

## **An Automated Objective-Driven Approach to Drive the Usage of the NAF Framework**

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### **ABSTRACT**

*The request for a model-based system engineering (MBSE) is continuously growing and the compliance to standard architecture frameworks such as NAF becomes an almost mandatory requirement, in particular for defence & security projects.*

*On the other hand, the popularity of such frameworks now leads to requests that are more framework-oriented than focused on the primary business expectations. For example, some requests are expressed in terms of NAF views to be developed rather than in terms of engineering issues to be solved.*

*We propose to present an automated approach that effectively realigns the design tasks on the projects' needs. The results of this approach is then embodied into a specific document; the Modelling Management Plan that is fully inline with NAV-1 scope, Purpose and viewpoint section. It also contributes to establish the enterprise dictionary (NAV-2) and the metamodel compliance (NAV-3b).*

*This objective-driven approach ensures that:*

- *All architecture designs are scoped by these objectives,*
- *The compliance to a framework (e.g. NAF) is deduced and not defined as a starting point,*
- *There is a continuous governance of the objectives achievement.*

### **1.0 THE APPROACH OVERVIEW**

The benefits of a model-based system engineering (MBSE) approach to design complex systems are made substantial when the designed models are integrated into a shared repository. This mechanism ensures the consistency of the system design from different viewpoints: capability, operational, system, service.... The contents of such repositories are then used to generate consistent system documentations including synthetic computed information.

The NATO Architecture framework (NAF) is one of the current frameworks dedicated to defence projects (others similar frameworks are DoDAF, DnDAF, MODAF) that can be used to define the data structure of a shared repository. This framework defines the different types of architecture elements that are of interest, and clusters them into views that match a specific concern. For example, the NCV-2 view is dedicated to the definition of capabilities while the NSV-1 view addresses the systems and their interfaces.

The definition of the NAF views is more than useful since it clearly identifies the type of concerns that must be addressed. However, the modelling tasks only guided by the views may lead to risks and difficulties; the views set does not induce the method that drives the production of the related architectural artefacts nor the decision criteria that enable to resume/stop the design. To do so, modelling objectives must be defined that can be evaluated and governed. In this situation the NAF views are considered as means to support the achievement of these objectives and not as an end by themselves.

This analysis could appear obvious but lot of current projects have to face the following issues due to the NAF (and similar) framework popularity: sneakily the generation of such or such views replaces the SMART modelling objectives that are a better help for the architect to conduct his/her tasks.

In order to alleviate this issue and to help keeping in mind the reasons why the modelling activity is asked for, we propose an approach that starts from the modelling objectives and finally reaches the NAF views as a consequence of the design method chosen by the architects. This approach is split into the following steps:

1. Define and prioritize the modelling objectives,
2. Determine the relevant architecture concepts that must be modelled to achieve the objectives,
3. Map the project concepts to the NAF framework concepts,
4. Select the architectural products (deliverables) and the corresponding NAF views,
5. Define the evaluation indicators that will help governing the design.

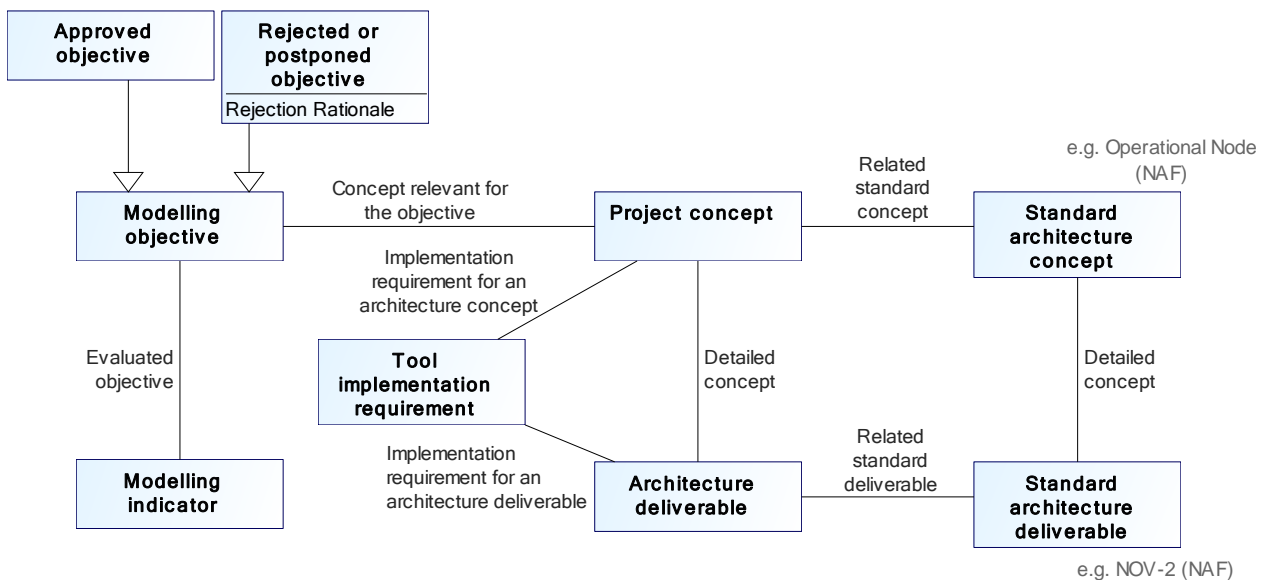
The result of this process is composed of two documents:

