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

Dr. Michael L. Brodie
Chief Scientist
verizon
Information Technology

The Set Up

A Leading Provider of Communications Services

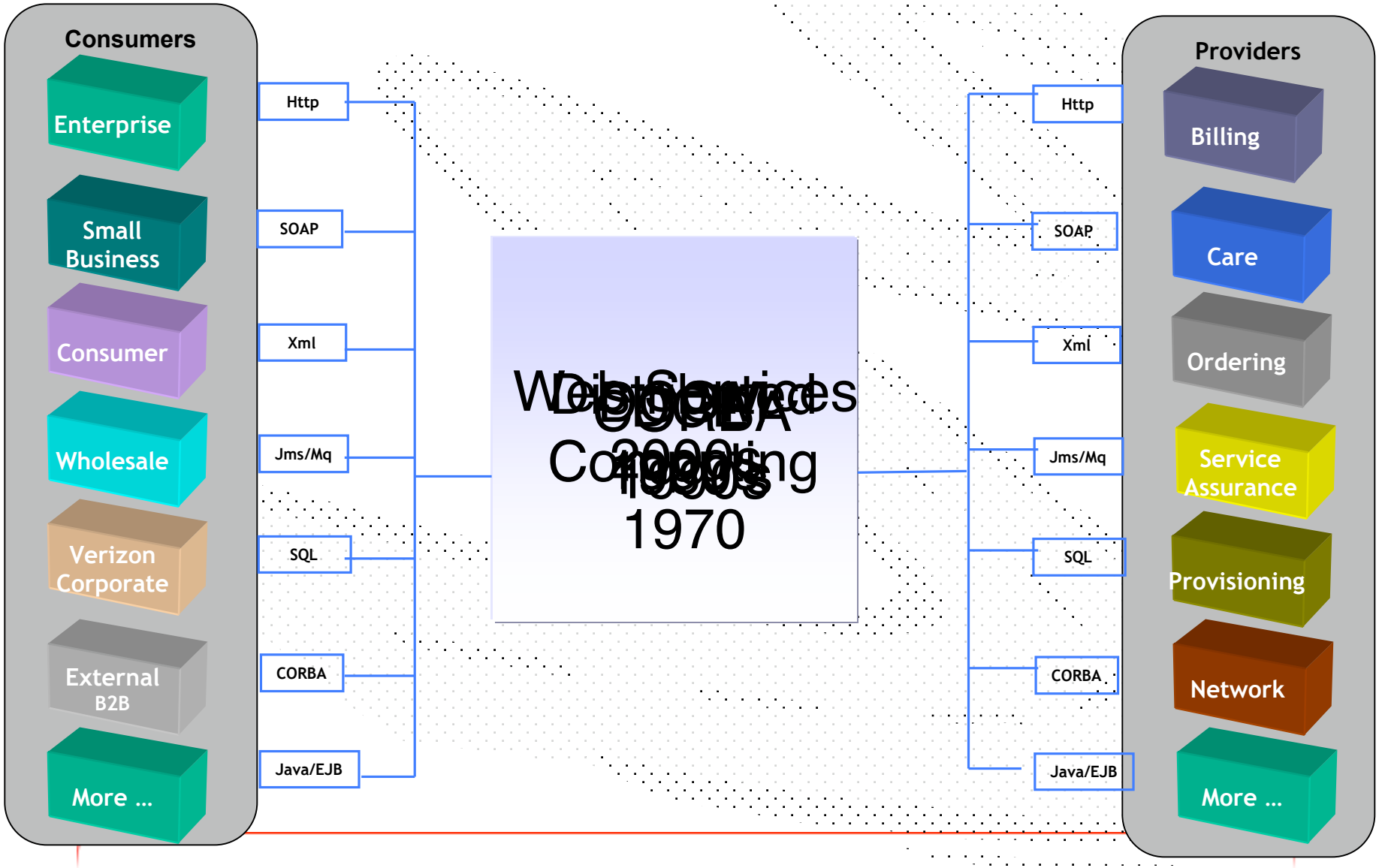
- **Verizon Communications** (NYSE: VZ) is formed by the merger of Bell Atlantic and GTE, is one of the world's leading providers of high-growth communications services. Verizon companies are the largest providers of wireline and wireless communications in the United States, with over 137 million access 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.
  - Forbes, April 2003: 8th "best" company, "best" Telco
  - 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



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 - “discount”
- Dynamic: Real-time access works accurately
- Seamlessness
- 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

