Redesign of the International Timetabling Process (TTR)

TTR IT Landscape Analysis

version 1.01

Please, note that this TTR document is a working document and might be subject to changes based on the experience gathered by the pilots and outputs of the TTR working groups

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1.0	20 November 2018	The document was created by Seid Maglajlić and Mario Toma with TTR IT core team support
1.01	23 May 2019	Minor changes to improve the readability of the document

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1. Introduction

1.1. Purpose of this Document

The main purpose of this document is to give a detailed overview of the IT landscape analysis of the stakeholders' national systems as well as to provide a 'To-Be status' as well and to define the steps to reach this status.

IT landscape analysis is the first activity of the TTR WG4 (IT) in the TTR implementation phase and must deliver two major results:

As-Is analysis of the stakeholders' IT landscapes, focused on:

- Analysis of existing systems for business process steps in today's timetable planning
- Analysis of possibilities of these systems to exchange information with other (e.g. central) systems
- Identification of steps of the business process in which the current systems are capable of information exchange with other (e.g. central) systems
- The situation of these systems in the context of the TAF/TAP TSI master plan (will they be adapted for TAF/TAP TSI or replaced by the new systems)

- Provision of a proposal for the to-be enterprise architecture model based on the conclusions of the TTR project
  - must provide a list of the gaps between As-Is and To-Be
  - must provide a plan for how to get from As-Is to To-Be

1.2. Intended Audience

The intended audience of this document are:

- TTR IT Working Group members
- RNE
- FTE
- Stakeholders (IMs, ABs and RUs)

1.3. About this Document

Based on the document 'Redesign of International Timetabling Process (TTR)' and collected information about stakeholders' national systems, the information below will be part of this document:

- Analysis of As-Is situation
- Description of the current landscape regarding business, application and technology (as far as possible)
- Provision of To-Be landscape following the EAM approach (business, application, technology, IT infrastructure, project portfolio)
- Provision of migration plan from As-Is to To-Be
  - Note: Completeness and accuracy of As-Is model influences To-Be model

This document will be the basis for preparing development documentation.

1.4. Scope and Objectives

The scope of the TTR IT landscape is a new architecture of the IT system framework for the implementation of TTR.

IT system framework consists of:

- Central TTR IT framework
  - RU layer
  - IM layer
  - Common layer (Messaging module, Big Data module)
- External IT systems
  - External IT systems for data exchange with RUs/applicants
  - External IT systems for data exchange with IMs (IMs national systems)

The focus is set on the central TTR IT framework and data exchange between external IT systems.

The major objectives of the project are:

- Complete harmonisation of timetabling procedures between European countries supported by the central TTR IT framework
- The future central TTR IT framework must have up-to-date capacity information from IMs
- The future TTR IT framework must support all business processes of TTR:
  - Capacity modelling and partitioning
  - Capacity product preparation, coordination and publication
  - Coordination, consultation and influence of TCRs on capacity
  - Overview of the prepared capacity products and TCRs
  - Rolling Planning (RP) process
  - Annual timetable process including all sub-processes e.g. ad-hoc and late PR
  - Updates of all kinds (modifications, alterations, cancellations, RP capacity updates)

1.5. Project Deliverables

Deliverables of this project included:

- Analysis of the current situation (As-Is), the proposed target situation (To-Be) and migration plan from As-Is to To-Be state
- Microservices (modules and services) in order to achieve one common IT solution (central TTR IT framework)

Deliverables excluded:

- Implementation of necessary changes in national systems (national module updates, interfaces)

1.6. Timeline

The image below presents the timeline for conception. This document belongs to the conception phase.

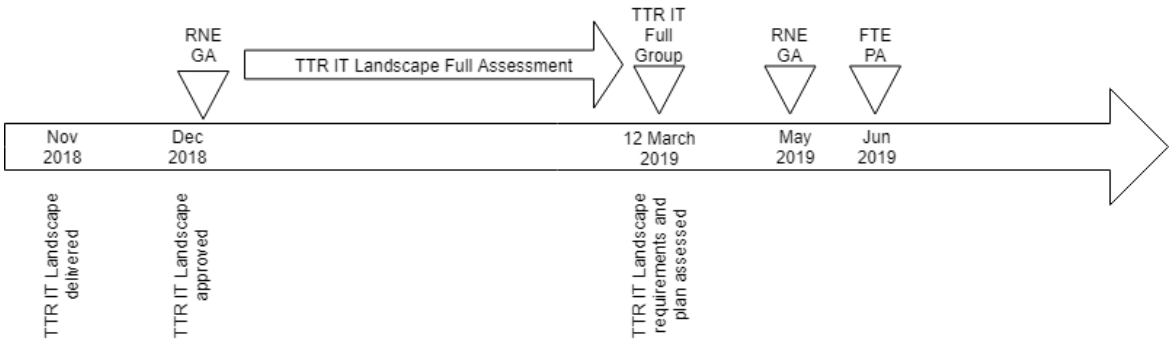


Figure 1 Conception phase - timeline

This document will be reviewed and fully assessed by March 2019. The final result will be presented at the RNE GA and FTE PA in 2019. This document will belong to the documentation which will be used for a call for suppliers.

1.7. Definitions and Abbreviations

This document uses many terms that are already known within the current timetable process. However, some new technical terms will be used as well. Below is an overview of these terms:

Abbreviation	Description
RU	Railway Undertaking (in the text also referenced as applicants)
IM	Infrastructure Manager
AB	Allocation Body
Rolling Planning (RP)	A Rolling Planning request is a path request placed at any time within the relevant deadlines (between four and one months before the first day of operation). It concerns a path that is consistent with the dedicated displayed IM capacity supply, with operation starting as soon as needed, and for a maximum duration of 36 months. The answer to such a request, built on the basis of 'first come – first (and best) served', in the order in which the request was received, is: • a path for the current timetable period • a slot (capacity), which will be converted into a path year by year, for the subsequent timetable period(s).
GUI	A graphical user interface is a type of user interface that allows users to interact with electronic devices through graphical icons and visual indicators such a secondary notation, instead of a text-based user interface with typed command or text navigation.

TCR	Planned temporary capacity restriction. It indicates that the restrictions have been planned (no *force majeure*) and are temporary (not long-lasting bottlenecks).
X	Timetable change
M	The first day of operation, referenced in Rolling Planning
Pre-arranged Paths (PaP)	A pre-constructed path on a Rail Freight Corridor according to Regulation 913/2010. A PaP may be offered either on a whole RFC or on sections of the RFC forming an international path request crossing one or more international borders.
Pre-planned Path	Path pre-constructed by the IMs based on the outcome of the capacity partitioning, to be used primarily for annual TT requests
Catalogue Path (CP)	A catalogue path is a path that has been constructed by the IM according to various parameters, with no specific request from an RU.
EAM	Enterprise architecture management - is a 'management practice that establishes, maintains and uses a coherent set of guidelines, architecture principles and governance regimes that provide direction and practical help in the design and development of an enterprise's architecture to achieve its vision and strategy.'
Positive capacity	Pre-constructed capacity products (capacity bands, rolling planning slots, pre-planned paths) published by IMs + other (non-pre-constructed) available capacity
Negative capacity	The term 'negative capacity' is used to indicate TCRs and other capacity that cannot be requested, such as already allocated paths (booked or offered)
Microservice	The term 'microservice' is used here to indicate that the modules of the To-Be TTR IT landscape are not going to be put in a monolithic system without the possibility of separation of particular modules according to the business needs.

1.8. Methods

The Enterprise Architecture Management (EAM) standard shall be included in the TTR programme management as a precondition.

For thorough analysis, questions have been prepared, which were asked when interviewing the stakeholders.

- Survey – web form with questions or pre-defined Excel file
- Direct interviews (workshops) supported by the IT strategy groups of RNE and FTE

The surveys and workshops have to answer two questions: (1) are the process steps and events covered by the applications, and (2) are the applications capable of data exchange via interfaces with other (possible remote/central) systems.

The investigation will be executed separately for RUs and IMs since both RUs and IMs have their specific business aspects and different business roles.

1.9. Usage of the Central TTR IT Framework

The future central TTR IT framework will be used internationally for the harmonisation of international rail transport according to TAF/TAP TSI. The future tool can be used nationally as well but it is not specifically designed to substitute the national systems.

2. Analysis of As-Is Situation

For the analysis of the As-Is situation, the business process landscape and application landscape, as well as the technology landscape (for the evaluation of technical interfaces) have to be provided.
The business process landscape is divided into:

- **business process view** (business process steps for path management as we know it today)
- **business events view** (business ad-hoc events such as modifications, alterations, cancellations, TCRs and similar)

As an introduction, we provide an example application landscape which covers the above-mentioned process steps and events.

The technology landscape will indicate if the common-standard / licensed or 'home-grown' software is used, as well as the technical indications of the interfaces, if any. The technology landscape will also answer the question if the TAF/TAP-compliant common interface is already in use and for which communication.

The list of currently running projects should reflect the current activities of the stakeholders and help to create the To-Be landscape.

To collect answers, the link was sent to stakeholders and all stakeholders were asked to fill in the form with their answers.

19 stakeholders (companies) participated in the survey:

- 10 Infrastructure Managers (IMs)
- 7 Railway Undertakings (RUs)
- 2 Allocation Bodies (ABs)
-

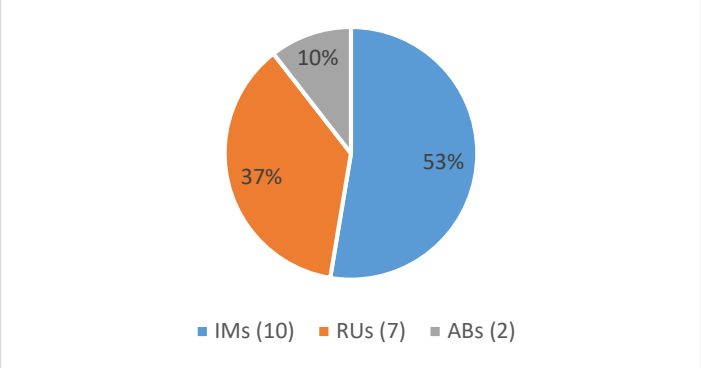


Figure 2 Companies by type

In the survey, general information about existing applications was provided, as well as information on the processes which are covered by these applications. Further, an overview was gained of the existing interfaces and interface types.

Also, the TAF/TAP TSI-compliance of the applications and plans to become TAF/TAP TSI-compliant were considered.

Direct interviews were conducted with stakeholders who participated in the survey to gain deeper insight into national processes and applications. The interview questions were based on the answers given in the survey and general topics were defined.

2.1. Business Process Landscape

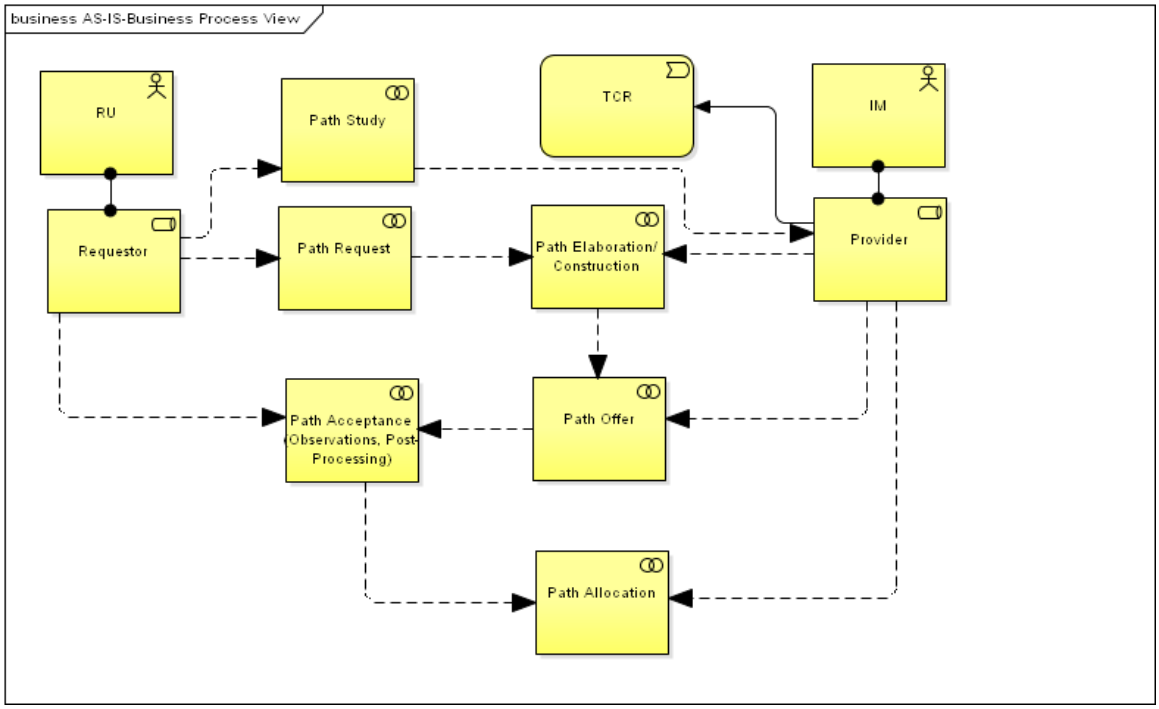


Figure 3 Business Process View

The surveys and workshops should provide answer to the following questions:

a) *Path Management*
How are the following business process steps in path management supported by the systems:

- Path Request
- Path Elaboration / Construction
- Path Acceptance (Observations, Post-Processing)
- Path Allocation
- Path Operation
- Path Study
- Annual Timetable
- Ad-Hoc - running timetable: Modification, Alteration, Cancellation, New Request

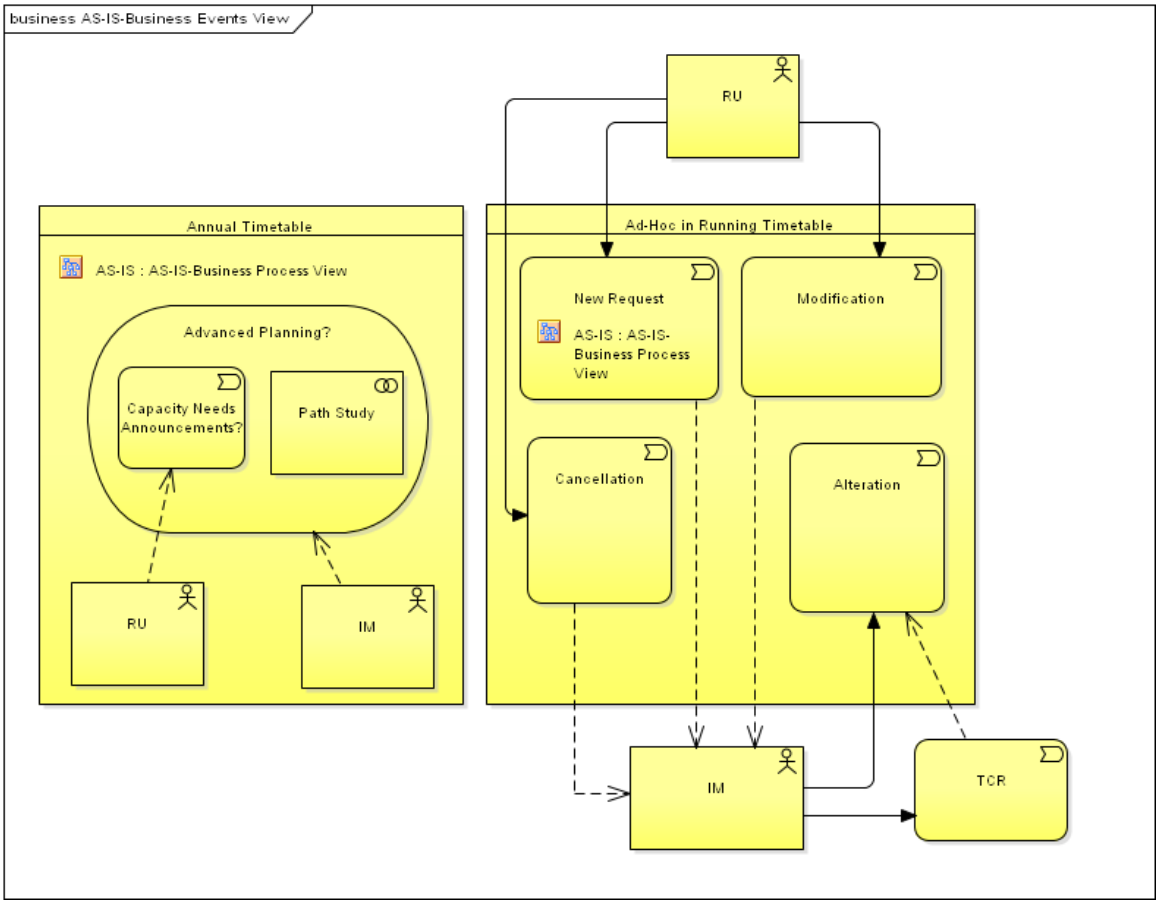


Figure 4 Business Events View

b) Advanced Planning

- Is 'Advanced Capacity Planning' supported?
- Are Capacity Needs Announcements by the RUs supported?

c) Ad-hoc requests

- How are the Ad-Hoc requests supported during the running timetable?

d) TCR

- Is TCR Management supported?
- Is there interrelation with other business process events (i.e. alteration) and business process roles (i.e. RUs/applicants)

2.2. Survey and Interview Results

IMs and RUs have some different demands regarding the path management processes and due to that not of all processes are covered by the system.

2.2.1. Railway Undertakings (RUs)

The most covered processes from RU side are:

- Path request for next annual timetable (ATT)
  - New path request
  - Late path request
- Ad-hoc path request for the running timetable

Some RUs (freight) have a system which covers the path study (Feasibility study) process.

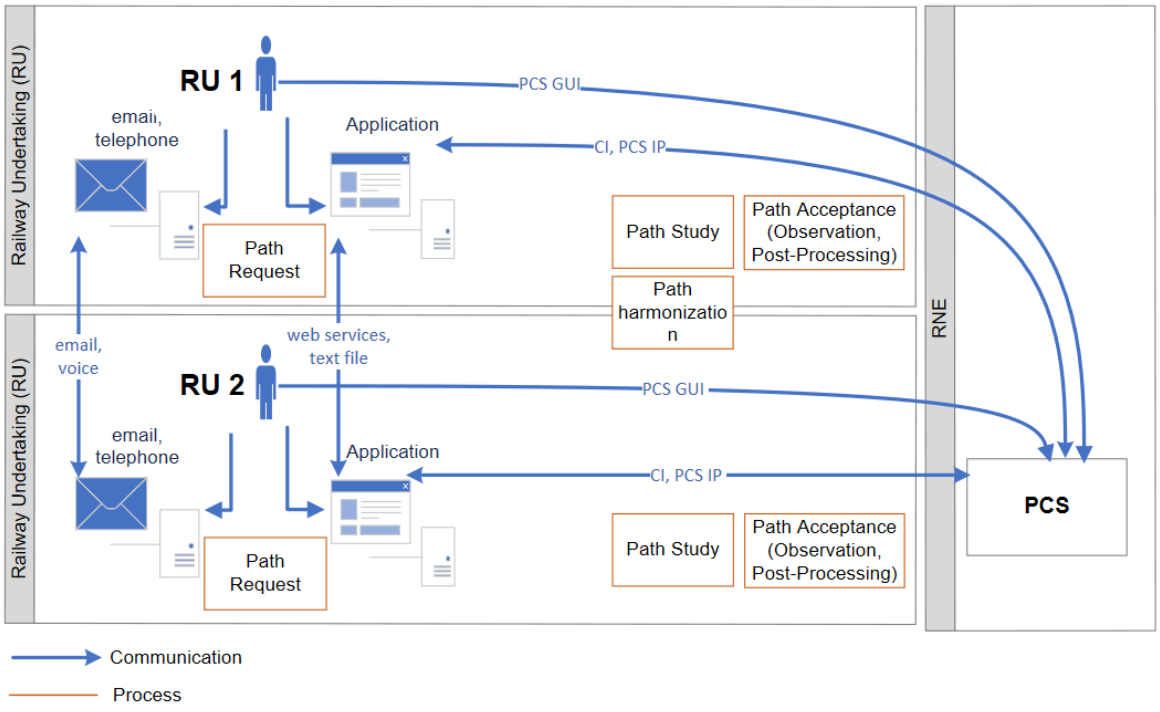


Figure 5 RU-RU Business Process View - Communication

Considering the aspects of communication between RUs, we are talking about three different kinds of communication:

- Telephone and e-mail
- RU's own application
- RNE PCS system

When the RU considers the customer's request, the RU chooses its partners and communicates by phone or e-mail to arrange the necessary information (paths, special conditions). There is still a lot of communication by phone and e-mail. Some of the RUs use PCS to harmonise their request, creating a new dossier and calling partners for their participation and acceptance. In this case, the RU uses its own system to exchange data with

the PCS system. If the RU does not have its own system or does not have an interface to the PCS system, the PCS GUI (graphical user interface) for manual data entry is used.

The way these processes are covered are slightly different between stakeholders. Mostly, big RUs have their own systems and interfaces while smaller RUs do not have systems and need help from the IM side. Sometimes IMs enter path requests on behalf of RUs for the annual timetable path requests.

Small RUs mostly request ad-hoc paths and IMs have developed web-based applications for this purpose, so small RUs can enter path requests on their own, directly into the IM system.

Some IMs have created special portals where RUs can enter their path requests and track the whole process of path management. On these portals, RUs can get information about the available capacities and information about occupied capacities or TCRs as well.

The path management business process is similar for all RUs, but its implementation is different.

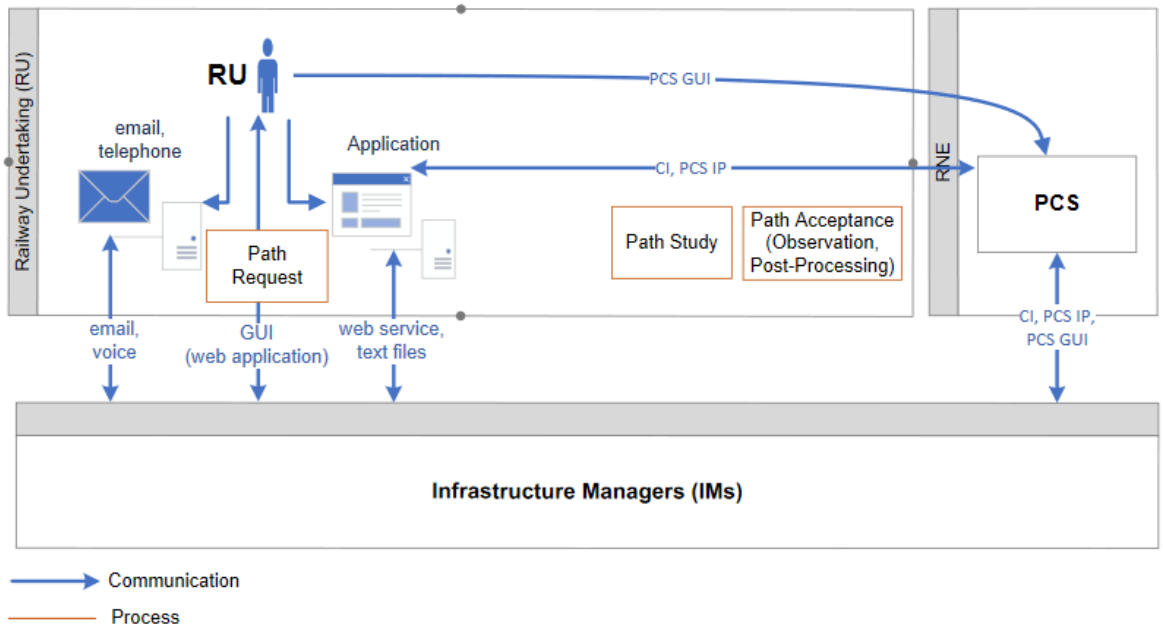


Figure 6 RU-IM Business Process View – Communication

Regarding the communication between RUs and IMs, the TTR IT landscape analysis has shown that there are four different ways of communication that RUs use to communicate with IMs. An RU can start the communication through:

- own application (big RUs often have their own applications)
- an application provided by an IM (web or desktop application)
- telephone and e-mail
- RNE PCS system

Using its own application, an RU may request a path directly through the IM system, using a web service that the IM has released for that purpose or by creating a non-standardized structured file (xml, text file, excel) which is then sent to the IM's server in a predefined manner (e.g. FTP). The structure of these files is usually prescribed by the IMs and is tailored to be easily imported into their systems. Via the same communication channel and format, RUs receive answers from IMs. RUs can download information about TCRs which is provided by IMs and take it into consideration when preparing the requests, in the format provided by the IM.

Small RUs generally do not have their own systems and use the applications which IMs have released for them. These applications are a light version of the IM system and have been published to meet the needs of the RUs and reduce the need for manual entry of data on both sides. Through these applications, RUs can request paths but also track the status of the request and get relevant information about TCRs, available and occupied capacities and similar. Some of these applications are web-based but some are desktop applications and IMs provide a dedicated connection to a server for the applicants (e.g. Citrix).

Small RUs mostly request ad-hoc paths and enter their needs manually into the provided system by creating a new request. The entered requests are compared with the capacities and TCRs and if the requests are properly entered, they are taken for further processing. Entered data is processed in the IM system and the IM answers the request. The answer is visible to the RUs in the same application in which they requested the path. RUs are able to make some modification to the request or cancel the request, depending on the national rules in the current timetabling process applied by the particular IM.

Due to old habits and also lack of automated communication in the system, communication by telephone or e-mail is still common. This kind of communication mostly is used when RUs request paths for the annual timetable (particularly smaller RUs). The RU typically calls or sends an email to the IM to request a path. In the same way, the IM provides an offer to the RU. After receiving the request, the IM enters it into the national system. TCRs and capacities are taken into account and if the IM is able to respond positively to the request, it prepares the offer and sends it by e-mail. If the offer is acceptable, the RU responds to the e-mail and the IM allocates the path. A disadvantage of this communication is that both parties must manually enter the data which in most cases originated in another system. Small RUs track their requests afterwards mostly by using MS Excel and exchange the particular Excel file per e-mail with other logistic partners (e.g. traction companies).

Some RUs have interfaces to the RNE PCS system in a test environment and they will be able to create path requests automatically from their systems using the PCS common interface (CI) in the near future. In addition, RUs can use the PCS GUI (Graphical User Interface) to enter their requests. These requests are taken by IMs for further processing.

Some of IMs use the interfaces to the PCS system (PCS integration platform or common interface) and import requested data. IMs answer the requests using the same interfaces. If an IM does not have an interface with the PCS system, it is possible to enter data using the PCS GUI.

The simplified view from the aspect of the business process landscape looks as follows: After the path request has been received, the IM attempts to respond to the request and take TCRs, occupied / available capacities and other concurring requests into account. If it is not possible to positively answer the request, the IM tries to find the most suitable solution by taking into account all available possibilities. When the solution is found, the IM sends an offer to the RU. Upon receipt of the offer, the RU considers whether this offer is acceptable (also contacts any other RUs that might be involved in the harmonisation process) and then responds to the offer by accepting or by cancelling. If the offer is acceptable, the IM will allocate the path and path goes to operation.

Considering the advanced planning (advanced capacity planning and capacity needs announcements), RUs do not have systems to support this process in general. Since the RUs do not have the required information in this early phase of planning and due to other important developments they have on their schedule, RUs will find it useful to have a common European capacity system in the future.

RUs do not have systems for TCR management, and TCR information is usually consumed from the IM system. Information about the TCRs is provided in the web applications which IMs have released for RUs and also are published for all RUs in a file (e.g. Excel). RUs usually take into account these TCRs with the requested paths or investigate the impact to their traffic which is already agreed with the IM. At national level, the IM tries to find the best way and time to carry out important (re)construction and maintenance works. Regular maintenance mostly is done during the night, when the traffic is lower. These maintenance works are mostly safeguarded. However, this information is currently mostly processed manually by the RUs, and the impact analysis or traffic simulations combined with TCRs are usually possible only for big RU companies able to invest in such systems.

