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## A Model-based Approach to Architectural Frameworks

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## Overview

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2. The Framework for Architectural Frameworks (FAF)
3. The FAF in Use
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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?

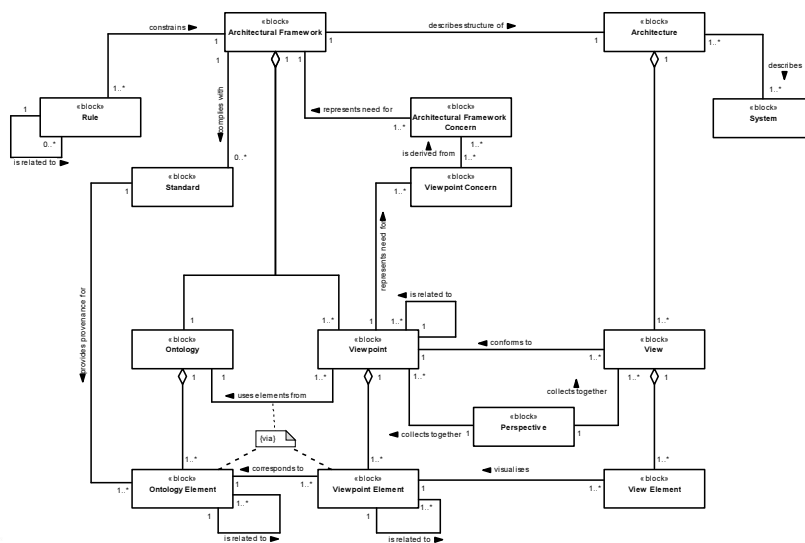


## The Framework for Architectural Frameworks (FAF)

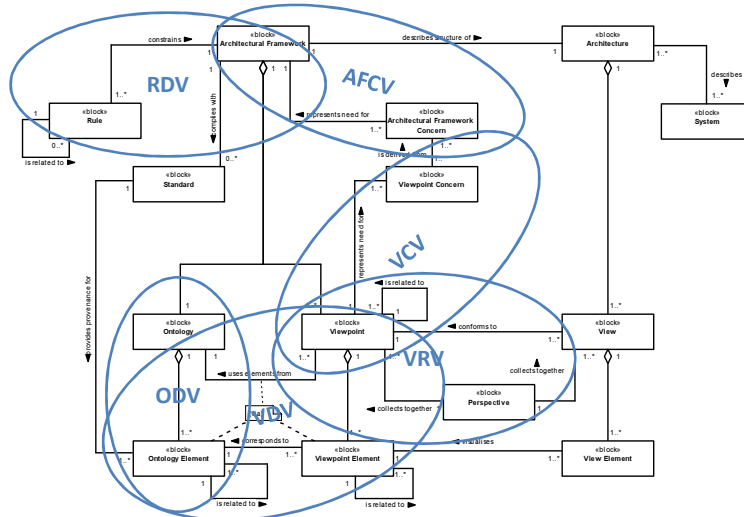
- The FAF addresses the six questions through an MBSE approach based around the ideas of ontology, viewpoints and framework
- Ontology
  - Define concepts and relationships between them
- Viewpoints and Framework
  - Define viewpoints organised into a framework
  - Viewpoints can only use concepts from 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

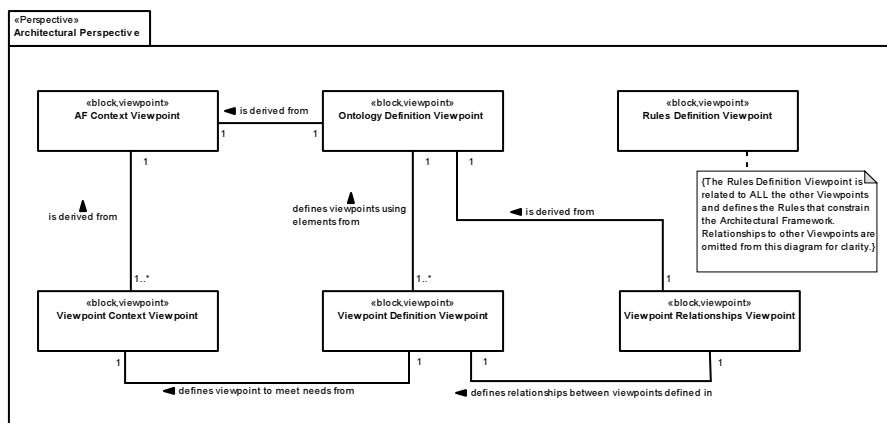
- **AF Context Viewpoint (AFCV)**
  - What is the purpose of the AF?
    - Defines the context for the AF
    - Represents the AF concerns in context, establishing why the AF is needed
- **Ontology Definition Viewpoint (ODV)**
  - What domain concepts must the AF support?
    - Defines the ontology for 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