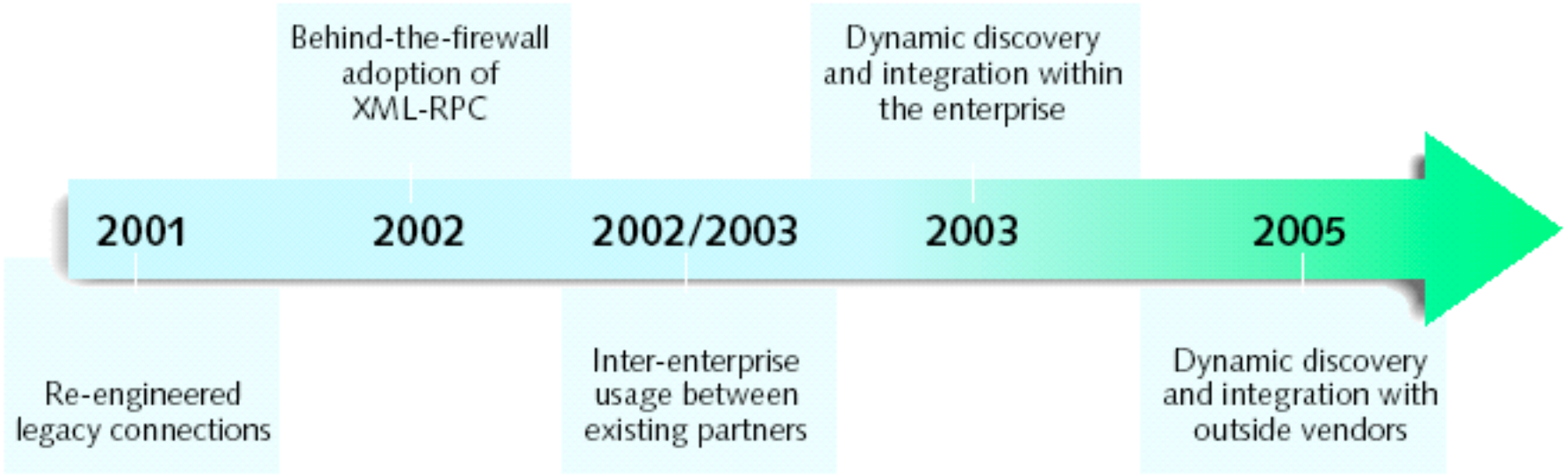
The problem is not in the plumbing
It's in the semantics

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

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, …

The Grand Challenge of Information Technology

- 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 $610B / 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 B2Bi (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 history[1]
- Potential of greater
  - Precision
  - Automation
  - Optimization
  - Solutions - industrial problems
  - Visions

[1] University of California, Berkeley P.Lyman, H.Varian, A. Dunn, A. Strygin, K. Swearingen, How Much Information? October 2000 [24 exabytes (2^{60} bytes)]

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

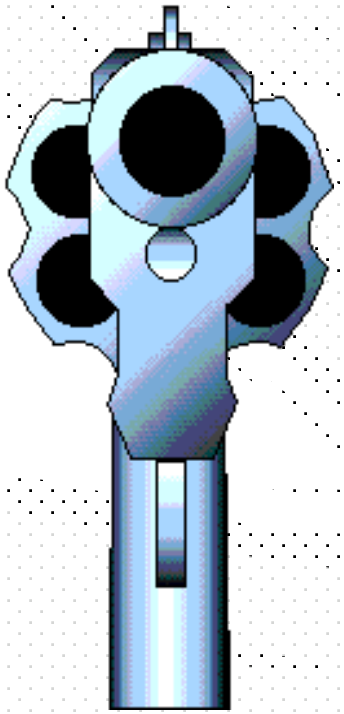
Minimum Acceptance Criteria

- 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 Vision1 (e.g., CORBA)
    - Dramatic claims / promises
    - Vision1 trouble
  - Big Vision2 (e.g., JAVA)
    - Dramatic claims / promises
    - Big Vision1 subsides or vanishes
    - Vision2 trouble
  - Big Vision3 (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

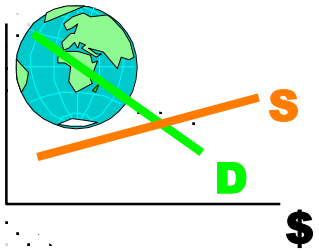
Since 1970 …

Avoiding Silver Bullets: Five Factor Analysis

- **Financials**
- **Technical requirements**
- **Strategic importance**
- **Industry support**
- **Momentum**

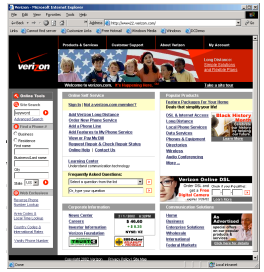
1. Its Never About Technology

Economic Models



Business Models

Processes / Applications



Technology

Ten Rules: Business

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 ?