2.2.2. Infrastructure Managers (IMs) and Allocation Bodies (ABs)

IMs have covered all processes of path management in their systems. The business process steps are slightly different from IM to IM and depend on national law (e.g. for carrying paths over into the new timetable different rules might apply in different countries).

Some IMs have developed technical interfaces to their systems for RUs and additionally created a light version of applications, so the RUs can enter their requests into the systems and can then be automatically imported into the IMs' systems. This facilitates the process and reduces efforts on the IMs' side and at the same time decreases the possibilities for mistakes.

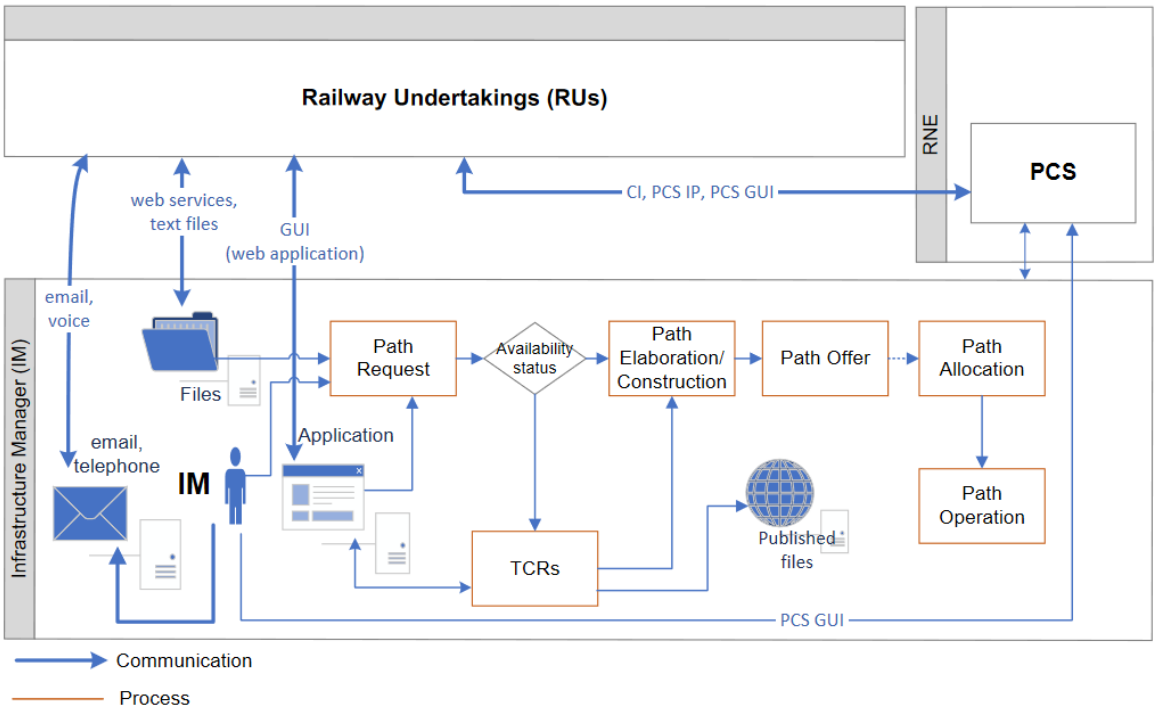


Figure 7 IM-RU Business Process View – Communication

Data which are entered manually into the IM system or by using the interface (web service or text file exchange) are combined with available (given) capacities, known TCRs and other requests and, if possible, are accepted. An offer is sent through the system and after the RU's acceptance, it is allocated.

A similar situation would be that RUs request paths by sending an e-mail or by calling the IM, then the IM uses the system GUI and enters the requested data. After the whole procedure, if the request is acceptable, the IM sends an e-mail message with the offer, and allocates the path after acceptance.

Certain IMs have a connection to the PCS system and can respond to the Rus' requests through the PCS. IMs who have not implemented the PCS interface can enter path data using the PCS GUI.

Communication between IMs takes place via the PCS system. IMs use their systems to exchange data with PCS using technical interfaces. It is mostly done in both directions. IMs also use the PCS GUI to support processes and enter the needed data to start or harmonise requests.

Communication by phone or by email is still present. When all IMs develop technical prerequisites, this mode of communication will no longer be needed.

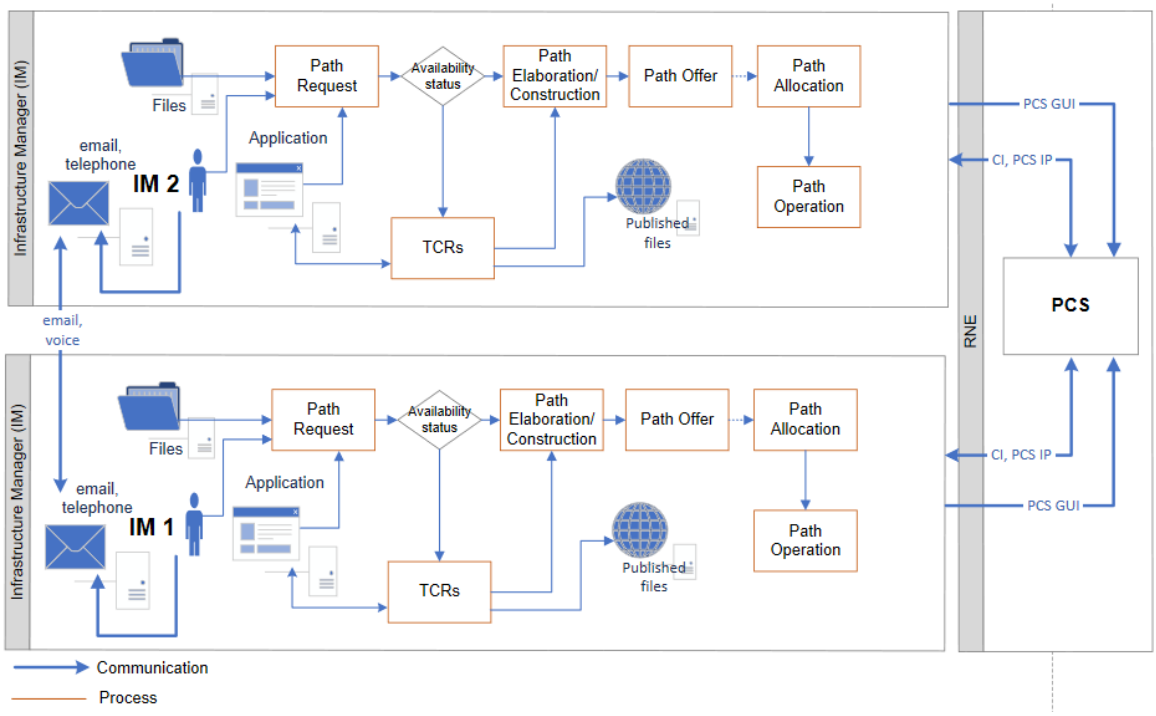


Figure 8 IM-IM Business Process View - Communication

IMs and ABs partially have applications for advanced planning and cover this process, but only at national level. IMs which do not have a system for this process wait for results from TTR pilot phase 1 (capacity model) and also wait for the European capacity system to be developed.

Some of the IMs have systems for TCR management but these systems are used at national level. These systems are used to manage TCRs and exchange information with the national RUs. At international level, Excel files (Adonis') are used to harmonise the TCRs. In most cases, at borders, every particular TCR (which is important for the border crossing) is coordinated with both sides (both IMs) looking at their respective timetables and discussing how to harmonise it. Some IMs do not have deviation possibilities because some of the main lines are closed. Sometimes, some of the TCRs cannot be commented, because they have to be just accepted as it was defined (in case of work which cannot be postponed or urgent works).

In the case that some other IM has made changes in the 'window' after publication, the coordination of such a conflict is not easy and sometimes not possible.

IMs give RUs the opportunity to download all TCRs, so RUs can combine these TCRs with their requested paths to see the impact on their traffic.

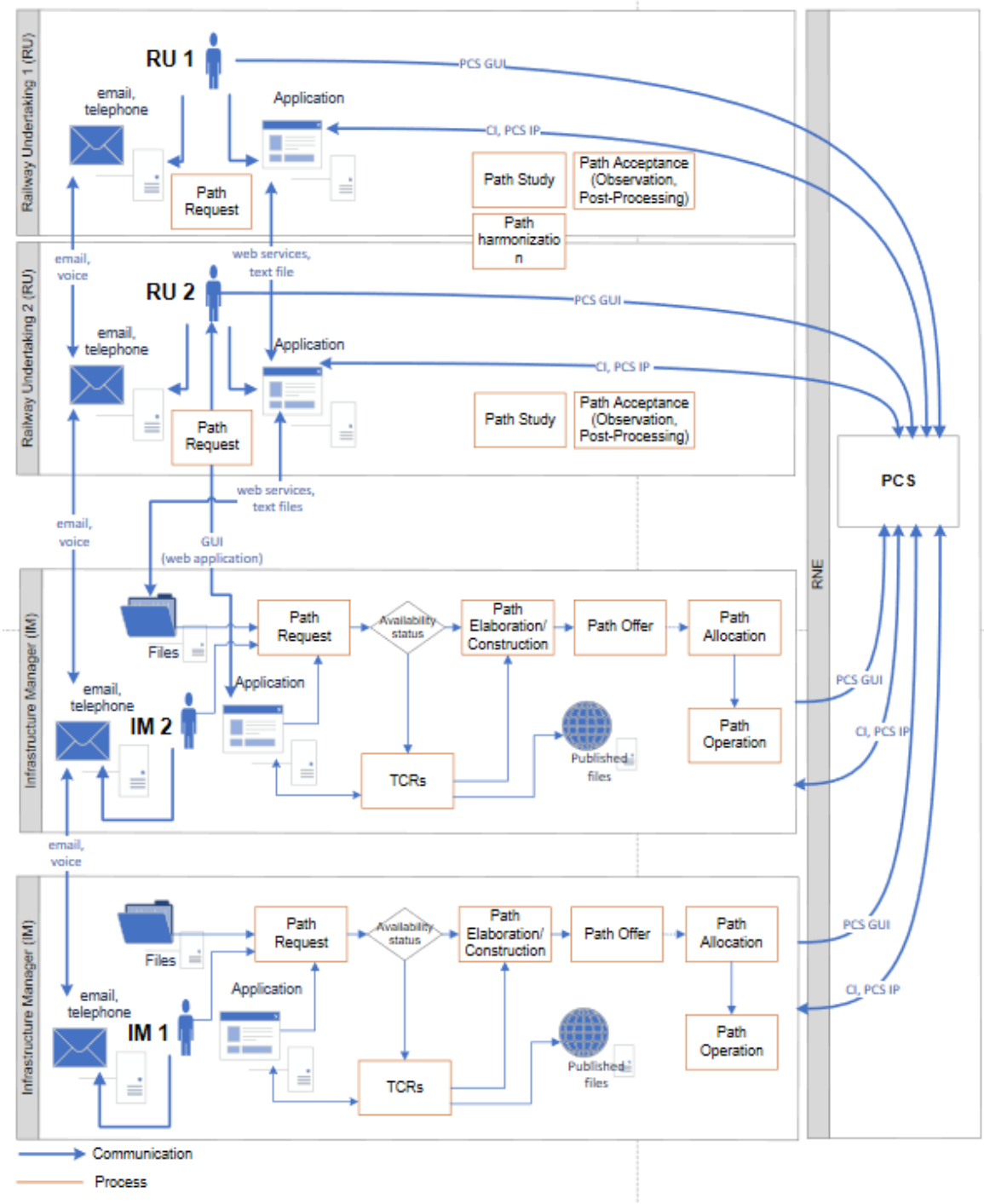


Figure 9 AS-IS Business Process View – Communication

2.3. Application Landscape

a) Path Management

How are the process steps in path management supported:

- ✓ One application for path management?
- ✓ Separate applications for different steps and phases in path management?
- ✓ Which business objects are handled by which application?

An example of the application landscape may look as follows:

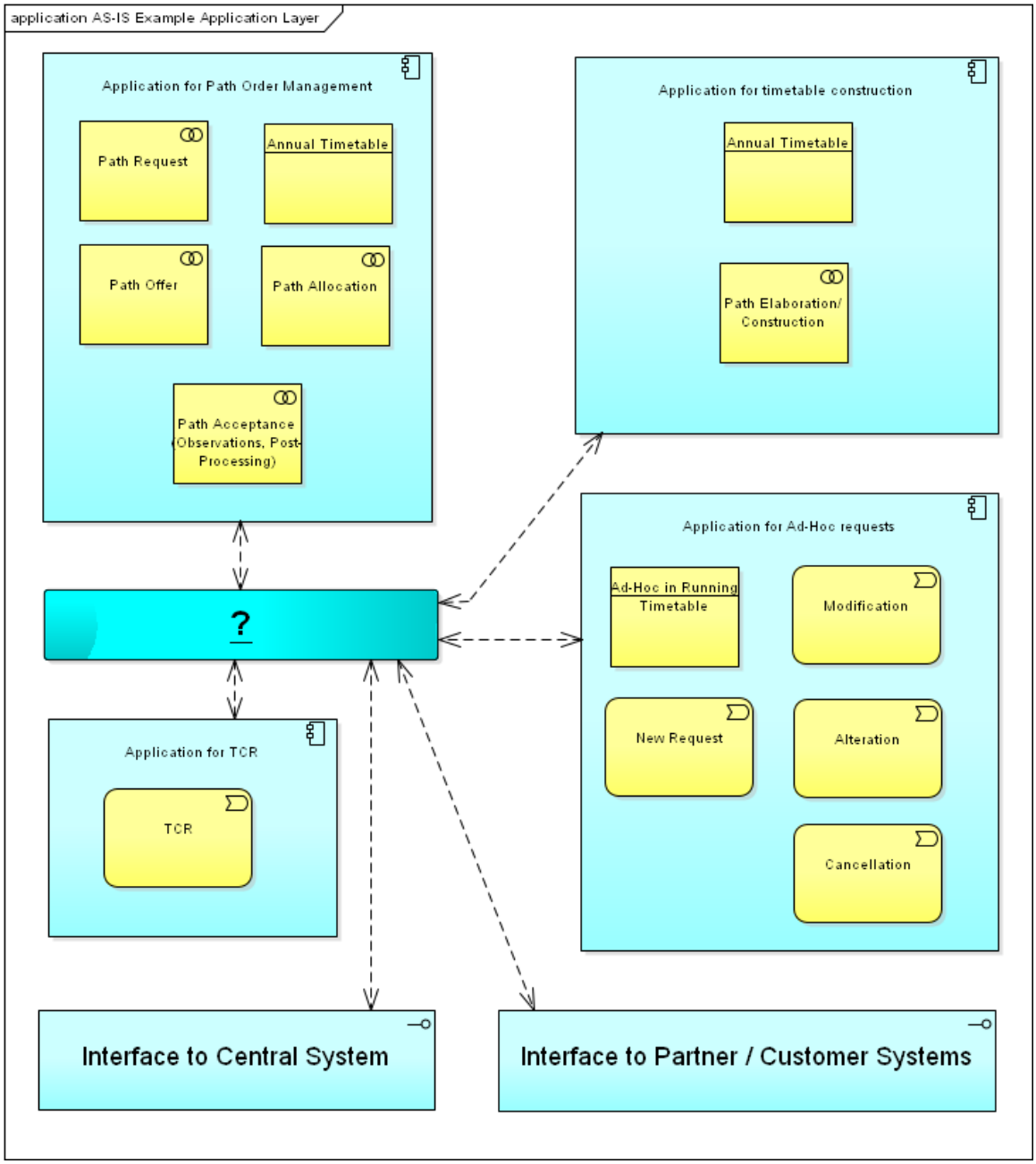


Figure 10 Application Landscape – Example

b) TCR

Is there a TCR management tool?

If yes – is there an interface to path management?

- ✓ Is it linked to the path management tool?
  - Linked to path order already?
  - Linked to path construction?

c) Interfaces

Are the applications capable of information exchange with other systems/applications?

- ✓ Within the corporate network?
- ✓ Outside of the corporate network?
- ✓ Which central/partner applications are they connected to, if any?

d) TAF/TAP TSI

Are the existing applications foreseen in the TAF development?

Will the applications be adapted or replaced by new ones for TAF/TAP implementation?

What is the lifecycle of the application (release cycles, planned fade-out)?

2.3.1. Survey and Interview Results

Generally, all IMs have systems to support all path management processes, as was already mentioned in chapter 'Business Process Landscape'. In most cases, IMs have one or maybe two applications which cover all path management processes.

Some IMs use more systems to support path management processes, but those companies are already in the process of consolidating and preparing a new or updated system that will unify all functionalities of these multiple systems. With consolidation, a number of interfaces between systems will be reduced, maintenance will be easier and also, the number of different databases will be decreased. Generally, IMs plan to have a central database which will be used by all systems they have. The central database will be used as a source of the data needed for exchange with RUs' and IMs' systems, nationally and internationally.

An overview of the national systems that support path management processes can be seen in the table below:

Company	Path Request	Path Construction	Path Allocation	Path Operation	Path Study	Annual TT	Ad-hoc
VPE	KAPELLA	TAKT	KAPELLA			TAKT	KUMO
Infrabel	PCS, BookIn	ROMAN, A170	ROMAN, A170/UPS	RCS	ROMAN	ROMAN	A170/UPS
SNCF Reseau	GESICO, DSDM	THOR, SIPH		BREHAT, NOPANIC, DYNAMIC, OLERON	DISCO (current), SIPH (target)	THOR (current), SIPH (target)	THOR/HAUT (current), SIPH/MGOC (target)
SŽDC	KANGO, KADR	KANGO, KADR	KANGO, KADR	ISOŘ	KANGO, KADR	KANGO	KADR
Trafikverket	AoK, MPK	Trainplan, MPK/TPS		OPERA, ATL, NTL	AoK, Trainplan, MPK	MPK	MPK

DB Netz AG	TPN	Rut-K	Rut-K, TPN	LeiDa-S/LeiDa-F, Leidis	TPN, Rut-K	TPN, Rut-K	TPN. Rut-K
ProRail	DONNA	DONNA	DONNA	VOS/PRL	DONNA	DONNA	DONNA
SBB	NeTS	NeTS	NeTS	RCS	NeTS	NeTS	NeTS
Trenitalia	PNO					PNO	
RCA	ZugDB AT				ORBIT	ZugDB AT	ZugDB AT

Table 1 Path Management processes supported by application/s

For the path operation process, IMs use completely different systems than for the rest of the path management processes.

All these systems are mutually connected via the technical interfaces (web-services, structured text files) or via the database layer (systems use the same database or database data are synchronised at a certain time).

The table above shows that there are many systems at national level which cover the path management processes. This was to be expected. Some IMs do not cover every business process. All these systems should communicate with each other via a common data exchange system as it is shown in the picture below.

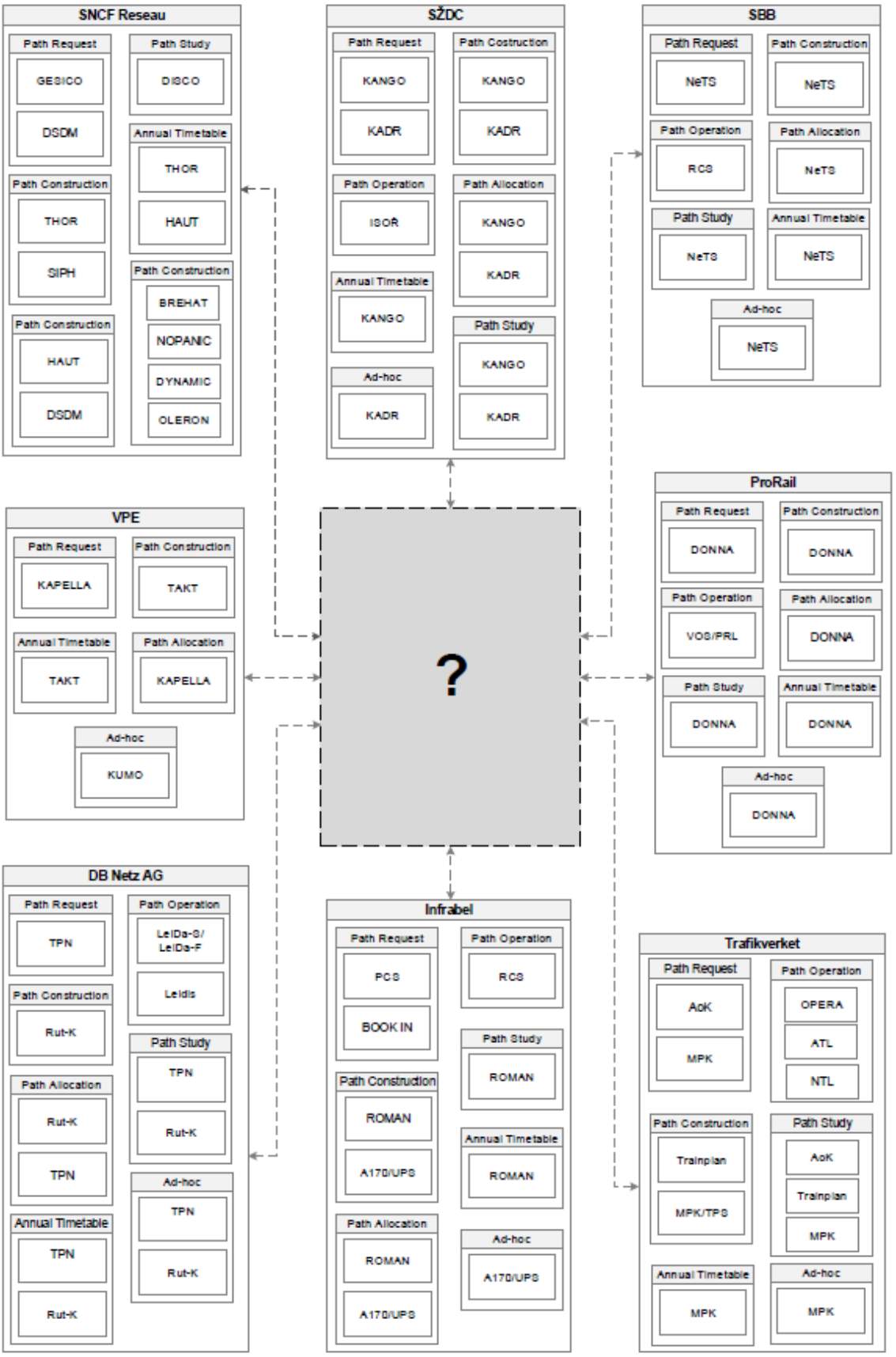


Figure 11 Common Data Exchange system – Path Management

Checking the system which is used at national level, it is possible to simplify this picture, because one application covers several business processes.

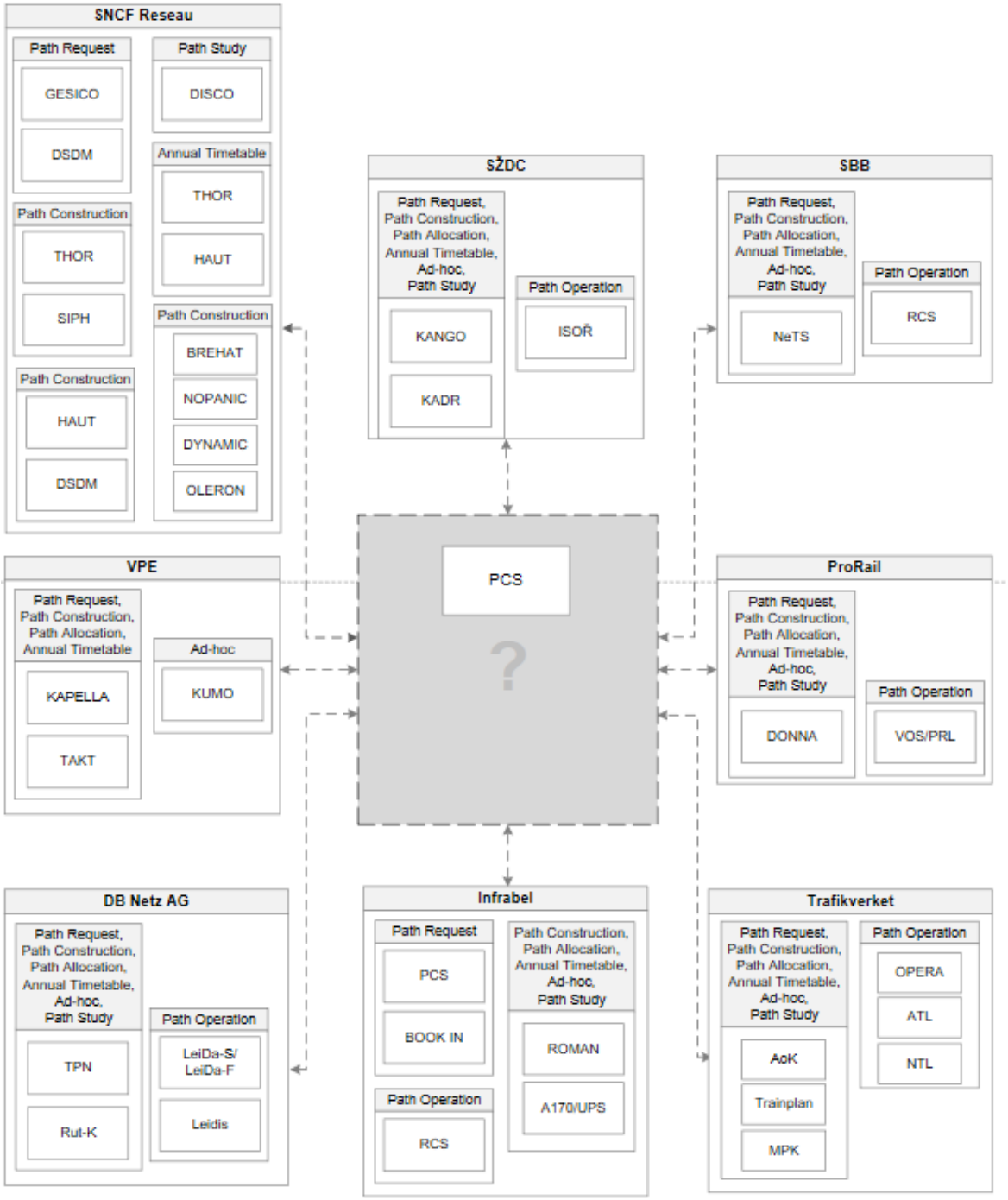


Figure 12 Common Data Exchange system – Path Management simplified the view

Common data systems should be fed by national systems and should cover all business functionalities needed for harmonisation at international level.

TCR

Systems supporting the TCR management process exist, but only at national level. The following table provides an overview of the systems for TCR management per company.

Company	TCR long	TCR short
VPE		
Infrabel	A170-GIS	A170-GIS
SNCF Reseau	TCAP	PORTCROS / CORTE
SŽDC	CSV	DOMIN
Trafikverket		Trainplan, MPK
DB Netz AG	BBP	Rut-K
ProRail	RADAR/PION/BTD-PLANNER	RADAR/PION/BTD-PLANNER
SBB		
Trenitalia		
RCA		

Table 2 TCR Management process supported by application/s

For international level TCRs, data are exchanged using Excel files (‘Adoni’s’) and mostly harmonised manually. That means that IMs coordinate the TCRs, which are important for border crossings and affect both sides, by looking into their timetables and discussing how to harmonise. This is done for each individual TCR.

Some IMs’ systems are real ‘window’ applications and these ‘windows’ can be flexible or fixed. In the application, a ‘window’ is free and flexible until two years before publication. After that period it is more restrictive.

