Information Systems in a Services Based Economy

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Summary

- Economy shift
- Role of IT
- Growth trends
- Industry implications
- Research directions

Credits:
- IBM Global Technology Outlook 2006
- Diem Ho, IBM Academy of Technology
- Mark Colan, IBM Evangelist, SOA and Web Services
A services-based economy

Services represent over 70 percent of the economy in western countries and the segment is growing rapidly.

<table>
<thead>
<tr>
<th>Nation</th>
<th>% WW Labor</th>
<th>% A</th>
<th>% G</th>
<th>% S</th>
<th>25 yr % delta S</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>21.0</td>
<td>50</td>
<td>15</td>
<td>35</td>
<td>191</td>
</tr>
<tr>
<td>India</td>
<td>17.0</td>
<td>60</td>
<td>17</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td>U.S.</td>
<td>4.8</td>
<td>3</td>
<td>27</td>
<td>70</td>
<td>21</td>
</tr>
<tr>
<td>Indonesia</td>
<td>3.9</td>
<td>45</td>
<td>16</td>
<td>39</td>
<td>35</td>
</tr>
<tr>
<td>Brazil</td>
<td>3.0</td>
<td>23</td>
<td>24</td>
<td>53</td>
<td>20</td>
</tr>
<tr>
<td>Russia</td>
<td>2.5</td>
<td>12</td>
<td>23</td>
<td>65</td>
<td>38</td>
</tr>
<tr>
<td>Japan</td>
<td>2.4</td>
<td>5</td>
<td>25</td>
<td>70</td>
<td>40</td>
</tr>
<tr>
<td>Nigeria</td>
<td>2.2</td>
<td>70</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2.2</td>
<td>63</td>
<td>11</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>Germany</td>
<td>1.4</td>
<td>3</td>
<td>33</td>
<td>64</td>
<td>44</td>
</tr>
</tbody>
</table>

A = Agriculture: Value from harvesting nature
G = Goods: Value from making products
S = Services Value from enhancing the capabilities of things (customizing, distributing, etc.) and interactions between things
Services economy and internetworking

Companies are seizing new business opportunities by building more efficient IT systems, streamlining their business processes and embracing the Internet

- **Business services are factorized and delocalized**
  - Decomposition / Reshaping
  - Globalization

- **Internetworking is the key enabling factor**
  - Within/across organizations
  - Within/across communities
Services and events

An increasing number of companies are addressing the needs of event-driven information services

- **Real time services**
  - eCommerce and B2B transactions, fraud management, risk and compliance, trading online, etc.

- **Pervasive devices**
  - Smart sensors, RFID, location based service, mobile telecom, logistics, etc.

- **Integrated infrastructures**
  - Route, transform and derive events from multiple streams
  - Content management solutions supporting large volumes of time-dependent data
  - Event information extraction from applications (ERP, CRM, etc.) and sensors
SOA is the answer

Services-based economy requires information exchanges, flexibility, and responsiveness: this is at the basis of Service Oriented Architectures

- **Services allow both integration and decomposition**
  - Modularization
  - Retrieval and orchestration
  - Functional and business semantics
  - Centralized and distributed architectures

- **Services facilitate scalability and quality control**
  - Time-bound transactions
  - Event-driven capabilities
  - SLA
Growth trends in the IT space

The number of service providers grows, but data volumes grow much faster, while business vocabularies remain stable (in size)

- **Services number (and variety) grows at constant rate**
  - Number of registered hosts shows a linear progression

- **Service schema (business vocabularies) dimensions stay within fixed limits**
  - Ontologies converge to a ‘cognitive upper bound’?

- **Serviced (time-dependent) data grow dramatically**
  - Exponential progression due to the increasing capability of capturing facts and events
Industry implications of services orientation

Business is being conceptualized in terms of processes, entities, activities, relationships, etc. to allow flexible composition, distribution, and integration

- Development will be driven by models (MDA) that are intended to capture services semantics and facilitate complex infrastructural programming
- Based on models, infrastructures will enhance retrieval, composition, and integration, both in centralized and distributed architectures
- Services will allow rapid deployment over heterogeneous infrastructures
- Complex service infrastructures will need specific monitoring and management practices
Industry implications of event handling

The real world is being captured (e.g. through sensors) and modeled at increasing spatiotemporal resolution

- On demand businesses will need to evolve to deal with (monitor, process, store, and respond) the increasingly event-driven world