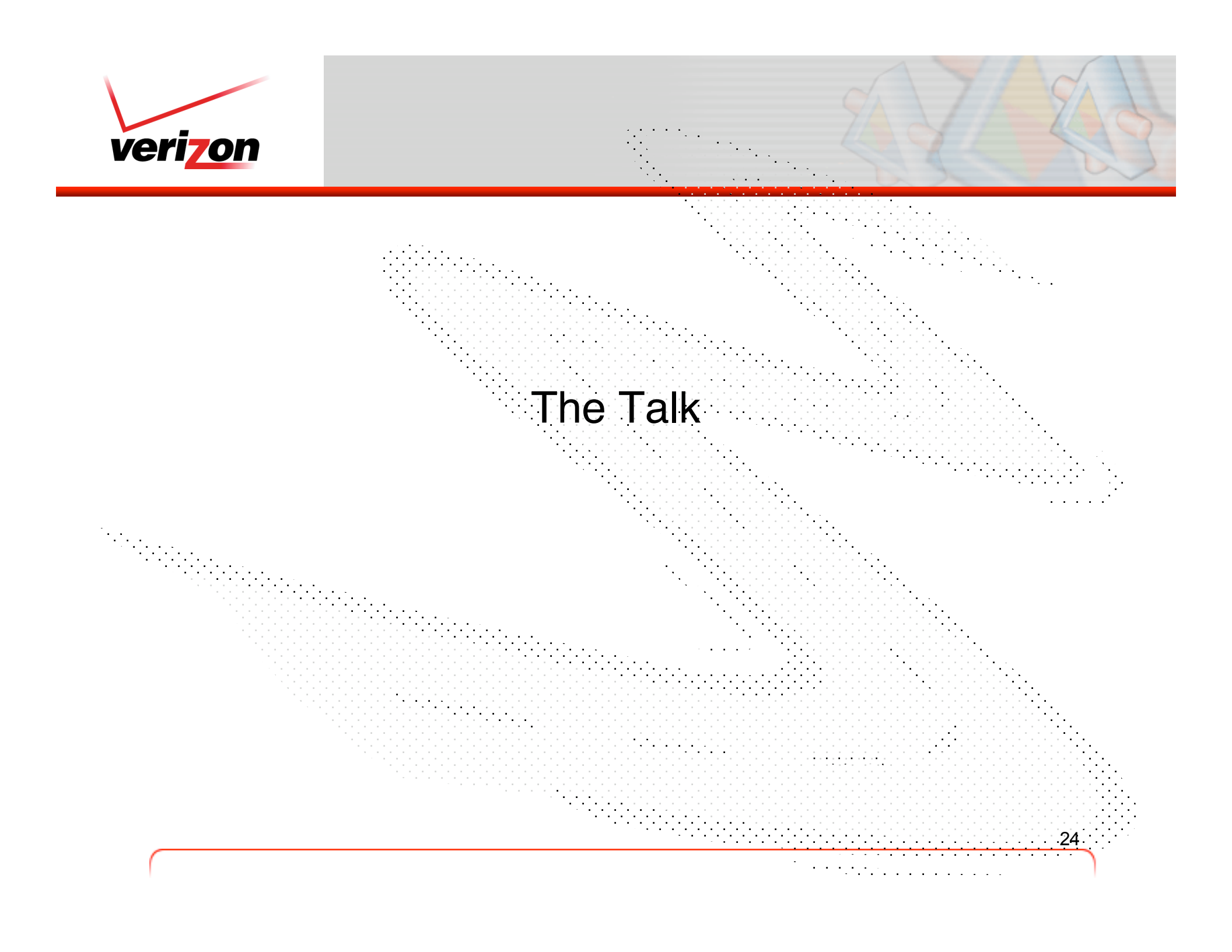
Ten Rules: Technology

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

Roles for the Semantic Web

- 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
  - With customers
- 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 thru 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

