



Harmonized EU NAP architecture

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Abstract

The deliverable describes the crucial parts of the final version 2 of the Reference Architecture of National Access Points (NAP). The developed NAP Reference Architecture (NRA), including full descriptions and a model available via NAPCORE website, serves as a technical, organizational, and functional blueprint for creating and harmonizing NAP activities.

This milestone extends the milestone M2.9 “Harmonisation of EU NAP architectures and first layout of potential NAP federation” where the underlying processes, work steps and status of the NRA were described. Therefore, the main purpose of this deliverable is to provide a thorough description of the NRA version 2.0 developed by NAPCORE. It offers an updated and summarized description of the reference architecture creation process and identifies FRAME and its tools as the main methodology. The document outlines the NAPCORE approach and describes specific guidelines created by NAPCORE for the development and maintenance of the NRA. It thoroughly depicts the FRAME methodology for creating reference architecture, with detailed descriptions of individual architectural views and the contained object types, tools, and principles utilized in the creation of the NAP Reference Architecture. Specifically, it provides a general and technical description of the key features of the developed NRA with quantifications, summary descriptions, and example objects of each developed view, where necessary for in the M2.9 defined NAP types, Metadata directory and Data platform. The Metadata directory contains only information about externally hosted data and services, while the data platform can also host data and provide access. It also discusses the usability of the NRA through one practical use case.



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Abbreviations

Abbreviation	Meaning
DATEX II	DATa EXchange for traffic related data
DCAT-AP	Data Catalogue Application Profile
DR	Delegated Regulation
EC	European Commission
FRAME	FRamework Architecture Made for Europe
ITS	Intelligent Transport System
KPI	Key Performance Indicator
LoS	Level of Service
MMTIS	Multimodal Travel Information Services
mobilityDCAT-AP	Mobility Data Catalogue Application Profile
MS	Member State
NAP	National Access Point
NAP	National Access Point
NAPCORE	National Access Point Coordination Organisation for Europe
NAPCORE	National Access Point Coordination Organization for Europe
NB	National Body
NLKF	NAP LoS KPI Framework
NRA	NAP Reference Architecture
RTTI	Real Time Traffic Information
SRTI	Safety-Related Traffic Information
SSTP	Safe and Secure Truck Parking
UML	Unified Modelling Language
WG	Working Group



1. Introduction

The National Access Point Coordination Organization for Europe (NAPCORE) project aims to enhance the interoperability of National Access Points (NAPs), which serve as the backbone for European mobility data exchange. NAPs focus on the exchange of static and real-time traffic and travel data, as mandated by the ITS Directive [23] and its supplementary Delegated Regulations (DRs), to benefit pan-European drivers and travellers.

Each Member State (MS) is required to establish at least one NAP¹ to ensure the accessibility, exchange, re-use, and updating of data necessary for providing high-quality, continuous travel and traffic information services across the EU. However, the implementation, functionalities, and organization of these NAPs were left to the discretion of the Member States, resulting in a diverse landscape of NAPs.

To harmonize technical systems, a unified system architecture and a description of functionalities and interfaces are essential. Such an architecture defines how systems should interact, ensuring that third parties do not need to implement different interfaces to interact with these systems. Achieving NAP interoperability depends on defining a reference architecture.

A system architecture is a **conceptual model** that defines the structure, behaviour, and **more views** of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviours of the system.

The architecture could be defined as “**a set of objects and the rules to combine them to make systems**” where these objects could be described on various levels of detail forming a definitive and consistent framework to guide proposal, development, implementation, and maintenance of ITS. [17]

An architecture can be described at various levels, including a framework architecture, a reference architecture, and a specific architecture. The reference architecture consists of:

- **Motivational layer:** This answers the question of WHY and sets up the system.
- **Functional view:** This describes the bounded functionalities of the system, with information exchange (among functionalities, and with other systems). It also describes processes realized by the functionalities.
- **Physical view:** This describes how the functionality could be implemented in separate subsystems and identifies the critical interfaces that need to be harmonized.
- **Communications view:** This describes the interaction and data exchange between the different components of the system.
- **Organizational (enterprise) view:** This describes the relationships between actors in the system.
- **Security view:** This provides a high-level overview of the system security.

Depending on the level of detail in the views, the architecture could be further enriched by outputs such as:

- Common/communication requirements
- Component/interface specification
- Cost-benefit study
- Best practice implementation and guidance material

¹ The term NAP evolved within the delegated regulations, but the obligation was there, nevertheless.



The NAPCORE task T2.3 aims to develop the NAP Reference Architecture (NAP reference architecture) considering all existing NAP practices and new requirements emerging from the NAPCORE project using FRAME² methodology [19]. The task T2.3 has several missions, which aim to result in:

- A shared understanding of general NAP-related terms among the Member States
- Technical guidance on achieving functionalities
- Enhanced comparability of identical features across different NAPs
- Interfaces for international metadata, data, and service exchange

These four pillars form the foundation for any exchange or harmonization activities and shape the vision of the NAP reference architecture.

The NAP reference architecture describes the minimum required functionalities, processes, and interfaces to enable a harmonized exchange of information (metadata and data) for an EU-wide reuse of data to create the basis for an EU-wide mobility data space.

The content of the NAP reference architecture should be designed in such a way that each NAP within Europe can identify the functionalities and artefacts necessary to enable the seamless data exchange. This consolidates all NAPCORE National Access Point harmonization activities. While this document does not describe the final architecture due to ongoing developments in NAP harmonization, it does include and represent all achievements and results currently available within NAPCORE. Future results and further harmonizations from ongoing NAPCORE developments will be continuously integrated into the architecture, as outlined in the maintenance procedure.

By utilizing the well-known software, Enterprise Architect, and the most suitable toolkit, FRAME, we ensure that the architecture is both understandable and future-proof.

The NAP reference architecture can be applied in three different scenarios:

1. To create a harmonized NAP from scratch by implementing the necessary functional and organizational elements using the architecture.
2. To harmonize existing NAPs by updating already existing NAP functionalities and processes in line with the developed NAP reference architecture.
3. To establish a basis for comparing NAPs by breaking down complex functionalities and processes. Comparisons can also be conducted using the NLKF tool.

2. Scope and Outline

2.1 Scope

The deliverables intention is to give insight of how the NAP Reference Architecture (NRA) was created, what are its key features, how the content looks like, and how the NRA could be used, not to fully cover the NRA content.

Therefore the deliverable covers NAPCORE approach and the FRAME methodology used creation of the NAP Reference Architecture (v2.0). Provides extensive walkthrough of the created NRA, specific created guidelines together with example usage. This document does not provide, due to its extensive length and technical nature, full documentation of the NRA and created guidelines, these are available via NAPCORE website.

² FRAME-NEXT website: <https://frame-next.eu/frame-next/>



2.2 Outline

The deliverable follows a clear structure. In chapter “**Introduction**” it covers NAP and NAPCORE and FRAME context, generic reference architecture creation process and identifies FRAME and its tools as the main methodology. Chapter “**Scope and Outline**” informs readers about the focus and structure of the document. And chapter “**Terms and Definitions**” defines important terms used in the document. Chapter “**NAPCORE approach to develop the NAP reference architecture**” provides an update and the summary of the NAPCORE approach and describes specific guidelines created by NAPCORE for the development and maintenance of the NAP Reference Architecture

As we describe final product, NAP Reference Architecture v2.0, the understanding of each part is crucial, therefore the following chapter “**FRAME architecture principles**” explains FRAME methodology, tools, and principles utilized in the creation of the Reference Architecture, outlines different views on the Reference Architecture, used elements and the underlying principles.

The main chapter “**NAP reference architecture**” describes part of the key features of the created architecture. The complete documentation of the architecture is referenced within the document and in the “**Annex A**”. The full documentation of the NAP Reference Architecture v2.0 is available on the NAPCORE website³.

To showcase the use of the architecture the chapter “**Practical use of the NAP reference architecture**” describes how the NRA is used to analyse the German NAP. This also gives an insight of trainings and real-world practise. Finally in the chapter “**Conclusion**” summarizes findings, learnings and follow up activities regarding NAPCORE (X).

3. Terms and definitions

For the purposes of this document the definitions from ISO 14813-5:2020(en)⁴ and the following terms and definitions apply.

Abbreviations

Term	Definition
data portal	A web-based system that contains a catalogue with descriptions of datasets and their distributions.
national access point	A data portal facilitating access to transport-related data according to the EC ITS Directive.
Architecture	fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution. [SOURCE:ISO/IEC/IEEE 42010:2011]
architecture framework	conventions, principles and practices for the description of architectures established within a specific domain of application and/or community of stakeholders

³ Browsable model https://napcore.github.io/Reference-Architectures-website/uml/nap_architecture/ and full report of all views and model <https://github.com/NAPCORE/NAP-Reference-Architecture>

⁴ <https://www.iso.org/obp/ui#iso:std:iso:14813:-5:ed-2:v1:en>



	[SOURCE:ISO/IEC/IEEE 42010:2011]
architecture view	work product expressing the architecture of a system from the perspective of specific system concerns [SOURCE:ISO/IEC/IEEE 42010:2011]
artefact	an object that can be of several types, where a connected set of such different objects form a view
Mobility data	Mobility data includes all data types that are directly related to a person or good movement via motorized or non-motorized, individual or public transport, or new transport modes. It includes general real-time and statistical information.
Content Provider (Data Holder)	any stakeholder that is required by the Delegated Regulations to provide data/information or services to the Content Consumers via the NAP. It includes the term Data Holder as it is defined in the MMTIS and RTTI regulations. For more information see the explanation in the Content Provider role in the regulations.
Content Consumer (Data User)	any stakeholder that is specified by the Delegated Regulations explicitly as the user of the data/services made available by Content Providers via NAP. It includes the term Data User as it is specified in the MMTIS and RTTI regulations. For more information see the explanation in the Content Consumer role in the regulations.

4. NAPCORE approach to develop the NAP reference architecture

To achieve the in the Scope and Outline mentioned objectives, task T2.3 aims to define the requirements for the NAP architecture from existing NAPs, data sharing communities and determine how harmonization shall be approached for the benefit of operators and users. This involves identifying common NAP elements by comparing different approaches across several NAPs, and identifying minimum required functionalities, processes, and interfaces to enable a harmonized exchange of information.

In Milestone 2.9 [16] the approach definition, exact methodology, used tools to transfer findings and other procedures were described in detail. This chapter is based on M2.9 but adds new methodologies like guided documents and enhanced maintenance processes.

This NAP reference architecture consolidates all NAPCORE National Access Point harmonization activities and serves as a technical, organizational, and functional blueprint for creating and harmonizing existing National Access Points (NAP). This is in accordance with the Delegated Regulations, stakeholder implementations, and best practices, as evaluated through several reviews by various NAPCORE working groups.

This chapter details our approach to develop the NAP reference architecture, which is a complex system. As mentioned in the NAPCORE Grant Agreement, this work extends the basic FRAME NAP reference architecture based on the requirements gathered as part of T2.1 and gap analysis during workshops, meetings and alignments.

The work started by collecting and selecting the relevant supporting documents for the further development of the NAP reference architecture. Much of this work had already been performed by NAPCORE T2.1 which provided descriptions of the main processes of a NAP and in the past under the FRAME-NEXT project which proposed a first version of the NAP reference architecture.

The feedback was transformed into suggested changes in the organizational, functional, and physical views of the NAP reference architecture in a series of work meetings.

In addition to the work on architectural views, this task focuses on alignment with other tasks. This is achieved during regular or ad-hoc joint meetings covering discussion on interoperability, terminology, and other important harmonization aspects that could be referenced from NAP reference architecture, such as the interoperability documents.

The development workflow of the NAP reference architecture, as depicted in chapter 5, can be divided into three primary inputs:

- **Minimum set of functionalities for NAP**
Identification of all necessary functionalities, processes, terms, and definitions to perform minimum function of the NAP per its type, one containing the metadata only, the Metadata Directory, and other containing both data and metadata, the Data Platform., this requires cooperation with T2.1 specifying NAP level of service: *Creating NAP reference architecture*
- **Demonstrator Requirements**
Collecting important lessons learned from other working groups that are dealing with the interfaces and data exchange standards, this requires cooperation with T2.4 specifying NAP level of service, WG2.2 collecting standards and other NAPCORE WGs/tasks: *Identifying and creating interoperability documents*
- **Identify gaps**
While working on the architecture topics, gaps will be identified requiring harmonization effort. Such gaps are then discussed with other NAPCORE tasks dealing with the gap to find a solution: *Aligning with other WGs*



4.1 Work environment – the FRAME

FRAME, an acronym for the **FR**amework **A**rchitecture **M**ade for **E**urope, is a minimum stable framework necessary for the deployment of integrated and interoperable ITS and includes a reference architecture for NAPs, which serves as a starting point for this task. FRAME utilizes a highly flexible visual modelling and design tool Enterprise Architect by SparxSystems, to encompass all necessary functionalities.

The FRAME is a collection of the ready-made framework architecture, methodology and a tool used to develop reference and specific architectures. The FRAME provides a systematic basis for planning ITS implementations in Europe, facilitates their integration when deploying multiple systems and helps ensure interoperability, across European countries.

In the project FRAME NEXT (2017-2021) a NAP Reference Architecture v1.0 [22] based on legal obligations and extrapolated functionalities from the Delegated Regulations was created. To reuse and extend the work done previously, the FRAME architecture methodology was selected for further development of the NAP reference architecture.

NAP reference architecture (NAP reference architecture) is not created from a scratch, it is based on already created NAP reference architecture within the FRAME-NEXT project. This offers the advantage of a head-start and reuse of previous efforts but also has the potential challenges associated with legacy issues (disadvantage).

This created a good basis for the harmonisation activities within NAPCORE and to create a common understanding of NAPs.

4.2 Selecting and analysing sources

The NAP reference architecture development utilized various sources of information, including milestone reports created by NAPCORE WG2. Earlier documents from NAPCORE WG2 provided descriptions of the main NAP processes, key performance indicators, levels of service, and best practices from operational NAPs. NAPCORE deliverables and other inputs include (available as NAPCORE milestones or internal documents):

- M2.1 Typology of NAPs based on the description of levels of service and assessment of associated costs and benefits [8]
- M2.2 Overview of gaps and actions needed [9]
- NAP Levels of Service computation using KPI Framework [10]
- User (NAP operator) perspective on NAP Architecture [12]
- Conceptual Model for mobility DCAT-AP [13]
- Definitions of data categories included in the DRs supplementing the ITS Directive [15]
- M2.7: List of requirements concerning the use of data standards, profiles, and metadata [11]
- M4.2.5: Technical specifications of TN-ITS [14]

In addition to the NAPCORE documents stated above, several other relevant sources were identified and used in the development of the NAP reference architecture. The latest applicable versions of the DRs related to RTTI, SRTI, MMTIS, and SSTP were used as references to understand the requirements for the NAPs. All deliverable reports from the FRAME-NEXT project, including the theory of operations [20][21], description of ITS system artifacts [19], and the FRAME NEXT version of the NAP reference architecture [18][22], also served as important references. FRAME deliverables are available for download at the FRAME-NEXT website.



4.3 Refinement of the process with NRA Guidelines

While developing the NRA and within the alignment procedures topics and issues were identified which have not been solved or included in existing NAPCORE tasks. Therefore, a need for support of the NAP Architecture user community and NAPCORE task leaders were identified. This support activity also is essential to create a complete and consistent NRA.

4.3.1 Issue documentation within architecture

The identification and documentation of issues and gaps is crucial to develop a consistent architecture. Therefore, a procedure within the NRA was developed.

Rules for issue documentation:

- An element of type “issues” needs to be created next to the most issue related existing element within the architecture
- An issue must be described in a well understandable text
- If the issue was already handed over, a comment with date, person, task/WG should be done

4.3.2 Guideline NRA to NLKF updating principles

This guideline document outlines how the NAP Level of Service KPI Framework (NLKF) Key Performance Indicators (KPI) are included in the NAP Reference Architecture (NRA) and how they are being updated. The individual NLKF KPI are transferred into the Enterprise Architect (EA) model of the NRA to the “**Supplements\KPI framework**” folder as NRA KPIs. Each NRA KPI group is in a separate subfolder with a view representing the individual NRA KPIs.

The NRA KPIs are modelled as “requirements” (by a requirement class). They impose a requirement to the NRA; they are connected to the objects defined in the NRA.

The Guideline NRA to NLKF updating principles [3] document is available on NAPCORE SharePoint [here](#) (available to authorised users only).

4.3.3 Guidelines Feedback Demonstrators

This type of feedback is for demonstrators to bring **back any good practice/information** about what platform has been used, what approach has been taken, how it was organized, etc. The feedback is organized into sections with specific information:

- Licenses
- Interfaces
- Specification
- Functionality
- Processes
- Quality Parameters/Requirements
- Additional Info

The main goal was to transfer experience within the demonstrators into requirements and best practice to the architecture.

The Guidelines Feedback Demonstrators [2] document is available on NAPCORE SharePoint [here](#) (available to authorised users only).



4.3.1 Guidelines organisation description

This guideline mainly focuses on the organisational view and describes how an organisation must be described, and which information is needed to understand the organisational viewpoint and the relation to the connected specifications and agreements.

A role description consists at least of the following parts:

- Who owns and/or manages each Component and the Communications network
- Who owns the data used by the Components
- Who will provide the inputs and receive the outputs
- What is their current relationship?
- Are there any relationship issues?

“Who” must be:

- Actual Stakeholders or represented by Stakeholders
- Involved in gathering Stakeholder Aspirations

The Guideline for organisation description [4] document is available on NAPCORE SharePoint [here](#) (available to authorised users only).

4.3.2 Guide to use of Interfaces in Reference Architectures

Interfaces as described a “point of interaction between two systems, entities, or components, facilitating communication and functionality” are a key element for interoperability and basis for crucial implementation on NAPs.

In different contexts, the term can have specific meanings:

- **User Interface (UI):** The space where interactions between humans and machines occur. This includes graphical elements like buttons, icons, and menus in software applications.
- **Programming Interface:** In software development, an interface defines a set of methods or functions that a class or system must implement, enabling different software components to interact.
- **Hardware Interface:** The physical and logical connections between different hardware components, such as USB ports or network interfaces.

In FRAME, the interface is specified by the analysis of **communications requirements** of the physical data flow and identification of **related standards** and the **way the interface is intended to** be used.

Therefore, a unified guideline how an interface is described and what is needed to be specified for an implementation was created. An interface needs to contain following information:

- **Type:** User Interface, Programming Interface, Hardware Interface
- **Short description:** usually a sentence mentioning the parts connected via the interface
- **Contextual Use:** how is the interface intended to be used
- **Related documents:** any relevant materials + links
- **Communication requirements** (analysed per functional data flow)
 - **Data type:** raw: static / dynamic / metadata + comment
 - **max bytes per message:** estimation for the largest data we will be transferring
 - **maximum delay [s]:** the tolerance of the receiver to wait for data to be transferred
 - **message interval:** how often are data generated (an approximation needed)
 - **security level:** how sensitive and critical the information is, necessitating high/moderate or low level of security.

A combination of the information above led to the estimation of needed line capacity.



The Guide to use of Interfaces in Reference Architectures [5] document is available on NAPCORE SharePoint [here](#) (available to authorised users only).

4.3.3 Guideline to use specifications

While developing the architecture we identified several types of specifications, which are used in very different ways. This led to inconsistencies and missing links. To solve and prevent inconsistencies an internal guide “how to use specifications” was developed.

This guide defines:

- What is a specification
- Which types of specifications exist (mandatory, recommended and optional)
- How to describe a specification, including predefined structure and content
- How to link a specification to interface and to other artefacts, see chapter 5.3.6 Communications View

All guidelines and results were aligned and exchanged with the FRAME maintainers to share knowledge and create higher value for the FRAME architecture community.

The Guide to use of Specifications in Reference Architectures [6] document is available on NAPCORE SharePoint [here](#) (available to authorised users only).

4.4 Transformation of inputs

The processing of the collected supporting documents into the NAP reference architecture began by selecting the views to be covered. At the start of the task, a decision was made to update the organizational, functional, and physical views of the NAP reference architecture created in the FRAME-NEXT project, with other views slated for revision in a later release.

