Overview of the ESA Architecture Framework

Anthony Walsh, ESA/ESOC

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1. ESA Architecture Framework Objectives

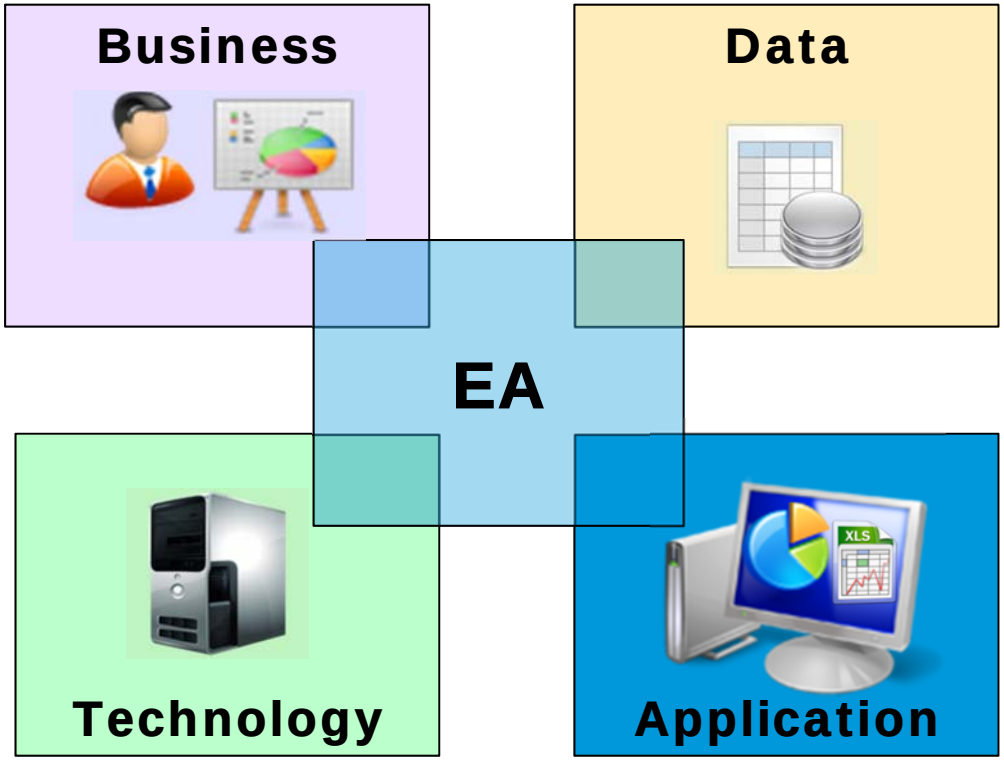
Deliver a solid base for enterprise architecting and systems of systems (SoS) engineering in the space domain by establishing a common architecture definition language and processes tailored to ESA's needs as well as associated exploitation best-practices

2. Introduction: Enterprise Architecture

Enterprise Architecture:

describes current and future structure and behaviour of organization's processes, technology, applications, and data aligned with the organization's core goals and strategic direction

