Advanced Enterprise and Federation Application Integration with MDA, SOA and WS

MDA, SOA, and Web Services: Delivering the Integrated Enterprise
Orlando, Florida
March 21-24, 2004
Copyright and other Legal Stuff

• The contents contained herein may be copied for internal use only, and must be accompanied with the copyright.
• Integrated, Interoperable and Collaborative Systems Architecture and Engineering
• Global and Local Perspectives
• “Business” and Technology Unification
• Integrated, Interoperable and Collaborative Systems Architecture and Engineering
• Networks of Systems / Systems of Networks including software, enterprises, networks of enterprises, and “open” / global systems
• The Enterprise is the System: Agent, Component/Composite, Knowledge Domain / Application
• Embed MDA, SOA, and WS

• Member IEEE and OMG
Introduction and Background

MDA, SOA, and Web Services:
Delivering the Integrated Enterprise
Orlando, Florida
March 21-24, 2004
Positioning of Tutorial in the Workshop

• Integrates information presented the previous day with an holistic systems approach grounded in General Systems / System Theory and the “Modeling Discipline”

• Presents a “global” picture where following presentations will focus in on specific parts
Perspective and Focal Points

• **Primary Perspective: Systems Architecture and Engineering**
  – in the General Systems / Systems Theoretic Sense
  – With the “Modeling Discipline”

• **Architecture and Engineering Focal Points for this tutorial presentation:**
  – Enterprise Systems (Enterprises as Systems / Agents / Components / Knowledge Domains / “Applications”
  – Software Systems (Software Systems as Systems / Agents / Components / Knowledge Domains / “Applications”
  – Model Driven (and Cognition / Knowledge based) Systems
  – Service Oriented Systems
  – Web Services implementation of Model Driven (and Cognition/Knowledge based) and Service Oriented System Designs
  – (Inter-) Enterprise Application Integration (and Interoperability and Collaboration)
Perspective and Focal Points

Enterprise Architecture  X  Model Driven Architecture  X  
Service Oriented Architecture  X  Web Services

The IT system is the platform, offering a set of IT services, for the business made up of an integrated, interoperable and collaborative set of applications.

Goal: Architect and Engineer the enterprise in such a way that the IT system maximally enables the business.
Perspective and Focal Points
Enterprise Architecture X Model Driven Architecture X
Service Oriented Architecture X Web Services

A system, e.g.:
- A network of enterprises
- An enterprise
- Enterprise organization (e.g. division, department, etc.)
- Enterprise Line-of-Business
- Enterprise Business Process
- Software Application
- Etc.

Three principle types:
- Organizational Component
- Process Component
- Resource Component

A single component may exhibit characteristics of any type

Sometimes the component is referred to as the service – this is what the component does, not what it is

Input

Service Requester / Service Provider / Service Broker / Service Registry

System Component / Application / Subsystem

Output (Offered as a Service)
Approach

Tutorial will take an approach that unifies a number of domains into a unified approach to systems

- General Systems Theory / Systems Theory
  - Emergence
  - Static and Dynamic Systems
  - Stationarity
  - Stability
  - Evolution
  - Learning
  - Cognition / Intelligence

- The “Modeling Discipline”
  - The Modeling Discipline Trichotomy
  - Modeling Systems,
  - Model Systems,
  - Modeled Systems
  - Meta
Shifts in Paradigms

- MDA, SOA, WS
  - Move from software component-based development to model-based development
  - Component management, service management -> model management
Subject Areas are not equivalent but do have overlapping concerns.

Enterprise architecture has governance over model driven architecture and service oriented architecture within an enterprise.
What is Meant by “Application”
“Application Integration”

- Traditionally, an “application” refers to an large grained software system that is architected independent of business processes (e.g. 3rd party COTS products)
- Tradition is changing in that
  - virtual applications (within and between enterprises) may be a priori defined, specified and “instantiated” by business processes
  - There is a set of applications that do this
  - the virtual application may arise dynamically through negotiation

- The set of traditional applications, evaluated and selected for, within an enterprise must be integrated in such a way as to enable interoperability and collaboration among the members of the set within the parameters of a (meta) process
- The integration should be done in a way that
  - This is done in such as way so as to optimize performance, efficiency, and maximize value
Enterprise ("Application") Systems

- 10s of 1000s to evaluate, select and integrate
- CRM, ERP
- Analytical: Statistics, Mining, Reporting,
- (Business) Process, (Business) Rules, (Business) Activity, Workflow
- Security
- Warehouses
- Rules
- Performance and Capacity / Continuity
- Etc. Etc.
Outline

• Introduction to the Integrated, Interoperable and Collaborative Systems: Architecture and Engineering Approach (IICSAE™)
• Fitting IICSAE and MDA Together
• Relationships Between MDA, SOA, and WS
• Enterprise Application Integration Examples with MDA, SOA, and WS
  – Build Environments
  – Unified and Converged Communications
  – Security and Privacy
Advanced Conceptualization of Enterprise and Inter-Enterprise Integration, Interoperability and Collaboration

and

Systems and Model based Unification of EA, MDA, SOA, and Web Services to Achieve Integration, Interoperability and Collaboration
Foundation Elements

- All elements expressed in (semi-)formal (meta-) languages
- As concrete components – the meta is realized and implemented
- As intelligent agents – the meta is used in reasoning

Integration, Interoperability and Collaboration
Best Practices and Standards / Policies and Procedures
Algorithms and Computation
Ontology and Semiotics

Core Elements:
- Each element may be considered to be a knowledge domain
- Each element may be considered to be a system
- Each element may be considered to be a component
- Each element may be considered to be a viewpoint
Enterprise “component” subsystems
E.g. Applications / Services

Enterprise “component” systems
E.g. Process systems / Services

Enterprise Systems

“Open” Global Systems

Networked Enterprise Systems

- Downward Causation -
Higher level systems constrain Lower level systems

- Emergence –
Lower level systems “unify” to Create new features at a higher Systems level

