



# Impact of Advanced Integration Technologies on the Next Generation of Energy Systems

## Uloga Novih Integracijskih Tehnologija i CIM- standarda na Razvoj Slijedeće Generacije Programskih Rješenja za Upravljanje i Vođenje Elektro-energetskih Sustava

Stipe Fuštar

May 26, 2009



# Presentation Outline

- Realities of Today's Systems
- New System Trends
- Utility Landscape and Functional Model
- Role of Integration
- Integration technologies
  - ESB
  - EII
  - ETL
  - XTP
  - SOA and EDA
- Next Generation Platform Considerations

# Today's Realities of Enterprise Systems

- **Systems are:**
  - Too expensive to deploy and maintain
  - Too complicated and often difficult to use
  - Too monolithic:
    - » They were built for the specific purpose and largely ignore the informational needs of the surrounding functional areas.
    - » Not easy to integrate
  - They are constraining the business efficiency

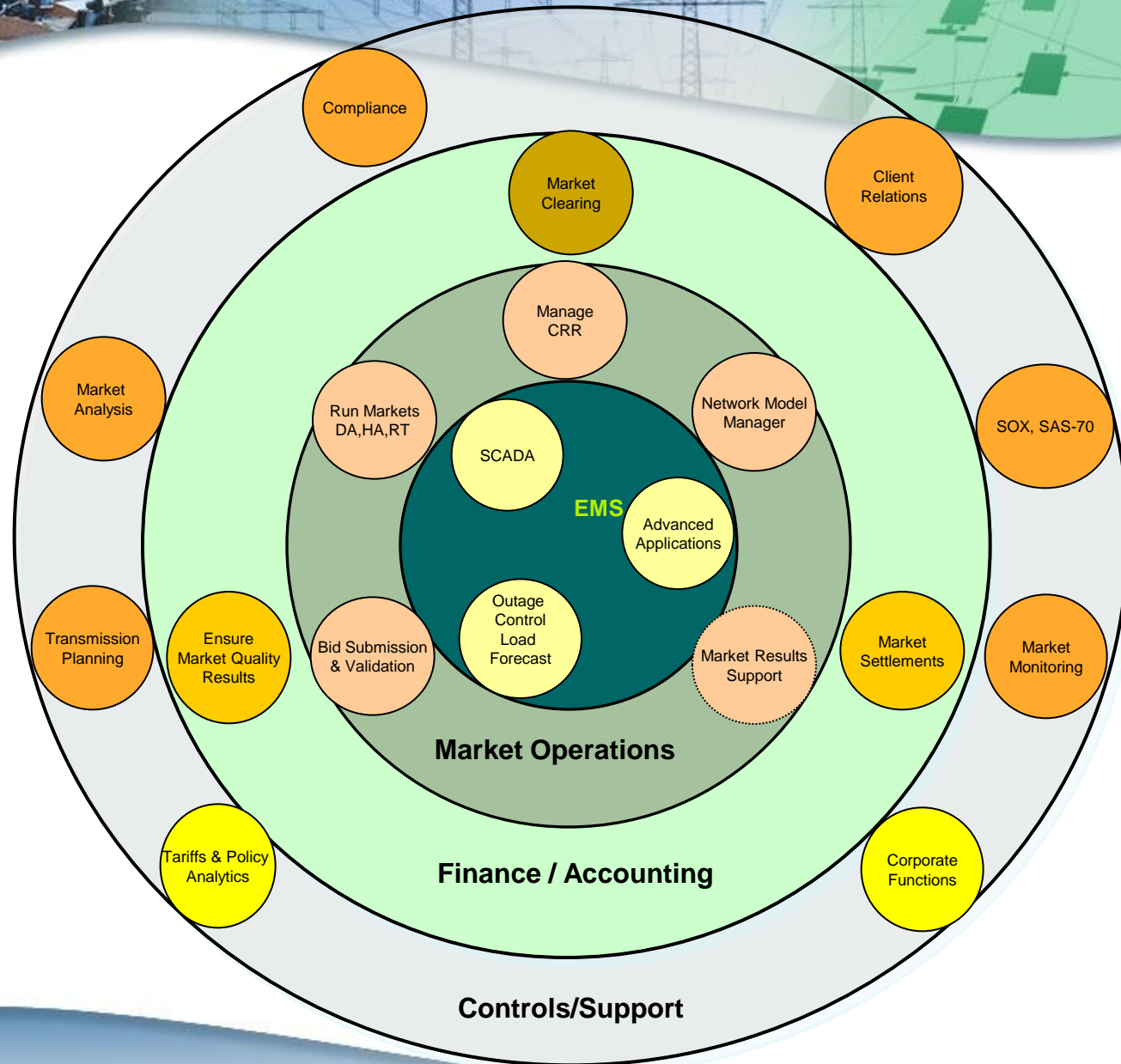
# New Enterprise Systems Trends

- **New Systems are expected to provide a revolutionary application platform that includes Open Source, Standard-based Solutions, XML and SOA.**
  - **Ideally, Systems will be**
    - » **Dramatically easy to use,**
    - » **Highly Adaptable; Responsive to the often changing needs**
    - » **Significantly lower TCO**
    - » **Built-to-integrate**
    - » **Driven by industry standards**
- **Visionary Companies will Target Traditional Market in non-traditional way**
  - **Configuration rather than coding**

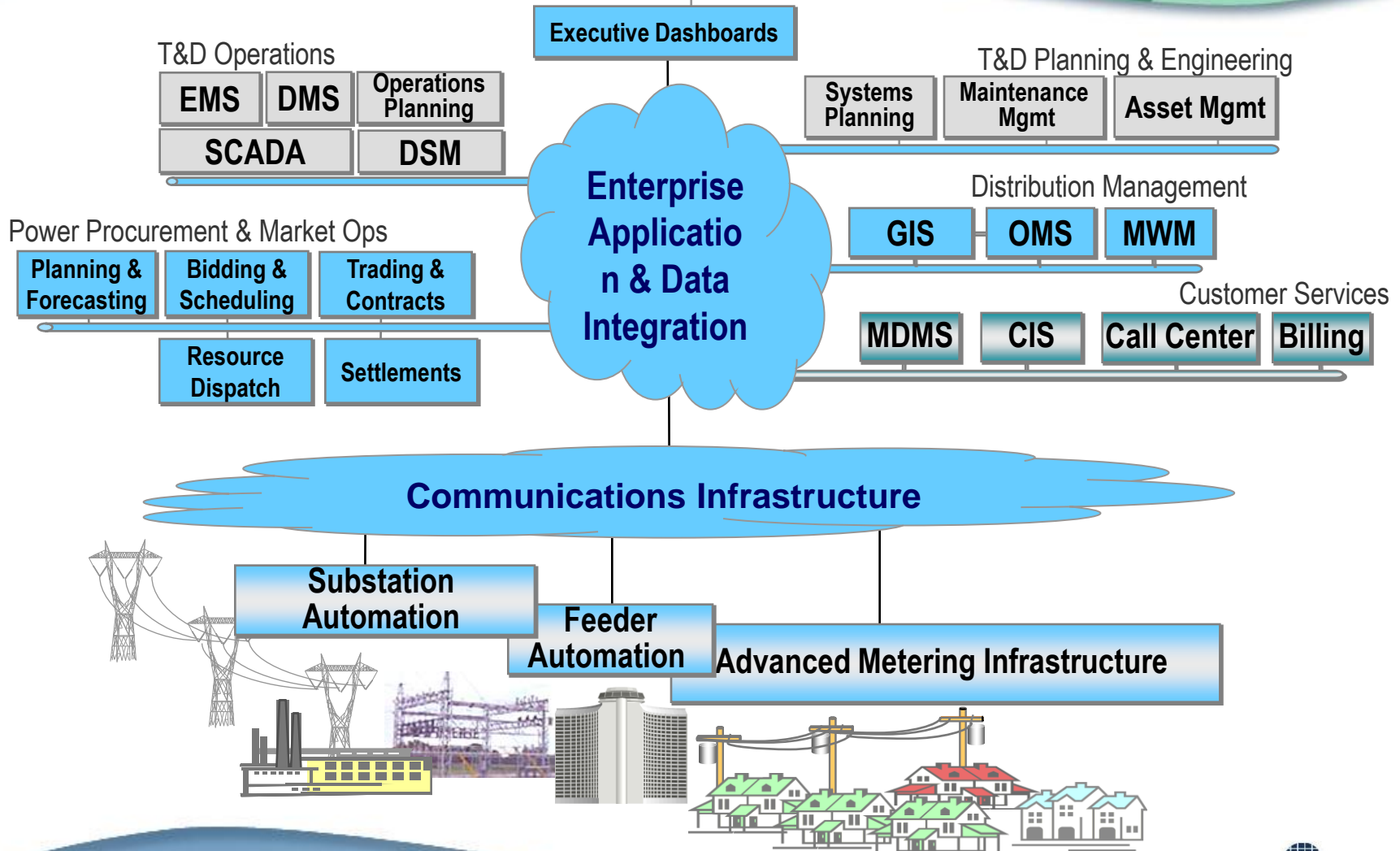
# Next Generation of Energy Systems Considerations

- Leverages latest Integration including Open Source Technologies
- Returns as Composite Application or System of Systems Framework
- Presents a new opportunity for vendors' collaboration
  - (Pre)-integrated Multiple Vendors Solutions
- Forces “built-to-integrate” approach
- Requires new standards

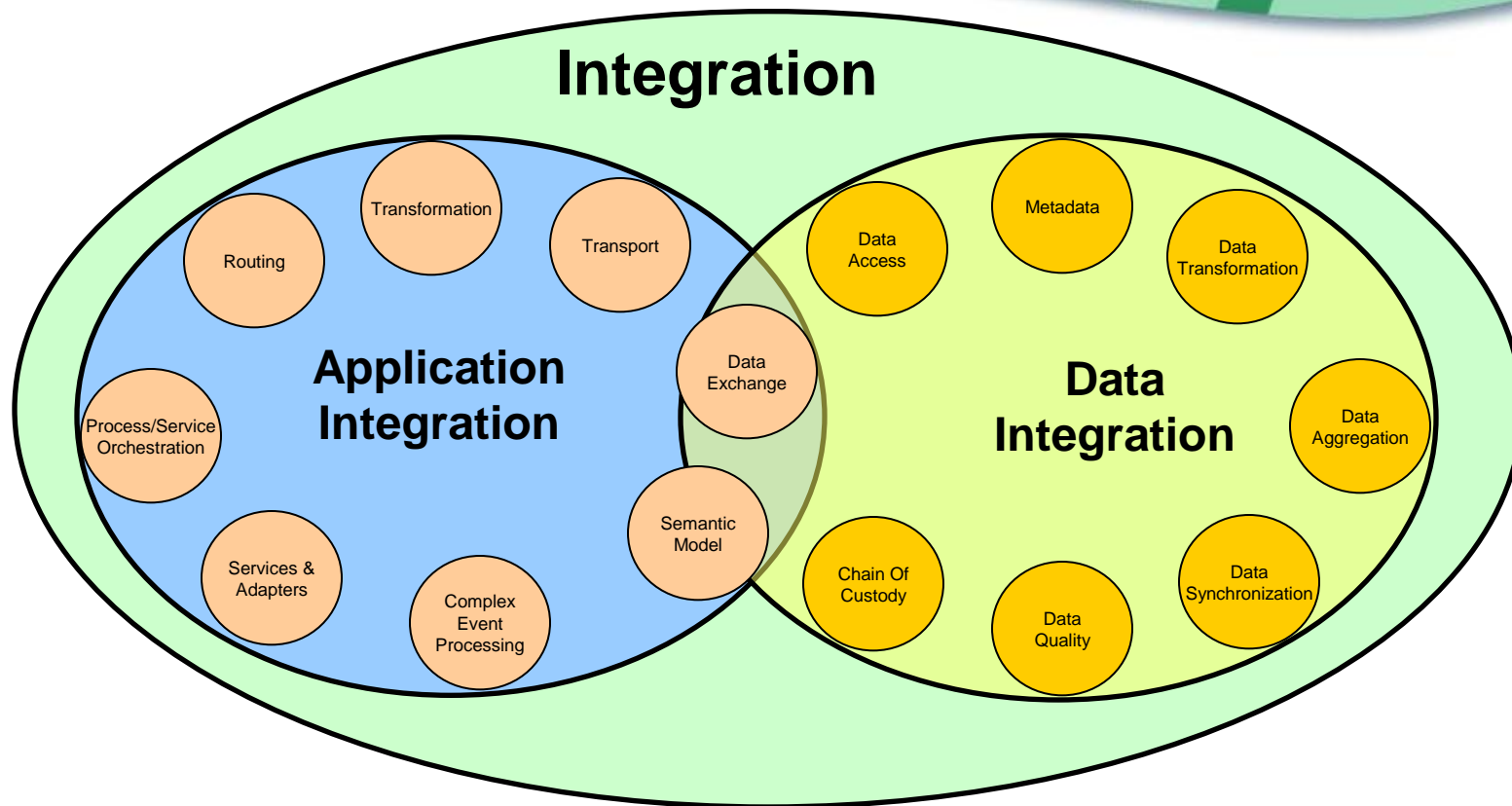
# Restructured Energy Systems Real-Estate



