The Long and Winding Road to Industrial Strength (Semantic) Web Services

Dr. Michael L. Brodie
Chief Scientist
Information Technology
The Set Up
Verizon Communications (NYSE: VZ) is formed by the merger of Bell Atlantic and GTE, is one of the world’s leading providers of high-growth communications services. Verizon companies are the largest providers of wireline and wireless communications in the United States, with over 137 million access lines and over 34 million wireless customers. Verizon is also the world’s largest provider of print and online directory information.

- A Fortune 10 company with more than 221,000 employees and $67 billion in 2002 revenues, Verizon’s global presence extends to over 30 countries in the Americas, Europe, Asia and the Pacific.
  - Fortune, April 2003: 10th “largest” US company.
  - Business Week, Sept 2003: one of “The” 25 e-Business leaders
  - InformationWeek, Sept 2003: in top 2 of 500 most innovative users of IT

- One of the world’s largest
  - Data processing enterprises
    - 5,000 applications, 99.97% availability
    - 150,000+ desktops
    - 1.5 petabytes of storage
  - Private networks (size of most Telcos)
Problem 1: Verizon’s Business
Problem 1: Verizon's Business

Web Services

1970

1990s

Distributed Computing

Http

SOAP

Xml

Jms/Mq

SQL

CORBA

Java/EJB

Http

SOAP

Xml

Jms/Mq

SQL

CORBA

Java/EJB

Providers

Billing

Care

Ordering

Service Assurance

Provisioning

Network

More ...

Consumers

Enterprise

Small Business

Consumer

Wholesale

Verizon Corporate

External B2B

More ...

Verizon’s Business

Web Services

1970

1990s

Distributed Computing

Http

SOAP

Xml

Jms/Mq

SQL

CORBA

Java/EJB

Http

SOAP

Xml

Jms/Mq

SQL

CORBA

Java/EJB

More ...)
Problem 2: The Integration Problem

**Characteristics**

Integrate multiple independent
- Data repositories
- Processes
- Applications

Data Integration
- Single customer database from 30

Application Integration
- Single billing systems from 30

Processes Integration
- Single End-to-end business process over 30

Ensure
- Semantic equivalence of “equivalent” things - “disjoint”
- Dynamic: Real-time access works accurately
- Seamlness
- Flexible: systems enter and leave integration
- Performance
- Accommodate future requirements - more integration

**Challenges**

- **Layers of integration**
  - Humans
  - User interface
  - Business Processes
  - Applications
  - Meta-data: tables / repositories / schemas / ...
  - Data
  - 'Plumbing / infrastructure
  - Platform'

- 2 - 200 (10,000) sources

- **Distributed**

- **Must communicate - “semantic” agreement**
  - Query
  - Update

- **Heterogeneous**
  - Structured and unstructured data w&w/o meta-data
  - Internal and external sources
  - Varying “soundness”, cleanliness, content, ...
  - Representations

- Where is the “meaning”?
And on, and on …

**Every Business Area**

- Legacy evolution / migration
- Reverse engineering
- Integrated application suites
  - ERP: all finance and HR data
  - CRM: all customer data
  - Supply Chain / Logistics
  - Product Management
- Data warehouse
- Web
  - Search
  - Web-based Information Systems
  - Portals: enterprise, employee, customer
- Collaboration ($4.5 B sales in 2002, IDC)
  - Design
  - Ordering
  - Claims processing
- E-Business
  - E-catalogue: integrate 10,000 catalogues
  - B2C: Multi-channel integration
  - B2B: E-Marketplaces

**Legacy Modernization**

- Decompose: **EAI** - Enterprise Application Integration (real time access)
  - Break into “basic” functions
  - Expose via API
- Analyze
  - Identify common functions
- Re-engineer
  - Make common functions equivalent
- Publish: for enterprise use
- Combine: into new services
- Debug: when errors detected
- Advanced
  - Discover dynamically
  - Invoke dynamically
Integration Solutions Up the Wazoo

- **Tool-Driven Solutions**
  - Chaos: No community agreement
  - Non-integrated, point solutions
  - Semantics largely ignored