- The Modelling Management Plan (MMP): this document details the results of the steps listed in the list above.
- A governance document that is regularly exposed to determine the current level of design and to support the project management decisions (new priorities, postponing...).

In the following sections we expose the steps of the proposed approach in details including validation recommendations. We demonstrate how a formal description of the modelling management artefacts brings additional benefits such as the ability to quickly determine the impacts of a rejected or postponed objective on the modelling workload.

A formal description means the approach itself is implemented through models. Thus, the benefit of a modelling approach is applied to this preliminary modelling activity (consistency, automated checks, and impact analyses).

The following figure shows all the notions that are involved in the approach and that are detailed in the later sections.



**Figure 1: The concepts modelled to formalize the approach.**

Finally, this paper presents the complementary perspectives regarding the day-to-day work of the architect:

- Ability to input the data according to a project vocabulary easing the exchanges with the project stakeholders while the storage mode is confidently compliant with the NAF framework.
- Considering the proposal as an application of the DSM (Domain Specific Language) approach to the domain of the system engineering based on a framework, we can envisage using the same approach with the potential future frameworks based on ontology (IDEAS [4], MODEM [5]).

## 2.0 DEFINING THE MODELLING OBJECTIVES

The definition of the modelling objectives is the first step of the proposed approach. The modelling adjective associated to the objective term is important in our context: this paper is strictly focusing on the modelling activity and the main idea is to enable the tailoring of such activity. So, the objectives that are dealing with are really those the architect must achieve thank to the modelling activities. Obviously the chief engineer and the project manager have their own project objectives that are surely connected to the modelling objectives, but the question we need to answer as an architect modeller is: why am I modelling? The answer to this question must include the benefits from the stakeholders' point of view. Assessing the objectives should help these stakeholders to decide whether such or such objectives must be effectively achieved.

The assessment of the modelling objectives must be jointly performed with the project stakeholders. This is an important step of the project; being involved in the objectives list creation, the stakeholders feel more confident regarding their ability to decide what must be done or not. This selection decision must be traced; a subset of the candidates objectives are declared as rejected or postponed and the rationale of the rejection is also written down.

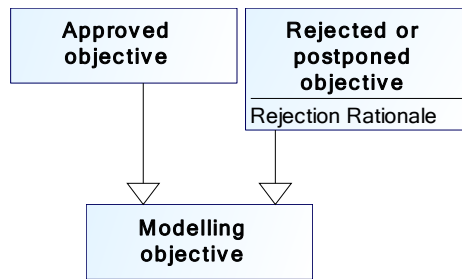


Figure 2: The objective concepts: approved and rejected objectives are listed.

Another consideration to keep in mind is the modelling objectives are not to create deliverables. For example, we recommend avoiding such objective:

*Create the functional coverage matrix of the technical components.*

Such a matrix is likely relevant as the result of the architect activity. But it will be considered as a deliverable that embodies the objective. Then, a more appropriate formulation could be:

*Determine the functional coverage of the technical component.*

Let's consider a simple example that will be used as an approach illustration: we are requested to help the understanding of the connection of multiple information systems. Each information system manages data and needs to communicate with others according to operational needs. In this example, we'll define two objectives:

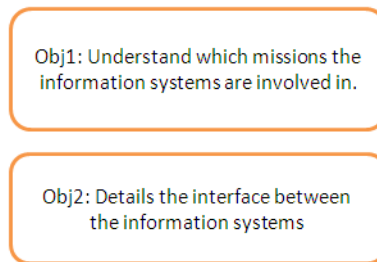


Figure 3: Sample - The Two Objectives of the Modelling Project.

