Services Computing: A New Research Area for Modern Service Science

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Agenda

- Progress and directions towards a smarter planet
- Service innovation
    - how to design complex systems that serve customers, increasingly enabled by advanced ICT
- Services Computing and the lifecycle of the service innovation process
- A Service Science perspective on Services Computing
- Conclusions

Progress & Directions
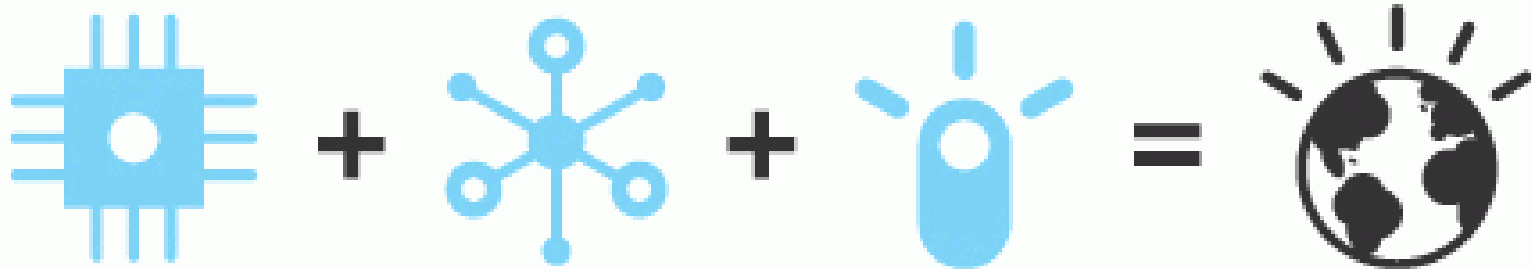
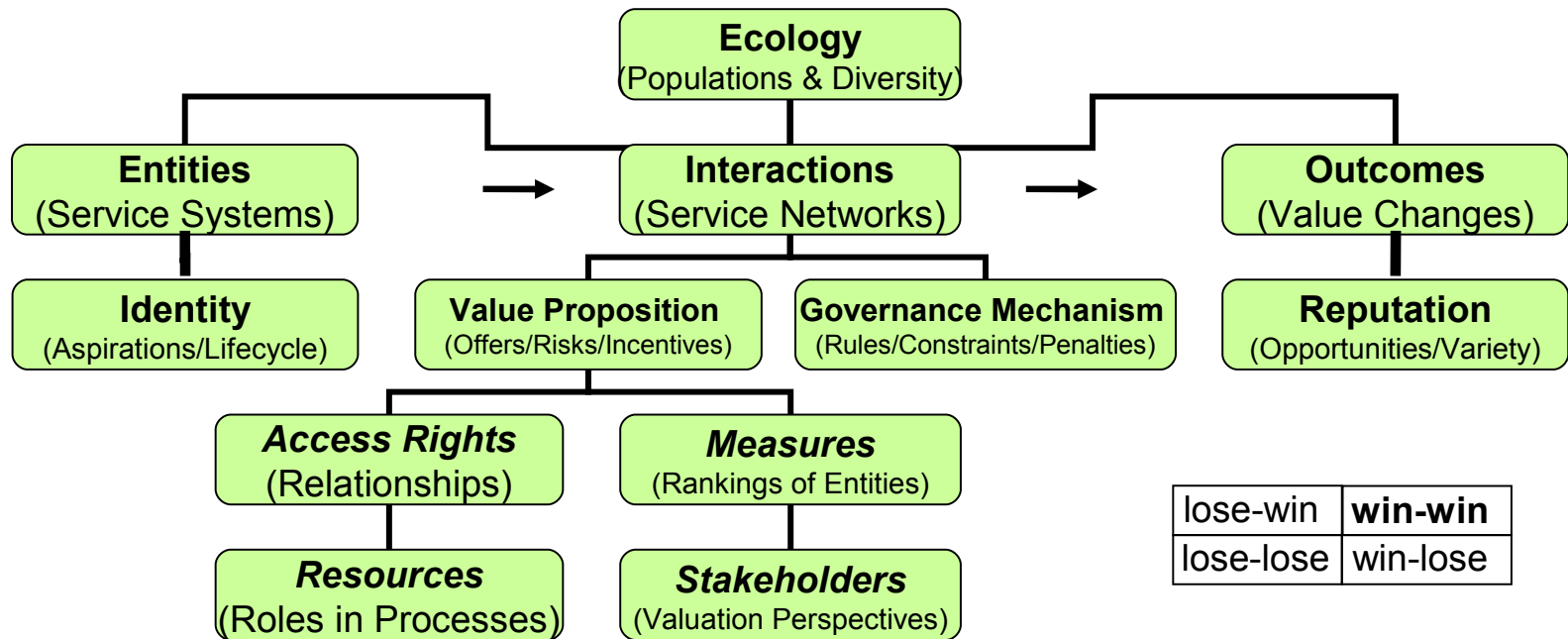## Working Together to Build Smarter Planet

22 opportunities for a smarter planet

- ... cities, industries and organizations get smarter

Overview	Energy	Products	Stimulus
Analytics	Events	Public safety	Sustainability
Banking	Food	Rail	Traffic
Buildings	Government	Retail	Transportation systems
Cloud computing	Healthcare	Security and resilience	Water
Communications	Infrastructure	Services	Work
Education	Oil	Smarter Cities	

- many opportunities to apply the new way of thinking in a world economy that is globally integrated and service-based

- applications are re-factored and delivered as service-oriented business applications

- re-architect IT through service computing to help meet fats-changing business requirements

Service System Ecology: Conceptual Framework

Ecology (Populations & Diversity)

