory Management

**SERVICES2010-4046**

**Polychronis Ypdimatopoulos, Maja Yukovic, Jim Laredo, Sriram Rajagopal (MIT Media Laboratory; IBM TJ Watson Research Center, USA; IBM India)**

Locating IT Inventory Management information is a challenging task, as the knowledge gets transferred among employees that move within or leave the context of a large organization. Information that relates to IT inventory is hidden in the knowledge of individual team members. This fact is not reflected in organizational expertise repositories and therefore locating those employees becomes a cumbersome manual process, if not intractable. In this paper, we present an expert discovery service that leverages the professional social network of an employee, who was previously known to hold the desired inventory information but is no longer available. Evaluation results suggest that this method reconstructs the desired information more than 80% of the time, as per our experiment involving 50 cases. We demonstrate how a carefully designed crowdsourcing approach can effectively extract the targeted information from the employee’s professional social network and discuss its limitations.

### Workshops

**WS-CS-Testing Session 1** (Session Chair: Jia Zhang, Northern Illinois University, USA)

**Description and Matching of Triggering Capabilities in Event-Driven Services** (SERVICES2010-4047)**
Event-driven services, or notification and event-handling services, provide specific information or functionality, repeatedly in a periodical or reactive way in response to events in which consumers are interested. Although such services have played primary roles in distributed computing paradigms and human activities, machine-accessible description or matching methods for such services has not been investigated. This paper presents and discusses foundations for description and matching of triggering capabilities in event-driven services. Specifically, requirement description by the consumer side and service description by the provider side are presented as well as their matching, including specific concepts such as configurability by the consumer side. This paper provides discussion on both of a foundational, general theory and a prototype implementation.

An Algorithm to Predict the QoS-Reliability of Service Compositions (SERVICES2010-4048)
Anja Strunk (Technical University of Dresden, Germany)

The idea of the future Internet of Services is to combine several services of numerous service providers to new value-added services or applications. To sell these services on so-called service marketplaces the providers have to ensure both a high quality and a high quality/reliability. But how could a provider of a composed service know the quality-reliability of his service without costly tests? This article describes an approach to predict the quality-reliability of service composition based on a three-step algorithm. The algorithm calculates the expected number of service level objective (SLO) violations caused by the composition’s sub-services. The expected number of SLO violations can be used as metric for the QoS-reliability.

Web Services Feature Interaction Detection Based on Situation Calculus (SERVICES2010-4049)
Jiuyun Xu, Wengong Yu, Kun Chen, and Stephan Reiff-Marganiec (China University of Petroleum; University of Leicester, UK; Beijing University of Posts and Telecom, China)

Feature interaction has been identified as a problem in the telecommunications domain in the 1980s, but since it has been shown to be a problem of systems that are composed of individually designed components. Clearly Web service composition is a way of building services from independently designed components and hence is subject to the same problem. This paper investigates the detection of feature interactions in Web services at runtime and proposes a novel detection method by taking inspiration from the Situation Calculus. Two case studies show that it is effective for detecting feature interactions in composite Web services.

WS-CS-Testing Session 2 (Session Chair: Hong Zhu, Oxford Brookes University, UK)

A Mechanism for Web Service Selection and Recommendation Based on Multi-QoS Constraints ... (SERVICES2010-4050)
Shao-chong Li, Hao-peng Chen, and Xi Chen (Shanghai Jiao Tong University, China)

Service-Oriented Architecture (SOA) provides a flexible framework for service composition. In a service market scenario, given a functional description of service, different providers may offer diverse service implementations that match such a functional description, but differ for some QoS attributes. It is increasingly vital to provide a service selection and recommendation mechanisms that best meet the QoS requirements of the service user. Different from most of the existing approaches to service selection, we consider a Web service selection and ranking mechanism with multi-QoS attributes, focusing on simulating degree of consumer satisfaction and hypothesizing consumer preference historical information. Efficient service selection mechanism and heuristic algorithm for consumer preference of multi-QoS are presented in this article and their performances are studied by simulations.

A Composable, QoS-Aware and Web Services-Based Execution Model for ebXML BPSS Business Transactions (SERVICES2010-4051)
Andreas Schönberger, Guido Wirtz, Christian Hueener, Marco Zapletal (Otto-Friedrich-University of Bamberg, Germany; Vienna University of Technology, Austria)

Adequate IT support for Business-to-Business integration (B2Bi) is indispensable in today’s globalized world. Agreement among personnel from different enterprises as well as distributed computing issues are major challenges to the automation of B2Bi processes. These challenges can be addressed by applying the choreography language ebXML BPSS (ebBP) for declaratively specifying B2Bi processes and using Web services and WS-BPEL as dedicated integration technologies. ebBP BusinessTransactions (BT) are the primary building block of ebBP choreographies and specify the exchange of up to two business documents in a declarative and technology-agnostic way. Composing BTs within choreographies and realization of QoS raise important requirements for the orchestration layer. This paper investigates these requirements and presents a composable, abstract, flexible and QoS-aware execution model that can be implemented using Web Services and BPEL.

Business Semantics Centric Reliability Testing for Web Services in BPEL (SERVICES2010-4052)
Yongbo Wang, Fuyuki Ishikawa, and Shinichi Honiden (The University of Tokyo; National Institute of Informatics, Japan)

The Business Process Execution Language (BPEL) has become the standard in web service composition, so that been adopted by industries to create mission critical services. The business process reliability especially business process consistency when some services failed is critical to composite services especially involving various organizations. However, it is difficult to conduct business process reliability testing for composite services due to complex business process in service composition, remote deployed services and long time testing duration. Little research is done to test fault tolerance capabilities of composite services only from low level. This paper proposes a technique on how to test the reliability of composite service defined in BPEL from the view of business semantics with little cost using fault injection. We present an approach for reliability testing of web services by using service stubs with semantic faults instead of real services which can be placed at service provider side or service consumer side. Unlike existing studies, we focus on how to find the reliability problems associating with business process - called semantics as the problems are not pure coding error but faults related to business process. In addition, the behavior of composite services in BPEL is analyzed when there are faults in orchestrated services invoked. Finally, a case study is given to show the whole process of reliability testing for composite web service.

WS-CS-Testing Session 3 (Session Chair: Jia Zhang, Northern Illinois University, USA)

Towards a Metrics Suite for Measuring Composite Service Granularity Level Appropriateness (SERVICES2010-4053)
A. Khoshabarforoushia, R. Takein, P. Jamshidi, and F. Shams (Shahid Beheshti University GC, Iran; Royal Institute of Technolog, Sweden)

One of the prominent principles of designing services is the matter of how abstract services should be i.e. granularity. Since service-oriented analysis and design methods lack on providing a quantitative model for service granularity level evaluation, identification of optimally granular
In this paper, we propose a new access control model, called STRAC, which enables access control of user personal information with system. Personal information access control depending on user situations is greatly necessary. However, it is complicated to manage personal information access control directly, because the existing access control methods only support regular access control, not for emergency cases. In such a situation, an emergency system of sharing and exchanging user’s personal information is demanded in medical treatment and disaster situations. In such a context, the existing access control methods only support regular access control, not for emergency cases. In this paper, we propose a new access control model, called STRAC, which enables access control by adapting to user situations and environments. The initial prototype of the architecture already allows investigate new ways of evaluating performance of Web services based on a contract model and improved existing service discovery solution through the incorporation of quality-of-service issues and related metrics for ranking matches.

A Performance Evaluation for a QoS-Aware Service Oriented Architecture (SERVICES2010-4055)
Julio Cezar Estrela, Rubens Kenji T. Tsyohara, Bruno Tardiole Kaehne, Thiago Caproni Tavares, Regina H. C. Santana, Marcos J. Santana, and Sarita Mazzini Bruschi (University of São Paulo, Brazil)
Web services have emerged as a technology that aims at improving the communication between applications, through the service-oriented paradigm. Researches involving web semantics, ontology and composition of services has currently been developed. However, research in performance evaluating of web services architecture with quality of service support (QoS) is little widespread. Some works separately approach techniques as composition of Web services and models of architectures to improve the quality of Web services. Considering the lack of work involving jointly these different boardering, the purpose of this work is show a performance evaluating of a prototype architecture named WSARCH (Web Services Architecture) that relating quality of service attributes. The initial prototype of the architecture already allows investigate new ways of evaluating performance of Web services based on a contract model and improved existing service discovery solution through the incorporation of quality-of-service issues and related metrics for ranking matches.