→ ***brings together business and technical perspectives***

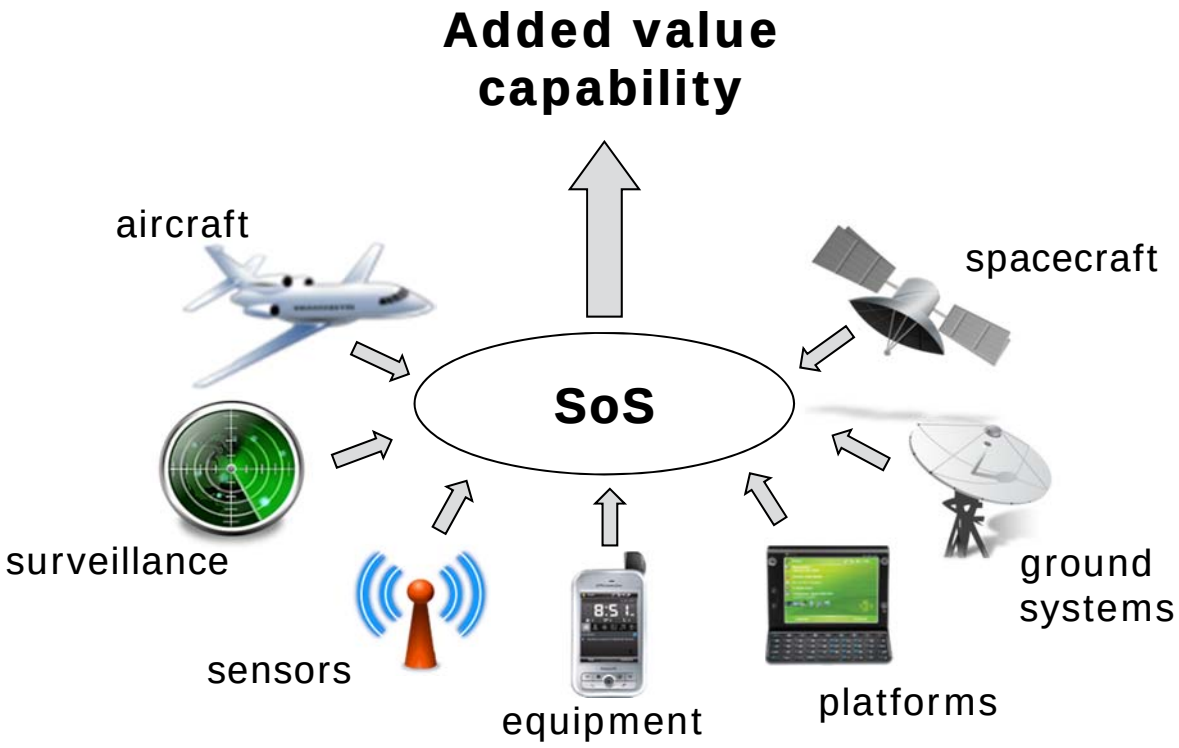


2. Introduction: System of Systems Engineering

Systems of systems:

“large scale integrated systems that are heterogeneous