



Project: COMPASS

Grant Agreement: 287829

C O M P A S S

Comprehensive Modelling for Advanced Systems of Systems

**Final Report on Guidelines for
Architectural SoS Modelling**

Document Number: D21.5

Date: September 2014

Public Document

<http://www.compass-research.eu>

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Abstract

This deliverable contains the report on guidelines to be used in architectural System of Systems (SoS) modelling for defining an appropriate architecture to realise stated needs and capabilities. The guidelines relate to different SoS and Constituent System (CS) types, a set of SoS characteristics and to different SoS development contexts.

The report is split into two parts:

- D21.5a provides practical guidelines addressed to the engineer
- D21.5b provides a methodology to set up an Architectural Framework for the development of CS *or* SoS architectures. Whereas the resulting architectural framework is used by engineers constructing an SoS, the methodology in this second part is applied well before the actual construction.

Because the audiences for the two parts are distinct, they are delivered as separate documents.

Part 21.5a defines a process to support architectural modelling and analysis in early stages of SoS development. The architectural guidelines have been validated against the COMPASS Bang & Olufsen case study and the CIG Smart Grid case study. This has led to changes in some of the fundamental assumptions on SoS architectural modelling. These are document in D21.5a.

Part 21.5b defines an Architectural Framework (AF), called the COMPASS Architectural Framework Framework (CAFF). CAFF can be used for defining concrete Architectural Frameworks and has been employed by B&O in their industrial case study to develop a concrete domain-specific AF. In general, the CAFF is a meta-framework that that serves to define AFs for SoS engineering projects.

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1. Introduction

This document presents the results of a study into architectural modelling of System of Systems (SoS).

1.1. Scope of the document

This document presents a set of guidelines for architectural SoS modelling.

Figure 1 shows the main other deliverable related to these guidelines, the *Final Report on Guidelines for SoS Engineering* (D21.6) which describes the systems of systems engineering process. The Engineering Guidelines document includes guidelines for establishment of appropriate constituent systems (CS) and guidelines for the SoS acceptance test activity. The guideline documents are presented in the context of the classical V-model for systems and software development, which can also be related to development or realizations of SoS.

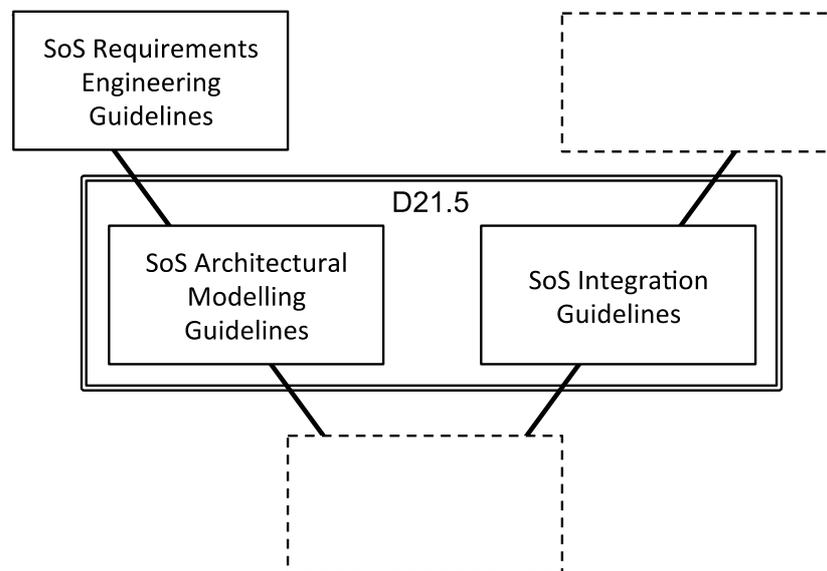


Figure 1- Scope of the SoS Architecture Guidelines in relation to the other SoS Guidelines

Figure 1 illustrates the scope of this report. Its focus is on architectural modelling and analysis. We have to say something about SoS requirements but do not talk about SoS requirements engineering. This is the subject of D21.1 and will not be repeated here. Although D21.4 discusses SoS integration, we discuss integration in the report. The treatment of integration focuses on *planning*. Given the constraints imposed on the architecture, which tests can be done, what do they involve, who is responsible and how volatile are they?