A system in the General Systems Theory sense

Emergent Systems Cone™ □ □ Universal IIC Cone™

The “Glue”
Advanced Enterprise and Federation Application Integration with MDA, SOA and WS

Integration, Interoperability and Collaboration System-Component/Composite-Platform

Collaboration
System-Component/Composite-Platform
- Offering Collaboration Services

Interoperability
System-Component/Composite-Platform
- Offering Interoperability Services

Integration
System-Component/Composite-Platform
- Offering Integration Services

Foundations
Core

Has an architecture
May be service-oriented

Has a set of roles

Each exists at all emergence levels
Each modeled, meta-modeled
PIMs, PSMs, PIMs
MDA

Each has an architecture
May be service-oriented
Each may be implemented
with WS technology
Each has a set of roles

Modeled,
Meta-modeled
MDA
Advanced Enterprise and Federation Application Integration with MDA, SOA and WS

<X> System

<X> System, a system in the General Systems Theory and systems-theoretic sense, emerges from Core and Foundations subsystems

Feedback

Models

Foundations

Core

Foundations

Core

Foundations

Core

Those subsystems of Core and Foundation Systems that are concerned with <X>

Process and Workflow / Behavior and Action

Cognition / Intelligence

Knowledge, Information, and Data

Technology

Communication(s)

Security and Privacy

Roles

Economics

Law

Quality

General Systems / System Theory and the “Modeling Discipline”

Integration, Interoperability and Collaboration

Best Practices and Standards / Policies and Procedures

Algorithms and Computation

Ontology and Semiotics
<X1> System, a system in the General Systems Theory and systems-theoretic sense, emerges from Core and Foundations subsystems.

<X2> System, a system in the General Systems Theory and systems-theoretic sense, emerges from Core and Foundations subsystems.
Advanced Enterprise and Federation

**<X> System Services**

- **<X> System Engine**
  - "a software service, or 'engine', that provides the run time execution environment for a <X> System service instance"
  - E.g. - real-time
  - monitoring
  - analysis, prediction, optimization
  - self defining
  - dynamic configuration
  - self managing, self-diagnosing, self-adapting etc.

- **<X> Tool / System**
  - Has a role
  - Goals and Objectives are attributed to it

- **<X> System (including humans)**
  - Has a role
  - Goals and Objectives are attributed to it

**Other <X> System Engines**
(e.g. in a Federation)

**<X> Interoperability**
"the ability of two or more <X> engines to communicate and interoperate in order to coordinate and execute <X> service instances across those engines"

**Product / Service Definition / Specification**
(architects and engineers)

**May be remote**

**<X> Systems**

**<X> System APIs and Data Interchange**

**<X> System Operational Administration and Monitoring Tools**

**Foundation (sub) Systems**

**Core (sub) Systems**

**Stakeholder Systems**
Service Requester / Service Provider

May be remote
M: a model
SM: a modeling system
Sw: a modeled system
M: a set of internal model states (representations) as a function of context
W: a set of "world" states as a function of context
A: actions (behavior) of the "world"
F: modeling function
R: representation function (e.g. perception, measurement)
C: context

External, shared models expressed in a set of (formal) languages with tool support.

Ontologies / Subject matter models
Meta models
PIMs
PSMs
PMs
Transformation Models
Some Key Benefits of Model Driven Architecture

– Improved productivity for architects, designers, developers and administrators
– Decreased cost of development and management
– Enhanced integration, interoperability and collaboration
– Business models and technologies evolve independently at their own rate
Some Semantics

<table>
<thead>
<tr>
<th>What it isn’t</th>
<th>What it is</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process, Methodology</td>
<td>A general approach, strategies, to architect and engineer (information) systems</td>
</tr>
<tr>
<td>Technology</td>
<td>“An approach to IT system specification that separates the specification of functionality from the specification of the implementation of that functionality on a specific technology platform” (Draft MDA Guide: <a href="http://www.omg.org/docs/ab/03-01-03">www.omg.org/docs/ab/03-01-03</a>)</td>
</tr>
<tr>
<td></td>
<td>An emerging knowledge domain, based in the “modeling discipline”, whose universe of discourse is the engineering of information systems through models and modeling. (Mathet Consulting)</td>
</tr>
</tbody>
</table>
Some Semantics

“Model Driven Architecture”

Software System

“Model Driven Architecture”

Enterprise Systems,
Networked Enterprises Systems,
Global Systems

“Model Driven Architecture”

IT System

“Model Driven Architecture”

“Model Driven (IT System) Architecture”

The Technology Platform for the Business of the
Enterprise Systems, Networked Enterprises Systems,
Global Systems

May be distributed at the
• Enterprise,
• Networked Enterprises,
• Internet Level

Sense 1: An architecture for MDA Tool Sets (a “platform” for creating system architectures)

Sense 2: An architecture for OMG standards

Sense 3: An (IT) system architecture created using the MDA approach and MDA tool sets
OMG Enterprise

OASIS
W3C
Etc.

Collaboration

MDA Standards

Enterprises

MDA Vendor Enterprises

Web Services Tool Vendors

Collaboration

WS Standards

MDA sense 1

MDA sense 2
meta-models for example

MDA sense 3

Enterprise Model Driven,
Service Oriented Architecture
implemented with Web
Services

COTS Products
Platform Independent Models
Platform Specific Models

• Platform: “A set of subsystems / technologies that provide a coherent set of functionality through interfaces and specified usage patterns that any subsystem that depends on the platform can use without concern for the details of how the functionality provided by the platform is implemented” (David Frankel)

• Platform Independent Model (PIM)
  – A model: a representation / specification of some part of a current or future world
  – As a meta-model (MOF)
  – As a usage model

• Platform Specific Model (PSM)
  – A model
  – Specific to a platform

• The use of the MDA approach explicitly architects the meta in systems being developed
  – Ensures interoperability
A Model Classification

In general, all can be
- PIMS
- PSMs
Equating Models as a Class and Modeling System

Model in Context:
- Goal
- Language
- Viewpoint
- Requirements
- Vertical Domain
- Community of Practice
- Business Domain
- Development Stage
- Problem Domain
- Etc.

