Enhancing the Practice of Enterprise Architecture Modelling through LEAD: Layered Enterprise Architecture Development

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• Reader in Business Computing, Sheffield Hallam University, UK
• Leadership and expertise in Enterprise Architecture and Conceptual Structures - 'bringing humans and computers together’
• TOGAF 9 & LEAD Certified
• Co-chairman of the Global University Alliance that partners with the LEAD (Leading Enterprise Architecture Development) practitioner community and vendor-neutral standards body—LEADing Practice

• Published widely with over 100 learned publications to date.
• Editor-in-chief of the International Journal of Conceptual Structures and Smart Applications (IJCSSA) published by IGI-Global
Agenda: Modelling through LEAD

- Difficulty of EA modelling in domains (discussion on example TOGAF)
- Layered Enterprise Architecture Development (LEAD)
- Enterprise Architecture Layers
- Enterprise Architecture Sub-Layers
- The relationship between EA and Enterprise Modelling concepts (the meta objects of the layers)
- How to work with Layers
- Layered Enterprise Architecture examples
Agenda: Modelling through LEAD

• Difficulty of EA modelling in domains (discussion on example TOGAF)
  • Layered Enterprise Architecture Development (LEAD)
  • Enterprise Architecture Layers
  • Enterprise Architecture Sub-Layers
  • The relationship between EA and Enterprise Modelling concepts (the meta objects of the layers)
  • How to work with Layers
  • Layered Enterprise Architecture examples
Difficulty of EA modelling in domains (discussion on example TOGAF)

- Working in Domains
- Inherently Linear
- Decomposition and composition is not ideal in a domain context
- Think and work simultaneously within and across domains
- It isn’t necessarily so that we start with A and then B, etc., for example:
  - Robotic automation starts with C, potentially
  - SAP starts with C…
  - Handheld device automation start with D…
  - Etc…
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- Layered Enterprise Architecture examples
The main principle behind the Layered Enterprise Architecture Development (LEAD) concept, and what makes it different from other, more traditional Enterprise Architecture frameworks, is the fact that it does not only work in domains, but across layers (business, information, and technology). The ability to work across layers and thereby simultaneously work within multiple domains through the use of the decomposition and composition of meta objects, effortlessly integrating the right objects across the different layers while interlinking the different enterprise modelling, engineering and architecture principles.

The Layered Enterprise Architecture Reference Content consists of the following:

- Business Layer
- Information Layer
- Technology Layer
Enterprise Architecture Layer: Business

BUSINESS LAYER
Enterprise Architecture Layer: Information
Enterprise Architecture Layer: Technology

- BUSINESS LAYER
- INFORMATION LAYER
- TECHNOLOGY LAYER
Enterprise Architecture Sub-Layer: Value Architecture

BUSINESS LAYER

Value

INFORMATION LAYER

TECHNOLOGY LAYER
Enterprise Architecture Sub-Layer: Capability Architecture

- BUSINESS LAYER
  - Value
  - Capability

- INFORMATION LAYER

- TECHNOLOGY LAYER

(C) LEADing Practice Layered Enterprise Architecture Reference Content [#LEAD-ES40001AL]
Enterprise Architecture Sub-Layer: Service Architecture

BUSINESS LAYER
- Value
- Capability
- Business Service

INFORMATION LAYER

TECHNOLOGY LAYER
Enterprise Architecture Sub-Layer:  
Process Architecture

<table>
<thead>
<tr>
<th>BUSINESS LAYER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value</strong></td>
</tr>
<tr>
<td><strong>Capability</strong></td>
</tr>
<tr>
<td><strong>Service</strong></td>
</tr>
<tr>
<td><strong>Process</strong></td>
</tr>
</tbody>
</table>

| INFORMATION LAYER |

| TECHNOLOGY LAYER |

(C)LEADing Practice Layered Enterprise Architecture Reference Content [#LEAD-ES40001AL]
Enterprise Architecture Sub-Layer: Application/Solution Architecture

**BUSINESS LAYER**

- Value
- Capability
- Service
- Process

**INFORMATION LAYER**

- Application

**TECHNOLOGY LAYER**
Enterprise Architecture Sub-Layer: Data Architecture

BUSINESS LAYER
- Value
- Capability
- Service
- Process

INFORMATION LAYER
- Application
- Data

TECHNOLOGY LAYER

© LEADing Practice Layered Enterprise Architecture Reference Content [#LEAD-ES40001AL]
Enterprise Architecture Sub-Layer: Platform Architecture

**BUSINESS LAYER**
- Value
- Capability
- Service
- Process

**INFORMATION LAYER**
- Application
- Data

**TECHNOLOGY LAYER**
- Platform

© LEADing Practice Layered Enterprise Architecture Reference Content [#LEAD-ES40001AL]
Enterprise Architecture Sub-Layer: Infrastructure Architecture