All information elements gathered during the source analysis stage were compared to the FRAME NAP reference architecture to update existing architectural elements or add new ones. A Concept Board was used to create the first draft set of elements. This process includes extensive discussions and refinement and took several working meetings. Once this task was completed and all identified “issues” were accounted for and recorded within the Concept Board tool, we began to develop the initial content of identified functionalities. Once the initial content was created, we ceased working in the Concept Board and began transferring the findings to the FRAME, via updating the FRAME NAP reference architecture in the Enterprise Architect (EA) software tool.

The views in the FRAME NAP reference architecture were subsequently checked for consistency and edited only if new elements were needed from the Concept Board or the EA revision process.

Regarding the security view, a decision was made to include a high-level view regarding the security architecture developed by the SWG4.1 DATEX II.

4.5 Continuous alignment for validation of the NRA

This section provides a detailed description of the progress made towards the NAP reference architecture during the NAPCORE project. The collaborative efforts of multiple NAPCORE WGs are instrumental in shaping the NAPCORE project landscape, particularly through their inputs to the pivotal NAP reference architecture task. This section documents the associations, inputs and impact each WG has, while emphasizing their unified direction and commitment to moving forward as a cohesive whole towards harmonization.



4.5.1 Close cooperation/alignment within WG2

Close cooperation is important within WG2. Collaboration and alignment are necessary at the level of project deliverables. WG2 aims at harmonizing the level of service of NAPs considering the currently adopted data standards and NAP architecture while also taking steps towards the maintenance and extension of this architecture. Interoperability demonstrators are also within the scope of WG2 aiming to describe and develop technical solutions enabling increased interoperability and improved NAP level of service.

The alignment within WG2 aims to facilitate coordination between all harmonization relevant tasks and in project objectives. This collaborative effort seeks to prevent duplication of work and promote a shared understanding of key concepts.

The relevant WG2 tasks within the scope of NAP reference architecture and important work objectives requiring harmonization include:

- T2.1 *“Level of service of NAPs”*: Focuses on the unified description of NAP level of service, defines relevant terminology, develops key performance indicators, their minimum values, the framework for assessing the level of service, and, from the derived outputs, identifies gaps in NAP implementation = this task requires **collaboration**, so all their deliverables are aligned. The NAP Level of Services KPI Framework (NLKF), a significant output of T2.1, requires alignment with the NAP reference architecture. Therefore, the content of the NLKF was examined in multiple working sessions and compared with the NAP reference architecture. The analysis and comparison revealed the need for updates to the NLKF's value descriptions, overall text, values, and minimum levels. To monitor updates, we developed a document for proposing changes, advocating for them, and consolidating resolutions.
- T2.2 *“Definition of requirements concerning data standards, reference profiles and metadata and support tools”*: Focuses on the improvement of data interoperability by defining common data standards, reference profiles, and metadata (including requirements for them) = this task requires **propose/adopt** cooperation type since it defines interfaces and recommendations for profiles.
- T2.4 *“NAP service interoperability demonstrators”*: Aims to showcase experiences from and best approaches/practices on real-world use of NAP reference architecture to support the interoperability and continuity of ITS services = this task requires **propose/adopt** cooperation type since the experiences from implementation shall be reflected in the architecture.

4.5.2 Cooperation with further NAPCORE WGs

Cooperation within NAPCORE, which mostly covers roles, such as “collect”, “propose”, and “adopt” (defined in M2.9 [16]) is needed with other WGs. This collaboration is related to terminology collection and dissemination, sharing ideas on what is needed by the NAP reference architecture and adopting relevant outputs of other WGs. The relevant working groups with their respective scopes and important work objectives requiring harmonization are:

- WG3 *“Data content”*: aims to establish a mutual understanding of the current and future content of NAPs by monitoring and assessing the availability of ITS-related data. A robust framework to evaluate data quality as well guidelines to support fair, trusted, and enhanced accessibility of data are part of this WG. This task requires **propose/adopt** cooperation type since it defines data types and data sharing, and quality requirements shall be reflected in the NAP reference architecture.



- WG4 “Standardization”: Focuses on the development of standards. This task requires adopt cooperation type since the standards and other relevant findings by the groups shall be reflected in the NAP reference architecture.
- WG5 “*National Body*”: Focuses on the development of National Body (NB) processes, self-declarations, compliance assessments and on the creation of a NB architecture. This task requires mainly **propose/adopt** cooperation type since NB and NAP must cooperate and due to the exchange of experience when creating the NB / NAP architecture (both are FRAME based).

4.5.3 Cooperation with FRAME maintainers

The latest version of the FRAME, 5.2, was published during the project FRAME Next in 2021. After the end of the project, the content, technical stability and versioning of the FRAME is maintained by the “FRAME maintainers”. Using FRAME for update of the NRA led to general findings and raised issues which need to be solved in the FRAME. Therefore, we cooperated with the FRAME maintainers and held several meetings to discuss the problems and solve them together. As a result, there will be a new version of the FRAME soon.

The updated NRA will be integrated into the FRAME and replace the previous version 1.0 of the NAP Reference Architecture.

4.6 Support activities and issue tracking

The collaboration and alignment within the NAPCORE project led to multiple parallel inputs and requirements. To prevent misunderstandings, double work and provide a greater value for the NAPCORE community T2.3 started several support activities.

This support consists of interoperability documents, guidelines, an information website for easy access, a reporting portal for issues and feedback and a clear description of change management including versioning.

4.6.1 MS word exports of the NRA and in NAPCORE development

Within the runtime of the NAPCORE project, the easy procedure of commenting and reviewing current NRA has been adopted:

1. The latest fixed state of the NRA model in Enterprise Architect was exported, per view, into a MS Word documents using a custom template.
2. The MS Word documents were reviewed and commented in the change mode. These changes / comments were accepted / rejected based on a consensus.
3. The results were transferred into the model and new MS Word files for further commenting were created.

MS Word templates developed during this phase are used to present a final version of the NRA.

4.6.2 Setting up a maintenance website

The maintenance of the architecture gets more complicated the more NAPCORE tasks and users are involved, since they have different perspectives and requirements regarding the architecture. To receive feedback on issues, improvement as well as general feedback, a structured issue description was developed.

To receive feedback a GitHub page was created:

<https://github.com/NAPCORE/NAP-Reference-Architecture>



We decided to use GitHub because the official NAPCORE.eu website structure was not capable to have regular changes and issue management. Another reason was that GitHub can fulfil further necessary tasks regarding version management and providing additional information.

Therefore, the NRA GitHub hosts:

- Releases of numbered versions and current draft of NAP reference architecture as
 - a binary Enterprise Architect file (ext:qea).
 - MS Word exports from the architecture for tracking purposes
- Guidelines as MS Word files
- Wiki describing the architecture, its use and maintenance procedures
- Issues with their tracking and assignment to releases of architecture

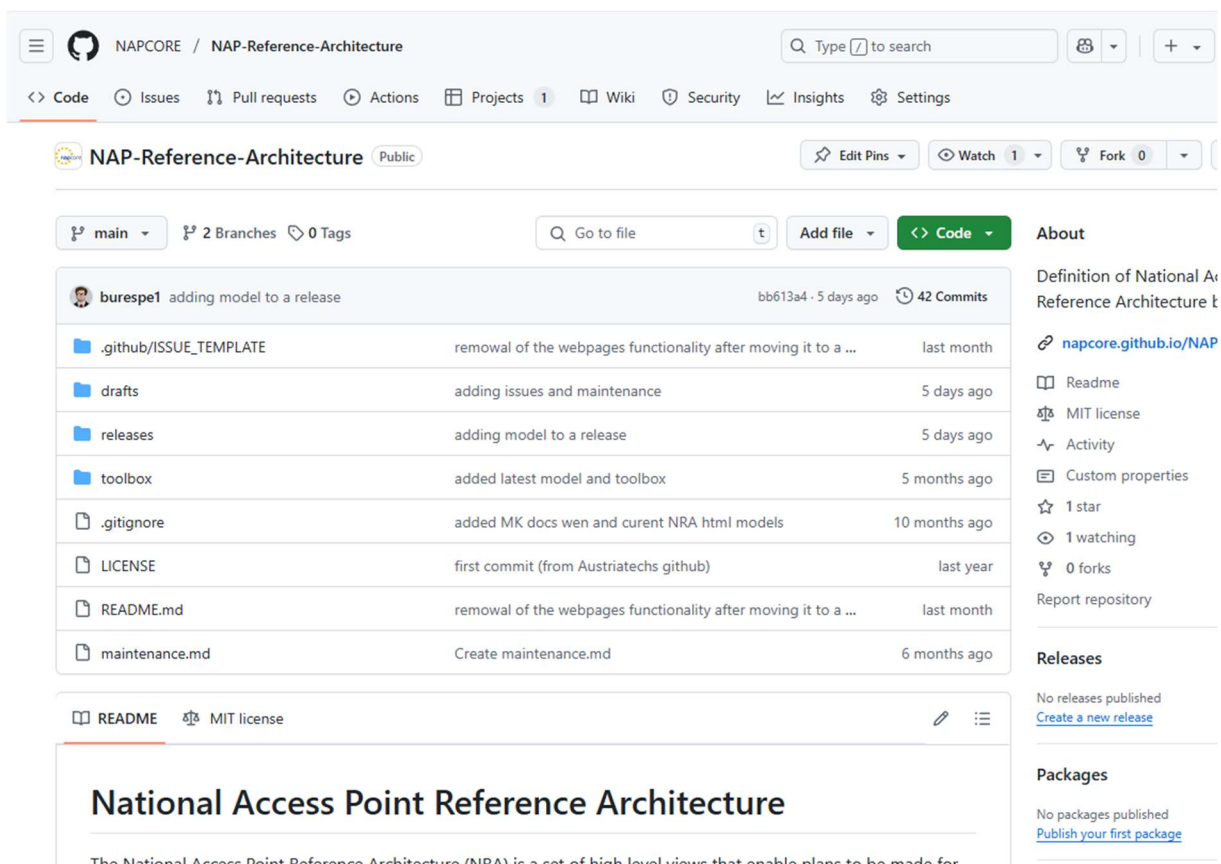


Figure 1 Screenshot of NAP Reference Architecture GitHub [NAPCORE, 2025]

To structure the issues a template was created. An issue shall address (in reference to guidelines):

- Issue name: composed of the problem description and scope identification
 - [View / Object Type / Object Name] – as inserted by the user, see description above
 - Short description
- Label assigned by user:
 - Issue type (General/ Editorial / Technical)
 - Scope (bug, enhancement, question)
- Contents of the issue:
 - Comments – initial comments from the filing user
 - Proposed Change – initial proposal from the filing user.
- Content of the issue follow-up
- Observation: a sequence of comments to the issue ending with a resolution.



We developed accordingly a reaction time for different types of issues:

- For any issue
 - Step 1 –2: **one month**, ideally during monthly NRA maintainers meeting
- For a minor - nonbreaking change:
 - Step 3: two months
 - Step 4: **one week**
- For a major – breaking change:
 - Step 3-4: **two months**
 - Step 5: **one week**
 - Step 6: **two weeks to two months** to implement resolution of major issue based on its complexity.

4.6.3 Setting up an information website

GitHub is a technical and experts dedicated web interface to present and maintain tools and projects. To present the NRA and related information to a broader and non-technical audience an easy to read website was created: <https://napcore.github.io/Reference-Architectures-website/>.

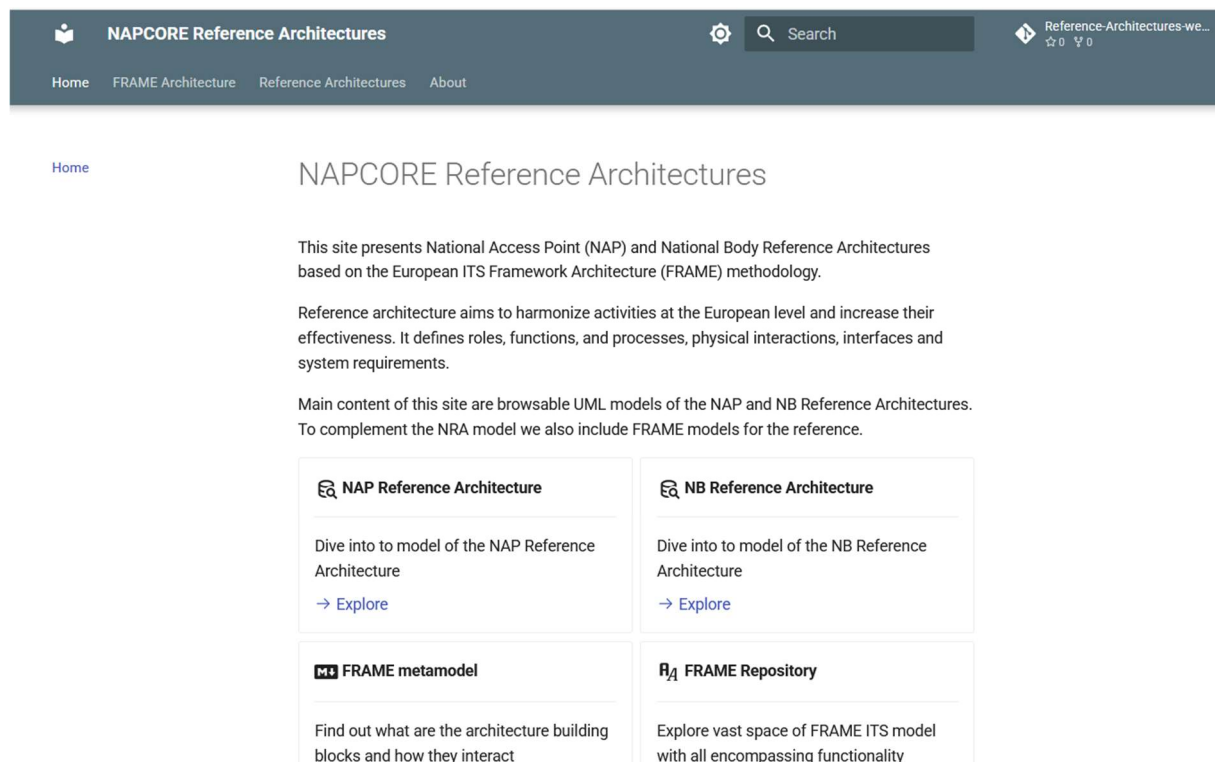


Figure 2 Screenshot of Reference Architectures information Website [NAPCORE, 2025]

To align with the NB Reference Architecture, which is using the same FRAME architecture environment, the information from both architectures were combined into this website.

The website informs the audience about:

- Latest version and changes
- Basic principles of the FRAME methodology
- Knowledge about elements, how to read, principles
- A browsable UML model from both reference architectures



This website also improves the non-discriminatory and free access to the reference architecture and eases up the usage of the reference architectures.

4.6.4 Update and Versioning of NRA

The NAP reference architecture has been updated from a FRAME NEXT version 1.0 to a version 2.0. The alignments, developments and improvements related to the NRA are continuous. Also, a continuation of its development is planned in NAPCORE-X. Therefore, we must foresee a handling of updates and versions of the NRA. Such ongoing developments will likely result in changes leading to new releases of the NRA.

For new releases of the NRA the following scheme will be used (based on: <https://semver.org/>)

- New versions will be released periodically (e.g. quarterly) fixing several issues, improvements and bugs at once, i.e. not every issue resolution will trigger new version release.
- The versioning scheme will follow semantic versioning ([Semantic Versioning](#))
- Given a version number MAJOR.MINOR.PATCH, increment the:
 - MAJOR version when you make incompatible API changes
 - MINOR version when you add functionality in a backward compatible manner
 - PATCH version when you make backward compatible bug fixes
- Additional labels for pre-release and build metadata are available as extensions to the MAJOR.MINOR.PATCH format. (alpha [a], beta [b], release candidate [rc])

The versioning scheme applies to architectural views (i.e., motivational layer, user needs, functional view, physical view, organizational view, etc.) and to a file itself. Only views that changed will have the version increased. Version on the level of architectural objects is date of change of the object (e.g. date modified).



5. FRAME architecture principles

This chapter outlines the principles and methodologies for creating a reference architecture using FRAME, detailing the modelling of layers and views essential for the ITS development. It defines the objects used for modelling different views of the reference architecture and describes the principles and methodologies developed for the reference architecture in the NAPCORE project.

5.1 The FRAME

The FRAME is a framework that provides a systematic basis for planning ITS implementations in Europe. The FRAME consists of three pillars: architecture, methodology and tools.

- The **FRAME architecture** is a repository of user needs and functions, which are grouped into several functional areas.
- The **FRAME methodology** employs the FRAME architecture while also utilising the building blocks, glossary, and definitions to provide a clear procedure for the ITS architect to develop ITS service architectures.
- The **FRAME tool**, which enables the ITS architect to create ITS architectures as sub-sets of the FRAME Architecture to implement one or more ITS services.

In the FRAME tool (the Enterprise Architect software⁵ with a customised toolbox) the model is organized into folders so they could be easily worked with in the project browser (1). Selected parts of the model could be visualized in the diagram area (3) and all connections between objects in the model could be visualized in Traceability (4) and Relationships (6) docks, new objects could be added to the view from the toolbox (2).

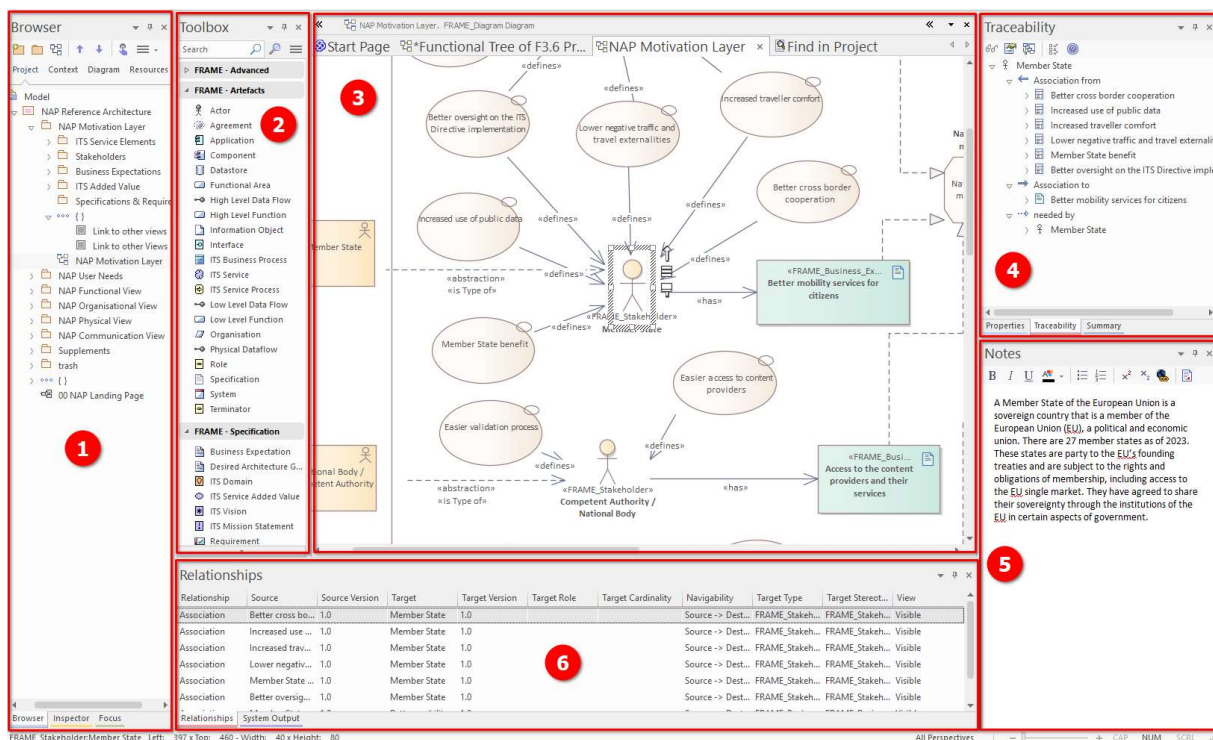


Figure 3 Enterprise Architect SW used for FRAME [NAPCORE, 2025]

⁵ Enterprise Architect is the tool that is used to maintain the FRAME Architecture. A 30-day Enterprise Architect Trial Edition or unlimited use Enterprise Architect Viewer can be downloaded at <https://sparxsystems.com/products/ea/downloads.html>. To modify the contents of the architecture, the Enterprise Architect Edition is required.