A UML Class: e.g. an algebra where $C = \langle AT, f_i : i = I \rangle$
Where $C$ – class, $AT$ – set of Attributes (each attribute has a set of values),
$f_i$ – family of operations.

State-space is a subset of the cross product of the attribute domain sets:
$SS \subseteq A^n$, $A^n = a_1 \times a_2 \times \ldots \times A_n$, $a_i \subseteq A$ (any of which may be context dependent)

Note: This representation assumes that normal sub-setting relation with parent and child classes. If the sub-setting relation is disjoint, for example, the class is better represented with partial functions.
THE MDA Pattern

A set of models that are independent of a class of platforms in the context of the MDA pattern.

May be associated with a view and viewpoint and role.

Independence: contains no platform (specific) information.

2 Senses: Independent of a class of platform → independent of all platforms in a class.
Independent of all classes of platforms.

A model that serves as data input (a source) to a transformation system—an abstract model whose attributes do not violate any assumption associated with any algorithm is the set of algorithms that make up a platform-specific transformation system.

Platform Independent Model

May have metamodel.

A set of algorithms for a specific transformation associated with a specific platform. There is a set of transformation algorithms associated with the set of platforms.

Transformation System for a class of platform

Platform Model

May have metamodel.

There is a distinction to be made between Independent / Dependent and specific and non-specific.

PIM and PSM are not symmetric.
PIM refers to the class.
PSM refers to one platform in the class.

Platform Specific Model

May have metamodel.

Contains information specific to a (one) platform thus is specific to the class the platform belong to.
THE MDA Pattern

A "Business" Domain Model
An "Information" Model
A "Business" Ontology - Subject Matter Models

PIM

Transformation
Engine Type 1

PM-1
- A Class of Platform Models -

Platform Specific Model
Relative to PM -1
Platform Independent Model
Relative to PM -2

Platform Specific Model
(PSM)

Transformation
Engine Type 2

PM - 2
- A Class of Platform Models -

Platform model stacking →
platform system stacking

Refinement Relationship

A Platform Specific Model
may be a model of a Platform

PMs may be PSMs

Specific to one PM of the class

A set of subsystems /
technologies that provide a
coherent set of functionality
through interfaces and
specified usage patterns that
any subsystem that depends
on the platform can use without
concern for the details of how
the functionality provided by
this platform is implemented.
THE MDA Pattern

Composable Services and Processes
OMG Enterprise Distributed Object Computing (EDOC)

Service Flow
Web Services Business Process Execution Language (WSBPEL)

Service Publication / Discovery
Universal Description, Discovery and Integration (UDDI)

Service Description
Web Services Description Language (WSDL)
XML Messaging
Simple Object Access Protocol (SOAP)

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A Business

IT System Platforms

A Platform Specific Model at one level may be a (class of) Platform Independent Model at a lower level

A Platform Specific Model at one level offers services to platforms at a higher level

3 - Enterprise Service

Application
HTTP, SMTP, SIP...

6 - Presentation

5 - Session

4 - Transport
TCP, UDP

3 - IP

Internet

2 - Datalink

1 - Physical

"User" System Model
- model specific to the platform
- is dependent on the services the platform offers

(pClass of Platform)

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Advanced Enterprise and Federation
Application Integration with
MDA, SOA and WS

Ontology and Semiotics
Algorithms and Computation
Best Practices and Standards / Policies and Procedures
Integration, Interoperability and Collaboration

Process and Workflow / Behavior and Action
Intelligence
Knowledge, Information and Data
Technology
Communications
Security and Privacy
Quality
Economics
Law
Roles

IT System Platforms

A Business
8 - Enterprise Service
7 - Application
HTTP, SMTP, SIP...

Traditional Middleware
6 - Presentation

5 - Session
4-1

"User" System Model
- model specific to the platform
- is dependent on the services the platform offers

Transformation System
- OMG Query View Transformation
Contains sets of algorithms that take models at each level as data input and produce models as data output

Domain Upper Ontology
Application Ontology
"Business Platform" Domain Models
Information
Computation

Business Domain Models

Refinement

Application PIM

PIM

(PIM Independent Model)
Advanced Enterprise and Federation Application Integration with MDA, SOA and WS

Modified from “OMG’s MDA-An Architecture for Modeling, Enabling Model-Driven Integration” Desmond DSousa, Kinetium
Contracts in Context

• Note that there are no explicit model dependencies. If a set of attributes are context dependent, and the context changes, the contract will change (e.g. new negotiation criteria)

• This helps to protect both service requester and service provider when the meaning of their models change as a function of context.
Model and Model Fragments are Created in an Instance of a **Context**

A representation / specification of some part of:
- The current world (of interest)
- A future world (of interest)

- **Business Context**
- **Language Context**
- **Technical Domain Context** (Messaging, Transaction etc.)
- **Development Stage Context** (Analysis, Design)
- **View Domain Context**
- **Business Domain Context** (Marketing, Engineering, etc.)
Advanced Enterprise and Federation
Application Integration with MDA, SOA and WS

System <X> Package
("Business" Model)

Subsystem A
System Package Platform Independent Model
Technology Set 1
(e.g. J2EE)
Technology Set 2
(e.g. WS)

Subsystem B
Technology Set 1
(e.g. new J2EE version)
Technology Set 1
(e.g. J2EE)
Technology Set 2
(e.g. any new technology)

Design Reuse

Models
Managed in a
Repository / Registry

Architecture
and Engineering

Software Redundancy:
two -
Different Implementations of
the same specification,
- Different versions in normal SDL.
- Different versions of the technology