**BUSINESS LAYER**
- Value
- Capability
- Service
- Process

**INFORMATION LAYER**
- Application
- Data

**TECHNOLOGY LAYER**
- Platform
- Infrastructure
Agenda: Modelling through LEAD

- Difficulty of EA modelling in domains (discussion on example TOGAF)
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- Enterprise Architecture Layers
- Enterprise Architecture Sub-Layers

- The relationship between EA and Enterprise Modelling concepts (the meta objects of the layers)

- How to work with Layers
- Layered Enterprise Architecture examples
Business Layer: The Value Meta Objects

- Purpose & Goal
  - Force
  - Driver
  - Value Indicator
  - Value Expectation
  - Value Driver
  - Value Proposition
  - Performance Indicator
  - Performance Expectation
  - Performance Driver
  - Vision

- Mission
- Strategy
- Goal
- Objective
- Quality
- Risk
- Security
- Business Measure
- Report
- Timing
Business Layer: The Business Service Meta Objects
Business Layer: The Capability Meta Objects

BUSINESS COMPETENCY
- Organizational Construct
- Organizational Unit
- Business Area
- Business Group
- Business Capability
- Business Competency
- Resource
- Actor
- Business Role
- Business Function
- Business Owner

- Cost
- Revenue
- Business Object
- Product
- Contract
- Business Rule
- Business Compliance
- Location
- Business Channel
- Business Media
- Business Workflow
Business Layer: The Business Process Meta Objects

- Business Process
  - Process Area
  - Process Group
  - Business Process
  - Process Step
  - Process Activity
  - Event
  - Gateway
  - Process Flow
  - Process Role
  - Process Rule
  - Process Measurement
  - Process Owner
Application Layer: The Application Meta Objects

Application

- Logical Application Component
- Physical Application Component
- Application Module
- Application Feature
- Application Function
- Application Task
- Application Service
- Information Object
- Application Owner

Application/System Flow
System Measurement
Application/System Report
Application/System
Application Role
Application Rule
Application Compliance
Application Media
Application Channel
Application Layer: The Data Meta Objects

DATA
- Data Component
- Data Object
- Data Entity
- Data Table
- Data Service
- Data Flow

- Data Owner
- Data Rule
- Data Compliance
- Data Media
- Data Channel

Business Competency
Business Process
Infrastructure
Technology Layer: The Platform Meta Objects
Technology Layer: The Infrastructure Meta Objects

- Infrastructure Meta Objects
  - Logical Infrastructure Component
  - Physical Infrastructure Component
  - Infrastructure Device
  - Infrastructure Function
  - Infrastructure Feature
  - Infrastructure Service
  - Infrastructure Owner
  - Infrastructure Rule
  - Infrastructure Compliance
  - Infrastructure Media
  - Infrastructure Channel

Platform

Infrastructure
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- How to work with Layers
- Layered Enterprise Architecture examples
How to work with Layers

BUSINESS LAYER
- Value
- Capability
- Service
- Process

APPLICATION LAYER
- Application
- Data

TECHNOLOGY LAYER
- Platform
- Infrastructure
How to work with Layers:
Meta Objects and Layers
How to work with the Meta Objects through the Layers

The main principle behind the Layered Enterprise Architecture Development (LEAD) concept, and what makes it differ from other traditional Enterprise Architecture frameworks, is the fact that it does not only work in domains, but across layers (business, application and technology) within multiple domains through using the decomposition and composition method to integrate effortlessly across the different layers when interlinking the different modelling principles.

As shown in the example below, each layer’s specific Meta Object and the relations are defined by the specific layers requirements, the capability of the object, the resources, tasks and information. The functions that a layer provides can be seen as the layer’s services since a layer provides a set of functions and tasks and thereby services to its upper layer.

In turn, the upper layer uses the lower layer’s services (functionality and tasks) to achieve its own functions (services). The “n”th layer (+1 and/or – 1) can therefore be seen as a service requester or provider since it either gives input or uses the services provided by its lower layer.
How to work with the Meta Objects through the Layers

META OBJECT
Decompose objects

SERVICE TO LAYER N+1
Defined by needed requirements

LAYER N
Requirements, capabilities, resources, tasks and information

SERVICE TO LAYER N-1
Defined by needed requirements

Value (purpose & goal)

Capability

Business Services

Business Processes

Applications

Data

Platforms

Infrastructure
Layers with Levels (Contextual, Conceptual, Logical and Physical)