# Utility Enterprise Level Integration For "Smart Grid" Operations



# What is Integration?



*Making two or more independently designed things (applications, systems or DBs) work together to achieve a business goal (Gartner).*

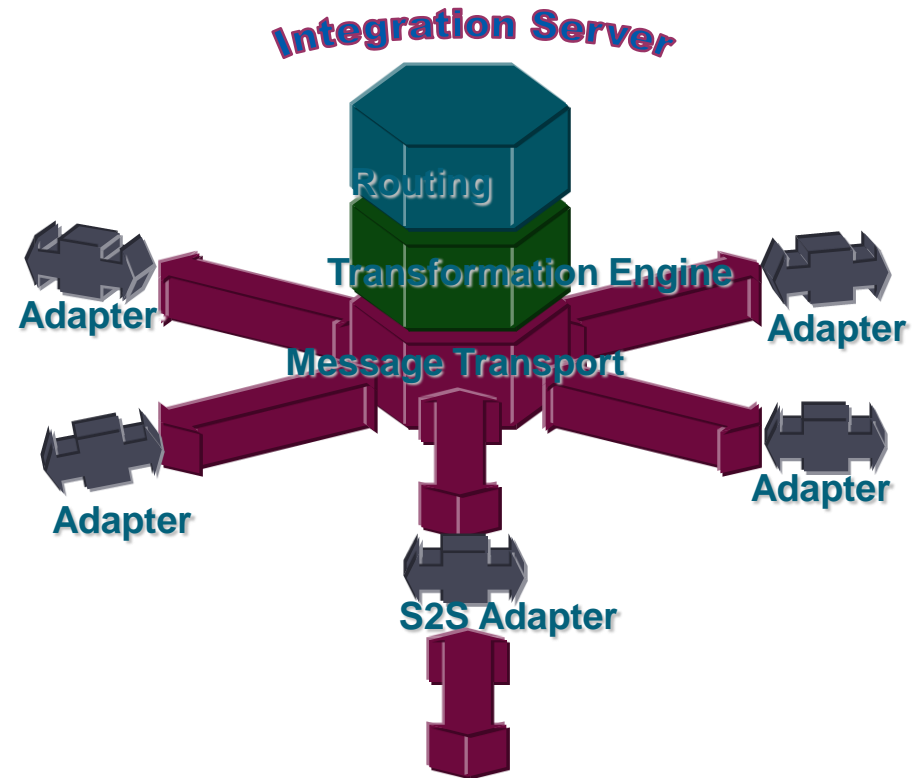
# Enterprise Service Bus

- “A new architecture that exploits Web services, messaging middleware, intelligent routing, and transformation. ESBs act as a lightweight, ubiquitous integration backbone through which software services and application components flow.”
- “An ESB can be a sensible first step toward a systematic Enterprise Nervous System because it provides the basic connectivity backbone. It can interoperate with a variety of disparate application servers simultaneously, smoothing over technical differences and also providing services for communication and integration.”

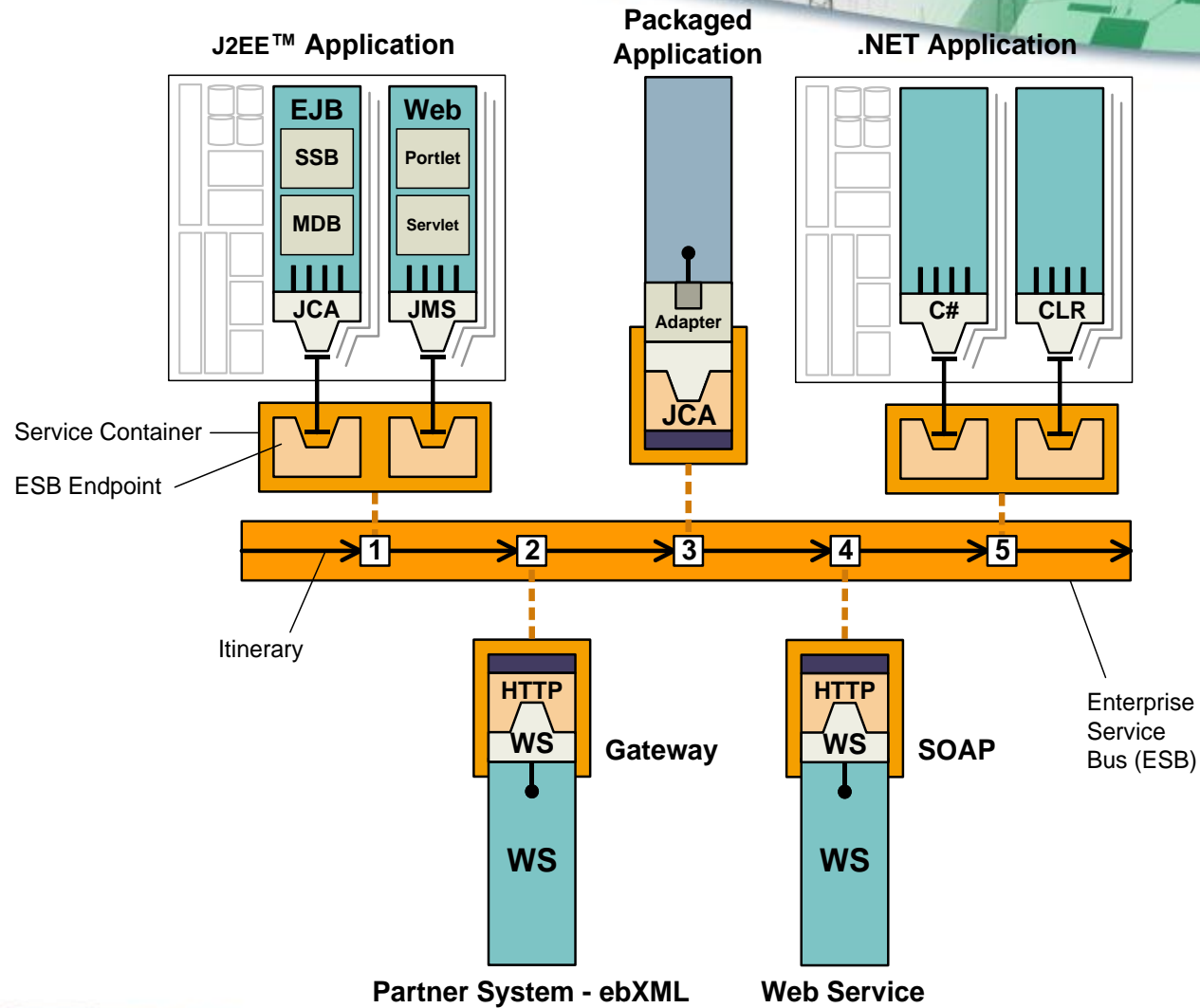
*Built on heritage of EAI and Application Servers*

# EAI/ESB Concept

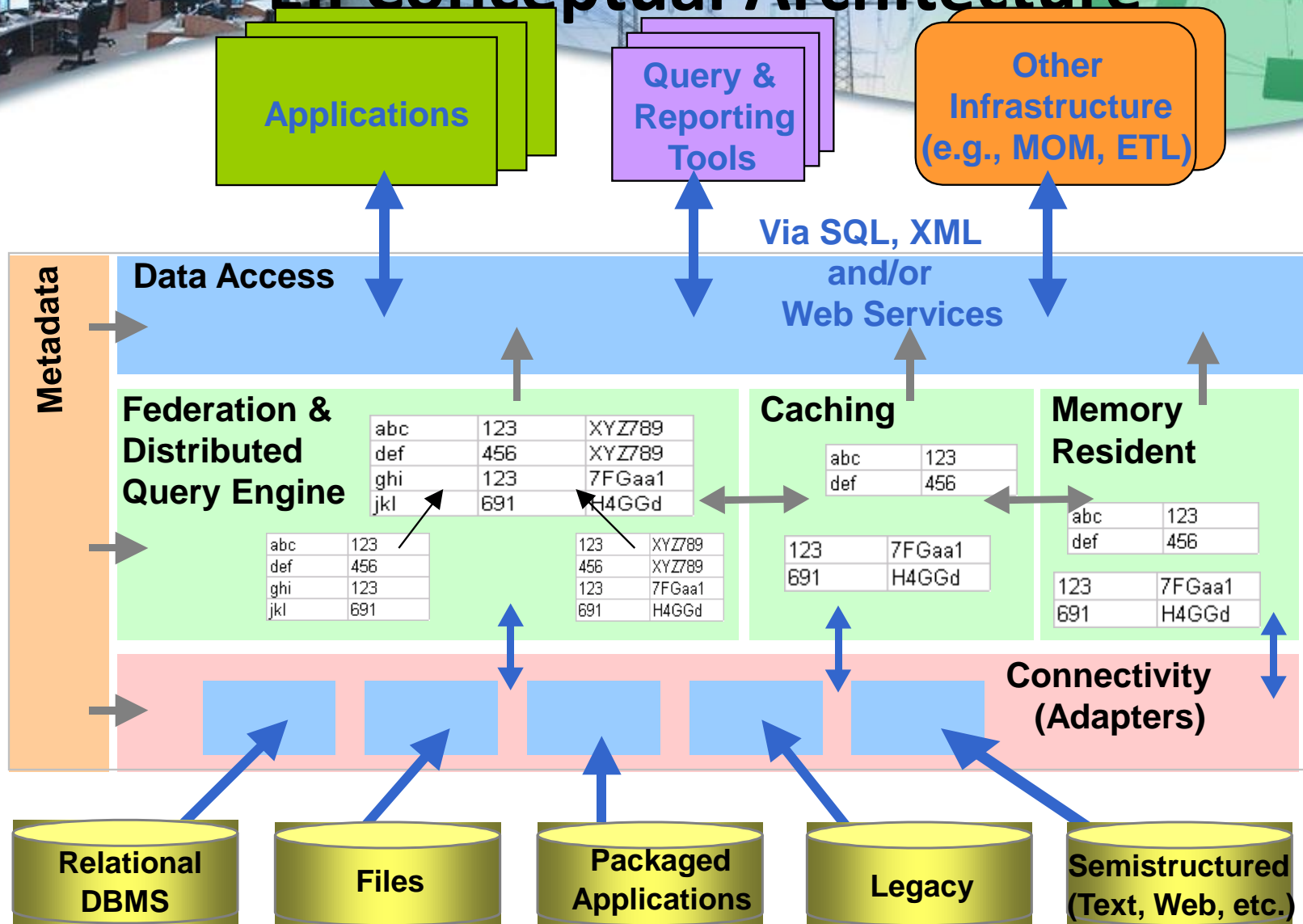
- **Message Transport**
  - Moves data from the application to broker and vice versa
- **Transformation Engine**
  - Translates Messages from one format to another
- **Process Management**
  - Provides ability to apply business logic to events
- **Routing**
- **Application Adapter**
  - Forms the bridge between integration layer and application layer