### 3.0 DEVELOPING THE ARCHITECTURE CONCEPTS

The architecture concepts are the concepts which enable the design of the system and which are aligned to the selected objectives. These concepts are expressed in the project stakeholders' language. At this level, there is no obligation that they match any framework or standard. The important point is the concepts are easily understood by the stakeholders having to read the produced models.

The architecture concepts can be modelled via a Data Model diagram including entities and their properties, and the association between the entities. Then, the objectives must be linked to the relevant concepts, and associations. This will ensure we know what must be modelled to achieve the approved objectives and we are able to determine the impact of an objective selection change. In large projects, the delegation of the modelling tasks often leads to the continuous updates of no longer useful data due to a recent objective rejection or postponing.

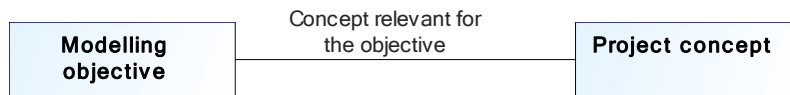


Figure 4: The architecture concepts (and associations) are linked to the objectives they support.

One criterion to validate the concepts and associations are properly listed for one objective, is by creating a natural language sentence that is the answer of the objective and that includes all the found out concepts and associations.

If we consider the previous example:

*Determine the functional coverage of the technical component.*

The natural language answer to this objective could be:

*The functional coverage is determined comparing the complete list of system functions against the list of technical components supporting them.*

Such sentence helps finding out the need to model the system function and the technical components (concepts) and a relationship between the two concepts matching the support of a function by a component.

Considering the started example, the project concepts could be the followings; *Operational Missions* are linked to the supporting *Information Systems* that are connected (*Connection*) to transfer *Data*. The following figure shows how the concepts and associations are mapped to the objectives. Note that the *Information System* concept is involved in both the two modelling objectives.

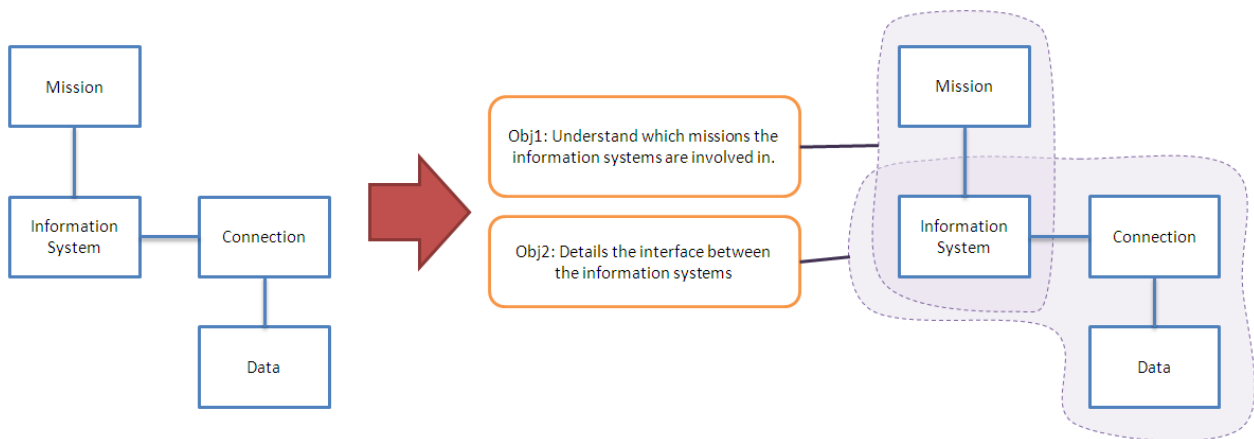


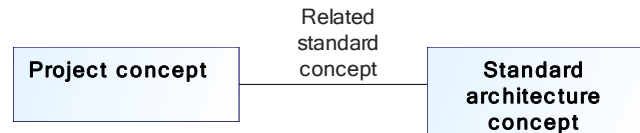
Figure 5: Sample – The Concepts Are Identified, Then The Objectives Are Linked to the Project Concepts.