and independently operable on their own, but are networked together for a common goal”

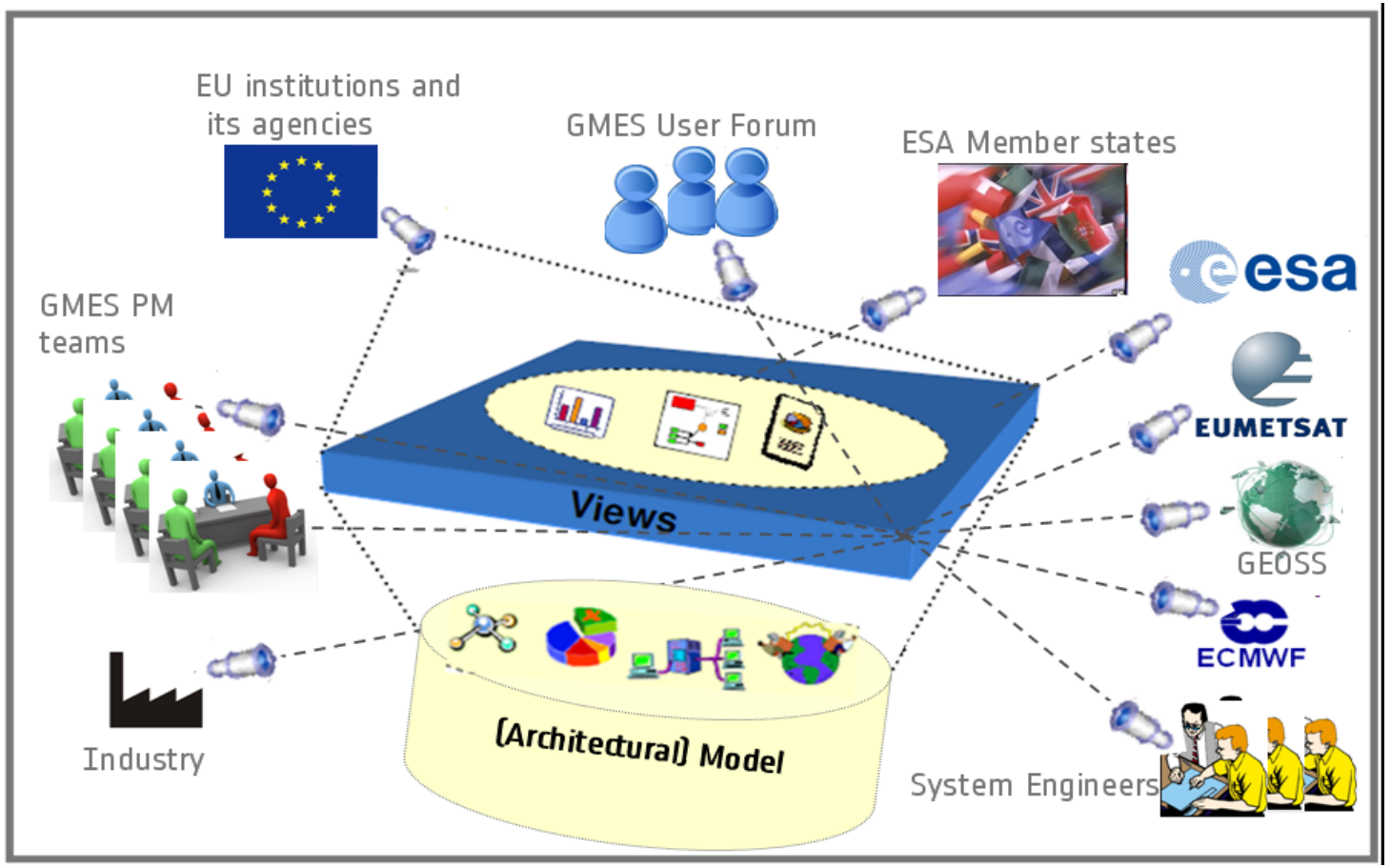
Jamshidi, M., Systems of Systems Engineering: Innovation for the 21th Century, Wiley, 2009