5.2 FRAME methodology introduction

The FRAME Architecture consists of a predefined Functional View, the content of which is linked to a set of predefined User Needs. FRAME architecture users could create their own sub-set Functional View to support the ITS Services they wish to deploy by identifying the User Needs that match the content and requirements of the Services they wish to implement.

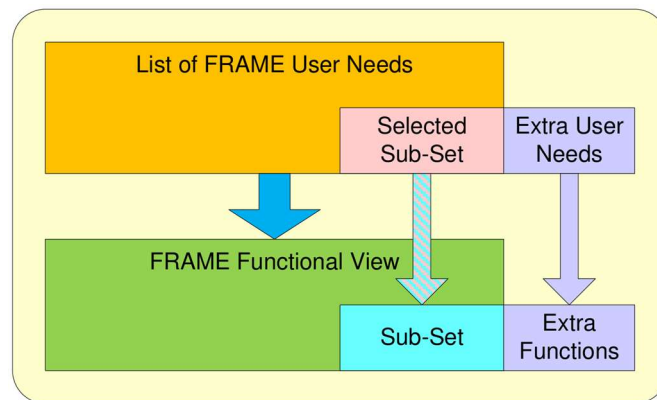


Figure 4 Selecting a Sub-set Functional View [FRAME, 2015]

The users are expected to produce descriptions of the ITS Services they need and are encouraged to get these agreed upon with all their stakeholders. As a result, these descriptions are called Stakeholder Aspirations, and they could be mapped to the User Needs and further reused to build a Motivation Layer (a more formal version of the Stakeholder Aspirations). The FRAME methodology, supported by computer-based tools, assists in creating logically consistent subsets of the FRAME architecture functional view and subsequent physical, communication and organizational views. Thus, the FRAME architecture serves as a framework from which specific models of integrated ITS can be systematically created.

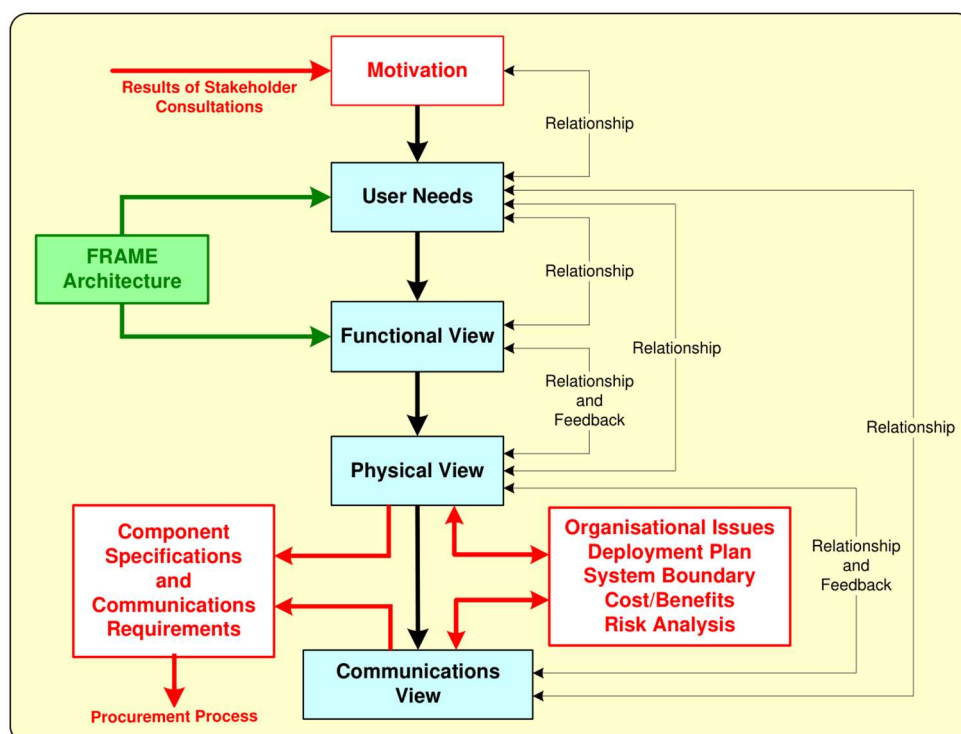


Figure 5 ITS Architecture Development [FRAME, 2015]



In the project NAPCORE we expanded this set of views / perspectives to cover legislative and standard requirements and recommendations, NAP level of service mapping to the NAP reference architecture, support for process descriptions and support for issues.

5.3 FRAME Views and their role in creation of reference architecture

In this chapter the purpose and methodology of different parts of the FRAME process for the creation of the reference architecture is described. It begins with the **Motivational Layer**, which defines the goals, stakeholders, and scope of the service. The **User Needs and Requirements View** translates these motivations into specific, testable requirements. The **Functional View** details the system's functional structure using hierarchical Data Flow Diagrams. The **Physical View** describes the deployment of software and hardware components. The **Organizational View** explains the roles, responsibilities, and relationships of the actors involved. The **Communications View** focuses on data exchange and interaction between system components. Finally, the **Safety and Security View** addresses potential hazards and threats.

5.3.1 Motivational Layer

The Motivation layer documents the reasons for the current effort to create the service as well as the goals, relevant stakeholders and the scope of the service. The intention of this section is to formulate an idea of the service, to get an impression of the intended result of its use and to identify the conditions under which it will be used. Naturally, each stakeholder has some aspirations regarding participation in the value creation.

The Motivational Layer outlines the initial position of system development, the stakeholders involved, and the expected added values and business goals. It includes key elements such as the ITS Vision and the ITS Service description. This layer models the motivations, reasons for the creation of the ITS Service, and the expectations of its successful implementation. The layer includes stakeholders, represented by actors, who have a vision realized through a mission. This mission, along with their expectations, defines the ITS Service, which in turn provides added value. The ITS Service operates within a domain and satisfies user needs and requirements.

Once the results of the Motivation analysis are known, those that relate to the desired ITS service can be developed further. This is done with the assistance of the User Needs.

5.3.2 User Needs and Requirements View

The results of the Motivation analysis are likely to contain a number of ideas, written in a variety of styles, and which may be open to interpretation. It is therefore necessary to re-write them in a consistent manner, and the User Needs provide a way of expressing these ideas in a way that is Unambiguous, Testable (with objective tests), Traceable (with unique reference numbers) and Singular (with only one idea at a time). They are therefore written in a standard manner – see below.

The User Needs are split into 10 main groups, which are themselves split further into further subgroups. All the User Needs begin with the words “The system shall ...”; this is to ensure that it is clear what the system should provide and can later be tested to confirm it does.



7 Traffic Management		
7.1 Traffic Control		
7.1.4 Traffic Flow Control	7.1.4.4	The system shall be able to provide advice to drivers as they approach car parks
7.1.11 Parking Management	7.1.11.1	The system shall be able to monitor the current usage of the parking facilities
	7.1.11.4	The system shall be able to collect and store data from all car parks to provide a historical record

Figure 6 Example of 2 User Needs from traffic control sub-group [FRAME, 2015]

User Needs are tailored to represent the smallest possible portion of an ITS Service. The minimum set of functionalities to realize the service are cross-referenced to these User Needs, so the creation of the Functional View starts by selecting a subset of User Needs that best describes the intended ITS Service. This initial selection may require additional functional elements to achieve the desired ITS Service.

Once the results of the User Needs allocation are known, the linkage to the Functional View of the desired ITS service can be developed further. This is done with the assistance of the User Needs and is usually an iterative process.

5.3.3 Functional View

The Functional View focuses on the functional aspects of a system, defining the architectural elements that deliver its functionality. It documents the system's functional structure, including key elements, their responsibilities, and interactions. This view is often the cornerstone of architecture descriptions and is usually the first part stakeholders read.

The FRAME Architecture uses the Function-Oriented design technique of hierarchical Data Flow Diagrams. The highest level is the Context Diagram, showing the relationship between a system and its environment (Terminators). The System Boundary separates the ITS under consideration from external entities like people, organizations, and equipment that interact with it. Terminators can be a person, organization, or another system (e.g., vehicle).

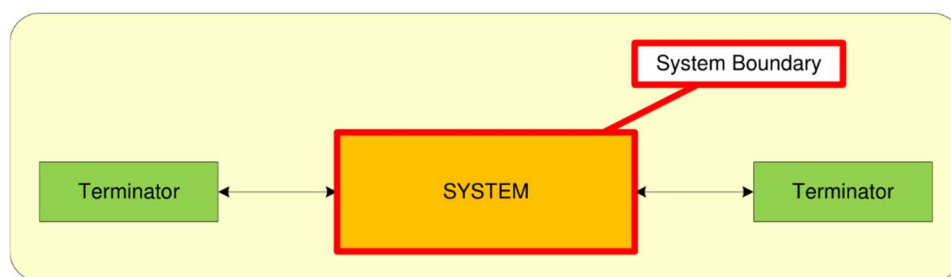


Figure 7 Context diagram [FRAME, 2015]

At lower hierarchy levels, functionality is described as a chain of functions connected via functional data flows, with terminators at both ends. This chain represents a data processing sequence in the designed system. Datastores model real databases by representing the ability of a function to store and retrieve data.

Functions are structured hierarchically, with rarely more than 10 functions in a single diagram. Higher-level functions provide a mechanism to manage the large number of low-level functions in the entire FRAME Architecture.

At the highest level of decomposition are the nine Functional Areas:



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1. Provide Electronic Payment Facilities
2. Provide Safety and Emergency Facilities
3. Manage Traffic
4. Manage Public Transport Operations
5. Provide Support for Host Vehicle Services
6. Provide Traveller Journey Assistance
7. Provide Support for Law Enforcement
8. Manage Freight and Fleet Operations
9. Provide Support for Cooperative Systems

As each area comprises more than 10 functions, they are sub-divided into a hierarchy of lower-level functions (functional decomposition), using a multi-level numbering system. Each function that includes lower-level functions has its own Data Flow Diagram.

Table 1 Hierarchical decomposition of functionality in a functional view [FRAME, 2015]

DFD 3 Manage Traffic: Comprises Functions 3.1 to 3.5			
 DFD 3.1 Provide Traffic Control: Comprises Functions 3.1.1 to 3.1.3			
 DFD 3.1.1 Provide Urban Traffic Management: Comprises Functions 3.1.1.1 to 3.1.1.5			
 DFD 3.1.1.5 Provide Urban Traffic Management Facilities: Comprises Functions 3.1.1.5.2 to 3.1.1.5.24			
 F3.1.1.5.8 Detect Urban Traffic Violations: This is a Low-Level Function that may be used in Physical View. Each one has a detailed description of what the function does (for use in specifications), and (normally) a list of one, or more, User Needs that this Function helps to satisfy.			

The Functional hierarchy results in a corresponding hierarchy of Data Flows, with higher-level Data Flows often composed of multiple lower-level Data Flows. These higher-level Data Flows are used solely to make the diagrams easier to understand. This process is known as Functional Decomposition. It is important to note that only the lowest-level Functions, along with their respective lowest-level data flows, connected datastores, and terminators, are used in the Physical View.

Creating the Functional View involves using identified user needs, which represent stakeholder aspirations, to select the necessary functionality (functions, data flows, datastores, and terminators) for providing services. The functionality included in a Functional View is a subset of the complete FRAME Architecture and usually does not need to be extended by the FRAME End User, except when new functionality is required to provide services not currently included in the FRAME Architecture.

Once a consistent subset of the Functional View has been created, the next step is to develop the desired Physical View.

5.3.4 Physical View

The Physical View presents the system from a system engineer's perspective, focusing on the topology of software and hardware components and their physical connections. It describes how a subset of the Functional View will be deployed in a given situation. For example, functions and data stores may be located in different places, requiring suitable communications links for transfer of data in contained functional data flows, identified as a physical data flow, see the next figure.



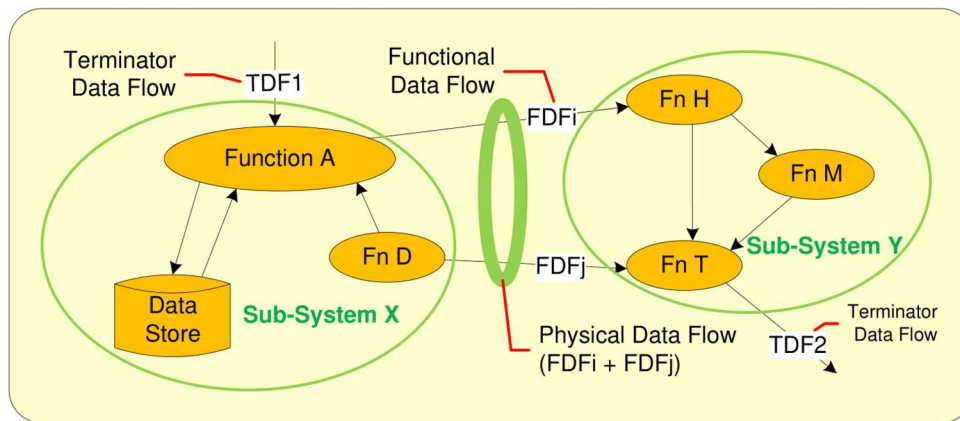


Figure 8 Creating a Physical View from a Functional View [FRAME, 2015]

The specifications for Sub-Systems can each be formed from the descriptions of the Functions of which they are composed. The communications requirements can be found by analysing the combined Functional Data Flows between connected Sub-Systems.

Sometimes it is useful to divide a Sub-System into two or more Modules, either for clarity, or to provide options. In this situation it should be noted that there may be additional Physical Data Flows for each Module which make up Physical Data Flow for the Sub-system, see next figure.

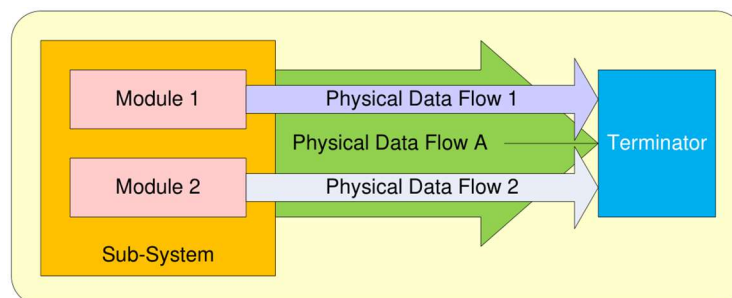


Figure 9 Constituent Physical Data Flows [FRAME, 2015]

Sub-systems, Modules, and Physical Data Flows are created using the FRAME tool as part of the FRAME Methodology, which provides guidelines for naming conventions, physical locations, and descriptions. There are no limits on the number of Functions and Data Stores in a Sub-system, but a large number may increase complexity and difficulty in replacement. Similarly, there is no limit to the number of Modules, though fewer Modules may result in higher complexity.

Sub-systems can be located in various physical categories:

1. Roadside – detectors, traffic signal controllers, variable message signs, etc.
2. Centre – a fixed location not at the roadside.
3. Vehicle – includes motorcycles and some forms of goods, e.g. a container.
4. Personal device – smart phone, laptop, tablet, e-book, etc.

Multiple instances of locations in the same category are allowed for different sub-systems within the same system. There is no limit on the number of constituent Functional Data Flows in any Physical Data Flow, but a large number may complicate finding relevant international standards for External Physical Data Flows.

Once the Physical View is created, the next step is to develop the Communications or Organizational Views and other supplementary views.

5.3.5 Organizational View

The Organizational View provides information about actors, their roles and responsibilities, and the relationships between these roles, whether lawful or contractual. Additionally, it depicts desired business results and processes for ITS deployment, such as ownership, planning, maintenance, deployment, implementation, and tendering. The Organizational View consists of ITS actors performing one or more roles, agreements between these roles, and their relationships to components (sub-systems) and modules.

Actors, their roles, the agreements between roles, and the relationship of the roles to the system (physical view) at different stages of its lifecycle are created by FRAME Architecture End Users using the FRAME tool as part of the FRAME Methodology. The FRAME methodology provides a guidance of how roles, including responsibilities, tasks, and capabilities that are typical and necessary for the value creation of ITS services shall be described. Roles are a significant component of ITS value-added chains, taken by ITS actors and stakeholders depending on the requirements of the ITS service. A single ITS actor or stakeholder can occupy one or more ITS roles and vice versa.

In NAPCORE, a detailed definition of the distribution between actor and role has been created, along with a detailed structure of an agreement object specifying the involved parties, the nature of the agreement, and the obligations nested in the agreement.

5.3.6 Communications View

The Communications View focuses on the interaction and data exchange between system components (subsystems and modules). It outlines communication protocols, data formats, and interfaces used for data transmission. This view is crucial for understanding information flow, component interaction, and external system interfaces. It aids in designing efficient communication strategies, ensuring seamless data exchange, and improving overall system performance and reliability.

It extends the Physical View by adding interface definitions to each identified physical data flow, specifying protocols, data models, standards, recommendations, or best practices. Interfaces and specifications are created by FRAME Architecture End Users using the FRAME tool as part of the FRAME Methodology. This methodology provides guidelines for analysing basic communication requirements, such as data type, message size, delay, frequency, and security, enabling proper interface design.

In NAPCORE, the Interface Specification artefacts were significantly modified along with the way they are used in the architecture. To support harmonized description, detailed guidelines for interfaces and specifications were created.

Interface description was adapted to include the purpose, type of interface, and direct links to related documents describing the interface as a whole. The communications requirements that serve as basis to identify what type of capacity is needed, were modernized, see chapter 4.3.2 Guide to use of Interfaces in Reference Architectures.

The specifications were adapted in a similar way, allowing to identify specification, provide a brief description along with its intended use in the ITS system. The specifications were classified into the following categories: legal document, standard, profile, recommendation and guideline. The specification can be linked to any object in the architecture signifying the origin of the artefacts content and obligations (mainly for organizational objects) or implying the use of a standards.

In NAPCORE we decided to map specifications to interface in the following way:

- **Standard:** an interface can be linked to more standards. Linking means obligation to use it. Linking 0 standards means that there is no consensus.
- **Profile:** same as above but the content is more specific than in a standard.



- **Recommendation:** an interface can be linked to more recommendations. Linking means approval of recommendation by NAPCORE. Recommendations approved guidelines.
- **Guideline:** an interface can be linked to more guidelines (each for a specific purpose). Guideline is NOT approved by NAPCORE and is voluntary. Guidelines are good practices, implementation guides, examples, descriptions of how other linked specifications shall be orchestrated.

Linking of specifications to the interfaces is a key task in the communications view.

5.3.7 Safety and Security View

This View addresses two key aspects: safety and security. Safety refers to freedom from hazards that can cause physical harm, while security pertains to protection from threats and abuse, including unauthorized disclosure (loss of confidentiality), unauthorized modification (loss of integrity), and unauthorized deprivation of access (loss of availability).

The FRAME methodology assesses safety issues in ITS deployments by creating a "PASSPORT Diagram" and conducting a "What if?" analysis to identify potential problems. The analysis results in high-level safety requirements for each subsystem/module, categorized into:

- System safety – due to incorrect system functioning.
- HMI Safety – due to distractions for road users.
- Traffic Safety – due to incorrect vehicle management/behaviour.

Security issues can be complex, covering various types of attacks, from data access to system control. These attacks can result in denial of service or modification of the service, potentially causing safety issues. The analysis produces security requirements for each subsystem/module, sorted into problem-mitigation pairs.

5.4 FRAME artefacts

In this chapter, artefacts used to build FRAME Views are presented. These descriptions were compiled from FRAME NEXT deliverables D4.2 and D3.1 and have been thoroughly revised by NAPCORE. The building blocks (artefacts) of reference architecture views, such as the Motivational Layer (1), Functional View (2), Organizational (Enterprise) View (3), Physical View (4), and Communications View (5), are depicted in the next figure and described in the following text.



