WELCOME
SCARECROW CONSULTANTS
A Model-based Approach to Architectural Frameworks

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Overview

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1. Introduction - What Are AFs and Why Are They Important?

• Architectures are now seen as essential to any systems engineering undertaking
  – Core element of any model-based systems engineering (MBSE) approach

• An architecture should cover both the structural and behavioural aspects of the system
  – Often only structure considered

• An architecture must be seen and treated as an evolving artefact
  – Too often created (at great expense) and then forgotten

• Architectures should be based on an architectural framework (AF)
What Are AFs and Why Are They Important?

• An AF defines:
  – Viewpoints of a system that any architecture based on the AF can contain
  – Consistency rules between the viewpoints

• The use of an AF helps to ensure a consistent approach to the production of an architecture
  – Views that can be produced are defined
  – Engineers know what is expected of them and
  – Helps ensure that the architecture is fit for purpose by ensuring that all the concerns that the architecture must address are covered
The Problem with the Existing Approach To AFs

• Many AFs exist
  – MODAF, DoDAF, NAF
  – TRAK
  – Zachman etc.

• Many organisations will adopt one of these AFs for the development of their system architecture

• Unfortunately, this is often done without first assessing the stakeholder concerns that the architecture is to address against the viewpoints defined in the chosen AF

• Results in the adoption of an unsuitable AF that unnecessarily constrains or twists the resulting architecture
The Problem with the Existing Approach To AFs

• For example, consider MODAF
  – Created to assist the MOD in acquisition of systems
  – BUT often used by suppliers when creating architectures internally (i.e. for their own internal system development work)

• Often done without any consideration as to whether MODAF defines viewpoints that address the concerns that their architecture must capture

• Results in architectures that are:
  – Very good examples of MODAF architectures
  – Not fit for purpose as system engineering architectures

• If the stakeholder concerns are considered by an organisation, then the conclusion may be that a bespoke AF is needed
2. The Framework for Architectural Frameworks (FAF)

- The FAF was developed to improve the definition of Architectural Frameworks (AFs)
- The FAF is designed to force anyone defining an AF to consider the following six questions:
  - What is the purpose of the AF?
  - What domain concepts must the AF support?
  - What viewpoints are required?
  - What is the purpose of each viewpoint?
  - What is the definition of each viewpoint in terms of the identified domain concepts?
  - What rules constrain the use of the AF?
The Framework for Architectural Frameworks (FAF)

• The FAF addresses the six questions through an MBSE approach based around the ideas of ontology, viewpoints and framework
• Ontology
  – Define concepts and relationships between them
• Viewpoints and Framework
  – Define viewpoints organised into a framework
  – Viewpoints can only use concepts from the ontology
• Consists of:
  – An ontology
  – Six viewpoints
  – Supporting processes
• The FAF is defined using the FAF
• Can also be used to define so-called enabling patterns
The FAF Ontology
The FAF Viewpoints – Ontology Areas
The FAF Viewpoints

• AF Context Viewpoint (AFCV)
  – What is the purpose of the AF?
    • Defines the context for the AF
    • Represents the AF concerns in context, establishing why the AF is needed

• Ontology Definition Viewpoint (ODV)
  – What domain concepts must the AF support?
    • Defines the ontology for the AF
    • Derived from the AF Context Viewpoint & and defines concepts that can appear on a Viewpoint

• Viewpoint Relationships Viewpoint (VRV)
  – What viewpoints are required?
    • Shows the relationships between the Viewpoints that make up an AF
    • Groups them into perspectives. It is derived from the Ontology Definition Viewpoint
The FAF Viewpoints continued

• Viewpoint Context Viewpoint (VCV)
  – What is the purpose of each viewpoint?
    • Defines the context for a particular Viewpoint
    • Represents the Viewpoint concerns in context for a particular Viewpoint, establishing why the Viewpoint is needed. It is derived from the AF Context Viewpoint