The Health Web Sites Importance as Justification for the Development of a Wide Evaluation Methodology of Its Quality (SERVICES2010-4056)
Patrícia Leite Brandão, José Ávelino Victor, and Álvaro Rocha (Instituto Politécnico do Cávado e Ave, Portugal; Instituto Superior da Maia, Portugal; Universidade Fernando Pessoa, Portugal)
The use of a methodology for the evaluation, comparison and quality improvement of Health Web Sites is justified by its widespread adoption and visibility to Internet users. Due to the sensiveness of their content and impact on users, health related sites should be evaluated. This paper proposes three different dimensions for the development of quality evaluation methodologies of Health Web Sites: contents, services and technical. We consider that these dimensions should be addressed transversally, providing a better overall evaluation.

Adaptive Admission Control Algorithm in IEEE 802.16e Broadband Wireless Access Networks (SERVICES2010-4057)
Chiapin Wang, Hsin-Chi Lin, and Hao-Kai Lo (National Taiwan Normal University, Taiwan)
The emerging IEEE 802.16e Broadband Wireless Access (BWA) network is one of the most promising solutions to provide ubiquitous wireless access with high data rates, high mobility, and wide coverage. In the paper we develop a novel Connection Admission Control (CAC) algorithm for IEEE 802.16e mobile BWA networks to simultaneously improve the utilization efficiency of network resources and guarantee Quality of Services (QoS) for handoff connections. The proposed CAC scheme dynamically adjusts the amount of reserved bandwidth for handoff users according to the arrival distributions of handoff and new coming connections. Simulation results demonstrate that the proposed CAC algorithm can increase the number of admitted connections and also provide handoff QoS.

STRAC: Personal Information Access Control for Emergency Systems (SERVICES2010-4058)
Kyoji Kanoque and Keisuke Kasai (Ritsumeikan University, Japan)
An emergency system of sharing and exchanging user’s personal information is demanded in medical treatment and disaster situations. In such a system, personal information access control depending on user situations is greatly necessary. However, it is complicated to manage personal information access control directly, because the existing access control methods only support regular access control, not for emergency cases. In this paper, we propose a new access control model, called STRAC, which enables access control of user personal information with consideration of context changes. In our proposed model, a concept of situations is introduced. Moreover, the proposed model is based on a concept of TAMAC, which is an extension of a conventional RBAC model.

Implementing RUTE’s Usability - The Brazilian Telemedicine University Network (SERVICES2010-4059)
W. Coury, L.A. Messina, J.L. Ribeiro Filho, and N. Simões (RNP - Rede Nacional de Ensino e Pesquisa, Brazil)
The Brazilian Telehealth initiative enables videoconferencing, diagnosis and formative second opinion, continuous and permanent education and web conferencing, by linking university and teaching hospitals via RNP (Rede Nacional de Ensino e Pesquisa), Brazil’s national research and education R&E network. It operates two significant national projects: The Telemedicine University Network, RUTE (Rede Universitária de Telemedicina - www.rute.mp.br) and the National Telehealth Primary Care Program, Brazil Telehealth (www.telessaudebrasil.org.br); respectively from the Science and Technology Ministry MCT and Health Ministry MS. The municipal, state, national and international health institutions coordinate collaborative projects in research, innovation, development, management, education and assistance.

Weighted Kernel Density Estimation of the Prepulse Inhibition Test (SERVICES2010-4060)
Hongbo Zhou, Qiang Cheng, Hong-Ju Yan, and Haiyun Xu (Southern Illinois University, USA)
Art Prepulse inhibition (PPI) refers to the reduction in startle reaction towards a startle-eliciting “pulse” stimulus when it is shortly preceded by a sub-threshold “prepulse” stimulus. PPI deficits have been seen in patients with schizophrenia and animal models of this mental disorder. The goal of this study was to provide an alternative method for the analysis of PPI data. The new method is expected to be more reliable and sensitive than the existing conventional method. We applied the Kernel density estimation (KDE) in the analysis of PPI data. KDE is a non-parametric method of estimating the probability density function of a random variable and is widely used in inferring population statistics based on limited, noisy samples of continuous random variables. Our results showed that the KDE method performed better than the conventional method and offered some advantages which are of significant in the post-session analysis of PPI data and in performing animal experiments.

Analysis of Involuntary Movements for Adapting Input Devices to People with Motor Impairments Based on 3-Axis Accelerometers (SERVICES2010-4061)
Tetsuya Hirotomi and Yoshiyuki Katai (Shimane University, Japan)
People with motor impairments often need adaptation of input devices to interact with surrounding people and home-appliances via communication aids and environmental control systems. During the adaptation, a body part to be used, a device to be activated, its specific location, and a posture to use it should be decided by assessing accuracy and speed of motions. Additionally, the strength and frequency of involuntary movements should be taken into account. The successful adaptation is a key determinant to improve Quality of Life (QOL). However, the adaptation is carried out, in most cases, based on only subjective assessments. That is why, we are developing a quantitative method to detect involuntary movements and measure the adaptability of input devices. Our method is based on the root mean square (RMS) values of 3-axes accelerations. In our case studies, a set of accelerometers were attached to corresponding body parts to detect involuntary movements. The results indicate that the RMS values became higher when conspicuous involuntary movements observed. Special attention is paid to analyzing the RMS values in touch panel adaptation.

SWF Session 1 (Session Chair: Artem Chebotko, University of Texas at Pan American Session)

Ecosystems Monitoring: An Information Extraction and Event Processing Scientific Workflow (SERVICES2010-4062)
Ahmed Abdeen Hamel, Byung Suk Lee, and Anne E. Thessen (University of Vermont, UVM; Marine Biological Laboratory, MBL)
This paper presents a novel architecture that brings together Information Extraction (IE) with Event Processing (EP) research areas to globally monitor human activities and biodiversity dynamics and measure their impact on ecosystems. The two areas (IE and EP) are rich on their own and we believe their integration will achieve a much more comprehensive solution to ecosystems monitoring. The integration is based on a closedloop mechanism that guarantees the communication and the evolution of the overall architecture. While we use Microblogging communities (e.g., Twitter) as a news producing tool, we keep track of the vulnerable ecosystems using a GIS tracking database. We also make use of Google Map/Earth API capabilities to dynamically update the GIS database. After a complete cycle, the architecture produces a list of vulnerable ecosystems. This architecture leverages the rich research in Scientific Workflows to achieve the integration and communication of the various components. We are in the process of developing a system that can be used by conservationists and decision makers to efficiently allocate their time and limited resources in response to ecosystems perturbation.

Functional Units: Abstractions for Web Service Annotations (SERVICES2010-4063)
Paolo Missier, Katy Woltencroft, Franck Tanoh, Peter Li, Sean Bechhofer, Khalid Belhajjame, Steve Pettifer, and Carole Goble
(University of Manchester, UK)
Computational and data-intensive science increasingly depends on a large Web Service infrastructure, as services that provide a broad array of functionality can be composed into workflows to address complex research questions. In this context, the goal of service registries is to offer accurate search and discovery functions to scientists. Their effectiveness, however, depends not only on the model chosen to annotate the services, but also on the level of abstraction chosen for the annotations. The work presented in this paper stems from the observation that current annotation models force users to think in terms of service interfaces, rather than of high-level functionality, thus reducing their effectiveness. To alleviate this problem, we introduce Functional Units (FU) as the elementary units of information used to describe a service. Using popular examples of services for the Life Sciences, we define FUs as configurations and compositions of underlying service operations, and show how functional-style service annotations can be easily realised using the OWL semantic Web language. Finally, we suggest techniques for automating the service annotations process, by analysing collections of workflows that use those services.

The Networked Environment for Music Analysis (NEMA) (SERVICES2010-4064)
Kris West, Amit Kumar, Andrew Shirk, Guojun Zhu, J. Stephen Downie, Andreas Ehmann, and Mert Bay (Widget Works Ltd, UK; University of Illinois at Urbana-Champaign, USA)
Conducting valid comparative evaluations of techniques in the field of Music Information Retrieval (MIR) presents particular challenges to MIR researchers due to issues of copyright and data sharing. Further, the interdisciplinary nature of MIR research and multi-faceted nature of human music perception make the sharing and reuse of techniques and implementations for particular facets of music perception and music information retrieval tasks highly desirable. In addition the field makes use of a diverse range of file formats, software environments and toolkits for extracting, encoding and accessing MIR data and services, making reuse extremely challenging. The NEMA project aims to provide the MIR field with a highquality, secure and extensible workflow environment to facilitate: computation over remote audio and resource collections; optimal code reuse, interoperability between data formats and types, sharing and dissemination; standardised, high-quality evaluation procedures; and the encoding of metadata, data and results in a format suitable for distributed systems.