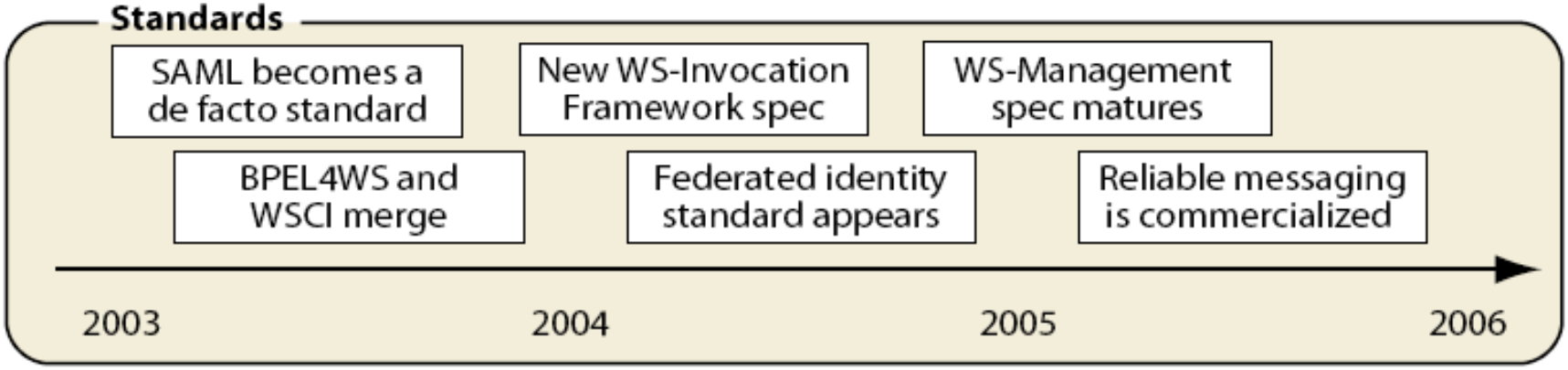
- Web Service Usage in 2003 (1)
  - XML: 87%
  - SOAP: 31%
  - WSDL: 3%
  - UDDI: 14%
- Web Service Plans in 2003 (2)
  - 85% Web Services internally
  - 57% Web Services for customers
  - 44% adopt supplier web services
  - 24% join standards activities
- Waves of Adoption (3)
  - Opportunistic Integration
    - 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
3. Forrester, The Truth About Web Services, May 2002

Web Services Reality

Four-Year Web Services Standards Roadmap



Source: Forrester Research, Inc.

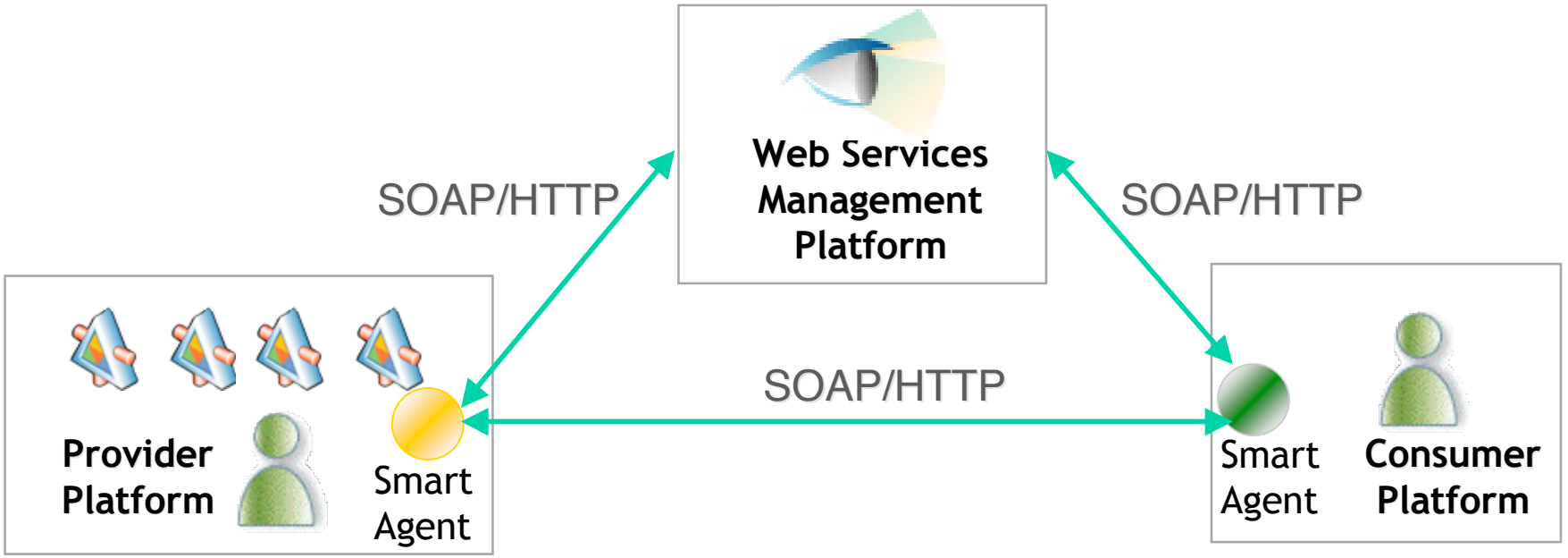
Source: Road To A Service-based Architecture, Forrester, December 2002