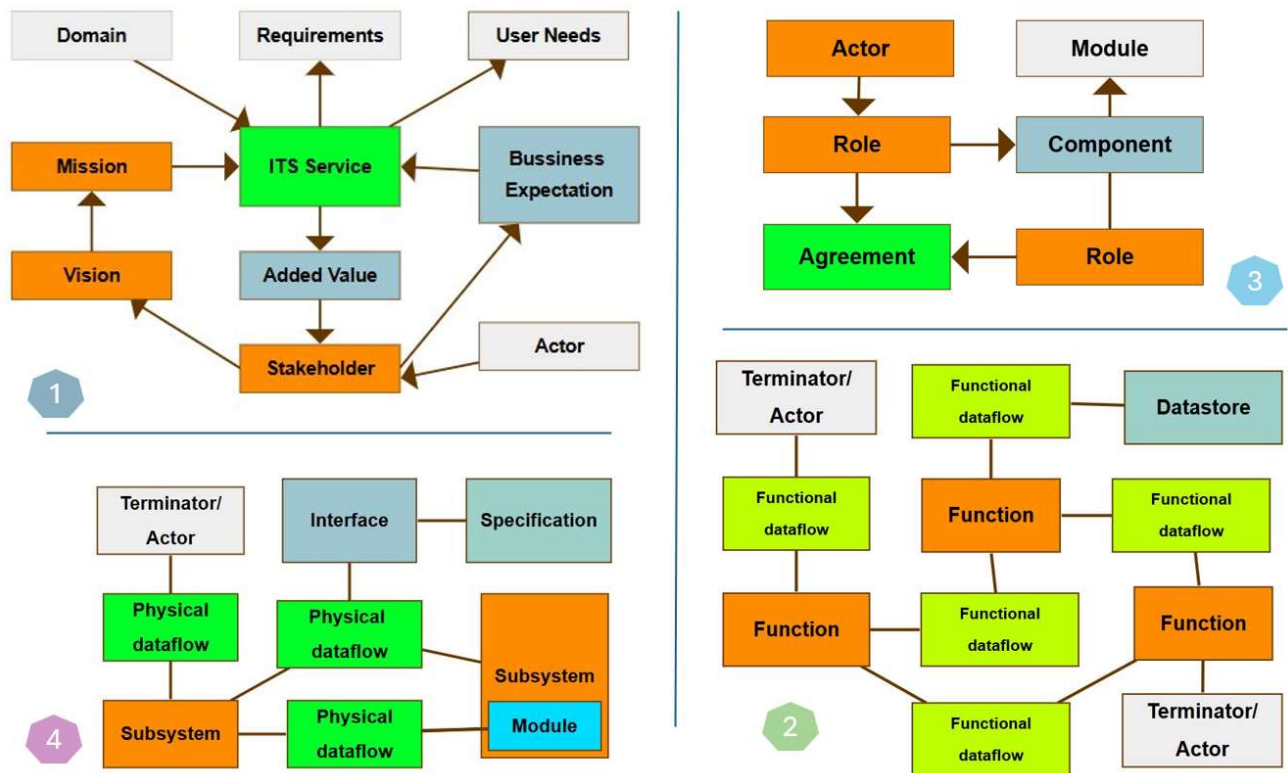


Figure 10 Components of FRAME views, Motivation (1), Functional (2), Organizational (3) and Physical (4) and Communications (4) views [NACORE, 2025]

5.4.1 Motivation layer artefacts

The **ITS Stakeholder** is an organization or individual interested in the deployment, operation, or outcomes of ITS services. They can be directly or indirectly affected by the decisions made during the entire lifecycle of ITS Services. They are usually decision-makers such as politicians, high-level managers, and others e.g., the general public or user groups, who typically have little or no knowledge of systems design and implementation beyond what they have acquired as end users.

The **ITS Vision** is the long-term objective and the aspirational goal for the future. The ITS Vision is shared by all ITS Stakeholders. It is a source of inspiration for the ITS Services and provides a clear goal to be adhered to by the ITS Services.

The **ITS Mission** is a short statement that highlights what is needed to be done by the ITS Stakeholders in the present to achieve the ITS Vision. It summarizes the purpose of the existence of the ITS Services and guides their use by the ITS Actors and/or the end users. It formulates a clearly structured, overarching policy objective of the defined ITS service deployment, considering the interests of stakeholders and end-users.

The **ITS Service** describes a value-added service provided by ITS actors in the field of transport, traffic, and mobility for end-users. The added value is created by combining technologies, organizations, processes, and people. The service can be delivered by a single actor or in cooperation with others, and it creates added value that may consist of individual benefits for mobile travellers, collective benefits for end-user groups or society, or a mixture of both. It describes the idea and functional elements of the ITS service as well as framework conditions.

The **ITS Domain** is a concept that categorizes the diverse applications of ITS into specific fields of application. It applies sector-specific knowledge and additional architectural knowledge to ITS. The domain also defines the boundaries of the ITS system or service at the start of an ITS architecture project, distinguishing it from similar or adjacent systems or services.



ITS Service Added Value represents monetary and nonmonetary benefits that are gained by the implementation of the ITS Service. Each individual ITS Service Added Value outlines a particular, impact/benefit of implementing the ITS Service affecting one or more stakeholders.

Business Expectations are what the ITS Stakeholders aim to achieve by the implementation/operation of the ITS Service. Business Expectations could be the political, economic, social, socio-economic, socio-political, operational, organisational, safety, and efficiency-related added values that are associated with an ITS service and are formulated as goals. These expectations are used together with the ITS Mission Statement to define the ITS Service

5.4.1 User Needs view

User Needs are a set of standardised high-level requirements that, in combination, describe all the ITS Services supported by FRAME

5.4.2 Functional view artefacts

A **Function**, also known as a “process”, is an action that involves receiving or processing input data. This data is then either passed on to another function or sent out as information or control instructions to an external entity. Functions are categorized into various levels: High-Level Functions (HLF) and Low-Level Functions (LLF). HLFs contain a group of functions concerned with a specific part of data processing and always have component LLFs. LLFs, on the other hand, perform a specific part of the data input, process, or information output process and have no component functions. User needs are allocated to LLFs, which are the only functions used in the FRAME Methodology.

Data Stores are repositories of data. Many of them are managed by their own dedicated Low-Level Functions. They store data from, and provide data to, (usually) more than one other Low-Level Function. Thus, Data Stores will always be part of Functional Areas or High-Level Functions.

Data Flows are the movements of data between different components of the system. There are three types of data flows. The first type is data flows between Low-Level Functions. The second type is data flows between Low-Level Functions and Data Stores. The third type is data flows between Low-Level Functions and Terminators/Actors.

Terminators/Actors define the world outside the FRAME Architecture, i.e. artefacts that are not modelled within it. Actors are used to identify variants of a Terminator, e.g. several types of vehicles and drivers, or the separate roles that a traveller may take during a trip.

5.4.1 Physical view artefacts

Sub-systems are at the highest level and may consist of one or more Modules. The number of Modules in a Sub-system is optional, and a Sub-system does not need to have any Modules if it lacks complexity. Sub-systems only exist in one geographic location, meaning that if the ITS deployment is being made across several locations, each location will have its own Sub-system. Sub-systems and Modules may be duplicated in total, or in part, in several locations.

Module consists of a computer program or system of computer programs that automate or implement useful functions. It uses ITS interfaces for communication with other ITS applications and realizes technical activities in an ITS business process. These are parts of Sub-systems in the Physical View of ITS. They contribute to the functionality of the Sub-systems and can be duplicated in total or partially across several locations. Modules communicate with each other and with Terminators/Actors through Physical Data Flows.

Physical Data Flows are the means of communication between Sub-systems, Modules, and Terminators/Actors in the Physical View of ITS. There are two types of Physical Data Flows: Internal, which links



Sub-systems and Modules together; and External, which link Sub-systems and Modules to Terminators/Actors. The creation of a Physical View is always based on a particular Functional View, which must have passed the logical consistency checks before it can be used.

5.4.1 Organizational view artefacts

The **ITS Actor** is part of an ITS value-added chain/network and is directly involved in value creation. It contributes to the added value of ITS benefits by using its ITS capabilities as part of its activities. It usually also represents the interests of ITS stakeholders who are not directly involved in the ITS value chain but have strong associated interests. The ITS end-user is also considered a special ITS actor.

The **ITS Role** defines and describes responsibilities, tasks, and capabilities that are typical and necessary for the value creation of ITS services. Is taken by ITS actors and stakeholders depending on the requirements of the ITS service to be implemented. A single ITS actor or stakeholder can occupy one or more ITS roles.

The **ITS Agreement**, Agreement is contractual or lawful relationship between two roles, that defines obligations/responsibilities of the roles to each other and also the obligations/responsibilities of the roles in this relationship to other roles. The Agreement could take the form of a European or national legislative document, memorandum of understanding, contract, license, or terms and conditions.

5.4.1 Communications view artefacts

An **ITS Interface** serves the exchange of information between systems. It corresponds to an interface specification consisting of the definition of a protocol and a data model and is used and implemented by ITS applications.

The **Specification** is detailed, precise description of the requirements, design, behaviour, or characteristics of a system, component, or process. Specifications are used to ensure that everyone involved in a project understands what is expected and to provide a basis for verifying that the final product meets the required standards.

5.5 NAPCORE specifics and architecture products

Apart from the views referred to in the previous chapters there are other products to create an additional description. These products are in NAPCORE situated into so called packages within the NRA reference architecture model.

5.5.1 Specifications and Requirements package

This package's main purpose is to organize Specifications and Requirements at one place within the architecture while capturing relationship of the specification artefacts to relevant artefacts within other architectural views. This package was added by NAPCORE together with detailed guideline for the creation of the specification object with regards to its structure and content and linkage [6]. Specifications could be legal documents, standards, profiles, recommendations, or guidelines.

The specifications are created by FRAME Architecture End Users using the FRAME tool as part of the FRAME Methodology.

5.5.1 NAP level of service KPI Framework package

NAPCORE specific package was added to the architecture supplements due to a strong link with the architecture. The NAP LoS KPI Framework (NLKF) is a tool to assess a NAP LoS based on a framework of Key Performance Indicators (KPIs) related to the offered NAP interoperability features and services. As such NLKF provides a bottom-up principal parameters, as a state of practice in Europe going from



This project has received funding from the European Commission's Directorate General for Transport and Mobility under Grant Agreement no. MOVE/B4/SUB/2020-123/SI2.85223 31

individual KPIs. The aggregated results for feature categories or for a NAP as a whole are expressed in quantitative manner (Grade of Achievement) or qualitative (Maturity Level, LoS).

The package provides mapping of the NLKF features to the individual parts of the reference architecture allowing to process any changes into the reference architecture whenever are NLKF parameters updated.



6. NAP reference architecture

The development of the National Access Point (NAP) reference architecture is based on the revision and update of the FRAME NAP reference architecture v1.0, incorporating findings from the NAPCORE project. This chapter provides a summary of the NAP reference architecture v2.0.

In the following subchapters we describe different parts of the NAP Reference Architecture, e.g. views. Since it would be impractical to describe full content of the views we focus in the description on:

- Brief definition of the view, to provide a context
- High level description of the changes done to the view from the version 1.0
- Diagram of the objects and their interaction in the view
- Quantitative and qualitative summary of the view covering description of its artefacts their interaction and providing examples of artefacts content in a different font.
- Conclusion for the created view

Full NAP reference architecture documentation in form of Enterprise Architect model files (gea), and MS Word documentation created by the export of the model using a template is available at the [NAP-CORE GitHub](#) and as online browsable html web page at [NAPCORE Reference Architectures](#) website.

6.1 Different NAP types definition and utilization in views

During the NAPCORE project, we decided to extend the functionality described in the FRAME NAP reference architecture to cover data distribution by the NAP. This decision led to the creation of two reference architectures within the FRAME tool. One for the **Metadata Directory** and another for the **Data Platform**.

Based on the alignments within NAPCORE the two NAP types have been defined as follows:

- **Metadata directory:** The metadata directory contains **descriptions** of the data and services important for their identification, assessment, and subscription by consumer, i.e., metadata. It provides facilities to authenticate data provider and functionality to insert a metadata records. The NAP provides search and discovery services of the hosted records to end users and via machine readable content to other portals. The NAP is not directly involved in the data exchange between data providers and data consumers.

--

Key features: Storage & provision of metadata records of data, services, and providers; search/discovery functionality; data provider authentication.

- **Data platform:** The data platform contains **descriptions** of the data and services important for their identification, assessment, and subscription by consumer, i.e., metadata, together with the data and/or services themselves. It provides facilities to authenticate data provider, and optionally, data consumer and functionality to insert a data and metadata records to NAP internal database. The NAP provides search and discovery services of the hosted records to end users and via machine readable content to other portals and distribution interfaces for data dissemination. The NAP is an intermediary between data provider and consumer, the data however remain in the ownership of the data provider.

Key features: Storage & provision of metadata records of data, services and providers, storage & provision of data and services; search/discovery functionality; data provider and data user authentication.



In the case there are different architecture realizations for Metadata Directory and for Data Platform, we provide a diagram for Data Platform where we distinguish between the parts belonging to Metadata Directory and the parts that are added to serve a Data Platform View. In the summary we follow the similar approach and describe the Data Platform parts on top of the metadata Directory. Therefore, it is not necessary to describe both NAP reference architectures separately.

6.2 The Motivation Layer

The Motivational Layer models the motivations, reasons for the creation of the NAP, and the expectations to be fulfilled by its successful deployment and implementation. For this view we do **not distinguish** between **both NAP types**, Metadata Directory and Data Platform.

Changes to the view: The motivation layer has been thoroughly updated, with almost every aspect of the NAP Reference architecture 1.0 changed or removed and addition of many new artefacts. Also, the methodology of the artefact's creation, namely connections between artefacts and its usage, has been updated and reported to the FRAME maintainers for adoption.



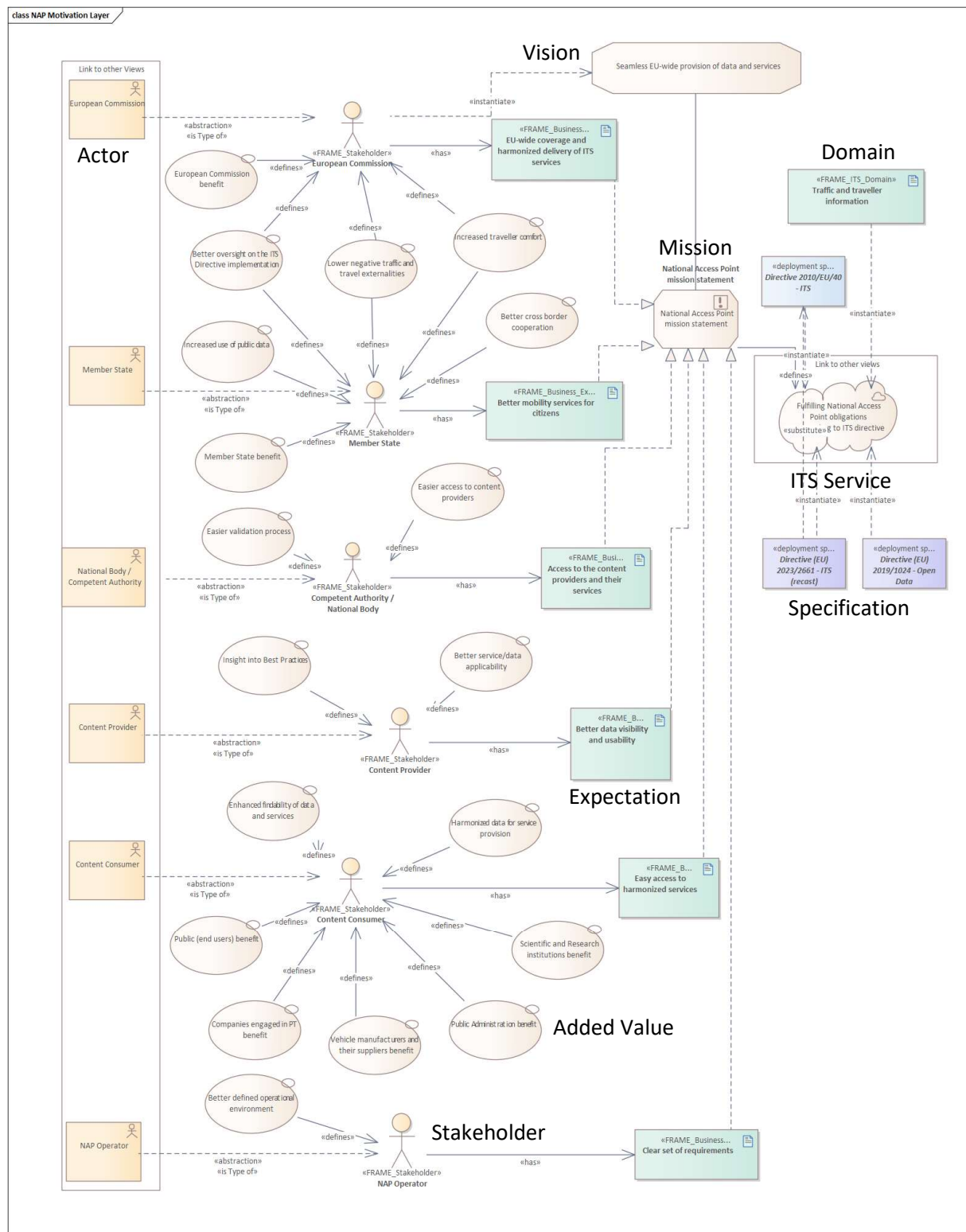


Figure 11 NAP Motivational Layer with a legend [NAPCRE, 2025]

There are 6 stakeholders active in the NAP ecosystem because they share a common vision, *European Commission (EC)*, *Member States (MS)*, *Competent Authorities (NB)*, *Content Providers (CP)*, *Content Consumers (CC)*, and *NAP Operators (NO)*. However, each stakeholder interacts with the NAP differently and has unique expectations and benefits. Together, they define the NAP as an ITS service, and this definition serves as the primary guideline for all other views in the architecture.

The *European Commission (EC)*, a key stakeholder, has a Vision of:



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“a Single European Transport Area, underpinned by a digital layer that interlinks all elements of transport. This digital architecture, built on open and common standards and interfaces, will foster an efficient and secure data ecosystem”.

This vision is realized through the EU Mission Statement:

“National Access Points (NAPs) will be established across Europe, facilitating access, easy exchange, and reuse of transport-related data, thereby supporting the provision of EU-wide interoperable travel and traffic services to end users.”

The vision and mission are achieved through the implementation of an ITS service, defined as:

“The National Access Point(s) provide non-discriminatory central access to data listed in Delegated Regulations”, with key requirements such as:

- *Language independence (English + local language)*
- *Discovery of metadata and data samples without user registration*
- *Data exchange based on standards*
- *Support for EU-wide interoperable ITS services for travellers*
- *Availability of data at standard interfaces and in machine-readable formats*
- *Extendable data content to all ITS-directive domains*
- *Respect for data owner rights while supporting data exchange”*

These requirements summarize the NAP as an easy-to-use central point of exchange for traffic-related data between providers and consumers. To achieve this, the NAP must have clearly defined operational domain, setting boundaries across various parameters (Transport Network, ITS Service, ITS Service Type, Level of Detail, Perspective, Focus).

The NAP environment involves all 6 stakeholders. Very important stakeholders are Content Consumer (CC) and Content Provider (CP). For example, Content Provider Stakeholder is defined as follows:

“Content Providers are national and international organizations, data holders, data, and service providers who are required by the Delegated Regulations of the ITS Directive to make data and/or service accessible via the National Access Point. Content Provider includes the Data Holder term as it is specified in MMTIS and RTTI Regulations. According to the obligation to the Delegated Regulations Content providers are represented by:

- *Public and private road operators, service providers, and broadcasters dedicated to traffic information [886/2013 (SRTI)]*
- *public and private service providers, parking operators, and road operators [887/2013 (SSTP)]*
- *road authorities, road operators, digital map producers, and public or private service providers, where ‘service provider’ means any public or private provider of a real-time traffic information service, excluding a mere conveyer of information, to users and end-users [2015/962 (RTTI)]*
- *transport authorities, passenger transport operators, infrastructure managers, transport-on-demand service providers, and travel information service providers. [2017/1926 (MMTIS)]”*

All Stakeholders are contributing to the ITS service through their business expectations. There are six expectations, one for each stakeholder.

- **EU-wide coverage and harmonized delivery of ITS services (EC)**
- **Better mobility services for citizens (MS)**
- **Access to the content providers and their services (NB)**
- **Better data visibility and usability (CP)**
- **Easy access to harmonized services (CC)**



- Clear set of requirements (NO)

For example, the *Member State (MS)* stakeholder expects “Better mobility services for citizens” as:

“Member States, as main protagonists in creating and implementing European Policy, have similar expectations to the European Commission, such as more efficient transport and fewer accidents. They also expect increased use of governmental and private data, better cross-border traffic management, and increased MS cooperation.”