<table>
<thead>
<tr>
<th>Enterprise Layers</th>
<th>Enterprise Sublayers</th>
<th>COMPOSITION</th>
<th>DECOMPOSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Contextual</td>
<td>Logical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value MO</td>
<td>Value Stereotypes, Types and Subtypes</td>
</tr>
<tr>
<td>BUSINESS ARCHITECTURE</td>
<td>VALUE ARCHITECTURE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INFORMATION ARCHITECTURE</td>
<td>CAPABILITY ARCHITECTURE</td>
<td>Capability MO</td>
<td>Capability Stereotypes, Types and Subtypes</td>
</tr>
<tr>
<td>TECHNOLOGY ARCHITECTURE</td>
<td>SERVICE ARCHITECTURE</td>
<td>Service MO</td>
<td>Service Stereotypes, Types and Subtypes</td>
</tr>
<tr>
<td></td>
<td>PROCESS ARCHITECTURE</td>
<td>Process MO</td>
<td>Process Stereotypes, Types and Subtypes</td>
</tr>
<tr>
<td></td>
<td>APPLICATION ARCHITECTURE</td>
<td>Application MO</td>
<td>Application Stereotypes, Types and Subtypes</td>
</tr>
<tr>
<td></td>
<td>DATA ARCHITECTURE</td>
<td>Data MO</td>
<td>Data Stereotypes, Types and Subtypes</td>
</tr>
<tr>
<td></td>
<td>PLATFORM ARCHITECTURE</td>
<td>Platform MO</td>
<td>Platform Stereotypes, Types and Subtypes</td>
</tr>
<tr>
<td></td>
<td>INFRASTRUCTURE ARCHITECTURE</td>
<td>Infrastructure MO</td>
<td>Infrastructure Stereotypes, Types and Subtypes</td>
</tr>
</tbody>
</table>
Semantic Relations

Choose Source Layer
- Business
- Information
- Technology

Choose Source Sub-layer
- Application
- Data

Choose Target Layer
- Business
- Information
- Technology

Choose Target Sub-layer
- Purpose & Goal
- Business Competency
- Business Service
- Business Process

<table>
<thead>
<tr>
<th>Source Meta Object</th>
<th>Semantic Relationship</th>
<th>Target Meta Object</th>
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</thead>
<tbody>
<tr>
<td>Data Component</td>
<td></td>
<td>Report</td>
</tr>
<tr>
<td>Data Object</td>
<td>enables creation of</td>
<td>Report</td>
</tr>
<tr>
<td>Data Entity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Semantic Relations

<table>
<thead>
<tr>
<th>Source Meta Object</th>
<th>Semantic Relationship</th>
<th>Target Meta Object</th>
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</thead>
<tbody>
<tr>
<td>Application Component</td>
<td>specifies</td>
<td>Data Table</td>
</tr>
<tr>
<td>Application Module</td>
<td>uses</td>
<td>Data Table</td>
</tr>
<tr>
<td>Application Feature</td>
<td>implemented by</td>
<td>Data Table</td>
</tr>
<tr>
<td>Application Function</td>
<td>implemented by</td>
<td>Data Table</td>
</tr>
<tr>
<td>Application Task</td>
<td>uses</td>
<td>Data Table</td>
</tr>
</tbody>
</table>
# Information Layer Data Illustration (Robotic Automation)

<table>
<thead>
<tr>
<th>Enterprise Layer</th>
<th>Sub-Layer</th>
<th>Object Number</th>
<th>Meta Object (Class Type)</th>
<th>Level 1 (Description)</th>
<th>Level 2 (Stereotype)</th>
<th>Reference (Literature/Link)</th>
<th>Level 3 (Type)</th>
<th>Description</th>
<th>Reference (Literature/Link)</th>
<th>Level 3 (Sub Type)</th>
<th>Instance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>62</td>
<td>Data Object</td>
<td>A logical cluster of sets of related data representing the data object view of a business or information object.</td>
<td>Structured Data</td>
<td>Has been or can be placed in fields</td>
<td>Adapted from LEADING Practice Taxonomy</td>
<td>Meta Data</td>
<td>a set of data that describes and gives information about other data.</td>
<td></td>
<td>Deskriptive</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Master Data</td>
<td>Has been or can be placed in fields</td>
<td>Adapted from LEADING Practice Taxonomy</td>
<td>Transcational/Operational Data</td>
<td>data describing an event (the change as a result of a transaction)</td>
<td></td>
<td>GL Account</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Analytic Data</td>
<td>Has been or can be placed in fields</td>
<td>Adapted from LEADING Practice Taxonomy</td>
<td>Unstructured Data</td>
<td>a collection of data on business performance that is used to support decision making</td>
<td></td>
<td>SAP R/3 Data</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Email Text</td>
<td>Has been or can be placed in fields</td>
<td>Adapted from LEADING Practice Taxonomy</td>
<td>Email Text</td>
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</tr>
</tbody>
</table>