# Realising the FAF with SysML

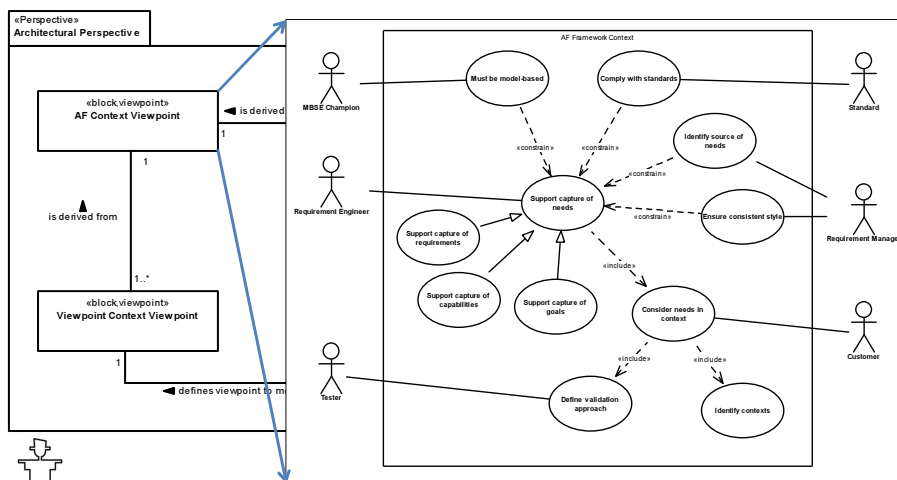
Viewpoint	SysML Diagram Used
AF Context Viewpoint (AFCV)	Use Case Diagram
Ontology Definition Viewpoint (ODV)	Block Definition Diagram
Viewpoint Relationships Viewpoint (VRV)	Block Definition Diagram <sup>[1]</sup>
Viewpoint Context Viewpoint (VCV)	Use Case Diagram
Viewpoint Definition Viewpoint (VDV)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