The ITS service, when implemented, creates additional benefits (Added Values) for various stakeholders. There are 19 service added values affecting one or more of the six stakeholders. One such added value affecting *Member State (MS)* and *European Commission (EC)* is “Increased traveller comfort”, as:

“By providing all modes of mobility data via the NAP, multimodal service providers can offer better services to travellers, advising them on more convenient travel options (accessibility and time), thus increasing their comfort”.

In total, the Motivation layer defined one vision, mission, ITS system and domain, 6 stakeholders with 6 expectations and 19 added values. The creation of the Motivational layer led to a clear identification of key stakeholders, their motivations and the benefits they get from the service. It allowed to shape clear vision and mission and describe the ITS service in a concise and efficient manner.

For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the Motivational layer model [here](#), or consult full textual documentation of the view [here](#).

6.3 User Needs

The User Needs provide an unambiguous, testable (with objective tests), traceable (with unique reference numbers) and singular (with only one idea at a time) requirements for an ITS system. The user needs are selected from a large, predefined set, linking to a specific functionality. For this view we do **not distinguish** between **both NAP types**, Metadata Directory and Data Platform.

Changes to the view: The FRAME described 8 generic user needs connected to NAP functionality. These have been reused with only a minor change to remove a contradiction about mandatory authorisation of content consumers. Apart from this alteration that we communicated to FRAME maintainers for adoption, we did not do any changes.

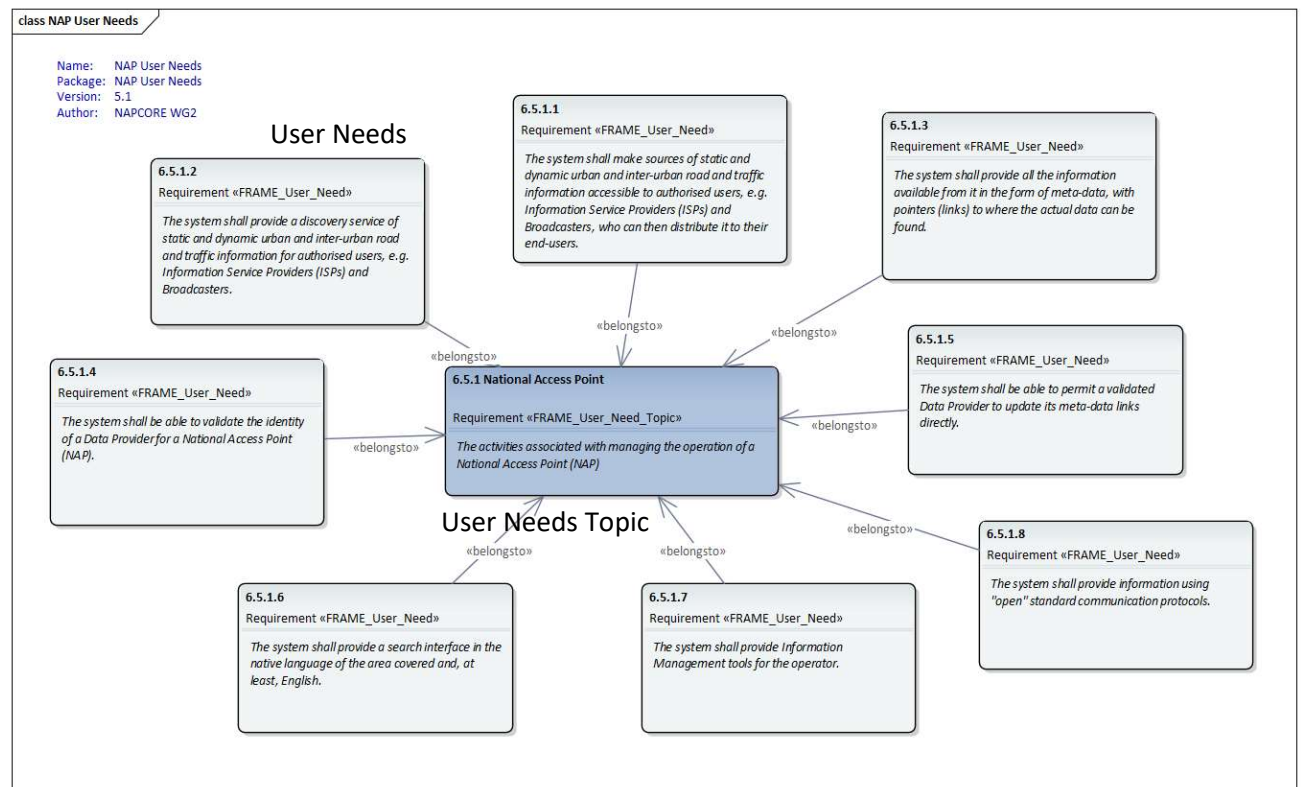


Figure 12 NAP User Needs with a legend [NAPCRE, 2025]

This part of the NAP reference architecture describes User needs matching the content and requirements on a NAP to be implemented (or upgraded, extended) and is composed of 1 topic with 8 User Needs. Topics serve just to organise similar user needs together. For example, the User Need 6.5.1.3:

“The system shall provide all the information available within to users as metadata and data or pointers (links) to where the actual data can be found.”

In total, User needs define 8 user needs grouped to one user needs topic. The User Needs were not expanded within the NAPCORE because their main intent is to provide high level requirement on the ITS service described within the FRAME functional view. It serves as an entry to FRAME Architecture and allows to select the right functionality to achieve stakeholders' aspirations. The requirements were not expanded, to avoid duplicity, as they are part of the descriptions of the artefacts in other views, this might be however revisited later.

For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the User Needs model [here](#), or consult full textual documentation of the view [here](#).

6.4 Functional View

The Functional View defines the architectural elements that deliver the system's functionality documenting the system's functional structure including the key functional elements their interactions. It is elaborated with respect of minimum functionality of two NAP types: **Metadata Directory** and **Data Platform**, building upon the functionality of the previous type.

Changes to the view: The functional view has been thoroughly updated compared to NAP Reference architecture 1.0 that described only metadata directory (with 4 functions). The additional functionality



for data platform was introduced. Also, previous functionality has been redrafted and expanded to better cover e.g. content provider user registration, quality checking and metadata management. New terminators were added to cover automatic machine to machine interaction with NAP.

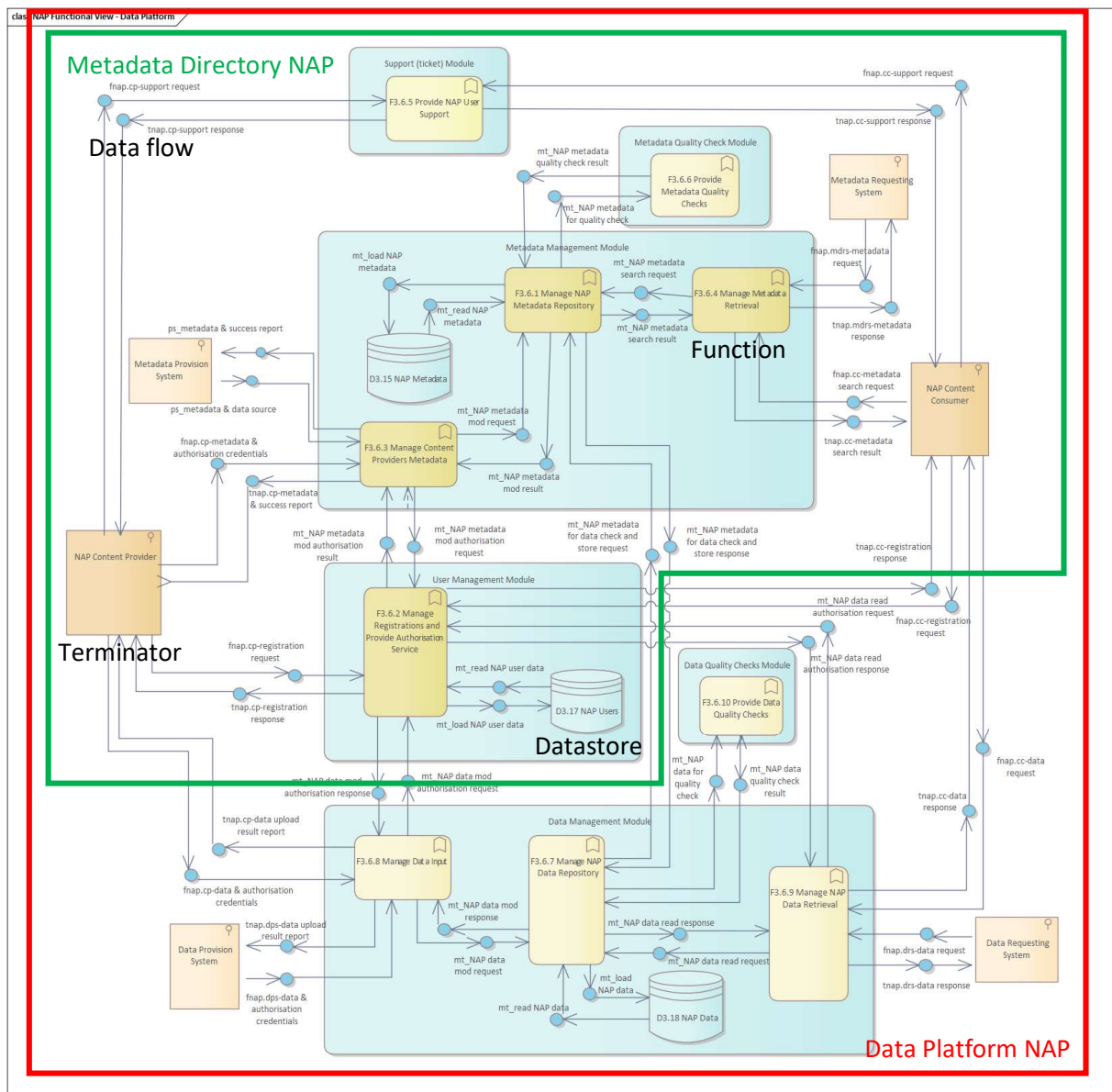


Figure 13 NAP Functional View of the data platform NAP (red) with indication of metadata directory NAP part (green), with a legend [NAPCRE, 2025]

The functional View of Metadata Directory consists of 4 terminators, NAP Content Provider (CP), NAP Content Consumer (CC), Metadata Providing System (MPS) and Metadata Requesting System (MRS). Each terminator is described in generic way, for example the NAP Content Provider is described as follows:

“The generic terminator role of the NAP Content Provider represents any provider of traffic and transport data.

The NAP Content Provider describes traffic and transport data with meta-data on the NAP (stored in D3.15 NAP Meta-Data). Information about the Content Provider, such as contact details, kept in D3.17 NAP Content Providers.

Content Providers are public and private road operators, road authorities, service providers, transport authorities, transport operators, infrastructure managers, and transport on-demand service providers.

The obligations to make traffic and transport data accessible via the NAP depend on the type of data according to the ITS Directive and its respective delegated regulations (see Content Provider Actor)

Key issue: Provide and publish content (which the content provider has the legal rights to publish); collect content.

Area of responsibility: Provide timely and accurate traffic and transport data.

Tasks: Provide content relevant to the ITS domain and according to contracts with the NAP and content consumers

Mnemonic: nap.cp”

The terminators interact with the system functionalities and creates a value chain. The Metadata directory has 6 functions connected together and with the terminators into complex system. For easier referencing each function has a number consisting of functional area number, high level function number and unique number within the lowest level of hierarchy. The functions are: F3.6.1 Manage NAP Meta-Data Repository, F3.6.2 Manage Registrations and Provide Authorisation Service, F3.6.3 Provide Interface for Content Providers, F3.6.4 Provide Access for NAP Meta-Data Retrieval, F3.6.5 Provide NAP User Support and F3.6.6 Provide Metadata Quality Checks. **Each function has a complex definition, for example function F3.6.2 Manage Registrations and Provide Authorisation Service is defined as follows:**

“This Function shall be capable of providing the following facilities:

- (1) The ability to receive and process a request from an entity that wants to become new NAP User.*
- (2) The ability to check the new NAP User in (1) above to include electronic identification, verification that the requesting entity exists based on information included in the request and agree with terms of the NAP User (different for NAP Content Provider and NAP Content Consumer)*
- (3) The ability to load information about the entity submitting the request in (1) above into the NAP Users data store, if the identification, verification, and acceptance in (2) above is successful.*
- (4) The ability to provide authorisation credentials to the requesting entity.*
- (5) The ability to send a rejection notice (including the reason for rejection) to the entity that submitted the request in (1) above if the identification, verification, and acceptance in (2) and (3) above was not successful.*
- (6) The ability to check the authorisation of an entity which sends its credentials to the NAP functions and to response to those functions if the authorisation check has been successful.*
- (7) The ability to process the information provided in an unsuccessful request for the update of NAP User data so that a suitable response can be sent to the entity that made the request and future unsuccessful update requests monitored.*
- (8) The ability to register multiple user accounts within a NAP User account, i.e. users' organization.*
- (9) The ability to register multiple machine accounts within a NAP User account, i.e. users' organization, for consuming or providing content from / to the NAP. The machine accounts stand for Data Requesting Systems and Data Supplying System.*
- (10) The ability to organize user and machine account registered under one NAP User into organization, where user accounts have different rights to access the NAP Users data store, i.e. view, modify, add, and delete records.*
- (11) The ability to remove electronic identity of the NAP User from the NAP Users data store based on reception of a request from a NAP User.*
- (12) The ability to register the as one or both NAP Content Provider and NAP Content Consumer with different rights / responsibilities to perform tasks assigned to provider or consumer in the NAP via Functions Manage Content Providers Metadata and Manage NAP Metadata Retrieval.*
- (13) Ability to provide registered NAP User data upon its successful authorization*
- (14) Ability to log in events connected with NAP User Activity to the NAP User data store*

NOTE: one physical user can be part of more NAP Users but under the different electronic identity. “

To model the database capability the Metadata Directory NRA introduces 2 data stores D3.15 NAP Meta-Data and D3.17 NAP Users, connected to manage functions and used to store user information and content providers metadata. For example, D3.17 NAP Users datastore is defines as:

This Data Store shall be used within the Manage Traffic Functional Area. It shall contain information objects that provide details of NAP Users, i.e. NAP Content Providers and NAP Content Consumers (for Data Platform NAP type). The Data Store contains private information used by NAP Users to access the NAP, to provide agreement on terms and conditions. Public metadata about traffic and travel information and other related information are stored in NAP Metadata store (D3.15).

For Content Providers the data store contains following data objects:

- (1) organization with name (1.1), postal address (1.2), website (1.3), agreement on licence terms (1.4), unique identifier assigned to organization (1.5), name and contact details of a responsible person to act as a contact (1.6).*
- (2) user account(s) with name (2.1), email (2.2), credentials (2.3), user type (2.4).*
- * (3) machine account with url (3.1), connection type (3.2), credentials (3.3).*

For Content Consumers the data store contains following data objects:

- * (1) organization with name (1.1), postal address (1.2), website (1.3), agreement on licence terms (1.4), unique identifier assigned to organization (1.5), name and contact details of a responsible person to act as a contact (1.6).*
- * (2) user account(s) with name (2.1), email (2.2), credentials (2.3), user type (2.4).*
- * (3) machine account with url (3.1), connection type (3.2), credentials (3.3).*

** Optional data object for Data Platform NAP type and even there it is optional provided the data is not openly accessible.*

Additionally, for both:

- (4) Event information (log in, log out, change of data)*

The necessary interconnection between terminators, functions and datastores is realised in metadata directory by 30 dataflows, 8 to the terminators, 4 to the datastores and rest between functions. Most important functions are management functions F3.6.1 and F3.6.2 having 10 and 8 dataflows. Each dataflow is described at general level, for example dataflow “fnap.cp-registration_request” from NAP Content Provider to F3.6.2 Manage Registrations and Provide Authorisation Service is described as follows:

It consists of inputs from the NAP Content Provider containing data objects that provide a registration request of and information about a potential NAP Content Provider which wants to register or a request with credentials of registered NAP Content Provider for retrieval of its data upon a successful authorisation. (Details of the information about the NAP Content Provider will be found in the description of the store of NAP Users).

The registration request contains relevant information about the entity to be registered under NAP Content Provider account, including identity information, licence terms approval, users, machines, and organization information.

For Data Platform there were additional 2 terminators added, Data Provision System and Data Requesting System to represent automatic data upload and retrieval via machine-to-machine interface. Four new



functions were added to model data storage by Content Provider, F3.6.8 Manage Data Input, data management and quality checking by NAP Operator, F3.6.7 Manage NAP Data Repository and F3.6.10 Provide Data Quality Checks, and data retrieval by Content Consumer, F3.6.9 Manage NAP Data Retrieval. To allow storing Content Providers traffic and transport data the data store D3.18 NAP Data was introduced. Their content is modelled similarly to the content referred to as an example in previous parts of this description. Very important functionality F3.6.8 Manage Data Input is described as:

This Function shall be capable of providing the following facilities:

- (1) The ability to receive and process traffic and travel data in different message types from NAP Content Provider or Data Provision System.
- (2) The ability to forward the authorisation credentials of the NAP Content Provider or of the Data Provision System to the Function Manage Registrations and Provide Authorisation Service and to receive a result about the authorised access.
- (3) The ability to perform basic checks on filled in information about data access (for automatic data retrieval by NAP) or checks of data format and expected size of the NAP Content Provider manually uploaded data.
- (4) The ability to send the data included in the request in (1) above to the Function Manage NAP Data Repository for loading into the data store if the checks in (2) and (3) above were successful.
- (5) The ability to send a “failure” response to the entity that made the request in (1) above if the checks in (2) and (3) above were unsuccessful or a “success” response if the checks were successful.
- (6) Ability to provide all data created by the NAP Content Provider and also data created by the NAP, i.e. quality records and data event log.
- (7) Ability to record NAP Content Provider activity into the NAP Data store.

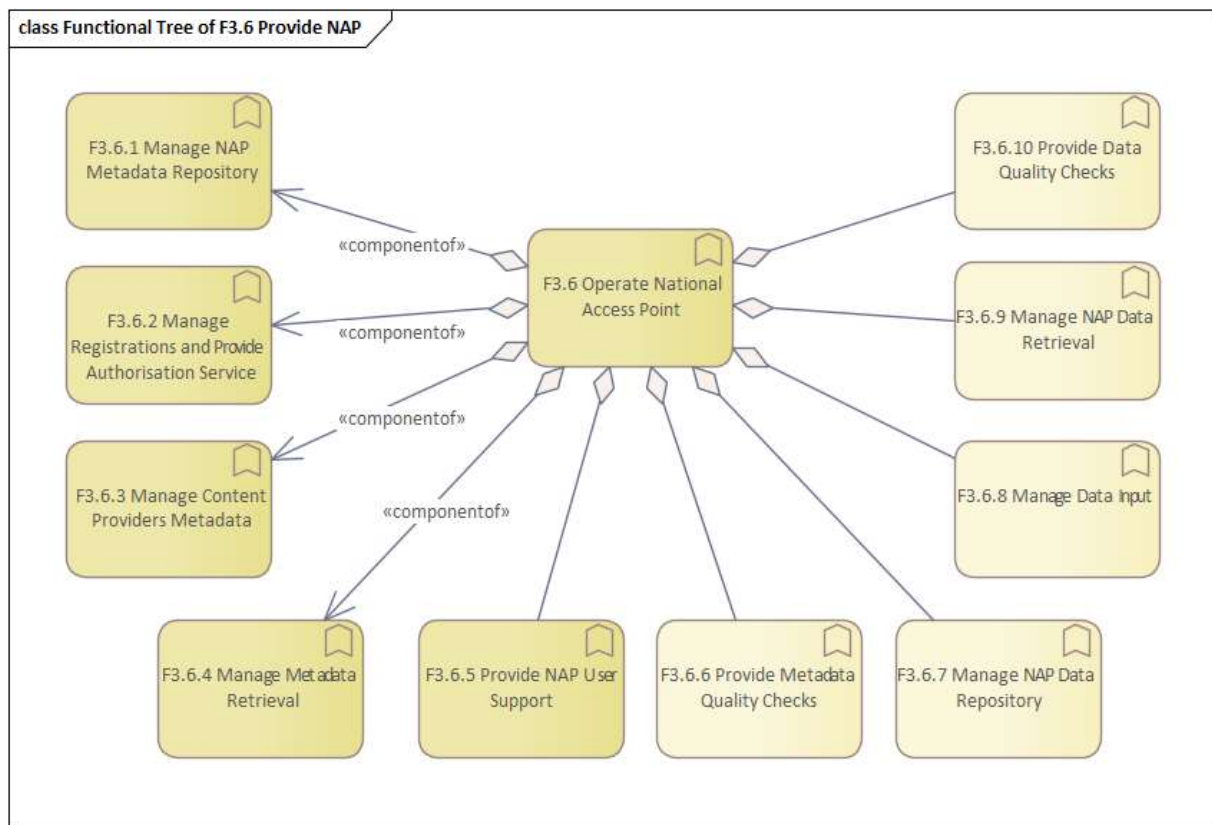


Figure 14 NAP Functionality tree for both NAP types described by functional [NAPCRE, 2025]

In total, the functional view defines 10 functions (7 for metadata directory + 3 for data platform), 6 terminators (4+2), 3 datastores (2+1) and 52 dataflows (30+22). The creation of the Functional View is a foundation for building a NAP clearly identifying functional blocks and their main properties, that could be later (out of the scope) transformed into functional requirements. Building Data Platform functionality on top of metadata directory makes planning transition from one to the other type more manageable, since the additional connectors and functionality is easily identifiable.