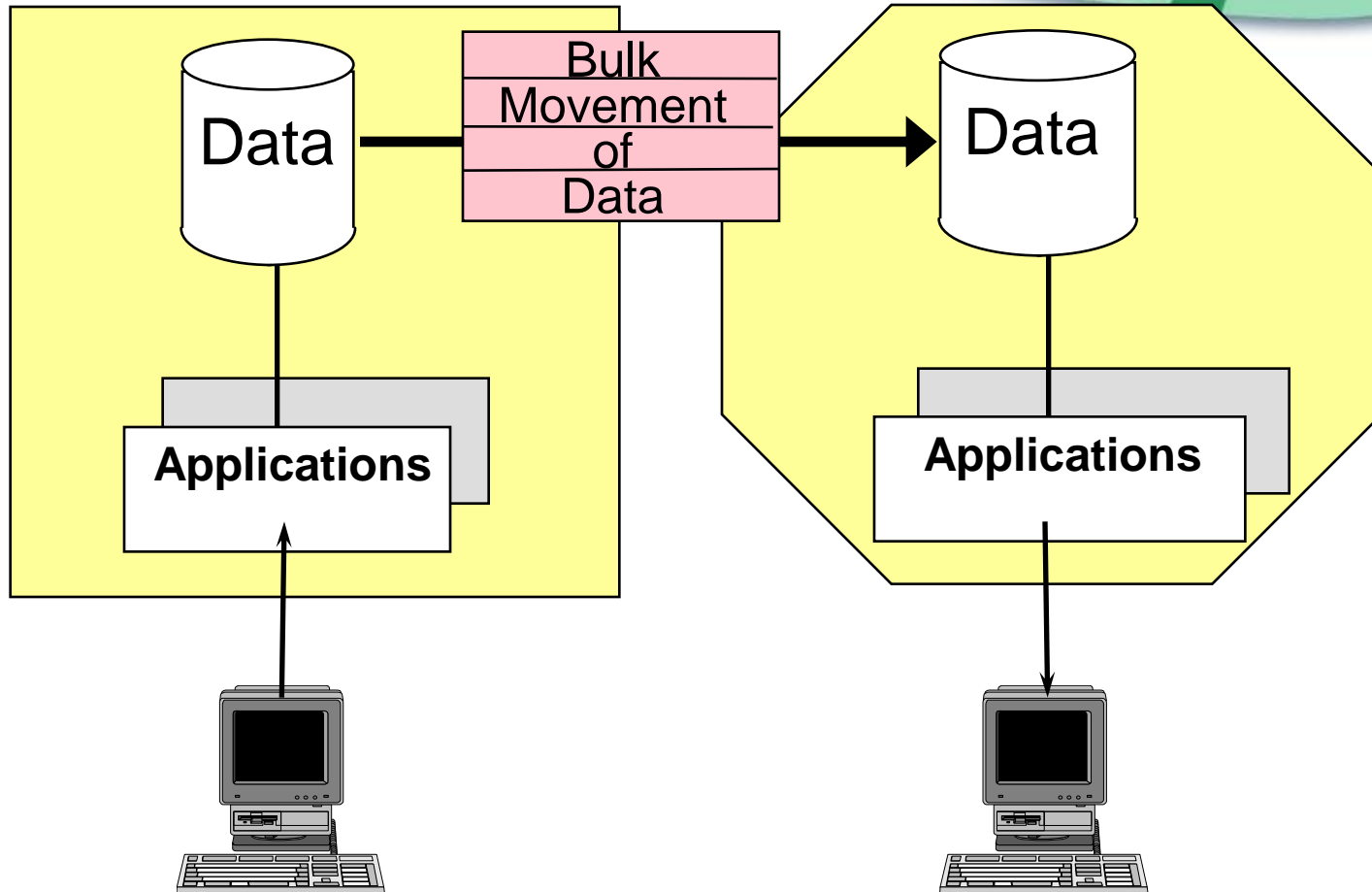
# Enterprise Service Bus



# EII Conceptual Architecture



# Extract, Transform and Load (ETL)

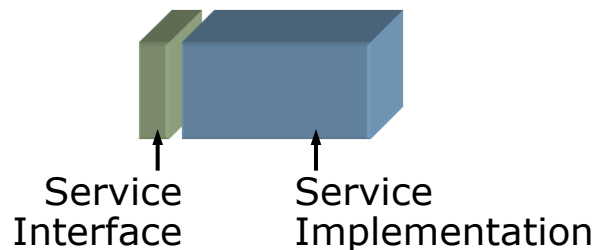


# Service-Oriented Architecture

## The architecture of interfaces

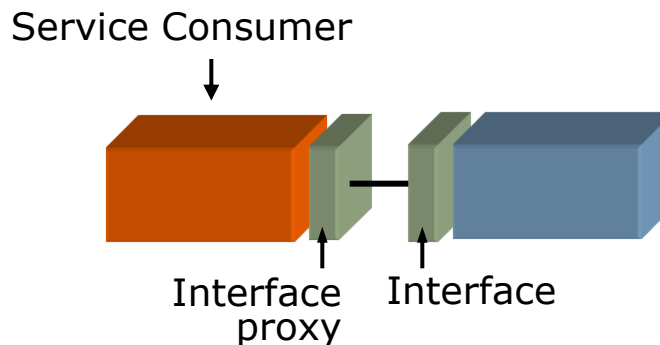
### What is Service?

Software component that is a business-complete logical unit of work, accessible programmatically from independently designed contexts via a direct openly documented interface



### What is SOA?

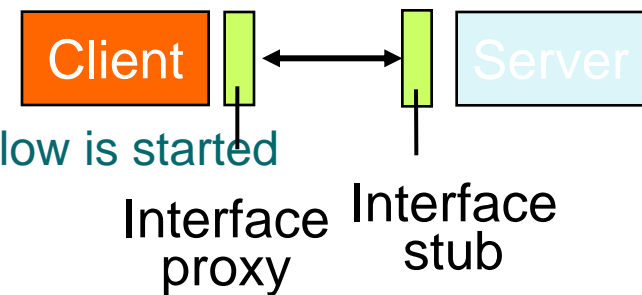
Application software topology consisting of services and service consumers (clients) in loosely coupled 1-to-1 relationships



# Event-Driven vs. Service-Oriented

## Service-Oriented Architecture Interaction

- Consumer directs flow
- Linear path of execution
- Can not react to new external input once a flow is started



## Event-Driven Notification

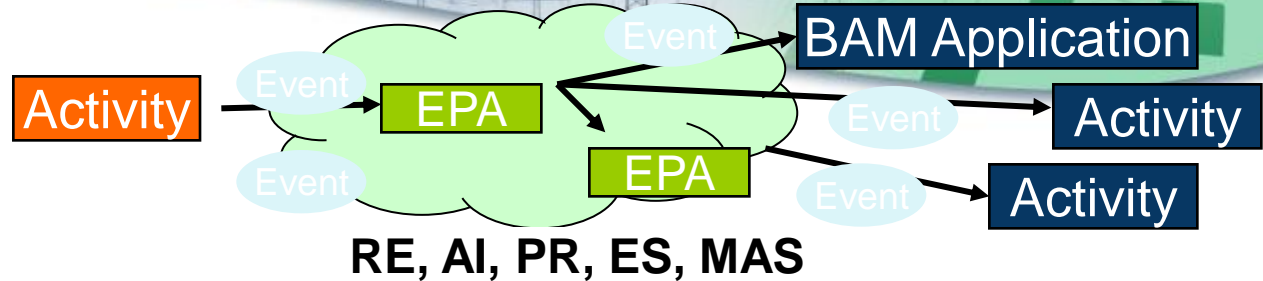
- Sink (recipient) determines flow
- Dynamic, parallel, asynchronous flows
- Can react to new external input while process is in flight