Entities (Service Systems) → **Interactions** (Service Networks) → **Outcomes** (Value Changes)

Identity (Aspirations/Lifecycle)

Value Proposition (Offers/Risks/Incentives)

Governance Mechanism (Rules/Constraints/Penalties)

Reputation (Opportunities/Variety)

Access Rights (Relationships)

Measures (Rankings of Entities)

Resources (Roles in Processes)

Stakeholders (Valuation Perspectives)

lose-win	**win-win**
lose-lose	win-lose

- Resources: People, Technology, Information, Organizations
- Stakeholders: Customers, Providers, Authorities, Competitors
- Measures: Quality, Productivity, Compliance, Sustainable Innovation
- Access Rights: Own, Lease, Shared, Privileged

James C. Spohrer, IBM University Programs World Wide
ICSOC (Service-Oriented Computing) 2010
San Francisco, December 8, 2010

Service System Innovations improves Quality-of-Life

A. Systems that focus on flow of things that humans need

1. <u>Transportation</u> & supply chain
2. <u>Water</u> & waste recycling/Climate & Environment
3. <u>Food</u> & products manufacturing
4. <u>Energy</u> & electricity grid/Clean Tech
5. <u>Information</u> and Communication Technologies (ICT access)

B. Systems that focus on human activity and development

6. <u>Buildings</u> & construction (smart spaces)
7. <u>Retail</u> & hospitality/Media & entertainment/Tourism & sports
8. <u>Banking</u> & finance/Business & consulting (wealthy)
9. <u>Healthcare</u> & family life (healthy)
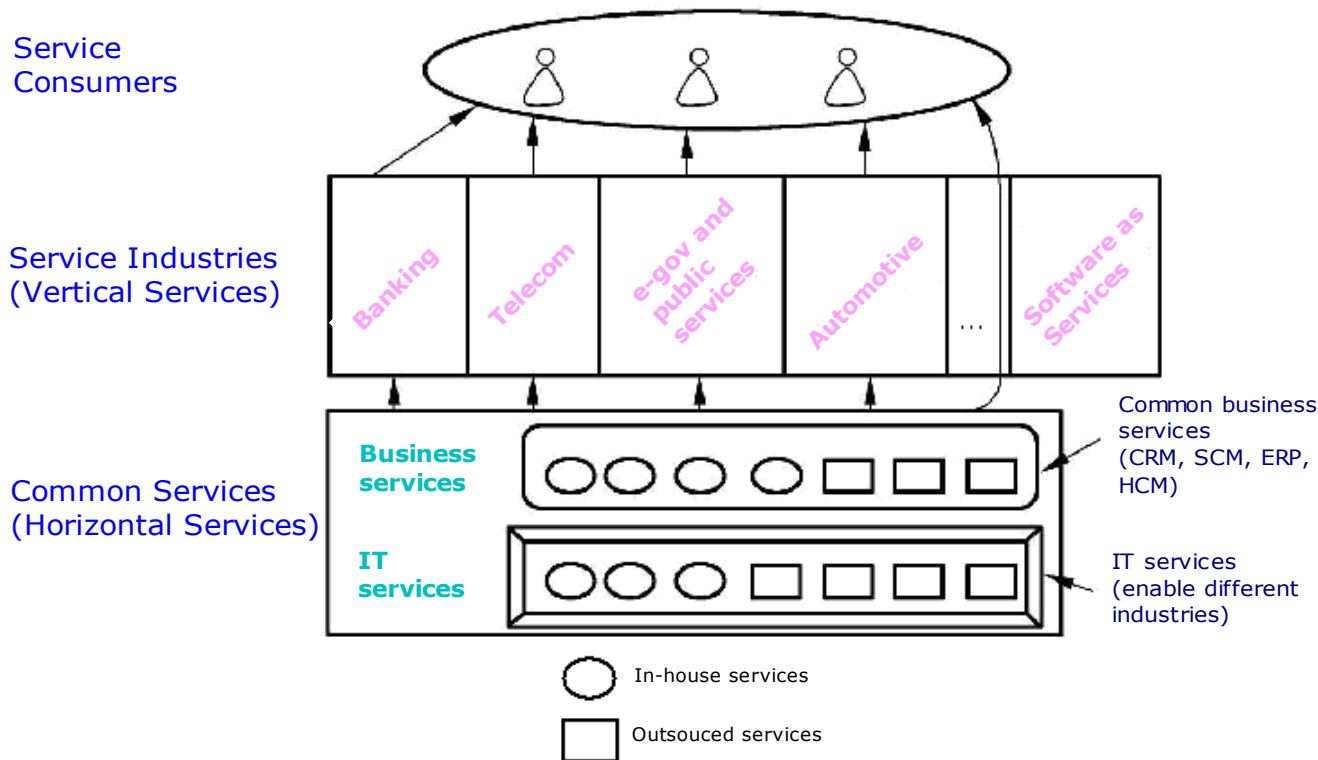10. <u>Education</u> & work life/Professions & entrepreneurship (wise)