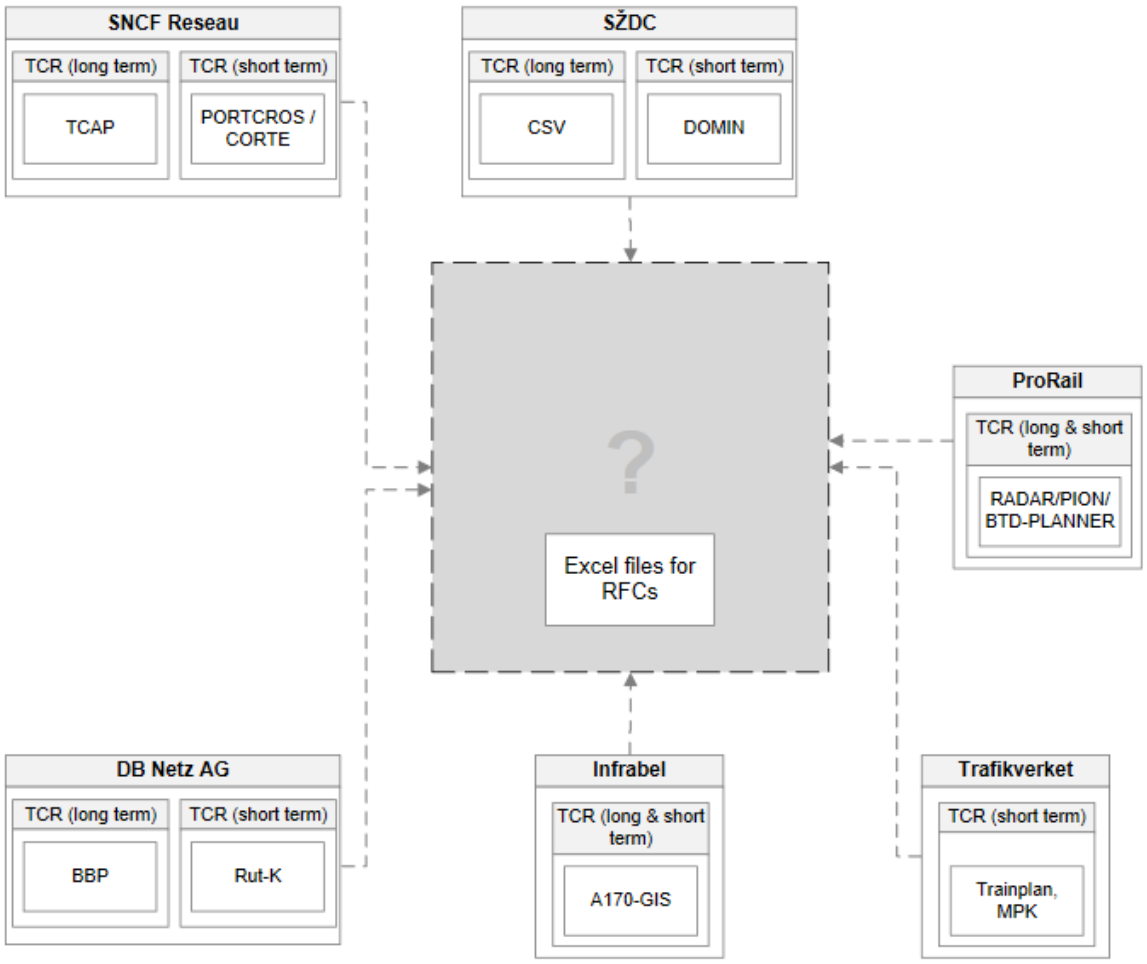


Figure 13 Common Data Exchange system – TCR

The connection between the TCR system and path management systems exists and TCR data are used when path construction is considered. On the other side, RUs download the TCR data and use it when requesting paths. All subsequent TCRs, after paths are assigned, are discussed with the RUs.

At international level, there is no connection between systems. Also, the RNE TCR tool is in the pilot phase and temporarily it is not possible to connect as the technical interface is not defined yet.

For the RUs' needs, the IMs create files with the defined and harmonised TCRs and in addition provide TCRs through the applications which are developed for RUs.

RNE has prepared the TCR tool as a central TCR management system and this system is currently in the pilot phase on four RFCs.

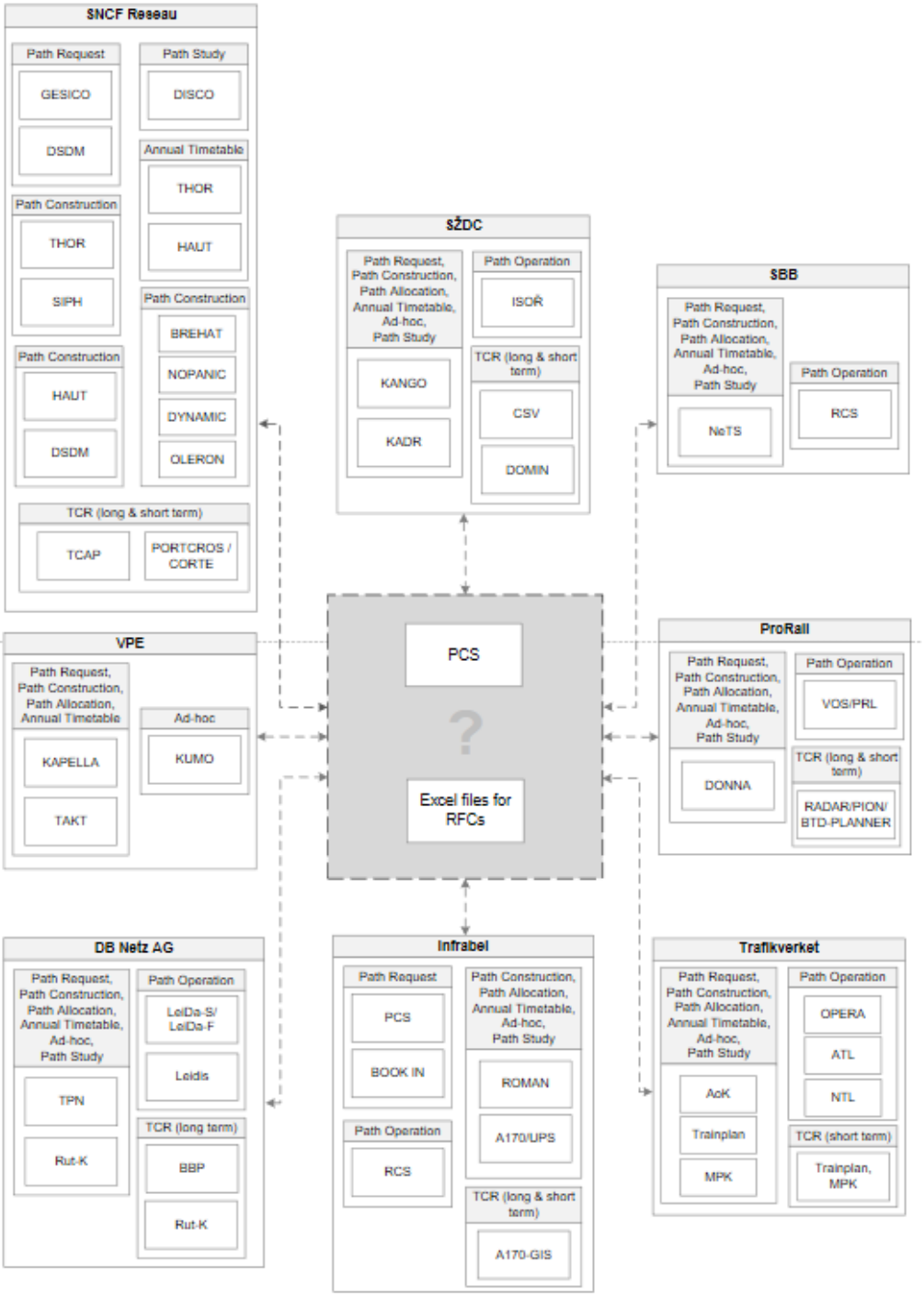


Figure 14 Common Data Exchange system

As discussed during the interviews and as it is shown in figure 14, at national level, companies use two different systems to cover all functions of the path management process.

IMs have published interfaces to their systems and, in most cases, these interfaces are used for the communication with RUs. Of course, these interfaces could be used for the communication between the IMs, but not all the functionalities of path management are covered. In most cases, IMs do not use technical interfaces to exchange data between each other.

For path harmonisation at international level the RNE PCS system is used and for TCR harmonisation ‘Adoni’s’ Excel files are used.

Interfaces

Internally, the companies' systems communicate using technical interfaces (web-services, structured text file) but also communicate through the database layer (use the same database). In some cases, there is a synchronisation procedure which is being performed automatically at a defined time, synchronising data between the systems.

Interfaces with external partners (RUs) exist and they are mostly web-services or interfaces based on the exchange of structured text files (non-standardised files).

The companies have interfaces with the RNE PCS system. Some companies use the PCS integration platform (PCS IP), while others use the common interface (CI). The list of companies and corresponding type of the interface can be seen in the table below:

Interfaces to PCS				
Company	Company type	Interface type	Direction	Status
Infrabel	IM	PCS IP	National → PCS	Production
SNCF Reseau	IM	PCS IP	National ↔ PCS	Production
SBB	IM	PCS IP	National ← PCS	Production
SŽDC	IM	PCS IP	National ↔ PCS	Production
ProRail	IM	CI	National ↔ PCS	Test
Trafikverket	IM	CI	National ↔ PCS	Test
VPE	AB	PCS IP	National ↔ PCS	Preparation
Rail Cargo Austria	RU	CI	National ↔ PCS	Test

Table 3 List of companies connected to PCS (in production and test)

The table lists companies that were surveyed and interviewed.

There are different interfaces between national systems and the RNE PCS system. Those interfaces are shown in the figure below.

Mostly, companies use the communication interface in both directions to communicate with the PCS system. Half of the interviewed companies are connected to the PCS test system to test communication and interfaces they have developed (TAF/TAP TSI-compliant interfaces). A TAF/TAP TSI-compliant interface is the basis for successful implementation of TTR. Other companies are connected to the PCS production system and use the PCS integration platform (PCS IP) to communicate with the PCS. They plan to switch to the common interface in the next 2-3 years.

Also, there is a possibility to use the graphical user interface (GUI) in PCS. To support the harmonisation process, some companies use the GUI to manually create and harmonise path requests. This functionality is useful for small companies with a small number of requests and could be used as the latest option when other possibilities are not available.

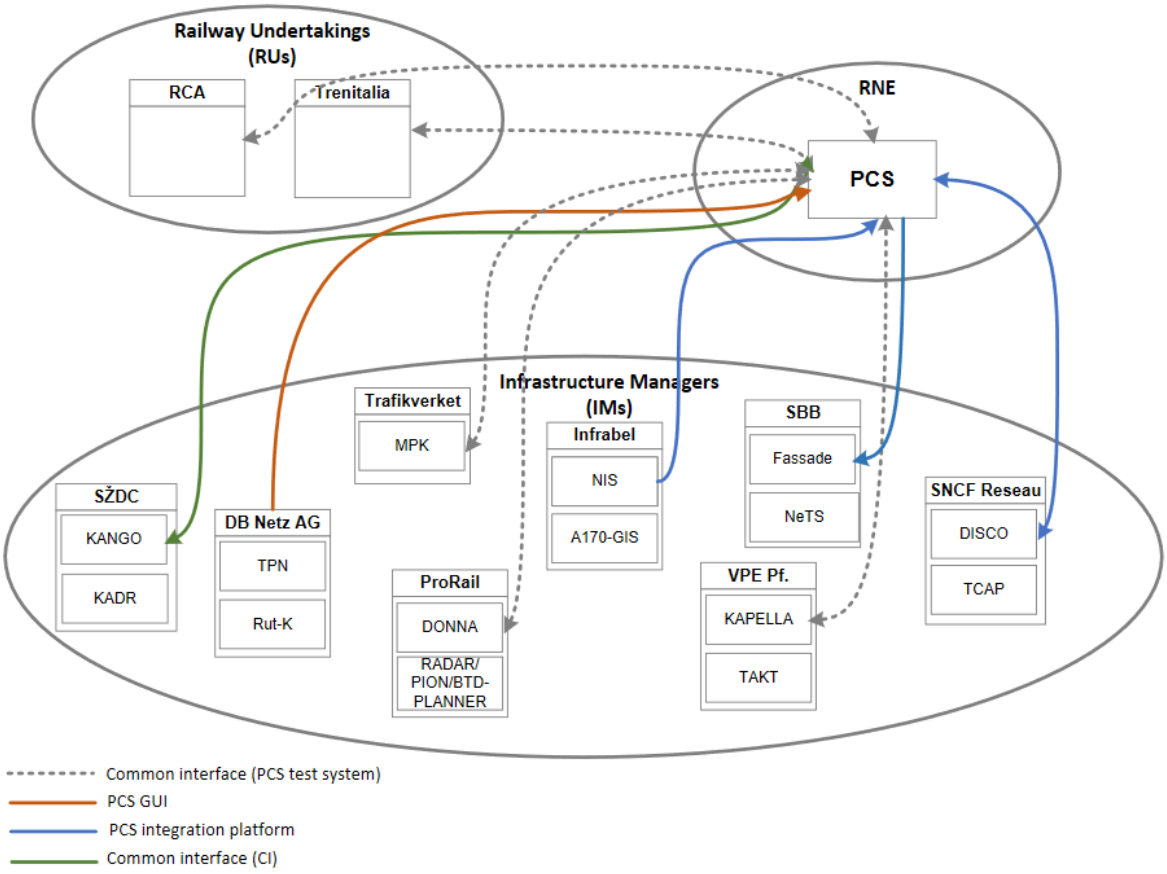


Figure 15 Interfaces between national systems and PCS system

TAF/TAP TSI

Companies are in the development phase and plan to create or update their systems to be TAF/TAP- compliant.

The following table shows when companies plan to have finished their developments and to be TAF/TAP - compliant, as well as information on which process phases will be supported.

Phases Supported	DB Netz AG	Infrabel	ProRail	SBB	SNCF Réseau	SŽDC	Trafikverket
New Path Request	2022	exists	2019	2019	exists	exists	2020
Late Path Request		exists	2019	2019	exists	exists	2020
Ad-Hoc Path Request	2022	exists	2019		exists	exists	2020
Ad-Hoc Path Request (pre-accepted)		exists	2019		exists	exists	2020
Feasibility Study	2022					exists	
Path Modification	2022	2022	2019		exists	2022	2020
Path Alteration	2022	2022	2019		exists	2022	2020

Table 4 Supported Phases and plan of the companies to be TAF/TAP compliant

2.4. Technology Landscape

In the technology landscape, we mainly focus on the systems and their interfaces, from the technical side. The additional information about in-house custom software development or standard / branded software should to help to get an overview of possible synergies or easier interfacing between the business partners and/or central systems.

a) TAF/TAP Common Interface

When is CI connection planned?

Comment: it is not relevant if the company will choose the CCS CI or the company will develop its own CI.

b) Type of systems

- ✓ In-house development
- ✓ Standard / branded software (customised)
  - If yes, which

c) Type of interfaces

It is supposed to be evaluated which interfaces are currently in use by the particular systems.

- ✓ External (to external partners or external central systems)?
- ✓ Internal (only data exchange within the corporate network)?
- ✓ Technical type:
  - Web - services?
  - File transfers?
  - Other?

d) The object model of the system (optional)

This activity is linked with the application landscape investigation: based on the list of business objects handled by the application, the list of information objects handled by the underpinning systems should be established.

Since this is a complex task, it is not mandatory in the survey methods. It will be addressed in the workshops, and established, if possible, in a rough mode.

2.4.1. Survey and Interview Results

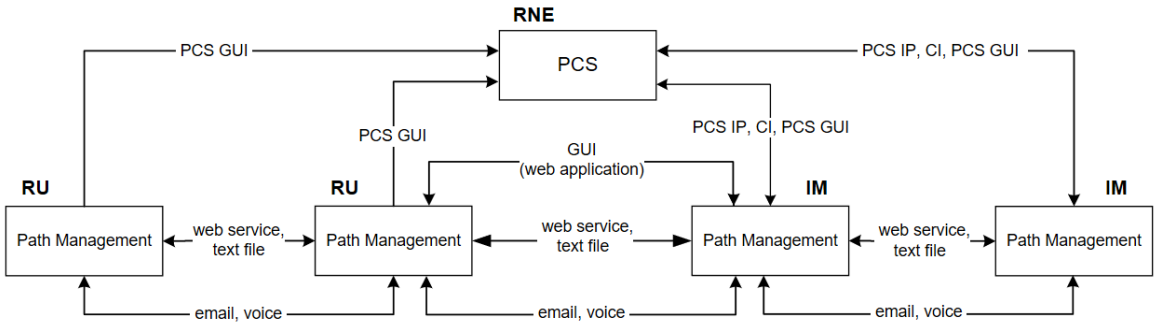


Figure 16 Types of interfaces between IMs, RUs and RNE systems

Most IMs and RUs are in the development process of building a new or updating an existing system and developing new functionalities and/or implementing new interfaces which will be TAF/TAP TSI - compliant. Most companies plan to use TAF/TAP - based communication internally, between the national systems.

After implementation of the newly developed functionalities, communication will no longer be handled via telephone or e-mail. Also, the plan is that non-standardised interfaces will not be used either.

2.5. Currently Running Projects

The project portfolio – the list of projects which are currently running and may have an influence on the future developments required by TTR will have to be established/investigated including the timelines and milestones.

- ✓ TAF Masterplan regarding short-term path request and corresponding activities of the stakeholders must be investigated
- ✓ Participation in the Joint Sector Pilot for TAF/TAP TSI Short - Term Path Request and TrainID
- ✓ Projects for connection (interfacing) to central systems such as:
  - PCS
  - New RNE TCR tool
  - RNE Common application database ‘Big Data’

Detailed analysis and a list of all projects is available in chapter 4.1.

3. To-Be Landscape

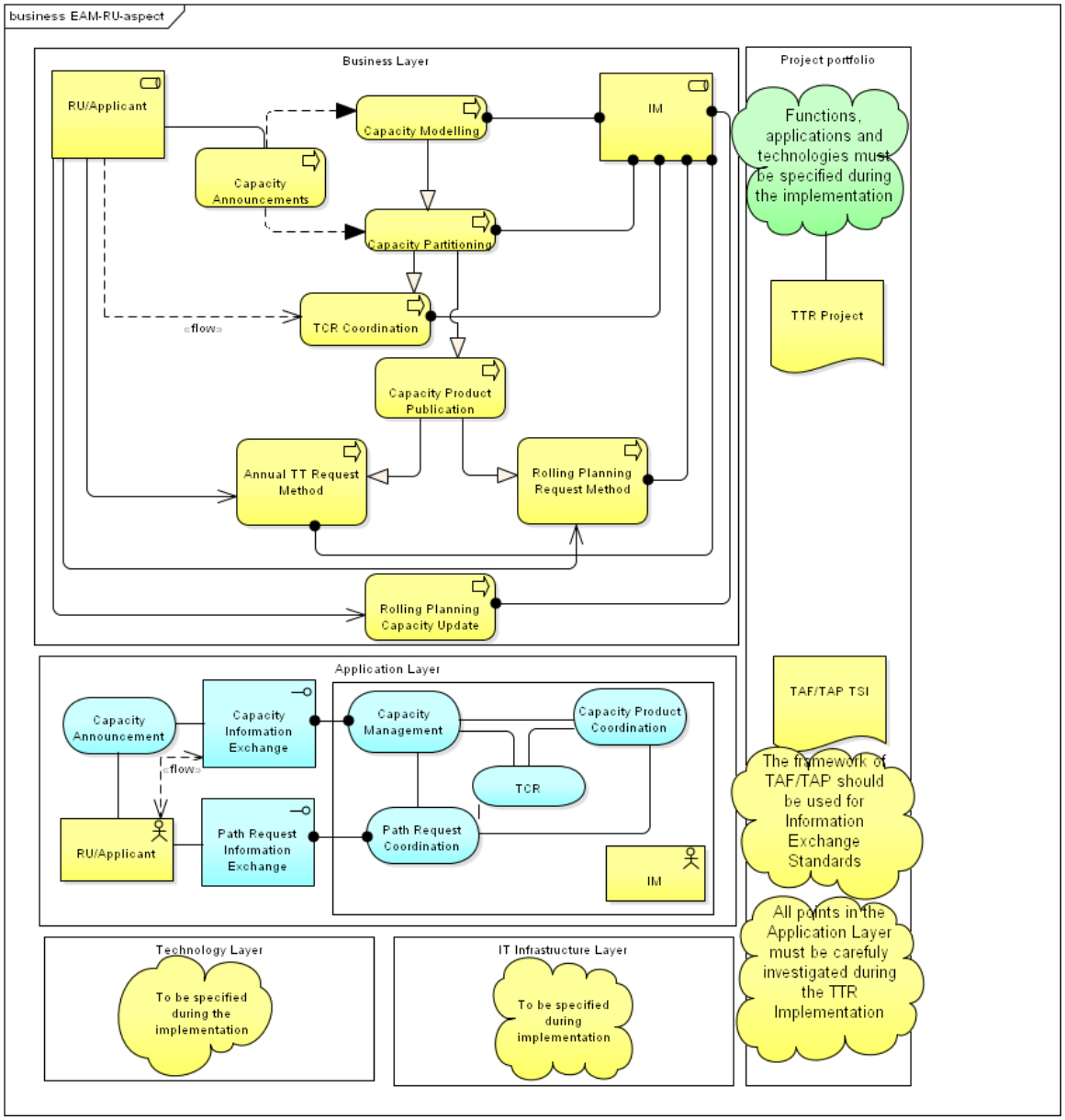


Figure 17 EAM - RU/Applicant aspect. The model was created initially, during the basic IT analysis within the finalisation of the TTR preparation phase, in the 1st quarter 2017. It has to be worked out in detail during the TTR implementation. The project portfolio will be handled in the separated chapter 'Migration from AS-IS to TO-BE'

3.1. Business Process Layer

The business reference model should be made up of the business process modules, as provided in the business landscape. The new TTR process according to the document '**Redesign of International Timetabling Process (TTR)',** delivered by TTR WG2 in January 2017, will serve as the basis.

The business process landscape and business reference model will be divided into:

- ✓ Centralised processes
- ✓ Local (domestic) processes
- ✓ Processes for interoperable (international) coordination and harmonisation

The modelling will be made from the aspect of RUs on one side and aspect of IMs on the other side.

The business reference model will consist of (roughly):

- ✓ Capacity modelling
  - Local activities
  - Activities for harmonisation and coordination
- ✓ Capacity partitioning
  - Local activities
  - Activities for harmonisation and coordination
- ✓ Capacity needs announcements
  - Local activities
  - Activities for harmonisation and coordination
  - Centralised activities
- ✓ TCR coordination
  - Local activities
  - Activities for harmonisation and coordination
  - Centralised activities
- ✓ Capacity product creation and publication
  - Local activities
  - Activities for harmonisation and coordination
  - Centralised activities
- ✓ Request methods:
  - Annual timetable request with all business process steps, events and timelines
  - Rolling Planning request with all the business process steps events and timelines
- ✓ Updates and modifications after allocation
  - Local activities
  - Centralised activities
  - Harmonisation and coordination

The detailed investigation during the first phase of the TTR implementation will result in the detailed business reference model based on the '**Redesign of International Timetabling Process (TTR)'** document**.**

3.1.1. Long-Term / Advanced Planning

To manage capacity, a rough estimation of the demand for the various requirements is of high importance. For cross-border lines, the capacity strategy including major TCRs needs to be exchanged with the neighbouring IMs and having a first view on future capacity needs is the major aim of a capacity strategy. These capacities should be exchanged with applicants as well.

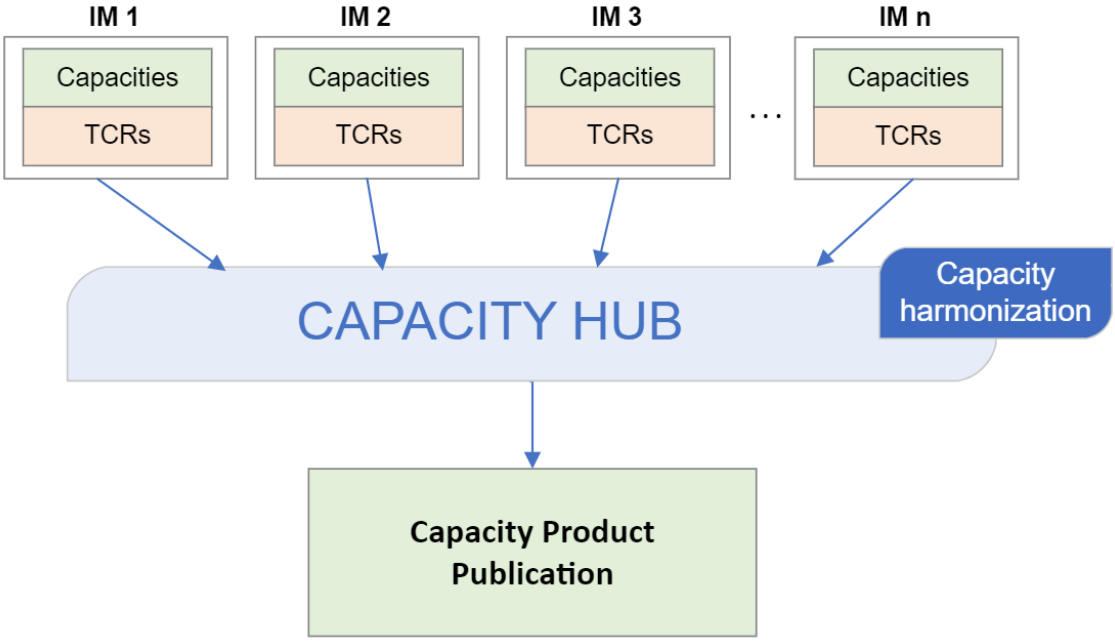


Figure 18 Capacity Product Publication

A key factor in ensuring the stability of international timetabling is the availability of capacity. Every IM has to provide a clear picture of the available infrastructure on its network (three years in advance). This picture takes into account some key elements which can be described in long-term planning: estimation of the demand, including own requirements for maintenance/known works, assignment of the demand to the lines or part of the network, capacity analysis and capacity investments scenarios. From the capacity management point of view, the rough estimation of the demand for the various requirements is of high importance. Having this first view on future capacity needs is the major aim of the capacity strategy. It enables an IM to exchange information on future capacity needs with neighboring IMs and applicants. IMs need to translate expectations for future demands into capacity products that can be planned, safeguarded and offered to customers.

Temporary capacity restrictions (TCRs) are capacity-reducing factors and, if badly coordinated, decrease the stability and therefore the quality of timetables. It is important to coordinate these TCRs at international level, include applicants in the process, and communicate unavailable capacity accordingly. Therefore, all known TCRs should be presented and taken into account if they impact capacity on the lines.

RUs can send their capacity needs announcements, which will be integrated into the IM's available capacity as well. IMs need to make plans for how the infrastructure will be used in the future and IMs can do this in cooperation with applicants or by themselves. On international lines, harmonisation is essential and studies about routing and frequencies of national and international connections on the network should be included. National regulations should be considered in this phase as well.