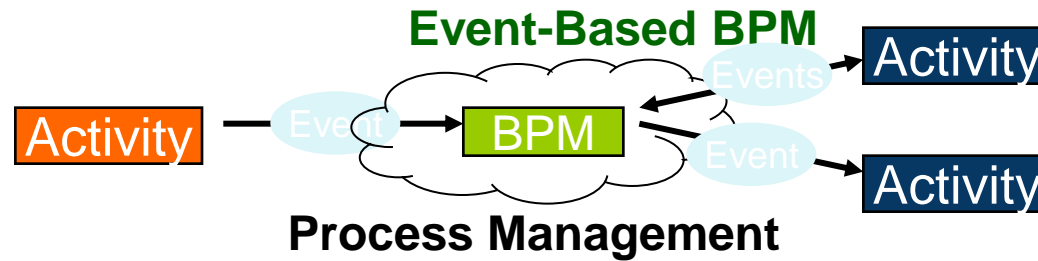
# Events Classification

Event Manager, Event Processing Agents

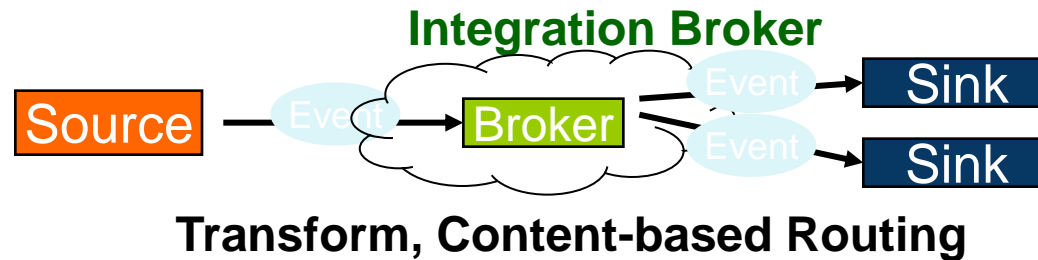
Complex-Event Processing



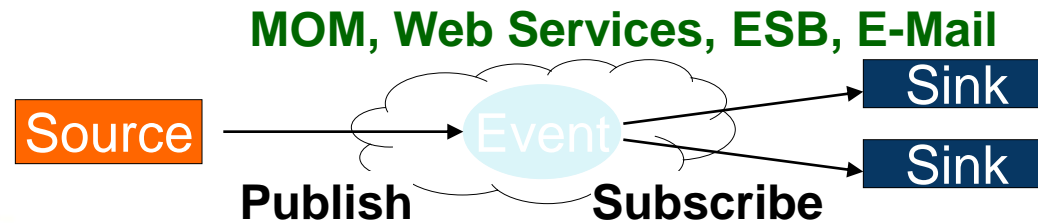
Event-Enabled Processes



Mediated Events



Simple Events

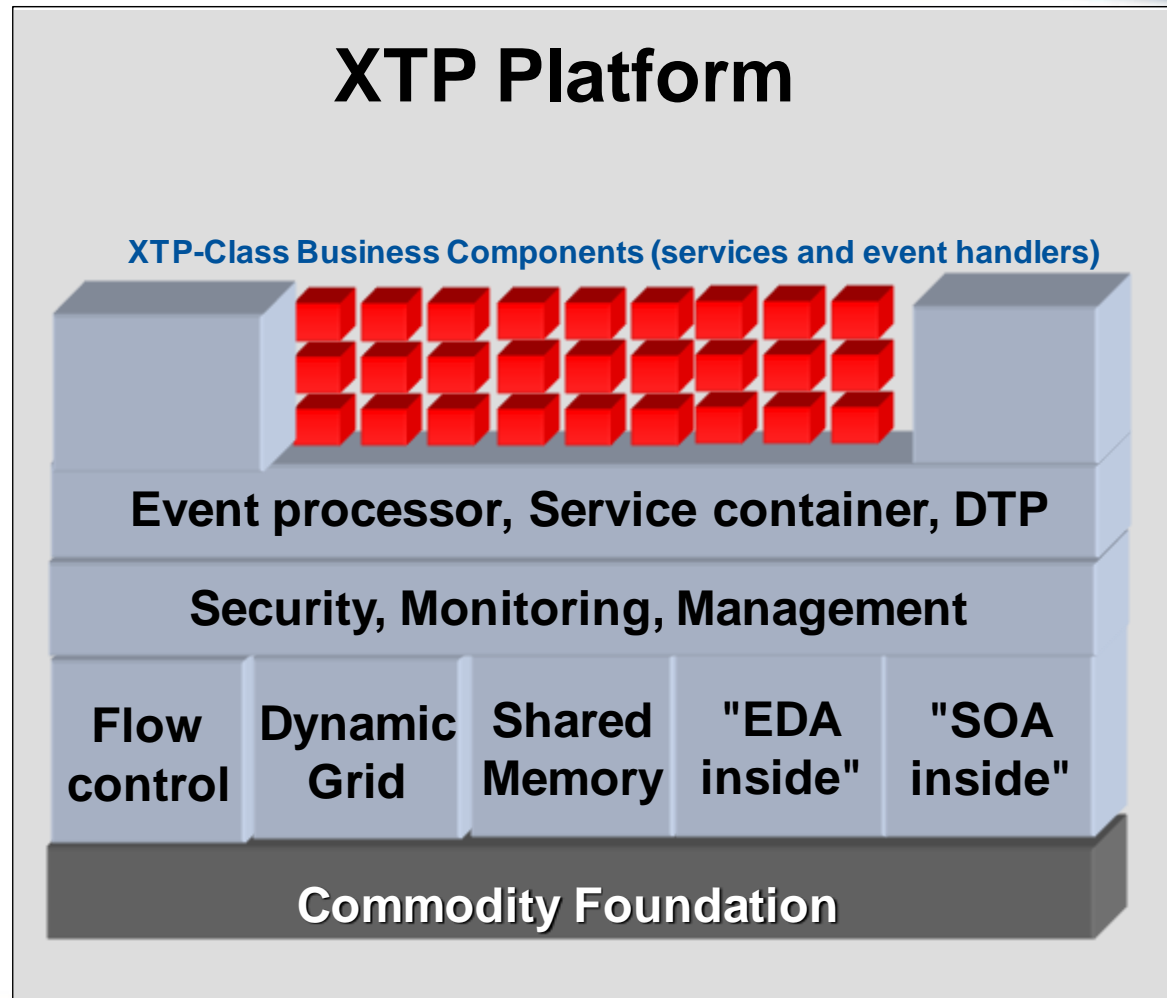


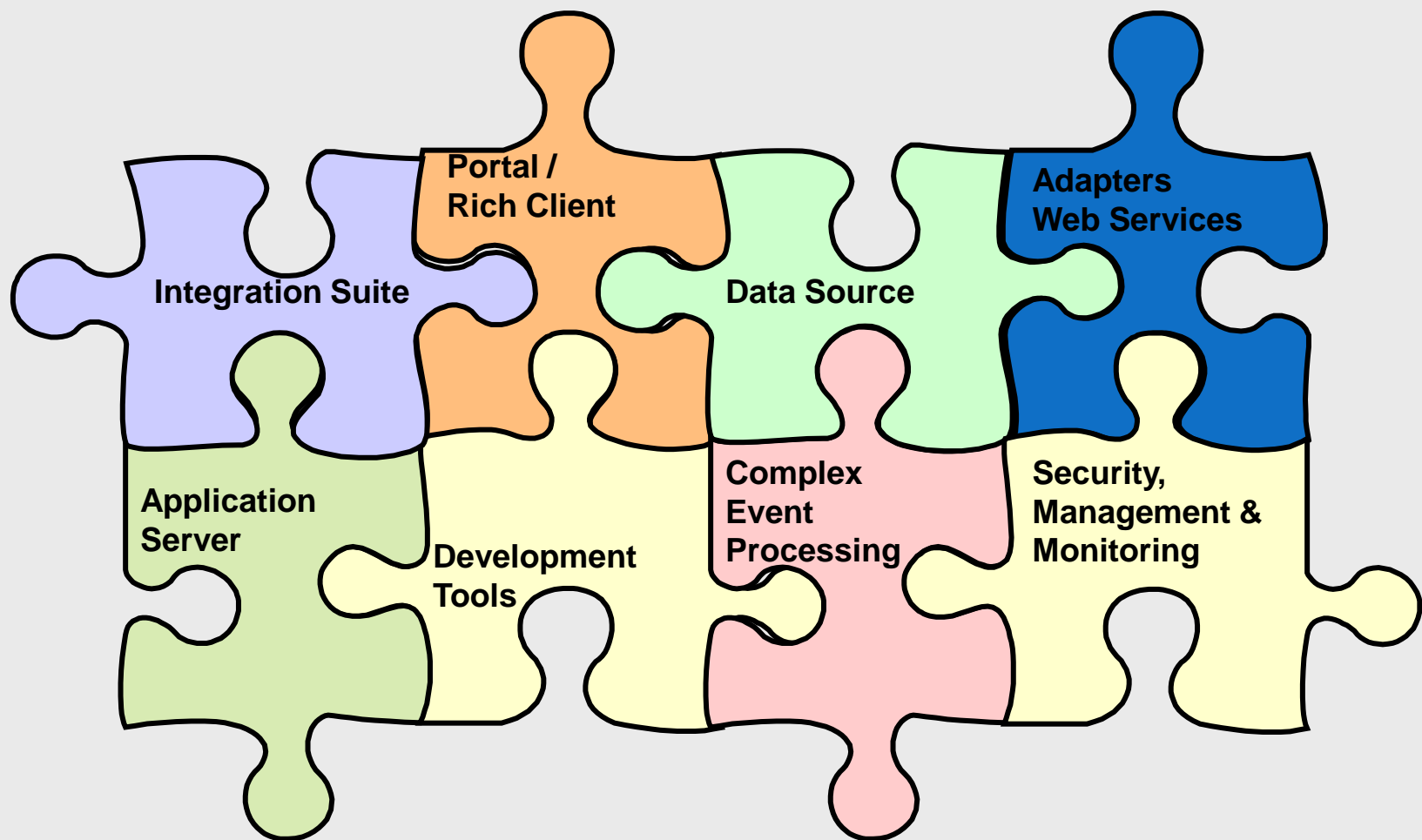


# Complex Event Processing

- Leverages Intelligent Systems Technologies:
  - Expert System
  - Pattern Recognition
  - Neural Network
  - Multi-agents (intelligent, goal-directed agents)
  - Rule Engines

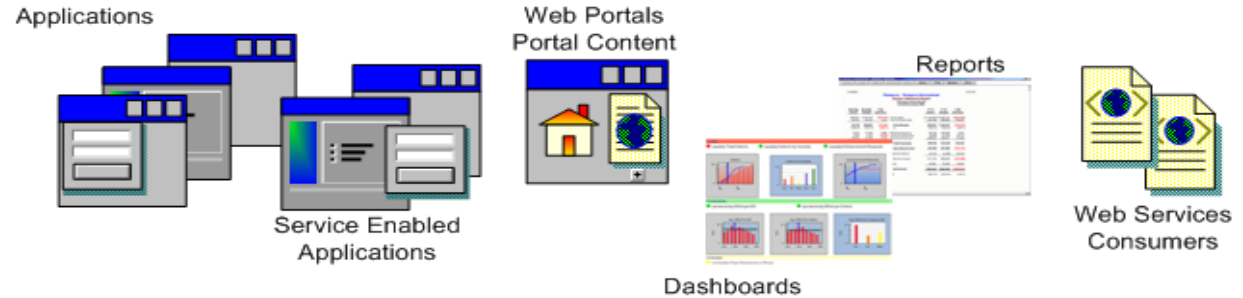
# Conceptual View of XTP Platform





# Integration Technologies – A Holistic View

## Integration Conceptual Architecture



## Enterprise Service Bus

- Enterprise-Class Backbone
- Standard-Based Integration
- Loosely Coupled
- Coarse Grained
- Event Aware
- Asynchronous

## Messages

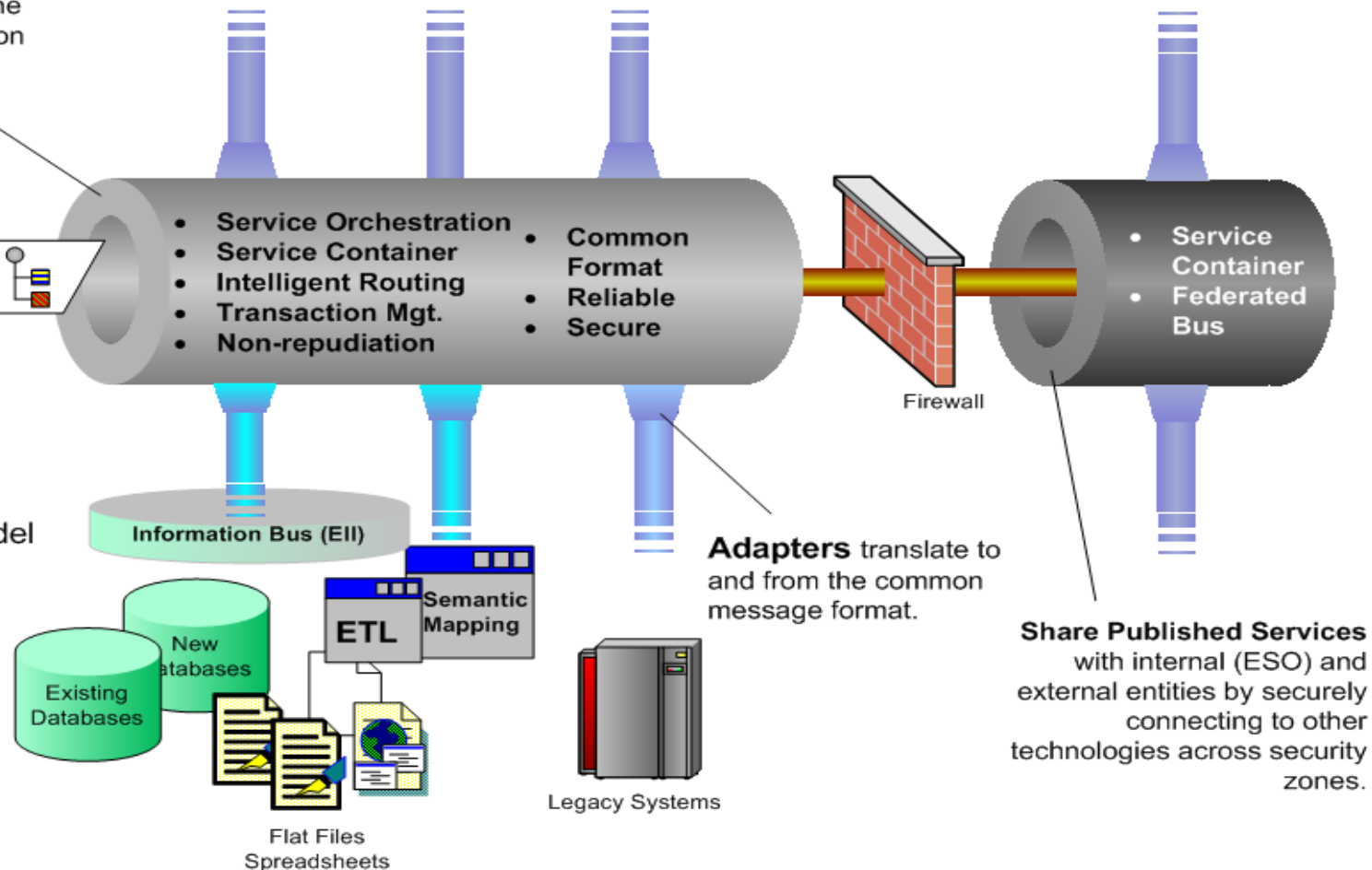
- Real-time data updates
- Guaranteed Delivery
- Common Format