SWF Session 2 (Session Chair: Wei Tan, University of Chicago and Argonne National Lab, USA)

Network Resource Control for Grid Workflow Management Systems (SERVICES2010-4065)
Rudolf Strijkers, Mihai Cristea, Vladimir Korkhov, Damien Marchal, Adam Belloum, Cees de Laat, Robert Meijer (Universiteit van Amsterdam; TNO Informatie- en Communicatietechnologie, The Netherlands; CNRS, France; ETH Zürich, Switzerland; St. Petersburg State University, Russia)
Grid workflow management systems automate the orchestration of scientific applications with large computational and data processing needs, but lack control over network resources. Consequently, the management system cannot prevent multiple communication intensive applications to compete for network resources, which leads to unpredictable performance. Currently, the lack of control over network resources may prevent certain applications, i.e. applications that need high capacity and Quality of Service, to utilize Grids. Hence, such applications would use
Flexible Creation and Adaptive Execution of Scientific Workflows in Cloud and Grids Environments by Using Web 2.0-Based Electronic Lab Notebook Metaphor (SERVICES2010-4066)
Aleksander Slominski (Indiana University, USA)

A metaphor of Electronic Lab Notebook (ELN) can be leveraged not only to make the process of creation and editing of scientific workflows easier, but to execute, monitor, and troubleshoot workflows. By using ELN as a metaphor for Scientific Workflow Management System (SWFMS), scientific users can have the familiar user interface it offers with the benefits of SWFMS, such as the ability to automate recording provenance of scientific experiments and to facilitate reproducing of scientific results. Furthermore, Web 2.0 can enhance ELN to make it easier to collaborate and share scientific content by using emerging Web standards. Cloud and Grid environments require that workflows be fault-tolerant and can adapt to changes. ELN, as an underlying storage model for SWFMS, allows necessary flexibility in adapting running workflows both automatically and by users editing ELN to change their workflows.

Scientific Workflow Development Using Both Visual and Script-Based Representation (SERVICES2010-4067)
Ketan Maheshwari, and Johan Montagnat (University of Nice – Sophia Antipolis; CNRS, France)

In this paper we propose to achieve a semantic equivalence between a visual- and a script-based workflow development paradigm. We accomplish this by building a script language which execution semantics matches an existing sophisticated, data-parallel scientific workflow language and its underlying GUI-based core workflow enactor. It facilitates multiple representations of a scientific workflow while preserving the execution semantics and enactment engine. This development caters to the need of users with different levels of expertise within a single workflow platform. A two-ways representation translator makes it possible to convert any source workflow into its semantically equivalent counter-part, and therefore use a single enactor independently of the user's preferred representation.

Fault-Tolerance in Dataflow-Based Scientific Workflow Management (SERVICES2010-4068)
Ustun Yildiz, Pierre Moulallem, Mladen Voyk, Daniel Crawl, and Ilkay Altintas (University of California; North Carolina State University; San Diego Supercomputer Center, USA)

This paper addresses the challenges of providing fault tolerance in scientific workflow management. The specification and handling of faults in scientific workflows should be defined precisely in order to ensure the consistent execution against the process-specific requirements. We identified a number of typical failure patterns that occur in real-life scientific workflow executions. Following the intuitive recovery strategies that correspond to the identified patterns, we developed the methodologies that integrate recovery fragments into fault-prone scientific workflow models. Compared to the existing fault-tolerance mechanisms, the propositions reduce the effort of workflow designers by defining recovery fragments automatically. Furthermore, the developed framework implements the necessary mechanisms to capture the faults from the different layers of a scientific workflow management architecture. Experience indicates that the framework can be employed effectively to model, capture and tolerate the typical failure patterns that we identified.

Towards Flexible Event-Handling in Workflows through Data States (SERVICES2010-4069)
João E. Ferreira, Qinyi Wu, Simon Malkowski, and Calton Pu (University of São Paulo, Brazil; Georgia Institute of Technology, USA)

Despite recent advances in many real-time and workflow management systems (WFMS), event-handling is still a manual or semi-automated task. The integration of automated event processing with workflows remains an open research challenge to both academic and industrial communities. In this work, we propose a concrete approach that logs interactions between workflow component activities in the form of data states that accurately and efficiently store necessary information for event-handling. Our approach (called WED-flow) explicitly represents various dependencies and constraints of a WFMS in sophisticated data states. Due to the availability of this large amount of historic information, our approach is able to support a flexible event-handling in WFMS. In this paper we present definitions for workflow management systems that incorporate events, and characterize such systems using the WED-flow approach. We also present a scientific workflow example in genetic testing to illustrate the advantages of integrating events with workflow through the WED-flow approach.

CAMERA 2.0: A Data-centric Metagenomics Community Infrastructure Driven by Scientific Workflows (SERVICES2010-4070)
Ilkay Altintas, Abel W. Lin, Jing Chen, Chris Churas, Madhushan Gupral, Shoei Sun, Weizhong Li, Ramil Manansala, Mayya Sedova, Jeffrey S. Grethe, Mark Ellision (San Diego Supercomputer Center; Center for Research in Biological Systems; California Institute for Telecommunications and Information Technology; University of California, USA)

Over the last decade, workflows have been established as a mechanism for scientific developers to create simplified views of complex scientific processes. However, there is a need for a comprehensive system architecture to link scientific developers creating workflows with researchers launching workflows in large scale computing environments. We present the architecture for the CAMERA 2.0 Cyberinfrastructure platform that provides a scaffold where workflows can be uploaded into the system, and user interface components for launching and viewing results are automatically generated. In CAMERA 2.0, scientific developers and metagenomics researchers seamlessly collaborate to (i) wrap data-analysis software applications and heterogeneous tools as Resource Oriented Architecture (ROA) components integrating them using scientific workflows; (ii) publish and run scientific workflows via dynamically generated uniform portal interfaces; (iii) map heterogeneous workflow products to provenance and CAMERA semantic database through a transformation component, to save output data resulting from workflow runs based on this mapping; (iv) record and visualize the provenance of all workflow run-related data and processes; and (v) conduct queries across multiple workflow executions and link these workflow executions to each other through data and provenance related to these runs. Furthermore, workflows added to CAMERA also have access to a variety of physical resources for computation and data management. Here, we demonstrate the usability of this framework with some of the developed metagenomics workflows.
Service Recommmendation: Similarity-Based Representative Skyline (SERVICES2010-4071)
Liang Chen, Jian Wu, Shiguang Deng, Ying Li (Zhejiang University, China)
Skyline attracts more and more attention from academic circle and industrial circle because of its application in multi-criterion decision support, preference answering and data analysis. However, it seems unnecessary to recommend all services in skyline while the number of skyline points is large. The number of services in skyline is always large for the reason that comparability decreases with the increase of data dimensionality. Users always want to get only 2 or 3 recommendations instead of all services in skyline. Motivated by this, we propose to compute the representative skyline which contains some points that best describe the contour of the full skyline. In this paper, we propose a new definition which we call “similarity-based representative skyline”. We provide an algorithm SBRSA, which is based on a traversal approach to compute the value of similarity. In particular, we propose an algorithm to maintain the result of SBRSA in dynamic data environment. An extensive performance study using real and synthetic service data is reported to verify its great performance in representation and computing cost.

Heterogeneous Service Selection Based on Formal Concept Analysis (SERVICES2010-4072)
Stephanie Chollet, Vincent Lestideau, Philippe Lalanda, Diana Moreno-Garcia, and Pierre Colomb (Laboratoire Informatique de Grenoble; Laboratoire d’Informatique, de Mod’elisation et d’Optimisation des Syst’emes, France)
In this paper, we present an approach based on Formal Concept Analysis in order to organize the services registry at runtime and to allow the “best” service selection among heterogeneous and secured services according to a set of specifications. This solution has been validated in the European SODA project on pervasive applications.