The NAP functionality is designed to describe following processes:

- Content Providers and optional Content Consumers registration and enrolment and account management including machine accounts if necessary
- Metadata and data upload to the NAP by user or a machine, their storage, execution of quality checks, change management and access control management including authorisation
- Metadata and data retrieval from the NAP by user or a machine, their discoverability and access control management including optional authorisation
- NAP process management including User to NAP reporting and event logging

For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the Functional View model [here](#), or consult full textual documentation of the view [here](#).

6.5 Physical View

The Physical View describes the arrangement of physical elements. It consists of Sub-systems Modules and Physical Data Flows between them and is based on a previously defined Functional View. To reflect this the Physical View is described for both NAP types: **Metadata Directory** and **Data Platform**.

Changes to the view: The physical view has been completely redesigned compared to NAP Reference architecture 1.0. Formerly almost each single functionality has been hosted by an application enclosed within its own subsystem, resulting in 3 subsystems, also terminators were defined with a subsystem and application. In version 2 the subsystems for terminators were removed, NAP subsystems were merged to one per NAP type. The applications were transformed into modules, that is more consistent with the FRAME methodology. The physical views were redrafted and populated with content according to the subsystems change.



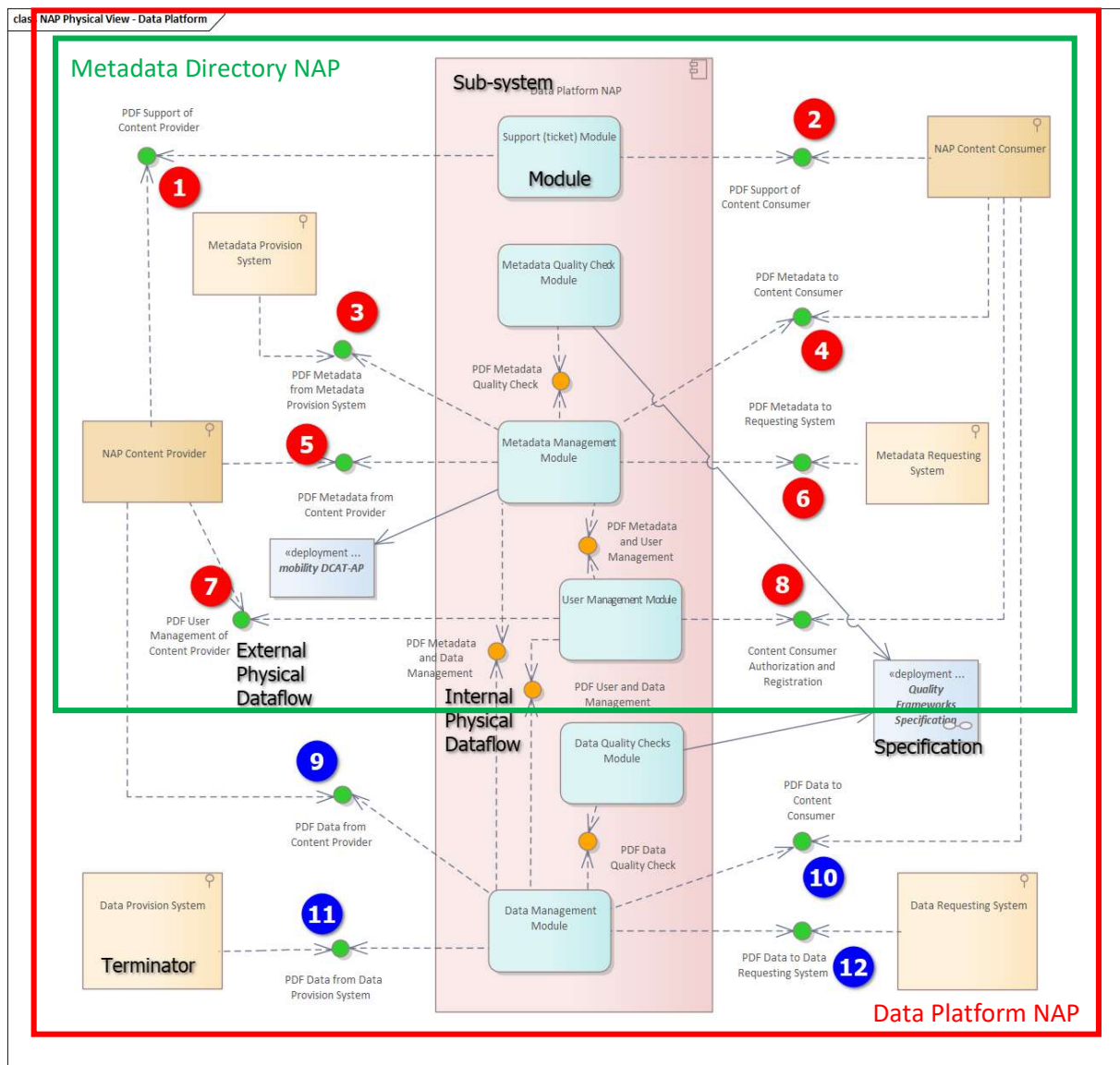


Figure 15 NAP Physical View of the data platform NAP (red) with indication of metadata directory NAP part (green), based on the Functional view [NAPCRE, 2025]

The Physical View of **Metadata Directory** consists of 1 subsystem and 4 modules, Metadata Quality Check module, Metadata Management module, User Management module and Support (ticket) module. The subsystem being defined from the encapsulated functionality as:

The Metadata Directory NAP sub system represents the hardware/software implementation of the ITS Service. It consists of modules performing metadata quality checks, hosting metadata, user data, and credentials, allowing the creation and retrieval of metadata records from the internal database as well as user support.

Each module is performing certain subset set of functionalities, for example Metadata Management module containing F3.6.1 Manage NAP Meta-Data Repository, F3.6.3 Provide Interface for Content Providers, F3.6.4 Provide Access for NAP Meta-Data Retrieval and D3.15 NAP Metadata datastore, is defined as:

This Module handles metadata input (upload, update, or deletion) from NAP content providers and its retrieval by NAP content users. It uses the NAP Metadata store to store all metadata and related information.



The modules are defined so they can be if needed supplied by different vendors. There are 8 external physical dataflows between subsystem or modules and terminators and 2 internal physical dataflows between modules. Each physical dataflow contains one or more functional dataflows. For example, **external physical dataflow** PDF Metadata from Content Provider, **connecting** Metadata Management module and Content Provider, **consisting of 2 functional dataflows**, is defined as:

This Physical Data Flow facilitates information exchange between Metadata Management Module and Content Provider. This exchange concerns inputs from the NAP Content Provider with new or updated metadata objects, requiring authorisation credentials.

Based on the recommendations from NAPCORE, via approved deliverables, there are 2 specifications, **mobilityDCAT-AP** and **Quality Frameworks Specification** connected to the **Metadata Management Module** and **Metadata Quality Check Module** and **Data Quality Check Module**, recommending use of **mobilityDCAT-AP** metadata specification and usage of **NAPCORE Quality Frameworks** the content of the **mobilityDCAT-AP** specification is:

Title: mobilityDCAT-AP (Metadata Specification for Mobility Data Portals)

Reference: mobilityDCAT-AP

Type: Technical Specification

Full Name and Hyperlink: [mobilityDCAT-AP](#)

Contextual Use: mobilityDCAT-AP is a formal metadata specification for mobility data portals, extending DCAT-AP. It contains a model with definitions of the syntax and semantics for various data elements and how these elements relate to each other. This specification provides precise and unambiguous metadata designations for any mobility-related data offerings, facilitating harmonised, platform-independent metadata descriptions in both human-readable and machine-readable formats.

Document Number: Not specified

Publication Date: Latest version available at [mobilityDCAT-AP releases](#)

Related Documents:

- [Core Vocabulary \(mobilityDCAT-AP Core\)](#)
- [Controlled Vocabularies \(mobilityDCAT-AP Vocabularies\)](#)

For **Data Platform** there is different sub-system with additional 2 modules (above the ones from metadata directory) added, **Data Quality Checks module** and **Data Management module** to represent data upload and retrieval in the NAP. These new modules necessitated definition of 3 new internal physical dataflows and four new external physical dataflows. Their content is modelled similarly to the content referred to as an example in previous parts of this description.

In total, the physical view defines 12 external dataflows (8 for metadata directory + 4 for data platform), 2 subsystems (one for each NAP type), 6 modules (4+2) and 2 specifications. Key issue of the physical view is to identify separate parts of the system, so they could be further defined by associated specification or requirements and to allow for creation of interfaces and their specification by definition of the physical dataflows. The description the physical view artefacts are constructed as summary of encapsulated functional view artefacts and is less important than its associations / links.

For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the Physical View model [here](#), or consult full textual documentation of the view [here](#).



6.6 Communication View

The Communications View describe interaction happening on the physical dataflows identified in the previous view, by definition of their interfaces and specifications, requirements and recommendations related to those interfaces. Communications View is described for both NAP types: **Metadata Directory** and **Data Platform**.

Changes to the view: The communications view has been completely redesigned compared to NAP Reference architecture 1.0. There are new interfaces for newly defined physical dataflows, and due to creation of NAPCORE methodology for interfaces and specifications the content and structure of both interfaces and specifications has changed. A decision to have 1 interface per physical dataflow with multiple specifications (standards, recommendations and guidelines) focusing on different aspects of the interface [6] and decision where to connect a specification applicable for multiple parts of the system led to a system reconstruction.

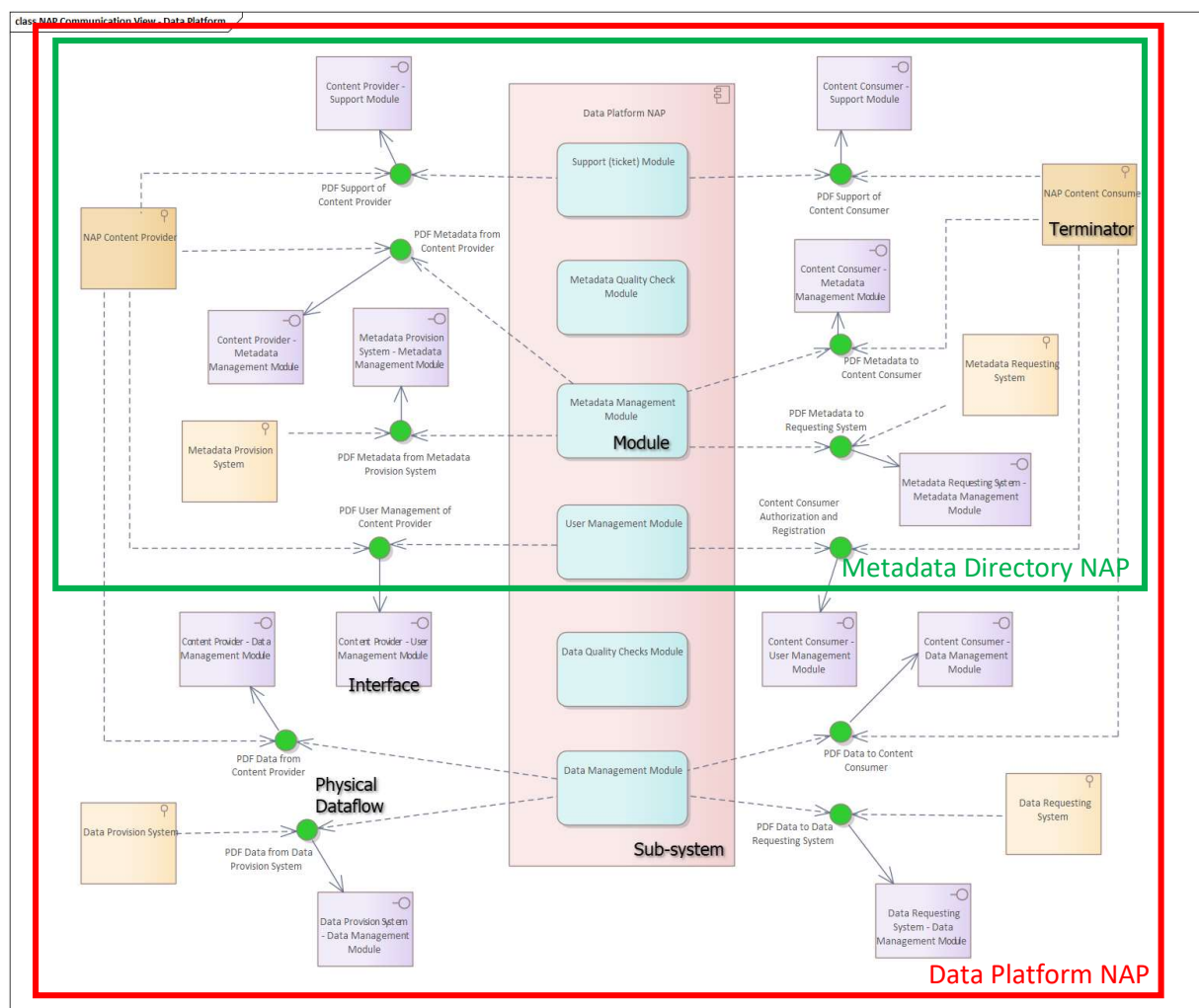


Figure 16 NAP Communications View of the data platform NAP (red) with indication of metadata directory NAP part (green), without specifications objects [NAPCRE, 2025]

The Communications View of **Metadata Directory** consists of 8 Interfaces between modules and terminators subsystem, the interfaces are named after the artefacts they connects e.g. Content Provider – Data Management Module interface. According to NAPCORE guideline for interface [5], the content is composed of communications requirement analysis and of general description of the Interface, for example, the Content Provider - User Management Module interface is described as:



Type: User interface

Short description: This interface provides the content provider access to the user management.

Contextual Use: It is assumed that the NAP shall have a registration procedure for metadata provider. The registration can differ in Member States. The trust of the registered person should be guaranteed and should follow international standards. To enable machine to machine meta data harvesting a registration of such an interface and credentials is needed.

Related Documents: <https://napcore.eu/activity-wg2-interoperability-and-level-of-service-of-naps/>
 === Communications Requirements ===

As a guideline for minimum expectation the following values can be used

- **Data type:** Raw data
- **max bytes per message:** up to 500 kB per request
- maximum delay [s]
- system response time below 100ms (independent from user internet connection)
- delay for submitting request: 0.5s
- message interval: On occurrence
- **security level:** level high (authorization by the system, encrypted data transfer on system side)

There are multiple specifications (legal document, standards, profiles, recommendations and guidelines) defined within the supplements to the NAP reference architecture. Their connection to the interface or to the subsystem / module has to be negotiated within NAPCORE. Therefore, even though more than 30 different specifications were identified only few are connected to the architecture (not shown in Figure 16).

NOTE: In NAPCORE we decided to map specifications to interface in a following way:

- **Standard:** an interface can be linked to more standards. Linking means obligation to use it. Linking 0 standards means that there is no consensus and is notified as an issue.
- **Profile:** same as above but the content is more specific than in a standard.
- **Recommendation:** an interface can be linked to more recommendations. Linking means approval of recommendation by NAPCORE. Recommendation is an approved guideline.
- **Guideline:** an interface can be linked to more guidelines (each for a specific purpose). Guideline is NOT approved by NAPCORE and is voluntary. Guidelines are good practices, implementation guides, examples, descriptions of how other linked specifications shall be orchestrated.

We envisage more Specifications to be connected to the interface based on the approval of the respective NAPCORE working group or guidelines if such approval is not provided.

One of such specifications are data standard requirements, for example DATEX II specification:

Reference: CEN/TS 16157

Type: Technical Specification

Full Name and Hyperlink: DATEX II [CEN/TS 16157](https://www.cen.eu/standards/standards/16157)

Contextual Use: The DATEX II standard series provides a comprehensive framework for the exchange of traffic and travel information. It defines the structure and content of messages exchanged between systems, ensuring interoperability and consistency across different platforms. The standards cover various aspects, including location referencing, situation publication, variable message signs, measured data, and more. This ensures that traffic management systems can effectively communicate and share information, enhancing overall traffic efficiency and safety.

Publication Date: under continuous development

Related Documents:

- Part 1: Context and framework
- Part 2: Location referencing
- Part 3: Situation publication



This project has received funding from the European Commission's Directorate General for Transport and Mobility under Grant Agreement no. MOVE/B4/SUB/2020-123/SI2.85223 47

- Part 4: Variable Message Sign (VMS) publications
- Part 5: Measured and elaborated data publications
- Part 6: Parking publications
- Part 7: Common data elements
- Part 8: Traffic management publications and urban extensions
- Part 9: Traffic signal management publications
- Part 10: Energy infrastructure publications
- Part 11: Publication of machine interpretable traffic regulations
- Part 12: Facility related publications
- Part 13: Status & Fault

Notes

- DATEX II is being maintained and developed by a user community
- more information: <https://www.datex2.eu/datex2/specifications>
- profiling: <https://webtool.datex2.eu/wizard/>

For **Data Platform** there are additional 4 interfaces defined (above the ones from metadata directory). Their content is modelled similarly to the content referred to as an example in previous parts of this description.

In total, the communications view defines 12 interfaces (8 for metadata directory + 4 for data platform). There are X specifications are connected to the Interfaces, however there is still a potential to connect more based on direct input from other NAPCORE WGs, using either a pool of defined specifications in the specifications and recommendations supplement to the reference architecture (see respective chapter for more information) or creating a new one. Key issue of the communication view was to analyse requirements on the communications links, the standards were also identified, however we were unable due to lack of response from the NAPCORE working groups to refer to them from the views.

For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the Communications View model [here](#), or consult full textual documentation of the view [here](#).

6.7 Organizational View

The Organization View provides information about the actors, their roles and responsibilities, and relationships between roles in terms of lawful or contractual relationships. For this view we do **not distinguish** between **both NAP types**, Metadata Directory and Data Platform.

Changes to the view: The organizational view has been completely updated compared to NAP Reference architecture 1.0. The number of roles internal to the NAP has been significantly shortened just to two. Content of actors, roles and of agreements has been rewritten to fit the NAPCORE created methodology. The methodology is focused on content distribution between actors and roles and the structure of the agreements. Also, the lawful obligations are always stated between policy maker and other role, even though they are effective between two non-policy makers roles. The part with relationship of the role to the physical component of the system has been removed since it was not mature enough.