Major types of demand

Major Types of Expertise/Knowledge

C. Systems that focus on human governance - security and opportunity

11. <u>Cities</u> & security for families and professionals (property tax)
12. <u>States</u>/regions & commercial development opportunities/investments (sales tax)
13. <u>Nations</u>/NGOs & citizens rights/rules/incentives/policies/laws (income tax)
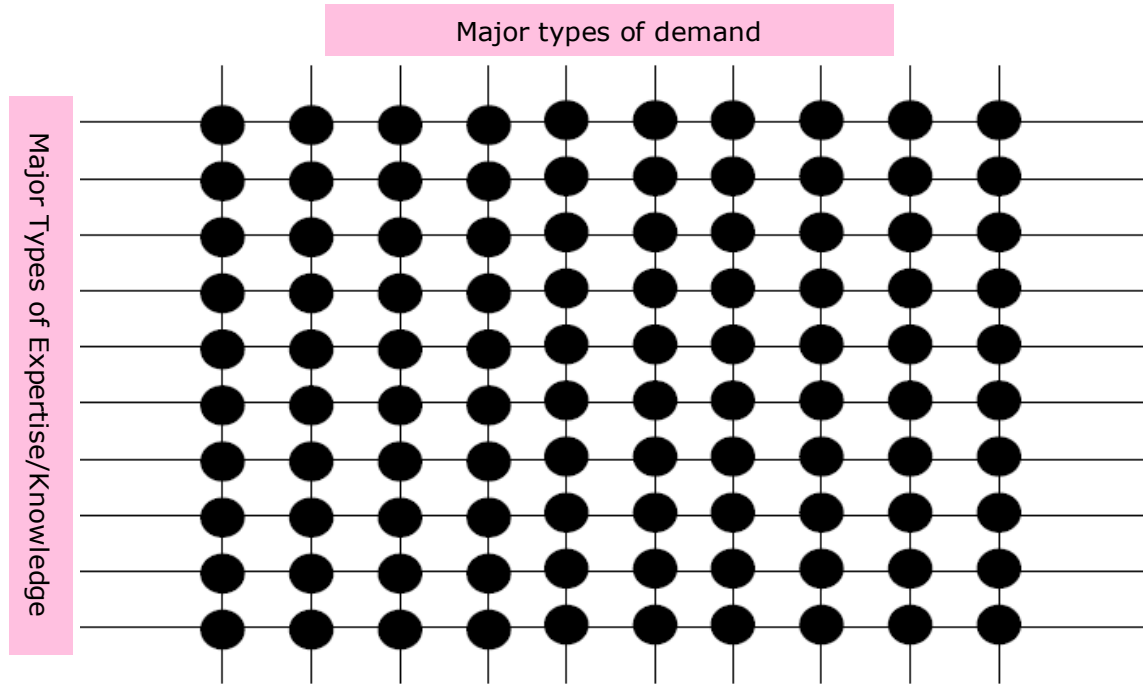
Services Ecosystem

- a culture of service defines new business "spaces" to foster a *"smarter" or sustainable innovation*

- *smarter systems and modern service?*

Service Consumers

Service Industries (Vertical Services)

- Banking
- Telecom
- e-gov and public services
- Automotive
- ...
- Software as Services

Common Services (Horizontal Services)

Business services

IT services

Common business services (CRM, SCM, ERP, HCM)

IT services (enable different industries)

○ In-house services

☐ Outsouced services

- novel approaches to deliver services

- business increasingly depend on IT technologies as a source of innovation and differentiation

- IT is moved to a higher level to align with business needs in the whole service lifecycle

- *one service (service consumer perspective) is provided by multiple service providers and service partners in an agreed approach through a service value chain*