## Enterprise Information Integration (EII)

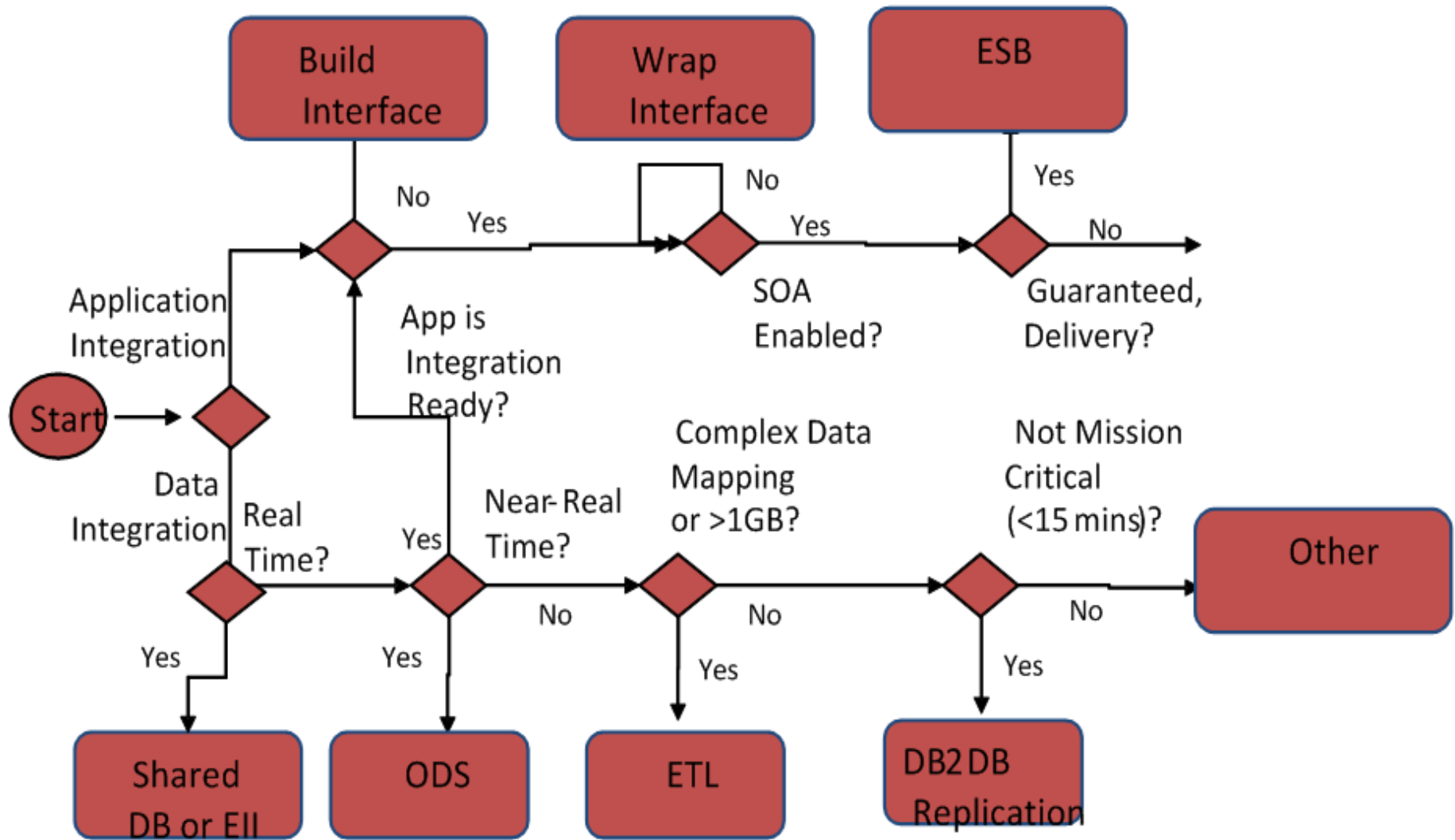
- CIM Based Virtual Model
- Granular Data Level Security

## Semantic Mapping

- CIM
- Common Vocabulary
- Standard Messages in CIM Semantics and Syntax



# Integration Decision Tree



# NEXT GENERATION ENERGY SYSTEMS PLATFORM

- *“The Next Generation energy platform is seen as a high-performance, highly distributed operational data management infrastructure that encompasses hierarchically clustered gateways / agents with distributed memory resident data sources to provide very low-latency, predictable, high-throughput data sharing and event distribution. The platform is envisioned as dynamic massive server networks (dynamic grid), massive distributed and replicated memory spaces, use of event-based internal architecture for intra-systems communications (EDA and CEP inside) and use of an extensible modularity of platform technology (SOA inside).”*

**(Stipe Fustar CTO, Power Grid 360 and Chief Scientist, Verdeeco Inc.)**

# “(E/D/G/M)MS Cube”

## Next Generation System Assemblies

**Technology Components**

Portal / Rich Client / Ajax  
 Application/Web Servers  
 Data Mgmt  
 EAI    ETL    EII    Security  
 Runtime Bridges  
 SOA, EDA, CEP  
 XTP

**Service**

- **Presentation services**
- **Business/Application services**
- **Data services**
- **Management services**
- **Enterprise services**
- **QoS services**
- **Business-to-Business**