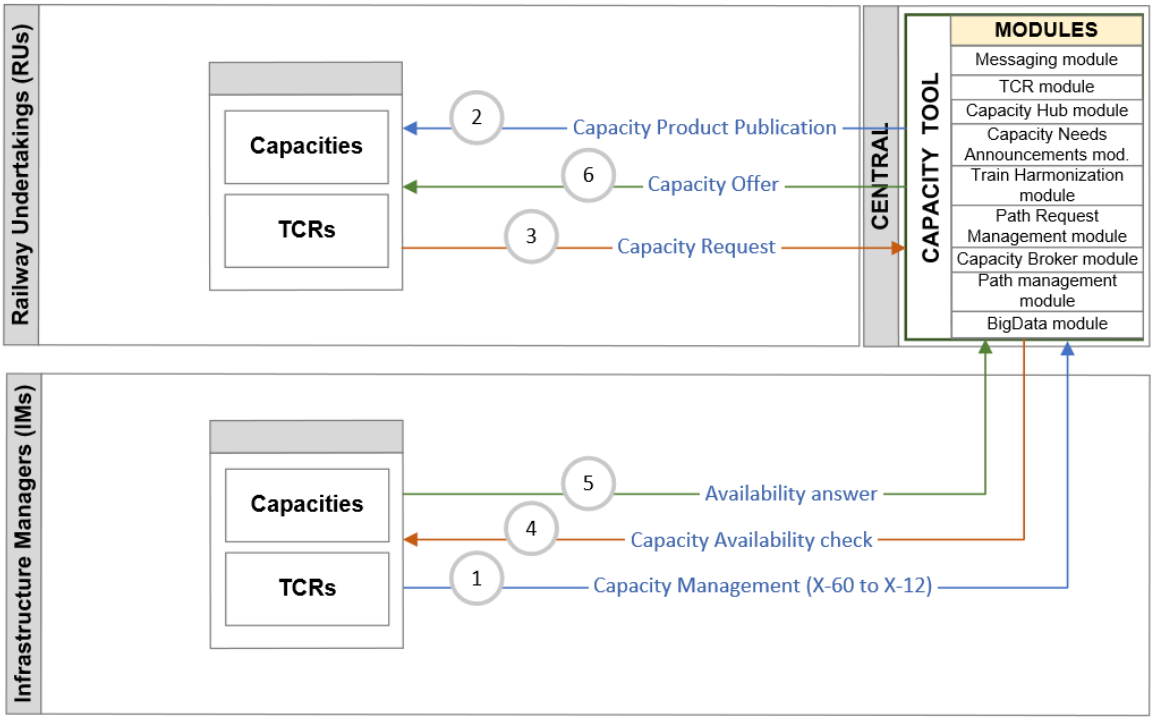


Figure 19 Business Process View (To-Be)

IMs should exchange all available capacities on their networks, positive and negative (TCRs), via a central system's module called 'Capacity Hub'. The Capacity Hub module will collect and present all available information about capacities and TCRs in an early stage of planning. Also, capacity data harmonisation between IMs is a major functionality to help IMs in the coordination. The Capacity Hub module shall help to prevent unharmonised capacity publication which is the most important functionality. It should enable automatic detection of affected companies (an intelligent help for coordination), automatic detection of neighbours and conflicts of the planned capacity with TCRs, and automatic linking of applicants' announcements. The option of automatically constructed paths immediately after placing the path request should also be considered.

Path construction remains, in any case the responsibility of Infrastructure Managers.

Each IM has its own path construction tool, including a path calculation module. It is not the purpose of a centralised tool to replace these individual tools that are specific to each network. The aim of the central tool is to speed-up the business and technical process and to intensively communicate with the IM tools.

The automatic path construction function within the Capacity Broker can be utilised as follows:

- The Capacity Broker will be interfaced with network-specific (IM-owned) path calculation modules.
- The Capacity Broker first analyses the request and tries to match it with the published positive capacity objects.
- If for the whole request or one part of the request no object can be found, then the broker will request a path calculation from the corresponding national calculation module, receive the answer and propose a draft offer. If the draft offer is not accepted by the RU, the IM evaluates alternatives.

The automatic path construction by the Broker is a configurable option for the IMs, i.e. IMs may opt to use the automatic path construction option of the Broker if their national systems are not able to calculate and assign capacity in real time.

It is clear that human work has added value for ad-hoc path construction, and that any automatically constructed path must be at minimum checked and confirmed by the planner, and potentially be adapted.

Therefore, any offer of an automatically constructed path can only be a draft offer. The final offer must always come from the IM.

Automatic path construction should be seen as an optional functionality provided by the Capacity Broker to provide an earlier view, for the RU, on the offer it may get.

For IMs, the Broker can, therefore, be a major opportunity to provide path feasibility studies.

The results provided by the Capacity Hub are used for capacity product publication and subsequently serve as input for the Capacity Broker module.

The Capacity Broker module takes into account capacity product publication data and RU's capacity needs announcements

3.1.2. Capacity Publication

IMs will publish all available capacities for Annual Timetable (ATT) and Rolling Planning (RP) requests. Capacity bands play a major role in IMs' displayed capacity and are based online/section-related, parameters (length, speed, weight, etc.), promised maximum running time and days and time reference (e.g. starting time related to starting point). Within these capacity bands, IMs will put a number of slots, depending on the size of the capacity band. This publication has to be done for the upcoming 36 months (for each calendar day). It needs to be updated immediately after a slot has been requested and the paths have been allocated for the first TT year as well as the IMs' capacity commitments for the upcoming TT periods. The continuation of publication should be done on a day-by-day basis.

There are three possible scenarios when speaking about capacity publication:

- The first scenario: IMs will publish all their capacities, national and international, to the RNE central system
- The second scenario: IMs will publish only international capacities to the RNE central system
- The third scenario: IMs will not publish capacity at all

All these three scenarios should be taken into consideration. Nevertheless, it should be possible that the Capacity Broker provides information about the capacity of any kind of request, **therefore the recommendation is to publish all types of capacity: national as well as international.** As more capacity data is put into the system, the central TTR IT framework will be able to provide better answers.

For every request from RU side, a tool will generate an automatic proposal for the answer, but the final confirmation will be done after communication with the respective IMs' national systems (to check if the capacity is available and/or if there are some changes in the capacity).

Also, all known TCRs (with major, high and medium impact), including regular/real-time updates, will be published. All present traffic, as well as RUs' capacity needs announcements, should be taken into account by the IM when preparing the capacity for Annual and RP requests. All data should be presented in visual form to make it easier to see all capacities and

all TCRs and possible conflicts. A detailed overview of the split of available capacity according to the various needs per line/section/network would be ready as well. As a result of the international harmonisation process, the capacity product publication should contain capacity for ATT requests and safeguarded capacity for RP requests.

Business objects and parameters:

- ✓ TCRs
- ✓ Capacity bands (volume/type of paths)
  - Lines/sections
  - Speed, length, weight
  - Promised maximum running time
  - Number of slots (RP slots)
- ✓ Pre-constructed paths (like PAP's, pre-planned paths, etc).

3.1.3. Capacity Needs Announcements: Business Layer

In the advanced planning, RUs have the possibility to exchange information with the IMs about capacity needs for the upcoming timetable period. The RUs that are already in business analyse their current amount of traffic and compare it with the business needs for the upcoming timetable period. The result of this analysis (keeping the same amount of traffic, increasing traffic or decreasing) is supposed to be communicated to the IMs. A current example is the practice of the RFCs (Rail Freight Corridors) that already apply this approach. In the TTR future business landscape, this should be the general approach.

Local Activities

RUs will check the domestic needs.

For the passenger RUs, the domestic traffic is usually known exactly at the time it is needed, including the schedule and the frequency of the trains. This information should be provided to the domestic IMs.

For the freight RUs, precise prediction of the train load and schedule long before the timetable year is hardly possible. The estimated number of trains and their load per line and per time period should be communicated to the IMs, taking into account the RUs' market prediction of growth.

Business Objects and Parameters

- ✓ Train (in the passenger case: pretty precise; in the freight case: a rough load and length estimation)
- ✓ Number of trains per line per unit of time
  - Unit of time agreed with IMs (hour, day, month, quarter, year)

Harmonisation and Coordination

The harmonisation and coordination between international partner RUs regarding the capacity needs announcements can ensure that the capacity is announced to the neighbouring IMs. This should help the IMs to shape the capacity products in the best way to fit the market and to coordinate the TCRs in order to not have a negative influence on the Rus' business.

Business Objects and Parameters

- ✓ Cross-border train
- ✓ Number of trains per line, per unit of time with a focus on border line segments (Unit of time agreed with partner RUs and IMs (hour, day, month, quarter, year))

3.1.4. Collaboration with IMs on TCR Planning, Capacity Modelling and Capacity Partitioning

The capacity needs announcements of the RUs cannot be separated from the RU activities in the collaboration of the RUs with IMs during TCR planning, capacity modelling and capacity partitioning. The information exchange between RUs and IMs is supposed to be supported intensively in this phase in the future. The RUs must be involved in the planning in a consulting role, combined with the capacity needs announcements.

For valid consultations, the RUs should be in possession of an IT system which can provide simulations according to the IMs' inputs on available and occupied capacity planned for upcoming periods. Such a system should be able to compare the RUs' plans for traffic loads, trains and their proposed schedules with the capacity planned in advance.

The feasibility study will continue. It could be supported in better way, if the system for simulation of the trains according to the RUs' main characteristics in the timetable based on the capacity model (capacity bands, rolling planning slots, pre-planned paths and another available capacity, taking TCRs into account) existed.

Local Activities

TCRs:

All planned national TCRs should be coordinated with RUs, using national systems or the RNE central system.

The information about planned TCRs should be provided by IMs to RUs. RUs can:

- ✓ react with their capacity needs announcements to influence the planning of TCRs;
- ✓ take into account the planned TCRs when creating their internal transport plans.

Centralised Activities

All planned international TCRs should be coordinated between involved IMs. After coordination, all TCRs will be visible to all involved RUs for consultation. For the coordination and consultation of the TCRs, the RNE central system will be used.

Business Objects and Parameters

- ✓ TCR
- ✓ Big Data topology (network – PLCs, segments, sections)

Capacity Modelling and Partitioning

The same activity as for capacity needs announcements is foreseen. The RUs should provide the estimation of the traffic volume and intensity. The same business objects and parameters should be exchanged as for capacity needs announcements.

The capacity model should be regularly updated at least once a year. As agreed, the available capacity should be split and assigned to the various needs.

Collaboration with IMs on Capacity Product Preparation

Currently, the example for collaboration of RUs with IMs on capacity product shaping is provided by the RFCs. This activity has to be combined with the capacity needs announcements. The same business objects as foreseen for capacity needs announcements should be processed.

Centralised Activities

The important use cases for the IMs in the advanced planning are:

- ✓ Exchange information about all known TCRs
- ✓ Coordinate all TCRs with involved neighbouring IMs to decrease the negative influence of TCRs on business
- ✓ Harmonisation of TCRs with the RUs, taking into account their needs
- ✓ Publication of harmonised TCRs

The important use cases for the RUs in the advanced planning are:

- ✓ Harmonised, coordinated TCRs: Uncoordinated TCRs between IMs at international level have a negative influence on RUs' business
- ✓ Harmonised and consistent capacity products: non-harmonised and uncoordinated capacity products or capacity products that do not take into account the TCRs in the proper way, are not usable for RUs. Negative examples have been given in past timetable years with uncoordinated PaPs (RFC pre-arranged path)

Therefore, the centralised approach is necessary for the IMs, who must ensure the coordination of the TCRs and harmonisation of the capacity products, while taking into account the capacity needs of the RUs.

3.1.5. Capacity Hub – for both IMs and RUs

It is important that the future Capacity Hub can collaborate also with the RUs and their systems according to the above-mentioned requirements.

The most important part of the system could be the algorithm to find the best fitting capacity according to the inquiry request by RUs/applicants. This algorithm will give information to the RUs/applicants that their requests fit the available capacity or information that there is a problem due to TCRs or similar. Also, it will solve the RUs'/applicants' problem with creation and harmonisation of path requests when maintenance works have to be taken into account and there is need to constantly update data in the PCS because of these works.

All capacities should be harmonised between the neighbouring IMs. All negative capacities should be coordinated between neighbours (on the main and deviation lines) and then marked as harmonised. The harmonised capacities form the capacity product, which will be published at X-12.

The capacity product publication would be downloaded by applicants and used for capacity demands. Applicants can start with capacity requests using the central capacity tool. The capacity tool will reroute defined requirements to the one or more IMs involved to check the availability of the capacity. If capacity is available, a positive answer is sent to the capacity tool and the RU receives a response in the form of a capacity offer from the capacity tool.

- It is vital to have an RU system / RU hub in place that can be used and must be used for all planning phases. All planning phases are needed. But not all planning phases are mandatory in TAF/TAP TSI. Only short-term path request is mandatory.

3.1.6. Capacity Request Methods and Allocation

RUs will request the path according to the TTR process implementation concept:

- ✓ For Annual Timetable (ATT)
- ✓ For Rolling Planning (RP)
- ✓ Ad-hoc

The processes are defined in the separate document 'Redesign of the International Timetabling Process (TTR)' which is managed by the TTR Process Implementation Group. Therefore, we do not describe these request processes here in detail.

Important for RUs is the following:

ATT

The path request process does not differ much from today's ATT process, but some important things have to be mentioned:

- ✓ The request is earlier. The deadline is X-8.5
- ✓ The draft offer is earlier: X-6.5
- ✓ The draft offer is supposed to be more stable than today. It must take into account the major, high and medium TCRs, and must be harmonised at international level between IMs
- ✓ For the passenger RUs: the ticket sales may start at X-6 already, and the train schedule for ticketing should be based on the stable draft offer. In order to achieve the early ticket sales, the following has to be taken into account by the RUs:
  - The timetable data for sales will be based on the draft offer (draft timetable).
  - The timetable data must be transferred to the ticket sales systems in two weeks (in the period from X-6.5 to X-6). This process currently takes around 6 weeks. This is a clear demand for the improvement of the RUs' IT systems for this purpose.

RP

This is the new process type. However, the process steps are the same as we know it for the path request procedures. The main differences copared with today's process are:

- ✓ The request can be placed any day in the year (no fixed deadline)
- ✓ The request cannot be placed earlier than 4 months before the first operational day of the train and not later than one month before the first day of operation.
- ✓ The request may contain the demand for a capacity slot based on capacity bands (see the process document for further details) for 36 months. But (important!) in the current timetable year in which the request is placed (the timetable year of the first operational day of the train), the concrete path with the precise minutes will be allocated. For the subsequent timetable years (if capacity is requested for a longer period than one timetable year up to 36 months), the capacity slot is reserved for the particular train. The precise path for the upcoming timetable year will be constructed at X-1.5 by converting the slot into the path, according to the process definition.

Ad-hoc

Residual capacity will be used for requesting the ad-hoc paths. IMs will also have the possibility to reserve capacity for ad-hoc requests exclusively in the capacity model.

Changes of the Request by the RU before the Allocation

These changes are possible in the practice. However, such changes are supposed to be rare in the case of RP and are more probable for ATT, as it is today. The changes are driven by the business (customer) needs of the RUs. With RP, the date of request is much closer to the real business date for the train operation, and therefore, less probable to be changed.

According to the main process document, there are 2 types of changes:

- ✓ Major: such changes cause the cancellation of the original request and provision of a new request by RU
- ✓ Minor: such changes can be taken into account by the IMs and processed during the path elaboration/offer preparation – no new request is required

The table of the parameters and their change categorisation is given in Annex 2 of the main process document. This is of crucial importance for the rule engine of the future path request systems.

Business Objects and Parameters

- ✓ Train (and identifiers)
- ✓ Path request
  - Requested schedule for the train
- ✓ Path
  - Timetable
- ✓ Capacity slot

Local Activities (IM):

- ✓ Preparation and elaboration of the capacity in the national systems
- ✓ Feeding the Capacity Hub module (from the national systems) – *more details are provided in the sequence diagram under Capacity Hub Module*

Centralised Activities

All the activities and process steps in both ATT and RP are centralised activities, from the aspect of the RUs:

- ✓ Harmonisation
  - The RUs must be able to exchange information about the path request for the particular train through a central tool
  - Only harmonised requests will be accepted by the IMs
  - The central tool, which will deliver request information to the IMs, must get status information about the request – if it is harmonised or not. (Today's example is PCS.)
- ✓ Request
  - The request will be centrally collected and distributed to the corresponding IMs. (Today's example is PCS.)
- ✓ Acceptance of the offer
  - The acceptance of the offer by the RUs, even if it was thought to be delivered to the corresponding IM, must be communicated also to the partner RUs in order to indicate the status of the process. This is important especially for the leading RU.

3.1.7. Processing Updates and Modifications After Allocation

After the path is allocated, it is possible to apply the changes driven by RUs or IMs, regardless of the process type used for the path request (ATT or RP).

RU-driven changes are:

- ✓ Modifications
- ✓ Cancellations

IM-driven changes are:

- ✓ Alterations

The details about these processes can be found in the main process document. These procedures must be handled with IT support, according to TAF / TAP TSI, in a standardised way.

RP – Special Case: Converting Slot to Path

In the main process document, the process for converting the capacity slot, which has been reserved for the upcoming timetable periods by the RP-request, has been defined as follows (brief overview copied from the main process document):

Applicants: Early confirmation for the upcoming timetable period	X-5
IM: Draft offer; start of observation phase	X-4
End of observation phase	X-3
Start of post-processing	X-3
Final offer	X-2
Acceptance	X-1.75
Final allocation	X-1.5

X = timetable change

Table 5 Converting slot to the path

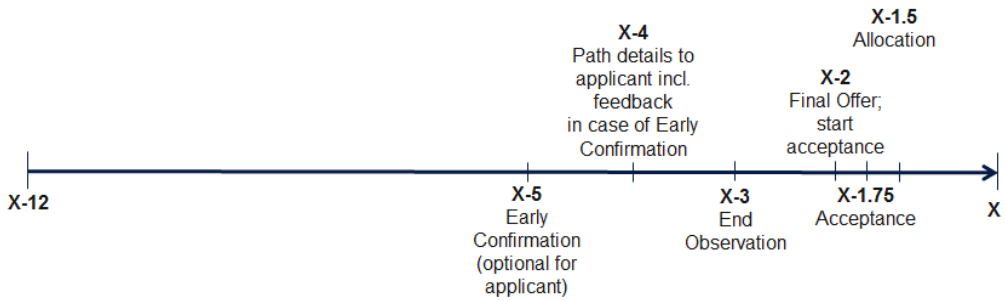


Figure 20 Converting slot to the path – Rolling Planning

Modifications

The modifications of the allocated path are categorised in major and minor modifications. Major modifications will force the RU to cancel the existing path and request the new one in the Ad-Hoc process.

Minor modifications can be applied at any time. Annex 2 of the main process document contains the table of the major/minor modifications, which serves as the harmonised rule for handling modifications.

Cancellations

Cancellations by RUs/applicants are described in the main process document (brief overview):

- ✓ Cancellation of one or more operational days
- ✓ Cancellation of the whole path
- ✓ Cancellation of part of the path: this function has to be handled with care. The parts of the cancelled path can be accepted by the IMs only at the beginning or at the end of the path, but not in the middle, in order to not destroy the traffic concept foreseen for the particular path.

RP: Converting Slot to Path

As given in the process definition in the main process document, the RUs can trigger this process already at X-5 by confirmation that the path will stay with the same characteristics as in the current timetable year, or the path has to be modified according to the modification data provided by the RU. Important: This is not a mandatory action for RUs until the existing capacity request contains all the necessary information that is required for path request.

The RUs are notified by the IMs with the IMs' draft offer at X-4, according to the X-5 action, or, if no X-5 RU action was done, the IM provides the notification about the path within the provided/reserved capacity slot.

The RUs can make observations and, after post-processing, accept or reject the final offer of the path at X-2. The time for this action is one week (acceptance should be done by X-1.75). If the final path offer was accepted, the path is finally allocated with precise minutes at X-1.5.

The creation of the capacity model is done by the IMs in cooperation with the applicants but is finalised by X-18. After that, the slots for safeguarded capacity must be considered fixed (of course, the availability will change in the request phase, but the slots themselves are to be left untouched).

Modification of requests before the allocation in Rolling Planning is not foreseen since the timelines for this process are rather short. There will be possibilities for minor changes (see chapter 10.6 of the TTR description).

The modification and cancellation of an allocated path can be done any time after the allocation. The modification and cancellation of slots for upcoming periods are also possible at any time after the allocation. However, in both cases, strict commercial conditions will apply as this is seen as blocking of capacity by the applicant, inclusion of redundant work and subsequent inefficient path allocation. Also, modification for Rolling Planning capacity can only be done within the aforementioned slots in the capacity model.

Business Objects and Parameters

- ✓ Train
- ✓ Path request
  - Type = modification
- ✓ Path
  - Timetable
- ✓ Capacity Slot (RP slot)

Centralised Activities

Modifications by RUs must be done in a harmonised way if the modification affects the partner RU in any sense. If the RU does not harmonise the modification request, the central system for registration of modifications and forwarding to IMs must react and notify the affected RUs about the modification. In the modification case, it is also the precondition that the request is harmonised.

In the case of cancellation as well, harmonisation is necessary. If more than one RU is involved, the cancellation of any operation day of the train affects all involved. Also, the 'geographical' cancellation of the part of the path must be communicated to the partners, if it affects their business (e.g. in passenger traffic – the information for the passengers).

In the case of conversion of the slot to the path, this needs to be communicated between the partners, firstly between the RUs that are triggering the confirmation process at X-5 and also from the central point at X-4 regarding the draft offer.

Path Alteration

In principle, the path alteration process is based on the process jointly developed within TAF & TAP TSI (*for more information see the document 'Redesign of the International Timetabling Process (TTR)'*).

3.2. Application Layer

The application layer serves to fulfil the needs of the business landscape. The applications and modules which will cover the steps and activities described in the business landscape are proposed here. The transformation of business objects into information objects is an important part of the application layer.

The investigation is based on the business reference model by covering the:

- ✓ Centralised activities
- ✓ Local (domestic) activities
- ✓ Activities for interoperable / international harmonisation and coordination

This is supposed to be the important input for further development and/or improvement of not only central but also local applications. The above mentioned activities will be transferred to the future application functions (Functional Model).

As a result, the input for the requirements specification in terms of functional model, data reference model, technical reference model and service reference model will be provided.

- A data reference model will be established:
  - Logical data model = business object model
    - Definition of the capacity object in the business object model is needed
    - Business object model will be derived from the business reference model according to the business landscape model
    - The business object model will be compared and, where possible, merged with the TAF/TAP TSI business object model
  - Information reference catalogue = information object model
    - The current information reference catalogue from TAF TSI (data catalogue and information object model) will be used wherever possible within the TTR information object model

- Service reference model
  - A list of services for data exchange between the applications will be provided
    - Information objects on capacity (positive / free capacity, negative / occupied capacity / TCRs)
    - Information objects for timetable harmonisation and coordination
    - Information objects for TCR harmonisation and coordination
    - Services for publication of the capacity products and TCRs (by IMs)
    - Services for the consumption of the capacity products and TCRs (by RUs/Applicants)

- Technical reference model
  - The investigation into the technical reference model will be made when the business object model and information object model is established. The best-matching technical reference model will be chosen.

The concept must take into account the needs of the RUs/applicants and IMs by applying the separation of concerns according to the business landscape.

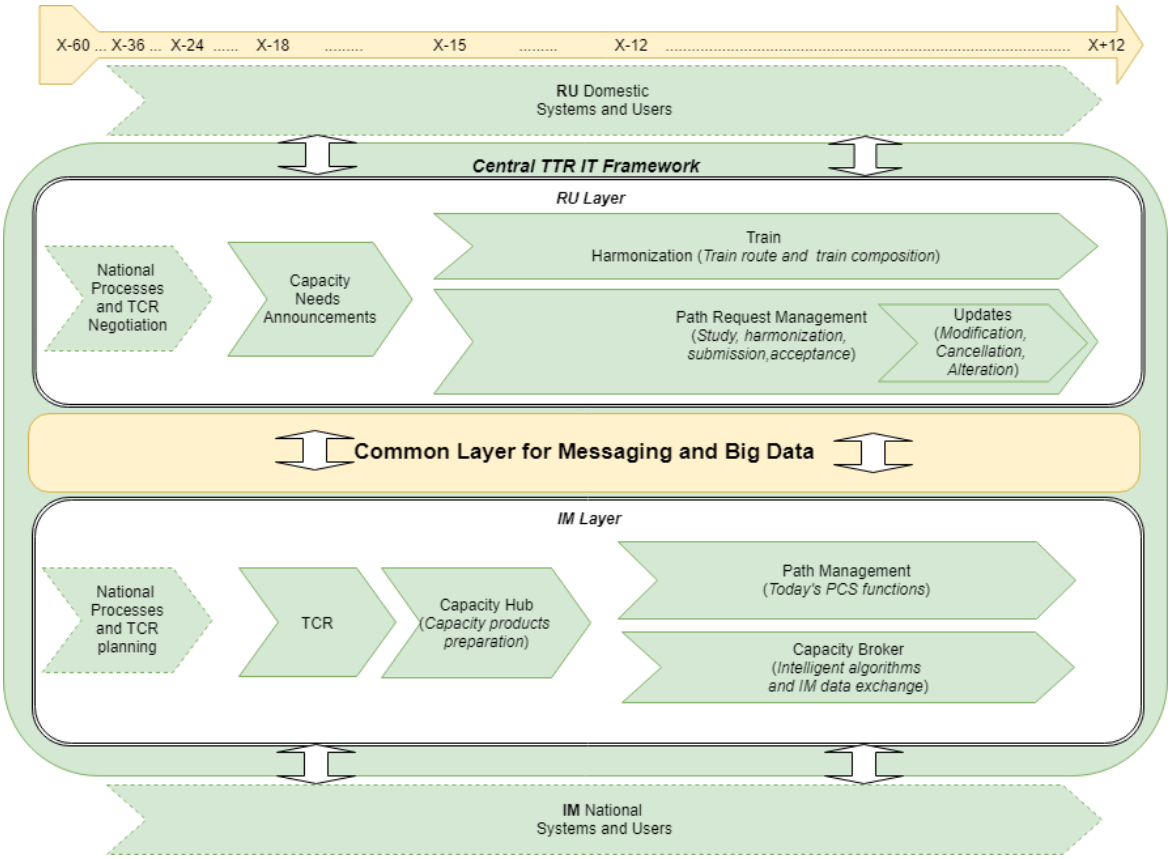


Figure 21 Rough architecture overview with the timeline

3.2.1. IM Aspect

For capacity management in the application layer, the tool for this purpose for the IMs is necessary and has to be conceptualised and developed.

The approach is to look at the future capacity tool from two aspects:

1. Advanced planning: capacity modelling, planning and product development (**Capacity Hub)** (the period from the start of the capacity planning, X-24 or earlier, up to the capacity product publication on X-11).
2. Timetable production: from publication to running timetable, capacity requesting that allows the customers (RUs/applicants) to request the capacity products, from X-11 to X+12, (**Capacity Broker**). We can start talking about the Broker after the capacity product is published at X-11 through the Capacity Hub. This published data will be used by the Broker and national systems will update Broker data frequently.

Capacity Hub

The Capacity Hub is supposed to gather information from the IMs about available capacity in the form of pre-planned paths, capacity bands and TCRs. It will gather capacity needs announcement information from the applicants' side and give them the first feedback on their requests. To do that, the Capacity Hub will have some sort of artificial intelligence (AI) with the following functionalities:

- Automatic detection of the affected companies: When something is changed during the capacity planning and creation of the capacity products, the Capacity Hub should distribute this information to all involved parties.
- Automatic detection of the neighbours: The Capacity Hub module should automatically detect all neighbours involved in the capacity planning and will inform if something is changed in the capacity.
- Automatic detection of conflicts: When IMs send data about capacity bands and TCRs, this module should be able to automatically detect potential conflicts and provide information to the IMs accordingly.
- Automatic linking of announcements: When RUs send their capacity needs, this module will automatically check the feasibility of the capacity need announcement against the planned capacity. Also, it will give feedback to the RU if its request is not possible to accept and propose the closest alternative available capacity in this early phase of planning.