Investigating, Modeling, and Ranking Interface Complexity of Web Services on the World Wide Web (SERVICES2010-4073)
Xiaoyi Lu, Jian Lin, Yonggiang Zou, Juan Peng, Xingwu Liu, and Li Zha (Chinese Academy of Sciences, China)
Analyzing factors of affecting Web Service invocation performance is a hot topic. Among the factors, service interface complexity is a key one investigated by much research work. However, these researches mainly analyze the impact on the performance of primitives, some simple data structures like mesh interface object, or array of them. For the complex data structures, these works lack of a systematic approach to characterize the impact. This paper firstly makes a detailed statistics of service interface complexity based on a large sample space (10K+ WSDL files) on the World Wide Web, and we find about 41.6% services contain complex data structures. The statistic results guide us to conduct many experiments for finding out the correlation of service interface complexity to invocation performance. We discover an interesting feature on commonly used Web Service platforms (Axis/gSOAP/.Net), called Data Structural Form Unaware. As each parameter or return value can be represented as a tree with two kinds of nodes, structure type node and primitive type node, then the feature means that the overhead caused by parameters or return values is independent of the organization of nodes in the trees, but it is only related with the number and the type of nodes. By this feature, we present a simple model to quantify the impact of service interface complexity. Using our model, a Service Interface Performance Vector can be calculated by parsing a WSDL file to estimate the overhead of service interface design. This vector, together with the invocation probability of each operation, generates the Service Interface Performance Score, a comprehensive complexity indicator which can be used to evaluate and rank the service interfaces. At last, a rank report of services on the WWW is shown. Our work can play a guiding role in service interface designing, service interface performance predicting, and ranking.

An Extension of Business Process Model for XML Schema Modeling (SERVICES2010-4074)
Ondřej Macek and Martin Necasky (Czech Technical University in Prague; Charles University in Prague, Czech Republic)
Various notations for business process modeling are nowadays very popular for software analysis. They allow modeling business processes as well as exchanged data at the conceptual level. Later, a conceptual schema of a business process can be translated to an executable script expressed in, e.g. BPEL. While this part of translation has been solved in recent research, there is a lack of methods which allow to easily derive suitable communication data formats between the components of the business process. Usually, XML is considered for message exchange. However, XML formats suitable for the business process must be derived manually by schema designers. In this paper, we present a novel method which derives XML formats for message exchange among components of a business process. We suppose a conceptual schema of the business process as an input. We then derive XML formats for communication links in the conceptual schema and optimize them by minimizing two metrics. Firstly, we measure data redundancies in respective XML documents. Secondly, we measure how easy it is to evaluate a set of business rules given by the conceptual schema. The result is a set of quality XML formats with respect to the conceptual diagram of the implemented business process.

Service Oriented Enterprise Architecture Framework (SERVICES2010-4075)
Mohammad Kazem Haki and Maia Wentland Forte (University of Lausanne, Switzerland)
The concept of Service Oriented Architecture (SOA) has had a significant impact not only on software engineering but on the analysis of an organization’s business layer as well. In this paper we demonstrate that using the SOA concept into the Enterprise Architecture (EA) framework makes the best of the synergy existing between these two approaches. We will examine the characteristics of this relationship before proposing a roadmap for integrating SOA and EA into the Service Oriented Enterprise Architecture (SOEA). Some managerial aspects leading to a successful implementation of this kind of projects will be discussed.

A Maturity Model for Implementing ITIL v3 (SERVICES2010-4076)
Rúben Filipe de Sousa Pereira, Miguel Mira Da Silva (Instituto Superior Técnico, IST/INOV, Portugal)
Information Technology Infra-structure Library (ITIL) is the most popular “best practices” framework for managing Information Technology (IT) services. However, implementing ITIL not only is very difficult but there also are no best practices for implementing ITIL. As a result, ITIL implementations are usually long, expensive, and risky. In this paper, we propose a maturity model to assess an ITIL implementation and provide a roadmap for improvement based on priorities, dependencies, and guidelines. We then demonstrate a practical application of the proposed model with a questionnaire to assess the ITIL Incident Management process that was evaluated in two real-world organizations.

NCSE Session 3 (Session Chair: Zhixiong Chen, Mercy College, USA)
A Comprehensive SOA Governance Framework Based on COBIT (SERVICES2010-4077)
Facizat Hojaji, Mohammad Reza Ayatollahizadeh Shirazi (Amirkabir University of Technology, Iran)

SOA governance has a critical role in achieving success and realizing the benefits of SOA. Without effective SOA governance, organizations will experience some predictable challenges including difficulties in designing effective decision structures and building a SOA roadmap, lack of service funding, lack of consistent governance processes and gap between IT and business. Study of existing SOA governance frameworks reveals that these frameworks do not completely document SOA processes, governance procedures and SOA roadmap, and also they are not expressive enough to cover all important elements of SOA governance. Therefore, in this paper, we propose a new framework named AUT SOA governance framework based on COBIT that is more comprehensive and expressive than its counterparts. The proposed framework is obtained by enforcing control and governance aspects of COBIT and applying service management activities into a lifecycle approach. This framework is a perceptible framework that clarifies all processes, their relationships, related roles and responsibilities and measurement metrics and promotes control and policy enforcement by defining management control objectives. Also, imperative elements of SOA governance that existing frameworks do not cover them completely specially, service portfolio management, SOA roadmap, performance metrics and evaluation processes have been completely added and described in this framework.

An Analysis of Using State of the Art Technologies to Implement Real-time Continuous Assurance (SERVICES2010-4078)
Chien-Cheng Lin, Fengyi Lin, Deron Liang (National Taiwan Ocean University; National Taipei University of Technology; National Central University, Taiwan)

With the integrity of the information in financial reports being questioned and the shift towards more rapid financial reporting, the auditing profession has found that Continuous Assurance is an effective means of facilitating early detection of fraudulent financial reports. However, according to recent surveys, Continuous Assurance has not been widely applied to date. This fact motivates us to investigate if state-of-the-art IT technologies are capable of supporting Continuous Assurance. The contribution of this study is threefold. First, we develop an ISO/IEC 9126-based Continuous Assurance evaluation framework with six technical criteria. Second, based on the proposed framework, we review two (real-time) IT technologies, namely the Embedded Audit Module (EAM) and the Interceptor mechanism, and explore the feasibility of using them to implement real-time Continuous Assurance (CA). Overall, the interceptor approach outperforms the EAM approach, although neither approach satisfies all of the framework’s technical criteria. Third, we find that using the interceptor mechanism in the middleware layer, rather than in other layers, improves the implementation of a real-time auditing interceptor. In light of the proposed evaluation framework, we consider the future development of a middleware interceptor technology that can be used to firmly establish a real-time Continuous Assurance framework.

Towards a Formalization of Contracts for Service Substitution (SERVICES2010-4079)
Marlon Dumas, Yong Yang, Liang Zhang (Fudan University, China)

In a service-oriented system, service substitution can be used to repair faults, improve performance, and/or enhance resilience via graceful degradation. Correct service substitution must preserve the essential properties of the system, particularly the proper termination and/or liveness. However, ensuring correct service substitution poses some challenges. The main obstacle is that, in the general case, the behavior of services is opaque to service designers due to the autonomy of services. While the bulk of prior researches on service substitution assume that services advertise their interaction protocols (e.g., in the form of BPEL), existing services (i.e., in the form of WSDL) rarely do so. In this paper, we study the problem of service substitution under the assumption that services do not expose their interaction protocols. To this end, we characterize the behavior of interacting services by means of contracts consisting purely of input/output messages and message exchange patterns revealed in WSDL interfaces. On the other hand, the behavior of service compositions is assumed to be known to service designers. In this setting, we define notions of compatibility for self-contained systems and for open systems. Based on these notions, we propose a theory of contracts for service substitution. We also study a notion of degraded substitution based on the “may-”, “should-” and “must-” testing pre-orders.

NCSE Session 4 (Session Chair: Ming Qi, South China University of Technology, China)

Intercloud Directory and Exchange Protocol Detail Using XMPP and RDF
David Bernstein, Deepak Vij (Huawei Technologies, USA)

Working groups have proposed building a layered set of protocols to solve the Cloud Computing interoperability challenge called “Intercloud Protocols”. Instead of each cloud provider establishing connectivity with another cloud provider in a Point-to-Point manner resulting in the n2 complexity problem, Intercloud Directories and Exchanges will act as mediators for enabling connectivity and collaboration among disparate cloud providers. Point to Point protocols such as HTTP are not suitable beyond 1-to-1 models, therefore the discussions around many-to-many mechanisms have been proposed, including XMPP. This paper details the use of an XMPP mechanism for such mediation. On top of that, for the federation of the resources themselves, we define a resources catalog approach, using the Semantic Web Resource Definition Framework (RDF) along with a common Ontology of Cloud Computing Resources to work across a variety of heterogeneous cloud providers.