Web Services in the Large (Verizon)

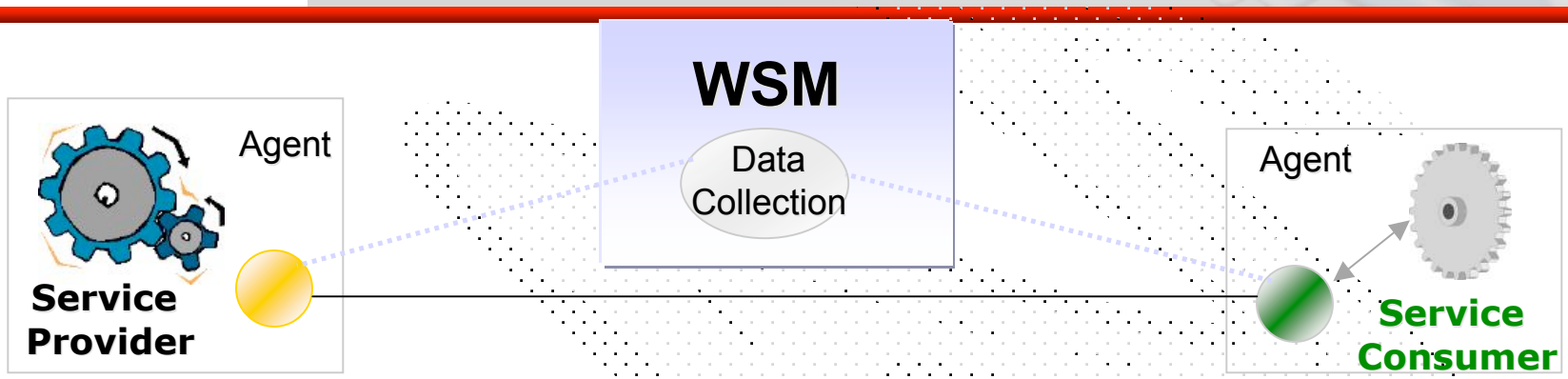
- Flurry of activity: 45 major projects
- Common Services Strategy
  - Common business services: 1,000+
  - Common system services
- Planning
  - Web Services: +300
- Implementation
- Standardization
- Managing Web Services - in scale

Web Services "Architecture"

Facilitated Peer-to-Peer WSM (**Interceptor Model**)