IMs should send, and update, all available information on capacities on their networks to a central Capacity Hub module. This includes:

- Negative capacity
  - Already allocated paths (booked or offered)
  - TCRs
- Positive capacity
  - Pre-planned paths,
  - Pre-arranged paths,
  - Catalogue paths,
  - Capacity bands,
  - Rolling Planning slots

All remaining available capacity (i.e. neither negative nor represented as one of the above listed capacity products) not published in the Capacity Hub can of course be requested for the tailor-made paths.

The output from this module will be the capacity product publication.

Capacity Broker

After X-11 to X+12, all capacity and path request handling will be done by the Broker module. The most important feature of this module could be the algorithm to find the best-fitting capacity according to the inquiry of RUs. This algorithm will provide information to the RUs that their requests fit the available capacity or information that there is a problem due to TCRs or similar. Also, it will solve the RUs' problem with creation and harmonisation of path requests when maintenance works have to be considered (to avoid the current situation to constantly manually update data in the PCS because of these works). The critical border/handover points are highlighted by the Broker: negative border points, too long handling times (outside of the

agreed timeframe for the border/handover handling). Similarly to PCS, the Broker will have a final acceptance indicator (green light) and this indicator cannot be set if something is critical as described above.

The national IT systems of IMs should be upgraded to handle the border harmonisation, automatic notification process with the neighbours and finally confirmation of activity. In the case of national capacity brokers, data exchange should not be the problem until the defined TAT/TAP messages are used.

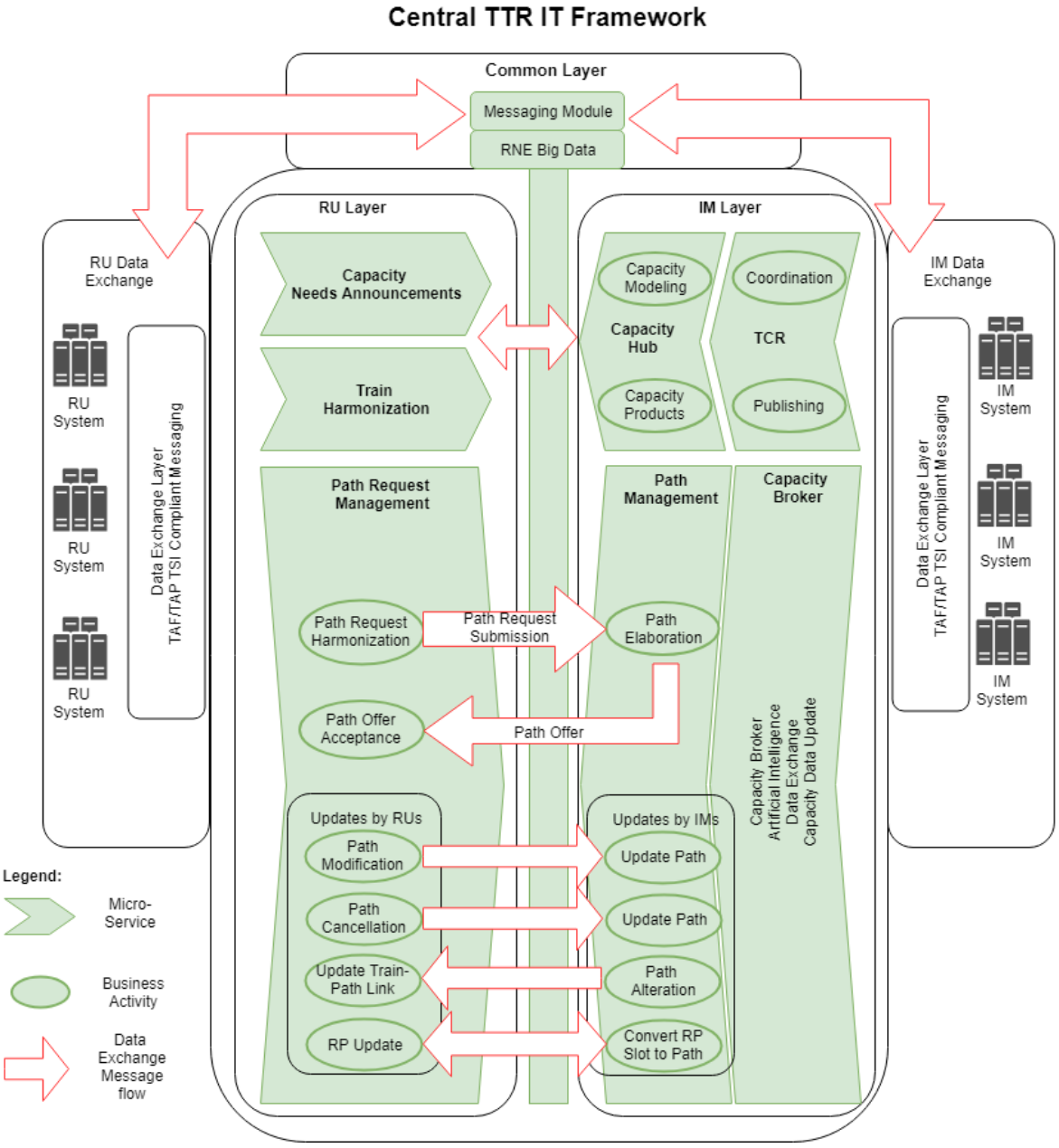


Figure 22 TTR IT Landscape architecture

All data about available capacity (capacity bands) on the infrastructure, which IMs can offer, will be collected and saved in a Capacity Hub module. On the other hand, data about all known TCRs in that early stage of planning will be collected in the TCR module. The Messaging module is able to accept all these messages (data) and to forward them to the defined system (e.g. capacity data to the Capacity Hub module and TCRs to the TCR module).

The Messaging module is the only module for communication with the IMs and applicants' systems. It is based on TAF/TAP TSI and is able to translate messages from central systems to the TAF/TAP message structures and vice versa. National systems will feed the RNE central system using the Messaging module.

Also, the Messaging module will communicate with the Big Data module and consume needed data within the communication in the central TTR IT framework. In the external communication (communication with domestic systems of RUs and IMs) the CRD (and in the future RINF) have to be used as the reference databases, also in order to have Big Data functioning in the central communication.

Furthermore, applicants send their capacity needs announcements using the Messaging module and they will be forward to the Capacity Hub module and saved there.

Since RNE has a TCR module that has the basic function of collecting and assisting IMs in the coordination process and consultation process with applicants to harmonise the TCRs, the Capacity Hub module will use these harmonised TCR data together with capacity data (available capacity bands and applicants' capacity needs) to help in further harmonisation and coordination, taking all this data into account. The final result of this coordination will be a capacity product publication which will be published at X-11 and available for usage by all IMs, applicants and the Broker module.

For the applicants which do not have capacity planning tools, the applicants' module (GUI) will provide information on capacity bands, TCRs, reserved and confirmed paths, etc.… Using this module, applicants have the possibility to request capacity and obtain other needed information.

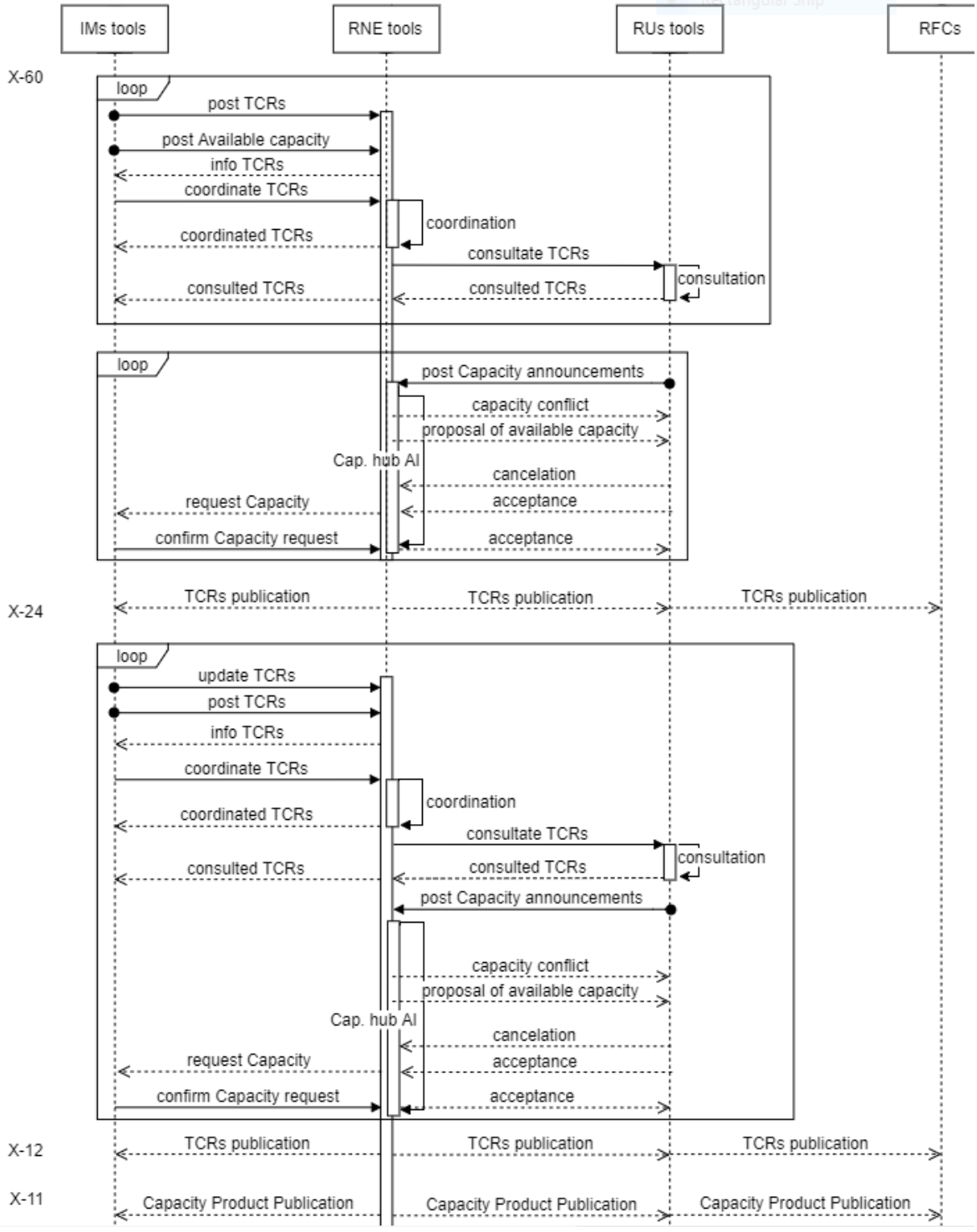


Figure 23 Advanced planning sequence diagram

Having a first view on the capacity needs is the major aim of the advanced planning. In this advanced planning, IMs post their TCR data (known and available capacity data on their networks) to the central system. Other IMs have an overview of this capacity information (TCRs) and the coordination process can start. All TCRs or which this is feasible at that time will be coordinated between IMs. After the coordination process is finished and no later than X-25, all TCRs with the status 'Coordination' will be promoted to the consultation phase. Now applicants have a first view on the TCRs which are planned and can comment and consult on them with IMs, expressing their needs.

Applicants post their capacity needs or at least estimations whenever they have information about commercial needs. The Capacity Hub module receives these capacity needs and automatically compares them with the planned capacity. If there is no conflict with the planned capacity, the capacity needs announcement is sent to the IM system and is in turn confirmed. After confirmation, the Capacity Hub module sends an acceptance message to the applicant. If there is a conflict with the planned capacity, the Capacity Hub gives feedback to the applicant about this conflict and proposes the closest available capacity which can be used. Applicants can agree on the proposal and send a confirmation or disagree and cancel the announcement. These processes can be run in several iterations.

The preliminary consultation phase for the major TCRs finishes at X-24, when all TCRs with major and high impact will be published and visible to all applicants and RFCs.

After X-24, if needed, IMs update TCRs or post data about new TCRs. Other IMs receive information about these modifications and if needed, the coordination process between IMs starts. IMs coordinate TCRs and when finished, but no later than X-13, these TCRs are promoted to the consultation phase and visible to the applicants. Applicants comment the TCRs if needed, taking into account their needs. As it is the case in advanced planning, applicants send their capacity needs announcements and the Capacity Hub module answers them, taking into account the confirmation from the IM side. This is a recurring process.

At X-12, all coordinated and consulted TCRs with major, high and medium impact will be published and visible to all applicants.

At X-11. the capacity product with the harmonised capacity data will be published and visible to the applicants.

Timetable Production

The timetable production period starts at X-11 after the capacity products are finally published, and all major/high/medium TCRs are fully fixed. The RUs are able to see and use these capacity products to construct path requests (it could be tailor-made path request as well). For this purpose, the idea of the Capacity Broker, briefly mentioned above, fits perfectly.

Regarding the draft offers for ATT requests placed between X-11 and X-8.5, IMs forward a reliable draft offer to applicants at the earliest after the finalisation of ATT requests placed on time.

Regarding the draft offer for RP requests, IMs forward a reliable draft offer to applicants, with response time depending on the type of path request (maximum 4 weeks). IMs will forward a draft offer for the subsequent TT period respecting the agreed time window of +/- 30 minutes. Applicants have the possibility to submit justified observations or minor changes to the initial path request.

Regarding all other offers for the requests for annual timetable placed after the deadline, they will be handled according to the procedures described in chapter 9.3. and 9.4.2. of the referenced document Redesign of the International Timetabling Process (TTR)' (description of the redesigned timetabling process).

National Systems:

- ✓ Interface development (non-existing or non-functioning interface between national systems and central system)
- ✓ Implementation of TAF/TAP TSI framework
- ✓ Implementation (improvement) of the national IT systems
  - Upgrade to handle border harmonisation,
  - Upgrade to be able to exchange capacity information with a central system (interfaces, data structures, capacity functionalities (planning, create/update, harmonised, exchange data in both directions (with the central system), etc.))
  - Introduction of early (advanced) planning (available capacity, TCR)
  - Upgrade to handle the multi-annual requesting possibility
  - Support ongoing update of slots for RP and to feed the RNE central system in a frequent manner (frequency to be defined – minutes, hours, days…)
  - Automatic promotion of non-requested RP capacity into residual capacity, should be shifted automatically 30 days before each calendar day, to be available for any short-notice path request
  - Upgrade to be ready to receive path requests for the upcoming ATT at X-8.5 and forward a reliable draft offer to applicants at X-6.5

Centralised Systems:

- ✓ Development of the centralised Capacity Hub and Capacity Broker modules
  - Automatic notification process for neighbours and confirmation of finalisation
  - Highlighting of critical border/handover point (negative border points, too long handling times outside the agreed timeframe) and acceptance indicators
  - Handling multi-annual requesting possibility
  - Continuous harmonisation required for cross-border RP requests
  - Visualisation of the capacity: it is important to develop a user-friendly way to display capacity in the form of an advanced, interactive space time diagram. The example for this is the TTR pilot on the corridor Antwerpen-Rotterdam, which can be used as the leading example of displaying the capacity for both IMs and RUs.

The IM layer can be shown in a simplified manner as follows:

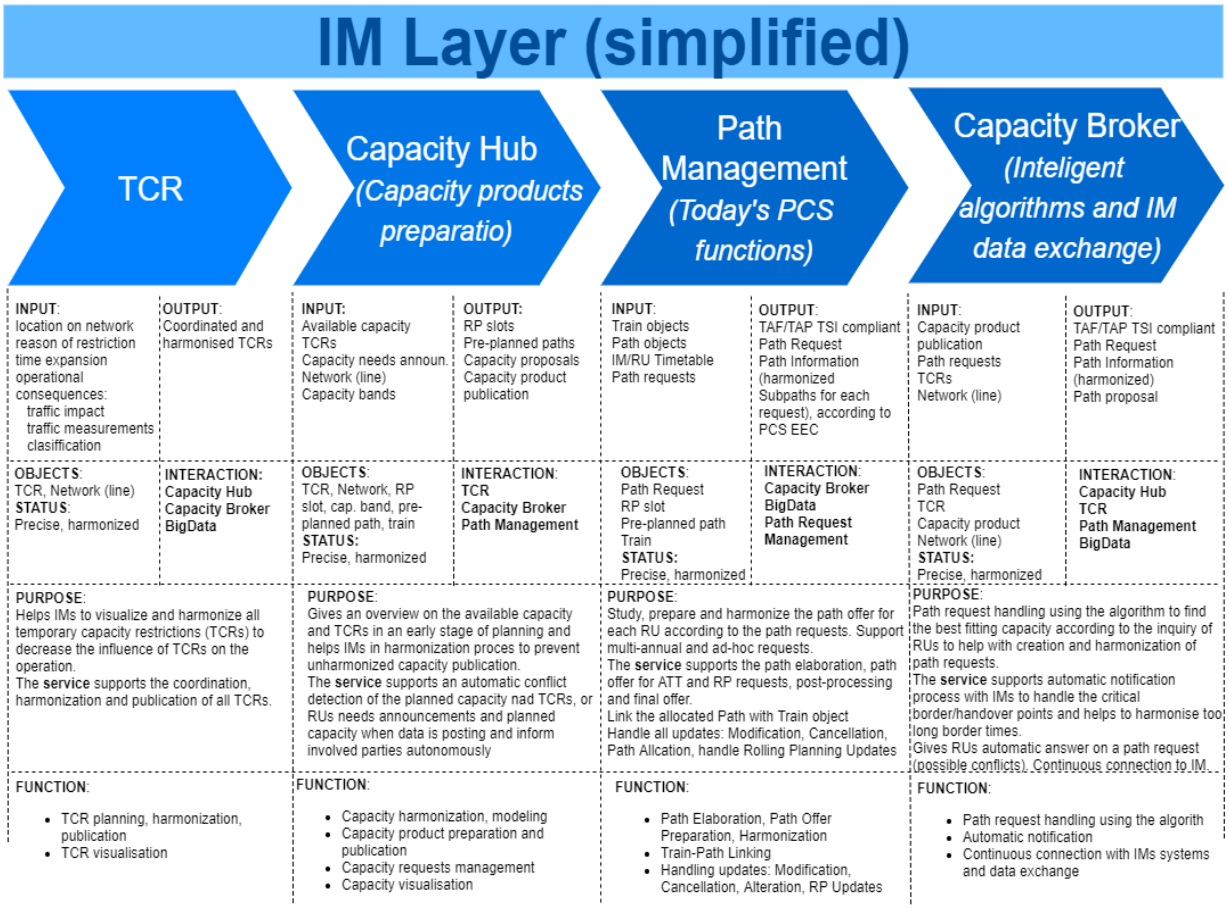


Figure 24 IM Layer and its components

3.2.2. RU Aspect

Business Object Model Transformation to Technical Information Object Model

The business object model which serves as the basis for the logical data model looks as follows (simplified).

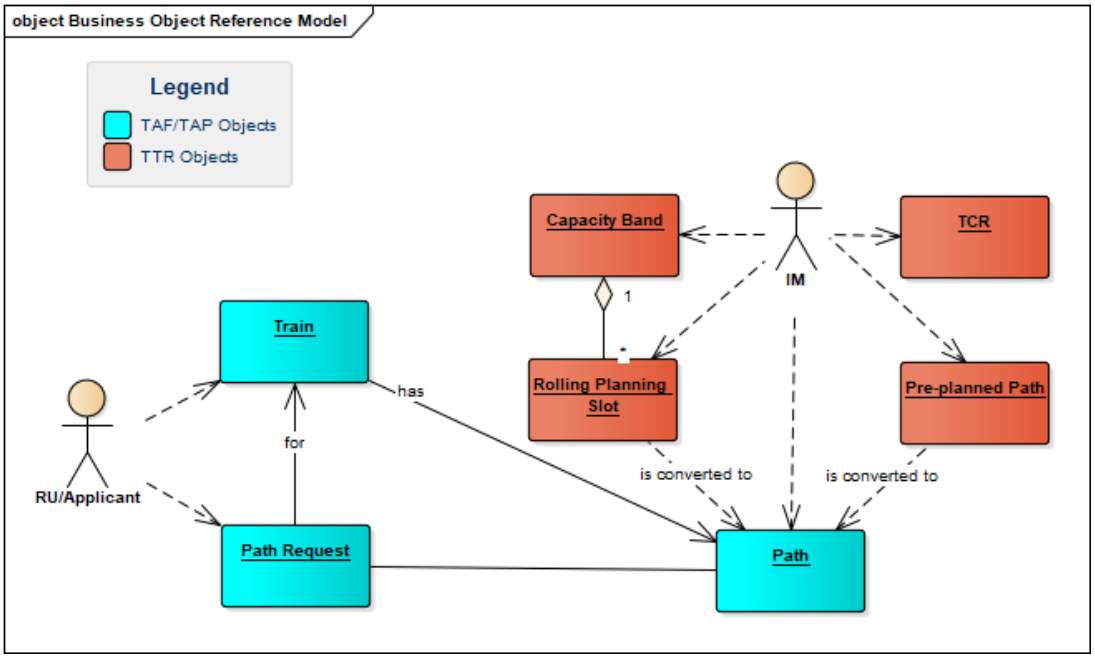


Figure 25 Simplified Business Object Reference Model. RU is in charge of Train and Path Request, IM is in charge of Capacity, and everything linked with it, and, as the last product – allocated path. The relationship between Capacity Band and Rolling Planning Slot is 1..*. This is given by the definition provided in the main process document.

The glossary of the main process document contains the following explanation for the capacity band and Rolling Planning slot relationship and the definition of the pre-planned path:

Capacity band	Time frame up to several hours that includes capacity for at least one path for Rolling Planning requests. Publication in the form of a number of 'slots' per defined capacity band
Rolling Planning slot	'Capacity usage possibility' within a capacity band that will be converted into a path year after year
Pre-planned paths (dedicated for Annual TT)	This is a path that an IM has planned at the beginning of the capacity process on the basis of the cap. partitioning as well as its own expectations regarding market needs, requirements contained in Framework Agreements, and capacity needs announcements made by applicants. TCRs according to the RNE guideline 'TCR' have to be taken into account as much as possible

The objects Train, Path Request and Path correspond to the TAF/TAP TSI objects. When transformed to information objects, the objects Train, Path Request and Path correspond to the technical structure of the TAF/TAP TSI objects which is given in the TAF/TAP Data Catalogue (XSD) for Common Metadata, described in the TAF/TAP TSI Sector Handbook.

The objects Capacity Band, Rolling Planning Slot, Pre-planned Path and TCR are not given in TAF/TAP TSI, but for the technical definition, the elements of TAF/TAP TSI data catalogue can be used for Capacity Band, Rolling Planning Slot and Pre-planned Path completely. The missing elements are the object types for TAF/TAP identifiers (current code list of object type has to be adapted). The technical elements of the information objects will be the technical elements of the path, as given in TAF/TAP XSD in the path information element.

As regards TCRs, the technical information object is constructed in the RNE TCR project.

In this simplified object model, it is not shown due to complexity reasons that other relationships than those shown in the model exist. For example, the path request of the RUs / applicants may contain the relation to the pre-planned path (for annual timetable) or to the Rolling Planning slot (for Rolling Planning requests). Or, the initial train timetable contained in the train object may also have the relation to the pre-constructed products of IMs, such as pre-planned path or Rolling Planning slot.

In the end, after the allocation, the train is linked to the particular path as shown in the diagram, but other relationships exist as well.

According to the activities of RUs mentioned in the business layer, the RUs are supposed to exchange the information about the volumes, main train characteristics (as far as possible at that early stage) and a number of trains per line in the defined timeframe as the capacity need announcement.

In the advanced planning, the idea of the train for the future timetable year is conceptualised by RUs: volume, frequency, timeframe, a period of the year, possible routes and schedules. The concrete path request during the advanced planning is not possible for the RUs, but the feasibility study, together with IMs is possible. Therefore, the complete train object and complete path request are not possible during the capacity needs announcements.

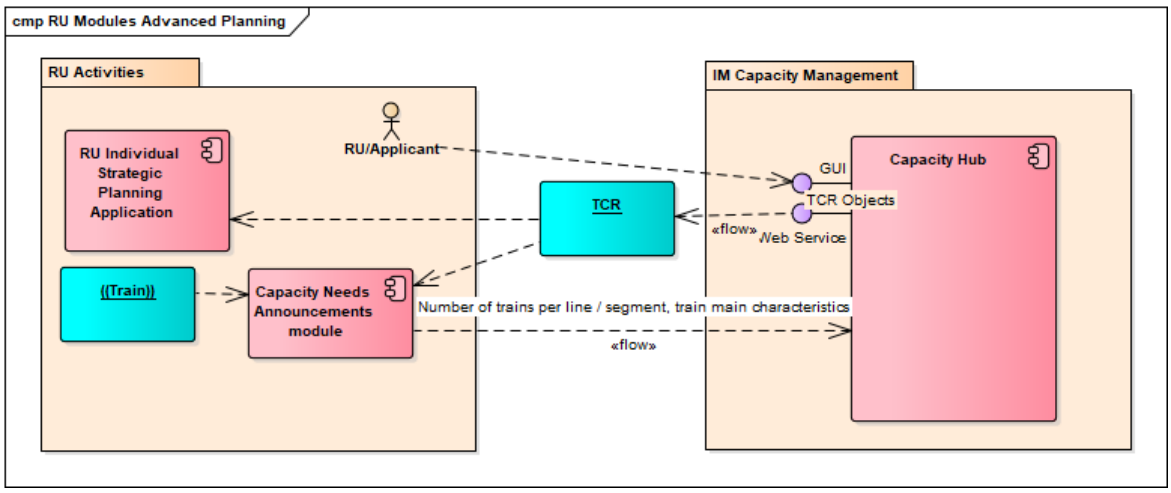


Figure 26 Advanced Planning by the RUs: simplified Application Landscape

Timetable Production

In the Timetable Production phase, the RUs are supposed to work on path requests for their trains.

Observations related to the draft offer will be reduced to two weeks (four weeks previously). It is necessary to have a harmonised, common definition of 'justified objection' which must be respected by all IMs and RUs.