#### 4.0 MAPPING THE CONCEPTS TO THE NAF FRAMEWORK

Once the project concepts are defined, it is time to map them to the frameworks selected by the project. This mapping, in charge of the Architecture Framework (AF) expert, must demonstrate the compliance of the modelling task against the AF metamodel. In the case of the NAF framework, the mapping is produced against the NMM (NAF MetaModel).

The goals of this task are multiple:

- Agree on the NAF concepts that are relevant to support the project concepts to model,
- Check the mapping is globally consistent that means the project associations between two project concepts are supported by a path between the corresponding NAF concepts that are mapped to the project concepts,
- Determine which concepts are not supported by the NAF and thus feed the NAV-3b view that must list the extensions against the NMM.



**Figure 6: The Project Concepts Are Mapped to the NAF Concepts.**

Another parallel goal is to convince the project stakeholders that the NAF compliance is strongly supported and stored in a document that would be retrieved later. This is particularly important with stakeholders having few or no knowledge about the NAF concepts but wanting to play a role in the decisions regarding the modelling tasks. Participating in the mapping process allow such stakeholders learn step by the step the NAF vocabulary but this is not felt as a constraint since the project vocabulary is the first one that will be used.

To comfort this learning phase one important deliverable is the “translation” table that will display the project concepts and the associated NAF concepts. This table allows the stakeholders smoothly integrate the NAF vocabulary.

The mapping can be formally established if the tool used to support this approach lists all the available NAF concepts. Such list could be the UML diagrams that represent the complete NAF metamodel as defined in the NAF Chapter 5 document [1]. In practice, the list of NAF the definitions is enough to propose a convincing and actionable mapping allowing to start the modelling.

Considering the started example, the mapping of the project concepts against the NAF could be the one illustrated in the following figure. To simplify the graphical representation, only the groups of concepts are mapped but the real mapping associates each individual items. For example, the association between the *Mission* and the *Information System* project concepts is mapped to the NAF path *ActivityToFunctionMapping* → *Function* → *FunctionProvision*.

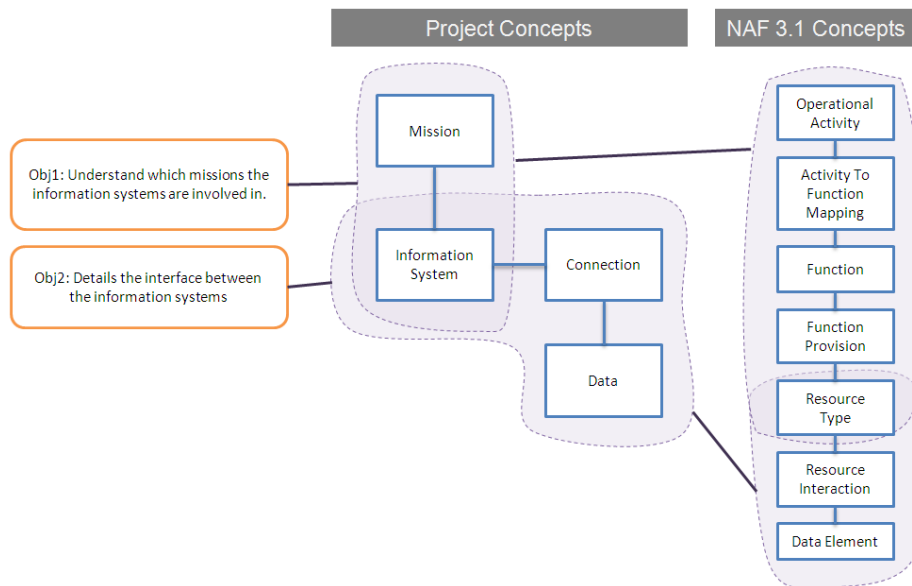


Figure 7: Sample - Project Concepts Are Mapped to the NAF Concepts

## 5.0 DEFINING THE EXPECTED DELIVERABLES

This is only at this step that the NAF deliverables are found out. Thanks to the project and NAF concepts mapping it is possible to trace the path from the selected modelling objectives to the NAF views that could host the modelled data. The retrieved views are only proposals for the architecture description delivery.

