Introduction to Unified profile for DoDAAF and MODAF

Benefits of using **UPDM**

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Co-chair and one of the leading architects for the current OMG UPDM standard development group

Holds the following professional certificates:
- OMG Certified Expert in SysML (OCSMP)
- OMG Certified UML Professional
- OMG Certified Expert in BPM
- Professional Scrum Product Owner

Holds PhD. in Informatics Engineering
1. Introduction to UPDM

2. UPDM Benefits

3. Summary
Architecture Framework
UPDM

- UPDM is Unified Profile for DoDAF, MODAF, and NAF
- UPDM is NOT a new Architectural Framework
- UPDM is not a methodology or a process
- UPDM is an enterprise modeling language
- UPDM was developed by members of the OMG with help from industry and government domain experts
Standards
Unification

- Common metamodel to build DoDAF, MODAF, and NAF models
  - Viewpoints (e.g. Capability (DoDAF & NAF) vs. Strategic (MODAF))
  - Views (e.g. OV-2 Operational Resource Flow Description (DoDAF) vs. OV-2 Operational Node Relationship Description (MODAF) vs. NOV-2 Operational Node Connectivity Description (NAF))
  - Concepts (e.g. Performer (DoDAF) vs. Node (MODAF & NAF))
- Infrastructure for tools to be able to provide different environments for DoDAF, MODAF, NAF - underlying ontology is the same
- Easy transition among DoDAF, MODAF, and NAF models
Scope

- Whole Enterprise (multiple organizations)
- Single Organization
- Department
- Programme/Project
- Mission

MBSE
Why MBSE?

- No alternative standardized frameworks for MBSE
  - You always end-up using an architecture framework whether you want one or not, or whether you intend to or not
- Integration with existing OMG standards, e.g. SysML, UML
  - Integrated Architecture Repository
  - Application of engineering analysis methods
  - Interoperability
Outline

1. Introduction to UPDM

2. UPDM Benefits

3. Summary
## Patterns

<table>
<thead>
<tr>
<th>Structure</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types</td>
<td></td>
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<tr>
<td>Active</td>
<td>Individuals</td>
</tr>
<tr>
<td>Passive</td>
<td>Activities</td>
</tr>
</tbody>
</table>

- **Patterns:**
  - Usage - Definition
  - Typical - Actual
  - Behavior - Structure

  - Information Flows
  - Measurements
  - Traceability
OMG Ecosystem

- UML - traceability, extendibility, transition to IT architectures
- SysML - visualizations, parametrics, transition to systems design
- XMI - interoperability
- OCL - constraints
- fUML - simulation
- BPMN - notation
- SoaML - service oriented architecture

Best practices for building, using and governing models
OMG Ecosystem: Benefits

OMG Ecosystem enables:

• Standardized Visualizations
• Traceability
• Impact Analysis
• Coverage Analysis
• Requirements Compliance Analysis
• Trade Studies
• Simulation
Visualizations
Block Definition Diagram
Internal Block Diagram & Matrix
### Table

<table>
<thead>
<tr>
<th>#</th>
<th>Exchange ID</th>
<th>Needline ID</th>
<th>Operational Exchange Item</th>
<th>Sending Node</th>
<th>Receiving Node</th>
<th>Producing Operational Activity</th>
<th>Consuming Operational Activity</th>
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<tr>
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<td>Control Order</td>
<td>Tactical C2 Node</td>
<td>Search Node</td>
<td>Send Warning Order</td>
<td>Process Warning Order</td>
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<td>5</td>
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<td>Task</td>
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<td>7</td>
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<td>2</td>
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<td>Monitor Health</td>
<td>Provide Medical Assistance (Status Out: Medical Condition)</td>
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<td>Person In Distress</td>
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<td>Send Distress Signal</td>
<td>Receive Distress Signal</td>
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<td>3</td>
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<td>Send Distress Signal</td>
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<td></td>
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<tr>
<td>11</td>
<td>IE6</td>
<td>6</td>
<td>Track Info</td>
<td>Monitoring Node</td>
<td>Tactical C2 Node</td>
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<td></td>
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</tbody>
</table>
Chart
Traceability
Traceability