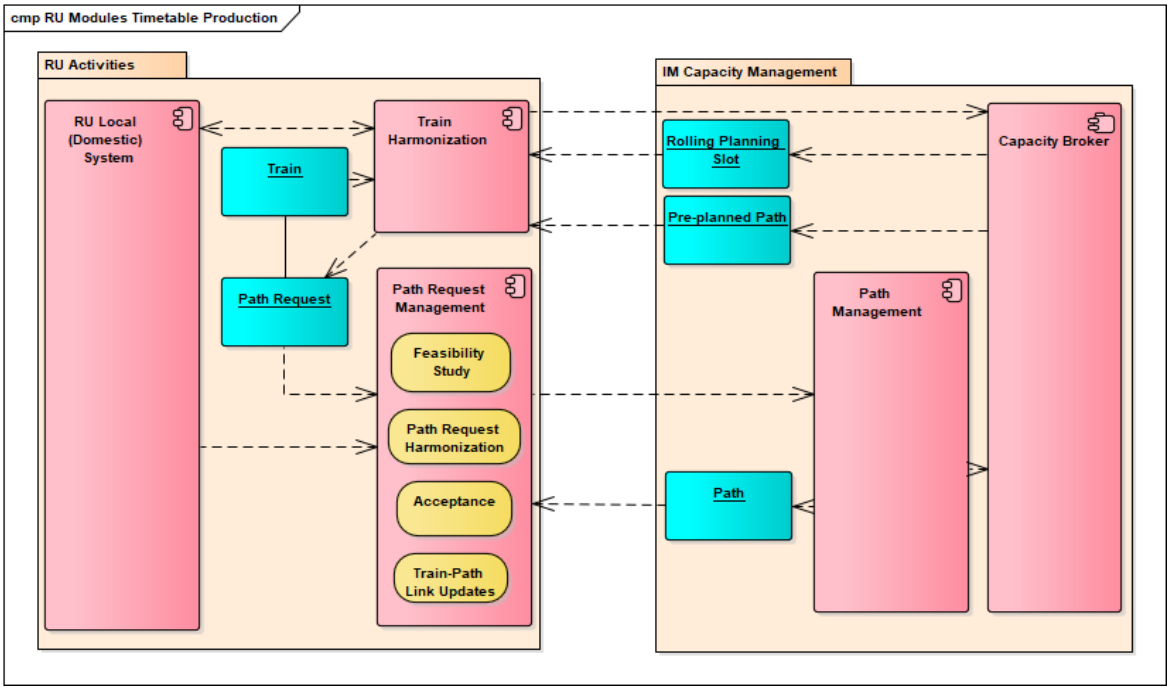


Figure 27 Modules for RU activities in the Timetable production

The RU layer can be shown in a simplified manner as follows:

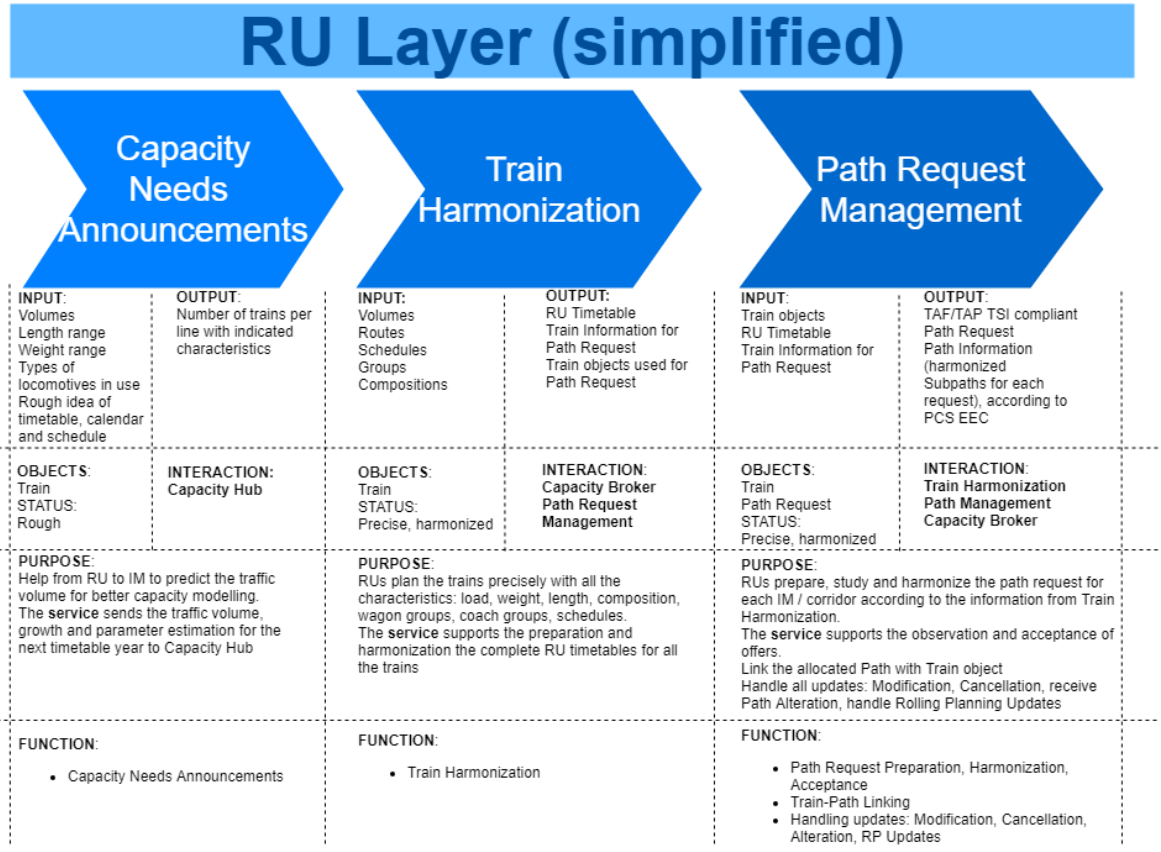


Figure 28 RU Layer and its components

3.3. TTR Modules

Role of Modules

The modules given in the diagrams and models in this chapter are the future functional units. They can be seen as the **microservices** that will be in the future application landscape. This concept still does not prescribe which central system will own the microservices. It could be one central system, or it could be a separate system of RUs and IMs – the options have to be investigated during the first step of the migration from AS-IS to TO-BE.

3.3.1. Messaging Module

The Messaging module is the main module for the communication between RNE central systems and external systems of IMs and applicants and is the single point of connection between the systems. The module is completely based on the TAF/TAP TSI message exchange and will be able to accept capacity and path messages from the IM side and transfer these messages to the respective module (e.g. TCR messages to TCR module and capacity messages to Capacity Hub module). At the same time. it can accept capacity announcement requests from the RU side and translate these messages to the Capacity Hub module. All outputs from the central system as a result of the request (e.g. automatic detection of conflicts of the planned capacity with TCRs from the Capacity Hub) will be sent to the original sender.

An additional functionality of the Messaging module is to aid in communication between IMs' and RUs' systems. RUs can use the Messaging module as a centralised single point of connection to communicate with IMs' or other RUs' systems, without consulting the rest of the centralised modules. The Messaging module will be used as a router for communication with other partners. RUs and IMs will have the benefit of not having to create different interfaces to establish communication with each IM or RU, but they may use one point of connection to communicate with others.

Benefit: Only one point of connection for all RNE modules, and one point of connection to all IMs' and RUs' systems

Supported unctionalities of the module:

- Communication between national systems of IMs, RUs and RNE central systems
- Communication between national systems of RUs and IMs

RU aspects	Communication with RNE central systems
○ Local activities	
○ Central activities	
IM aspects	Communication with RNE central systems
○ Local activities	
○ Central activities	
Inputs	*All communication between national systems and RNE central system*
Outputs	

TAF/TAP compliance	
○ Objects	*All objects defined in modules below*
○ Messages	*All messages defined in modules below*
Notes:	
Correlation with other modules	*All modules defined below*

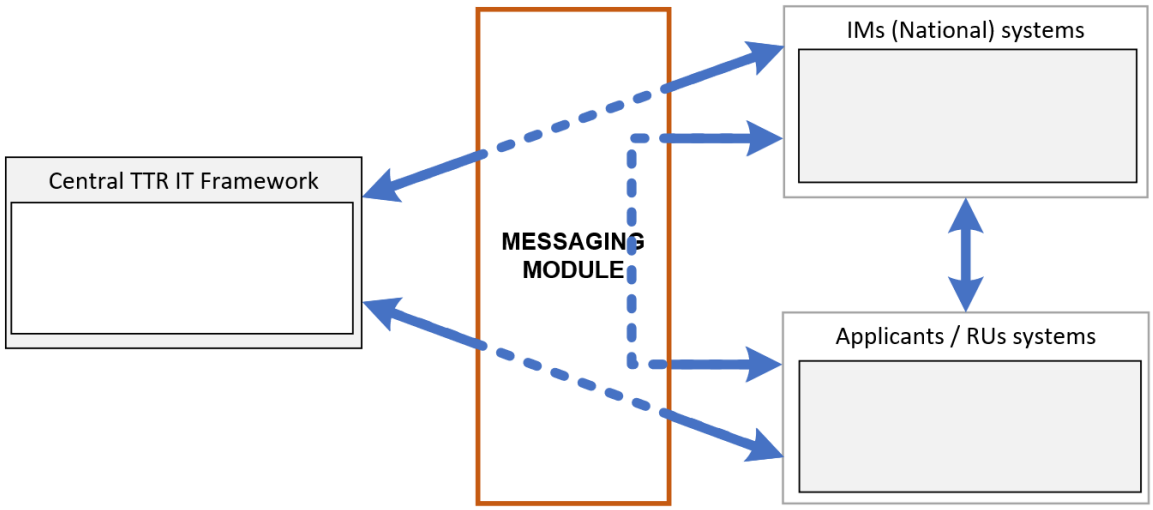


Figure 29 Communication possibility between the systems

3.3.2. Capacity Hub Module

The Capacity Hub module is a module for capacity modelling, planning and product development. The Capacity Hub module collects all data from the IMs (available capacities, bands and TCRs) and RUs (capacity needs announcements) and gives an overview of the available capacity and TCRs at an early stage of planning. It safeguards capacity for RP requests, and it is responsible for answering the capacity requests in the advanced planning phase.

The Capacity Hub module prevents publication of unharmonised capacity and has implemented some form of AI which allows automatic detection of affected companies and affected neighbours to give them information when something is changed during the capacity planning, thus providing intelligent help in coordination. When data is added, the system automatically checks for conflicts between the planned capacity and TCRs or RUs' need announcements and informs the affected partners.

Benefit: Automatic detection of capacity conflicts and information provided to involved parties autonomously by the system

Supported functionalities of the module:

Capacity model:

- Exchange of data between the national tools of IMs and RNE central system
- Visualisation of the possible capacity usage (capacity partitioning)
- Exchange of information between IMs and with involved stakeholders
- Decision procedure on the future capacity usage
- Accepting and answering RUs' capacity needs announcements (recognise requests and allocate the safeguarded capacity if applicable)
- Providing a clear picture regarding the detailed needs (volume/type of paths, TCR lines opening, characteristics, etc.)
- Providing the capacity model overview
- Accepting frequent ongoing update of slots for RP (frequency to be defined – minutes, hours, days…)

Capacity request:

- ✓ In the pre-planned phase:
  - Exchange of data between the national tools of IMs
  - Visualisation of the possible capacity usage (capacity partitioning)
  - Compilation and harmonisation of national paths at handover points
  - Visualisation of path compilation
  - Visualisation of the drafts and 24 hour plans through a graphic view
  - Description of the network: observed traffic data, regular-interval timetable, freight traffic matrix, 24 hour view of the model, commercial offer underlying capacity bandwidth
  - Quality check of path compilation on the basis of pre-defined criteria
  - Notification on border-time / parameter inconsistencies
- ✓ In the requesting phase:
  - Brokerage of the available capacity
  - Harmonisation of a capacity/path requests involving more than one path applicant
  - Provision of an intelligent proposal of the best-fitting available capacity for the request
  - Placement of the capacity/path requests for national and/or international traffic for up to 36 months
  - Notification of the applicants regarding request inconsistency or capacity reduction
- ✓ In the publication phase:
  - Publication of detailed paths for Annual Timetable for the upcoming TT period
  - Publication of slots for Rolling Planning capacity, bookable for up to 36 months
  - Publication of complete capacity product (all harmonised capacities together with fixed safeguarded capacity, pre-planned paths for ATT, publication of slots for RP (up to 36 months prior) for every calendar day) at X-11
  - Provision of a regular update of the capacity model (at least once a year)
  - Multi-annual requesting possibility (RP – up to 36 months prior), Acceptance of frequent ongoing update of slots for RP (frequency to be defined – minutes, hours, days…)

RU aspects	Request for a capacity, overview and consulting capacities, capacity needs announcements (ATT, RP)
○ Local activities	Capacity planning (ATT, RP) and capacity announcement (using national tools or applicant's module)
○ Central activities	Check the published capacities
IM aspects	Publishing capacities, capacity harmonisation, safeguarded RP requests
○ Local activities	Check domestic situation, long-term strategic planning, provide information about all capacities (positive and negative), preparation and elaboration of the capacity, feeding the central system
○ Central activities	Gathering information about capacity needs (ATT, RP), harmonising all capacities (common view on cross border lines), visualisation of capacities, safeguard capacity, commercial capacity bands publication
Inputs	Available capacity, TCRs, capacity needs announcements, network data, available capacity bands
Outputs	Capacity product publication (clear picture regarding detail capacities and needs), capacity proposal, RP slots, pre-planned paths
TAF/TAP compliance	
○ Objects	TCR, networks (lines), RP slots, capacity bands, pre-planned paths, Train, number of trains per line
○ Messages	PathRequestMessage, PathDetailsMessage, PathCancelledMessage, ReceiptConfirmationMessage, PathConfirmedMessage, PathDetailsRefusedMessage, PathNotAvailableMessage, PathInformation
Notes:	*Currently, a TAF/TAP message for RP does not exist and it should be decided, if some specific TAF/TAP messages are needed or not*
Correlation with other modules	TCR module, Messaging module, applicant's module, capacity needs announcements

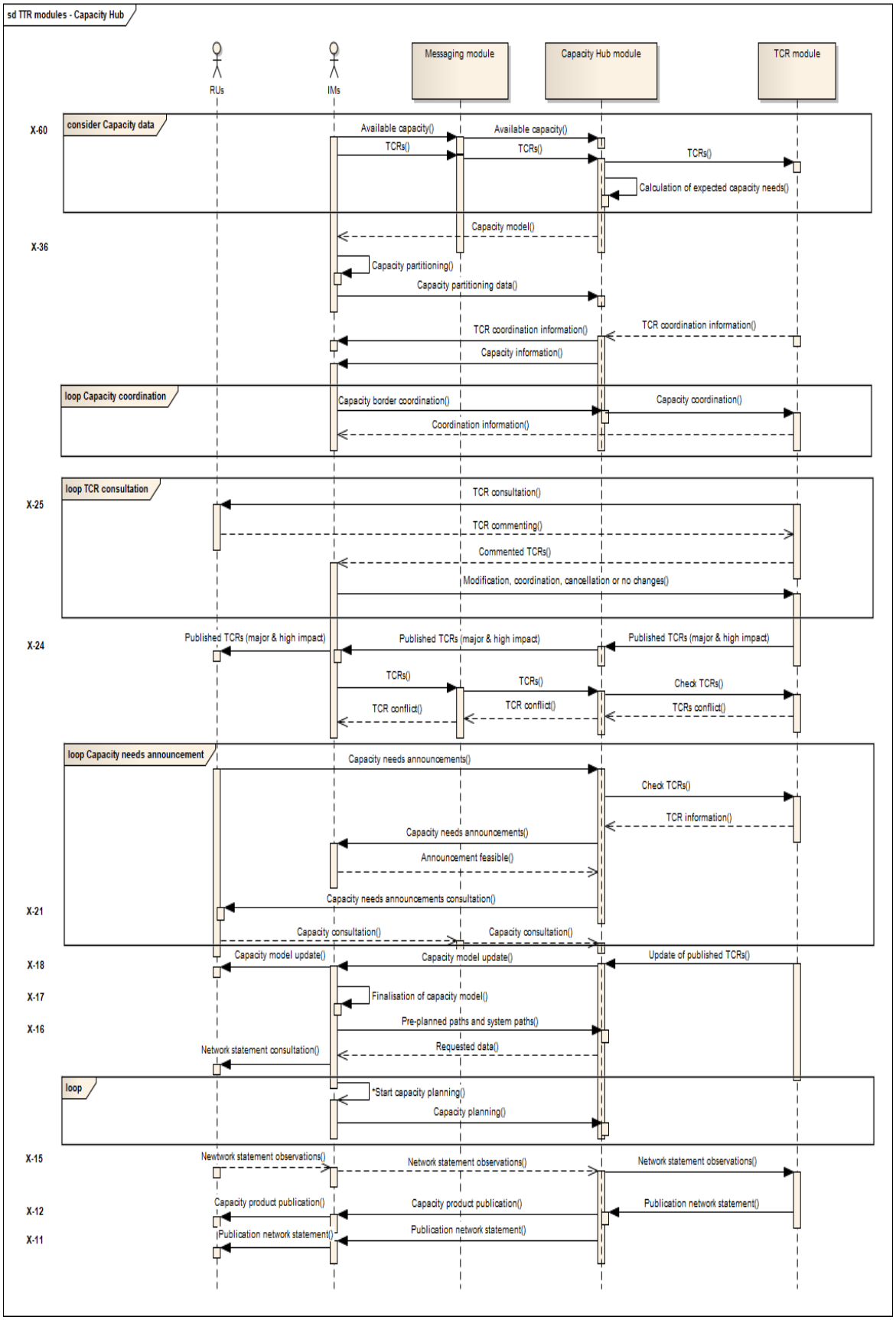


Figure 30 Capacity Hub module sequence diagram (see Annex 1)

3.3.3. Capacity Broker Module

The Capacity Broker module is a module for capacity inquiry and request. The Capacity Broker module uses harmonised capacity product publication data as input and all inquiries and requests from RU side will be validated against it. The Capacity Broker summarises all requests from RU side and gives feedback whether the requirement fits the available capacity or not, due a conflict with a TCR. It will solve the RUs' problems with the creation and harmonisation of path requests affected by maintenance works. Also, if the capacity is already booked, the Capacity Broker must be able to get this information from the IMs' national systems in real time. The Capacity Broker module will check the available capacity against national IT systems before the offer of the path through the Path Management module. The final answer to the path requests should be done by the IM and delivered back to the Broker which will broadcast the message to RUs via the Path Management module.

Supported functionalities of the module:

- *Continuous (**real-time**) connection to the IMs' systems*

  Capacity request:

  - Ongoing update of the residual capacity for Annual Timetable request (after X-8.5 deadline until X-2)
  - Ongoing update for the residual Rolling Planning capacity (for up to 36 months until M-1)
  - Algorithm to find the best-fitting capacity according to the inquiry request by RUs (will give information to RUs that their requests fits the available capacity or information that there is a problem due to TCRs or similar)
  - Multi-annual requesting possibility
  - IMs' national systems must be able to respond to the capacity inquiries in real time even if they have not published the capacity product for the particular line or train characteristic. More precisely, if the RU makes an inquiry in the Broker that does not only take into account the published capacity products, the IM's system must be able to answer if there is available capacity to be used for a tailor-made offer (or combination of capacity product and tailor-made)

  Capacity allocation:

  - Receipt of all kinds of requests (Annual Timetable (before the deadline, after the deadline and Ad-hoc), Rolling Planning, short-term requests less than 30 days before the operation) for traffic for an operational period of up to 36 months (for Rolling Planning)
  - Full or partial withdrawal of requests
  - Communication of minor and major changes to the request by path applicant to IM
  - Real-time communication with IMs' national systems for an update of published capacity products, and for tailor-made construction of paths (if no published capacity product could be used) based on the request of RUs
  - Compilation and harmonisation of national paths at the hand-over points
  - Visualisation of path request conflicts in the annual timetable
  - Conflict resolution procedure (e.g. calculation of distance and running days in order to define the priority value)
  - Coordination process between involved IMs
  - Forwarding of the draft and final path offers to path applicants
  - Placement of observations by the path applicants

- Forwarding of final allocation from IMs' national systems to the Path Management module
- Acceptance of path offer by the path applicant
- Highlighting the critical border/handover points (negative border points, too long handling times – outside the agreed timeframe), acceptance indicators
- Supporting conflict resolution (procedure on how to deal with path request conflicts)

After allocation:

- Modification of an allocated path by the path applicant, involving one or more IMs
- Full or partial cancellation of an allocated path by the path applicant, involving on or more IMs
- Communication from the path applicant to the IMs regarding the conversion of a Rolling Planning slot into a path for the upcoming timetable period
- Full or partial alteration of an allocated path by the IM, involving one or more path applicants
- Forwarding of an alternative IM offer in case of a path alteration to one or more path applicants
- Negotiation for the alteration of a guaranteed slot outside the promised time window between IMs and path applicants
- Accepting frequent ongoing updates of slots for RP (frequency to be defined – minutes, hours, days…)
- Possibility for RUs to cancel a path for ATT or RP, and if more than one RU is involved, it shall be possible that one RU keep its allocated path for another traffic
- Possibility of converting a slot into a path for upcoming TT period (IMs possibility to elaborate the path outside the agreed time window of +/- 30 min, subject to acceptance by applicant)
- Management of identifiers

RU aspects	Path requesting
○ Local activities	Plan needs, harmonise paths with RUs, path request, path acceptance
○ Central activities	Path harmonisation
IM aspects	Path management
○ Local activities	Path management
○ Central activities	Path management, path harmonisation, path offer
Inputs	Capacity product publication (clear picture regarding detailed capacities and needs), path requests, TCRs, network (line)
Outputs	Path offers
TAF/TAP compliance	
○ Objects	TCRs, capacity product, path request, network (line)
○ Messages	PathRequestMessage, PathDetailsMessage, PathCanceledMessage, ReceiptConfirmationMessage, PathConfirmedMessage, PathDetailsRefusedMessage, PathNotAvailableMessage, PathInformation
Notes:	*To be checked, if some specific TAF/TAP messages are needed*
Correlation with other modules	Messaging module, Applicant's module, Path Management module, Capacity module, TCR module

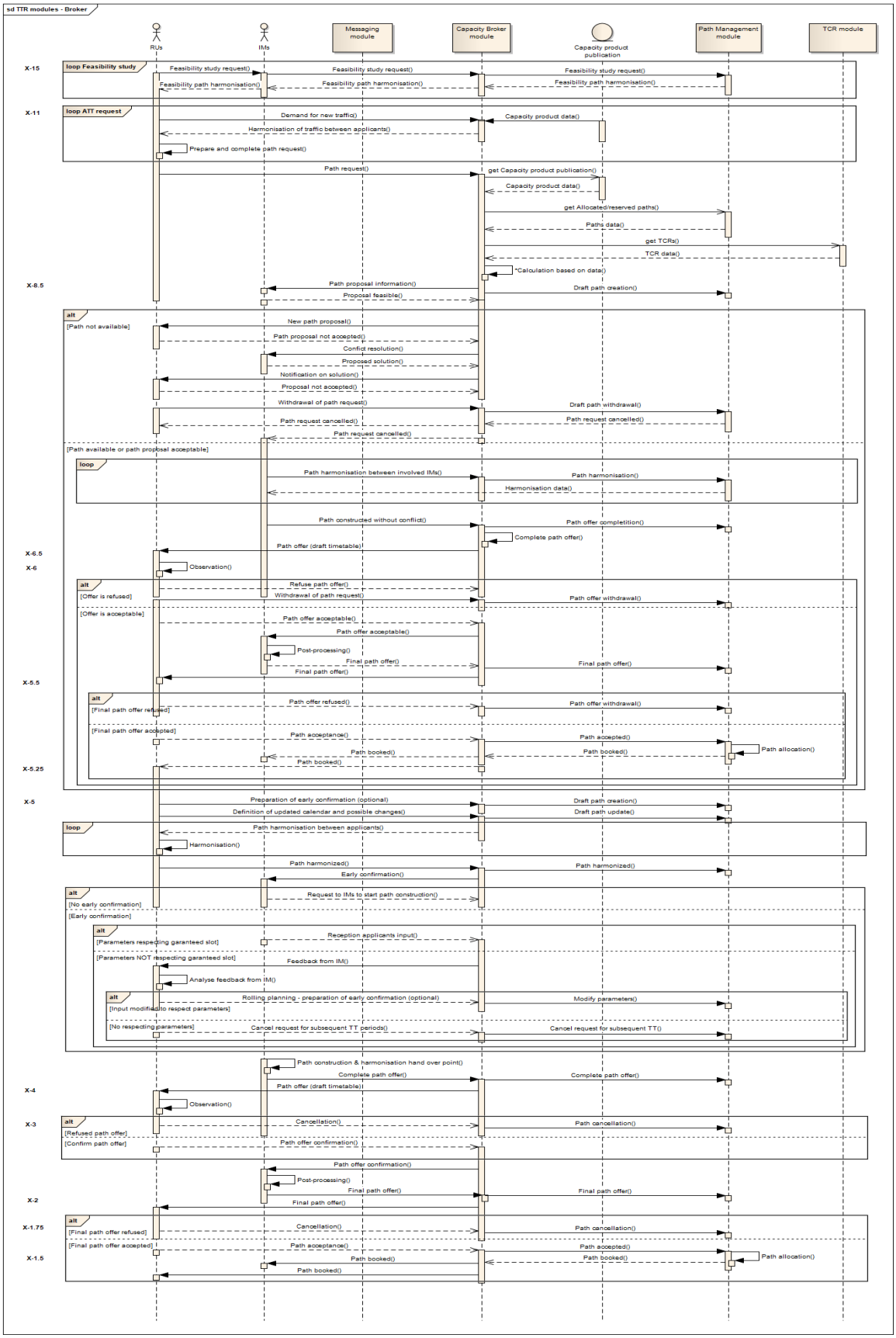


Figure 31 Capacity Broker module sequence diagram (see Annex 2)

3.3.4. Path Management Module

The Path Management module has all the functionalities needed to work with path requests (including RP), and to harmonise them. It optimises international path coordination by ensuring that path requests and offers are harmonised by all involved parties. It will work together with the Broker module to harmonise paths for all RU requests.

Supported functionalities of the module:

- Path elaboration, draft path offers for ATT and RP requests, post-processing and final offer, final allocation functionality
- Multi-annual requesting possibility
- IM path construction following a request for ATT, RP, request for a path modification and for converting a slot into a path for upcoming TT
- Harmonisation of each path offer (draft/final) of the IMs referring to cross-border traffic for ATT requests
- Harmonisation of each path offer (draft/final) of the IMs referring to cross-border traffic for RP requests, as well as for the subsequent TT period
- Possibility for applicants to submit justified observations and minor changes to the path requests (either for ATT or RP requests)

RU aspects	Path request
○ Local activities	Path planning, path harmonisation, path acceptance
○ Central activities	Path harmonisation
IM aspects	Path management
○ Local activities	Path management
○ Central activities	Path management, path harmonisation, path offer
Inputs	Path request, timetable
Outputs	Path offers
TAF/TAP compliance	
○ Objects	Train, path request, RP slot, pre-planned path, TCR
○ Messages	PathRequestMessage, PathDetailsMessage, PathCoordinationMessage, ReceiptConfirmationMessage, PathNotAvailableMessage, ErrorMessage, ObjectInfoMessage, PathConfirmedMessage, PathRefusedMessage
Notes:	*Currently no message for RP exists in TAF/TAP and it should be decided if this is needed or not*
Correlation with other modules	Capacity Broker module, Big Data module, Applicant's module

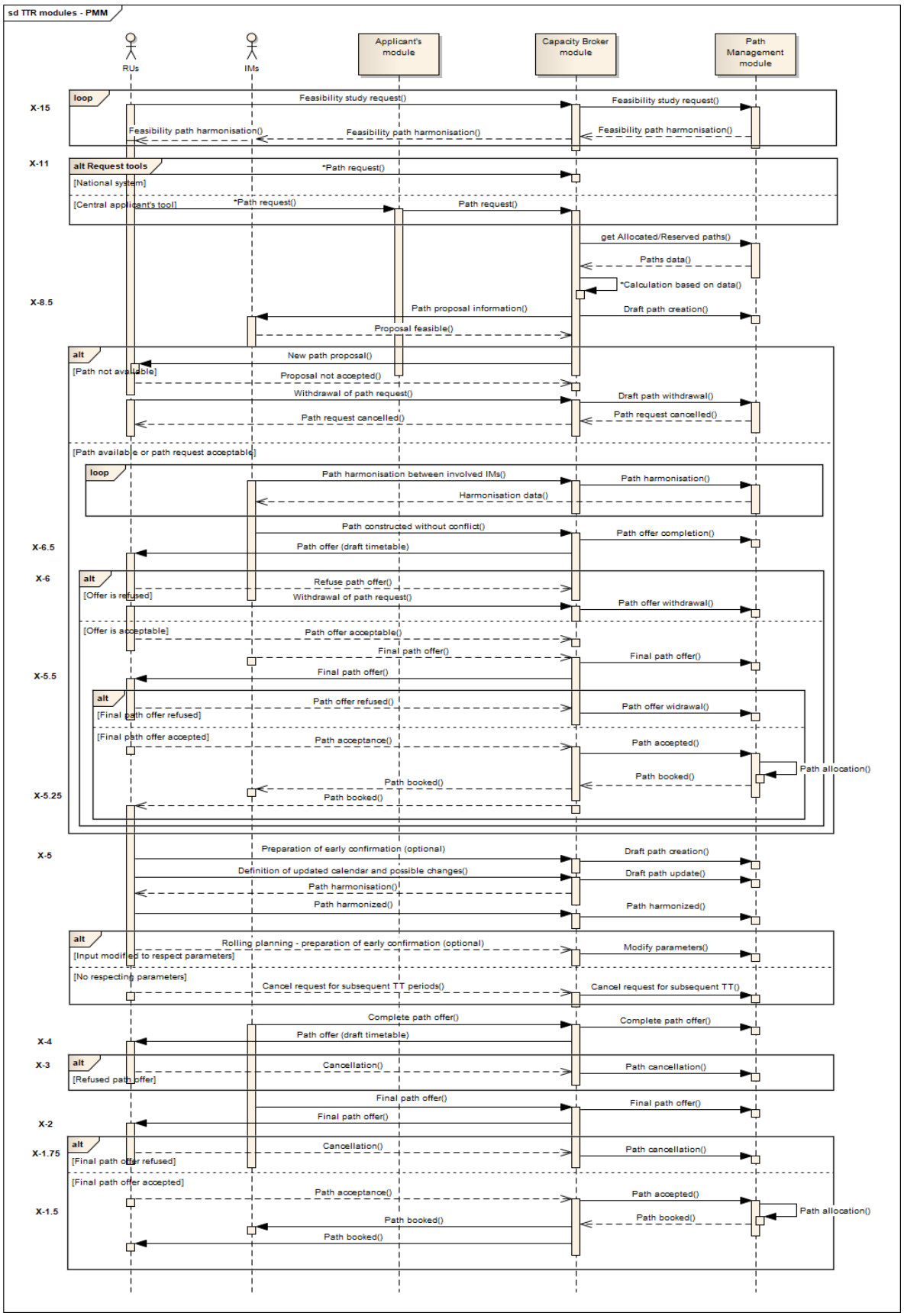


Figure 32 Path Management module sequence diagram (see Annex 3)

3.3.5. TCR Module

The TCR module is a module for the international harmonisation of all known TCRs. The TCR module has a possibility to visualise the TCRs and helps IMs in the coordination process to decrease the negative influence of TCRs on operation. TCRs are described by location on the network, reason for the restriction, time expansion, the operational consequences: traffic impact, traffic measurements and classifications. The output of this module are the coordinated and harmonised TCRs. Also, it provides the possibility to RUs to comment TCRs in a consultation phase before the TCRs are published. According to Annex VII of the Directive 2012/34/EU, all TCRs should be published internationally and nationally.

