The Future of Web Services

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Agenda

- Introduction
- Specifications Roadmap
- Conclusions
- Summary

XML Web Services – Perspective

- Today
  - All major vendors on board
  - Web Services are a universal application interconnection fabric
  - 17 released specifications including routing, security, coordination, transactions, trust, policy, addressing and reliable messaging
  - WSE 1.0 for Microsoft Windows .NET Framework has released
  - WS-I is fully operational
- Moving Forward
  - Increase customer feedback
  - Windows .NET Framework and Tools, Windows Servers and Clients, and Microsoft services will all support Web Services
  - Release of future specifications in security and reliable messaging

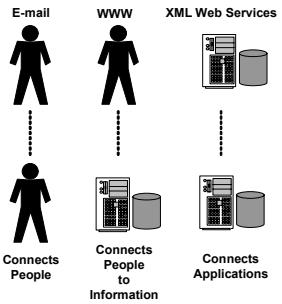
The foundation is in place – now we get to build upon it!

XML Web Services

- XML Web Services are here today
  - Used for cost-effective integration of enterprise and key partners
- Businesses want to use XML Web Services to support more complex intra- and inter-organizational scenarios
  - So we are extending XML Web Services with a series of additional Web Services specifications
- This architecture will be supported by the Windows .NET Framework and throughout the Windows Platform

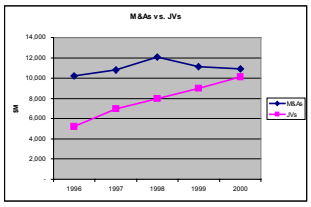
Move to Distributed Computing

Move to the distributed computing model reflects business needs

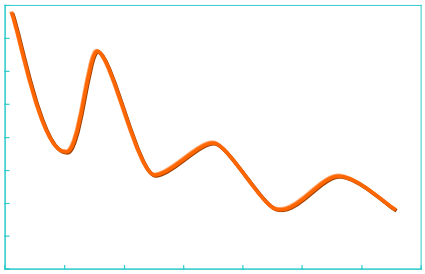


Distributed Business Requires Distributed Computing

Move to more loosely-coupled business relationships means that businesses will rely more on the interconnectivity of data and applications

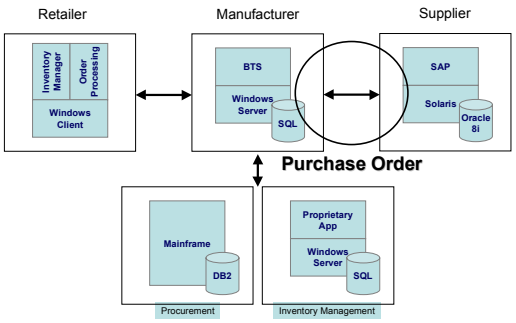


Impact Of Increased Competition *Average lifetime in S&P 500*



Source:Dick Foster, "Creative Destruction"

Inter-organization XML Web Services



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Required Capabilities - Example: P.O.

- Message-Level Security
  - Cannot leave secure connection open for days
- Routing
  - Single logical name for all partners
- Reliable Messaging
  - Need to deliver messages exactly once and in order for coherent process
- Transactions and Business Activities
  - When process is interrupted, can remember where you are in the process

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Basic Vocabulary

- XML - Extensible Markup Language
- XSD - XML Schema Definition
  - DTD – Document Type Definition
- WSDL - Web Services Description Language
- SOAP - Simple Object Access Protocol
- UDDI - Universal Description, Discovery and Integration
- HTTP - HyperText Transport Protocol
- XSLT – XML Transformations
- PSVI – Post Schema Validation Infoset
- DIME – Direct Internet Message Encapsulation
- MIME – Multipurpose Internet Mail Extensions

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XML Infrastructure Evolution

- The base set of standards evolves aiding the new system and deployment requirements
  - An XML Data Model has emerged
    - The XML Infoset
  - Additional type information can be specified and verified
    - The PSVI is nascent
  - XML Query, XPath 2.0 and XSLT 2.0 become type aware
- The trend is to add metadata enhancing the pre-existing Web Services infrastructure

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What Is Microsoft Web Services Architecture?