An Application-centric Model for Cloud Management
Terence Harmer, Peter Wright, Christina Cunningham, John Hawkins and Ron Perrott (Queen’s University of Belfast, UK)

The cloud model is increasingly popular as a means of creating dynamic, flexible and cost effective network-centric application infrastructures. The model separates the applications, or application cloud, from the resources, or resource cloud, upon which the applications will be hosted. There are an increasing number of utility resource providers that aim to provide cloud infrastructure on demand to users and libraries that aim to manage owned infrastructure as a resource cloud. There is, unfortunately, no common API for cloud resources and it is unlikely that one will emerge soon given the immaturity of the area and the competing commercial interests in the domain. In this paper, we outline our commodity and application-centric approach to resource management, and describe our integration framework for cloud application management--illustrating its use in a field deployed application and a particular dynamic component within that application.

RTSOAA Session 1 (Session Chair: Jun-Jang (JJ) Jeng, IBM T.J. Watson Research Center, USA)

Autonomous Short Latency System for Web Application Layer Firewall (SERVICES2010-4080)
Hironao Takahashi, Kinji Mori, and Hafiz Farooq Ahmad (Tokyo Institute of Technology, Japan; National University of Sciences and Technology, Pakistan)

Real-time application was required many types of industrial controllers, factory machines since 20-century. It is also utilizing many types of real time controllers for vehicle such as train, automobile and so on [1]. On the other hand, Web services that are using Internet are required short latency system. When the accesses are increased, services of quality are so important factors to achieve their requirement. Thus, these web
services are facing different levels of requirement. One is short latency of time service and other one is protection from malicious access. To support two of both at same time, it is big challenge in Web service today. The main issue is malicious web attacks on web application layer level accesses that came up recently. Today's web service provider is attempting to achieve this level of service. There are a few Web application level security technology but the all of their approach is black list or white list base. To analyze these HTTP protocol accesses, web site is always required high performance list search and compares them. From the analyzing processes have some events overhead. Keeping short latency of time, it needs high I/O performance solution. This paper is proposing L3 block cache node with eventually consistency technology to achieve timeliness autonomous decentralized system. The latency of time is compared with traditional approach system. Jmeter based web access response evaluation is shown very positive result. Thus, proposing short latency node system is great solution for Web Application Firewall with short latency.

Web-Based Decision Making for Complex Event Processing Systems (SERVICES2010-4081)  
Albert Kavelar, Hannes Obweger, Josef Schiefer, and Martin Santtiger (UC4 Sensitvice Vienna, Austria)

Sophisticated event-pattern rules are the key to successful applications of Complex Event Processing (CEP). However, creating such rules may place heavy demands on business users. In this paper we propose a novel approach to rule composition for the event-based system SARE: Via a web-based user interface, users can compose ruling logic from abstracted, configurable buildings block as previously prepared by power users; business users can thus create, modify and monitor their rules without the need to understand the event-based foundation of an application, or to install additional software. To emphasize the advantages of the new technique over existing approaches, we demonstrate our application in an exemplary workflow from the Value Added Tax (VAT) refund request domain.

On-Line Scheduling for Real-Time Services on Cloud Computing (SERVICES2010-4082)  
Shuo Liu, Gang Quan, and Shangling Ren (Florida International University; Illinois Institute of Technology, USA)

In this paper, we introduce a novel utility accrual scheduling algorithm for real-time cloud computing services. The real-time tasks are scheduled non-preemptively with the objective to maximize the total utility. The most unique characteristic of our approach is that, different from the traditional utility accrual approach that works under one single time utility function (TUF), we have two different TUFs—a profit TUF and a penalty TUF—associated with each task at the same time, to model the real-time applications for cloud computing that need not only to reward the early completions but also to penalize the abortions or deadline misses of real-time tasks. Our experimental results show that our proposed algorithm can significantly outperform the traditional scheduling algorithms such as the Earliest Deadline First (EDF), the traditional utility accrual scheduling algorithm and an early scheduling approach based on the similar model.

RTSOAA Session 2 (Session Chair: Josef Schiefer, Vienna University of Technology, Austria)

Towards Resource-Aware Runtime Reconfigurable Component-Based Systems (SERVICES2010-4083)  
Iounat David, Bojan Orlic, Rudolf H. Mak, and Johan J. Lukkien (Eindhoven University of Technology, the Netherlands)

The overall Quality of Service (QoS) delivered by a system depends on the resources available to its constituting components. Achieving predictable QoS behaviour therefore requires a resource-aware component framework. Moreover, for applications that exhibit highly fluctuating loads and that have to compete for resources at runtime, the framework must also allow dynamic reconfiguration. The goal of this paper is to explore some basic principles and architectural choices for building such a resource-aware component framework that allow predictable composition of a system from distributed components. Major features of the envisioned framework are: wrapping components into networked services, automated extension of those services with resource management, and runtime third-party composition of the networked services.

Virtual Services in Cloud Computing (SERVICES2010-4084)  
Jicheng Fu, Wei Hao, Michael Tu, Biao Ma, Joshua Baldwin, and Farokh B. Bastani (University of Central Oklahoma; Northern Kentucky University; Dakota State University; The University of Texas at Dallas)

Cloud computing has aroused wide research interests and has been accepted by industry. Services are playing the essential role in cloud computing as cloud computing refers to “both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services”. Therefore, service-oriented architecture should play an important role in cloud computing. In addition, one of the characteristics of cloud computing is to make services available on demand. Given a group of services, different demands may involve different set of services and in different order. This is related to services reuse and composition. However, existing methods only solve service composition in a binary manner: Either a solution exists or no solutions at all. In this paper, we propose the concept of virtual services, which physically do not exist, but are conceptually treated in the same way as physical services. Virtual services are useful when traditional service compositions fail. Virtual services can connect the existing physical services and enable the composition process to succeed. The specifications of virtual services will provide valuable information about how to develop real services to meet the requirements of the given demand. In this paper, we present algorithms that can help identify the virtual services in the case of composition failure and provide the specification of virtual services for further analysis and development.

Real-Time Service-Oriented Cloud Computing (SERVICES2010-4085)  
Wei-Tek Tsai, Qihong Shao, Xin Sun, and Jay Elston (Arizona State University, USA; Tsinghua University, China)

Cloud computing has received significant attention recently. This paper presents real-time issues related to cloud computing, such as multi-tenancy architecture, scheduling, paralleled computing and proposes a framework for real-time service-oriented cloud computing. Specially, we propose a novel real time architecture which solve the new challenges in Cloud Computing.

RTSOAA Session 3 (Session Chair: I-Ling Yen, University of Texas at Dallas, USA)

Real-Time Service-Oriented Distributed Governance (SERVICES2010-4086)  
Jian Huang, Tiansheng Zhang, I-Ling Yen, John T. Carson, Mike F. Siok, Farokh Bastani, Yajing Zhao, and Jing Dong (University of Texas at Dallas; Lockheed Martin Corporation, USA)

Distributed governance is the process for individual entities in the system to make autonomous decisions in response to special situations. It is an important principle in governing the actions in cyber physical systems to achieve operation responsiveness. In this paper, we extend the widely adopted service-oriented architecture (SOA) paradigm to build a distributed governance model in the context of cyber-physical systems. To achieve distributed governance, we develop the novel distributed workflow model and the autonomous service composition process. Our distributed workflow infrastructure facilitates easy modification and evolution of the workflows and effectively incorporates the distributed
service and workflow management mechanism. Our autonomous service composition scheme allows intelligent entities in the cyber physical system to participate in the composition process and make local composition decisions which collectively, best satisfy the global Quality of Service (QoS) objectives. The distributed workflow and autonomous composition concepts can greatly enhance the timeliness, effectiveness, scalability, and agility of large-scale Cyber Physical Systems (CPS)

**Autonomous Decentralized Community Construction and Reconstruction Technology for Service Assurance**

*Riyako Sakamoto, Khalid Mahmood, Yuuya Kanamaru, X. Lu, and K. Mori (Tokyo Institute of Technology, Japan)*

Current headway in the domains of mobile communication and ubiquitous computing has given surge of interest to mobile commerce applications. Current information systems promote concept of information service provision to anyone, anytime and anywhere. Autonomous Decentralized Community System has been proposed to meet the varying requirements of users. In this paper, the decentralized search service is taken up as an application. This retrieves service in which the service offer end time has been decided beforehand. Needs of this application are the accuracy, the adaptability, and the improvement of the assurance is requested. There are two requirements in this service. First, it is to prevent the network being crowded with the request message from the node where SP that can enjoy serving doesn't exist. And, it is to prevent the stability of the entire system from decreasing to update cash information. To solve these, it proposed the Autonomous Construction Technology and the Autonomous Change Adjustment Technology. Simulation results demonstrate the effectiveness of proposed technology in terms of improvement in service assurance and confirms the trade-off between accuracy and system stability.