3. Benefits of Enterprise Architecture and System of Systems Engineering for ESA

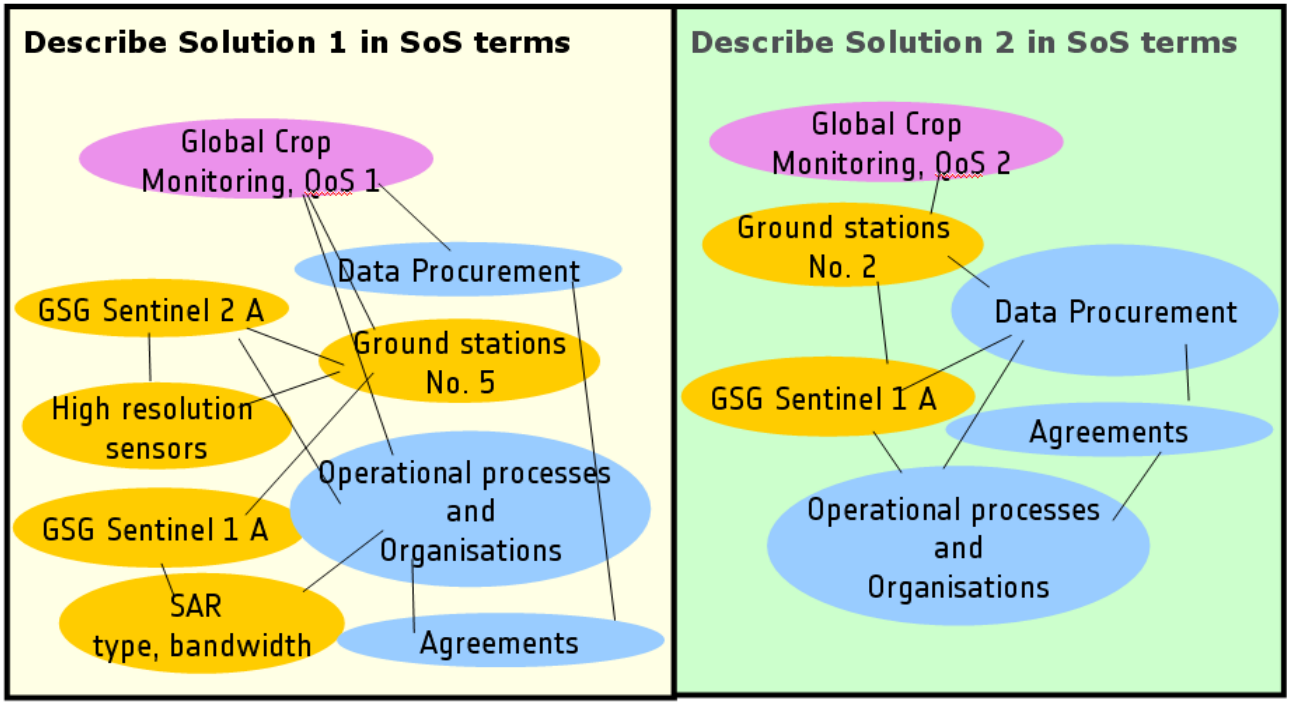
Mediation between multiple stakeholders

→ *establish common understanding*



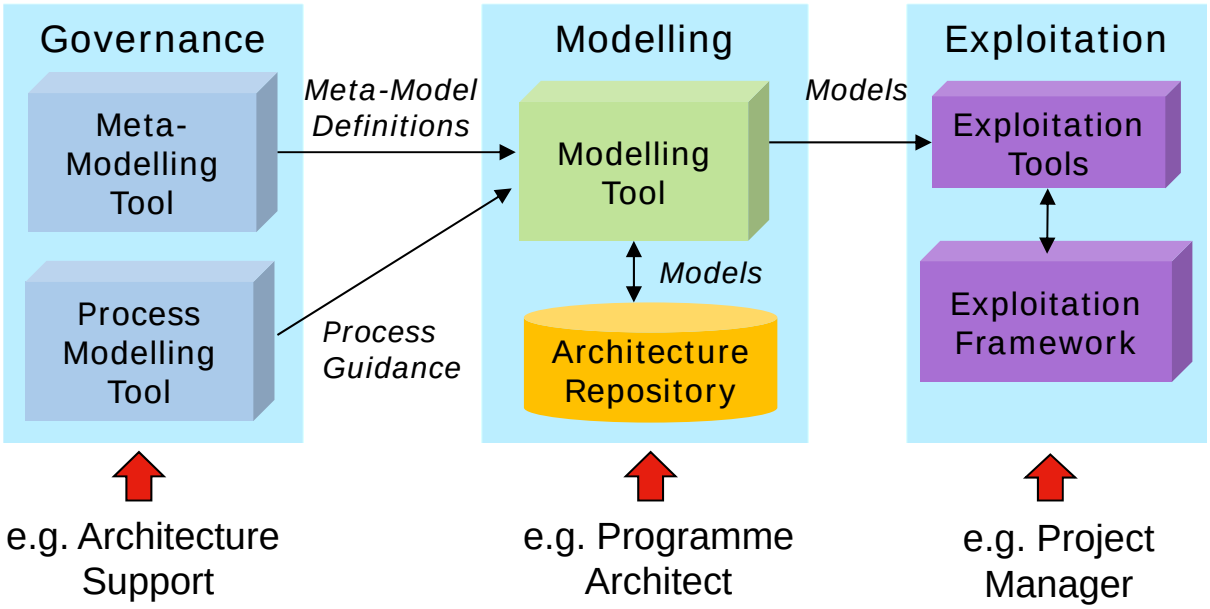
3. Benefits of Enterprise Architecture and System of Systems Engineering for ESA

- Repository of corporate knowledge
- Identification of procurement boundaries
- Systematic approach to architecting
- Facilitate gap-analysis
- Perform impact and trade-off analysis
- Manage systems migration in a structured manner
- Foster innovation