• Viewpoint Definition Viewpoint (VDV)
  – What is the definition of each viewpoint in terms of the identified domain concepts?
    • Defines a particular Viewpoint
    • Shows the Viewpoint Elements (and hence the Ontology Elements) that appear on the Viewpoint

• Rules Definition Viewpoint (RDV)
  – What rules constrain the use of the AF?
    • Defines the various rules that constrain the AF
The FAF Viewpoints

![Diagram](image)

-The Rules Definition Viewpoint is related to ALL the other Viewpoints and defines the Rules that constrain the Architectural Framework. Relationships to other Viewpoints are omitted from this diagram for clarity.

The diagram illustrates the relationships between the following viewpoints:

- **AF Context Viewpoint**
- **Ontology Definition Viewpoint**
- **Rules Definition Viewpoint**
- **Viewpoint Context Viewpoint**
- **Viewpoint Definition Viewpoint**
- **Viewpoint Relationships Viewpoint**

The diagram shows how viewpoints are derived from each other and how they define relationships and constraints within the Architectural Framework. The viewpoint context viewpoint defines viewpoints using elements from other viewpoints. The viewpoint definition viewpoint defines viewpoints to meet the needs of the context viewpoint. The viewpoint relationships viewpoint defines relationships between viewpoints defined in other viewpoints.
# Realising the FAF with SysML

<table>
<thead>
<tr>
<th>Viewpoint</th>
<th>SysML Diagram Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF Context Viewpoint (AFCV)</td>
<td>Use Case Diagram</td>
</tr>
<tr>
<td>Ontology Definition Viewpoint (ODV)</td>
<td>Block Definition Diagram</td>
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<tr>
<td>Viewpoint Relationships Viewpoint (VRV)</td>
<td>Block Definition Diagram [1]</td>
</tr>
<tr>
<td>Viewpoint Context Viewpoint (VCV)</td>
<td>Use Case Diagram</td>
</tr>
<tr>
<td>Viewpoint Definition Viewpoint (VDV)</td>
<td>Block Definition Diagram</td>
</tr>
<tr>
<td>Rules Definition Viewpoint (RDV)</td>
<td>Block Definition Diagram [2]</td>
</tr>
</tbody>
</table>

[1] Use packages to show Perspectives  
[2] Although a simple text “diagram” could be used, the use of blocks gives us something in the model that can be the source or target of traceability
3. The FAF in Use – ACRE

The image shows a UML diagram illustrating the relationship between viewpoints in the Architectural Framework (FAF). The diagram includes viewpoints such as AF Context Viewpoint, Ontology Definition Viewpoint, Viewpoint Definition Viewpoint, Viewpoint Relationships Viewpoint, and Rules Definition Viewpoint. The diagram explains that the Rules Definition Viewpoint is related to all other viewpoints and defines the rules that constrain the Architectural Framework. Relationships to other viewpoints are omitted for clarity.

The diagram also highlights the roles of MBSE Champion, Requirement Engineer, Tester, Standard, Requirement Manager, and Customer, showing how they support capture of needs, requirements, capabilities, goals, and contexts.

The diagram emphasizes the importance of being model-based, complying with standards, identifying sources of needs, ensuring consistent style, and considering needs in context. It also mentions defining validation approach and identifying contexts as critical activities.
The FAF in Use – ACRE

The Rules Definition Viewpoint is related to ALL the other Viewpoints and defines the Rules that constrain the Architectural Framework. Relationships to other Viewpoints are omitted from this diagram for clarity.
The FAF in Use – ACRE

The Rules Definition Viewpoint is related to ALL the other Viewpoints and defines the Rules that constrain the Architectural Framework. Relationships to other Viewpoints are omitted from this diagram for clarity.

1 defines viewpoint to meet needs from

1 defines relationships between viewpoints defined in

1 defines context for

1 defines needs in context from

1 identifies sources of needs on

1 defines constraints on descriptions of needs on

1 validates use case on

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The FAF in Use – ACRE

The Rules Definition Viewpoint is related to all the other Viewpoints and defines the Rules that constrain the Architectural Framework. Relationships to other Viewpoints are omitted from this diagram for clarity.

