

# The Future of Web Services

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## Agenda

- Introduction
- Specifications Roadmap
- Conclusions
- Summary

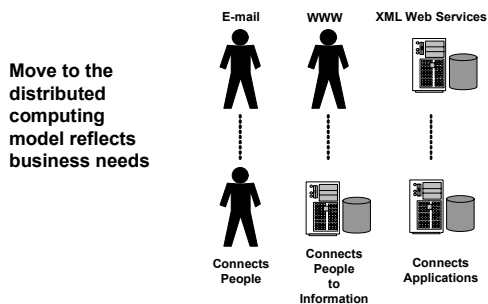
## XML Web Services – Perspective

- 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

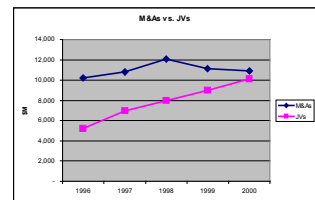
- XML Web Services are here today
  - Used for cost-effective integration of enterprise and key partners
- Businesses want to use XML Web Services to support more complex intra- and inter-organizational scenarios
  - So we are extending XML Web Services with a series of additional Web Services specifications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

## Move to Distributed Computing

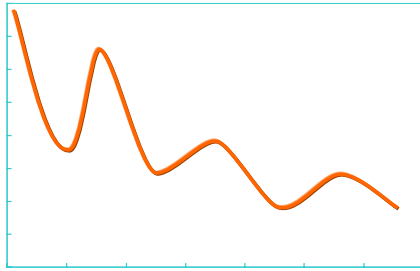


## Distributed Business Requires Distributed Computing

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

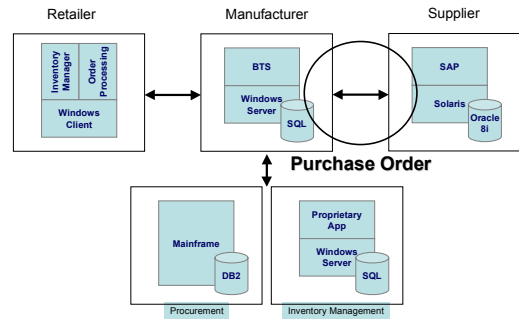


## Impact Of Increased Competition *Average lifetime in S&P 500*



Source: Dick Foster, "Creative Destruction"

## Inter-organization XML Web Services



## 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>



- 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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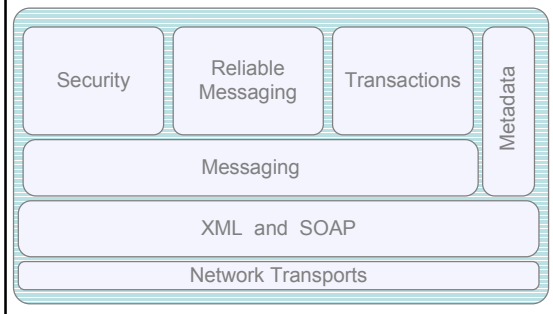
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## Foundation Protocols

*"Secure, reliable, transacted messages"*



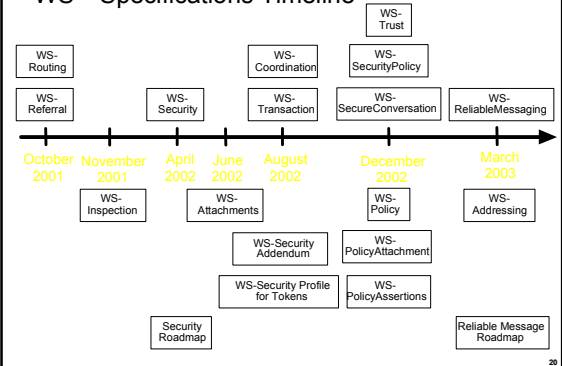
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## WS-\* Specifications Roadmap

- 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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## 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

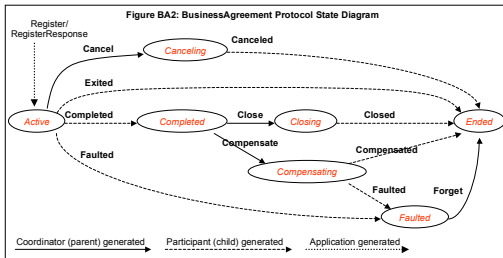
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## WS-Transaction: Criteria to use Part II protocols versus Part I protocols

- 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

## 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

## 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 1.0. is assumed but URI is identifier
  - They may be used by both the Web Service or by the client

## 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 envelope <Header> element from the specified Envelope element
  - RoleURIForHeaderBlock (node) - returns the SOAP role URI for the specified header block.

## 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 descendants and their attributes

## 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 patterns
- 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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