- Is a set of design principles we (Microsoft) use to architect the next version of Web Services
- Designed for interoperability and broad adoption
- Adds infrastructure-level capabilities to traditional Web Services
- Built with existing standards XML, SOAP, XML Schema, and WSDL

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Design Principles

- Modular and composable
  - Factored to stand alone or work together
- General-purpose
  - Agnostic to place it is running or originated
- Standards-based
  - Multi-vendor interoperation is critical
- Federated
  - No central point of administration, control, failure

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The Architecture is Standards-Based

- We are committed to:
  - Publishing our specifications
  - Working with partners to refine specifications
  - Working with partners, customers, and standards bodies for broad adoption
  - Working with all appropriate parties to promote interoperability

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Interoperability

http://www.WS-i.org

WS-I
WEB SERVICES INTEROPERABILITY ORGANIZATION

- An open industry effort
  - Industry initiative focused on promoting Web Services interoperability formed by leaders
  - Open participation and membership (160 +)
- Goal: Enable interoperability across platforms, applications, and programming languages
- Based on partnerships
  - Symbiotic relationship with other standards organizations through integration of their outputs
  - Success will accelerate adoption and deployment of Web Services
- Evidence of industry alignment around Web Services

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Baseline Standards

- XML 1.0 (second edition)
  - Base encoding for documents
- SOAP 1.1
  - Base encoding for messages
- WSDL 1.1
  - Description of Web Services
- UDDI 2.0 (API 2.04, data structure 2.03)
  - Directory for finding Web Service descriptions
- HTTP 1.1
  - Message transfer
- The WS-I Basic Profile 1.0 rationalizes the use of these specifications as a set

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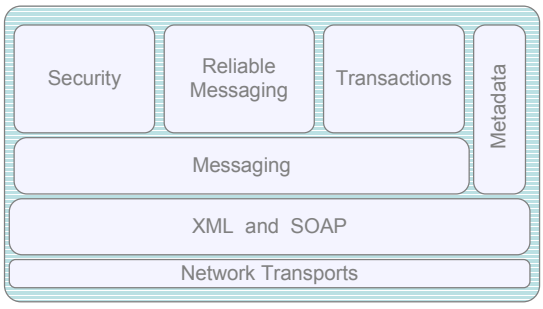
Foundation Protocols

"Secure, reliable, transacted messages"



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WS-* Specifications Roadmap

- WS-Routing
- WS-Referral
- WS-Inspection
- WS-Security
  - Addendum
  - Profile for Tokens
- WS-Attachments
- WS-Coordination
- WS-Transaction
- WS-Trust
- WS-SecureConversation
- WS-SecurityPolicy
- WS-Policy
- WS-PolicyAttachment
- WS-PolicyAssertions
- WS-Addressing
- WS-ReliableMessaging

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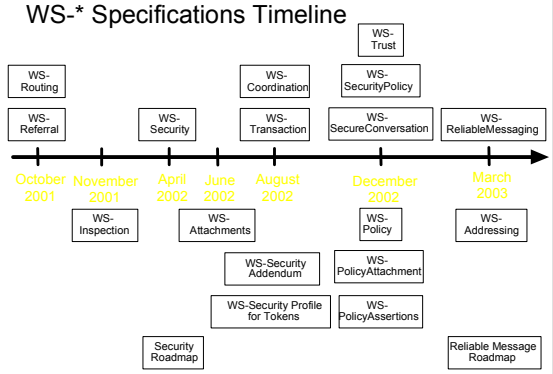
WS-* Specifications Timeline



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WS-Routing

- Routing – Microsoft October 2001
  - WS-Routing
    - Makes the network virtual
    - Routes messages across intermediate SOAP nodes
    - Provides a mechanism to interact with intermediary SOAP nodes
      - It makes them first class citizens
    - Partitions URL namespaces between nodes