- New middleware, programming models, and tools will emerge to deal with the increasing volume and time-dependent requirements of event-driven data

- SOA will be augmented with event orientation and processing, resulting in a hybrid between a web service and an event programming model
Enterprise Service Bus

- Routing messages between services
- Converting transport protocols between requestor and service
- Transforming message content between requestor and service
- Handling business messages (events) from disparate sources

Shape = Protocol
Color = Data type
Peer to Peer

- Retrieving the appropriate services
- Binding the appropriate transport protocol
- Understanding services’ semantics and perform appropriate interactions
- Handling business messages (events) from disparate sources
## Crucial factors: event processing

**The capability of processing business events in definite time frames**

<table>
<thead>
<tr>
<th>Increasing Capability</th>
<th>Responsiveness</th>
<th>Event Throughput</th>
<th>Event Processing Language</th>
<th>Scalability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard real-time (deterministic, us)</td>
<td>100,000’s</td>
<td>Inductive reasoning</td>
<td>Tools for integrating content behavior models</td>
<td>Internet scale: 100,000’s endpoints</td>
</tr>
<tr>
<td>Soft real-time (scheduled, ms)</td>
<td>10,000’s</td>
<td>Tools for integrating content behavior models</td>
<td>Collaborating domains</td>
<td></td>
</tr>
<tr>
<td>Near real-time (&lt; sec)</td>
<td>1000’s</td>
<td>Integration with processes, workflows</td>
<td>Tools for distributed deployment</td>
<td>Managed ESB with event services</td>
</tr>
<tr>
<td>Transactional OLTP</td>
<td>100’s</td>
<td>General multi-stream pattern specifications</td>
<td>Tools for designing event flow</td>
<td>Event server clusters</td>
</tr>
<tr>
<td>Data Mining OLAP</td>
<td>10’s</td>
<td>Sequences, thresholds, groups</td>
<td>Simple event pattern tool support</td>
<td>Single server</td>
</tr>
<tr>
<td>Data Warehouse</td>
<td>1’s</td>
<td>Message at a time filter/route</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Crucial factors: semantic interoperability

The (real) capability of integrating business models, processes, and data

<table>
<thead>
<tr>
<th>Languages</th>
<th>Task</th>
<th>Centralized</th>
<th>Decentralized</th>
<th>Scalability</th>
</tr>
</thead>
<tbody>
<tr>
<td>OWL</td>
<td>Automatic Composition, Model Checking</td>
<td>Semantic Web</td>
<td>P2P Web Services</td>
<td>Collaborating domains</td>
</tr>
<tr>
<td>BPEL</td>
<td>Choreography</td>
<td>EAI, ESB</td>
<td></td>
<td>Managed ESB</td>
</tr>
<tr>
<td>RDFS, UML</td>
<td>Discovery, Matchmaking</td>
<td>Portals</td>
<td>Business to Business</td>
<td>Server clusters</td>
</tr>
<tr>
<td>WSDL, XSD</td>
<td>Lookup</td>
<td></td>
<td></td>
<td>Single server</td>
</tr>
</tbody>
</table>
Conclusive discussion

An increasing number of services will need to integrate a fast-growing amount of information efficiently, according to quite stable schemas, either in a centralized or distributed way.

Are we addressing all the relevant research issues?
Conclusive discussion: schema-level issues

✓ **Formalism**
  ✓ Provide formal languages for better service modeling, classification, discovery, integration
  ✓ Focus on expressiveness (vs. tractability)

✓ **Technology**
  ✓ Develop specific reasoning tasks (discovery, matchmaking, composition, etc)
  ✓ Industry adoption underway (UML 2, ODM, WSMO, WSDL-S …)

✗ **Semantics**
  ✗ Ontology of modeling primitives (e.g. ‘part’, ‘activity’, etc)
  ✗ Characterization of conceptual mapping
  ✗ …
Conclusive discussion: data-level issues

✓ **Formalism**
  ✓ Provide formal languages for better data exchange / integration, event processing, query answering
  ✓ Focus on tractability (vs. expressiveness)

✓ **Technology**
  ✓ Develop specific integration middleware
  ✓ Industry adoption underway (e.g. WS II, OGSA-DAI)

✘ **Semantics**
  ✘ Naming vs. denoting (individual mapping)
  ✘ “Epistemology” of distributed query answering
  ✘ …
Conclusion

Well understood formalisms and solid technologies support the shift to a services based economy. Not surprisingly, the evil is in semantics …

Thank you for the attention!