- **Data-Driven Solutions**
  - Mappers
    - With some semantics: IBM (Life Sciences), Vitria
    - Without: Microsoft, Oracle, …

- **Process-Driven Solutions (B2B)**
  - Process integration: Microsoft, Oracle, Vitria

- **Model-Driven Solutions**
  - Vendor-centric Integrated Tools, Templates, and Architectures
  - Industry Templates and Architectures
  - Industry Ontologies: Vitria (e-Biz ontologies)

- **Web Services**

The problem is not in the plumbing. It’s in the semantics.


Naïve Web Services Vision

- “A universal set of communication protocols to enable computer systems and business processes to seek each other out over the Internet, ... [for] meaningful interactions with no human intervention.”

- “...provide standards-based mechanisms for static and dynamic discovery, composition, and invocation of simple and composite services within an enterprise, between partners, or with enterprises and customers Internet-wide. There will be scaleable and dynamic (i.e., automatic) means of registering and maintaining service descriptions in (public) directories; discovering services that meet requirements (a la Trader); and composing complex services from simpler services if required. Hence, the computing world will consist of service providers and service consumers. Providers can develop new services or expose legacy services and make them available within an enterprise, to partners, and to customers Internet-wide”
Web Services Adoption Timeline

Source: the Yankee Group, 2002

2001: Re-engineered legacy connections
2002: Inter-enterprise usage between existing partners
2002/2003: Dynamic discovery and integration within the enterprise
2003: Dynamic discovery and integration with outside vendors
2005:
Relational DBMS Adoption Time Line

- **1970**: E.F. Codd’s relational model
- **1974-77**: RDBMS prototypes: Ingres, Sybase, PACE, System R
- **1979**: Selinger’s Query processing
- **1978**: 1st commercial RDBMS: Multics Relational Data Store
- **1979**: Relational Software, Inc. (Oracle Corporation) releases SQL
- **1980**: Jim Gray’s “A Transaction Model”
- **1982**: Gray at al “Transactions and Consistency in Distributed Database Systems”
- **Mid-1980's**
  - SQL (Structured Query Language) becomes "intergalactic standard"
  - DB2 becomes IBM’s flagship product
  - Network and hierarchical models fade
  - Flurry of RDBMSs: RIM, RBASE 5000, PARADOX, OS/2 Database Manager, Dbase III, IV (Foxbase, Visual FoxPro), Watcom SQL
- **1990's**
  - Industry shakeout
  - Application development tools: PowerBuilder (Sybase), Oracle Developer, VB (Microsoft), etc.
  - Personal productivity tools such as Excel/Access (MS) and ODBC
  - Object Database Management Systems (ODBMS) prototypes start
- **Late 1990’s**
  - RDBMS maturity: high availability, limitless size, high performance, …
Semantics: capturing real world “meaning”

- Enhance Information Systems so that the automated actions and data more closely correspond to the real world actions and facts that they represent, with minimal human involvement.

- Stunning Example: ERP = “Books of Record” for all major corporations

- Stunning Problem: integration
Annual Grand Challenge Cost

• **Integration’s costs**: $500 BN / year worldwide
  – 24% of IT budgets: $180 B / year US (InfoWorld, January 2002 survey of 500 IT leaders)
  – 13% of IT spend: $100 B of $752 B / year US (Giga estimate based on May 2002 report)
  – 25-40% of all IT projects (various)
  – 6% of US IT spending: $34 B of $610 B / year US (IDC, May 2002)
  – 7% of IT spending: $90 B of $1.3T / year worldwide (IDC, May 2002)
  – 28+% of all consulting: $160 B / year worldwide (Gartner March 2002)
  – 43% of e-business consulting: $53 B / year worldwide (Gartner)
  – 1.75% to annual IT budget on EAI and B2B (Forrester, Dec 2001)
  – 10-30% of IT budgets (David Sink, IBM quoted in InformationWeek, May 27, 2002)

• **Data Quality’s costs**: $600 BN / year US
  – Data Warehouse Institute, 2002

• **Worldwide Annual Integration + Data Quality Costs**: $1 Trillion / year
Why Attempt the Grand Challenge?