**SC4B2B Session 1 (Session Chair: Birgit Hofreiter, University of Liechtenstein, Italy)**

**The CHORCH B2Bi Approach: Performing ebBP Choreographies as Distributed BPEL Orchestration**

*Andreas Schoenberger (Otto-Friedrich-University of Bamberg, Germany)*

Applying choreography and orchestration technology has become a popular method of attacking Business-2-Business integration (B2Bi) challenges like agreement and communication among integration partners, compatibility of interacting processes and distributed computing. ebXML BPS (ebBP) as dedicated B2Bi choreography standard and WS-BPEL as number one Web service orchestration language are particularly promising technologies. While ebBP can be used as means for agreement and communication among integration partners WS-BPEL and Web services can be used to solve distributed computing issues. The CHORCH approach applies model driven development to the ebBP-BPEL tool chain in order to further foster conformance of WS-BPEL orchestrations to ebBP choreographies, compatibility of interacting WS-BPEL processes and efficient software development cycles. This paper introduces 10 requirements for applying choreography and orchestration technology to B2Bi and shows how these are reflected in the CHORCH approach by applying three different types of ebBP modeling flavors.

**Size Matters!! Measuring the Complexity of XML Schema Mapping Models**

*Christian Pichler, Michael Strommer, and Christian Huemer (Research Studios Austria; Vienna University of Technology, Austria)*

Exchanging structured business documents is inevitable for successful collaboration in electronic commerce. A prerequisite, for fostering the interoperability between business partners utilizing different business document standards, is a mapping between different standards. However, the effort involved in creating those mappings is hard to estimate. For example, the complexity of standardized formats is one crucial aspect affecting the effort of the mapping process. Therefore, a notion of complexity is desirable for both, manual as well as automatic mapping processes. For this reason we develop an initial set of metrics, based on well established metrics for XML Schema, allowing to analyze the complexity of business document standards. Having such metrics at hand allows estimating the complexity and hence the mapping effort of a business document standard, prior to the actual mapping process. We demonstrate the complexity metrics on three different business document standards from the electronic commerce domain.

**SEASS Session 1 (Session Chair: Shiping Chen, CSIRO ICT Centre, Australia)**

**An Adaptive Solution for Web Service Composition**

*Hongbing Wang and Xiaohui Guo (Southeast University, China)*

Dynamic Web service composition is a challenging problem and has been intensively investigated in recent years. Nevertheless, most of existing approaches do not provide satisfactory composition results, especially when confronted with a large scale of services. In this paper, we present a novel algorithm called HRLPLA for composing Web services. The algorithm considers functional properties and QoS properties simultaneously. By using hierarchical reinforcement learning, it can deal with large scales of services and generate efficient service compositions. Moreover, the algorithm is suitable for composing Web services in dynamic environment, as reinforce-ment learning is very adaptive. We conducted experimental study to verify the effectiveness and efficiency of our method in dynamic service composition.

**LOG4WS.KOM: Self-Adapting Semantic Web Service Discovery for SAWSDL**

*S. Schulte, U. Lampe, J. Eckert, and R. Steinmetz (Technische Universität Darmstadt, Germany)*

In recent years, a number of approaches to semantic Web service matchmaking have been proposed. Most of these proposals are based on discrete and thus relatively coarse Degrees of Match (DoMs). However, different basic assumptions regarding the generalization and specialization of semantic concepts in ontologies and their subsequent rating in matchmaking exist. Hence, most matchmakers are only properly suitable if these assumptions are met. In this paper, we present an approach for mapping subsumption reasoning-based DoMs to a continuous scale. Instead of determining the numerical equivalents of the formerly discrete DoMs manually, these values are automatically derived using a linear regression model. This permits not only easy combination with other numerical similarity measures, but also allows to adapt matchmaking to different basic assumptions. These notions are implemented and tested in LOG4WS.KOM – a matchmaker for SAWSDL that provides very good evaluation results with respect to Information Retrieval metrics such as precision and recall.

**SEASS Session 2 (Session Chair: Jenny Yan Liu, Pacific Northwest National Laboratory, USA)**

**Proactive SLA Negotiation for Service Based Systems**

*Khaled Mahbub and George Spanoudakis (City University London, UK)*

In this paper we propose a framework for proactive SLA negotiation that integrates this process with dynamic service discovery and, hence, can provide integrated runtime support for both these key activities which are necessary in order to achieve the runtime operation of service based
Towards Knowledge Management in Self-Adaptable Clouds (SERVICES2010-4093)
Michael Maurer, Ivona Brandic, Vincent C. Emekaroha, and Schaibram Dastdar (Vienna University of Technology, Austria)
Cloud computing represents a promising computing paradigm where resources have to be dynamically allocated to software that needs to be executed. Self-manageable Cloud infrastructures are required to achieve that level of flexibility on the one hand, and to comply to users’ requirements specified by means of Service Level Agreements (SLAs) on the other. Such infrastructures should automatically respond to changing component, workload, and environmental conditions minimizing user interactions with the system and preventing violations of SLAs. However, identification of system states where reactive actions are necessary for the prevention of SLA violations is far from trivial. In this paper we investigate how current knowledge management systems can be used for the prevention of SLA violations in Clouds. First, we define a typical SLA use case and formulate the expected behavior of the knowledge management system in order to prevent possible SLA violations. Second, we investigate different methods for knowledge management, e.g., situation calculus and case based reasoning (CBR). We discuss how these methods match the expected behavior for SLA violation prevention. In particular we examine the CBR method and devise several approaches for knowledge management in Clouds based on CBR. Finally, we evaluate our approach based on the presented use case.

SOCMAS Session 1 (Session Chair: Rainer Unland, University of Duisburg-Essen, Germany)

A SOA Approach for Domain-Specific Language Implementation (SERVICES2010-4094)
Shih-Hsi Liu, Adam Cardenas, Xang Xiong, Marjan Mernik, Barrett R. Bryant, and Jeff Gray (California State University; University of Maribor; University of Alabama at Birmingham, USA; University of Alabama, USA)
Although there have been many benefits of Domain-Specific Languages (DSLs) reported from both academia and industry, implementation of DSLs continue to face challenges with respect to frequent evolution of both syntax and semantics. Techniques for implementing DSLs also lack interoperable capabilities among base languages and limited tool support. Such challenges result in increasing DSL development cost and constrain DSL adoption opportunities. This paper introduces a Service-Oriented Architecture (SOA) approach to address such problems. The approach utilizes WSDL to perform lexical and syntax analysis. Web services are used to define the semantics of a DSL, and WS-BPEL is then used to specify a DSL program. We present two case studies representing different DSL categories to show the feasibility of SOA-based DSL implementation. The case studies demonstrate the potential for easing the burden of DSL evolution and offering interoperability and tool support. Improved modularization and removal of tokenization/parsing are two additional advantages. Discussion and comparison among interpreter-based, model-driven and SOA-based DSL implementations are provided, which may raise more research interests in this area.

PECoDiM: An Agent Based Framework for Autonomic Web Services (SERVICES2010-4095)
Walid Chainbi, Haithem Mezni, and Khaled Ghedira (Sousse National School of Engineers, Tunisia; Jendouba University Campus; Institut Supérieur de Gestion de Tunis)
Autonomic computing is about systems that can manage themselves. Self-management includes self-configuration, self-healing, self-optimization, etc. (self-* properties). Agent technology offers key advantages for the development of autonomic computing systems as it supports autonomy, adaptability, etc. Current Web service standards and technologies don’t provide a suitable architecture in which all aspects of self-management can be designed. In this paper, we present an agent-based framework for autonomic Web services. This framework is based on a multi-agent system made up with five agents namely a Planning agent, an Execution agent, a Composition agent, a Discovery agent, and a Monitoring agent.