ISO / RTO

Transmission

Distribution

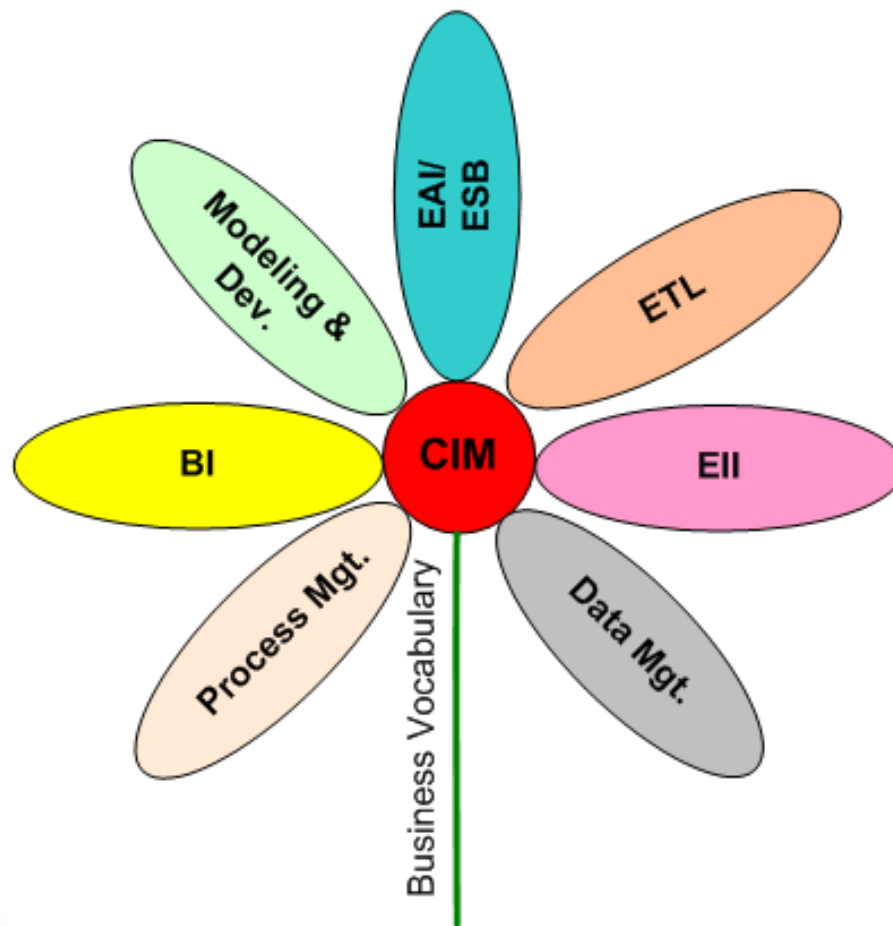
Market Participant

Generation

Consumers

**Customers**

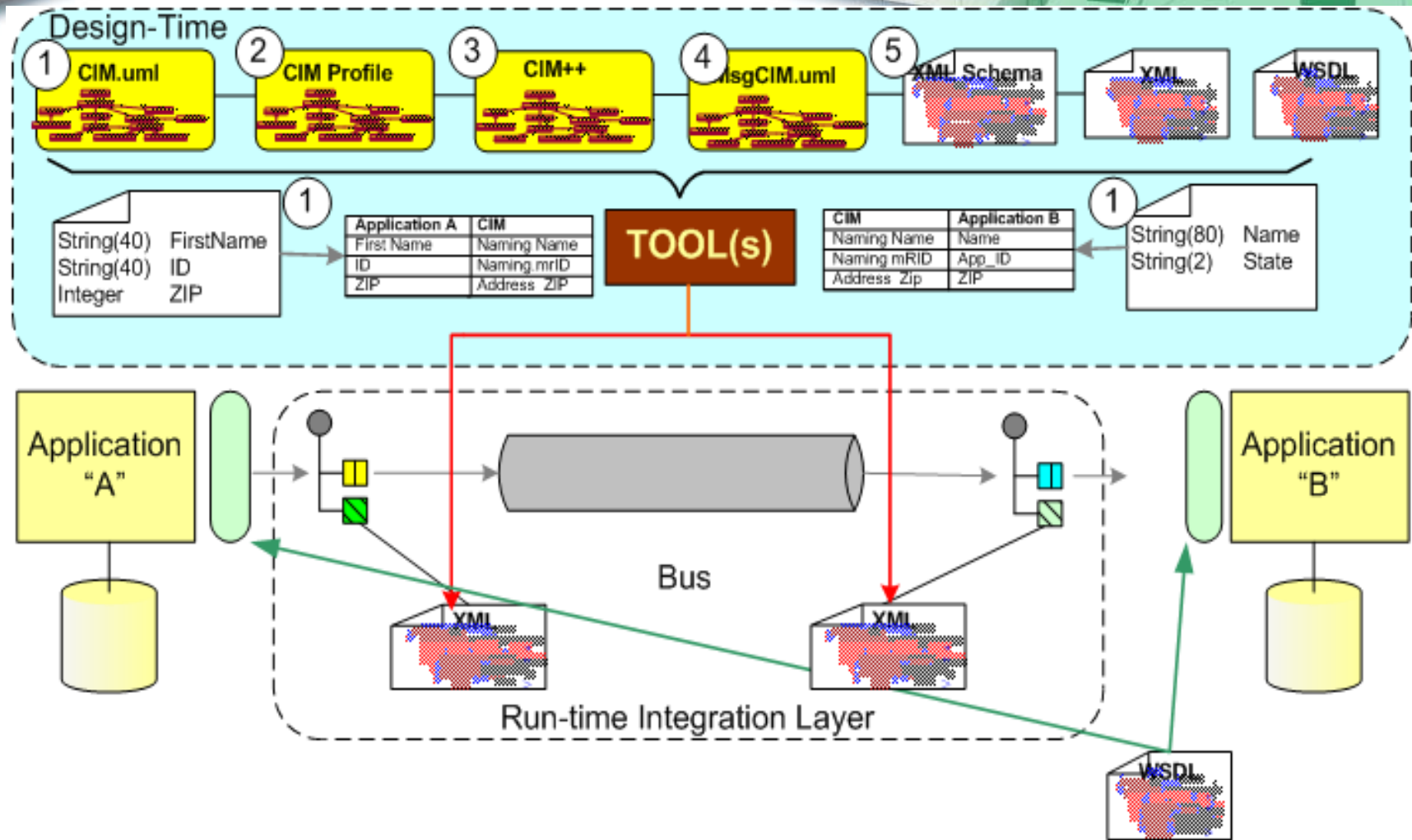
# CIM Usage Perspective



# CIM Usage

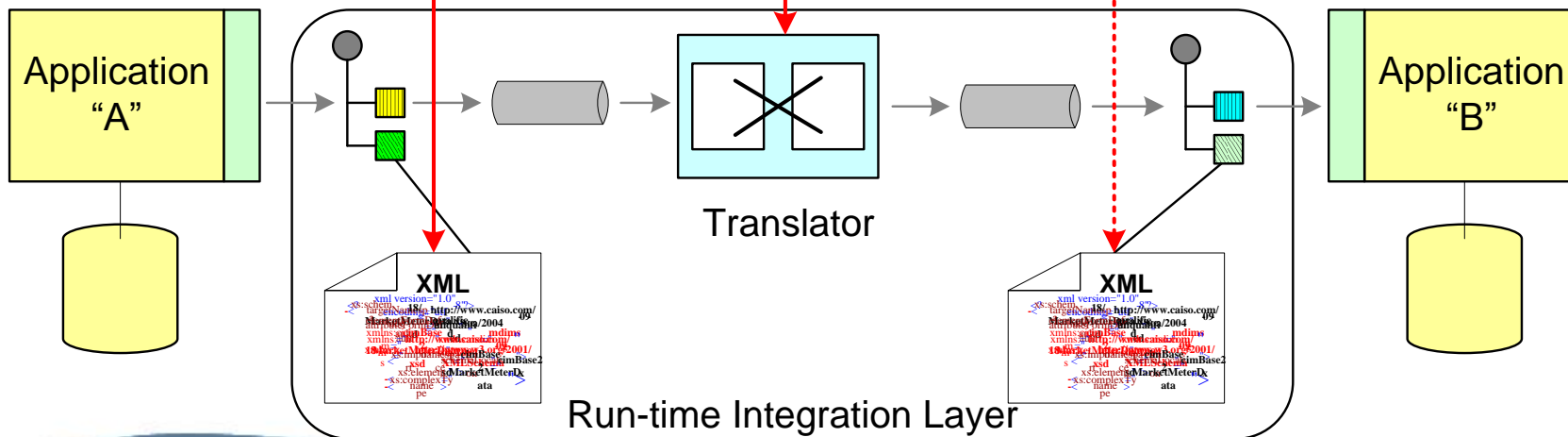
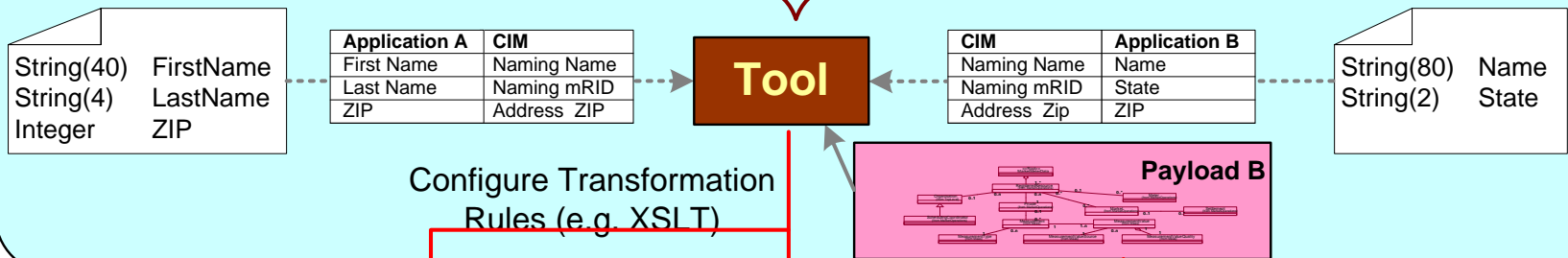
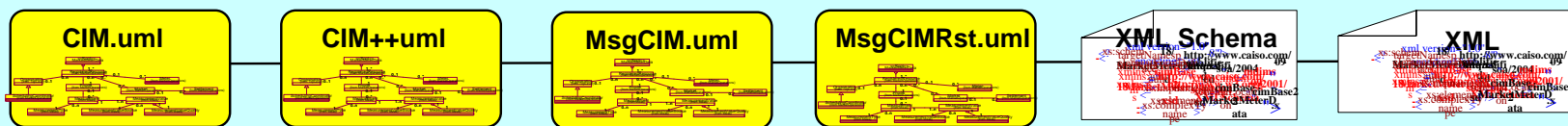
- **Enterprise Application Integrating (EAI) / Enterprise Service Bus (ESB)** –provides basis for standard-based message payloads and data transformation
- **Enterprise Information Integration (EII)** –provides platform-independent logical model as well as mappings to underlying systems and federated queries.
- **Extract, Transform and Load (ETL)** – Generates data transformation workflows to convert data from a source to a target data store using CIM – XSLT and DDL generation
- **Modeling and Development tools** –Create / extent / profile models (e.g. interface model) using CIM structures
- **Business Intelligence (BI) tools** –Using CIM and Business Vocabulary (BV) to generate common business views (AKA universes)
- **Data Management solutions** - provides platform-independent logical model and DDL generation as well as data exchange mappings from CIM-based payloads to underlying systems DDL
- **Process Modeling** –More effective process engineering leveraging CIM use cases and standard functional decomposition
- **Composite Applications Framework** –provides standard-based interoperability framework for linking business components into functional assemblies
- **Network Model data exchanges** - provides ability for multiple components (within the same organization or B2B) to exchange network models

# Example 1: CIM Usage – Web Service Design



# ETL Integration Pattern

## Design-time Metadata Flow



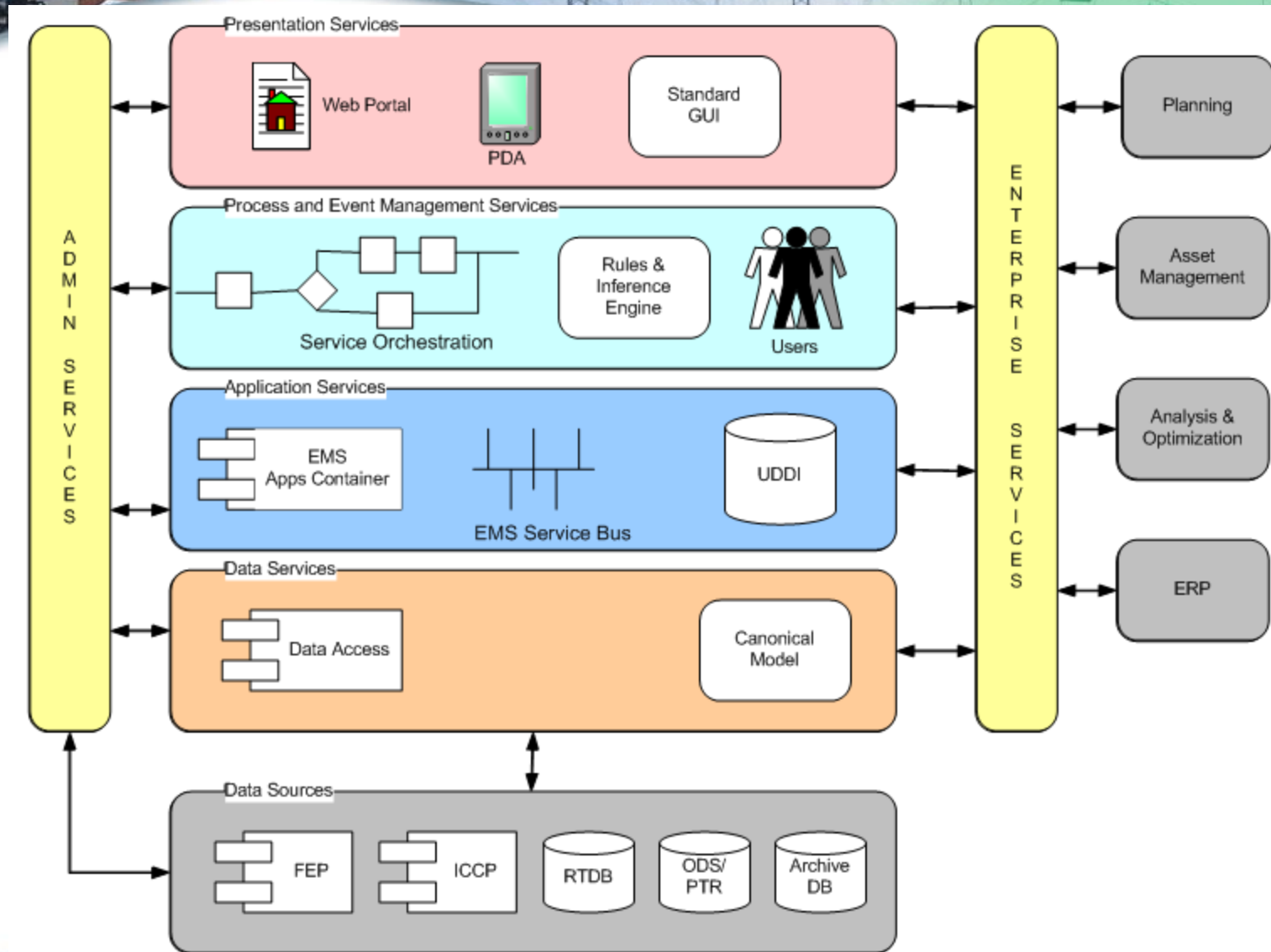
# TECHNOLOGY CANDIDATES FOR THE NEXT GENERATION ENERGY SYSTEMS

Type of System(s)	Candidate Technologies
SCADA	ESB, XTP, CEP
Complex SCADA /	CEP, XTP, ESB, EII
EMS with basic applications	CEP, XTP, ESB, WS, BPM, CA
EMS with advanced applications	CEP, XTP, EII, ETL, ESB, APS, BPM, WS, CA
EMS + Market Operations Suite	XTP, ESB, BPM, APS, CEP, POR, WS, CA
EMS + Market Operations + Finance Suite	XTP, ESB, BPM, APS, CEP, WS, EII, ETL, CA
EMS + Market Operations + Finance + Support	ESB, XTP, APS, EII, ETL, WS, EPS, CA, CEP
Smart Grid	XTP, CEP, EII, ESB
Basic DMS	CEP, XTP, ESB, WS, BPM
Advanced DMS	CEP, XTP, EII, ETL, ESB, APS, BPM, CA