Social Context of Services Computing

- paradigm reorientation - application development and enterprise IT infrastructure
    - SC – the centrepiece of enterprise IT infrastructure that includes Web services, SOA, SaaS and application service providers (ASPs)
- SC bridges the gap between business and IT
- SC promises to benefit business
    - A new cross discipline aims to enable IT to help perform business services more efficiently & effectively
    - Global standardization
        - Interactions between existing services
        - Small business go global
- Business initiatives
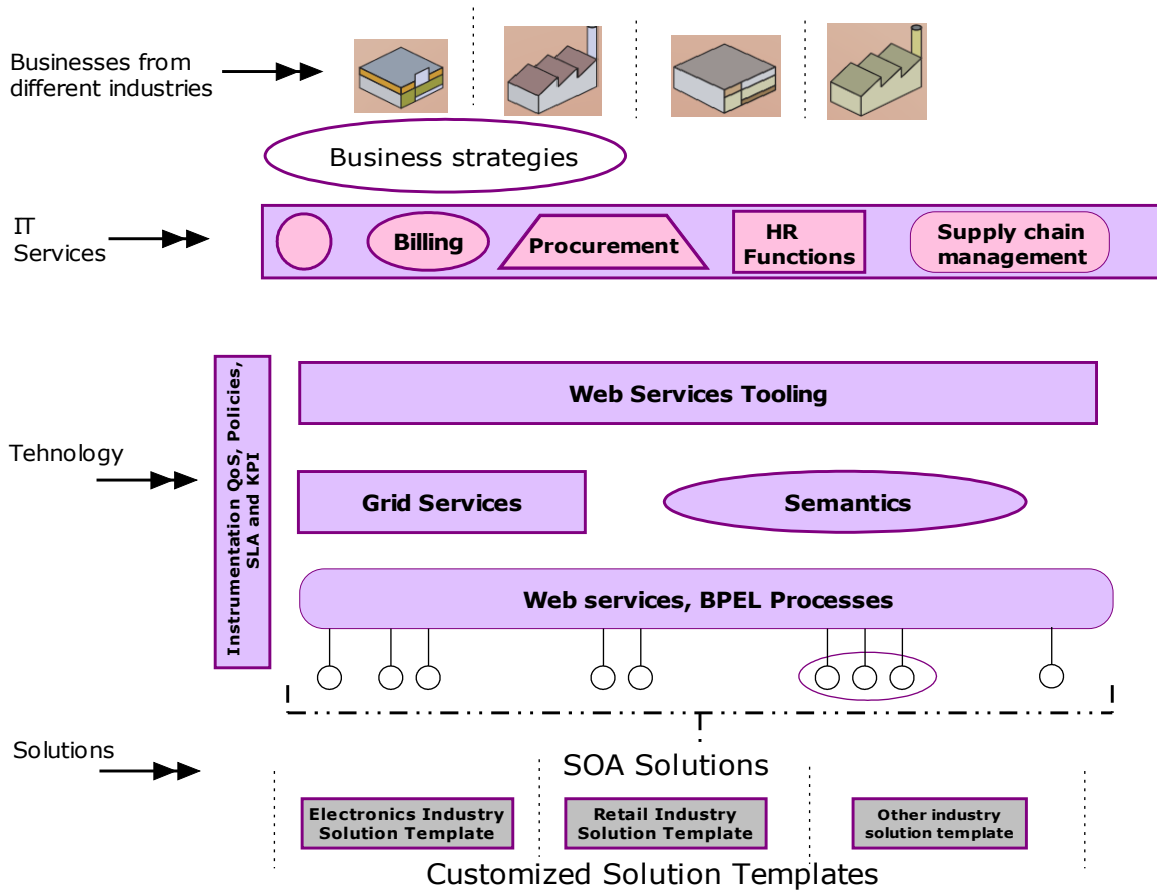   - Support by major software infrastructure vendors (IBM, SAP, Microsoft, Sun, BEA)
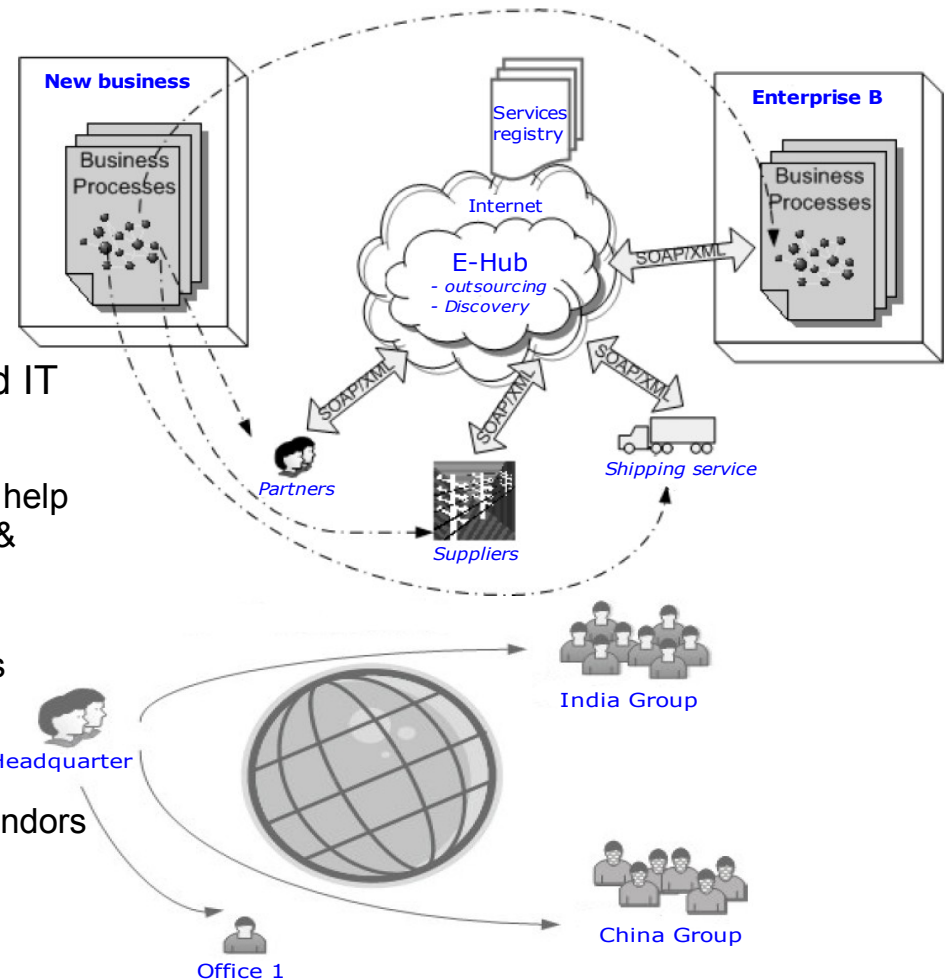
What is Services Computing ?

- *SC covers the science and technology of leveraging computing and IT to model, create, operate, and manage business services*.

  - web services - best enabling technology
    - universal accessibility through standard communication protocols
  - Service Oriented Architecture (SOA) - central architectural model
    - application framework facilitating services operations
  - standard support
    - SOAP, WSDL, UDDI
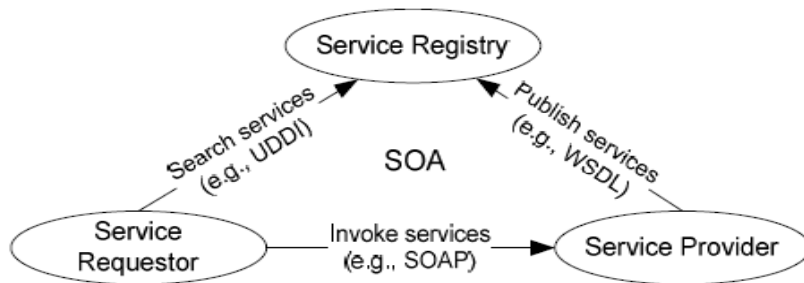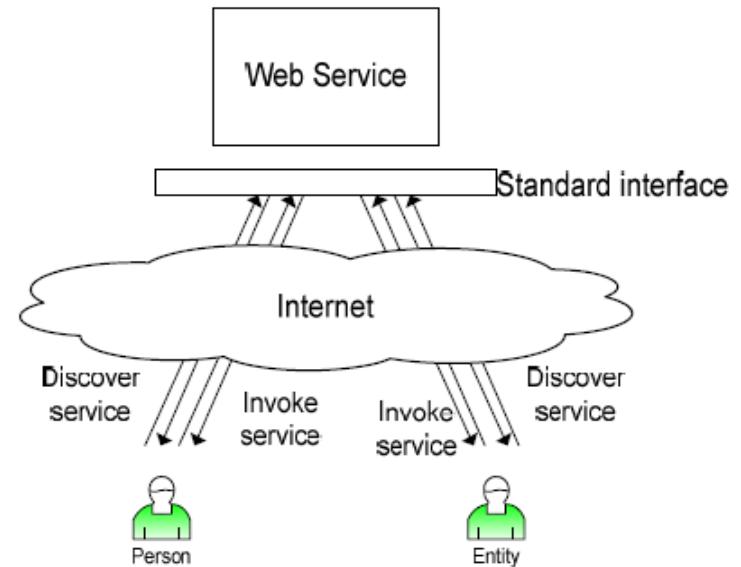
- techniques developed to facilitate information integration, enable business process automation, and increase the agility of enterprise information architectures