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WS-Referral

- Referral – Microsoft October 2001
  - WS-Referral
    - Configuration protocol for SOAP nodes
      - Allows for dynamic configuration
    - Enables routing strategies to be dynamically communicated and deployed
    - Provides a mechanism for delegating routing responsibility
    - Mechanism can be used for application load balancing

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WS-Inspection

- Inspection Language – Microsoft & IBM, November 2001
  - WS-Inspection (a.k.a. WS-IL)
    - XML format for the inspection of a site for available services
    - Rules for how inspection related information should be made available for consumption
    - May aggregate references to pre-existing service descriptions of a variety of formats
    - Inspection documents can be made available through references

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WS-Security

- WS-Security – Microsoft, IBM and VeriSign -- April 2002
  - Mechanisms for message-level security
  - June 2002 co-Submitted to OASIS with Baltimore Tech, Entrust, RSA Security, Oblix, Open Network, Documentum, SAP, and ….. Sun Microsystems
    - Credential exchange, message integrity, and message confidentiality
    - Encoding for common license formats
- WS-Security Addendum
  WS-Security Profile for XML-based Tokens
  – Microsoft, IBM and VeriSign – August 2002

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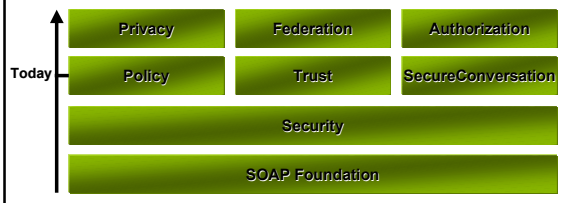
Web Services Security Roadmap



Security in a Web Services World

– IBM/MSFT White Paper, April 2002

WS-Security specification

– At OASIS, broad industry support

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Modularity: e.g. Routing and Security

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WS-Attachments

- WS-Attachments – Microsoft, IBM, Feb. 2002, June 2002
  - Abstract model for SOAP attachments
    - Attachments are described using the notion of a compound document structure
      - One primary SOAP message
      - Zero or more related documents known as attachments
  - Encapsulates a SOAP message and zero or more attachments in a DIME message
  - IETF Internet Draft
    - Expires Dec 2002

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Related Released Spec: Orchestration

- BPEL4WS -- Microsoft, IBM, BEA Systems – August 2002
  - Defines how Web Services are connected together and in what sequence in order to accomplish a particular task

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WS-Coordination

- WS-Coordination -- Microsoft, IBM, BEA Systems – August 2002
  - Introduces mechanisms to coordinate the joint operation of Web Services
    - How to refer to Web Services
    - How to transmit state among Web Services
    - How to create joint activities
    - How to register into activities
  - This specification is deceivingly short
    - In its two Appendix sections it covers Web Service references and state sharing using a context element

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WS-Coordination – The Basics

- Simple request-response protocols to:
  - **Create** an activity
    - Determines the behavior (s) to be followed
    - Establishes the context to be propagated
  - **Register** with an activity
    - Specifies behavior desired
    - Multiple registrations for different behaviors
- The specification has built-in:
  - Extensibility – activities may extend context
  - Encapsulation – information is self-contained
- Good for P2P and for coordinated services

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WS-Coordination - Example of Behaviors

- The need is to establish a session
  - B1: Three leg handshake
    - Hello, ACK of hello, ACK of ACK of hello
  - B2: Fire and forget
    - Hello
- The activity may also have a policy:
  - If B2 then must use reliable messaging
  - If using unreliable datagram messages then must use B1

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WS-Transaction

- WS-Transaction -- Microsoft, IBM, BEA Systems – August 2002
  - Enhances standard SOAP-based Web Services by defining protocols that add end-to-end transactional behavior
    - These behaviors are chosen by Web Services by using the WS-Coordination mechanisms
  - Behaviors Include
    - Standard two phase commit suite
    - Sophisticated, long-running agreement protocols for business activities

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WS-Transaction Part I – The Basics

- ACID transaction protocols
  - Two phase commit, 2PC
  - PhaseZero
  - Completion
  - Completion with acknowledgement
  - Outcome notification