Web Services
Agents

Factory Floor
Custom coding
COTS integration

Hardware
redundancy

Deploy and Measure

Test Environment

Deployment Model
Packages will show
Nodes and
Hardware / Software
Redundancy

Two Different Sets of
Operations / Methods
X two
different set of
technologies

Model / Design
Validation and
Verification

Software
Validation and
Verification

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Service Oriented Architecture and Web Services
Assumptions

• “Introduction to Web Services and Service-Oriented Architecture (Eric Newcomer)
• “Web Services and SOA in the Enterprise” (Cory Casanave)
Semantics

• “Service”
  – Sense 1: A system / component / agent that does something, a set of actions, for something else
  – Sense 2: The (set of) action(s) of a system / component / agent on the web (the output of a system / component / agent)
Semantics

• “Web”: port 80 / HTTP
• “Internet”: all ports, all transport protocols
  – A logical network
  – independent of the underlying physical and data link communications protocols and technologies (platforms)
  – Provides services and supports all transport protocols regardless of the type of communications (voice, data, multimedia, etc.) and modes (e.g. e-mail, web, facsimile, phone)

• “Web Service”
  – Sense 1: A system / component / agent on the web that offers services
  – Sense 2: The (set of) action(s) of a system / component / agent on the web (the output of a system / component / agent)

• “Internet Service”
  – Sense 1: A system / component / agent on the Internet that offers services
  – Sense 2: The (set of) action(s) of a system / component / agent on the Internet (the output of a system / component / agent)
Standards

BPEL4WS (Business Process Execution Language for Web Services) 1.1 [IBM, BEA, Microsoft: Specification] à
WSBPEL (Web Services Business Process Execution Language [OASIS: BEA, Hewlett-Packard, IBM, IONA, Microsoft, NEC, Oracle, SAP, SeeBeyond, Sun, Tibco, webMethods]
Common Base Event [IBM: Specification]
DNS Endpoint Discovery (DNS-EPD) [IETF: Committee Draft]
JSR 172 – J2ME Web Services [JCP: Specification]
JSR109 – (Web Services for J2EE) 0.3 [JCP: Public Draft]
SOAP (Simple Object Access Protocol) 1.2 [W3C: Specification]
UDDI (Universal Description, Discovery and Integration) 3.0 [OASIS: Specification]
WS-Addressing [IBM, BEA, Microsoft: Specification]
WS-Atomic Transactions [IBM, BEA, Microsoft: Specification]
WS-Attachments [IETF, IBM and Microsoft: Specification]
WS-BusinessActivity [IBM, BEA, Microsoft: Specification]
WS-Coordination [IBM, BEA, Microsoft: Specification]
WS-Experience Language (WSXLL) 2.0 [IBM: Specification]
WS-Federation Language [IBM, BEA, Microsoft, RSA, Verisign: Specification]
WS-Federation: Active Requestor Profile [IBM, BEA, Microsoft, RSA, Verisign: Specification]
WS-Federation: Passive Requestor Profile [IBM, BEA, Microsoft, RSA, Verisign: Specification]
WS-I Attachments Profile 1.0 [WS-I: Working Draft]
WS-I Basic Profile 1.0 [WS-I: Specification]
WS-I Basic Profile 1.1 [WS-I: Working Draft]
WS-I Simple SOAP Binding Profile 1.0 [WS-I: Working Draft]
WS-Inspection 1.0 [IBM, Microsoft: Specification]
WS-Manageability 1.0 [IBM, Talking Blocks, Computer Associates: Specification]
Standards – cont.

WS-PolicyAssertions [IBM, BEA, Microsoft, SAP AG: Specification]
WS-Provisioning [IBM: Specification]
WS-ReliableMessaging [IBM, BEA, Microsoft, TIBCO: Specification]
WS-Security 1.0 [OASIS: Open Standard]
WS-Security Addendum [IBM, Microsoft, Verisign: Supplemental Information]
WS-Security Kerberos Binding [IBM, Microsoft: Specification]
WS-SecurityPolicy [IBM, Microsoft, RSA, Verisign: Specification]
WS-Transactions [IBM, BEA, Microsoft: Specification]
WSDL (Web Services Description Language) 1.1 [W3C (IBM and Microsoft: note]
WSDL (Web Services Description Language) 1.2 [W3C (IBM and Microsoft: working draft]
WSRP (Web Services for Remote Portals) 1.0 [OASIS: Open Standard]
Vendors and Products (may be incomplete)

**Web Services Suites**

- Actional Corporation (Actional SOA Command and Control)
- Magic Software Enterprises (iBOLT Integration Suite)
- Novell (Novell exteNd Enterprise / Professional Suite)
- ReadiMinds Systems and Services Pte Ltd. (ReadiMinds WebServices Applications Suite – WSS)
- Sonic Software Corporation (Sonic ESB)
- Systinet Corporation (Systinet Product Suite)

**Web Services Desktop Integration**

- NetEdge Software, Inc. (Web Services Enabler)
- RatchetSoft, LLC (Ratcht – X)

**Web Services Development Tools**

- Above All Software, Inc. (Above All Studio)
- Altova GmbH (xmlspy)
- Ascential Software Corporation (Enterprise Integration Suite)
- Attachmate Corporation (myEXTRA! Smart Connectors)
- BEA Systems, Inc. (BEA WebLogic Workshop)
- ClientSoft, Inc. (ServiceBuilder)
- Commerce One Operations, Inc. (Conductor Composite Manager)
- Compuware Corporation (UNIFACE)
- FusionWare Corporation (FusionWare Integration Server)
- GT Software, Inc. (Ivory Web Services)
- IBM (Eclipse, Websphere)
- InterSystems Corporation (Ensemble)
- IONA Technologies (Artix)
- iWay Software (iWay Web Services)
- Panthere Corporation (Shared Data Services Suite)
- Rogue Wave Software, Inc. (Lightweight Enterprise Integration Framework – LEIF)
- Seagull Software Systems, Inc. (Trnasidion and LegaSuite)
- SeeBeyond, Technology Corporation (The SeeBeyond Integrated Composite Application Network – ICAN – Suite)
- Strikelron, Inc.
- Swingtide, Inc.
- TIBCO Software, Inc. (TIBCO Business Works)
- Verity, Inc. (Ultraceek)
- Vultus, Inc. (Webface Solution Suite)
- WDI (Redbern)
- WebCollage, Inc. (WebCollage Syndicator)
- webMethods Inc. (webMethods Glue)
Vendors and Products (may be incomplete – cont.)