Services Computing – IT Perspective

Businesses from different industries

Business strategies

IT Services

Billing Procurement HR Functions Supply chain management

Instrumentation QoS, Policies, SLA and KPI

Tehnology

Web Services Tooling

Grid Services Semantics

Web services, BPEL Processes

Solutions

SOA Solutions

Electronics Industry Solution Template Retail Industry Solution Template Other industry solution template

Customized Solution Templates

- service systems with higher reusability, flexibility, extensibility and robustness

- expose business applications through well-defined interfaces in a platform-independent manner
  - increase interoperability
  - foster the whole business collaboration chain

SC - aspects for business and IT services

- SC covers various aspects of business and IT services.

    - for business services:
        - service-oriented business consulting methodology and utilities;
        - business process modelling, transformation, integration;
        - business performance management;
        - industry solution patterns.

    - for IT services:
        - application integration services;
        - infrastructure services (e.g. utility business services, service-level automation and orchestration, resource virtualization services);
        - IT-level autonomous system management services.

Services Computing BoK

⚙ 14 main knowledge areas of disciplines included in the TSC (Taxonomy of Services Computing)

⚙ Technical Committee for Services Computing (TC-SVC) - four categories that compose the Body of Knowledge (BoK) in Services Computing :

- ⚙ Category 1: **Services and Services Systems** - *Principle of Services* (M1) and *Services Lifecycle* (M2);

- ⚙ Category 2: **Services Technologies** - *Web Services* (M3), *Service-Oriented Architecture* (M4), *Services Relationships* (M5), *Services Composition* (M6), and *Business Process Management & Integration* (M7);

- ⚙ Category 3: **Services Consulting and Delivery** - *Business Grid and Cloud Computing* (M8), *Enterprise Modeling and Management* (M9), *Service-Oriented Consulting Methodology* (M10), and *Services Delivery Platform and Methodology* (M11);

- ⚙ Category 4: **Services Solutioning and Management** - *Application Services and Standards* (M12), *Security, Privacy, and Trust in Services Computing* (M13), and *Services Management* (M14).

TSC Taxonomy, IEEE Computer Society,
http://www.computer.org/portal/pages/transactions/tsc/mc/tsc_taxonomy.html, 2008

SC – detailed taxonomy structure

Services and Services Systems
Principle of Services
Services Lifecycle

Services Technologies
Web Services
Service-Oriented Architecture
Services Relationships
Services Composition
Business Process Management & Integration

Services Consulting and Delivery
Business Grid and Cloud Computing
Enterprise Modelling and Management
Service-Oriented Consulting Methodology
Services Delivery Platform and Methodology

Services Solutioning and Management
Application Services and Standards
Security, Privacy, and Trust in Services Computing
Services Management

SC – detailed taxonomy structure (I)

- Services and Services Systems

1. Principle of Services
0. General
  a. Services Systems
  b. Services Models
  c. Services Technologies
  d. Services Architectures
  e. Optimization of Services Systems

2. Services Lifecycle
0. General
  a. Consulting and Strategic Planning
  b. Services Engagement
  c. Services Delivery
  d. Services Operation
  e. Services Billing
  f. Services Management
1. Key Factors in Services Lifecycle
  a. Data/Information
  b. Processes
  c. People
  d. Resources
  e. Financial Factors
  f. Knowledge and Skills
  g. Innovation and Technology
2. Service-Oriented Business Models
  a. Services Modernization
  b. Software as a Service
  c. Services As Software

SC – detailed taxonomy structure (II)

Services Technologies

3. Web Services

0. General
  a. Web Services Modelling
  ...
1. Composite Services
  a. Composite Web Services
  ...
2. Web Services Publishing
  a. Public Services Registry
  ...
3. Web Services Discovery
  a. Services Discovery Language
  ...

5. Services Relationships

0. General
  a. Relationships in Services Registries
  ...
2. Service-Oriented Relationship Modelling
  a. Business Services Relationship
  ...

6. Services Composition

0. General
  a. Aspects of Business Requirements
  ...
1. Services Integration Framework
  ...
2. Services Value Chain Collaboration
...

7. Business Process Management and Integration

0. General
  a. Business Process Modeling
  b. Business Process Management
1. Service-Oriented Business Process Management
...
2. Flexible Business Process Integration
  a. Lifecycle of an Integration Activity
  ...

4. Service-Oriented Architecture

0. General
  a. Operational Model
  ...
1. Services Invocation
  a. Simple Services Invocation
  ...
2. Bridging Business and IT Architecture
  a. Enterprise Level Transformation
  ...
3. Solution Lifecycle
  a. Solution Modelling
  ...
4. Solution Reference Architectures
  a. Architecture Overview Diagram
  b. User Interaction and Presentation
  c. Processes
  d. Services
  ...