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WS-Transaction Part I Interoperability in a Glass House

- In-house installations are heterogeneous
  - And we want to transact among them
- Virtual glass houses also exist
  - Across close partners
- Some Web Services require the ACID properties of transactions

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WS-Transaction Part II – The Basics

- Business activities protocols
  - Based on the support of compensating actions
  - Assumes the existence of ACID transactions
- They establish a parent-child agreement
  - A protocol for coordination agreement
  - Analogous to Robert's Rules of Order for parliamentary procedures but much simpler
- They only differ in the ability of the child to unilaterally know when the "unit of work" is complete

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WS-Transaction: Criteria to use Part II protocols versus Part I protocols

- One should use BA agreement protocols when:
  - Participants cannot hold locks for the duration of the coordination period of the activity
  - Participants cannot hold physical resources for the duration of the coordination period of the activity
  - Participants need not be simultaneously available for processing yet require coordination
  - Participants effect intermediate actions outside the systems involved
  - Participants have coordination units that may span multiple ACID transactions
  - Participants deploy activities that are far too expensive to use abort and retry

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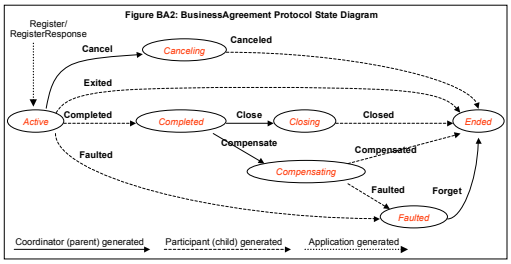
WS-Transaction Part II: Agreement Protocol



WS-Policy

- WS-Policy -- Microsoft, IBM, BEA Systems, SAP AG – December 2002
  - Flexible and extensible grammar for Web Services to communicate requirements, preferences and capabilities
    - Declarative and conditional assertions
  - Assertions may or not manifest on the wire
    - Authentication scheme, transport protocol
    - Privacy policy, QoS characteristics

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WS-Policy – The Basics

- Declaration of the policy assertion XML elements have mandatory usage attributes
  - Required, Rejected, Optional, Observed, Ignored
- Policy operators
  - **All** - all of its child elements are satisfied
  - **ExactlyOnce** - exactly one of its child elements is satisfied
  - **OneOrMore** - at least one of its child elements is satisfied
- Using a PolicyReference element references are supported
  - They even apply to policy operators sub-elements

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WS-PolicyAssertions

- WS-PolicyAssertions -- Microsoft, IBM, BEA Systems, SAP AG – December 2002
  - Describes general policy assertions that can be affiliated with a message
    - TextEncoding assertion
    - Language assertion
    - SpecVersion assertion
    - MessagePredicate assertion
      - XPath 10. is assumed but URI is identifier
  - They may be used by both the Web Service or by the client

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WS-PolicyAssertions – The Basics (1/2)

- Functions for use in XPath expressions for policies
  - GetBody (node) - returns the SOAP envelope <Body> element from the specified Envelope element
  - IsInBody (node) - returns true if the specified node is in the SOAP envelope <Body> element from the specified Envelope element
  - GetHeader (node) - returns the SOAP envelope <Header> element from the specified Envelope element
  - IsInHeader (node) - returns true if the specified node is in the SOAP envelop <Header> element from the specified Envelope element
  - RoleURIForHeaderBlock (node) - returns the SOAP role URI for the specified header block.

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WS-PolicyAssertions – The Basics (2/2)

- Functions for use in XPath expressions for policies
  - IsMandatoryHeaderBlock (node) - returns true/false depending on whether or not the specified header block is mandatory (*mustUnderstand* = true)
  - IsRoleURIForNext (node, string) - returns true/false depending on whether or not the specified role maps to the predefined "next" role for the version of SOAP used by the supplied message
  - IsRoleURIForUltimateReceiver (node, string) - returns true/false depending on whether or not the specified role maps to the predefined "ultimate receiver" for the version of SOAP used by the supplied message
  - GetNodesetForNode (node) - returns an XPath Node set for the node including the node, its attributes, all of its descendents and their attributes