According to the UML diagrams contained in the NAF chapter 5 document (metamodel description) [1], the NAF concepts can be mapped into the different NAF views. From this mapping, the objectives are indirectly associated to the corresponding NAF views.

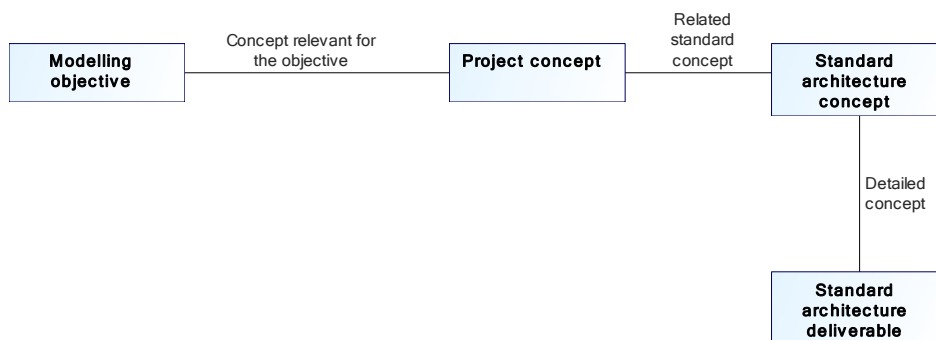


Figure 8: The NAF Views Are Proposed From the Modelling Objectives.

But this simple matrix rapidly leads to an important amount of candidate views for two reasons:

- The NAF concepts are often shared in more than one view,
- The objectives are often supported by more than one concept that leads to a higher number of views.

To make this views heuristic less prolix and so more useful, a relevance property is associated to each candidate view that simply takes the percentage of coverage of the project concepts against the proposed view. If an objective  $O_i$  is supported by  $n$  project concepts and associations and  $m$  of them are mapped on a NAF view  $NV$  then the relevance is simply:

$$r(NV)=m/n$$

This ranking of the views by relevance helps the selection. In our example, the *Mission* and *Information System* are respectively described in the NOV-5 and NSV-4 NAF views. Considering the objective *Obj1*, among the proposed views there are NOV-2, NOV-5, NSV-1, NSV-4, NSV-5. But the NSV-1 and NSV-5 views seems more appropriate according to the ranking criteria.

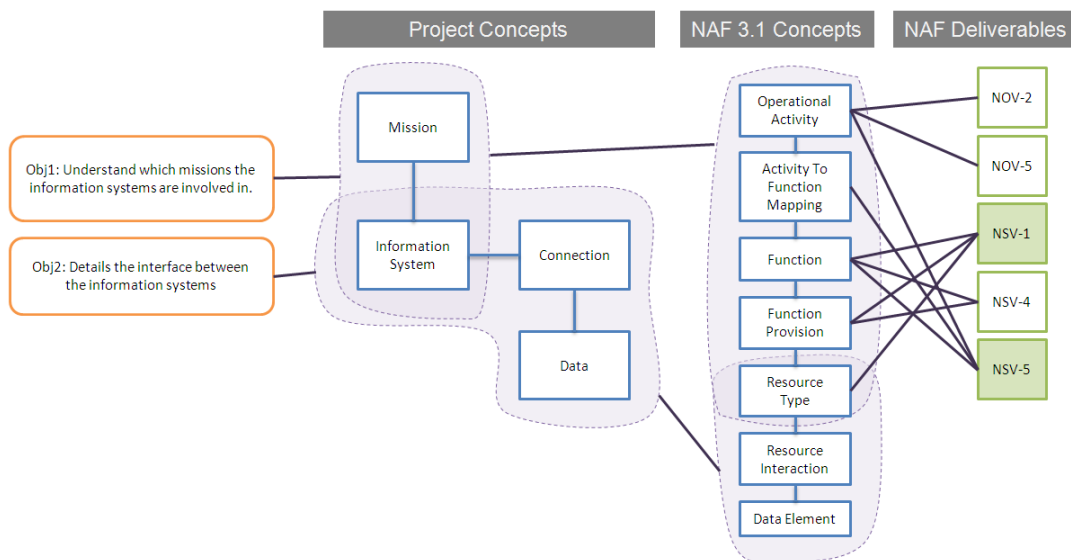


Figure 9: Sample - Ranking of the NAF Views to Support the *Obj1* Objective.