Smart Agents: In-flight Inspection of SOAP Messages



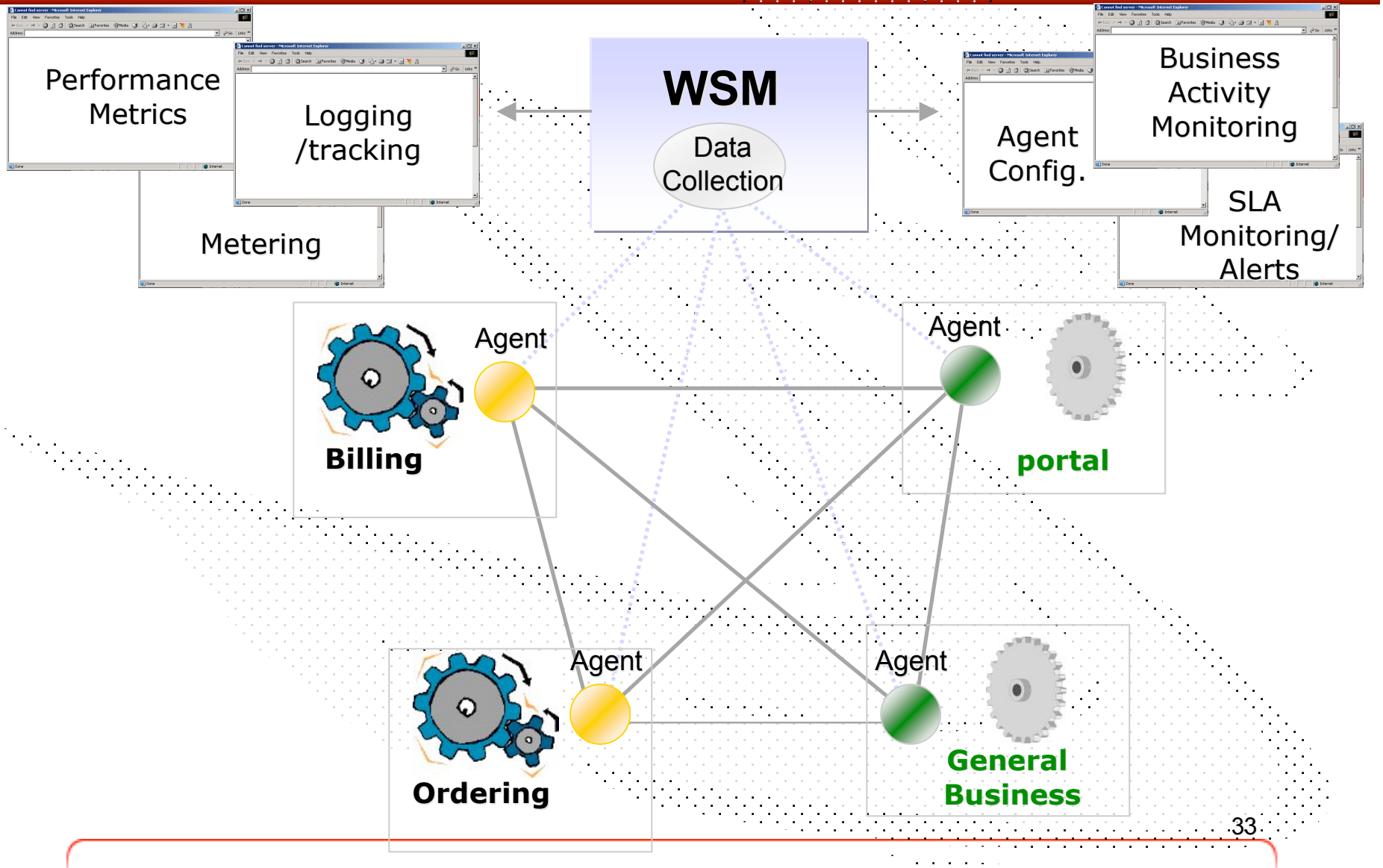
Provider Agent

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

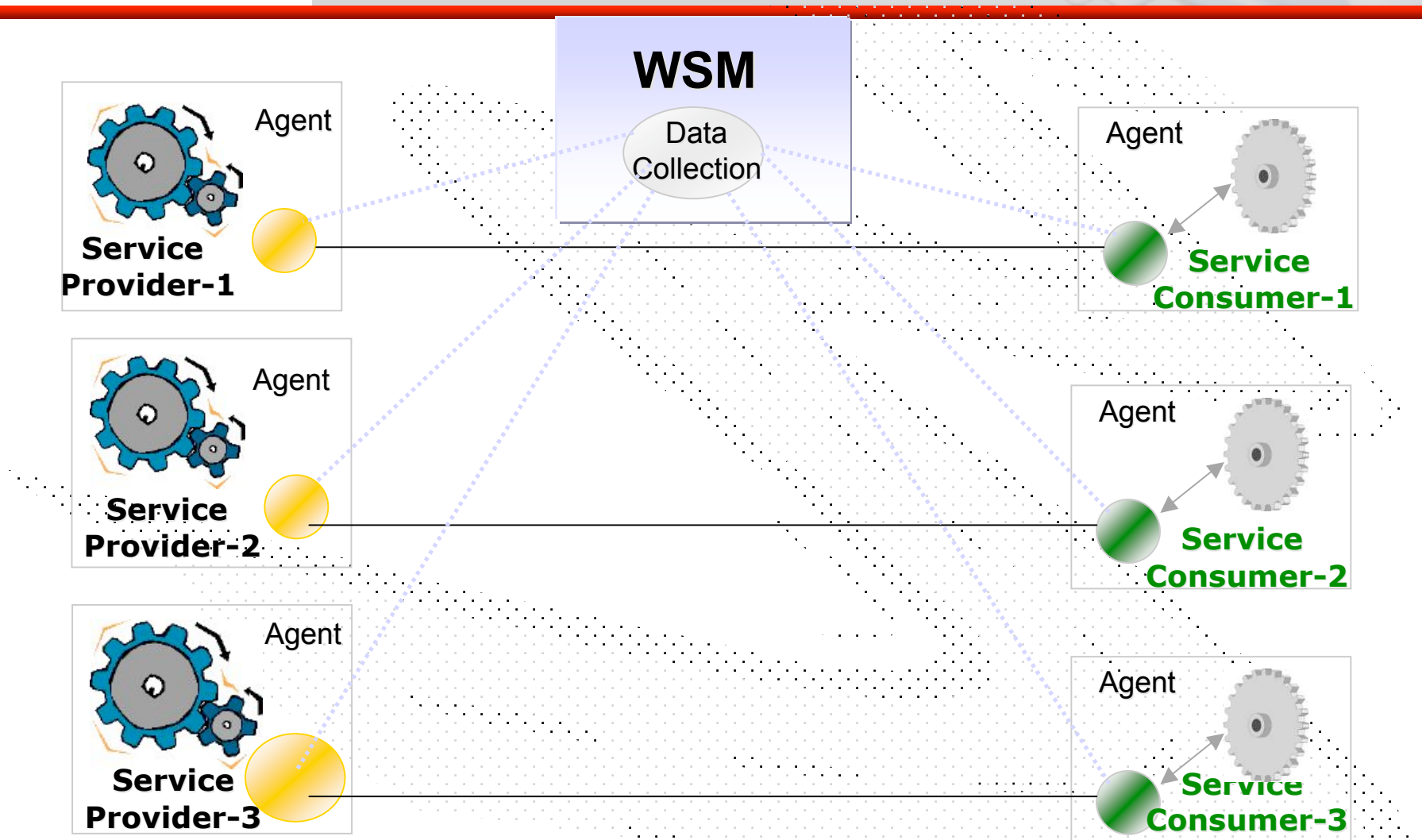
Consumer Agent

- Security