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WS-PolicyAttachment

- WS-PolicyAttachment -- Microsoft, IBM, BEA Systems, SAP AG – December 2002
  - Provides a standard mechanism for attaching the requirement and capability statements to Web Services
    - How to reference policies from WSDL definitions
    - How to associate policies with specific instances of WSDL services
    - How to associate policies with UDDI entities

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WS-PolicyAttachment – The Basics

- Policy expressions are attached to subjects or resources by explicit definition or by reference
  - XML elements
  - Arbitrary resources
- The precise semantics of how the [Element Policy] Infoset information item is schema-specific
- Use PolicyURIs and PolicyRefs attributes to comply with WSDL 1.1 portType extensibility restrictions

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WS-Trust

- WS-Trust -- Microsoft, IBM, RSA Security, VeriSign – December 2002
  - Defines extensions that build on WS-Security
    - Request and issue security tokens across different trust domains
    - Manage trust relationships
  - Web Services can require that incoming messages prove a required set of security claims
    - The freshness of information presented can be probed
    - They can publish these requirements using WS-Policy and WS-PolicyAttachment

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WS-SecureConversation

- WS-SecureConversation -- Microsoft, IBM, RSA Security, VeriSign – December 2002
  - Describes a framework to establish and share security contexts and to derive session keys from security contexts
  - Good for parties that want to exchange multiple messages in a secure way using a single context
  - Security contexts may be created by
    - Security token service
    - One of the communicating parties
    - Through negotiation

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WS-SecurityPolicy

- WS-SecurityPolicy -- Microsoft, IBM, RSA Security, VeriSign – December 2002
  - Describes general security policies that can be associated with a service as an addendum to WS-Security
  - Assertions cover:
    - Security tokens
    - Integrity
    - Confidentiality
    - Visibility
    - Security header constrains
    - Message age

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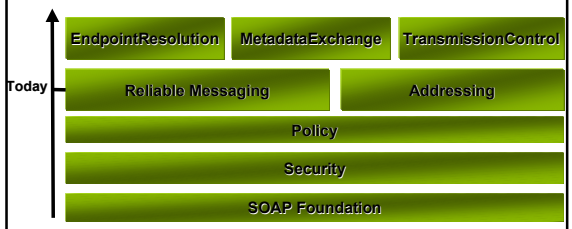
Web Services Reliable Messaging Roadmap



Reliable Messaging Delivery in a Web Services World

– IBM/MSFT White Paper, March 2003

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WS-Addressing

- WS-Addressing -- Microsoft, IBM, BEA – March 2003
  - Describes transport-neutral mechanisms to address Web Services and messages
  - Identification of Web Service end points
    - Endpoint reference: URI + application-specific information
  - End-to-end identification in messages

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WS-ReliableMessaging

- WS-ReliableMessaging -- Microsoft, IBM, BEA, TIBCO – March 2003
  - End-to-end delivery of messages with specific quality-of-service characteristics among two parties
    - Identification of sequences of messages
      - 64-bit counter
    - Specification of delivery assurances
      - At most once delivery
      - Exactly once delivery
      - In-order delivery
  - No restriction on the number of in-flight messages
  - Transport-independent

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Current Areas of Emphasis

- The rest of the security roadmap
- The reliable messaging roadmap
- Local discovery of services
- Message exchange patters
- Web services management

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Web Services Architecture Impact (0/5)

- Web Services architecture requires multiple stacks for its solutions
  - Processing stack
  - Protocol stack
  - Description stack
- Many layers from XML and IP transmission protocol upwards
  - Must keep these in mind do achieve good designs

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Web Services Architecture Impact (1/5)

- Use self-describing messages
  - Practices information hiding
  - Promotes interoperability
  - Enhances robustness
  - Aids horizontal scaling
- Firewalls will exist
  - They will hide “the network truth”
    - Virtualization saves the day
  - Probably with several administration authorities
    - Hence possible different behaviors
  - Ideally with published policies

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Web Services Architecture Impact (2/5)

