Autonomous Semantic Web Services

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Talk Overview

- The Vision
- Requirements and Challenges
- Web Services
- Semantic Web
- Multi Agent Systems (MAS)
- Semantic Web Services
  - OWL-S
- Future Directions

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From the Internet to the Semantic Web

Old World : "The eye-ball Web"	→	New World: "The Semantic Web"
The architecture of the Web is geared towards delivering information visually (Internet filled with human readable information)	→	The content of the Web becomes computer intelligible (Internet filled with machine understandable information)

Source: IBM

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From the Internet to Web Services

Old World : **"The eye-ball Web"**	→	**New World:** **"The transactional Web"**
The architecture of the Web is geared towards delivering information visually (Internet filled with human readable information)	→	**The architecture of the Web geared towards exchanging information between applications (Internet filled with executables)**

Source: IBM

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From the Internet to Semantic Web Services

Old World :

"The eye-ball Web"

New World:

"The Coordination Web"

The architecture of the Web is geared towards delivering information visually (Internet filled with human readable information)

The architecture of the Web geared towards applications that intelligibly coordinate information exchanges (Internet filled with machine understandable executables)

Source: IBM

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From the Internet to Autonomous Semantic Web Services

Old World :

"The eye-ball Web"

New World:

"The Agent Web"

The architecture of the Web is geared towards delivering information visually (Internet filled with human readable information)

The architecture of the Web geared towards goal directed applications that intelligibly and adaptively coordinate information and action (Internet filled with context-aware and self organizing agents)

Source: IBM

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The Integration Challenge

Integrate multiple independent and heterogeneous

- Data repositories
- Processes
- Applications

Ensure

- Semantic equivalence of equivalent concepts
- Performance
- Communication of "semantic" agreements
- Dynamism: real time access works accurately
- Flexibility: systems enter and leave integration

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The Integration Past and Future?

Numerous solutions to date (since the '70s):

- Tool driven
- Data driven
- Process driven
- Model driven
- Web services

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Web Services - A New Paradigm?

- Web Services heralded as:
  - "… self-contained, self-describing, modular applications that can be published, located, and invoked across the Web…"
- Which will allow…
  - …on the fly composition of new functionality through the use of loosely coupled reusable software components
  - …decomposition and distribution of large-scale processing tasks into component tasks executed simultaneously across many devices

"Web services are expected to revolutionize our life in much the same way as the Internet has during the past decade or so." (Gartner)

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So what is new about Web Services?

Component-Based Model	Web Services Model
Tightly coupled **software applications (high dependencies between systems)**	Loosely coupled **software applications (low dependencies between applications)**
Mainly designed for processes within the enterprise	**Mainly designed for** processes across enterprises
Uses different protocols and technologies **(e.g., Microsoft DCOM, CORBA)**	**Uses** standard protocols and technologies **(e.g., XML, SOAP, WSDL, HTTP)**

Web Services do for programs what the Web did for Documents

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Requirements and Challenges

- Information and action integration across the Web (currently the user is the "glue")
- System integration/interoperability Web-wide (within and across organizations)
- Semantic Interoperability
- Consistency of behavior of long running transactions (both for e-commerce and e-science) in the face of partial, distributed failures
- Dynamic and goal-directed discovery, interaction and composition of applications across the Web

Tension between the "anarchy" of the Web and the requirements for reliable, consistent, trusted transactions of e-commerce and e-science

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Current State: Web Services Standards

- SOAP: XML based web services communication protocol

Limitations

- Unbounded message format
- Has no communicative speech acts (cannot determine intention of actors or type of the message)
- WSDL: Structured mechanism to describe a WS interface
  - Abstract operations that a Web Service can perform
  - Format of messages it can process
  - Protocols it can support
  - Physical bindings to URIs and protocols

Limitations

  - No semantics for message sequencing and correlation
  - No semantics for message content

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Current State: Web Services Standards (cnt.)

BPEL: Description of how Web Services are composed

- Flow Model describes the structure of the business process in terms of activities of process steps and data and control links
- Global Model
  - Describes interaction between provider and requester
  - Mappings between internal operations and WSDL port types

Limitations

- No IOPEs
- Allows execution of a manually constructed composition

- UDDI: Directory Service for Web Services

Limitations: keyword searches, limited capability search

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Tackling Semantic Interoperability…

- Lack of Semantic Interoperability is a major hurdle for
  - **Discovery**
    - Different terms used for advertisements and requests
  - **Invocation**
    - Different specs for messages and WS interface
  - **Understanding**
    - Interpreting the results returned by the Web service
  - **Composing Services**
    - Reconciling private goals with goals of the WS
  - **Negotiating contracts & communications**
    - Different terminology and protocols used

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Is this a real problem?