[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

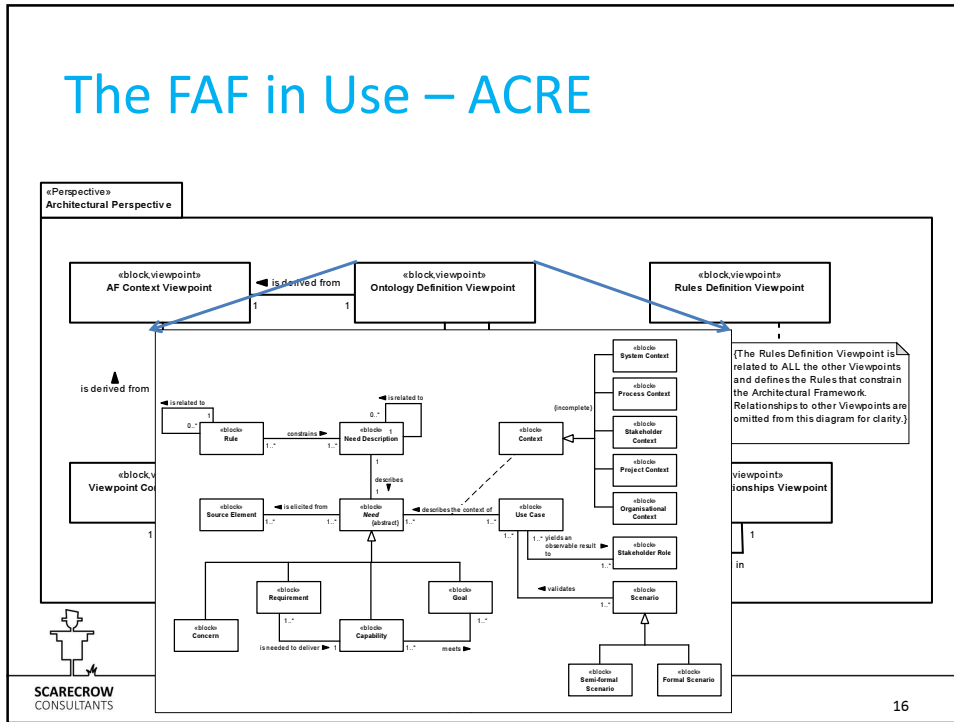


## 3. The FAF in Use – ACRE

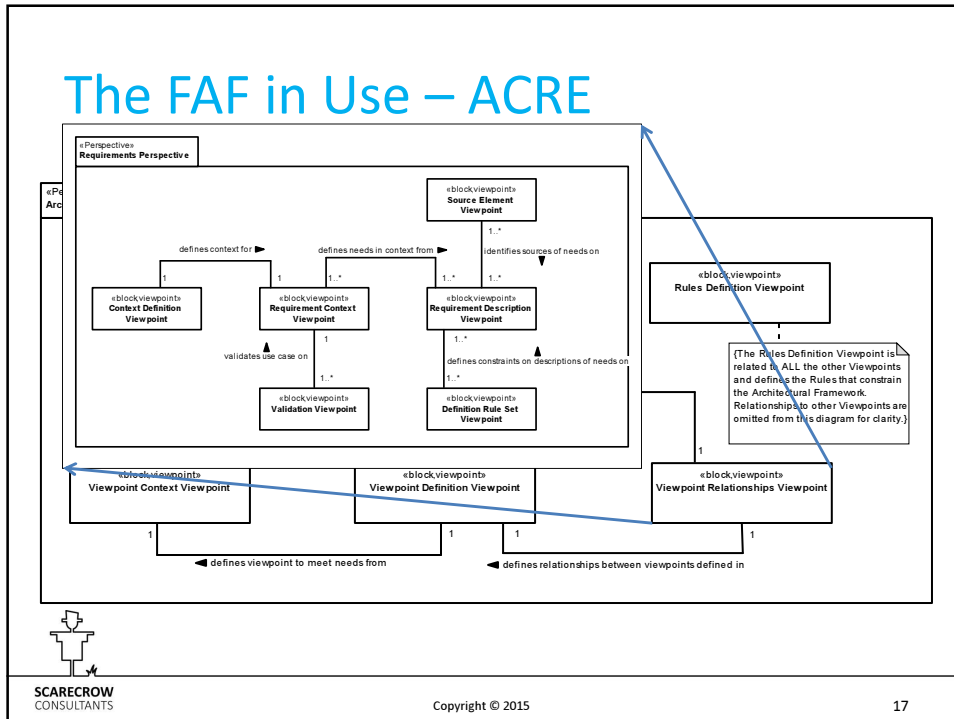




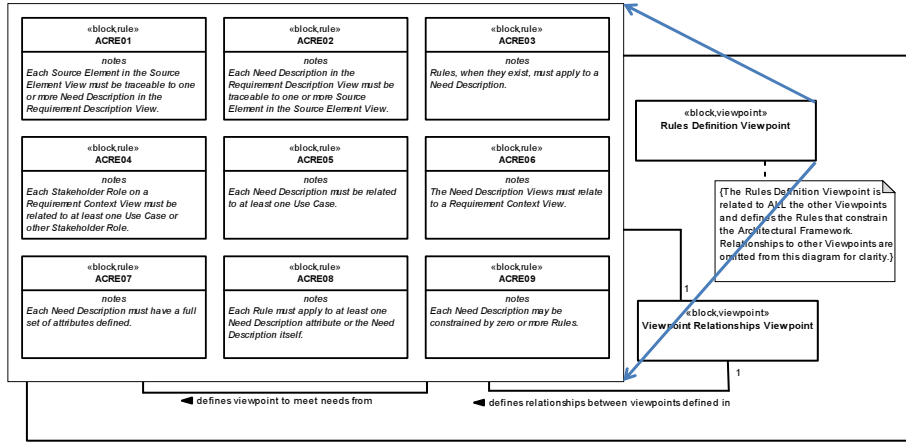
# The FAF in Use – ACRE



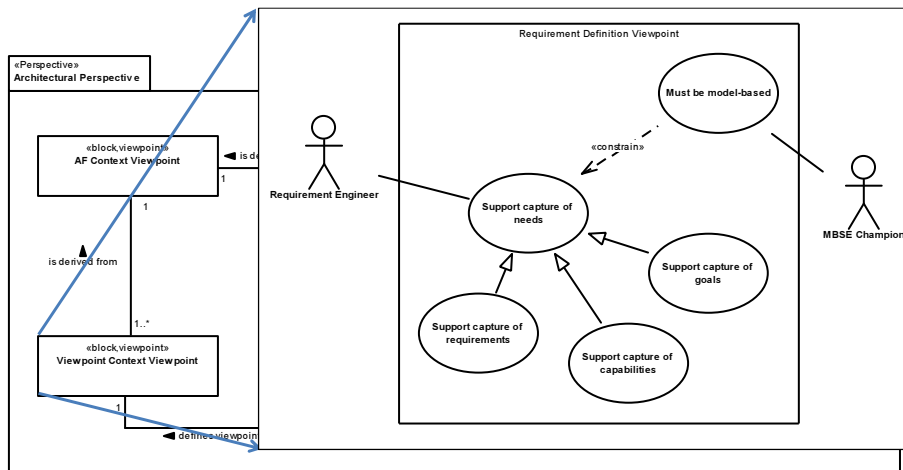
# The FAF in Use – ACRE



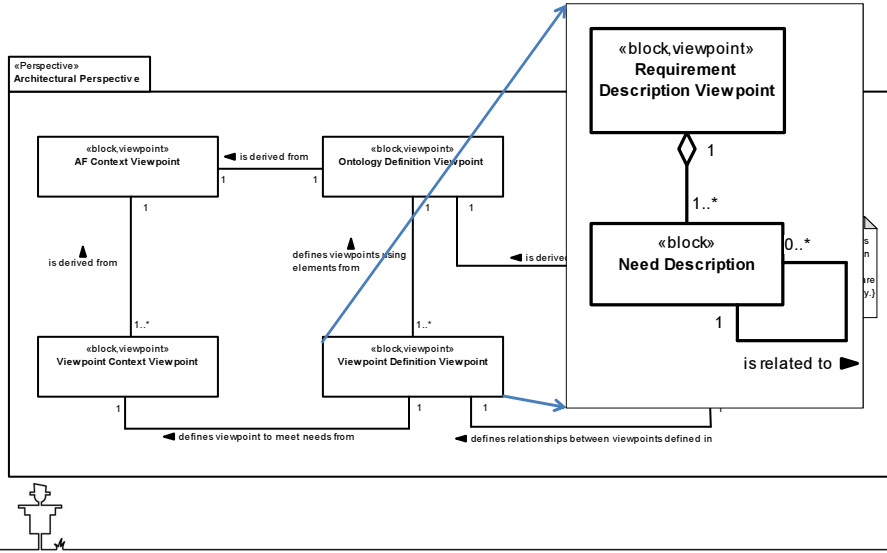
# The FAF in Use – ACRE



# The FAF in Use – ACRE



## 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:
  - Dickerson, C.E. & Mavris, D.N. 'Architecture and Principles of Systems Engineering'. CRC Press, 2009
  - INCOSE. 'Systems Engineering Handbook - A Guide For System Life Cycle Processes And Activities'. Version 3.2.2, INCOSE; 2011
  - ISO/IEC. 'ISO/IEC 15288:2008 Systems and software engineering – System life cycle processes'. 2nd Edn, International Organisation for Standardisation; 2008
  - ISO/IEC. 'ISO/IEC 42010:2011 Systems and software engineering — Architecture description'. International Organisation for Standardisation; 2011



## References & Further Information

- The key references used in this work are:
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  - Stevens, R., Brook, P., Jackson, K. & Arnold, S. 'Systems Engineering – coping with complexity'. London: Prentice Hall Europe; 1998
  - Zachman, J.A. 'Concise Definition of the Zachman Framework'. Zachman International; 2008. Available from <http://www.zachman.com/about-the-zachman-framework/>; Accessed November 2012
  - Holt, J, Perry, S & Brownsword, M. 'Model-Based Requirements Engineering'. IET Publishing, 2011



## 6. Questions



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