- SAP R/3 Data
  - T F 01: Financial Statements
  - T FS 10: GL Account Balances
  - T OD 08: Exchange Rates
- SAP Business Warehouse Data
  - Cost Accounts by LE and CC

Forecast One Data

Cost Accounts by Legal Entity and Cost Center
### Business Layer Purpose and Goal Illustration (Robotic Automation)

<table>
<thead>
<tr>
<th>Enterprise Layer</th>
<th>Sub-Layer</th>
<th>Object Number</th>
<th>Meta Object (ClassType) - Level 1</th>
<th>Description</th>
<th>Level 2 (Stereotype)</th>
<th>Reference (Literature/Link)</th>
<th>Level 3 (Type)</th>
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<tbody>
<tr>
<td>Business Layer</td>
<td>Purpose &amp; Goal</td>
<td>4</td>
<td>Value Proposition</td>
<td>Asset Utilization</td>
<td>Making practical and effective use of Assets</td>
<td>Adapted from LEADING Practice Taxonomy</td>
<td>Automation of Knowledge Work</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Time to Market</td>
<td>the length of time it takes from a product being conceived until its being available</td>
<td></td>
<td>Increased Performance and Reliability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Growth/Innovation</td>
<td>Make changes in something established, especially by introducing new methods, ideas, or products</td>
<td></td>
<td>Elimination of Human Error</td>
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<td>Human-Robot Collaboration</td>
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<td>Operational Efficiency</td>
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<td>Codification of Knowledge</td>
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<td>Rapid Automation and Simulation</td>
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<td>Open Innovation</td>
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<td>Better Application of Knowledge</td>
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<td>Diversion of Focus to Higher Value Work</td>
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<td>Increased Satisfaction</td>
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<td></td>
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<td>Production “re-shoring”</td>
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</table>
Illustration: Industry 4.0
### Illustration: Industry 4.0

<table>
<thead>
<tr>
<th>STEREOTYPE</th>
<th>TYPE</th>
</tr>
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<tbody>
<tr>
<td>SMART Transport</td>
<td>ITS, HEVs and Evs</td>
</tr>
<tr>
<td></td>
<td>Electronic Mobility</td>
</tr>
<tr>
<td></td>
<td>High Speed Trains</td>
</tr>
<tr>
<td>SMART Economy</td>
<td>Digital Economy, Block-Chain</td>
</tr>
<tr>
<td></td>
<td>Security, Global Trading</td>
</tr>
<tr>
<td></td>
<td>Crowdfunding and Investment</td>
</tr>
<tr>
<td>SMART Consumer</td>
<td>Crowd Purchase Consumer Trigger</td>
</tr>
<tr>
<td></td>
<td>Individual Production and Services</td>
</tr>
<tr>
<td></td>
<td>Digital Transformation</td>
</tr>
<tr>
<td>SMART Living</td>
<td>Entertaining, Leisure</td>
</tr>
<tr>
<td></td>
<td>Independence through Technology</td>
</tr>
<tr>
<td></td>
<td>Information when Needed</td>
</tr>
<tr>
<td></td>
<td>Connected when Needed</td>
</tr>
</tbody>
</table>
Illustration: Industry 4.0
<table>
<thead>
<tr>
<th>STEREOTYPE</th>
<th>TYPE</th>
<th>SUBTYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMART Apps</td>
<td>Intelligent Personal Assistant (IPA)</td>
<td>Voice queries assistant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natural Language App</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question User interface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intelligent Recommendations</td>
</tr>
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<td>Internet delegating requests</td>
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<td>Artificial Intelligence (AI) Apps</td>
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<td>Artificial Intelligence (AI) Apps</td>
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<tr>
<td>SMART home applications</td>
<td></td>
<td>Machine-learning Apps</td>
</tr>
<tr>
<td>Cloud Robotic Apps</td>
<td></td>
<td>Learning curve Apps</td>
</tr>
</tbody>
</table>
What else can be done with LEAD?

![Diagram showing layers of LEAD](image)

- **Business Layer**
  - Value
  - Capability
  - Service
  - Process

- **Application Layer**
  - Application
  - Data

- **Technology Layer**
  - Platform
  - Infrastructure
Blueprinting, Implementation, Requirement Management and Security is used across all Layers
Innovation & Transformation, Compliance, Risk and Governance is applied to all layers
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• How to work with Layers

• Layered Enterprise Architecture examples
LEAD Example: Service Orientation
Thank You

Dr Simon Polovina

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Web: www.polovina.me.uk

For more information on LEADing Practice:
www.LEADingPractice.com

OpenLEAD:
http://leadingpractice.com/about/openlead/