- Business need
  - $1 T / year
  - CIO Priority
  - Economic Growth dependent on the Web working and scaling

- Current solutions
  - May be imprecise or contain errors
  - Far too complex
  - Won’t scale
    - Web-based integrated resources
    - More data generated in the three years (00-03) than in recorded history¹

- Potential of greater
  - Precision
  - Automation
  - Optimization
  - Solutions - industrial problems
  - Visions

Industrial Perspective

• Absolute Requirements
  – Scale
  – Scope
  – Robustness

• “There is far more to putting Web Services in place at Verizon than most people appreciate. Far beyond most companies.” Verizon Senior Executive, October ’03

• Samir Desai, CIO, Motorola, CIO Magazine, October 2003
  “Most cultural change programs fail.
  Most strategic change programs fail.
  Most large IT programs fail or under perform.
  Aggressively adopting Web Services at the enterprise level is all three combined.”

• “The complexity of delivering web services may reduce the productivity gains derived from their deployment, according to a poll of 50 IT managers” October 21, 2003
Industrial Strength Requirements

Why?

- Business
  - Business continuity
  - Meet regulatory requirements

- Technical
  - Systems cannot crash and take down others
    - 10,000 agents can’t work

- But when failure occurs …
  - Recovery ASAP: restore business
  - Minimize damage: loss of information or work

Acceptance Levels

- Minimum
- Service Level Agreements (SLAs)
- Support Levels
  - Mission critical
  - Critical
  - Non-critical

Minimum Acceptance Criteria

- Performance
  - High availability
  - Load balancing

- Reliability
  - Backup
  - Recovery
  - Failover recovery
  - Disaster recovery

- Security
  - Single Sign-On Service
  - Session Strong authentication & Encryption
  - Strong Authentication for end-users
  - Non-repudiation (Legal binding signature)
  - Encryption – message or stored data
  - Vulnerability analysis, security controls design
  - Other security services

- Monitoring
  - Surveillance and error messages
  - Health checks

- Resource demand
  - Database management systems support
  - Capacity requirements
  - Network traffic / transaction rate

- Standard tools
  - Monitoring
  - Scheduling
  - Backup
Dodging Silver Bullets

Large Scale Industrial Trends
- Legacy extension/optimization
- Legacy migration
- Outsourcing
- Re-engineering
- Build environments and applications
- Buy: best of breed, best practices
- Unified COTS / ERP
- Integrated Systems Planning
- Integration: EAI
- Organic Computing
- Mobility
- Software as a service
- Collaborative commerce

Computer Science / IT Trends
- Client/server
- Expert systems
- Business process re-engineering
- Object-oriented products
- Workflow
- Enterprise modeling
- Conceptual modeling
- Domain orientation
- Business objects
- Business rules
- Re-use
- Class libraries
- Distributed object computing
- Agents
- Knowledge Management
- Business Intelligence
- Grid Computing
- Web Services
- Semantic Web
Silver Bullet Pattern

- Pattern
  - Big Vision 1 (e.g., CORBA)
    - Dramatic claims / promises
    - Vision 1 trouble
  - Big Vision 2 (e.g., JAVA)
    - Dramatic claims / promises
    - Big Vision 1 subsides or vanishes
    - Vision 2 trouble
  - Big Vision 3 (e.g., Web Services)

- Recurring Theme: Next-Generation Information Systems
  - Distributed
  - Service oriented
  - Scalable
  - Plug and play
  - Integrated
  - Re-use
  - Class libraries
  - Business objects
  - Process-oriented
  - Flexible

Since 1970 …
Avoiding Silver Bullets: Five Factor Analysis

- Financials
- Technical requirements
- Strategic importance
- Industry support
- Momentum
1. It's Never About Technology

- Economic Models
- Business Models
- Processes / Applications
- Technology
1. It’s never about Technology!