- ACRE01: Each Source Element in the Source Element View must be traceable to one or more Need Description in the Requirement Description View.
- ACRE02: Each Need Description in the Requirement Description View must be traceable to one or more Source Element in the Source Element View.
- ACRE03: Rules, when they exist, must apply to a Need Description.
- ACRE04: Each Stakeholder Role on a Requirement Context View must be related to at least one Use Case or other Stakeholder Role.
- ACRE05: Each Need Description must be related to at least one Use Case.
- ACRE06: The Need Description Views must relate to a Requirement Context View.
- ACRE07: Each Need Description must have a full set of attributes defined.
- ACRE08: Each Rule must apply to at least one Need Description attribute or the Need Description itself.
- ACRE09: Each Need Description may be constrained by zero or more Rules.

Each Source Element in the Source Element View must be traceable to one or more Need Description in the Requirement Description View.

Each Need Description in the Requirement Description View must be traceable to one or more Source Element in the Source Element View.

Rules, when they exist, must apply to a Need Description.

Each Stakeholder Role on a Requirement Context View must be related to at least one Use Case or other Stakeholder Role.

Each Need Description must be related to at least one Use Case.

The Need Description Views must relate to a Requirement Context View.

Each Need Description must have a full set of attributes defined.

Each Rule must apply to at least one Need Description attribute or the Need Description itself.

Each Need Description may be constrained by zero or more Rules.
The FAF in Use – ACRE

The Rules Definition Viewpoint is related to ALL the other Viewpoints and defines the Rules that constrain the Architectural Framework. Relationships to other Viewpoints are omitted from this diagram for clarity.

1. Requirement Description Viewpoint
   - Support capture of needs
   - Support capture of goals
   - Support capture of capabilities
   - Must be model-based
   - is derived from Requirement Engineer
   - «stakeholder role» MBSE Champion

AF Context Viewpoint
- is derived from Viewpoint Context Viewpoint
- «viewpoint» Viewpoint Context Viewpoint
- «viewpoint» AF Context Viewpoint
- 1..* defines viewpoints using elements from
- «viewpoint» Viewpoint Context Viewpoint
- «viewpoint» AF Context Viewpoint
- «perspective» Architectural Perspective

Support capture of needs
- «constrain» Requirement Definition Viewpoint

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The FAF in Use – ACRE

The Rules Definition Viewpoint is related to ALL the other Viewpoints and defines the Rules that constrain the Architectural Framework. Relationships to other Viewpoints are omitted from this diagram for clarity.

1 is derived from 1
1 defines relationships between viewpoints defined in
1
1 defines viewpoint to meet needs from
1
1 is derived from
1

The FAF in Use – ACRE
The FAF in Use

• Automotive
• Home entertainment
• Rail
• Fault modelling
• Research
• Enabling patterns
4. Conclusions

• When creating a system architecture, the use of an AF can help ensure
  – Consistency of approach
  – Coverage of the correct architectural concerns

• Choice of AF must be made to ensure that concerns can be addressed by an architecture based on the AF
  – Not always the case
  – This may require the creation of a bespoke AF
Conclusions

• An MBSE approach to definition of an AF allows the AF to be created using the same tools and techniques as are used in an MBSE approach to the definition of the system
• The FAF provides such an approach to the definition of AFs
• FAF Used successfully by Scarecrow and other organisations in the definition of AFs in a range of application domains including:
  – Automotive
  – Home entertainment
  – Fault-modelling
  – Rail
  – Research
• FAF is being used by Scarecrow & INCOSE MBSE Working Group in ongoing work on the definition of enabling patterns for system engineering.
5. References & Further Information

• The key references used in this work are:
References & Further Information

• The key references used in this work are:
6. Questions
Contact us....

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