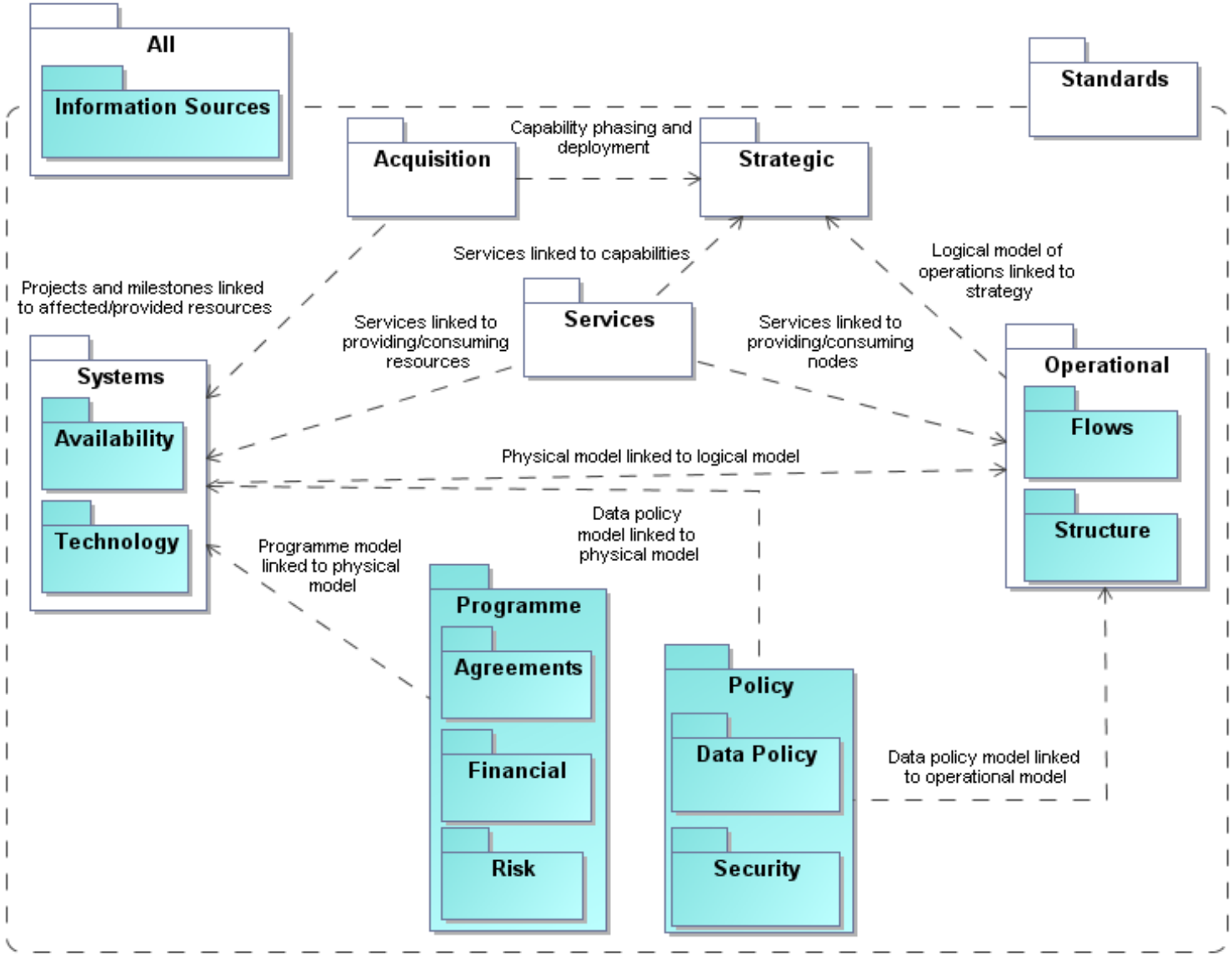


4. ESA Architecture Framework (ESA-AF) Overview

- Model-Driven Approach driven by Conceptual Data Model
- Meta-model based on extension of established UML based industry standard – Unified Profile for DoDAF/MODAF (UPDM)
- Exchange of reusable models in central repository
- Powerful exploitation framework with ad-hoc diagramming and reporting
- Considerable development effort (> 7 man years during last 5 years)