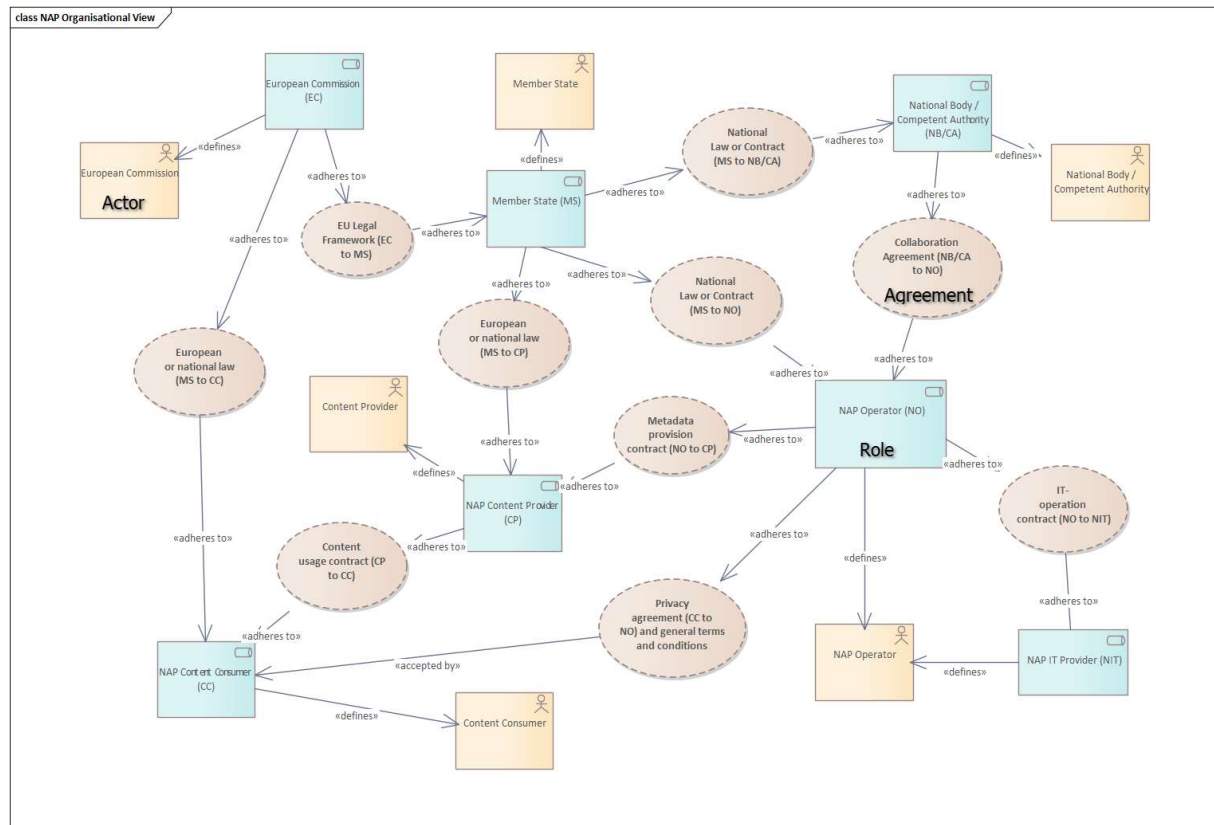


Figure 17 NAP Organizational View [NAPCRE, 2025]

The Organizational view contains 6 Actors, Content Provider, Content Consumer, NAP Operator, Member state, European Commission and National Body / Competent Authority, these actors are closely related to stakeholders in motivation layer and to terminators in functional view. The definition of the Actor contains a short description and whom they are represented. Most important actor, with regards to analysis of the representing organizations is Content Provider, that is defined as follows:

Any legal person, data subject, or public or private entity/organization who has the right to grant access to or to share the data under its control. The subject in question shall hold the data that are required to be made accessible via NAP by or more of the Delegated Regulations.

NOTE1: We do not create objects for each Content Provider actor type.

NOTE2: Content Provider includes the Data Holder term as it is specified in MMTIS and RTTI regulations.

Content Provider actor represents and fulfils the interests of the Content Provider Stakeholders.

Represented by:

For the RTTI (2022/670) concerning:

- **data on infrastructure:** road authorities, public or private road operator/s, tolling operators, recharging and refuelling-related stakeholders
- **data on regulations and restrictions:** road authorities, public or private road operator/s, tolling operators
- **data on the state of the network:** road authorities, public or private road operator/s, holders of in-vehicle generated data, service providers*
- **data on the real-time use of the network:** road authorities, public or private road operator/s, holders of in-vehicle generated data, service providers*, recharging and refuelling-related stakeholders

* ‘service provider’ means any public or private provider of a real-time traffic information service, excluding a mere conveyer of data to data users;

For the SRTI (886/2013) concerning:

- **road safety-related traffic data:** Service providers, public and/or private road operators, broadcasters dedicated to traffic information, and automotive industries (as service providers when processing vehicle data) [886/2013, art. 7]

For the SSTP (885/2013) concerning:

- **static and dynamic information related to safe and secure parking:** public or private parking operators and service providers (any public or private body that provides the information service to users) [885/2013 art. 5]

For the AFIR (2023/1804) concerning:

- **static and dynamic information related to alternative fuel infrastructure:** operators of publicly accessible recharging points and refuelling points for alternative fuels, or, under the arrangements between them, the owners

For the MMTIS (2017/1926 amended by 2024/490) concerning:

- **static, historic and observed travel and traffic data:** transport authorities, transport operators, infrastructure managers, transport on demand service providers
- **dynamic travel and traffic data:** see above
- **linking travel information services:** travel information service provider

The actors are represented by Roles in the NAP, there is one role for each Actor except NAP Operator Actor which is represented by two roles, the NAP Operator and NAP IT Provider. This distinction was made to highlight that these roles are different and can be provided by different actors. Each Role describes key issue and task and responsibilities. For example, the NAP Content Provider (CP) role is defined as follows:

IMPORTANT: Content Provider includes the Data Holder term as it is specified in MMTIS and RTTI regulation.

Key issue:

Publish metadata (and in certain cases data) at the NAP. Provide self-declaration and assistance in case of compliance assessment. Provide data in the prescribed format and with the desired level of quality.

Tasks and responsibilities:

Publish content they generate based on requirements from the Delegated Regulations under the FRAND conditions. In cases of safety-related traffic information publish content for free. Be of assistance to the NB/CA when performing a compliance assessment and correct any issues found promptly. Publish data with a desired level of quality in a timely fashion and in a prescribed format.

So, there is a clear distinction between an actor specifying “WHO” and role specifying “WHAT”. The relationship between roles, if exists, is defined by an Agreement. There are 10 agreements, the agreements can be lawful or contractual. Each agreement, according to the guideline developed in NAP-CORE, specifies parties involved, objective of the agreement, form of the agreement, obligations of the parties to each other, references to law and notes. The NAP Content Provider (CP) has 3 Agreements, European or national law (MS to CP), Content usage contract (CP to CC) and Metadata provision contract (NO to CP). For example, agreement between European or national law (MS to CP) is defined (shortened) as follows:



Parties: Member State (MS) and Content Provider (CP).

Objective: To identify CPs and set up obligations of the CPs.

Form: National law implementing the ITS Directive and direct execution of EU Regulations and Delegated Acts.

Obligations:

> MS to CP: ---

> CP to MS:

- To ensure that data is provided in a correct format to the content consumers (CC) under fair, reasonable, and non-discriminatory (FRAND) conditions.
- To publish relevant information about data/services (e.g., Metadata) and information on the data quality at the NAP.
- To provide data compliant with the EU requirements (Provide self-declaration towards the NAP and NB/CA and assistance in case further proof of compliance is required).
- To ensure that required data is updated at the appropriate and recommended time intervals.
- To provide a description of the data, digital map, or real-time traffic information services they provide as well as the information on the quality thereof and the conditions of re-use of these data and an evidence-based declaration of compliance to the NB/CA. And to cooperate in the compliance assessment process.

Reference to the EU law:

The obligations of the CP are related to the following laws: National law transposing 2010/40/EU (ITS Directive), 886/2013 (SRTI), 885/2013 (SSTP), 2015/962 (RTTI valid until 31. December 2024), 2017/1926 (MMTIS), 2022/670 (RTTI in force from 1. January 2025), 2023/1804 (AFIR), National law transposing 2023/2661 (ITS Directive amendment), 2024/490 (MMTIS amendment)

Selected references to the law: == not included == here are selected texts from the laws above where the obligations are cited.

In total, the Organization view defines 6 actors, 7 roles and 10 agreements. This view is very important since it identifies responsible organizations (in actors), specifies key responsibilities and main tasks of the roles. And in agreements covers in detail what are obligations between parties and where they are grounded (e.g. if they are coming from law, then which).

For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the Organizational View model [here](#), or consult full textual documentation of the view [here](#).

6.8 Security View

The Security View provides information about security threats and their mitigation. For this view we do **not distinguish** between **both NAP types**, Metadata Directory and Data Platform.

Changes to the view: The Security view did not exist in NAP Reference architecture 1.0. In version 2, with regards to the security view the decision was made to reference security architecture developed by WG4.1 DATEX working group.



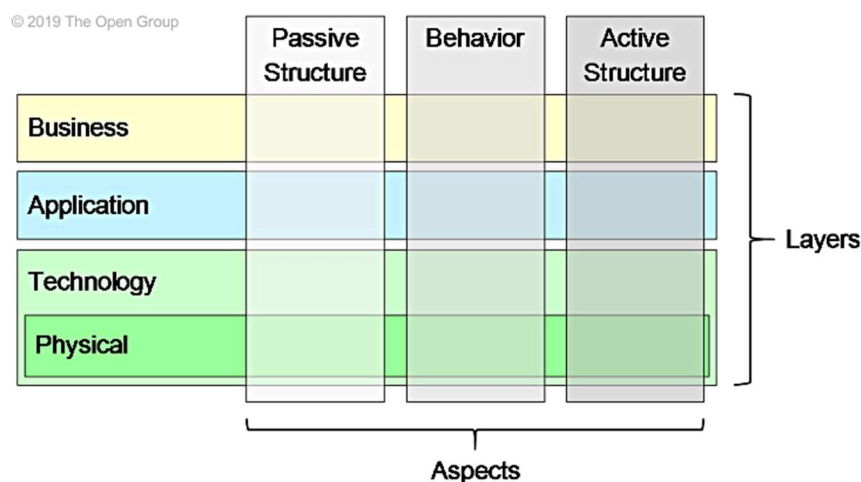


Figure 18 Security architecture coming from WG4.1 [NAPCRE, 2024]

The security requirements for the (meta)data upload / retrieval, user registration and interaction are partly common across all EU countries such as metadata integrity and partly specific to Member State such as data storing and retrieval processes. In some Member States, data is available with only basic security while in others access via user credentials is required. The implementation of security mechanisms is also dependent on the physical entities involved and the systems the Member States use for receiving, processing, and distributing (meta)data.

In the security architecture these aspects / layers are modelled

- **Business.** It models the organization structure of business functions and processes, services, and products to external parties.
- **Application.** It documents application landscape, interfaces, and dependencies that exist between applications.
- **Technology.** It describes the hardware, software, and network infrastructure.
- **Physical,** to model facilities, factories, and equipment.

6.9 KPI Framework package

The KPI Framework package provides mapping of the NLKF features to the individual parts of the reference architecture allowing to process any changes into the reference architecture whenever are NLKF parameters updated.

Changes to the package: The KPI Framework package did not exist in NAP Reference architecture 1.0. In version 2, the KPIs defined in NLKF were included as requirements in the architecture with original text and mapping, if possible, to NAP Reference architecture objects. This incorporation has led to many findings about the wording of KPIs, their options and minimum level, which were communicated back to the maintainer of the KPI Framework.

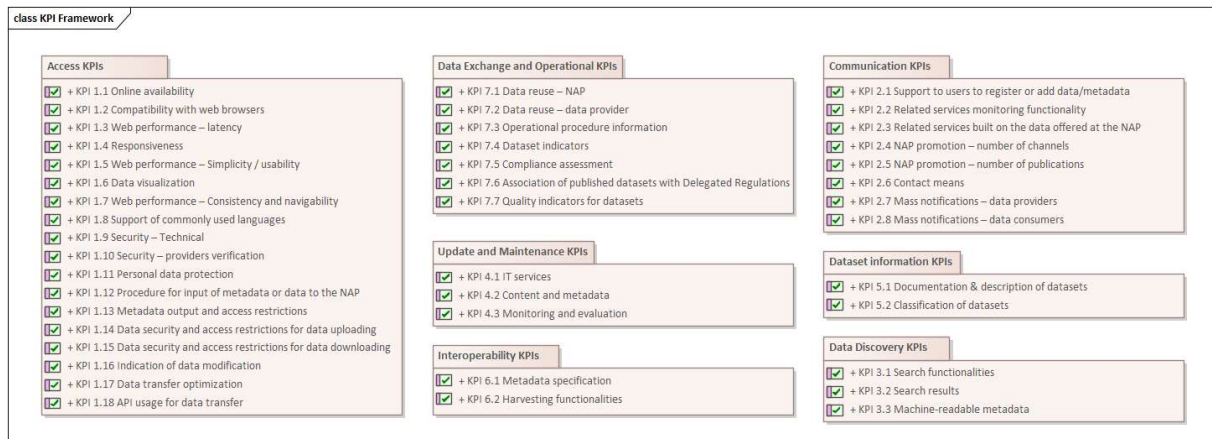


Figure 19 KPI Framework in the NRA [NAPCRE, 2025]

There are all 7 KPI groups modelled with all 43 individual KPIs. For example: KPI 1.1 Online availability is linked to subsystems in physical view representing both NAP types, with original text:

“On-line availability” KPI assesses whether the NAP platform is online or not. In this case, both REQ and ACC value is set to 1 to reflect that the on-line availability of a NAP constitutes a fundamental prerequisite.

Values:

0: No

1: Yes

Minimum acceptable value for interoperability: 1

In total, the 7 groups with 43 KPIs were brought into the NAP reference architecture. The main benefit was a tighter alignment between the two frameworks and both ways change propagation. Since the implementation the KPIs have been externally updated, this has not yet been adapted into the NRA.

For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the KPI Framework [here](#), or consult full textual documentation of the view [here](#).

6.10 Specifications and Requirements package

The Specifications and Requirements document describes legal and technical specifications as well as recommendations and profiles used for the ITS Service in different Views.

Changes to the package: The Specifications and Requirements package did not exist in NAP Reference architecture 1.0. In version 2, the methodology for specification structure was created and many specifications were identified, however since the linkage to the reference architecture objects requires general consensus only few are linked. The rest is available for study until the decision on its linkage.

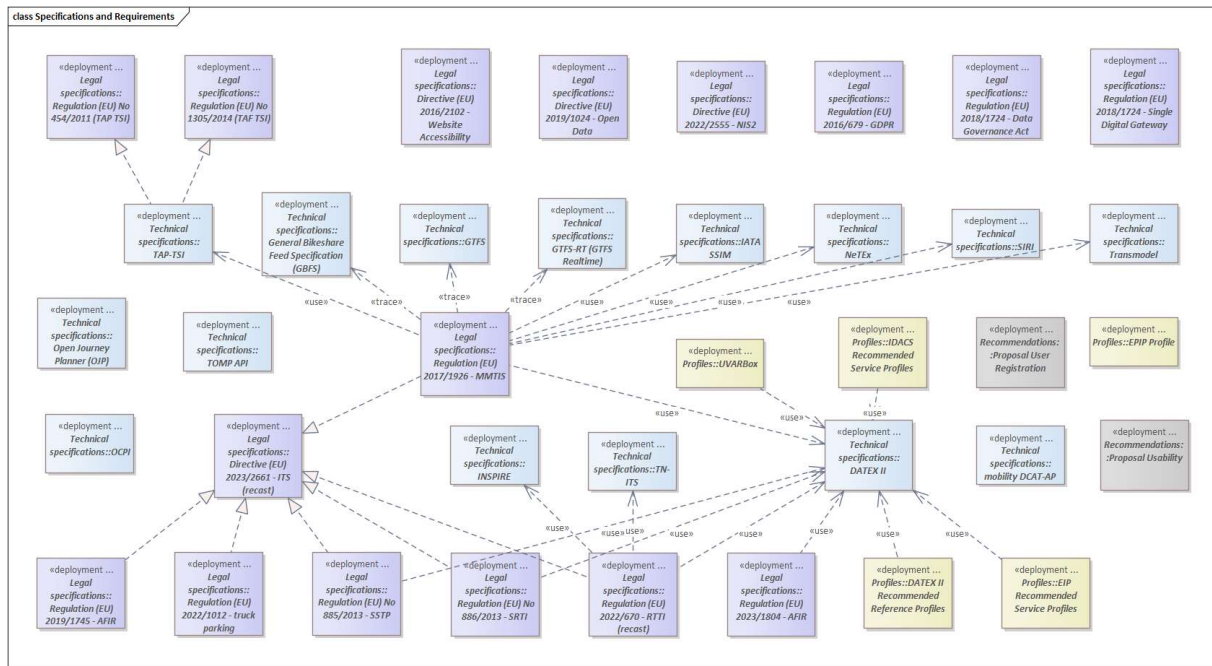


Figure 20 NAP Specification and Requirements package [NAPCRE, 2025]

The Specification and Requirements package within the supplements of the NRA was introduced to collect all relevant standards, legislative acts and recommendations that could be referred to by NAP Reference architecture. By “referred to” a linkage of artefacts appearing in different views of the NRA to the specification artefacts is meant, making them RECOMMENDED by NAPCORE.

In order to maintain the standards and recommendation the guideline was created within the NAP-CORE defining its structure and content of the object Specification that is used in NRA [6]. Defining its *title, reference number and date, type, full name and hyperlink, contextual use and related documents*. The Specifications were classified by type to 5 classes:

- Legal documents
- Technical specifications
- (data) Profiles
- Recommendations
- Guidelines

There have been 16 legal specifications identified (4 directives and 12 regulations) related to NAP operations covering:

- **EU Directives:** 2016/2102 - Website Accessibility, 2019/1024 - Open Data, 2022/2555 - NIS2, 2023/2661 - ITS (recast)
- **EU Regulations:** 2016/679 – GDPR, 2017/1926 – MMTIS, 2018/1724 - Data Governance Act, 2018/1724 - Single Digital Gateway, 2019/1745 – AFIR, 2022/1012 - truck parking, 2022/670 - RTTI (recast), 2023/1804 – AFIR, 1305/2014 (TAF TSI), 454/2011 (TAP TSI), 885/2013 – SSTP and 886/2013 - SRTI

For example, the Directive (EU) 2019/1024, linked to the ITS Service in the motivation layer is defined as:

Title: Open Data Directive

Reference: Directive (EU) 2019/1024

Type: Legal Specification

Full Name and Hyperlink: [Directive \(EU\) 2019/1024 of the European Parliament and of the Council of 20 June 2019](#)

Contextual Use: Establishes a framework for the reuse of public sector information, promoting the availability of open data. Aims to boost the socioeconomic potential of public sector information by making

it more accessible for startups, SMEs, and other entities. Encourages the use of dynamic data and datasets with high economic impact, fostering competition and transparency in the information market.

Document Number: 2019/1024

Publication Date: 20 June 2019

Related Documents:

- **Directive 2003/98/EC:** The previous directive on the reuse of public sector information, which the Open Data Directive recasts.
- **Directive 2013/37/EU:** Amended Directive 2003/98/EC before being repealed by the Open Data Directive.
- **[Regulation \(EU\) 2016/679:](#)** General Data Protection Regulation (GDPR), related to data protection and privacy.
- **Directive 96/9/EC:** Legal protection of databases.
- **Directive 2003/4/EC:** Public access to environmental information.
- **Directive 2007/2/EC:** Establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

There have been 15 technical specifications identified related to data made available via NAP, to services provided via NAP or to NAP structure: DATEX II, GBFS, GTFS, GTFS-RT, IATA SSIM, INSPIRE, mobilityDCAT-AP, NeTex, OCPI, OJP, SIRI, TAP-TSI, TN-ITS, TOMP API and Transmodel. For example, mobilityDCAT-AP specification is defined as:

Title: mobilityDCAT-AP

Reference: not specified

Type: Technical Specification

Full Name and Hyperlink: Metadata Specification for Mobility Data Portals – mobilityDCAT-AP releases

Contextual Use: mobilityDCAT-AP is a formal metadata specification for mobility data portals, extending DCAT-AP. It contains a model with definitions of the syntax and semantics for various data elements and how these elements relate to each other. This specification provides precise and unambiguous metadata designations for any mobility-related data offerings, facilitating harmonised, platform-independent metadata descriptions in both human-readable and machine-readable formats.

Publication Date: -

Related Documents:

- official recommendation for implementation is [here](#)
- [Core Vocabulary \(mobilityDCAT-AP Core\)](#)
- [Controlled Vocabularies \(mobilityDCAT-AP Vocabularies\)](#)

There were also 5 profiles identified, DATEX II Recommended Reference Profiles, EIP Recommended Service Profiles, EIP Profile, IDACS Recommended Service Profiles and UVARBox, now without linkage to artefacts to NRA views. The 2 recommendations are now being defined.