- SOAP Header Manipulation
- Client side Transformation
- Dynamic Discovery
- Error Handling

Peer-to-peer (P2P) Architecture

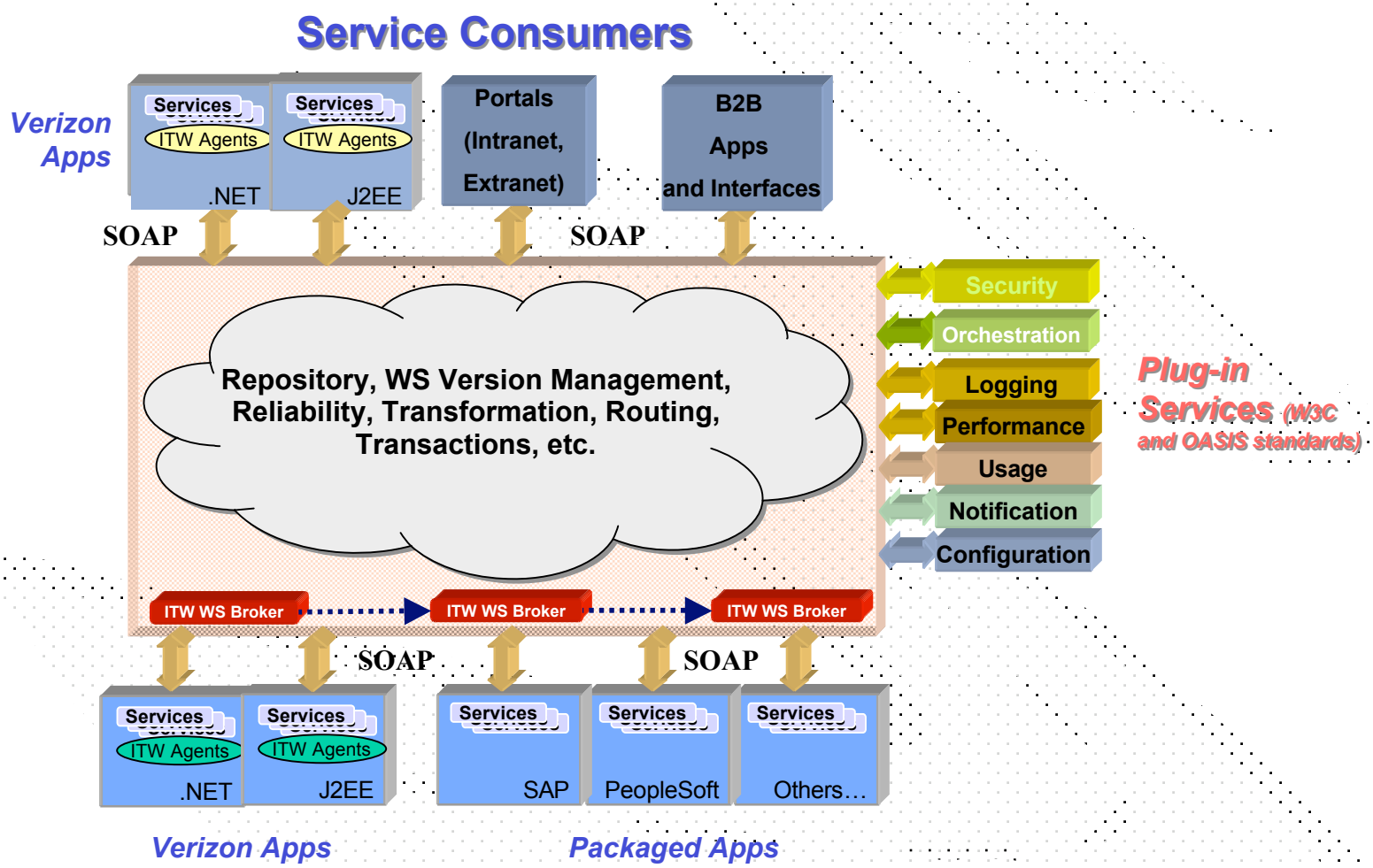


Scalable Architecture



ITWORKBENCH

Web Services Management (Functionality Overview)