Web Services Orchestration

ActiveBPEL (ActiveBPEL)
Active Endpoints, Inc. (ActiveWebFlow)
Collaza, Inc. (Collaxa BPEL Server – acquired by Oracle Corporation)
Commerce One Operations, Inc. (Conductor Composite Manager)
Corticon Technologies, Inc. (Corticon Decision Management Platform)
Dralasoft, Inc. (Dralasoft Workflow)
IBM Corporation (WebSphere Business Integration Modeler)
Metastorm, Inc. (e-Work)
Novell, Inc. (Novell exteNd Enterprise Suite)
OpenStorm Software, Inc. (Service Orchestrator)
Oracle Corporation (Oracle BPEL Process Manager – formerly the Collaxa BPEL Server)
ReadiMinds Systems and Services Pte Ltd. (ReadiMinds WebServices Applications Suite – WSS)
SeeBeyond, Technology Corporation (elnsightBusiness Process Manager)
Sonic Software Corporation (Sonic orchestration Server)
WebV2, Inc. (WebV2 ProcessCoupler)

Web Services Security

BEA Systems, Inc. (BEA Weblogic Enterprise Security)
Commerce One Operations, Inc. (Conductor Composite Manager)
DataPower Technology, Inc. (XML Security Gateway)
Digital Evolution, Inc. (DE Management Server)
Forum Systems, Inc. (XML Sentient)
Layer 7 Technologies, Inc. (SecureSpan)
Netegrity, Inc. (TransactionMinder)
Reactivity (Reactivity XML Firewall)
RSA Security, Inc. (RSA BSAFE Secure – WS)
Sarvega, Inc. (XML Guardian Security Products)
Teros, Inc. (Teros Web Services Security Gateway)
Vordel Limited (VordelSecure and Vordel SOAPbox)
Actional Corporation (XML Message Server) – formerly Westbridge XML Message Server

Web Services Testing

iTKO Corporation (LISA)
Parasoft Corporation (SOAPtest)
Mindreef, Inc. (SOAPscope)
Segue Software, Inc. (SilkPerformer Component Test Edition)

XML Data Routers, Message Routers, and Adapters

Appligent, Inc. (APConductor)
BEA Systems, Inc. (BEA Weblogic Integration)
Commerce One Operations, Inc. (Conductor Composite Manager)
Kanemea, Inc. (Web Messaging Platform)
NEON Systems, Inc. (Shadow z/Services)
Novell, Inc. (Novell exteNd Enterprise Suite)
Sarvega, Inc. (XML Context Router)
SeeBeyond, Technology Corporation (eWay Intelligent Adaptors)
Actional Corporation (XML Message Server) – formerly the Westbridge Message Server

XML Accelerators

DataPower Technology, Inc. (XML Accelerator)
Sarvega, Inc. (XML Speedway Accelerator)
Tarari, Inc. (RAX Content Processor and XML Content Processor)
Application of Advanced Conceptualization of EA, MDA, SOA, and Web Services and their Unification
Application of Advanced Conceptualization of EA, MDA, SOA, and Web Services and their Unification

Enterprise Systems
Enterprise Integration, Interoperability and Collaboration with EA, MDA, SOA and Web Services
Change as a Fundamental Concern

• A fundamental, if not the fundamental, concern in an enterprise and any enterprise specification is change / transformation.

• An enterprise is a system in the General Systems Theory sense.

• Types of change / transformation include:
  – Reactive Change / Proactive Change
  – Planned Change: Strategic / Tactical / Operational
  – Reflexive change (Autonomic responses)
  – Responsive Change - A priori determined change
  – Responsive Change - Immediate change as a result of processing
  – Proactive Change
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Enterprise Problem Domain - A Portfolio of Problems -

Enterprise Sub-problem Domain 1  →  Enterprise Sub-solution Domain 1
Enterprise Sub-problem Domain 2  →  Enterprise Sub-solution Domain 2
Enterprise Sub-problem Domain 3  →  Enterprise Sub-solution Domain 3
Enterprise Sub-problem Domain 4  →  Enterprise Sub-solution Domain 4
Enterprise Sub-problem Domain ..  →  Enterprise Sub-solution Domain..
Enterprise Sub-problem Domain ..  →  Enterprise Sub-solution Domain..
Enterprise Sub-problem Domain n  →  Enterprise Sub-solution Domain n
Enterprise Sub-problem Domain ..  →  Enterprise Sub-solution Domain..
Enterprise Sub-problem Domain N  →  Enterprise Sub-solution Domain N

Enterprise Solution Domain - A Portfolio of (Candidate) Solutions – Products and Services

Feedback Loop – Changes the Problem Domain

Portfolios of Programs / Projects
Advantages of Cross-Context Mapping / Merging

- Ensures consistency within an enterprise, federation
- Allows Validation and Verification at the different levels abstraction – information at lower levels do not confound evaluation at higher levels
- Allows new products / projects to be properly scoped and defined
- Allows the enterprise / federation, as a system to be emergent and adaptable
- Allows for the evaluation of discrepancies in model meaning between contexts
- Etc.
The Enterprise
- A System / Component / Knowledge Domain / Service / “Application”