This selection is not a final point; the architect must validate what will be the appropriate deliverables and to do so there are two concerns to take into account:

- What are the NAF compliant deliverables that will concretize my objectives?
- What are the project deliverables that are appropriate for my stakeholders?

### 5.1 NAF Compliant Deliverables

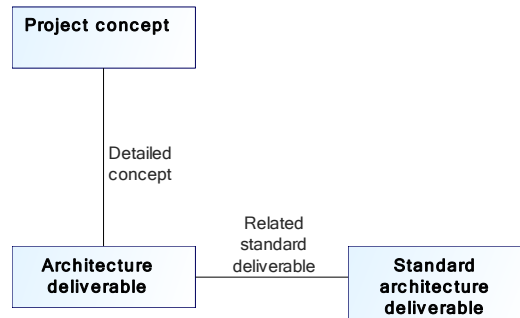
The answer to this question can be expressed as follows: “I am able to achieve this objective thanks to the products of an NOV2 view”. So, the justification of the NAF views usage is always objective-driven and there could be as many NOV-2 as necessary to support the corresponding objectives.

### 5.2 Relevant Project Deliverables

Even though the NAF views can be justified by the objectives, for some stakeholders the NAF acronyms are not always relevant in their context. For example, one project manager may refer to the INCOSE handbook [2], ISO15288 or national forces best practices standards to name the expected deliverables. What really matters is the ability to determine what such deliverables contain so the architect should create two sets of deliverables: those demonstrating the NAF compliance and those that match the project context.



All these deliverables are linked to both the supported objectives and the contained project concepts. This set of concepts associated to a deliverable could be a subset of (or differ from) the concepts linked to the corresponding objective since the modelling activity can result to a synthesis representation of the global data.



**Figure 10: The Expected Deliverables Are Listed Against the Project Concepts and Mapped to the NAF Views.**

In our example, a deliverable to support the objective *Obj1* could be named “*Functional Coverage*” and could contains the matrix of *Missions* and the *Information Systems* that are effectively linked but not all intermediate details (e.g. the function supported by the systems).

## 6.0 GOVERNING THE MODELLING ACTIVITIES

Once the modelling objectives are defined and agreed, the project concepts to support the objectives are defined and the compliance against the NAF is demonstrated and the deliverables to produced are identified, the modelling project is simply about to start. This will be a long process that must be governed. So, one step is missing that consists of the identification of the indicator that will allow to evaluate the modelling activity progress. In the Modelling Management Plan, these indicators must be:

- Identified and clearly defined so that they can be later measured,
- Associated to the project concepts and the deliverables they are measuring.

These indicators are specified to measure the modelling activity so that the project manager is aware of the progress and will be able to change the task priorities according to the current situation reflected in periodically refreshed dashboards.

### 6.1 Measuring the Modelling Progress

Not all the indicators can be automatically computed; some of them are updated by responsible stakeholders. But, if the indicator relates to the modelled architecture elements, they could be integrated into the modelling repository so that they are automatically refreshed according to the current repository contents. For example, for each project concept there is a phase of assessment. If the volume of the expected data is known the ‘*Population of the Architecture Element*’ indicator can be automatically computed. For this example, a dashboard can be created from the project concept diagram highlighting the concepts that are effectively listed and the level of population. This gives an easy understanding to the project manager of the remaining works.