- Traces helps to organize cross-association (mapping) of elements within the various structures or hierarchies of user model
- Trace relationships, e.g. Implements, Exhibits help:
  - Navigate in a model
  - Ensure that various parts of the model are properly integrated
  - Assess user model consistency
  - Direct future model activities
  - Perform impact and coverage analysis
  - Associate different types or different hierarchy elements
Direct Traces

SV-5 Example

Operational Activity

Function

Implements

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Capability Structural Map Example

Maritime SAR

- Assistance
- Recovery

- Search

- Rescue Node
- Search Node

- Aircraft
- Augusta Westland 139
- Boat
- Helicopter
- Life Saving Device
- Lighting Device
- Maritime Rescue Unit
- Maritime Rescue Unit V2
- MRT Swimmer

- Aircraft
- Augusta Westland 139
- Boat
- Fixed Wing Aircraft
- MRT Communicator
- MRT Searcher
- Naval Ship

Legend

- Implemented By
- Is Composed Of Capabilities
- Is Composed Of System Resources
- Is Exhibited By Node
Capability Behavioral Map Example
Indirect Traces

• Indirect traces based on transitive relationships
• There is a number of predefined indirect traces in UPDM
• Indirect traces can be used to:
  • build graphs (visual analysis)
  • construct matrices
  • perform impact analysis
  • navigate in the model
Indirect Traces Example
Impact Analysis
Impact Analysis

- Change impact analysis (IA) is for:
  - identifying the potential consequences of a change
  - estimating what needs to be modified to accomplish a change
- Impact analysis is usually performed on Requirements, Nodes and Resources
- Analysis identifies all connections and traces from and to the element
Impact Analysis on Node Role

Legend
- Exhibits Capability by Type
- Inputs
- Outputs
- Performs Operational Activity By...
- Multiple criteria

- Search
  - Searcher: Search Node
  - Process Warning Order
  - Transit to SAR Operation
- Recovery
  - SAR AC: SAR Asset Controller
  - Victim: Person in Distress
  - Provide Medical Assistance
  - Receive Distress Signal
  - Recover Victim
  - Rescue
- Rescuer DS: Rescue Node Day Shift
  - Searcher: Search Node
  - Victim: Person in Distress
- Rescuer NS: Rescue Node Night Shift
  - Searcher: Search Node
  - Victim: Person in Distress
- SAR AC: SAR Asset Controller
- TC2N: Tactical C2 Node
- MN: Monitoring Node
  - Search & Rescue: Medical Condition, Updated Location
- Victim: Person in Distress
  - Monitor Health
  - Receive Distress Signal
  - Search
  - Send Warning Order

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Impact Analysis on Resource Role

Legend

- Implements By Type
- Inputs
- Outputs
- Performs Function By Type
- Multiple criteria

Person In Distress
- RN ASR Helo
- Yacht
- Broadcast Message
- Receive Distress Signal
- Receive Message
- Receive Track Information
- Send Message
- Send TDM
- Send Track Information

Yacht
- Receive Distress Signal
- Receive TDM
- Receive Track Information
- Send Track Information

RNLI Lifeboat
- Broadcast Message
- Receive Message
- Transmit Distress Signal
Coverage Analysis
Visual Coverage Analysis

- **Visual coverage** analysis can be performed using traceability matrices
- It helps to identify:
  - Redundant elements
  - Imprecisely defined elements
  - Missing relationships
## Visual Coverage Analysis Example

### 03-Functional Architecture

<table>
<thead>
<tr>
<th>Requirement</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
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<th>12</th>
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<td>X</td>
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<td>F02 Cash Deposit</td>
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<td>F03 Money Transfer</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>F04 Balance Inquiry</td>
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</table>

### 04-Usability Objectives

<table>
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<tr>
<th>Requirement</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
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<td>U01 Easy to Learn</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
</tr>
<tr>
<td>U02 Reduce Service Time</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<td>U03 One Customer at a Time</td>
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<td>X</td>
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<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Numerical Coverage Analysis

• Coverage percentage helps to identify overall status of implementation, e.g. implemented nodes, exhibited capabilities, satisfied requirements etc.