A Process / System

<table>
<thead>
<tr>
<th>Business Change / Drivers / Problems</th>
<th>Analysis and Design</th>
<th>Build Environment</th>
<th>Execution Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Analysis</td>
<td>Requirements</td>
<td>Architecture and Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design</td>
<td>Factory Floor</td>
</tr>
<tr>
<td>Goals for Integration Interoperability Collaboration</td>
<td>Analysis of Integration Interoperability Collaboration</td>
<td>Design for Integration Interoperability Collaboration</td>
<td>Construct for Integration Interoperability Collaboration Test for Integration Interoperability Collaboration Integrate for Interoperability Collaboration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implementation</td>
<td>Testing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance</td>
<td>Retirement</td>
</tr>
</tbody>
</table>

There is a (sub) system associated with each step.
Each (sub) system has its own set of processes – operating concurrently.
These systems are loosely coupled, highly coherent.
Each (sub) system has a role.
Each sub system provides services to other systems with multiple feed-forward and feedback loops and control points.
All (sub) systems are operational systems – including those in the Build Environment.

The Enterprise System / “Application” is continuously evolving through, in part, continuous application integration.

The output of the Build Environment may be an Integration, Interoperability and Collaboration System (e.g. an Enterprise Service Bus)
Build Environments
(Upper Level Transformation Systems™)
Integration, Interoperability and Collaboration with EA, MDA, SOA and WS
The Upper Level Transformation System

Primary System Components (Subsystems)

- Goal System (Mission / Vision, Goals and Objectives)
- Requirements System
- Architecture and Engineering System
- Factory (Floor) System (Custom and COTS Construction)
- Project / Program / Portfolio Systems
- Risk System
- Change and Configuration System
- Research and Development System

- Memory System (Experience Factory)
- Reasoning / Inference System (Induction and Deduction)
- Learning System
The Upper Level Transformation System
(Supporting System Components)

- Ontology / Semiotics
- Algorithms and Computation
- Best Practices and Standards / Policies and Procedures
- Integration, Interoperability and Collaboration
- Process and Workflow / Behavior and Action
- Intelligence/Cognition
- KID
- Technology
- Communications
- Security and Privacy
- Quality Law
- Economics (Value Systems, Financial Systems, etc.)
- Roles
Transformation (Sub) System
Self-Adapting / Evolving

Upper-Level Transformation Subsystem
- Goals
- Requirements
- Architecture / Engineering
- Factory Floor
- Project
- Program
- Portfolio
- Risk
- Change
- Configuration

Lower-Level Transformation Subsystem
The Transformation Engine - Software / Hardware Runtime Environment

Quality System
- QA
- QC
- VV
- Testing
- Continuous Process Improvement
- Total Quality Management
- Six-Sigma
- ISO 9000
- Capability Maturity Models
- Etc.
Advanced Enterprise and Federation Application Integration with MDA, SOA and WS

Networked enterprises

Enterprise-to-Enterprise contracts

Enterprise

Architecture and Engineering System

Factory Floor - Custom Development, COTS Integration

Upper Level Transformation System

Deployed Products and Services
  e.g. Value Systems
  Financial Systems
  Transformation Systems
  Line-of-business Systems
  Web Services Systems
  Middleware Systems
  Process and Workflow Systems
  Content / Document / Records Systems
  Business Rules Systems
  Lower Level Transformation Systems
  Etc.

Lower Level Transformation System For “Build-time”

The Enterprise

Lower Level Transformation System For “Run-time”

All systems are operational systems
Advanced Enterprise and Federation Application Integration with MDA, SOA and WS
Advanced Enterprise and Federation Application Integration with MDA, SOA and WS

General Systems Mechanisms
Automation, verification and enforcement of architectural and engineering best practices / standards and policies and procedures
Mechanisms for Chief Architects to automate and extend their influence and enable automatic control of a specific architectural style (e.g. SOA) across projects, programs, portfolios, and products etc.

Architecture and Engineering Mechanisms
Mechanisms for plug-in support of Web Services, J2EE, .Net, application servers
Mechanisms for automation of custom UML profiles and architectural styles
Mechanisms to enable the Factory Motif
Mechanisms for meta-modeling
Mechanisms for plug-in re-use, dynamic loading etc.

Core Architecture and Engineering Mechanisms
Mechanisms for Process and Workflow / Rules
Mechanisms for Knowledge Integration, Interoperability and Collaboration

Foundation Architecture and Engineering Mechanisms
Mechanisms for Quality
Mechanisms for Legal
Mechanisms for Roles
Mechanisms for Economic

End-to-End Lifecycle Support
Mechanisms for PIM, PSM, and PM support
Mechanisms for development agents
Mechanisms for reverse engineering
Mechanisms for ad-hoc design and architectural divergence prevention
Mechanisms for global change propagation
Mechanisms for cross-product and project re-use
Mechanisms for versioning and release management
Mechanisms for execution environment feedback from services etc.

Mechanisms to Support Business and Upper Level Transformation Systems
Mechanisms to support contracts
Mechanisms for business partitioning, responsibilities, collaborations, roles
Mechanisms for automatic, visual recording, playback and documentation of business process flow, state transition tables and conditional transition paths
Mechanisms for business rules
Mechanisms for business model verification etc.

Enterprise run-time System
All products and services are integrated and function as a whole.
The specific configuration is determined by integration, interoperability and collaboration
Architectures created by the Architecture and Engineering System.

Deployed Products and Services
Business Process Systems
(Stakeholder Service Systems)
Organizational Structures
Custom LOB Products / Services
LOB COTS Products / Services
Workflow COTS Products / Services
Security COTS Products / Services
Data COTS Products / Services
Communications COTS Products / Services
Infrastructure COTS Products / Services
Service Management Systems etc.