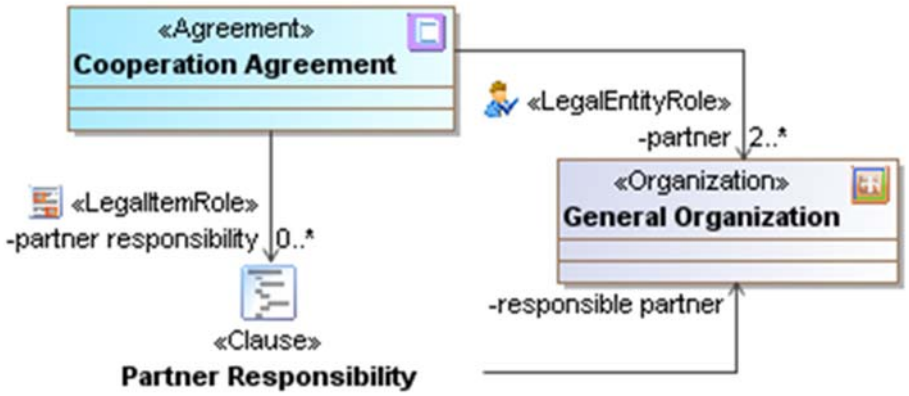


5. ESA-AF Meta-Model: UPDM + ESA-AF Extensions



6. ESA-AF Modelling

- UML based modeling using Magic Draw UML tool
  - Standards conformant (e.g. XMI)
  - Extensible
- Supported through ESA-AF profile and Magic Draw customizations generated from meta-model (e.g. Diagrams)
- ESA-AF Magic Draw plugins additionally provide:
  - Configurable diagram and element formatting
  - Validation suite based on Object Constraint Language (OCL) 2.0 constraints



7. ESA-AF Model Exploitation

- **Purpose**
  - **Provides ad-hoc diagramming and reporting capabilities suitable for business users**
  - **Support for enhanced decision making during evaluation of architecture options, impact or trade-off analysis at project or programme level**
  - **WSDL generation from service definitions**
- **Solution**
  - **Eclipse based framework**
  - **Diagramming based on Eclipse Graphical Modelling Framework (GMF)**
  - **Reporting based on the Business Intelligence and Reporting Tools (BIRT)**
    - **Data access based on Eclipse Data Tools Platform (DTP) Open Data Access (ODA)**