Supported functionalities of the module:

- *Managing TCRs (creation, import, modification, status promotion, etc.)*
- *Conflict resolution (validation routine checks against all existing TCRs)*
- *Coordination between involved IMs*
- *The possibility of commenting TCRs for RUs and consultations with IMs*
- *TCR harmonisation*
- *Publishing TCRs*

RU aspects	TCR consultation
○ Local activities	Check the impact of the TCRs on planned traffic, coordinate national TCRs with IM
○ Central activities	Comment on TCRs, consultations with IM(s)
IM aspects	TCR planning, coordination and harmonisation
○ Local activities	TCR planning, providing information about the TCRs, coordinate national TCRs with RUs
○ Central activities	TCR coordination and harmonisation, consultations with the applicant(s), TCR publication
Inputs	Planned (feasible) TCRs
Outputs	Published TCRs
TAF/TAP compliance	
○ Objects	TCR, network (line)
○ Messages	TCRImportMessage
Notes:	Messages currently do not exist in TAF/TAP
Correlation with other modules	Capacity Hub module, Capacity Broker module, Big Data module, Messaging module

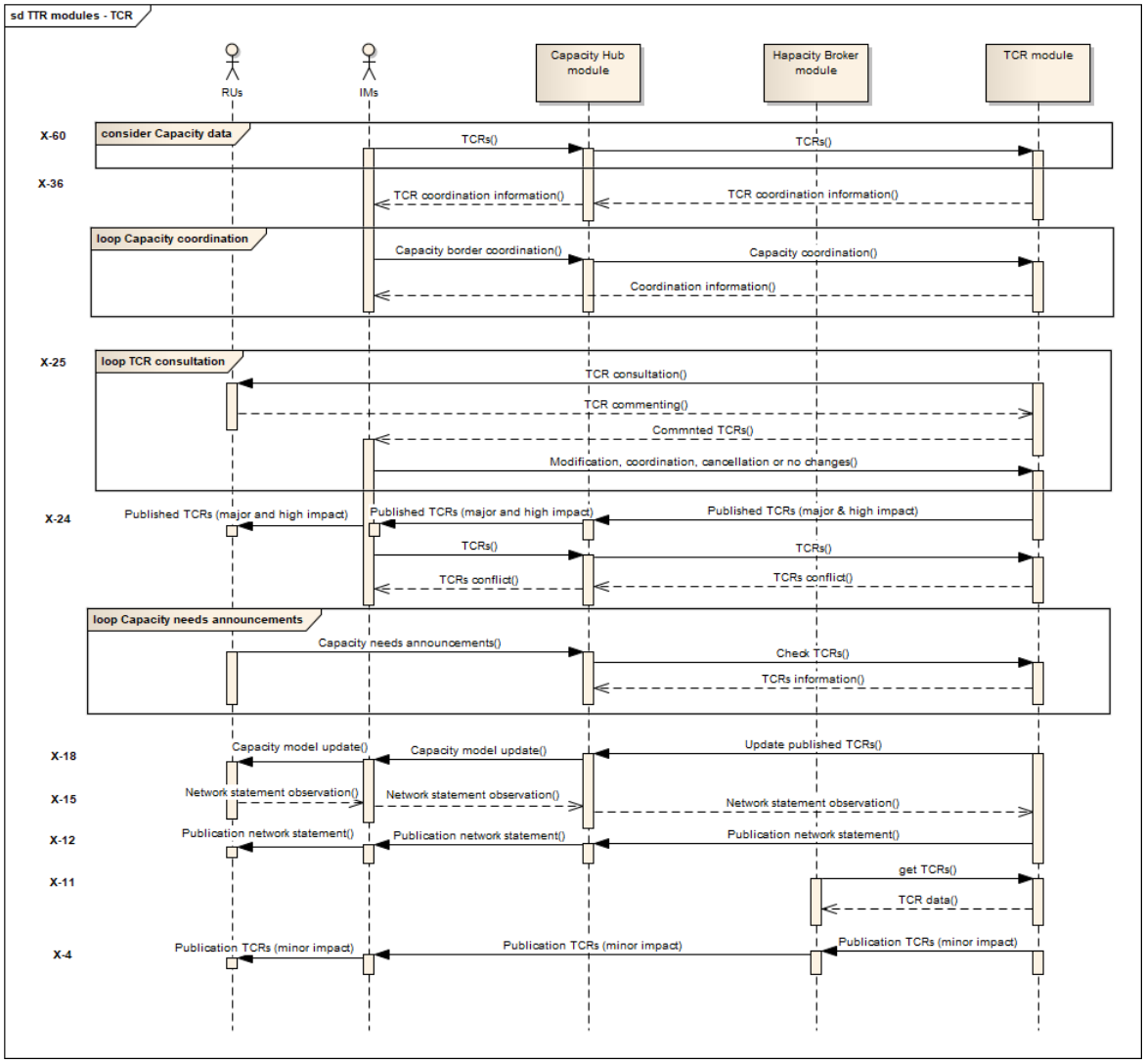


Figure 33 TCR module sequence diagram

3.3.6. Big Data Module

The Big Data module will synchronise Big Data database data with the CRD and RINF databases and will be responsible for keeping all infrastructure data up to date. It will share infrastructure information with all other modules and also, if needed, IMs and RUs can synchronise their infrastructure data using the Big Data module.

Supported functionalities of the module:

- Synchronisation with CRD and RINF databases
- Visualisation of data on the map (PLCs, segments, sections)
- Visualisation of different layers with different data granularity
- Possibility of creating a segment and section on layer

RU aspects	
○ Local activities	Refresh local infrastructure data
○ Central activities	

IM aspects	
○ Local activities	Refresh local infrastructure data
○ Central activities	Create/modify segments and a section on layers, data translation between layers, common data overview
Inputs	CRD data, RINF data
Outputs	Network topology data
TAF/TAP compliance	
○ Objects	Network data, CRD data, RINF data
○ Messages	
Notes:	
Correlation with other modules	Messaging module, TCR module, Path Management module

3.3.7. Applicant's Module (GUI)

The Applicant's module will help small IMs, RUs and other applicants who do not have their national systems in requesting capacities and paths, see TCRs, consult on TCRs and generally to communicate with the RNE central system (modules). This module will cooperate with all other RNE modules.

RU aspects	Path request, TCR consultation
○ Local activities	Plan capacity needs (ATT, RP) and request (using national tools or Applicant's module), check the impact of the TCRs on planned traffic, path planning, path harmonisation, path acceptance
○ Central activities	Comment on TCRs, consultations with IM(s), path harmonisation
IM aspects	
○ Local activities	
○ Central activities	TCR harmonisation, consultations with the applicant(s), path harmonisation, path offers, consultations with the applicant(s)
Inputs	TCRs, available capacity
Outputs	Path request, data visualisation
TAF/TAP compliance	
○ Objects	TCRs
○ Messages	PathRequestMessage, PathDetailsMessage, PathCoordinationMessage, ReceiptConfirmationMessage, PathNotAvailableMessage, ErrorMessage, ObjectInfoMessage, PathConfirmedMessage, PathRefusedMessage
Notes:	*Currently no message for RP exists in TAF/TAP and it should be decided if this is needed or not*

Correlation with other modules	Messaging module, Capacity Hub module, Capacity Broker module, TCR module

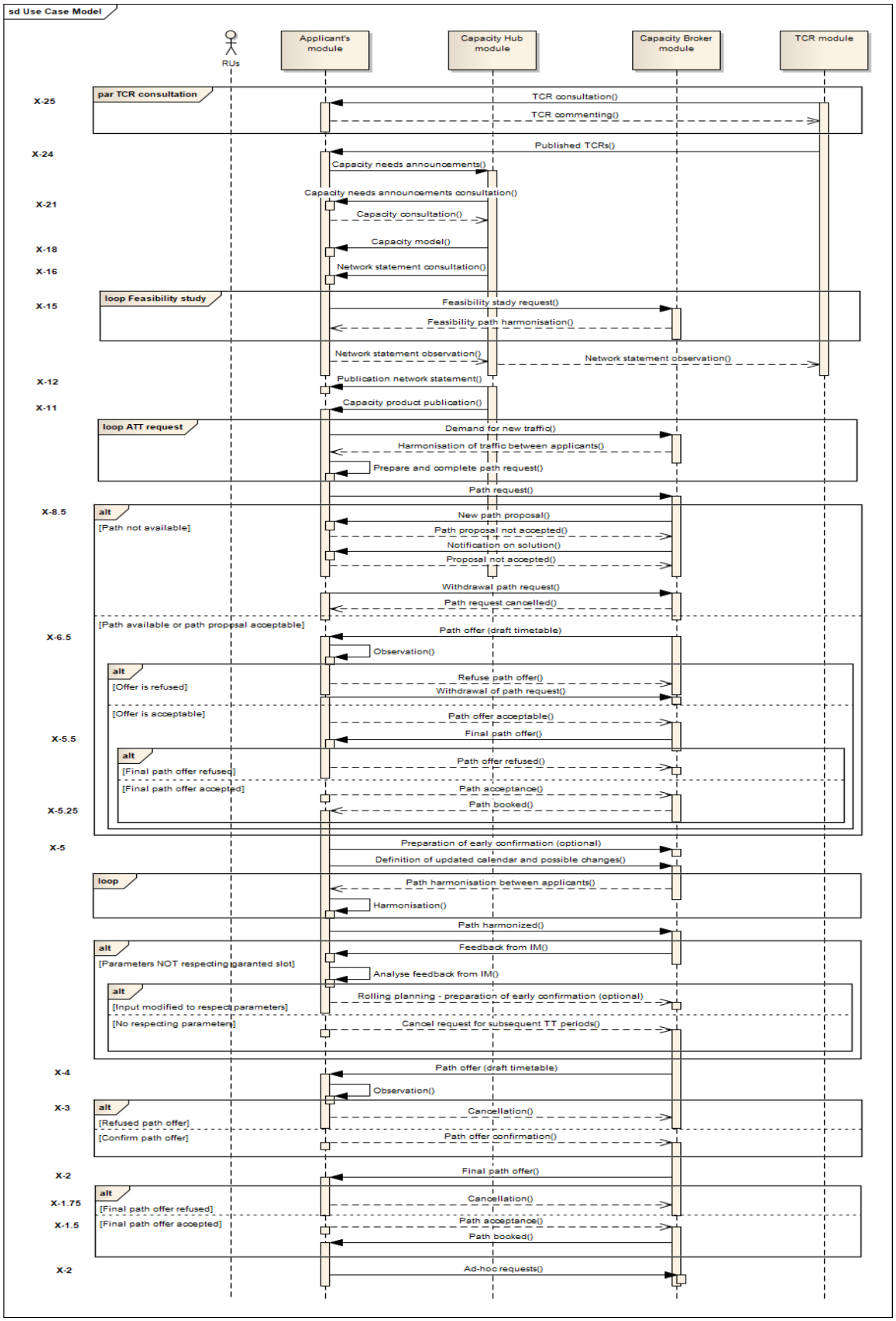


Figure 34 Applicant's module sequence diagram

3.3.8. Capacity Needs Announcements Module

Some RUs possess systems for long-term strategic planning. It would definitely be a huge advantage for RUs if a system like the Capacity Hub delivered information about TCRs to such systems for strategic planning so that these restriction objects can be taken into account in the capacity needs announcements.

As it was described in the business layer, it is foreseen that RUs should indicate their 'ideas' regarding the trains in the next timetable year. The train object in the diagram above is marked as '((Train))' in order to indicate that this is not the final train object which is ready for the path request. It is an indication of the volume, length range, weight range, types of locomotives in use, rough idea of a timetable, calendar and schedule.

The next important information transmitted from this module is the number of these trains per line or line segment. Therefore, the IM system must provide an overview of the lines, nodes and operation points with an indication of its possible occupation by TCRs.

Supported functionalities of the service:

- Announcing the need for capacity for ATT and RP (multi-annual planning)

RU aspects	Announcing capacity needs
○ Local activities	Plan and announce the capacity needs (ATT, RP), path request
○ Central activities	Capacity needs announcements
IM aspects	
○ Local activities	Response to capacity needs announcements
○ Central activities	Managing the capacity needs announcements, safeguard RP requests
Inputs	TCRs, Rolling Planning slots, pre-planned paths
Outputs	Capacity needs
TAF/TAP compliance	
○ Objects	Train, number of trains per line
○ Messages	Number of trains per line/segment, train main characteristic, PathRequestMessage, PathDetailsMessage, PathNotAvailableMessage
Notes:	
Correlation with other modules (scenarios)	1. Capacity Hub module, Messaging module, TCR module 2. Messaging module, IMs' national modules (systems)

3.3.9. Train Harmonisation Module

The harmonisation of the train objects at international level is necessary to make the path request harmonised. Therefore, the module for harmonisation must ensure the information exchange between the RUs about the train characteristics (load, weight, length, border handling, interchange etc.).

However, interchange with the Capacity Broker is also necessary. The train object preparation for the path request will be done by taking into account the information about the RP slots and pre-planned paths available from the Capacity Broker module. The intelligence of the Broker will help to provide the best matching combination of the capacity products to be used for the train.

Service Demand for the Local Activities

RUs who have their own system can exchange information with the central microservice for harmonisation. The messaging between the local RU systems and central microservice must be established. The proposal for the service specification will be done during the technical requirements specification.

Supported functionalities of the service:

- Path coordination with partners (cross-border paths)

RU aspects	Train objects preparation
○ Local activities	Harmonisation of the trains between RUs
○ Central activities	Train object preparation
IM aspects	
○ Local activities	
○ Central activities	
Inputs	RP slots, pre-planned paths
Outputs	Train route, train composition
TAF/TAP compliance	
○ Objects	Train
○ Messages	PathCoordinationMessage, ReceiptConfirmationMessage, ObjectInfoMessage
Notes:	The messages for transmitting the Rolling Planning slot or pre-planned path information from the Capacity Broker must be defined. One option is to use the messages Path Request and Path Details with special new codes for the type of request, in order to differentiate the

	procedure from the real request, study or modification. Another option is to use ObjectInfoMessage.
Correlation with other modules	Messaging module, Capacity Broker module

3.3.10. Path Request Management Module

After the train is harmonised, including the capacity product indication, the path request can be constructed and delivered in high quality.

Supported functionalities of the module:

- Multi-annual requesting possibility for Rolling Planning
- Path request harmonisation
- Path offer acceptance procedure including observation
- Possibility to modify the allocated path for ATT and RP, and guaranteed slots
- Possibility to do a full or partial cancellation of the allocated path
- Processing of path alteration initiated by IMs
- Processing of Rolling Planning (RP) updates
- Train path linking (see the separate chapter on 'Updates' provided below)

RU aspects	Capacity/path prediction, harmonisation, request the feasibility study, requesting paths, TCR consultation
○ Local activities	Path planning and requesting (ATT, RP), path modification, train/path request harmonisation, check the impact of the TCRs on planned traffic, path requesting
○ Central activities	Capacity/paths studying, path request, path acceptance
IM aspects	Consult service concept
○ Local activities	
○ Central activities	Studying capacity/paths, comment on TCRs, consultations with IM(s), path harmonisation
Inputs	Trains, paths, RP slots, pre-planned paths
Outputs	Capacity/path request
TAF/TAP compliance	
○ Objects	Train, number of trains per line, path request, RP slots, RP, TCRs
○ Messages	PathRequestMessage, PathCoordinationMessage, ReceiptConfirmationMessage, PathConfirmedMessage, PathRefusedMessage, PathDetailsMessage
Notes:	New 'Feasibility Study' type of message TypeOfRequest might be defined
Correlation with other modules	The RU timetable (train information element from TAF/TAP TSI) is taken over from train harmonisation service.

	Path request management exchanges data intensively with the Path Management Module from the IM Layer. For this purpose, the Messaging Module is used.

3.3.11. Feasibility Study Function (Part of Path Request Management Module)

The idea of the feasibility study module is close to today's implementation in PCS. The RUs may harmonise and request the feasibility study. IMs then propose potential products, however, these are still subject to change and do not present a final offer. It is up to the RUs/applicants and IMs to agree in the future if this answer may be the pre-planned path or a combination of Rolling Planning slots to indicate the feasibility according to the capacity model.

Supported functionalities of the module:

- Overview of the positive and negative capacity
- Requesting and coordinating the capacity requests (start of feasibility study at X-15)

RU aspects	Capacity/path prediction, harmonisation, request the feasibility study
○ Local activities	Capacity/path planning harmonise capacity/paths, capacity/path request
○ Central activities	Capacity/paths studying
IM aspects	Consult service concept
○ Local activities	
○ Central activities	Capacity/paths studying
Inputs	Pre-planned paths, RP slots
Outputs	Capacity/path requests
TAF/TAP compliance	
○ Objects	TCRs, capacity bands, paths, RP slots, pre-planned paths
○ Messages	PathRequestMessage (TypeOfRequest=Feasibility study), PathDetailsMessage, ReceiptConfirmationMessage, PathConfirmedMessage, PathDetailsRefusedMessage, PathCanceledMessage, PathNotAvailableMessage, ObjectInfoMessage
Notes:	
Correlation with other modules (scenarios)	1. Capacity Hub module, Messaging module 2. Messaging module, IMs' national modules (systems)

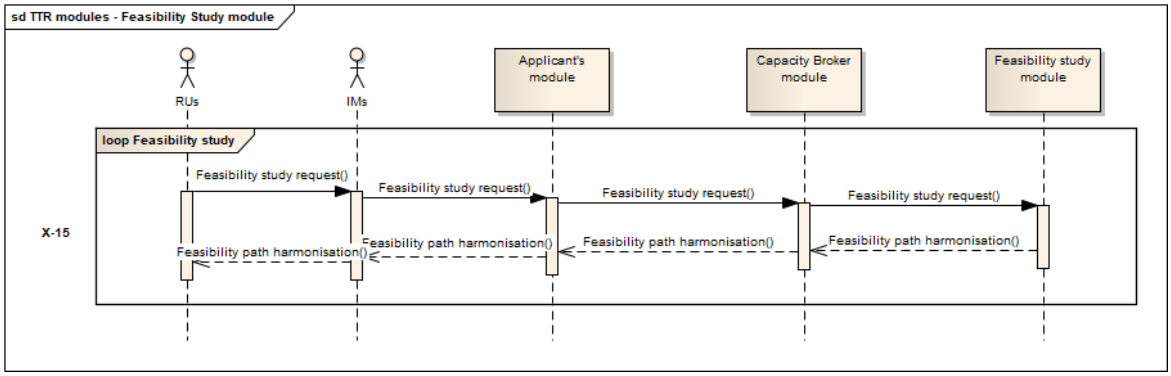


Figure 35 Feasibility study module sequence diagram

3.3.12. Updates (Modification, Cancellation, Alteration, RP Updates) and Train Path Linking (Part of Path Request Management Module)

This is the complex set of functions which serve to bring together the train and finally constructed path delivered by the IM. In this functionality, the acceptance procedure should be supported (observations, post processing of the offers). After acceptance of the path, it can be linked to the particular train object. In other words, the timetable/schedule for the train is provided.

However, support for updates and modifications is necessary, according to the business landscape. In this module, the handling of the modifications, cancellations, alterations and conversion from slot to path must be provided.

For each update/modification/cancellation, the linking of the train and path object is checked and updated where necessary.

Supported functionalities of the module:

- Planning, requesting and border harmonisation of the ATT, RP and ATT placed after deadline requests
- Conflict resolution for all requests placed on time
- An observation related to the draft offer and related to the offered slot for upcoming TT period(s) in case of RP
- Acceptance/final allocation
- Withdrawal of requests (full or partial of initial path) or making minor/major changes to the path request

RU aspects	Managing the path requests
○ Local activities	
○ Central activities	
IM aspects	Managing the path requests
○ Local activities	
○ Central activities	
Inputs	
Outputs	
TAF/TAP compliance	

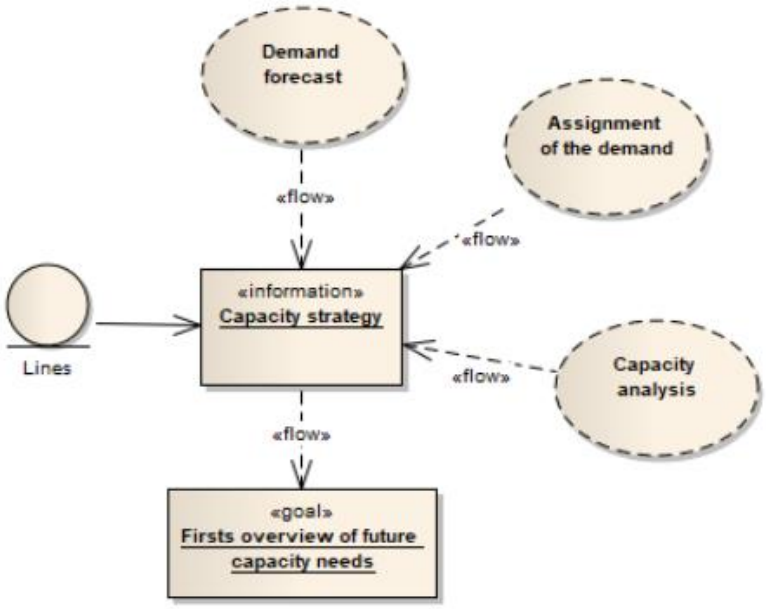
○ Objects	Train, number of trains per line
○ Messages	PathRequestMessage, PathDetailsMessage, PathCoordinationMessage, ReceiptConfirmationMessage, PathConfirmedMessage, PathRefusedMessage, PathCancelledMessage, ObjectInfoMessage, UpdateLinkMessage
Notes:	
Correlation with other modules	

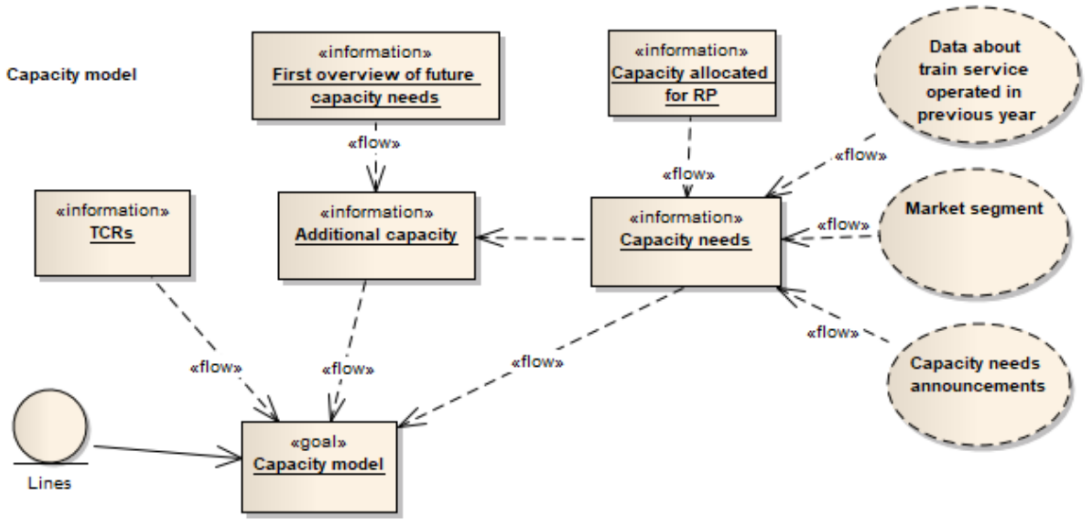
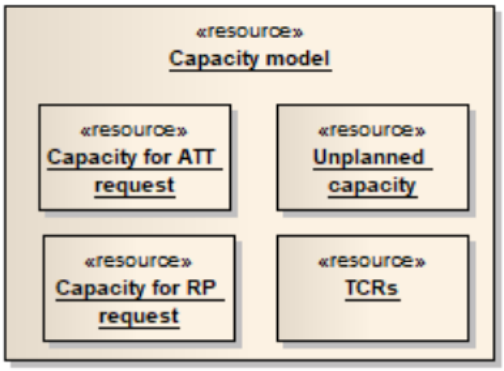
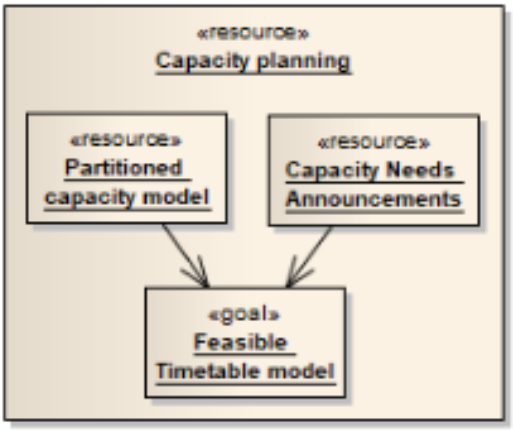
All RU-specific modules listed above shall utilise the Messaging module or GUI of the Capacity Hub, as defined above.