Model Driven Architecture Tool Set
Model Driven Architecture Tool Set

Architecture and Engineering System
Architects and Engineers

Factory Floor (Construction and Integration System)
Developers, Programmers, Integrators

COTS Products

Construction / Integration Feedback

Portfolio / Program / Project Systems

Goals System
Requirements System
C & C System
Risk System
R & D System
Components / Systems / Processes and Value

Arbitrary System
(e.g. Enterprise, IT, A/E, Value, etc.)

Each component / system has a total value as a function of different value dimensions, such as strategic, tactical, operational, architectural; shareholder, customer, user; tangible, intangible; financial, resource, knowledge; etc.

Value, an extrinsic attribute, is a function of perception, the intrinsic attributes of the component / system, context, interaction / collaboration, priorities, goals, etc.

The actual component / system “fits” the “socket” to some degree – bases for component / system evaluation and selection.

To properly evaluate the difference between expected and actual requires measures and metrics.

An system / component in a role offers a set of goods / services for use in a collaboration

When an entity is in a role, the services associated with that role are “exposed” to other entities

Knowledge of the role provides information as to the services offered (expected behavior)
A goal can generally be expressed in terms of a system state; either to maintain state or to change state.

A goal can be classified by THING, Viewpoint, Context, Purpose, Issue / Problem:

- State is a set of initial conditions.
- Has goal / objective.
- Has satisfied goal / objective.
- System State 1
- Transformation
- System State 2

Goals and objectives, needs and requirements are nested.

A goal, objective, need or requirement satisfied at a lower level, at least partially satisfies the associated goal at a higher level.
Advanced Enterprise and Federation Application Integration with MDA, SOA and WS

**Architecture Planning Horizon**

- Transitional Architecture
- Transitional Architecture
- Transitional Architecture
- Transitional Architecture
- Transitional Architecture
- Transitional Architecture
- Target Architecture

Enterprise Mission / Vision, Goals, Objectives, Strategies - Architecture Vision to Realize Them

**Strategic Planning Horizon: (Portfolio Systems)**

- Transitional Strategic Architecture
- Transitional Strategic Architecture
- Transitional Strategic Architecture
- Transitional Strategic Architecture
- Transitional Strategic Architecture
- Transitional Strategic Architecture
- Target Strategic Architecture

Reflects Enterprise Mission / Vision, Goals, Objectives, Strategies - High-level Needs and Requirements

**Tactical Planning Horizon: (Programs Systems)**

- Transitional Tactical Architecture
- Transitional Tactical Architecture
- Transitional Tactical Architecture
- Transitional Tactical Architecture
- Transitional Tactical Architecture
- Target Tactical Architecture

Reflects Enterprise Needs and Requirements for specific future enterprise components

**Operational Planning Horizon: (Project Systems)**

- Transitional Architecture (Engineering)
- Transitional Architecture (Engineering)
- Transitional Architecture (Engineering)
- Target Architecture (Engineering)

Requirements are “complete” for immediate implementation of a specific enterprise component.

Transitional architectures are blueprints for iterative and incremental “instantiation” of product or product component.

These are also architectures for changes to be made in a product or product component once deployed

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The Upper Level Transformation System
Mapping Vendor Products to
Enterprise Reference Architecture

• The reference architecture is a PIM – a “unification” of
  PIM from multiple knowledge domains for defining /
  specifying the business

• The set of applications when integrated must align with
  the PIM reference architecture.

• In architecture and engineering – the IIC of set of
  applications must be done in a way to align with the
  enterprise PIM

• Enterprises are emergent systems → the IIC must align
  and fulfill all called for functionality even if none of the
  individual components have a specific feature called for
  in the PIM

• The PIM takes into account emergence
Unified and Converged Communication(s) Systems
Integration, Interoperability and Collaboration with
EA, MDA, SOA and WS

Voice, Data, Graphics, Multimedia
Perspective and Focal Points

Enterprise Architecture X Model Driven Architecture X
Service Oriented Architecture X Web Services

Goal: Architect and Engineer the enterprise in such a way that the IT system maximally enables the business.

The IT system is the platform, offering a set of IT services, for the business made up of an integrated, interoperable and collaborative set of applications.
Perspective and Focal Points

Enterprise Architecture X Model Driven Architecture X
Service Oriented Architecture X Web Services

- Voice
- Data
- Graphics
- Multimedia

- Computers
- Handhelds
- Wireless phones
- Land-line phones

- E-mail
- Web
- Facsimile
- Voice
- Multimedia

Enterprise
Security and Privacy System

Foundations
Core

- Ontology / Semiotics
- Algorithms and Computation
- Best Practices and Standards / Policies and Procedures
- Integration, Interoperability and Collaboration
- Process and Workflow
- Intelligence
- Knowledge, Information, Data
- Technology
- Communications
- Quality
- Economics
- Law
- Roles

- Architecture and Engineering
- Management – Administration and Monitoring
- Service Requestors
- Other Security and Privacy Systems

- Network
- Application
- Information

- Layering / Tiering
- Events – Notification
- Real-time, Ubiquitous and Pervasive

- Security and Privacy Law and Legal Compliance
Additional Concerns

- Not just computers but devices of all kinds – phones (land-line, wireless, digital / analog) → containers for software components that function as in the services motif (requester, provider)
Public Switched Telephony Network (PSTN)
Uses circuit-switched technology

Communications Loop
Bidirectional communication
Bandwidth of a circuit-switched connection is 64 kbps - each call gets a 64 kbps link (more than is needed with today's technology)
Resulting communications link is maintained for the duration of the call
The communications link/resource cannot be employed by any other party until the call is terminated
Central exchanges and PBXs stay in the loop after the call is set up, released when the call is terminated
Signals may be digital or analog
QoS: jitter - ccc
QoS: delay -
Unified and Converged Communications

- Real-time, distributed, device-independent, multi-modal interactions / collaborations
- Converged Communications
  - Data, Voice, Multimedia $\rightarrow$ everything IP
- Unified Communications
  - E-mail, Web, Facsimile, Voice mail, Etc.
Unified and Converged Communications and Web Services