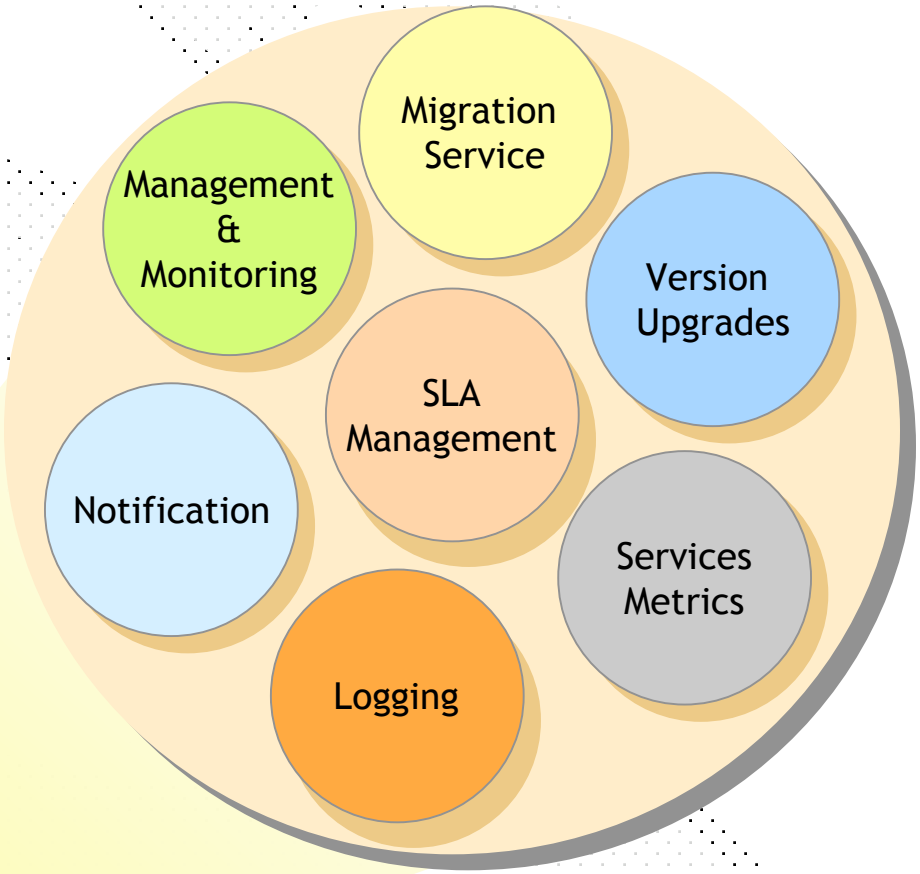


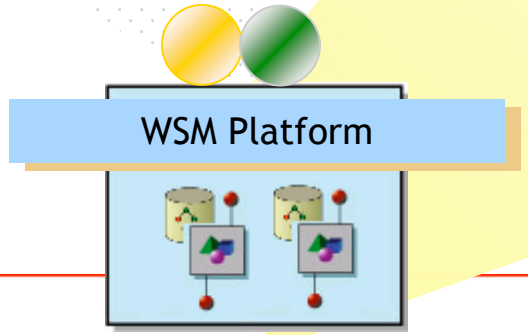
A Semantic Web Service: "A Little Semantics Goes A Long Way"

- 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

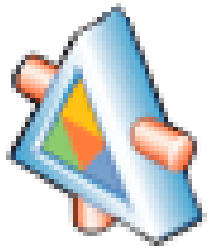
- Infrastructure Capabilities
  - Asynchrony
  - Scalability
  - Process management
  - Mediation
  - Reliable communications (WS-C)
  - Transactions (WS-T)
  - Deployment / provisioning
  - Addressing (WS-Addressing)
  - Tracking
  - Interoperability: WS-I (Web Services Interoperation)
- Complete Technical Solution
  - Service-Oriented Architecture (SOA)
  - Web Services Management
  - Web Services Development Framework
- Governance / Standards
- Economic Model

Really Big Challenges: Semantics

- 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