Service Discovery with Semantic Characteristics: ACTAS (SERVICES2010-4096)
Reinhold Kloos, Rainer Unland, Chereif Branki (University of Essen-Duisburg, Germany; University of the West of Scotland, Scotland)
Discovery is the task of locating (Web) Services by means of their semantic annotation. Semantic Web Services (SWS) annotate semantic information about their functionality through capability descriptions (e.g. WSMO, OWL-S). Many approaches of automatic discovery and composition of business services take advantage from SWS. However, discovery and composition of general services or discovery based on other service aspects as functionality are neglected. The paper introduces models of a Discovery Framework called ACTAS (Adaptive Composition and Trading based on Agents), which allows the matching through semantic characteristics and algorithms. Semantic service characteristics, published through an ontological repository, wrap service property objects and constraints. The description of services with the SWS interface needs rather an expert (e.g. in description logic (DL)). Semantic Service Characteristics can offer interfaces adapted for a definite user groups or domains. They allow the keeping of domain specific ontologies.

WebX Session 1 (Session Chair: Hong Cai, IBM China Software Development Lab)

A Service Composition Approach for the Fulfillment of Temporally Sequential Requirements (SERVICES2010-4097)
Xiaohui Wang, Zhongjie Wang, Xiaofei Xu, Alice Liu, and Dianhui Chu (Harbin Institute of Technology; IBM China Research Laboratory, China)
Traditional service composition approaches focus on selecting and composing multiple service components together to fulfill one single requirement. But in most realworld scenarios, there are multiple requirements raised by multiple consumers and they form a discrete and uneven flow (i.e., a temporal sequence). Due to the limited number of available services and their limited capabilities, how to ensure the equilibrium between the satisfaction degrees of these temporally sequential requirements becomes an important issue to be addressed. This paper proposes an equilibrium-oriented service composition approach taking into account both the limitedness of service capacity and utilization of historical data. The temporal sequential requirements are divided gradually along with the formation of length-flexible time-segments one by one. Based on this segmentation, service capacity is preserved proportionally for the estimated future requirements, and multiple requirements within one segment are ensured to get relatively equal chances of being satisfied with relatively equal quality. Experiments reveal improved sustainability and superior temporal stability of service quality compared with applying traditional methods to this scenario.

Towards a More Effective Mashup Using Mashable Service Model (SERVICES2010-4098)
Chun'e Ma, Jing Zhang, Chenting Zhao, Yuan Ni, Jun Zhang, Li Yi, and Xinsheng Mao (IBM China Development Lab; IBM China Research Lab, China)
Web is becoming a programmable platform and Mashup is emerging as a brand-new service composition paradigm. However, one of the biggest blocking issues with the universal adoption of Mashup is lack of a welldesigned inventory of mashable services for users to create mashups.
effectively. In this paper, we propose a novel and practical method to conceptualize, model and design the mashable services in a specific domain. Firstly, through analyzing current mashups theoretically, we present a conceptual model of mashable service, which describes not only a service, but also the relationships with other services. As a result, the services and their relationships in a domain can be formalized as a directed graph, in which vertex represent services and edges represent relationships. Furthermore, a mashup can be modeled as one of its subgraph. Secondly, we present a novel and practical method to identify and design the inventory of mashable services through mapping the well-known Entity-Relationship Model to mashable service model. The inventory of mashable services enables business users to create mashups for their situational problems effectively. Finally, the proposed method is applied to a real-world domain to show the feasibility and effectiveness.

An Approach to Event Driven Services and Composite Services (SERVICES2010-4099)
Massimo Maresca, Michele Stecca, and Pierpaolo Baglietto (University of Padova; University of Genova, Italy)

This paper presents a reference model for Event Driven Composite Services, shows how such a model can be used as a basis to design a Service Creation Platform and a Service Execution Platform and describes an example of a Composite Service that takes advantage of the model and of the platforms. The Event Driven Service Composition paradigm supports the design and the implementation of distributed applications in environments in which the services to be composed interact with external components that generate asynchronous events, as it happens, for example, in telecommunication, in factory automation, in resource monitoring, in social community interactions, in finance/administration and in many others cases. The approach proposed is in the direction of enabling people with no programming skills to design and implement services over networks, thus contributing to the diffusion of an active role of the users in service provisioning.

WebX Session 2 (Session Chair: Liang-Jie Zhang, IBM T.J. Watson Research Center, USA)

Improving Performance for Decentralized Execution of Composite Web Services (SERVICES2010-4100)
Xitong Kang, Xiaodong Liu, Haifong Sun, Yanjia Huang, and Chao Zhou (Beihang University, China)

Decentralized orchestration of composite web services offers performance improvements in terms of increased throughput and lower response time. However, most relevant research literature in decentralizing service composition omit the step of selecting component services, the locations of which have major impact on the amount of dataflow messages and the volume of network traffic during decentralized execution. In order to reduce the network traffic generated by data flow messages thus to improve the performance of the decentralized orchestration, this paper presents an approach to component service selection using data dependency graphs. The performance evaluation concludes that a substantial decrease in network traffic by use of our service selection approach results in a reduction of approximately 30% in execution time on average.

Model Driven Approach for Dynamic Service Composition Based on QoS Constraints (SERVICES2010-4101)
Assel Akchalova and Iman Poernomo (King’s College London, UK)

The problem of dynamic service composition of SOA systems based on QoS requirements may be framed as one of automatic generation of policies according to desirable level of QoS characteristics. In this paper, we provide a model driven approach to develop an optimal service composition policies for SOA systems with defined SLAs metrics and QoS constraints. Our work utilizes ideas from Dynamic Programming to calculate optimal policies.

Integrating Information Systems Using Web Oriented Integration Architecture and RESTful Web Services (SERVICES2010-4102)
Szepielak Daniel, Tumidajewicz Przemyslaw, Hagge Lars (Deutsches Elektronen-Synchrotron, Germany)

This paper proposes a method for the semantic integration of information systems that aims at shifting the main focus of the integration efforts, which is typically placed on software development, in the direction of business modeling with the goal of reducing the necessary code development and maintenance efforts. Proposed approach follows the principles of Web 2.0, which strongly promote the simplest, most open and best scaling software development approaches. For this purpose it employs the Web Oriented Integration Architecture (WOIA) which extends the concept of Web Oriented Architecture (WOA) that in recent years has been gaining attention as an alternative to traditional SOA. The WOIA allows information consumers to access information system resources regardless of their representations and interfaces of particular information systems, as well as without knowing where the required resources are located. The necessary functionality is delivered by the WOIA middleware which provides web service registration, discovery, composition and execution capabilities.

WebX Session 3 (Session Chair: Hong Cai, IBM China Software Development Lab)

Ranking-Based Suggestion Algorithms for Semantic Web Service Composition (SERVICES2010-4103)
Rui Wang, Sameedha Ganjoo, John A. Miller, and Eileen T. Kraemer (University of Georgia, GA)

The process of selecting Web services from a large number of potential services available on the Web is a challenging task for users engaged in Web service composition. This work is devoted to resolving this issue by suggesting Web services to the user. Our suggestion algorithm ranks all the available services for the user based on the semantic annotations of a service's inputs, outputs and functionality, as well as pre-conditions and effects, if available. This paper presents multiple algorithms for making suggestions during Web service composition. These algorithms extend traditional Web service discovery algorithms; in particular, they include new techniques for ranking the effectiveness of data mediation.

Business Rules Discovery from Process Design Repositories (SERVICES2010-4104)
Jannita Polpinij, Aditya K. Ghose, and Hoa Khanh Dang (University of Wollongong, Australia)

Traditional process mining approaches focus on extracting process constraints or business rules from repositories of process instances. In this context, process designs or process models tend to be overlooked although they contain information that are valuable for the process of discovering business rules. This paper will propose an alternative approach to process mining in terms of using process designs as the mining resources. We propose a number of techniques for extracting business rules from repositories of business process designs or models, leveraging the well-known Apriori algorithm. Such business rules are then used as a prior knowledge for further analysing, verifying, and modifying process designs.

A Pragmatic Approach for Matching UI Components on Web Service Operations (SERVICES2010-4105)
Christian Liebing, Ronny Memenrich, and Alexander Schill (Dresden University of Technology, Germany)

The service-oriented approach with his essential advantages of a uniform interface and the possibility to reuse distributed and heterogeneous services in other contexts has led to a high popularity in Business-to-Business (B2B) scenarios. However, the development of user interfaces (UI)
This paper also presents the framework and its pervasive applications development. Finally, a case study is used for demonstration.