7. ESA-AF Exploitation: Reporting Example

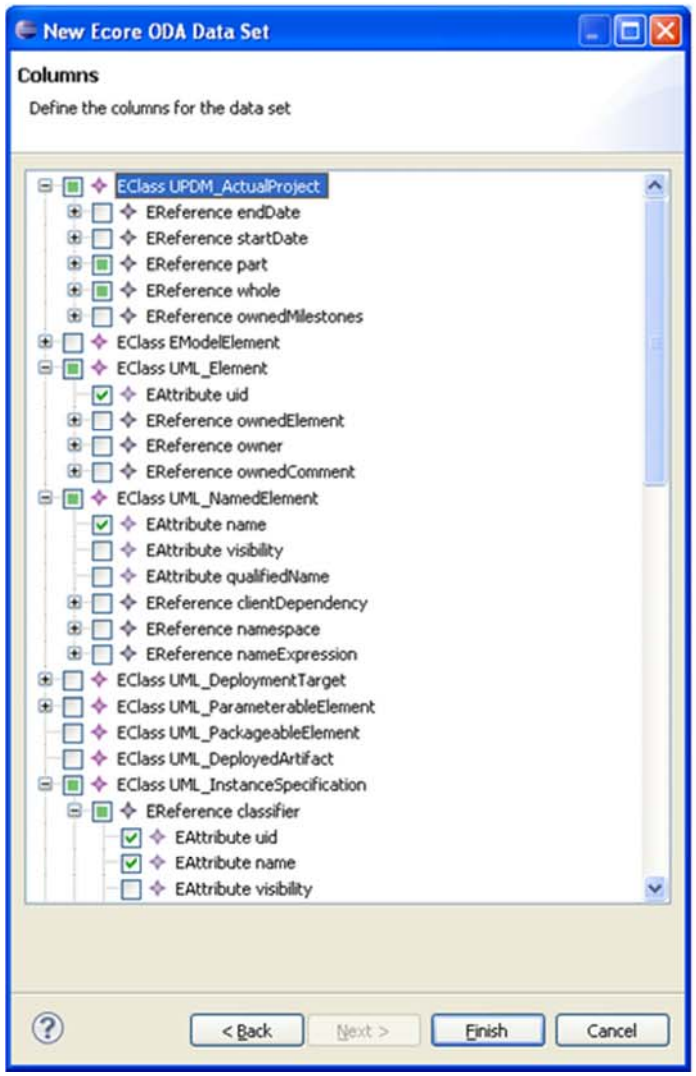


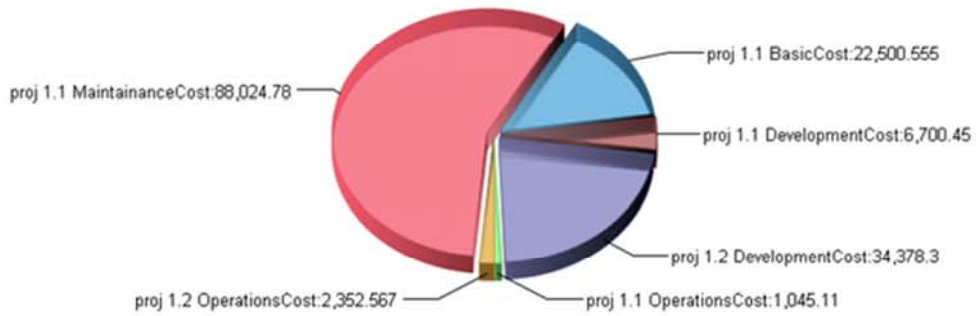
Table 1 and Chart 1 below show the cost distribution for the selected project based on its direct sub-projects (structure of sub-projects is not taken into account recursively). Thereby project names must be unique within the published model.

If the maximum allowed project value is exceeded through the sum of all currences totals the totals are colored in red in Table 1. The maximum project value can be adjusted through the corresponding report variable in the report Data Explorer.

Table 1: proj 1 Cost Distribution

Cost Type		proj 1		
		proj 1.1	proj 1.2	proj 1 TOTAL
EUR	BasicCost	22500.5550		22500.5550
	DevelopmentCost	6700.4500	34378.3000	41078.7500
	MaintainanceCost	88024.7800		88024.7800
	OperationsCost	1045.1100		1045.1100
	EUR TOTAL	118270.8950	34378.3000	152649.1950
USD	DevelopmentCost	45267.4610		45267.4610
	OperationsCost		2352.5670	2352.5670
	USD TOTAL	45267.4610	2352.5670	47620.0280

Chart 1: proj 1 Cost Distribution



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8. Application of ESA-AF

- ESA-AF has been applied on a number of pilot projects and studies
- Currently being applied on the Space Situational Awareness (SSA) Programme Architectural Design activities
  - System of systems with three completely different segments
  - Large number of sensors, data centers, users and services
  - Stringent security and data policy limitations
  - Complex operational concepts
- SSA Approach
  - Define functional design
  - Map functional design to physical design and explore options
  - Based on the functional and physical architecture support the creation of an operations and utilisation concept, performance analysis and optimisation, asset assessment, RAMS and interoperability concepts

9. Challenges

- ESA-AF is an extension of UPDM, which is a large and complex UML profile
- Experience of model stakeholders with UML and architecture frameworks is typically low
- Modeling can be done in many different ways
  - Clear guidelines required for different use cases
  - Model should be driven by required outputs / reports
- Education of stakeholders in the use of architectural frameworks required
  - Expose minimal aspects and then gradually increase level of exposure
  - Specific Enterprise Architect role should be considered – gathers information from domain experts

10. Conclusions and Outlook

- Importance of enterprise architecture and SoS engineering in ESA context
- ESA-AF is a means to address EA and SoS engineering challenges
- ESA-AF
  - Based on industry standards to foster adoption
  - Flexible, model-driven approach facilitating future framework development
  - Exploitation framework, enabling enhanced decision support by bridging the perspectives of technical and non-technical decision makers in space programmes

→ ESA-AF delivers a basis for enterprise architecting and SoS engineering in the space domain by establishing a common architecture definition language and processes tailored to ESA's needs as well as associated exploitation best-practices

THANK YOU