2. Are you sure it’s a revolution?

3. What’s the chance of that?

4. Watch out for that Chasm!

5. What would it look like?
Ten Rules: Technology

6. Is There an Unsolved Problem?
   – Grand Challenge: semantics

7. Does it Come with Batteries?
   – Holy Grail: complete solution

8. Will it Work?
   – Robust and Scalable

9. Does it Fly?
   – Deployable: overcoming the legacy / sins of the past
The Talk
Outline

• Two Roles for the Semantic Web
  – Engineering / Plumbing
  – Semantics

• Web Services
  – Vision and Reality
  – In Large Enterprise (Verizon)

• Engineering
  – Web Services Management
  – Big Challenges

• Semantics
  – Really Big Challenges
• Engineering / Plumbing
  – “Smarts” needed to engineer a complete solution
    • Smart agents
    • Semantically enriched management activities

• Semantics
  – Integration is about meaning not plumbing
  – Grand challenge applied to applications not plumbing
Web Services Vision

Technical

- Flexibility
- Universal access Internet-wide
- Facilitates integration: easier, lower cost
- Faster development and deployment cycles
- Increasing throughput, ...

Business

- Facilitate business interactions
  - Internal
  - With partners
- Strengthen relationships
- Accelerate business

Profound Change

Software Networks [1]

- Networks of business and systems services
  - Expose services across the enterprise, to all partners, to all customers thus increasing the value of the services

Leading to

- Network Effect
- Economic Growth

Software Networks enable direct implementation of business strategies:

CEO: strategy
- Lock in customers; reach new markets

COO: productivity
- Provide employees integrated information
- Improve time-to-market by linking partners into development processes
- Outsource noncore business services

CFO: cost replacement
- Cut transaction costs with automated direct procurement
- Reduce customer service and administration cost through self-service

CIO: control
- Transform IT functions into technology services
- Govern resources thru service registry

CMO: influence
- Put the corporate brand on SOAP interface
- Anticipate and deliver what customers will need
- Couple the interface experience to the browser experience.

1. Forrester, The Truth About Web Services, May 2002
Web Services Reality

- Web Service Usage in 2003 (1)
  - XML: 87%
  - SOAP: 31%
  - WSDL: 3%
  - UDDI: 14%

- Web Service Plans in 2003 (2)
  - 85% Web Services internally
  - 57% Web Services for customers
  - 44% adopt supplier web services
  - 24% join standards activities

- Waves of Adoption (3)
  - Opportunistic Integration
    - Read only
    - Write
  - Strategic Web Services
    - Semantics
  - Breakaway Applications

- Web Services are Not
  - Simple
  - Cheap

- Risks
  - Problems with what is in place
    - XML, SOAP, WSDL, UDDI
  - Technical solution incomplete
    - Engineering
  - Standards
    - Take time
    - Competing standards
  - Vendor cooperation breakdown

1. Gartner, April 2003
2. Forrester, Web Services Reach the Big Time, September 2003
Web Services Reality

Four-Year Web Services Standards Roadmap

<table>
<thead>
<tr>
<th>Standards</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAML becomes a de facto standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New WS-Invocation Framework spec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WS-Management spec matures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BPEL4WS and WSCI merge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Federated identity standard appears</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliable messaging is commercialized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Forrester Research, Inc.

Source: Road To A Service-based Architecture, Forrester, December 2002
• Flurry of activity: 45 major projects

• Common Services Strategy
  – Common business services: \(1,000^+\)
  – Common system services

• Planning
  – Web Services: +300

• Implementation

• Standardization

• Managing Web Services - in scale
Facilitated Peer-to-Peer WSM (Interceptor Model)

Web Services “Architecture”

SOAP/HTTP

Web Services Management Platform

Provider Platform

Smart Agent

Smart Agent

Consumer Platform
Smart Agents: In-flight Inspection of SOAP Messages

Provider Agent
- Security
- Monitoring/Heartbeat
- Logging
- Metering
- SLA Management
- Transformation

Consumer Agent
- Security
- SOAP Header Manipulation
- Client side Transformation
- Dynamic Discovery
- Error Handling
Peer-to-peer (P2P) Architecture

Performance Metrics
Logging /tracking
Metering

Billing

Ordering

WSM
Data Collection

Agent Config.