Finally, we design the DCIM algorithm to implement the data consistent instance migration, and an extensive set of simulations are performed to service-based framework supporting situation-awareness and workflow management is sketched to support execution of pervasive applications. Present an application model composed of a situation model, workflows, and required services for development of pervasive applications. A

extensions to Odin that further optimise resource usage. Augmented with support for context types that include location, performance, power and quantitative evaluation, context-aware Odin's low overhead is demonstrated along with significant gains in resource conservation.

Mobile devices such as smart phones are increasingly permeating society. With strides in computational power, coupled with the ability to connect to other small devices, smart phones are able to host novel services. To address the repetitive problems associated with mobile service development, namely service reachability, scalability and availability, we have developed Odin, which is a middleware platform for mobile service provisioning. Beyond providing a provisioning solution, Odin conserves scarce resources such as network bandwidth and device power supply. However, Odin has previously lacked an ability to take into account operational context. In this paper, we present context-aware extensions to Odin that further optimise resource usage. Augmented with support for context types that include location, performance, power and network, Odin is able to propagate context information to applications and dynamically adapt the middleware’s behaviour. Novelty of the work lies in a solution whose device overhead is very low, and one that offers a coherent approach to context dissemination and adaptation. Based on quantitative evaluation, context-aware Odin’s low overhead is demonstrated along with significant gains in resource conservation.
Study and Comparison of Adaptation Mechanisms for Performance Enhancements of Mobile Web Service Consumption (SERVICES2010-4112)

Apostolos Papageorgiou, Jeremias Blendin, Andre Miede, Julian Eckert, and Ralf Steinmetz (Technische Universität Darmstadt, Germany)

Mobile Web services lie on the intersection of two big IT trends, namely Service-oriented Architectures (SOA) and mobile applications. So, their usage is likely to expand dramatically in the next years. However, the heavyweight nature of service-orientation in terms of the messaging-overhead that is necessary in order to achieve interoperaibility and loose-coupling comes in contrast with the lightweight nature of mobile devices and with the need to transmit wirelessly as few data as possible. This study categorizes the mechanisms that have been designed in order to bridge this gap, provides comparisons, discusses the results of related experiments, and introduces the future scenario in which the insights of the study can be exploited.

A Service-Oriented Design for Controlling Multimedia Sessions over Stand-Alone MANETs (SERVICES2010-4113)

Tien Pham Van, Tien Dung Nguyen, Tuan Do Trong, Thanh Loan Nguyen, and Quyet Vu Khac (Hanoi University of Technology, Vietnam)

Distributed multimedia applications over mobile ad hoc network have a great potential in various scenarios. However, establishing ad hoc multimedia sessions is not simple given that ad hoc nodes are highly dynamic and resource limited. For session control, the conventional SIP is not applicable since using a particular mobile endpoint as a server is unrealistic. Recently, several proposals on extension of SIP have been introduced but most of reported results are in term of simulation statistics. In this study, we instead implement a real-world testbed for the proposed framework. Taking into account node mobility and route instability, we initiate a fully distributed and service-oriented design. In the strategy, routing information messages are exploited to convey user identity data. At the same time, each node maintains a compound routing table that contains both route data and peer address. Experimental results from the aforementioned testbed were reported, demonstrating the feasibility of our architecture.

EMSOS Session 3 (Session Chair: Ian Gorton, Pacific Northwest National Laboratory, USA)

Context-Driven Optimization of Mobile Service-Oriented Systems for Improving Their Resilience (SERVICES2010-4114)

Deshan Cooray, Sam Malek, and Roshanak Roshandel (George Mason University; Seattle University, USA)

Mobile software systems are characterized by their highly dynamic and unpredictable execution context. Such systems are permeating a number of domains where the systems operate in constantly changing conditions. We refer to such systems as Situated Software Systems. These systems are often deployed in mission-critical settings with stringent reliability requirements. Existing approaches to performing reliability analysis are insufficient in meeting the demands of situated software systems. We propose an approach aimed at such systems and present it in the form of a framework and tool suite known as REsilient Situated SoFTware system (RESIST). The framework utilizes information from the system’s context to produce reliability predictions, and places the system in the optimally reliable configuration with respect to other competing quality attributes.

Testbeds for Emulating Dependability Issues of Mobile Web Services (SERVICES2010-4115)

Lukasz Juszczyk and Schahram Dustdar (Vienna University of Technology, Austria)

Today’s ubiquitous internet access has opened new opportunities for mobile workers. By using portable devices, the workers are not only able to access their company’s data and/or services from everywhere, but are also offering their own services for being accessible on-demand. The result is on the one hand a higher flexibility, in terms of coordination, but on the other hand poses various challenges to the company’s internal workflows due to the dynamic nature of mobility. Consequently, the workflows must be tested at runtime in realistic scenarios in order to get evidence about their correct execution. In this paper we present an approach for emulating mobile workers in order to test the effects of unreliable dependability on workflows. By using the Genesis2 framework we generate testbeds consisting of real Web services and simulate their QoS as well as mobility issues such as packet loss, delay, and an unreliable availability. By generating a running testbed environment, our approach allows to investigate a workflow’s execution at to detect runtime faults.

SCCI Course Development Session

(Session Chair: Liang-Jie Zhang, IBM T.J. Watson Research Center, USA) (SERVICES2010-4116)

Services Computing Curriculum Initiative (SCCI) is an attempt to systematically integrate the best practices and result in the creation of Services Computing degree programs that are suitable for accreditation processes. SCCI is sponsored by the technical Committee on Services Computing (TC-SVC) at IEEE Computer Society. The session will open to ALL and focus on the information exchange of course development and its role in overall curriculum development such as Services Computing Curriculum (http://www.servicescurriculum.org/).

SOA Standards Symposium Session

(Session Chair: Liang-Jie Zhang, IBM T.J. Watson Research Center, USA)

This session is used as a forum for ALL international researchers and practitioners to discuss and establish standards around SOA. It is sponsored by IEEE Standards Association SOA and Web Services Working Group (http://soa-standards.org/). (SERVICES2010-4117)

Standards Symposium (Cloud Computing) Session

(Session Chair: Min Luo, IBM Software Group, USA) (SERVICES2010-4118)

This session is used as a forum for ALL international researchers and practitioners to discuss and establish standards around Cloud Computing. Presentations on Cloud Computing standard activities in various organizations (e.g. OpenGroup) will be given in an interactive manner.

Thursday: Business Lunch (Ashe Auditorium (Third Floor))

Overview and Planning of Services Computing Community’s Professional Activities (Q/A) (SERVICES2010-4119)
IEEE Computer Society
Technical Committee on Services Computing
http://www.ServicesComputing.org/

Dr. Ephraim Feig, Innovations-to-Market, USA
Prof. Patrick C.K. Hung, University of Ontario Institute of Technology, Canada
Prof. Hemant Jain, University of Wisconsin - Milwaukee, USA
Prof. Frank Leymann, University of Stuttgart, Germany
Prof. Calton Pu, Georgia Institute of Technology, USA
Prof. Jeffrey Tsai, University of Illinois at Chicago, USA
Prof. Zhiwei Xu, Chinese Academy of Sciences, China
Dr. Liang-Jie (L.J) Zhang (Chair), IBM T. J. Watson Research Center, USA

Sponsored Conferences:
IEEE World Congress on Services (SERVICES)
http://ServicesCongress.org

IEEE International Conference on Cloud Computing (CLOUD)

IEEE International Conference on Web Services (ICWS)
http://conferences.computer.org/icws and http://icws.org

IEEE International Conference on Services Computing (SCC)
http://conferences.computer.org/scc

IEEE European Conference on Web Services (ECOWS)
http://conferences.computer.org/ecows

IEEE Asia-Pacific Conference on Services Computing (APSCC)
http://conferences.computer.org/apscc

Community Links:
IEEE Transactions on Services Computing (TSC)
http://www.computer.org/tsc

International Journal of Web Services Research (JWSR)
http://www.servicescomputing.org/jwsr

International Journal of Business Process Integration and Management (IJBPIM)
http://www.servicescomputing.org/ijbpim
IEEE ICWS/SCC/SERVICES/CLOUD 2010
Conference Room Floor Plan

Banquet Room

Keynote Room

IEEE CLOUD-ICWS-SCC-SERVICES 2010
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