World Wide Annual Integration plus Data Quality Costs:
$1 Trillion / year

"The problem is not in the plumbing. It's in the semantics"
(quotation from Michael Brodie's invited talk at ISWC 2003)

Note: some standards committees, e.g. WSDL and UDDI start realizing this truth and planning to incorporate RDF and OWL in these standards

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Three Significant Technological Visions

- Semantic Web
- Multi Agent Systems (MAS)
- Semantic Web Services

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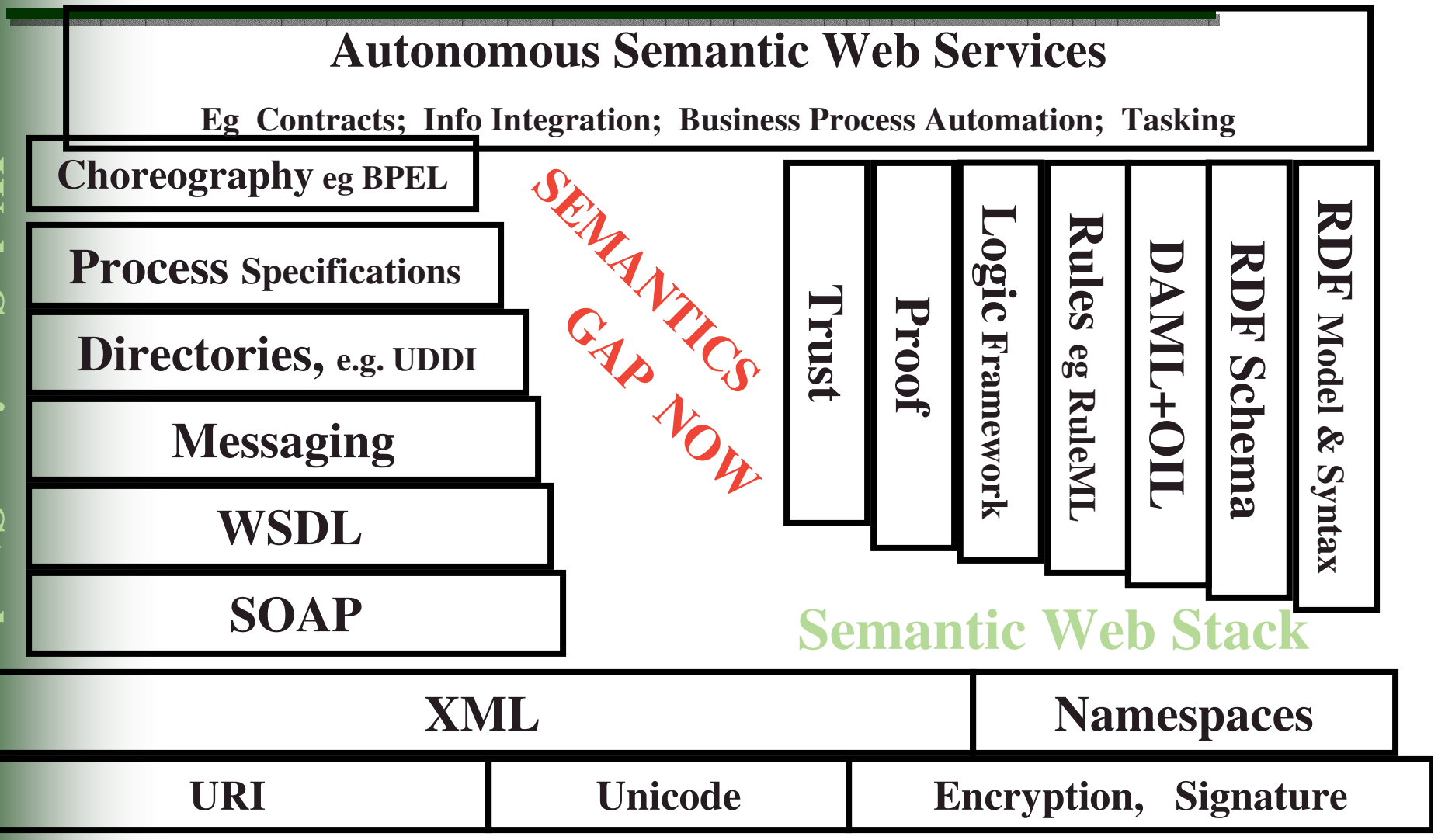
Autonomous Semantic Web Services Stack Diagram