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Capability Count</th>
<th>Capability Covered By Node Percentage</th>
<th>Capability Covered By Node Count</th>
<th>Node Count</th>
<th>Capability Covered By Node Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2014.11.26 00.32</td>
<td>11</td>
<td>18.18</td>
<td>2</td>
<td>2</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Requirements Compliance Analysis
Requirements Compliance Analysis

- Automated constraints, e.g. OCL (Object Constraint Language) to verify Capability Requirements
Constraints Verification
Tradestudies
Why Trade Studies?

1. Capability
2. Operational Scenario
3. Capability Configuration
SysML engineering analysis methods onto UPDM models, e.g. parametrics, behavioral execution, trade studies etc.

SysML Parametric Diagram

NOV-4 Typical
Trade Studies

• **Examining** various design alternatives by comparison

• Serve as a basis to integrate with more advanced analytical tools and techniques in accordance with the INCOSE Model-Based Systems Engineering (MBSE) vision in which all the analysis is carried out in the context of design models.

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### Rotary Pump variants

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Flow Rate</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Variant 1</td>
<td>200.0</td>
<td>0.2</td>
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<tr>
<td>2</td>
<td>Variant 2</td>
<td>180.0</td>
<td>0.19</td>
</tr>
<tr>
<td>3</td>
<td>Variant 3</td>
<td>300.0</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>Variant 4</td>
<td>150.0</td>
<td>0.14</td>
</tr>
<tr>
<td>5</td>
<td>Variant 5</td>
<td>300.0</td>
<td>0.34</td>
</tr>
</tbody>
</table>

### Energy consumption tests

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Time To Fill</th>
<th>Energy To Fill</th>
<th>Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Case 1: Coffee Machine</td>
<td>16</td>
<td>8.88888888888889</td>
<td>false</td>
</tr>
<tr>
<td>2</td>
<td>Case 2: Coffee Machine 1</td>
<td>16</td>
<td>8.0</td>
<td>false</td>
</tr>
<tr>
<td>3</td>
<td>Case 3: Coffee Machine 2</td>
<td>5.0</td>
<td>9.58333333333332</td>
<td>true</td>
</tr>
<tr>
<td>4</td>
<td>Case 4: Coffee Machine 3</td>
<td></td>
<td>6.11111111111111</td>
<td>false</td>
</tr>
<tr>
<td>5</td>
<td>Case 5: Coffee Machine 4</td>
<td></td>
<td></td>
<td>true</td>
</tr>
</tbody>
</table>

### Requirement

```
Id = "1"
Text = "Energy consumption should not exceed 7 Wh"
```

### Formal Constraint

```
ec : Real
r : Boolean
{ r = ec < 7 }
```

**The best alternative**
Simulation
The purpose of a simulation is to gain system (Organization, Hardware, Software, Data, Procedure, Facility, Person etc.) understanding without manipulating the real system, either because it is not yet defined or available, or because it cannot be exercised directly due to cost, time, resources or risk constraints.

Functional Simulation on UPDM models is performed using OMG fUML standard.

fUML can be used to validate system behavior by executing, animating, and debugging UPDM UPDM Activity (OV-5, SV-4) Diagrams.
Simulation
1. Introduction to UPDM

2. UPDM Benefits

3. Summary
Method. Language. Toolset
Modeling Solution is a combination of a modeling language(s), a methodology and a modeling tool that together provide a productive infrastructure for applying model-driven development in the context of a particular organization.
Modeling Culture

High Value from Modeling and Models
The Truth is in the Models

Thank You!

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