In total, the 38 specifications were identified, classified as legal (16), technical (15), profiles (5) and recommendations (2). The benefit of this is that every identified specification is described in sufficient detail with its intended use in the NAP ecosystem. The package describes all identified specifications, they become recommended by the NAP reference architecture by linking them to a specific architecture artefact. The linking is based on either explicit NAPCORE approval or implicit via confirmed milestones. Due to this fact, not many, potentially mandatory or helpful specifications were linked to this moment.



Develop first draft NB/NA reference architecture



For more information visit the NAPCORE Reference Architectures website [here](#), directly browse the Specification and Requirements package [here](#), or consult full textual documentation of the view [here](#).



7. Practical use of the NAP reference architecture

7.1 Scope of application and benefits of NAP reference architecture

The NAP reference architecture, based on the European ITS Framework Architecture (FRAME) methodology, outlines all harmonized functionalities and procedures of National Access Points (NAPs) and their interactions. Its scope of application includes:

- **Defining NAP Types and Terms:** Establishing specific terms for mutual understanding.
- **Harmonized Data Definitions:** Displaying harmonized data type definitions from Data Registries (DRs) to aid implementation and set user expectations.
- **Dataset Descriptions:** Specifying metadata, naming conventions, and use of keywords to enhance user search experience.
- **Technical Interfaces:** Specifying technical interfaces to facilitate access to data from multiple NAPs for service providers (NAP content consumers).
- **Cost-Benefit Analysis:** Conducting cost-benefit analysis to plan the implementation of additional NAP features.

The NAP reference architecture aims to harmonize NAP activities at the European level and increase their effectiveness. It defines roles, functions, and processes for NAP users, data registration, and data/metadata retrieval. It also outlines the minimum functionality for the two basic NAP types at the national level: Metadata Directory and Data Platform.

The design principles of the NAP reference architecture are simplicity, transferability, and understandability. Utilizing the NAP reference architecture should yield benefits such as:

- **European Compatibility:** Ensuring compatibility at the European level with minimum components and detailed system functionality.
- **Gap Identification:** Identifying gaps, harmonization needs, and emerging requirements in system specifications.
- **Inclusion of New Systems:** Facilitating the inclusion of new systems or components through technical system descriptions.
- **Improved Usability:** Enhancing usability based on gathered experience and evolving user needs.
- **Enhanced Planning:** Improving the planning of implementation phases, goal documentation, and result comparison.

7.2 Presentation of usage of the NAP Reference Architecture

To exemplify one of the benefits—gap identification—a comparison of the German NAP (Mobilithek) and the NAP Reference Architecture was conducted to identify gaps, harmonization needs, and emerging requirements.

The German NAP (Mobilithek) operates as a data platform, with most data offerings provided through a data broker. Mobility data accessible through data providers APIs can be referenced within the Mobilithek catalogue or uploaded and offered for download.

Different methods were used for the comparison to assess if the specified functions or other specifications have been implemented according to the NAP Reference Architecture:

1. Some of the functions can easily be discovered interactively on the Mobilithek website.
2. Some of the specifications can be discovered in the *Technical Interface Description*, published on the Mobilithek website.



3. Other functions or specifications can be read in the *Technical Specifications* document (not available publicly).

In the Functional View (Figure 21), the following aspects were compared:

1. **F3.6.4 Manage NAP Metadata Retrieval:**
 - All functionalities described in this function can be experienced within the Mobilithek search GUI, including the ability to provide a query form or comparable search interface, receive and process requests from NAP content consumers, and display metadata search results in an overview results page.
2. **tnap.mdrs-metadata response:**
 - The interface to a Metadata Requesting System provides metadata following a previous request formatted compliant to mobilityDCAT-AP.
3. **F3.6.5 Provide NAP User Support:**
 - User support as described in this function is implemented in Mobilithek with a ticketing system. Users can consult support through an online form or by phone.
4. **F3.6.6 Provide Metadata Quality Checks:**
 - This function defines the baseline for metadata quality checks, such as validating that URLs indicated in the metadata are available. Implementation details are described in the Mobilithek technical specifications document with one dedicated requirement.
5. **F3.6.2 Manage Registrations and Provide Authorization Service:**
 - This function describes the ability to receive and process requests from entities to become new NAP users, verify the existence of the organization, agree with terms and conditions, and other abilities required for the authorization service. Implementation details are found in several realized requirements described in the Mobilithek technical specifications document.
6. **Data Flows for Content Data Exchange (to/from Data Provisioning System):**
 - These data flows are described at a high level. Detailed specifications are not provided in the Functional View or Communications View. Details of these technical interfaces have not been harmonized so far, but the Mobilithek Technical Interface Description describes the implemented interfaces and their use entirely.
7. **Data Flows for Content Data Exchange (to/from Data Requesting System):**
 - Similar to the above, these data flows are described at a high level, with detailed specifications provided in the Mobilithek Technical Interface Description.

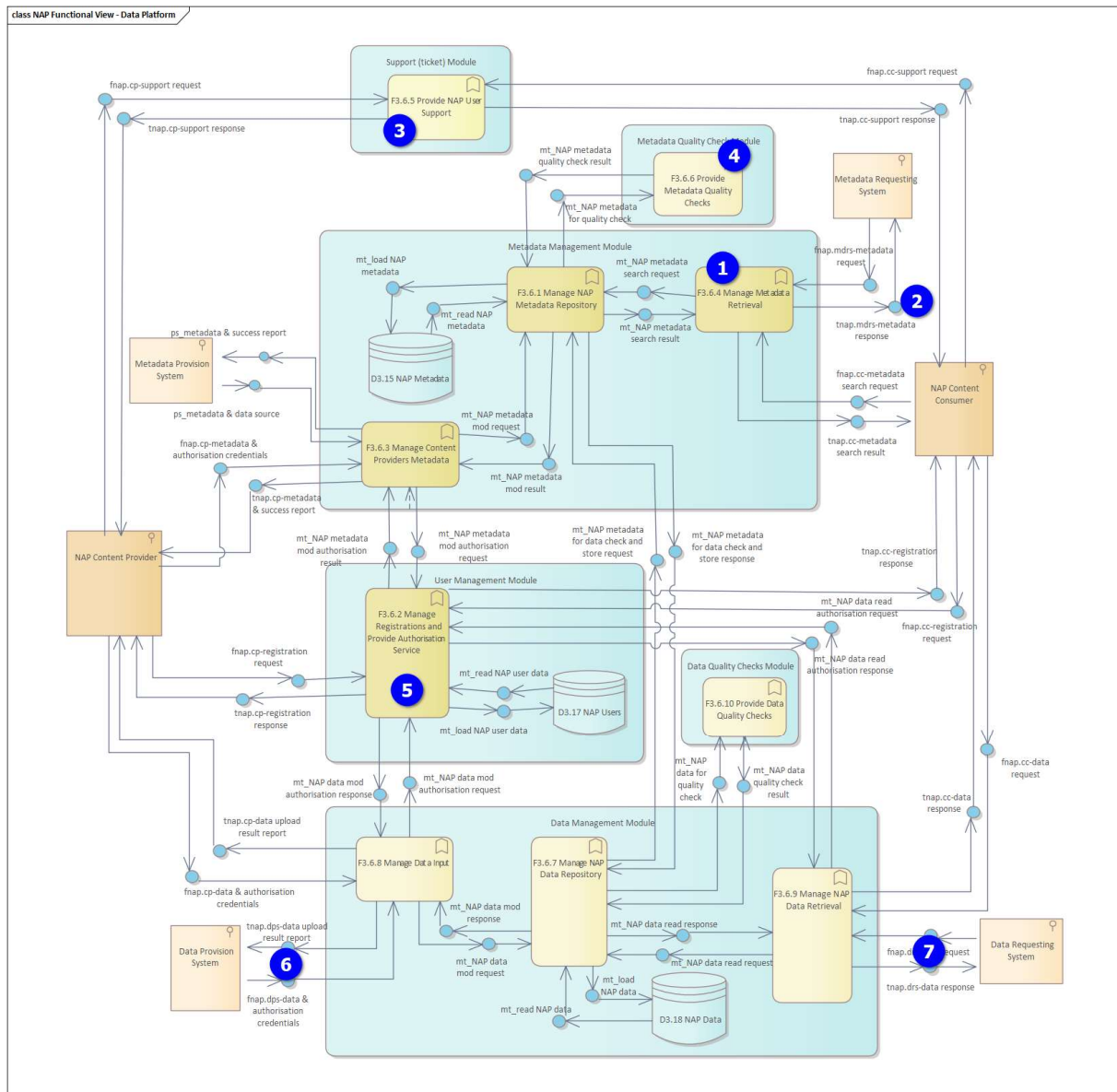


Figure 21: Functional View (of the data platform NAP) with indications of compared functions [NAPCRE, 2025]

Compliance with the aspects described in the Functional View mainly set the cornerstone for the technical interoperability and partly the procedural interoperability. This means that persons or systems interacting with different NAPs can rely on the same or at least similar implementation of processes and technical capabilities.

Looking at the Organisational View, the following aspects have been compared:

1. Privacy agreement (CC-NO) and general terms and conditions:

- This object outlines the obligations to be recorded in such contract-like documents, in this case the obligations of the NAP Operator (NO) towards the Content Consumer (CC) – e.g. best effort to publish up-to-date and accurate (meta)data about the Content Providers and their data at the NAP, but also basics to be considered concerning data protection – and the other way around the obligations of the CC towards the NO.
- Those aspects are covered for Mobilithek with the Terms&Conditions and the Privacy Policy published on the Mobilithek website.

2. Content usage contract (CP to CC):

- This object defines roughly that data must be published according to specifications and data are only allowed to be used according to licenses defined by the Content Provider (CP).



- Mobiliteh has implemented the possibility for CPs to indicate a standard license or provide a link to proprietary terms and conditions

Currently, on an organisational level, there is not much of legal interoperability. Mobiliteh has implemented many of the ideas given in the Organisational View. However, there is room for harmonization in order to reach legal interoperability for better data usage across countries.

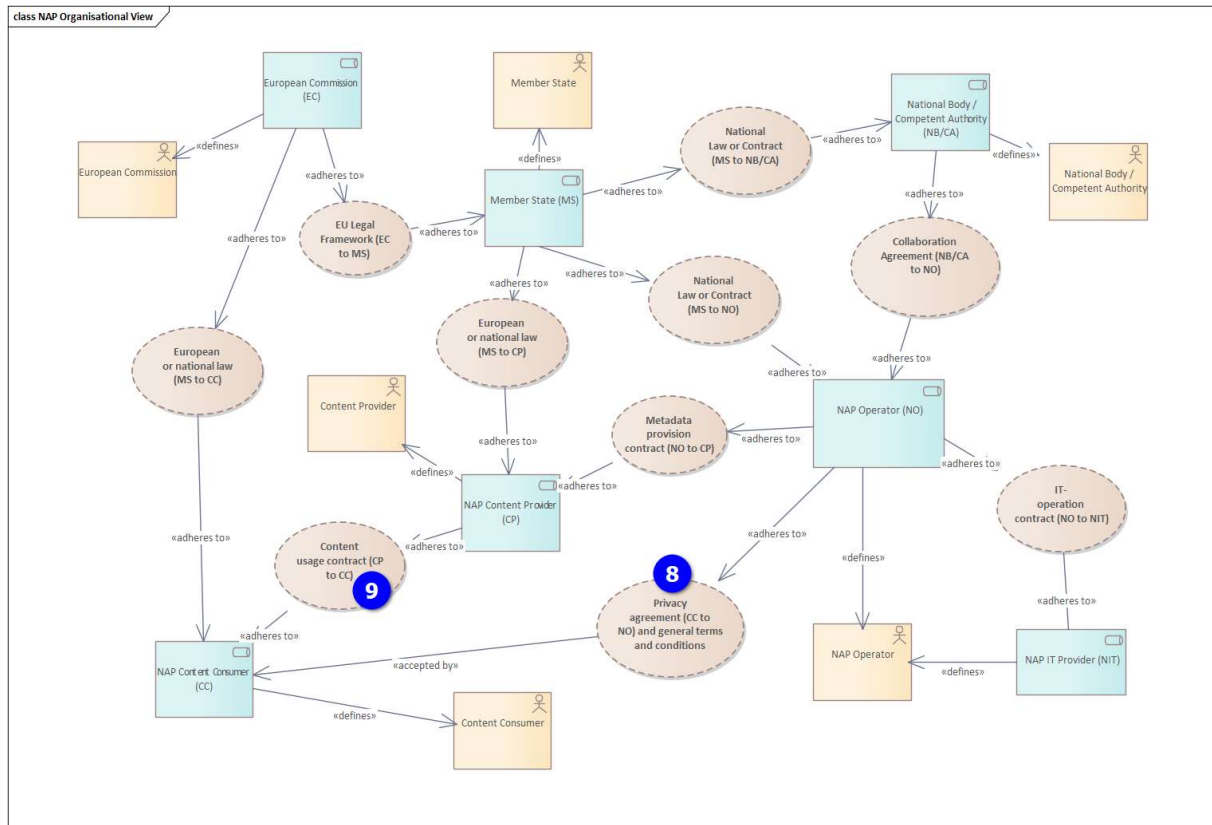


Figure 22: Organisational View with indications of compared objects [NAPCRE, 2025]

8. Conclusions

This report outlines the process of creating a harmonized NAP reference architecture (NRA), the FRAME methodology used for its development, the final product (NRA version 2.0) and provides an example of usage. The NRA consolidates all NAPCORE National Access Point harmonization activities. While this document does not detail every part of the NRA, it highlights the key building elements of different views, how they interact within the NRA and on examples documents the qualitative aspect of their content with.

8.1 Challenges and lessons learned

Updating the NAP reference architecture within the NAPCORE project presented significant challenges beyond the actual content of the architecture. One of the initial challenges was aligning terminology for NAP implementations, specifically the two types: Metadata Directory and Data Platform, many different labels used by NAP operators highlighted the importance of having common terminology.

Having two NAP types created a challenge in addressing their similarities and differences within the architecture. The decision to model the Data Platform on top of the Metadata Directory simplified the number of diverse artifacts but caused issues when describing functionalities that crossed type boundaries, adding complexity to the model.

Updating individual views was challenging because the FRAME methodology did not provide detailed guidance for creating reference architectures. The FRAME metamodel of the Motivation Layer lacked interactions between expectations and services, services and added values, and stakeholders. The methodology for the Organizational View did not precisely cover the expected content of actors, roles and agreements objects. The Physical View required alignment with already published and used terminology. In the Communications View, the interface and specification objects lacked precise explanations. We overcame these challenges by updating and detailing the methodology, adapting the FRAME model, updating the tool, and providing additional explanations and guidance, such as for the creation of specifications [6] and interfaces [5].

8.2 Outcomes and results

The NAP Reference architecture was developed for two NAP types, the Metadata Directory and Data Platform. It consists of these views and supplements:

- **Motivational Layer**, which defines NAP scope, goals, stakeholders, expectations and benefits.
- **User Needs View** that translates motivations into specific, testable predefined requirements.
- **Functional View** that details the NAPs functional structure using Data Flow Diagrams.
- **Physical View** describing the deployment of software and hardware components of NAP allowing for planned deployment.
- **Organizational View** explaining the roles, responsibilities, and relationships of the actors involved in NAP ecosystem.
- **Communications View** focusing on data exchange and interaction between system components by identifying and describing interfaces.
- **Safety and Security View** that addresses potential hazards and threats.
- **KPI Framework supplement** that provides a link between NAP LoS KPI framework (NLKF tool) and the NAP reference architecture.
- **Specifications and Requirements** supplement providing a pool of identified, legal and technical documents related to the NAP development that could be mapped to the parts of the NAP architecture



The NAP reference architecture is available as a browsable model at the NAPCORE Reference Architectures website [here](#) and as a file for the Enterprise Architect software or as full **textual** documentation export at NAPCOREs GitHub [here](#).

Developed NRA can be applied to create a harmonized NAP from scratch by implementing the necessary functional and organizational elements using the architecture, to harmonize existing NAPs by updating their functionalities and processes in line with the developed NRA (as it has been presented in chapter 7 Practical use of the NAP reference architecture, or to establish a basis for comparing NAPs by breaking down complex functionalities and processes. Comparisons can also be conducted using the NLKF tool.

8.3 NRA governance

Upon the completion of the first project phase of NAPCORE, the NAP reference architecture is accessible as a fixed version v2.0 described within this report and available on the NAPCORE website as browsable model, file for the Enterprise Architect software and full MS Word textual exports documenting the NRA as a whole.

The architecture is a living document, subject to updates based on strategic, political, legal, and technical developments. Future results and further harmonizations from post-project NAPCORE developments will be continuously integrated into the architecture according to the developed maintenance procedure. By utilizing the well-known software, Enterprise Architect, and the most suitable toolkit, FRAME, we ensure that the architecture is both understandable and future-proof.

For these future updates, the NAP reference architecture will be available on GitHub under an open license, and issues raised by maintainers or other parties will be addressed during regular releases.

The NAP reference architecture is a component of the FRAME architecture, requiring versioning maintenance for both the core FRAME functionality and the NAP reference architecture. The governance structure and maintenance processes are briefly outlined within chapter 4.6.4 Update and Versioning of NRA of this document.



9. References

9.1 NAP Reference Architecture materials

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10. Annex A Shortlist of created documents

This chapter lists guidelines and NAP Reference Architecture documentation created within NAPCORE. All documents are available at NAPCORE GitHub website <https://github.com/NAPCORE/NAP-Reference-Architecture>

10.1 Guidelines

- **Issue Documentation within Architecture:** Create an "issues" element next to the related existing element, describe the issue clearly, and add comments with date, person, and task/WG if handed over. [available as drafts [here](#) and [here](#)]
- **Guideline NRA to NLKF Updating Principles:** Transfer NLKF KPIs into the EA model of the NRA, organize in subfolders, and model as "requirements" connected to NRA objects. [available as draft [here](#)]



- **Guidelines for Feedback from Demonstrators:** Include information on licenses, interfaces, specifications, functionality, processes, quality parameters, and additional info. Transfer experiences into requirements and best practices. [available as draft [here](#)]
- **Guidelines Organisation Description:** Document ownership of components and data, input/output providers, relationships, and stakeholder involvement. [available as draft [here](#)]
- **Guide to Use of Interfaces in Reference Architectures:** Describe and implement interfaces, including type, description, contextual use, related documents, and communication requirements. [available as draft [here](#)]
- **Guideline to Use Specifications:** Define specifications, types (mandatory, recommended, optional), description structure, and link to interfaces and other artifacts. [available as draft [here](#)]

10.2 NAP Reference architecture view documentation

The documentation is available as a MS Word export of the respective part of the model from the Enterprise Architect software via the customised template.

- **Motivational Layer:** Models motivations, reasons for NAP creation, and expectations for successful deployment. No distinction between Metadata Directory and Data Platform. [available as a release 2.0 version [here](#)]
- **User Needs:** Provides unambiguous, testable, traceable, and singular requirements for ITS systems. No distinction between Metadata Directory and Data Platform. [available as a release 2.0 version [here](#)]
- **Functional View:** Defines architectural elements delivering system functionality, including key elements and their interactions. Elaborated for Metadata Directory and Data Platform. [available as a release 2.0 version [here](#)]
- **Physical View:** Describes arrangement of physical elements, including Sub-systems Modules and Physical Data Flows. Based on Functional View, described for Metadata Directory and Data Platform. [available as a release 2.0 version [here](#)]
- **Communications View:** Describes interactions on physical dataflows, defining interfaces, specifications, requirements, and recommendations. Described for Metadata Directory and Data Platform. [available as a release 2.0 version [here](#)]
- **Organization View:** Provides information about actors, roles, responsibilities, and relationships. No distinction between Metadata Directory and Data Platform. [available as a release 2.0 version [here](#)]
- **Security View:** Provides information about security threats and mitigation. No distinction between Metadata Directory and Data Platform. [available as a release 2.0 version [here](#)]
- **KPI Framework Package:** Maps NLKF features to parts of the reference architecture, allowing updates when NLKF parameters change. [available as a release 2.0 version [here](#)]
- **Specifications and Requirements:** Describes legal and technical specifications, recommendations, and profiles used for ITS Service in different views. [available as a release 2.0 version [here](#)]
- **Model of the NRA v2.0 in Enterprise Architect:** Contains all the above-mentioned views and packages. [available as a release 2.0 version [here](#)]