SC – detailed taxonomy structure (III)

- **Services Consulting and Delivery**

11. Services Delivery Platform and Methodology
0. General
 a. Services Delivery Mechanisms
 b. Services Engineering
1. Service-Oriented Services Delivery Platform
 a. Traditional Services Delivery Platform
 ...
2. Services Delivery Methodology
 a. Services Delivery Readiness Phase
 ...
3. Software as a Service
 a. Web 2.0 and Web X.0
 b. Service Mash-up
 c. New Business Models
4. Services as Software
 a. Asset-based Services Model
 b. Services Software

9. Enterprise Modeling and Management
0. General
 a. Dynamics of Services Ecosystem
 b. Requirements for Enterprise Modeling
1. Methodologies for Enterprise Modeling
 a. Balanced Scorecard and Strategy Map
 b. Component Business Modeling Circle
 c. Enterprise Architecture
 d. Enterprise Transformation
2. Enterprise Performance Management
 a. Enterprise Project Management
 b. Performance Management
 c. Service-Oriented Enterprise Management
 d. Enterprise Portfolio Management

10. Service-Oriented Consulting Methodology
0. General
 a. Consulting Method for Strategic Change
 ...
1. Service-Oriented Business Consulting
 a. ...
 c. Value Chain Analysis
 ...

8. Business Grid and Cloud Computing
0. General
 a. Service-Oriented Grid Computing
 b. Business Grid Solution Framework
 c. Cloud Computing
1. Logical Grid Infrastructure
 ...
 c. Business Process Grid
2. Business Grid Solution Development
 a. Business Grid Service Development
 ...

SC – detailed taxonomy structure (IV)

- Services Solutioning and Management

12. Application Services and Standards
0. General
  a. Case Studies in Industry
  ...
1. Solution-Level Quality of Service
  a. Context-Aware QoS Model
  b. Representation of QoS Model
  ...
2. Data Architecture Framework
  a. Constructs in Data Architecture
  ...
3. QoS Management Modeling
  a. Modeling of Resources
  b. Modeling the QoS Assurance Process
4. Web Services Standard Stack
  a. Transport
  ...
  e. Service Composition
5. Industry-Specific Standards
  a. Service-Oriented Solution Reference
  Architecture
  ...

13. Security, Privacy, and Trust in Services
 0. General
a. Security Concerns of Service-Oriented
Solutions
...
 1. Access Control in Services Systems
  a. Role-Based Access Control
  ...
 2. Security Enablement in Services Systems
a. Service-Oriented Security Enablement
at Software
Level
...
 3. Privacy Management in Services Systems
  a. Privacy Management in Data
  Collection
  ...

14. IT Services Management
 0. General
a. Management of Services
Design
...
 1. Application Management in Services
  a. Application Management Services
  ...
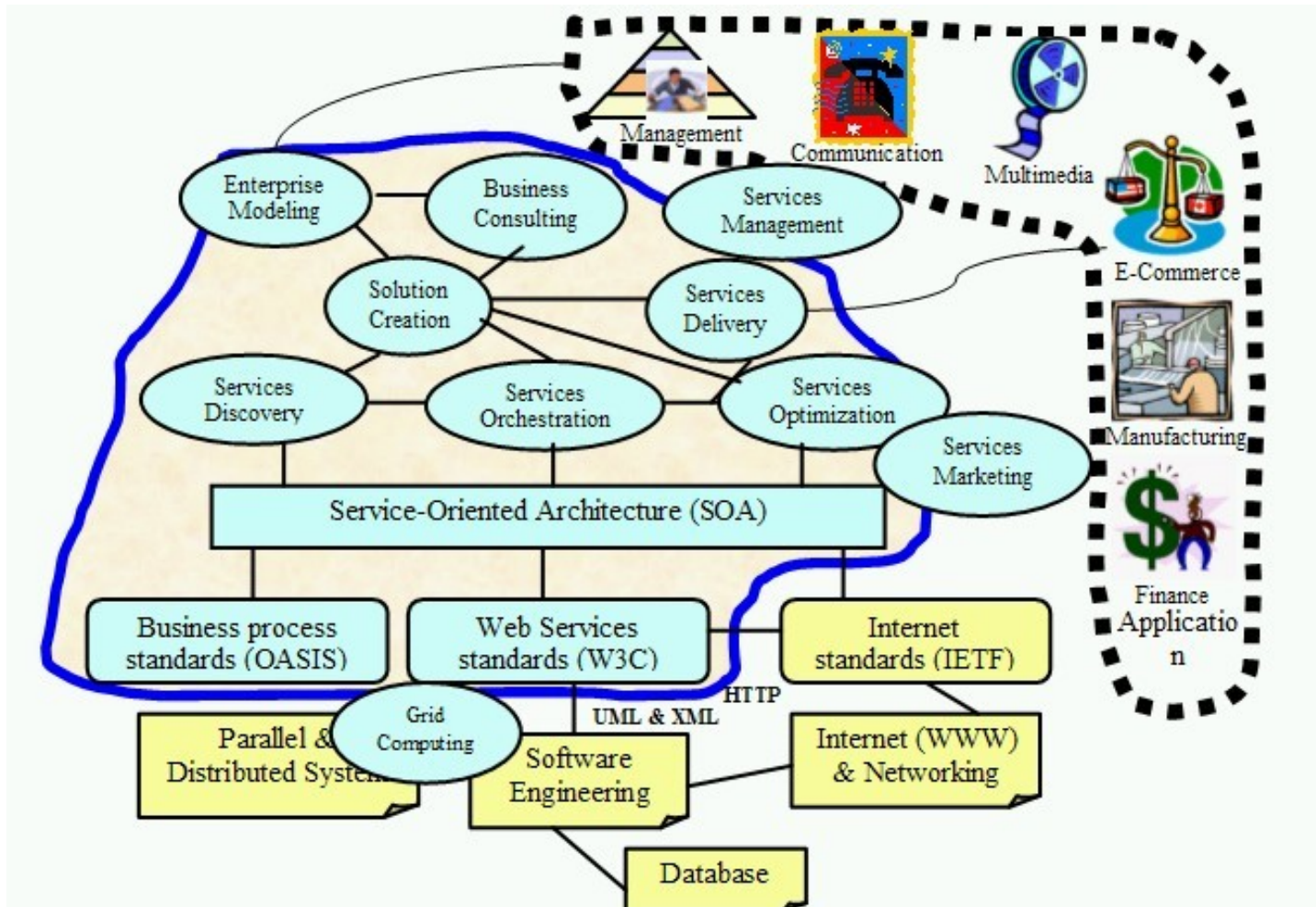 *2. Infrastructure Management in Services*
  a. Maturity Assessment in Services
  ...
3. Business and IT Aligned Management Services
  a. Service-Level Agreement for Contracts
  b. Key Performance Indicators for Business Processes
  c. Quality of Services for Services Offerings
  d. Management Methods and Tools for Business and
  IT Alignment