- Publish metadata that affects processing
  - Enables reasoning about the Web Services
  - Build logic to exploit existing metadata
    - E.g., QoS requirements, privacy mechanisms, locale
  - WS-Policy and WS-PolicyAttachment show the way
- Failure of transparency will occur
  - Networked software has more failure modes than tightly-coupled software
    - Isolate faults
    - Provide meaningful error reporting
  - End-point disconnection will happen
    - Recovery points have to be well defined
  - Latencies are not predictable

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Web Services Architecture Impact (3/5)

- End-to-end properties must (still) be preserved
  - Authentication, privacy, non-tampering
    - Much harder in a federated environment
  - Default values may differ at end-points
    - Discovery of this is a challenge
  - Coordinated outcomes need to be achieved
    - In the presence of long-running computations
  - Application needs differ substantially
    - E.g., message delivery characteristics
  - Third parties may complicate the picture

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Web Services Architecture Impact (4/5)

- Build ability to select what third parties are used to mediate an interaction
  - Normally to deal with trust, privacy and integrity
  - Exploit routing opportunities
- Outsourcing will occur
  - But Web Services allow you to tailor what mission-critical function is retained in-house
  - Trust cannot be assumed in a Federation
    - To prevent DoS attacks prior to committing resources verify the desire to process a message
- Asynchrony of communication is needed
  - Store and forward is powerful but not universal
  - Even traditional client/server Web Services benefit from internal batching

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Web Services Architecture Impact (5/5)

- Infrastructure has to support arbitrary behaviors while providing coordinated outcome
  - Deployment environments vary tremendously
    - E.g., lightweight clients using proxies
  - WS-Coordination and WS-Transaction show the way
- Build appropriate management support
  - Charge-backs require instrumentation
  - Debugging is helped by tracing
    - Challenge is to trace what is produced by others

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IT Over the Last 20 years

"Built to Last"

- TCO driven
- Business application build-outs
  - Band-aid solutions
  - Privileged access
  - 3+ year back log for feature requests
  - Told you where you were
- Outsource entire IT departments
- Corporate mergers: IT a huge factor

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IT Next 10 years

"Built to Change"

- Asset, ROI driven
- Beginning of new infrastructure build out
- Business application
  - Part of a business process
  - Controlled, secure access
  - 6 week change IT to match the business projects
- Outsource static business applications
  - e.g. HR, 401K, Payroll
- Integration as given
  - Built into tools, platform, partners
  - Standard protocols on both ends

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Build to Change

- The designs should “provide for choice”
  - Design for variation in outcome so that it may be different under different circumstances
  - Designs that permit variation flex under pressure and survive
- Design should understand and delineate the “interfaces of change”
  - Over time new refinements are focused only on these areas
  - Modularize and provide isolation among subsystems that have conflicting interests
- Helps you to go where you want

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Summary (1/3)

- XML Web Services are here today
  - Used for cost-efficient integration of enterprise and key partners
- Businesses want to use XML Web Services to support more complex cross-organizational scenarios
  - Requires additional standards-based capabilities in security, reliable messaging, discovery
- This architecture will be supported by the Windows .NET Framework and throughout the Windows platform
  - Aimed at building Web Services for intra- and inter- network environments

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Summary (2/3)

- Microsoft Today
  - Extending the baseline specifications with core XML Web Service specifications
  - Using VS.NET to easily create XML Web Services
  - Using Windows AD & Kerberos for enterprise federation
  - Using Passport - public Internet authentication at scale
- Moving forward on the WS-Security Roadmap
  - Windows "TrustBridge"
  - .NET Passport
- Evangelizing the WS-* family of specifications
- Use Web Services Enhancements 1.0 now
  - Enhances VS.NET and the Windows .NET Framework

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Summary (3/3)

- Learn more about Web Services at:
  http://msdn.microsoft.com/webservices
- Read about case studies at:
  http://www.microsoft.com/casestudies
- Search for each specification by name at:
  http://msdn.microsoft.com
- Join WS-I
  - Influence interoperability
    http://www.ws-i.org

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