Developing an SoS architecture is an essential SoS Engineering activity, which is discussed in sections 2.4.2 and 2.5 of COMPASS deliverable D22.3 “Report on Modelling Patterns for SoS Architectures” [D22.3 2013], can be characterized by:

- *SoS Architectures* are *core* to systems and SoS engineering; production of architectures is *not* an optional activity.

- *SoS Architectures* should be produced according to defined *Architectural Viewpoints* codified in an *Architectural Framework* that includes *consistency rules* defined between the various views produced and the information contained in them.
- *SoS Architectures* should be produced to address the *concerns of stakeholders* using *relevant* architectural viewpoints; it is important to know *why* a particular viewpoint is being used.
- It is essential that an *SoS architectural design process* is defined and followed. This must cover the definition, analysis, evaluation, documentation and maintenance of an architecture.
- *SoS Architectures* should address both *structure and behaviour*, including communications, functionality and data flow.
- Modelling is essential to the development of *SoS architectures*.

Figure 2 shows how the guidelines relate to the other architectural activities and scopes the content in this document.

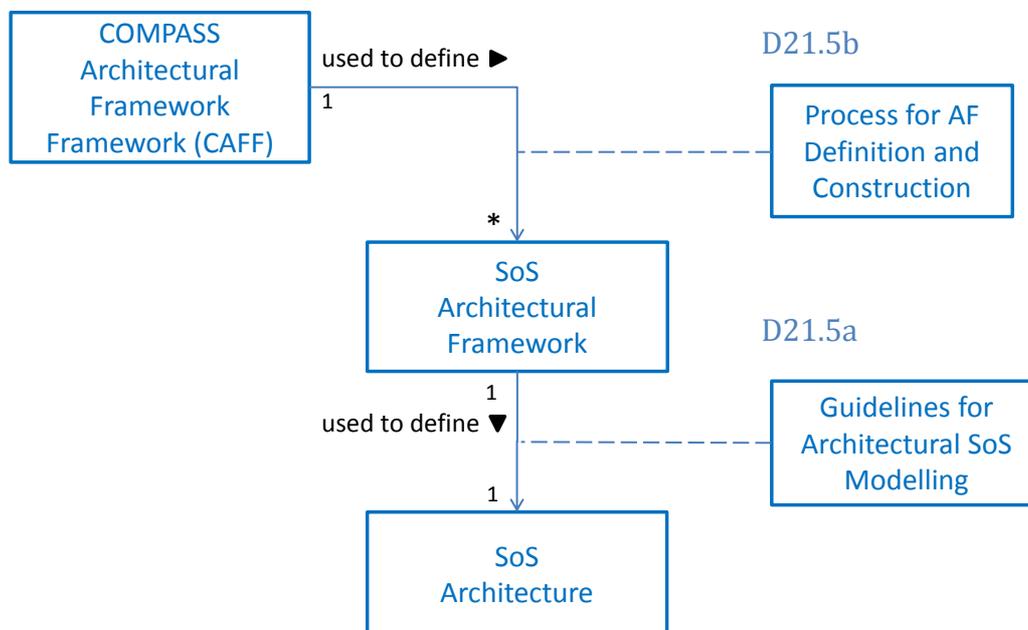


Figure 2 - Relations between Architectural Frameworks, Architecture, Processes and Guidelines

D21.5b introduces the COMPASS Architectural Framework Framework (CAFF), which is a meta-framework to be used in the construction of an Architectural Framework (AF) for a given SoS project. To assist in construction of a concrete SoS Architectural Framework, a process has been defined and described in Appendix A of D21.5b. An example AF defined using the CAFF has been defined in Appendix B of D21.5b.

D21.5a presents a set of guidelines for architectural SoS Modelling.

The primary target group of this document and the accompanying parts 21.5a and 21.5b are system and software engineers involved in architecting an SoS.

1.2. Software Ecosystems in SoS

Whether an SoS is suitable to host a software ecosystem depends highly on the characteristics of the SoS. In some case such as the B&O case study the SoS is composed of components by competitors who are in stiff competition. As such there is no interest in sharing features or system capabilities as they provide a competitive advantage. On the contrary, the different CS suppliers are inclined to obstruct each other to incite customers to buy only their CS. In other cases, e.g., in public services such as the emergency response SoS case study proposed by Insiel there will be a driving force (the state of Italy) that can enforce adoption of a common platform on which to build an ecosystem.

The subject of software ecosystems should be discussed independently of SoS In general, we have learned that it is better to be prudent with respect to the role different stakeholders play with respect to their expected cooperativeness in SoS.