## Legend

ETL =	Extraction, transformation & loading	APS =	Application platform suite
EII =	Enterprise Information Integration	EPS =	Enterprise platform suite
ESB =	Enterprise service bus	POR =	Portal, Reach Client
WS =	Web Service	BPM =	Business Process Management
BPM =	Business Process Management	CA =	Composite Applications
XTP =	eXtreme Transaction Platform	CEP =	Complex Event Processing

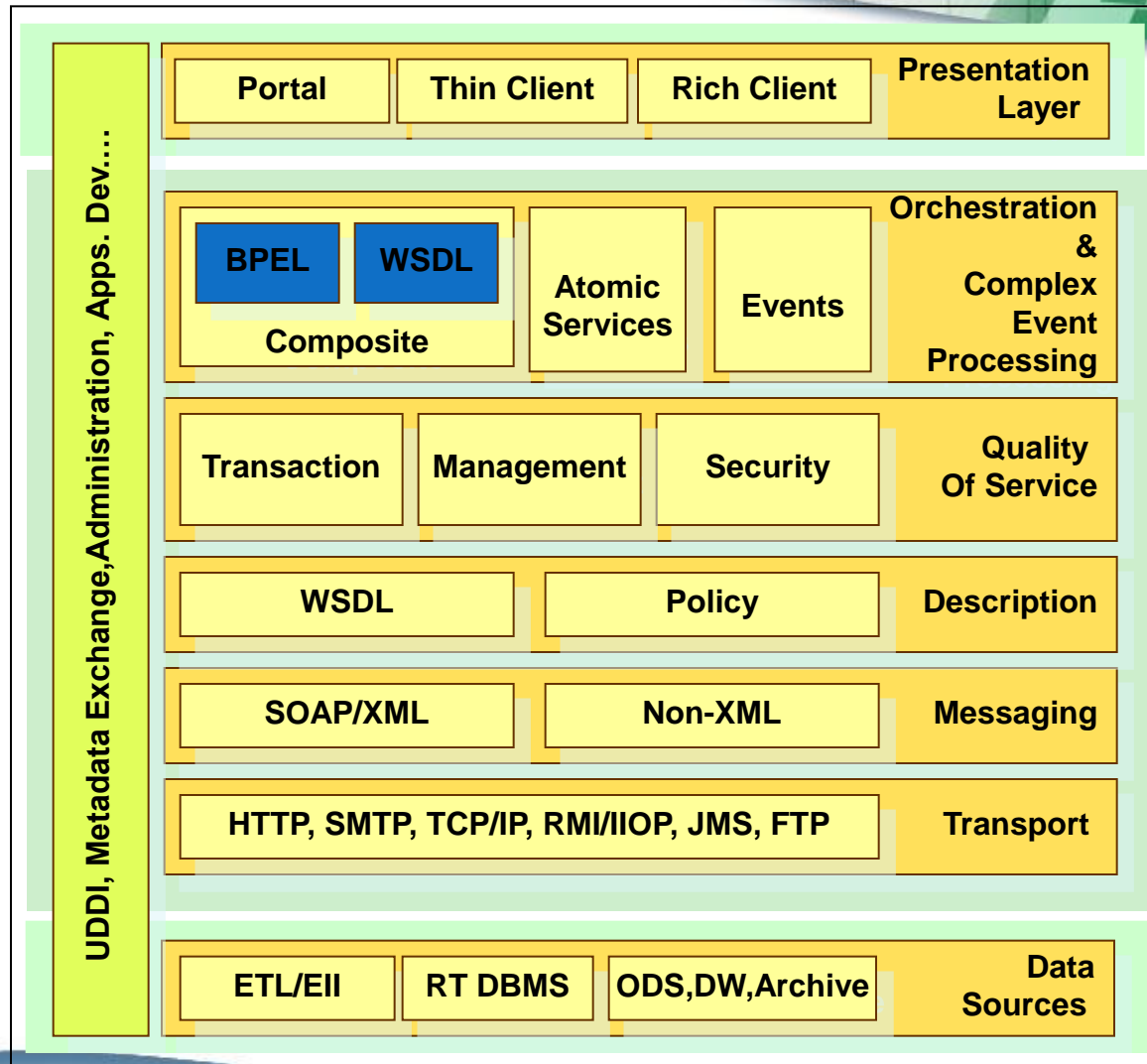
# EMS/DMS/MMS Multi-Tier Architecture



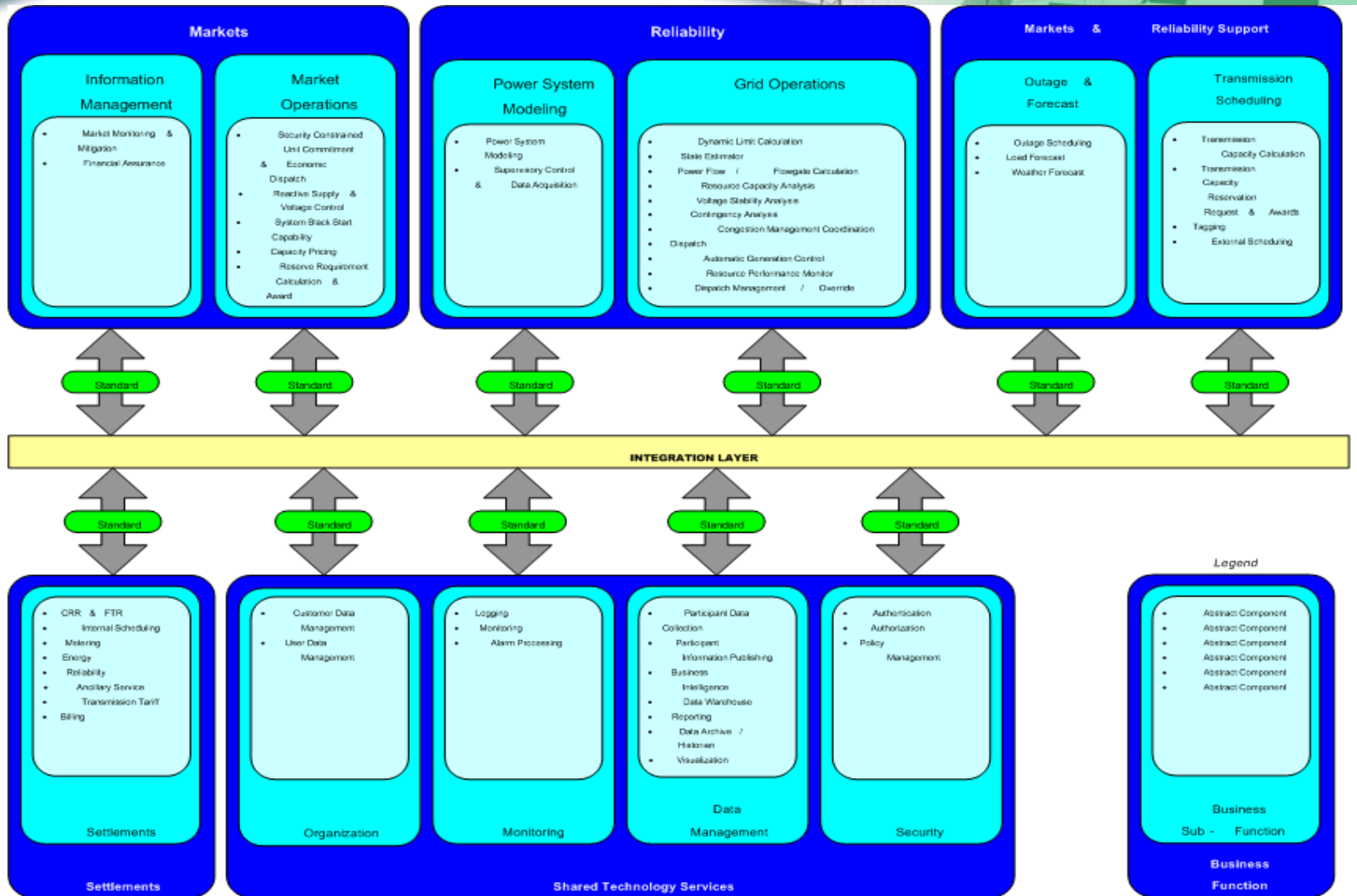
# Service Definition

- Header - The header contains a verb to describe the action represented by the message and a noun to describe the type of message payload.
  - Possible verbs based on IEC 61968 may include: BROADCAST, CREATE, CHANGE, CANCEL, CLOSE, DELETE, GET, CREATED (associate with CREATE), CHANGED (associated with CHANGE), CLOSED (associated with CLOSE), CANCELED (associated with CANCEL), SHOW (response from GET), LISTEN, PUBLISH, REPLY (response from CREATE, CHANGE, DELETE, CANCEL or CLOSE), SUBSCRIBE, UNSUBSCRIBE
- Request:, used for request messages (optional)
- Reply: used for response messages that provide details for success, failure and error
- Payload:, used to pass a message information (optional)

# Technology Stack



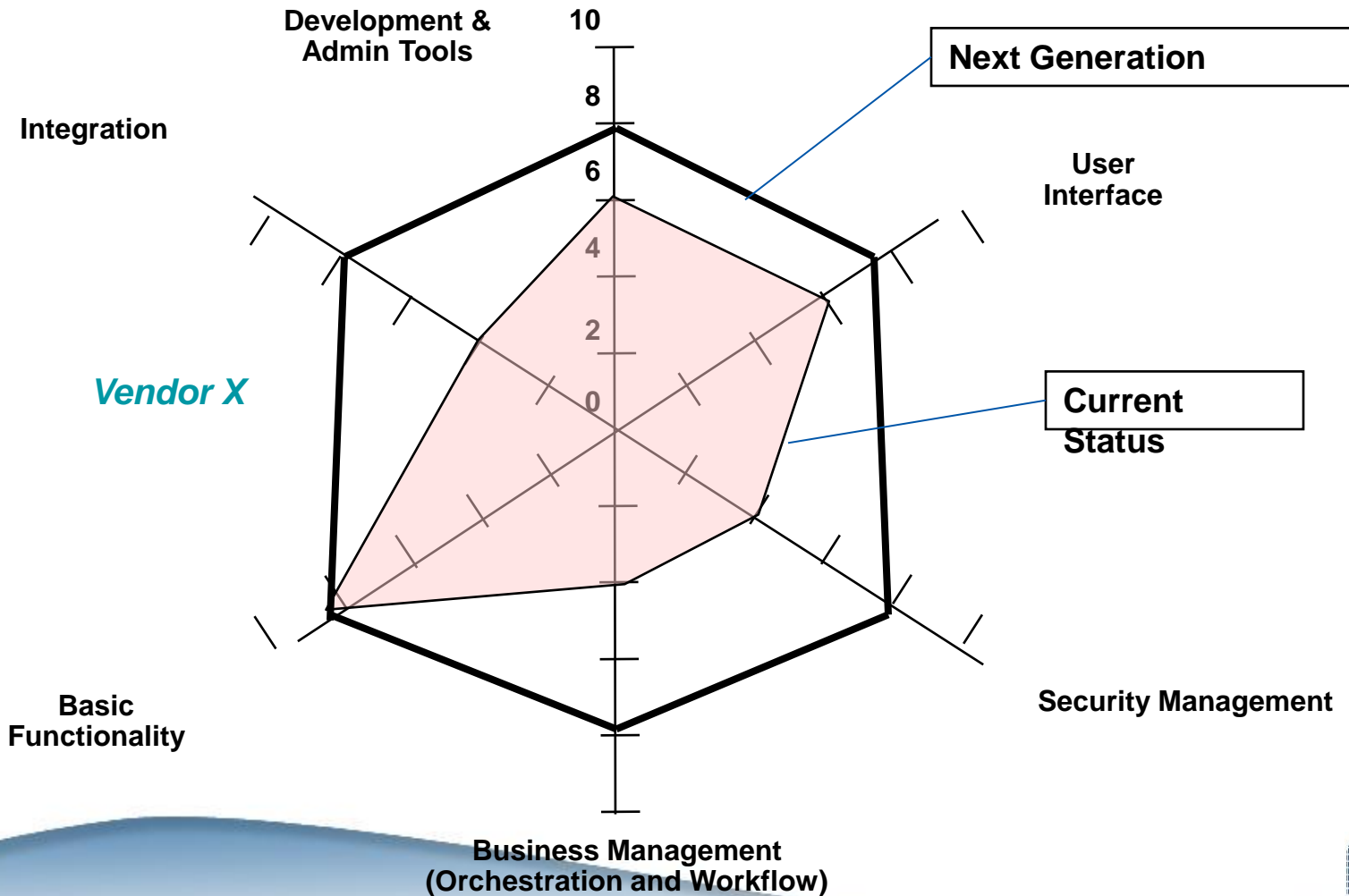
# EMS/MMS Business Functional; Decomposition