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Semantic Web
Definition

- Goal of Web Semantics: Development of common representation format, shared ontologies, reasoning mechanisms, and query engines to support improved utilization of Web knowledge
- Semantic Web technologies and tools
  - Rdf
  - OWL

"The Semantic Web is an extension of the current Web in which information is given a well-defined meaning, better enabling computers and people to work in cooperation. It is the idea of having data on the Web defined and linked in a way that it can be used for more effective discovery, automation, integration and reuse across various applications. The Web can reach its full potential if it becomes a place where data can be processed by automated tools as well as people"

From the W3C Semantic Web Activity statement

Semantic Web: semantic metadata and ontologies for web content to enable information access, integration, interoperation and consistency.

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Semantic Web

OWL

- OWL is a W3C standard
- OWL is a Description Logic-based Language: provides the basic constructs to describe ontologies
  - Definition of concepts
  - Relations between concepts
  - Special relation: subclass for generalization
  - Effectively computable
    - Good optimization algorithms support inference

- OWL specifications
  - W3C page on OWL
    - http://www.w3c.org/2001/sw/WebOnt/
  - OWL Guide and language reference
    - http://www.w3.org/TR/owl-guide/
    - http://www.w3.org/TR/owl-ref/
- Tutorials
  - Costello and Jacobs' OWL tutorial: http://www.xfront.com/owl

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RCal Calendar Agent

- Retsina Semantic Web Calendar Agent supports:
  - Browsing of agendas and schedules marked up in OWL & RDF
  - Invocation of related tasks, such as scheduling meetings and email
  - Integration of selected meetings and events into MS Outlook
- Can parse markup using several ontologies, including
  - Hybrid ICal Calendar Ontology
  - Dublin Core Ontology
  - Friend-of-a-Friend Ontology
- Schedule markup using other ontologies can be accessed via translation agents
  - DMA2ICal Agent converts OWL Meeting Agenda markup into ICal Markup.