• Voice-enabled Web Services
  – A web service that allows “agents” to interact with the service via a telephone using speech or a telephone keypad
  – The web service communicates with the caller using pre-recorded audio or synthesized voice
  – The web service collects responses from the caller using speech recognition or touchtone recognition

• Why Voice-Enabled Web Services
  – Approximately 1.3 billion telephone users
  – Approximately 250 million computer users
Unified and Converged Communications and Web Services

- Invoking a VoiceXML application (web service) (for example)
  - Callers access a VoiceXML application by dialing a dedicated phone number
  - The phone carrier processes the incoming call and forwards the call to the VoiceXML gateway
  - The VoiceXML gateway accepts the incoming call, maps the phone number into a URL, and makes the http request to fetch the main VoiceXML document with its associated resources from a document server (application server or Web server)
  - Once available, the VoiceXML application starts interacting with the caller; using ASR or DTMG for understanding voice input and TTS or pre-recorded audio to respond to the caller
# VoIP Protocol Stacks

## Voice Over IP Protocol Stacks

**H.323 Protocol**

<table>
<thead>
<tr>
<th>Data</th>
<th>Control and Signaling</th>
<th>Audio / Video</th>
<th>Registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.120</td>
<td>H.225.0 Call Signaling</td>
<td>H.245</td>
<td>H.225.0 RAS</td>
</tr>
<tr>
<td></td>
<td>Conference Control</td>
<td>RTP / RTCP</td>
<td></td>
</tr>
</tbody>
</table>

| TCP | = | UDP |

**Session Initiation Protocol**

<table>
<thead>
<tr>
<th>Signaling</th>
<th>SIP</th>
<th>Transport and Quality</th>
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<tbody>
<tr>
<td>H.323</td>
<td>SAP / SDP</td>
<td>RTCP</td>
</tr>
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</table>

| TCP | UDP |

### Routing Protocols

<table>
<thead>
<tr>
<th>Protocols</th>
<th>IP and ICMP</th>
<th>ARP, RARP, proxy ARP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet, IEEE 802.2, Token Ring, FDDI, SMDS, SDLC, ATM, LAPB, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethernet, IEEE 802, EIA-232, X.21, X21 bis, V.24, V.28, ISDN, ATM, Leased Lines, coax, packet radio, satellite, twisted pair, etc.</td>
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| Ethernet, IEEE 802, EIA-232, X.21, X21 bis, V.24, V.28, ISDN, ATM, Leased Lines, coax, packet radio, satellite, twisted pair, etc. | | |
Voice Components

- Caller Message Recording System
- Enterprise Vocabulary System
- Speech Recognition System
- Speech-to-Text, Text-to-Speech
- Facsimile
- Conference Calling
- TDD
- Credit Card Authorization
- Voice Natural Language Processing / Understanding

- License Manager
- Automatic Bandwidth Selector
- Automatic Phone Installer
- Automatic Phone Mover
- DHCP service
- Direct Directional Dialer
- Event Subsystem
- SMIT Interface
- Call Recorder (including detail records)
- Call Configurator (planner)
- Call Router
- Call Prioritizer
- Number Porter
- Performance Monitor Interface
- PRI Protocol Support
- Remote Process Controller
- Speed Dialer (Directory)
- Documentation
- Web Administrator
Voice Request

Account Summary Request

Telephone | VoiceXML IVR | Application Server | Database

Account Summary Web Service | Account Data
Application of Advanced Conceptualization of EA, MDA, SOA, and Web Services and their Unification

Security and Privacy Systems
Integration, Interoperability and Collaboration with MDA, SOA, and WS
Perspective and Focal Points

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Service Oriented Architecture X Web Services

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Goal: Architect and Engineer the enterprise in such a way that the IT system maximally enables the business.
Perspective and Focal Points

Enterprise Architecture X Model Driven Architecture X
Service Oriented Architecture X Web Services

- Assessment
- Protection
- Detection
- Response
- Review

- Identification
- Authorization
- Authentication
- Access
- Encryption

- Non-repudiation

- Trust
- E-mail
- Web
- Facsimile
- Voice
- Multimedia

Enterprise Security and Privacy System

Foundations Core

- Ontology / Semiotics
- Algorithms and Computation
- Best Practices and Standards / Policies and Procedures
- Integration, Interoperability and Collaboration
- Process and Workflow
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Session Initiation Protocol

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TCP

UDP

TCP/IP Implementation Hierarchy

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<thead>
<tr>
<th>OSI Reference Model</th>
<th>CORBA Variant</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Application Layer</td>
<td>Application Layer</td>
</tr>
<tr>
<td>6 Presentation Layer</td>
<td>GIOP / SECIOP</td>
</tr>
<tr>
<td>5 Session Layer</td>
<td>IIOP</td>
</tr>
<tr>
<td>4 Transport Layer</td>
<td>Transport Layer</td>
</tr>
<tr>
<td>3 Network Layer</td>
<td>Network Layer</td>
</tr>
<tr>
<td>2 Data Link Layer</td>
<td>IEEE 802.x X.25</td>
</tr>
<tr>
<td>1 Physical Layer</td>
<td>Physical Layer</td>
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<th>Composable Services and Processes</th>
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<tr>
<td>Enterprise Distributed Object Computing (EDOC)</td>
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<table>
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<tr>
<th>Service Flow</th>
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<tbody>
<tr>
<td>Web Service Business Process Execution Language (WSBPEL)</td>
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<table>
<thead>
<tr>
<th>Service Publication and Discovery (UDDI)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Service Description (WSDL)</th>
</tr>
</thead>
</table>

| XML Messaging (SOAP) |

Network

HTTP
Mathet Consulting, Inc.

Integrated, Interoperable and Collaborative Systems

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