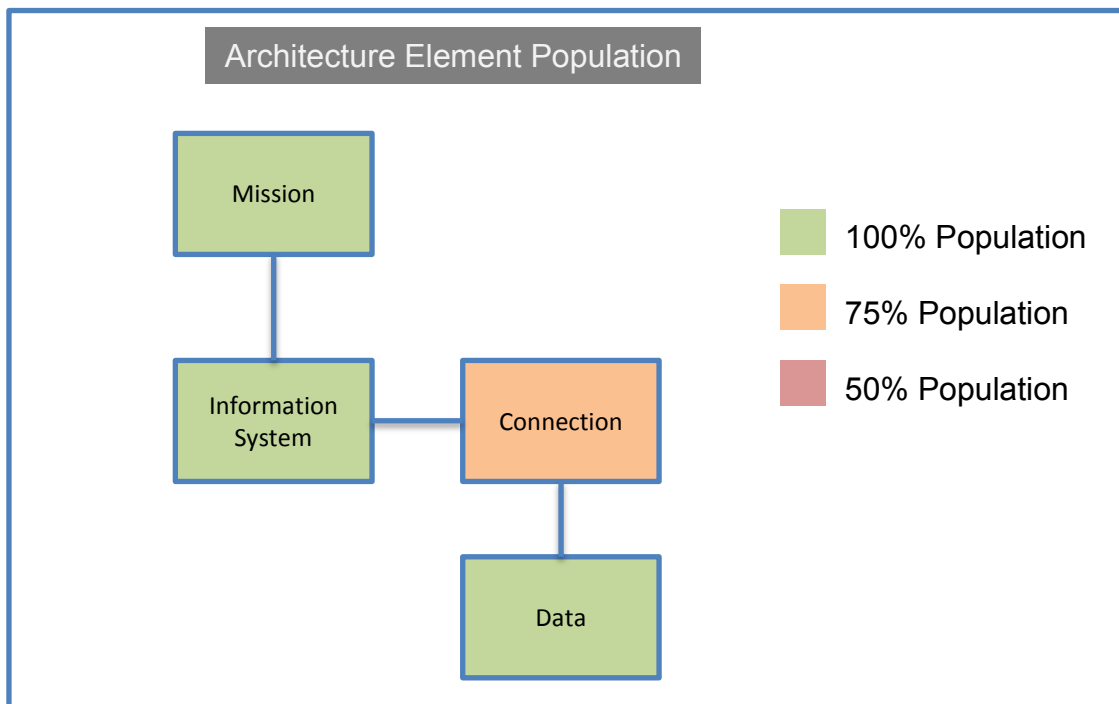


Figure 11: Sample – A Dashboard Showing the Current Level of Repository Population for Each Element to Model: Not All the Connections Between the Systems Are Assessed.

## 7.0 CONCLUSIONS AND PERSPECTIVES

The proposed approach enables the demonstration of the NAF compliance for the modelling activities of a system design. One important point is that this demonstration is driven by objectives the project stakeholders are easily able to understand, select, and prioritize. The NAF concepts and the NAF deliverables are only selected at the end of the process as a consequence of the objectives selection.

Another aspect is ensured by supporting the approach through preliminary models: modelling the objectives, the project concepts, the links with the NAF concepts and the produced deliverables brings the common analysis benefits we can expect from models:

- The impact of objective changes can be evaluated:
  - The current coverage of the project concepts by the NAF concepts,
  - The proposal of the NAF deliverables supporting the objectives,
  - The concepts that no longer need to be modelled,
  - The deliverables that must or not be produced.
- The evaluation of the current modelling progress.

But the definitions of the project concepts can be also useful during the project realisation to:

- Govern the current modelling progress (detailed above),
- Produce deliverables compliant with NAF but using the project terminology.
- Enable the input of data by the project stakeholders based on the project terminology.

## 7.1 The Current Status

Today, this approach is used to support about 10 EADS CASSIDIAN projects and the benefits have been clearly identified by both the NAF architects and the contributing stakeholders. People involved in the projects and just starting with the NAF framework were able to contribute to the decisions regarding the modelling tasks and scope through their own vocabulary. In order to speed up the preliminary phase, we implemented a wizard that initiates the modelling management models in a modelling tool so that the architects straight start the creation of objectives and project concepts and does not have to take care about the document creation. This wizard enables the generation the Modelling Management Plan (MMP), a document structuring the reading of the approach implementation. Another tool ensures the creation of dashboards according to the measure indicator defined in the MMP.

## 7.2 Perspectives

The NAF framework is not the only one that could be mapped thanks to this approach. Other frameworks involved in the system engineering can be integrated such as those related to requirement management (e.g. ISO 29148 [6]) this to demonstrate the level of compliance. The same way, mappings can be established to the concepts managed by the tools so that interoperability needs can be demonstrated (e.g. between a modelling tool and a requirement management tool).

The automation of the project deliverables based on the project-NAF mapping is not developed but the creation of such deliverables is realized manually and this is a first step that has demonstrated the relevance of this technique. A study is under progress to support this automation that should speed up the production of accessible deliverables and facilitate the input of data delivered by external stakeholders. In this study we are considering the mapping of ontologies [3] for two reasons: the project concepts and NAF concepts can be considered as mapped ontologies, the future AF framework will be probably based on ontology [4][5] and so the reuse of this approach should be easy.

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