http://www.daml.ri.cmu.edu/Cal

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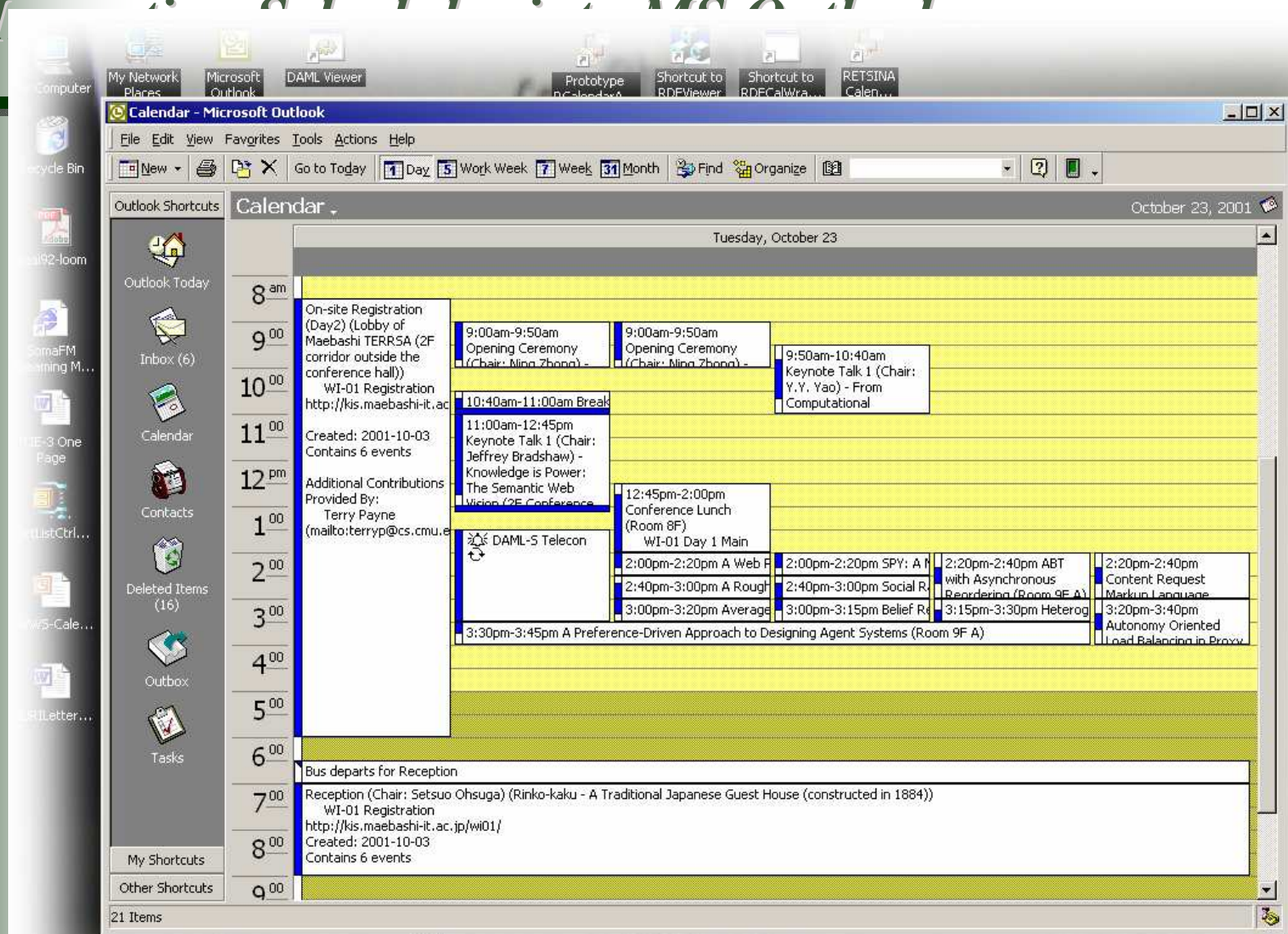
Calendar - Microsoft Outlook
File Edit View Favorites Tools Actions Help
New Go to Today Day Work Week Week Month Find Organize
Outlook Shortcuts
Calendar
October 23, 2001
Tuesday, October 23
Outlook Today
Inbox (6)
Calendar
Contacts
Deleted Items (16)
Outbox
Tasks
My Shortcuts
Other Shortcuts
On-site Registration (Day2) (Lobby of Maebashi TERRSA (2F corridor outside the conference hall))
WI-01 Registration
http://kis.maebashi-it.ac
Created: 2001-10-03
Contains 6 events
Additional Contributions Provided By:
Terry Payne
(mailto:terryp@cs.cmu.e
9:00am-9:50am Opening Ceremony
9:00am-9:50am Opening Ceremony
9:50am-10:40am Keynote Talk 1 (Chair: Y.Y. Yao) - From Computational
10:40am-11:00am Break
11:00am-12:45pm Keynote Talk 1 (Chair: Jeffrey Bradshaw) - Knowledge is Power: The Semantic Web
12:45pm-2:00pm Conference Lunch (Room 8F)
WI-01 Day 1 Main
DAML-S Telecon
2:00pm-2:20pm A Web
2:40pm-3:00pm A Rough
3:00pm-3:20pm Average
2:00pm-2:20pm SPY: A
2:40pm-3:00pm Social R
3:00pm-3:15pm Belief R
2:20pm-2:40pm ABT with Asynchronous Reordering (Room 9F A)
3:15pm-3:30pm Heterog
2:20pm-2:40pm Content Request Markup Language
3:20pm-3:40pm Autonomy Oriented Load Balancing in Proxy
3:30pm-3:45pm A Preference-Driven Approach to Designing Agent Systems (Room 9F A)
Bus departs for Reception
Reception (Chair: Setsuo Ohsuga) (Rinko-kaku - A Traditional Japanese Guest House (constructed in 1884))
WI-01 Registration
http://kis.maebashi-it.ac.jp/wi01/
Created: 2001-10-03
Contains 6 events
21 Items

Multi Agent Systems

Agent Characteristics

A software agent is a computational entity with the following key characteristics:

- Situatedness: agent receives sensory inputs from its environment and outputs actions (physical environments, Internet)
- Autonomy: agent is goal-directed and has control over its internal state (can reason and act without direct intervention of others)
- Interactivity/Sociability: agents interact in peer to peer fashion with humans and/or other agents in pursuit of their goals (individual or collective)
- Adaptivity: agents respond reactively or proactively to changes in their environment

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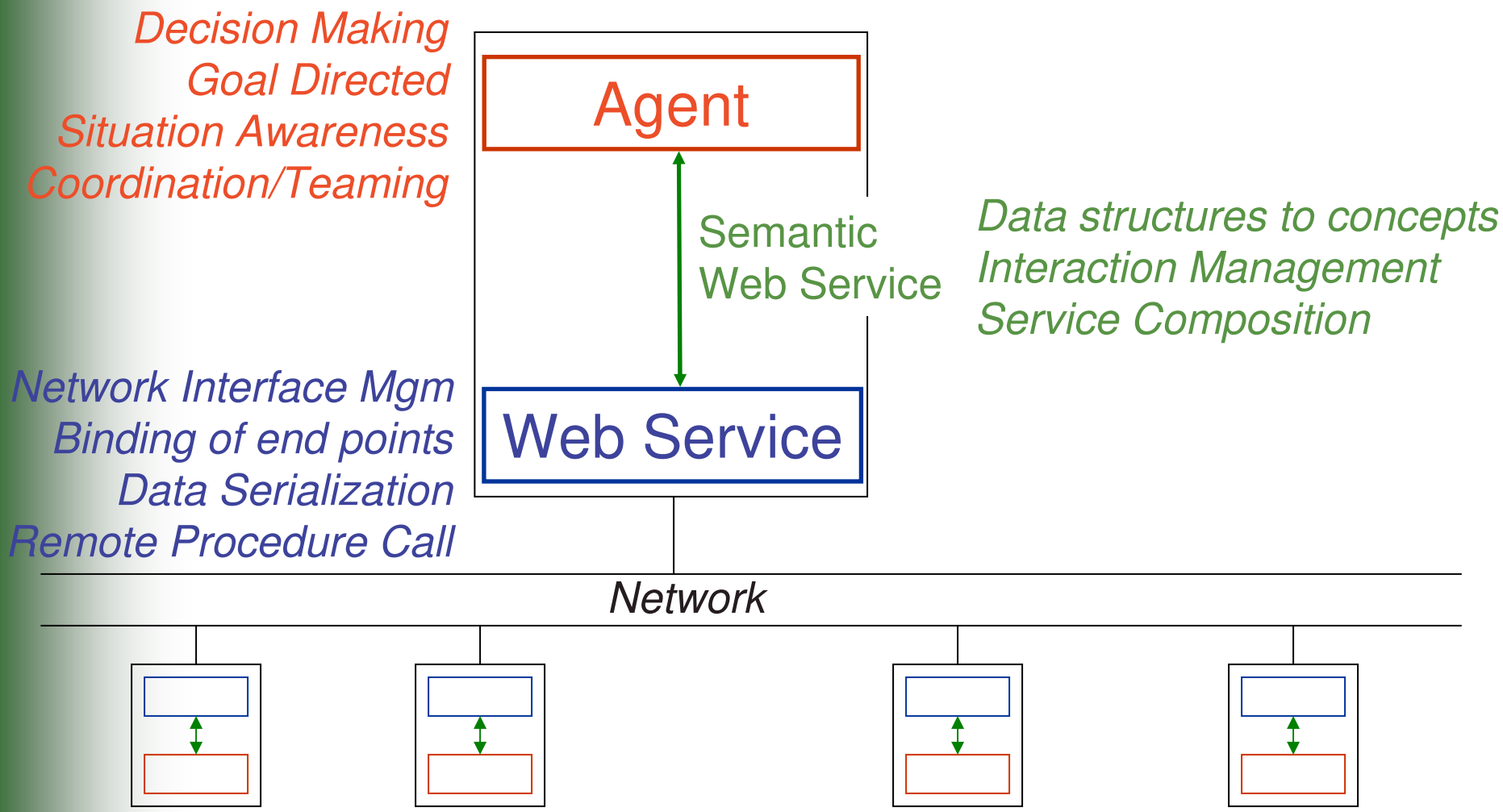
Relation Agents/Web Services



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