Services Computing Landscape

www.ibm.com

Services Computing - Research

- services delivery and cloud

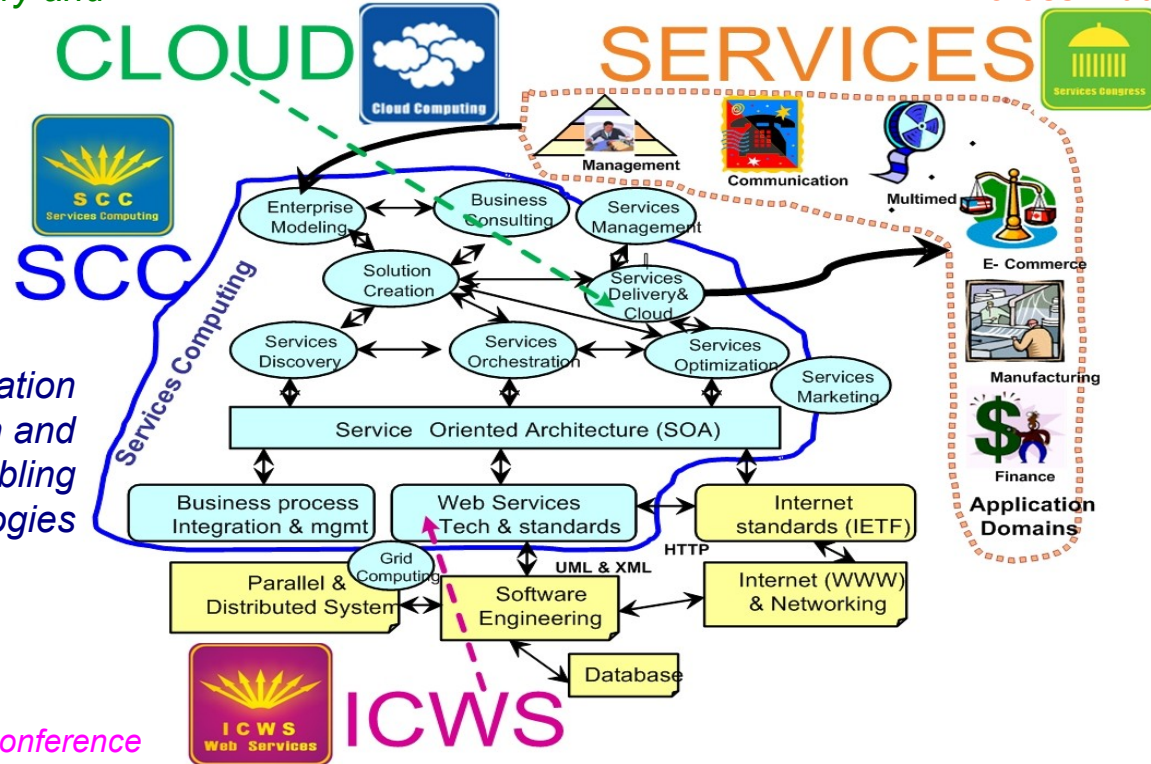4th IEEE 2011 International Conference on Cloud Computing

- business service sectors (vertical industries and cross-industries)

7th IEEE 2011 World Congress on Services

8th IEEE 2011 International Conference on Services Computing

- innovation research and enabling technologies

8th IEEE 2011 International Conference on Services Computing

- Web-based services, Web services technologies and standards

Services Computing for a Smarter World

http://www.thesrii.org

SRII Global Conference 2011

- "Future of IT" for Service Verticals:
    - IT for Healthcare
    - IT for Environmental Services
    - IT for e-Government
    - IT for Education Services:
    - IT for Engineering/ Manufacturing Services
    - IT for Agriculture Services

- Cloud Computing & new service models
- Mobile Technology & Service models
- "Intelligent" Services, Knowledge Management, Data mining
- Service Innovation/Quality
- Service Engineering/ Tools/Standards
- Service Marketing/Leadership
- Service System/Human Factor Engineering
- Service Life Cycle: Business Process/Models/Cost
- Service Management & Sustainability

Services Computing – A Service Science Perspective

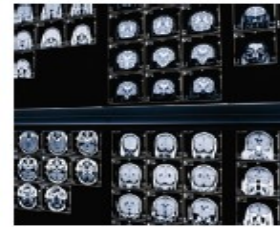- The World is Getting Smarter – as we build better service systems