Agent

Agent

Agent

Agent

portal

General Business

Business Activity Monitoring

SLA Monitoring/Alerts

Peer-to-peer (P2P) Architecture

Performance Metrics
Logging /tracking
Metering

Billing

Ordering

WSM
Data Collection

Agent Config.

Agent

Agent

Agent

Agent

portal

General Business

Business Activity Monitoring

SLA Monitoring/Alerts

Peer-to-peer (P2P) Architecture

Performance Metrics
Logging /tracking
Metering

Billing

Ordering

WSM
Data Collection

Agent Config.

Agent

Agent

Agent

Agent

portal

General Business

Business Activity Monitoring

SLA Monitoring/Alerts

Peer-to-peer (P2P) Architecture

Performance Metrics
Logging /tracking
Metering

Billing

Ordering

WSM
Data Collection

Agent Config.

Agent

Agent

Agent

Agent

portal

General Business

Business Activity Monitoring

SLA Monitoring/Alerts

Peer-to-peer (P2P) Architecture

Performance Metrics
Logging /tracking
Metering

Billing

Ordering

WSM
Data Collection

Agent Config.

Agent

Agent

Agent

Agent

portal

General Business

Business Activity Monitoring

SLA Monitoring/Alerts

Peer-to-peer (P2P) Architecture

Performance Metrics
Logging /tracking
Metering

Billing

Ordering

WSM
Data Collection

Agent Config.

Agent

Agent

Agent

Agent

portal

General Business

Business Activity Monitoring

SLA Monitoring/Alerts
Scalable Architecture
• getCSR: get customer record

• Requirements
  – Access back-end databases
  – High security
  – High performance < 100’s of milliseconds overhead

• Simple approach: SOAP + XML documents

• Successful approach: no XML documents
  – User profiles for authorization / rights information
  – Customer record selection criteria
WSM Functions

- Definition of business services being measured
- Time frame Measurement
- Assumptions/roles and responsibilities
- Service-Level metrics
- Measurement formula
- Escalation activity
- Contractual/exceptions/penalties/rewards
- Reward/penalty formula
- Priority codes (e.g. Silver vs. Gold)
Service Level Agreement (SLA)

SLA: contractual provider / consumer commitment on specific goals

**SLA components**
- Functionality
- Cost of functionality
- Response time
- Service operational time
- Acceptable level of defects
- Transactional management
- Performance metrics
- Error behavior
- Responsibilities

**SLA considerations**
- Define metrics to monitor SLA
- Automate the SLA Reporting
- Implement SLM Platform
- Be specific to individual application requirement
- SLA should contain meaningful
- penalties and incentives
- IT operation group should be involved in the SLA development Process
Big Challenges: Engineering

• Infrastructure Capabilities
  – Asynchrony
  – Scalability
  – Process management
  – Mediation
  – Reliable communications (WS-C)
  – Transactions (WS-T)
  – Deployment / provisioning
  – Addressing (WS-Addressing)
  – Tracking
  – Interoperability: WS-I (Web Services Interoperation)

• Complete Technical Solution
  – Service-Oriented Architecture (SOA)
  – Web Services Management
  – Web Services Development Framework

• Governance / Standards

• Economic Model
• Application, Data, and Process Integration

• Advanced Web Services (cf: computational complexity)
  – Description
  – Discovery
  – Composition

• Component-based software development [ACM, Aug 2003]
  – Decomposition
  – Re-use
  – Development
  – Testing / defect removal
  – Reliability
  – Recovery
Conclusion

• Belief
  – Web Services is the next (MAJOR) step to Service-Oriented Computing
  – Potential
    • Profound change
    • Massive value proposition

• Adoption time line: 2010-2020

• Semantic Web and Database communities have much to offer
  – Engineering / Plumbing
  – Semantics
  – Mission critical to scalable deployment