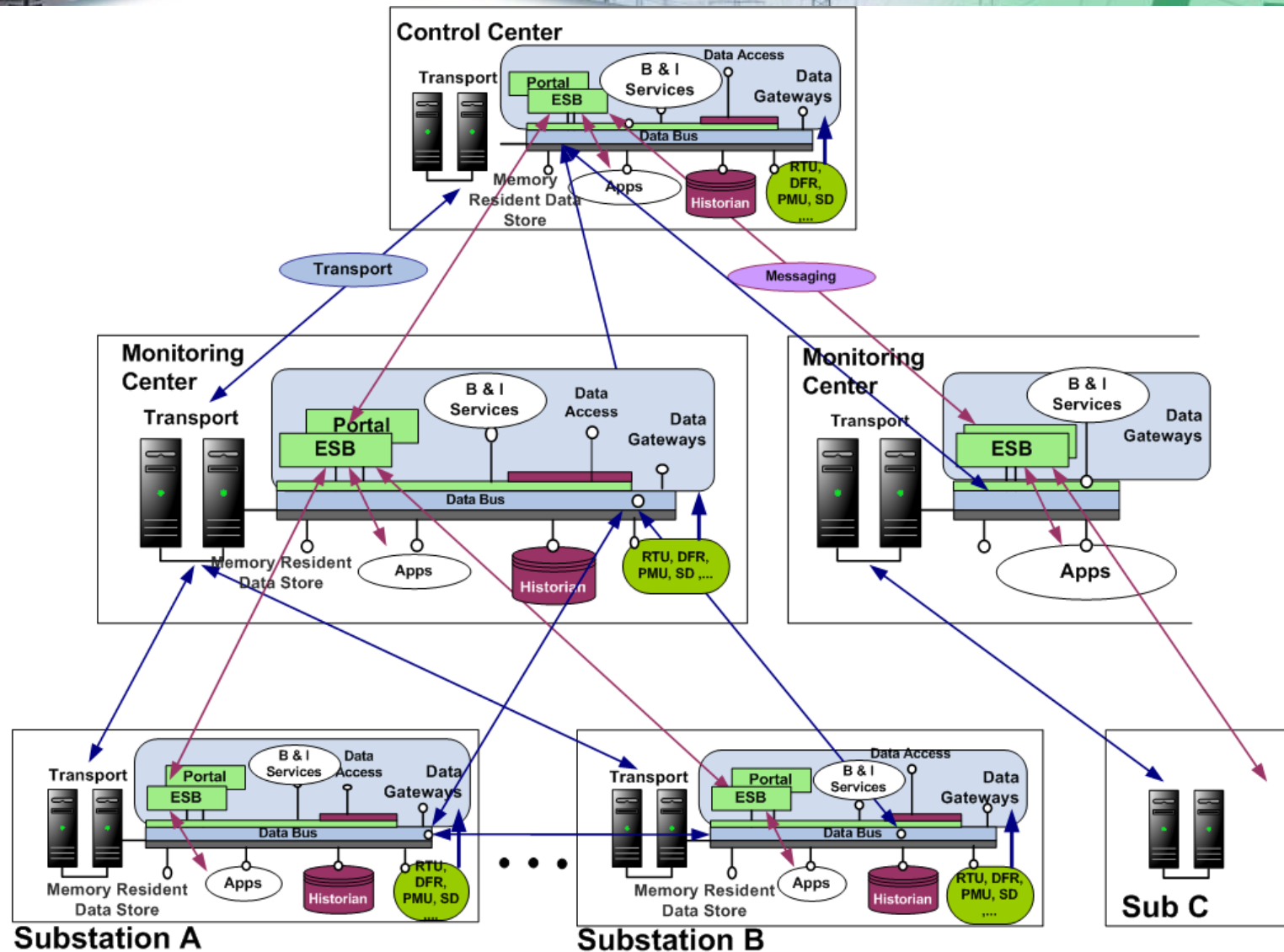
# State of The Current and Next Generation Systems: Evaluation Criteria

- Integration Readiness – this category refers to a product’s ability to interact with other systems and applications
- Development and Admin Tools –
- User Interface
- Basic Functionality
- Security - ability to leverage and comply with third party security tools
- Business process management

# State of The Current and Next Generation Generation Systems



# Next Generation Platform



# Integration Readiness Assessment

## Complexity of Integration vs. Compliance Levels (Traditional Integration Tools)

Integration Complexity	Description	Semantic Compliance Levels				Syntactic Compliance Levels			
		2	4	7	10	2	4	7	10
High	No Semantic Model, No Endpoints	✓	✓			✓	✓		
Med/High	No Semantic Model, Some Endpoints	✓	✓			✓	✓		
Medium	Semantic Model, Some Endpoints			✓			✓		
Med/Low	Semantic Model, Endpoints			✓				✓	
Low	Semantic Model and standard based Endpoints			✓	✓			✓	✓
Zero Coding Effort*	Plug & Play				✓				✓
Zero effort	True Plug & Play								✓

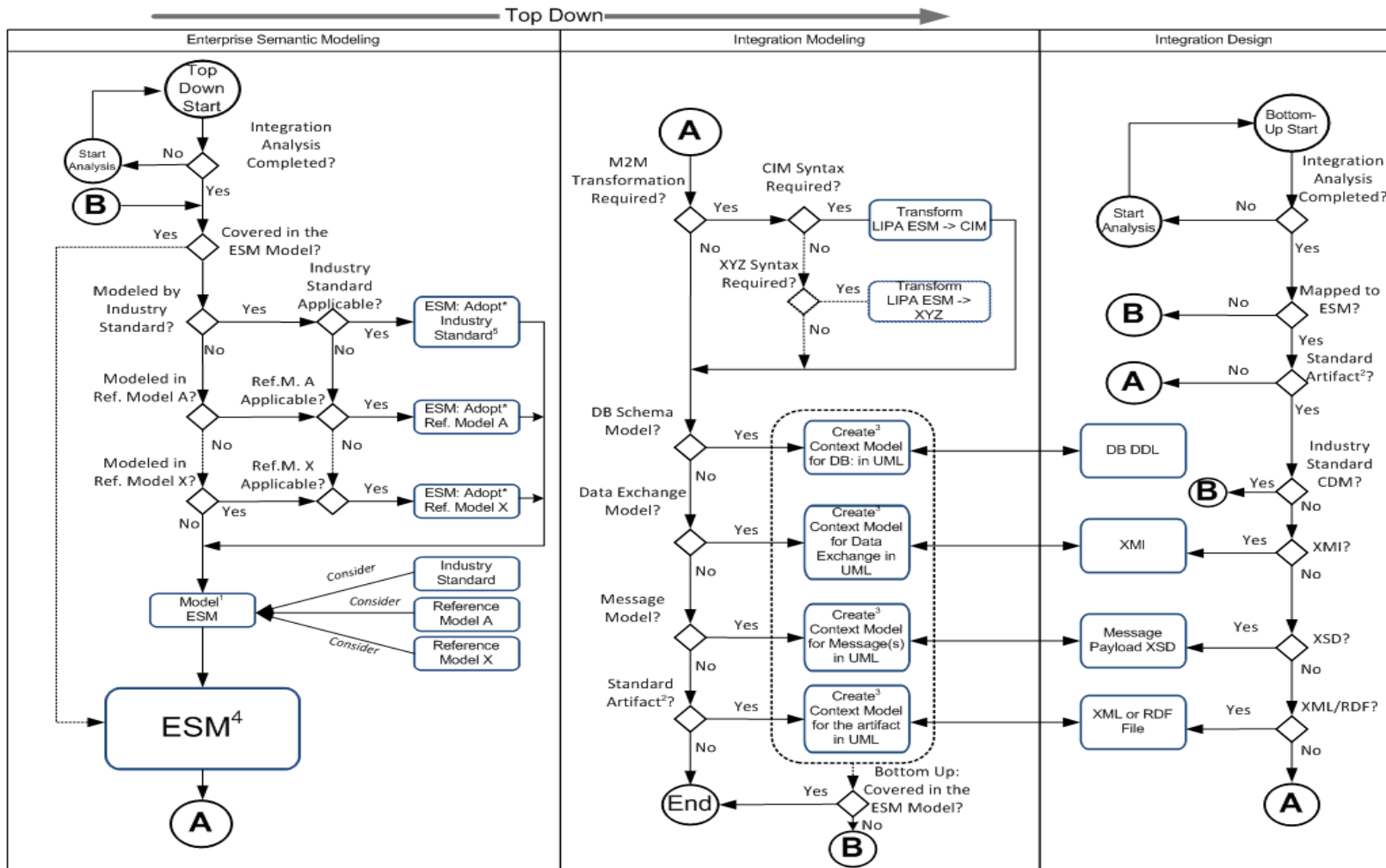
# Integration Readiness Assessment

## Complexity of Integration vs. Compliance Levels (Next Generation Tools)

Integration Complexity	Description	Semantic Compliance Levels				Syntactic Compliance Levels*			
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High	No Semantic Model, No Endpoints	✓	✓			✓	✓		
Med/High	No Semantic Model, Some Endpoints	✓	✓			✓	✓		
Low	<b>Semantic Model</b> , Some Endpoints			✓	✓		✓		
Configuration Effort	<b>Semantic Model</b> , Endpoints				✓			✓	
Configuration Effort	<b>Semantic Model</b> and standard based Endpoints				✓			✓	✓
Configuration Effort	Plug & Play				✓				✓
Zero effort	True Plug & Play				✓				✓

\*Semantic Model will be imported in Integration Tools and used as an Intermediary where all mapping and transformations will be defined for run-time. Therefore, semantic compliance will become more important in the future.

# ESM Dynamics



\* - Adopt or Leverage; <sup>1</sup>- Follow MD3i Modeling Rules; <sup>2</sup>- E.g. WG14 message, WSDL or CPSPM; <sup>3</sup>- Derive, transform or import; <sup>4</sup>- UML (.eap, ...), XMI; <sup>5</sup>- E.g. IEC CIM as CDM or profile (e.g. CPSPM, CDPSM, UCTE)

# Conclusions

- *Next generation of SCADA, EMS, MMS, DMS is envisioned*
- *Latest Integration Technologies will be leveraged*
- *New Standards are expected*
- *CIM and other standards will play significant role*



# Questions

- Contact Information

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