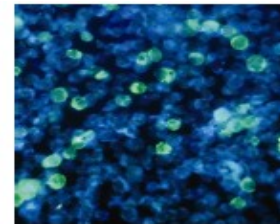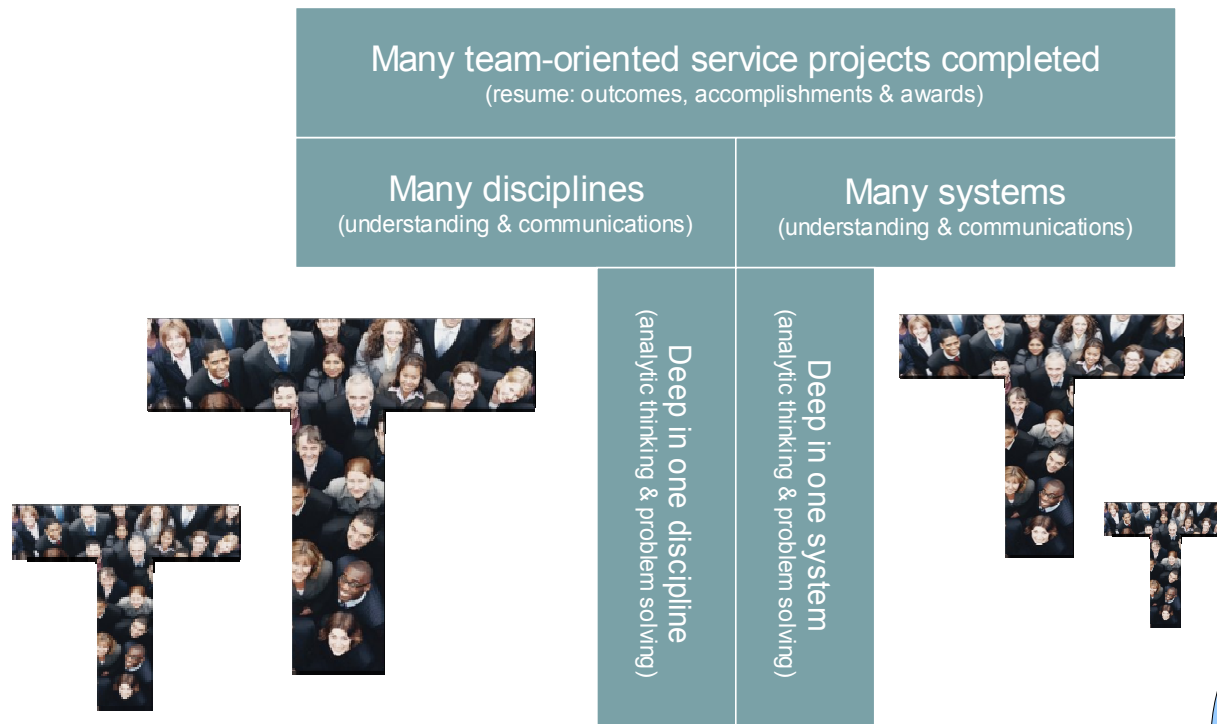|					
Smart traffic systems	Intelligent oil field technologies	Smart food systems	Smart healthcare	Smart energy grids	Smart retail
Smart water management	Smart supply chains	Smart countries	Smart weather	Smart regions	Smart cities

We have to discover the underlying principles of complex service systems (and the value propositions that interconnect them) in order to create investment roadmaps for continuously improvement of globally integrated service systems and the creation of a planet of future - Smarter Planet.

What is the skills goal? T-Shaped professionals, ready for T-eamwork!

Many team-oriented service projects completed
(resume: outcomes, accomplishments & awards)

Many disciplines (understanding & communications)	Many systems (understanding & communications)

Deep in one discipline (analytic thinking & problem solving)

Deep in one system (analytic thinking & problem solving)

SSME+D = Service Science, Management, Engineering + Design

The Service Science Model - Stepping from Innovation Needs to Human Capital Reengineering

Focus:
Smarter Service Systems =
complex systems
that serve customers,
increasingly enabled
by advanced ICT

Conclusions

- our world is becoming smarter, interconnected, instrumented - *the planet is becoming smarter*
    - intelligence is being infused into systems, processes and infrastructure that enable physical goods to be developed, manufactured, bought and sold
        - that allow services to be delivered
        - that facilitate the movement of everything from money and oil to water and electrons
        - that help billions of people work and live
- the world economy is now globally integrated and services-based, with cities as its hubs
    - businesses will locate activities where capital – both human and physical – is concentrated, i.e., cities
- the Service Industries have been the dominant contributor to GDP and employment
- this global phenomenon of services economy growth has largely been achieved due to major advances in the fields of Information & Communication Technologies (ICT).

MANUFACTURING   CUSTOMERS

WORKFORCE   SUPPLY   TRANSPORTATION   FACILITIES

Conclusions

- the advancements of IT brings more opportunities for *innovation*
  - several service-oriented technologies have emerged, such as Service Oriented Architecture (SOA), Web services, Grid Computing and Autonomic Computing
  - these technologies facilitate the construction of the *service systems with higher reusability, flexibility, extensibility and robustness*.

- Web services is changing the Internet from a repository of data into a repository of services

Services Computing covers the whole lifecycle of the services innovation process - business componentisation, services modelling, creation, realization, annotation, deployment, discovery, composition, delivery, monitoring, optimization, and management, and service-to-service collaboration

The goal of services computing is to enable IT services and computing technology to create, operate, and manage business services more efficiently and effectively.

MANUFACTURING

CUSTOMERS

WORKFORCE   **SUPPLY**   **TRANSPORTATION**   **FACILITIES**