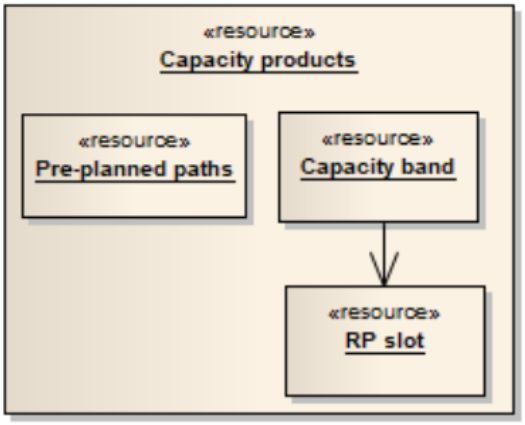
3.4. Information Layer

In the capacity strategy, all reliable information on new market needs, a possible new TCR concept (including known maintenance windows) or additional capacity on principal lines and nodes should be shared between involved IMs as soon as possible. Exchange of information between IMs on a regular basis and updates should be made in an internationally standardised format through national and international communication platforms. As an international platform, the Messaging module shall be used. The same Messaging module could be used for national communication between RUs and IMs as well.

In this early stage of planning (X-60 to X-36), the modules used for the capacity model (see below) can also be used for data exchange, but with less detailed data.

Capacity strategy (X-60 to X-36)	 A capacity strategy is a precondition for the development of a capacity model for a line, a part of the network, or the entire network. The major aim is to provide a first overview of future capacity needs.

Capacity model (X-36 to X-18)	 The capacity model is a description of a 24-hour overview reflecting market needs and TCRs with major/high impact. The aim is to provide a more detailed definition of the demand forecast, divided into an approximate share for commercial needs and TCRs (advanced planning).
Capacity partitioning (X-24 to X-18)	 The commercially available part of the capacity model is partitioned according to market needs for use through two operative modes: the capacity for Annual Timetable (pre-planned or just available) and capacity for RP requests.
Capacity planning (X-16 to X-12)	 Based on the partitioned capacity model and capacity needs announcements, a feasible timetable according to axis characteristics model will be elaborated.

Publication Product Portfolio (After X-12)	 Capacity for Annual Timetable requests in form of pre-planned paths and capacity for RP requests in form of a number of possibilities based on capacity bands for a defined time window, including principal characteristics: • Line/section-related • Parameters (length, speed, weight, etc.) • Standard running time

Capacity bands depend on the available information about possible TCRs (including known maintenance windows) and/or additional capacity on principal lines and nodes. These data are published in the form of a number of 'slots' per defined capacity band.

IMs will also take into account demand forecast, capacity analysis, assignment of the demand on lines and capacity investment scenarios (in case the analysis has revealed any bottlenecks) to define the future capacity needs. These capacity (market) needs have a direct impact on the available Rolling Planning slots of the capacity band by filling them up.

Capacity bands are related to the lines, part of the network or the entire network.

In order to be able to request RP capacity for up to 36 months, available RP capacity needs have to be published not only for the upcoming timetable period but also for the two subsequent periods.

Internationally harmonised commercial methods/conditions will prevent the blocking of capacity.

3.5. Technology Layer

The technology layer will focus on the interfaces, especially the usage of the TAF/TAP-compliant common interface for the information exchange model. In this case as well, centralised, local and interfacing (harmonisation and coordination) functions will be covered.

The TTR project will require a centralised IT landscape. Due to the life cycle costs and the strategy of all involved stakeholders, it will become necessary to provide the means for these systems to connect to this central IT landscape. Due to the new capacity approach it will become necessary for Infrastructure Managers to share information regarding available capacity. To ensure stable communication and overcome the problem of having a wide range of national systems, connectors are required.

The TTR IT landscape described in this document can be simplified (in a matter of architecture) and presented with four layers as it is shown on the following picture:

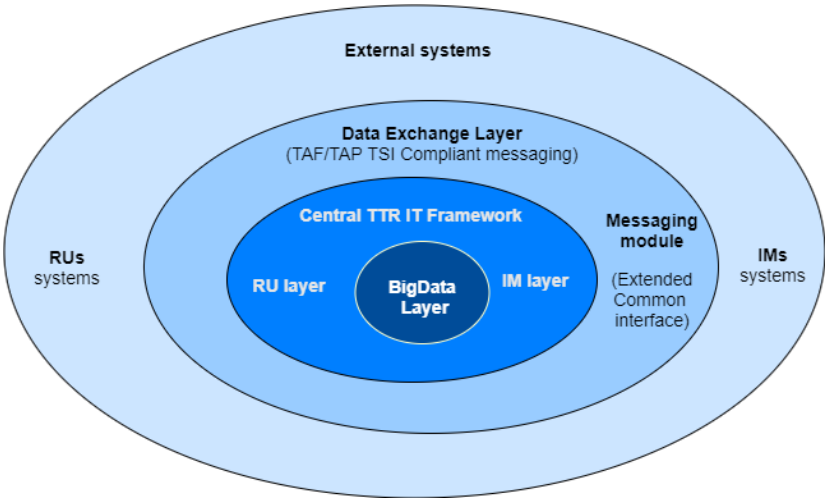


Figure 36 TTR IT Landscape – architecture

The first layer presents the external systems of the stakeholders - the IMs' and RUs' national systems. External systems will communicate with the central TTR IT framework using the common interface (extended with a new functionality) of the Messaging module. The Messaging module is presented on the second layer – the data exchange layer.

The third layer contains IM and RU layers. Those two layers of the central TTR IT framework present central modules and functionalities for RUs and IMs (*explained in chapter 3.3. TTR Modules).* The functionality of the central TTR IT framework uses the RNE Big Data module as a common layer, depicted in the center.

Detailed information about the modules and messages that should be exchanged between modules, as well as the correlation between modules is done in the tables and the sequence diagrams that are created for every module (*see chapter 3.3.*).

3.5.1. Basic Communication between Central and External Systems

National/stakeholders' systems will communicate with the central TTR IT framework via TAF/TAP messages (extended with sector messages like PathCoordinationMessage) through the common interface of the Messaging module. They also have the possibility to use the Messaging module for communication with other RUs or IMs. The common interface shall be used in the Messaging module also due to its functionality of 'reliable messaging' (to prevent communication breakdown between the systems). The common interface is already productively and intensively used in real-time messaging (especially in RNE TIS) and has proven to be a reliable system for messaging by offering the possibilities of storing and resending the messages that failed in the delivery.

The communication will be done similarly as today between national systems and the RNE PCS system.

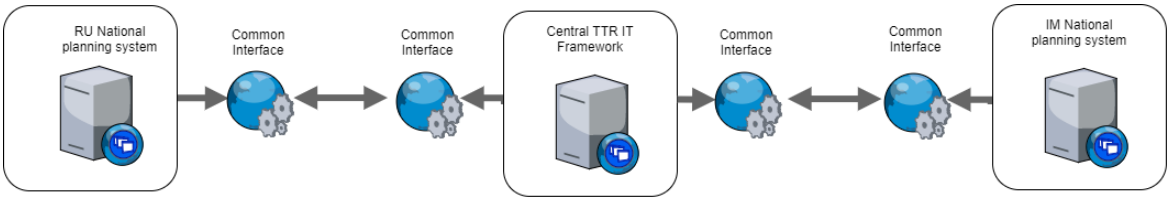


Figure 37 TTR IT Basic communication between systems

The main task for the implementation of the TTR IT landscape on the side of the stakeholders (RUs and IMs) for information exchange with the central TTR IT framework is the implementation of TAF / TAP TSI - compliant messaging. Within the central TTR IT framework the messaging framework of TAF/TAP TSI, enriched with sector messages, will be used.

3.5.2. Messages for Publishing and Announcing Capacity (X-60 to X-11)

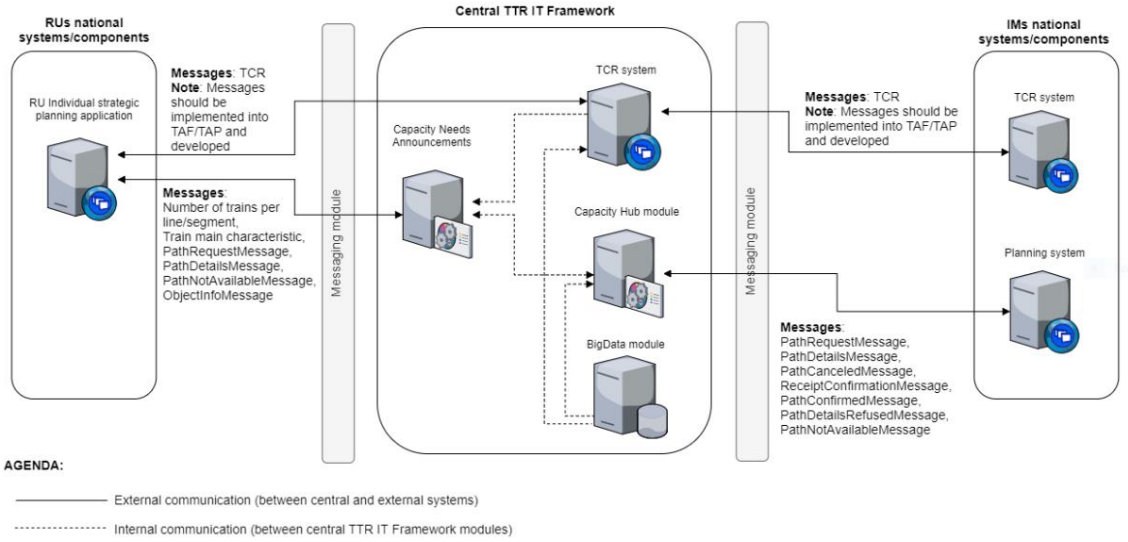


Figure 38 TTR IT messages in the advanced planning period

For the advanced planning, IMs will use the TCR message to send information about a feasible TCR and the PathDetails messages to send information about the available capacity on the network. It is important to mention that a structure of the TCR message is defined as the sector message in the framework of TAF/TAP TSI. It is not part of the mandatory messages in the TAF/TAP. Using the same TCR messages, IMs can coordinate TCRs.

IMs announce TCRs by sending the relevant data to the TCR module. The TCR module informs other involved parties about the new TCR for coordination purposes. During a certain time (*see the TCR sequence diagram*), RUs have the possibility to check and comment on the TCRs that affect them. After the publication of the TCRs, RUs can use (synchronise or export) them in their national systems for planning and preparation of the capacity needs announcements. The new messages have to be defined in the Messaging module which carries this information.

When an RU is ready to announce the capacity needs, the messages about the train, number of trains per line/segment and train main characteristics are sent to the central TTR IT framework in the Capacity Needs Announcements module. All this information is processed by the Capacity Hub module and exchanged with the IMs. The new messages have to be defined in the Messaging module which carries this information.

Based on the relevant IMs' information about TCRs and available capacity, and RUs' capacity need announcement information, the capacity model is prepared. The capacity model construction is an iterative process. The capacity model, as well as partitioning of a line, should occasionally be updated based based on these inputs. Based on the capacity model and capacity partitioning that is prepared in the Capacity Hub module, IMs will work on the complete timetable by combining pre-planned paths, Rolling Planning slots and framework agreement requests from previous years.

The final result of the Capacity Hub module is the capacity product publication.

The messages for coordination between IMs are the PathCoordinationMessages. The new TypeOfInformation codes for this purpose have to be worked out.

3.5.3. Messages for Ordering the Capacity (X-15 to X+12)

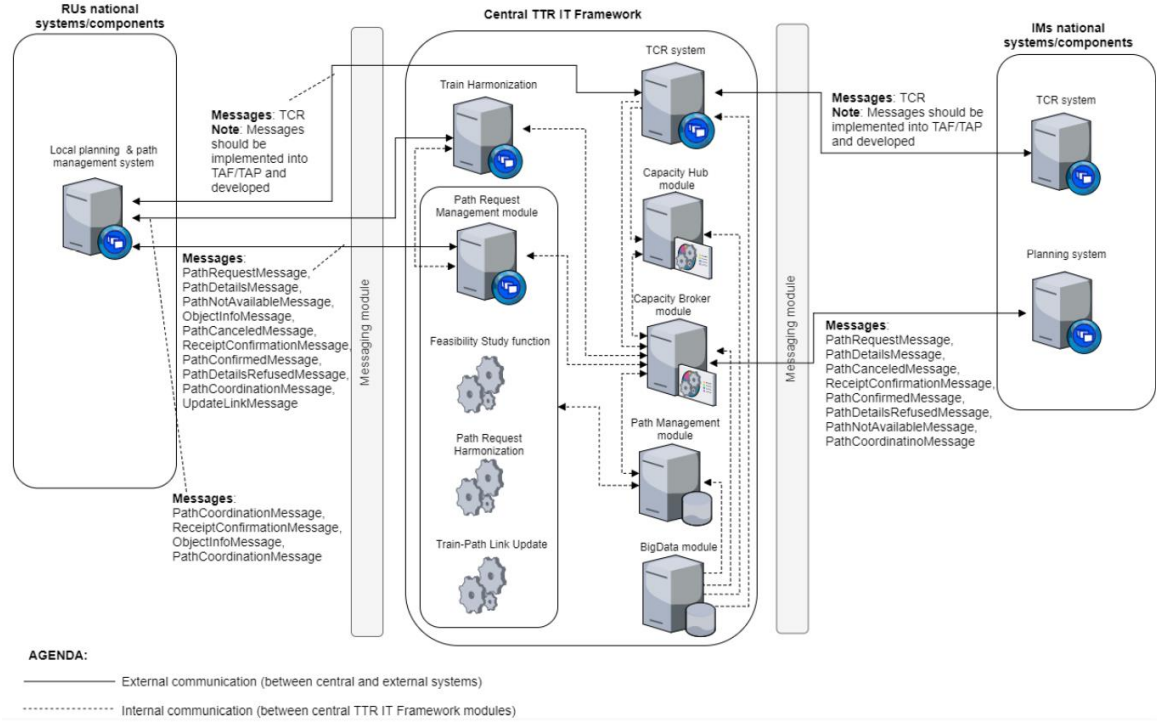


Figure 39 TTR IT messages in capacity ordering period

For ordering capacity/path, RUs will use the Capacity Broker module to exchange path-related messages. Based on published TCRs and the capacity product publication, RUs will prepare and request the capacities/paths and exchange information about the paths using the messages as it is shown on the graphic above.

After the capacity needs announcements, RUs will coordinate train data with other RUs using the Train Harmonisation module. After this data is harmonised, they will start with the path request preparation in their national systems and exchange data with the Path Requests Management module of the central TTR IT framework. First of all, paths in the feasibility study phase will be harmonised with the IMs. After that, RUs will start with requesting Annual Timetable and Rolling Planning capacity. This data will be processed by the Capacity Broker module, taking into account TCRs and capacity product publication and through the Path Management module exchange with the IMs. RUs may request information about the capacity from the Capacity Broker by using the ObjectInfoMessage (sector message in the TAF/TAP TSI framework). For requesting, the communication between the Path Request Management module and the Path Management module will be supported by utilisation of the PathRequestMessage.

Messages that will be exchanged between the central TTR IT framework and IMs' systems are path-related messages, such as the PathCoordinationMessage, PathDetailsMessage, forwarding of PathRequestMessages from RUs and so on. A detailed description of the communication is provided in the sequence diagram of the Capacity Broker module (*see chapter 3.3 TTR modules*).

3.6. IT Infrastructure Layer

The IT infrastructure layer for the central TTR IT framework will be worked out after final agreement on the modules within the TTR IT landscape that will be implemented. The housing and hosting of the modules as microservices will be specified accordingly.

For the stakeholders (RUs and IMs) it is important that their current infrastructure, which is planned to be used for fulfilment of TAF/TAP TSI, will be fully used here, and no significant changes are foreseen.

4. Migration Plan 'As-Is' to 'To-Be'

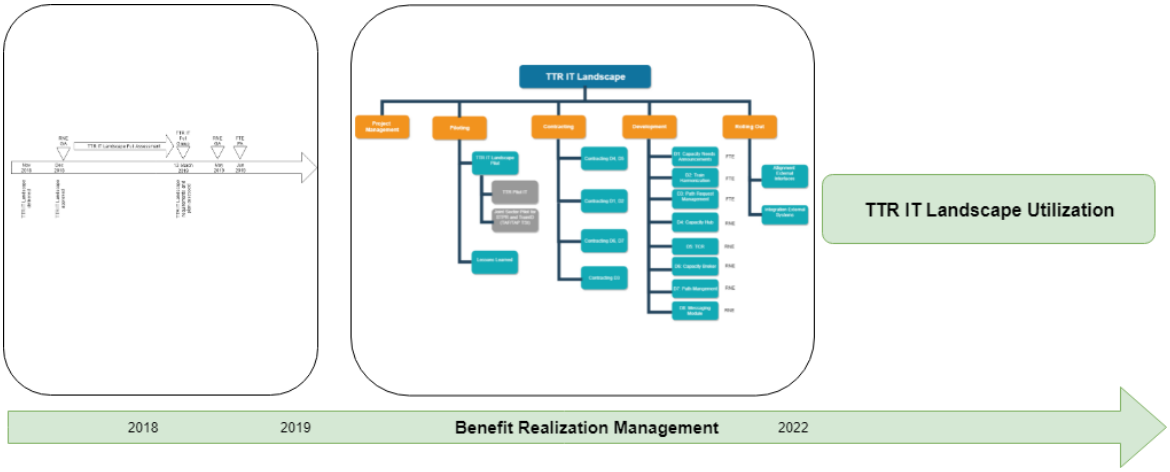


Figure 40 TTR IT – Benefit realization management: from TTR IT Landscape document (2018-2019) to the TTR IT Landscape utilization

4.1. Migration Scope

4.1.1. Migration Scope Statement

Deliverables are organised according to the modules that will be delivered by this project implementation. In the following, information is provided on which organisation is 'accountable' for each module, as well as a short description, prerequisites and acceptance criteria.

Deliverables:

- **Deliverable 1**: Capacity Needs Announcements
  - Accountable: FTE
  - Short description: The Capacity Needs Announcements module feeds the Capacity Hub with capacity needs of RUs
  - Prerequisites:
    - Definition of all attributes for capacity needs announcements by the TTR process concept

        - TTR process and TTR IT landscape commitment of FTE PA (Plenary Assembly)
        - Messaging module ready
    - Acceptance criteria:
        - All parameters defined int the TTR process for capacity needs announcements are included and processed in the tool
        - Successful communication with Messaging module
        - Successful information exchange with Capacity Hub according to the specification

- **Deliverable 2**: Train Harmonisation
    - Accountable: FTE
    - Short description: The Train Harmonisation module is a microservice which serves primarily for RUs to create the train object, harmonise the train route, train schedule and train composition. The train routes and schedules from the Train Harmonisation module will be further used by the Path Request Module for path request harmonisation and preparation.
    - Prerequisites:
        - Definition of all attributes for capacity needs announcements by the TTR process concept
        - TTR process and TTR IT landscape commitment of FTE PA (Plenary Assembly).
        - Messaging module ready
    - Acceptance criteria:
        - Train object with identifier created
        - Train route, schedule and train composition created
        - RU timetable prepared for usage for Path Request Management module
    - Dependency: The success of the implementation of this module depends on:
        - Messaging module

- **Deliverable 3**: Path Request Management
    - Accountable: FTE
    - Short description (functions): The Path Request Management module is the most important module for RUs for dealing with path request, path offer and updates of the timetable for any reason. This module consumes the information from the Train Harmonisation module and has intensive data exchange (path request, path offer, updates) with the Path Management module from IM layer. The idea of this module is similar to today's PCS, but with the separation of RU and IM concerns.
        - Path request harmonisation
        - Path offer acceptance
        - Updates
            - Path modification
            - Path cancellation
            - Acceptance of path alteration by IM
            - Rolling Planning yearly updates
    - Acceptance criteria:
        - Path request submission – receipt confirmation from Path Management module
        - Path offer reception
        - Path modification procedure support (according to TAF/TAP)

        - Path cancellation procedure support (according to TAF/TAP)
        - Processing of path alteration according to TAF/TAP
        - Processing of Rolling Planning updates for an upcoming timetable, according to the TTR process specification
    - Dependency: The success of the deliverable depends on:
        - Messaging module
        - Train Harmonisation module
        - Path Management module
        - Capacity Broker

- **Deliverable 4**: Capacity Hub
    - Accountable: RNE
    - Short description: The module serves for the preparation of capacity products by IMs, by supporting their coordination through interface communication.
    - Acceptance criteria:
        - Communication with IM domestic systems successful
        - Data from IM domestic systems reflected in Capacity Hub
        - Capacity products harmonised
    - Dependency:
        - Messaging module
        - Implementation of IM domestic interfaces for feeding the Capacity Hub
        - TCR implementation

- **Deliverable 5**: TCR
    - Accountable: RNE
    - Short description: tool for coordination and publication of TCRs
    - Acceptance criteria:
        - TCRs harmonised/coordinated
        - TCRs published
    - Dependency:
        - Messaging module
        - Implementation of IM domestic interfaces for feeding the TCR tool

- **Deliverable 6**: Capacity Broker
    - Accountable: RNE
    - Short description: intelligent module for brokering of published capacity products upon request from RUs and for automatic real-time updates about the availability of the capacity products by the IMs
    - Acceptance criteria:
        - The feasible combining of capacity products upon request
        - Successful two-way communication with IMs' domestic systems for real-time updates on capacity availability
        - Successful communication with modules:
            - Capacity Hub
            - Train Harmonisation
            - Path Request Management
            - Path Management
    - Dependency:
        - Messaging module
        - Capacity Hub
        - Implementation of IM domestic interfaces for a two-way real-time updates on capacity availability

- **Deliverable 7**: Path Management Service
    - Accountable: RNE
    - Short description: This module is the most similar to today's PCS with a workflow engine for path request process handling. However, the new approach of TTR Rolling Planning must be supported. It must communicate intensively with the Path Request Management module and Capacity Broker.
        - Path elaboration
        - Path offer
        - Updates
            - Acceptance of path modification
            - Acceptance of path cancellation
        - Path alteration
        - Rolling Planning yearly updates
    - Acceptance criteria:
        - Path request processed
        - Path offer created accordingly
        - Path offer coordinated/harmonised between IMs
        - Path alteration processed according to TAF/TAP
        - Path modification and cancellation processed according to TAF/TAP
        - TTR Rolling Planning approach for updates of upcoming timetable fully supported according to the TTR process specification
        - Successful data exchange with Capacity Broker
    - Dependency:
        - Messaging module
        - Path Request Management module
        - Capacity Broker

- **Deliverable 8:** Messaging Module
    - Accountable: RNE
    - Short description
        - As the basis, the current common interface will be used
        - It will be extended with additional communication channels
        - It will be extended with the additional messaging monitoring management for microservices
    - Acceptance criteria:
        - Message routing successful (the message received and delivered from and to the correct address: RU's system, IM's system, central TTR framework system)
        - Message exchange successful (with common interface checking mechanism of reliable messaging)

4.1.2. Migration WBS

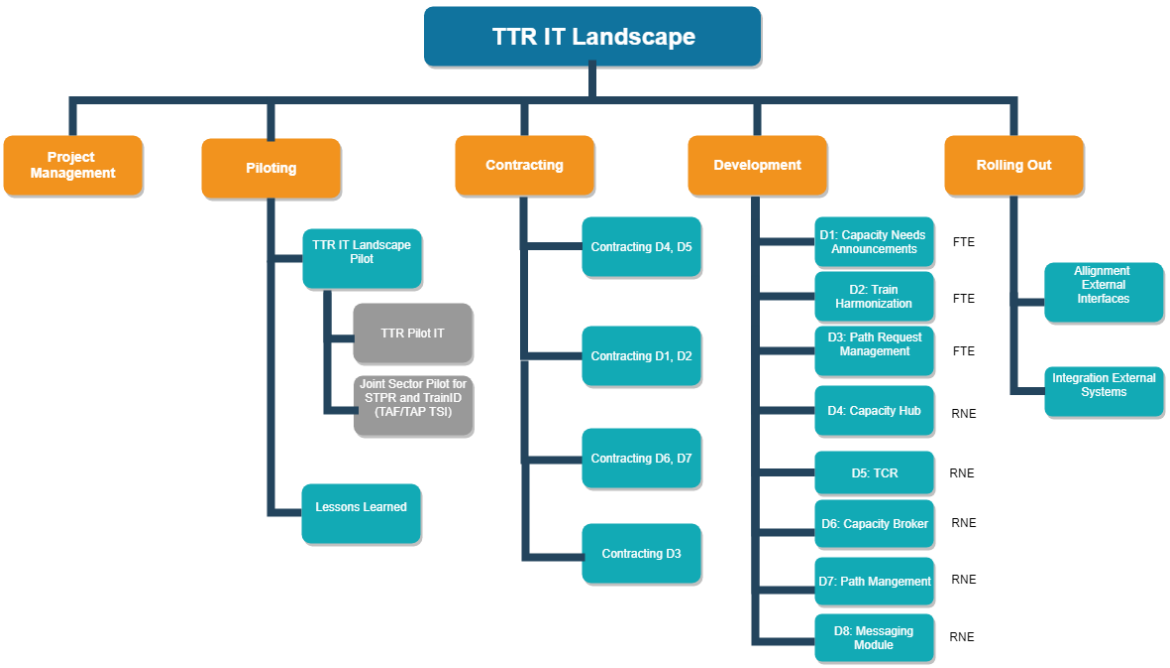


Figure 41 Migration Work-Breakdown Structure (WBS) - simplified

The work breakdown structure (WBS) is made of the following phases and tasks:

Task Name	Description
RNE-FTE-TTR_IT_Landscape	Project name
Project Management	Project management is the workstream that is executed during the whole project implementation
Piloting	This is the workstream where the currently running pilots are taken into account for this implementation
TTR IT Landscape Pilot	
JS Pilot for STPR and TrainID (TAF/TAP)	Joint Sector Pilot for short term path request and TrainID (TAF/TAP TSI): this pilot will provide crucial information on message exchange in the path request process
TTR Pilot IT	The IT needed for the execution of TTR Pilots; this will provide the necessary practical inputs as regards using TTR process
Lessons Learned	Analysis of the pilot results and their relation to the implementation of TTR IT landscape has to be done continuously

Contracting	This is the workstream for tendering. We will do separate tendering for separate modules due to their different implementation schedule and priority for TTR. All modules will be exposed to the contracting procedure, except D8 Message module which will be the continuation of common interface
Contracting D4, D5	Contracting for Capacity Hub and TCR
Documentation preparation for tender D4, D5	
Tendering process	
Contract signing	
Risk buffer	
Contracting D1, D2	Contracting for Capacity Needs Announcements and Train Harmonisation modules
Documentation preparation for tender D1, D2	
Tendering process	
Contract signing	
Risk buffer	
Contracting D6, D7	Contracting for Capacity Broker and Path Management modules
Documentation preparation for tender D6, D7	
Tendering process	
Contract signing	
Risk buffer	
Contracting D3	Contracting for Path Request module
Documentation preparation for tender D3	
Tendering process	
Contract signing	
Risk buffer	
Development	Deliverables of this workstream are the modules described in the TTR IT Landscape document. They all have development and testing as tasks.
D1: Capacity Needs Announcements	
Development	
Testing	
D1: Capacity Needs Announcements in Production	

D2: Train Harmonization	
Development	
Testing with national tools	
D2: Train Harmonisation in production	
D3: Path Request Management	
Development	
Testing with national tools	
D3: Path Request Management in production	
D4: Capacity Hub	
Development	
Testing with national tools	
D4: Capacity Hub in production	
D5: TCR	
Development	
Testing with national tools	
D5: TCR in production	
D6: Capacity Broker	
Development	
Testing with national tools	
D6: Capacity Broker in production	
D7: Path Management	
Development	
Testing with national tools	
D7: Path Management in production	
D8: Messaging Module	
Development	
Testing with national tools	
D8: Messaging module in production	
Rollout	The rollout depends on the implementation of the interfaces from the domestic systems, especially from the IMs to the central TTR IT framework, especially regarding Capacity Hub, TCR and Capacity Broker
Alignment external interfaces	Domestic implementation according to the TTR process
Integration external systems	Final integration of the external (IM or RU) systems into the central TTR IT framework

4.2. Migration Timeline

The timeline for implementation lasts from the beginning of 2019 until the end of 2024.

The implementation of the deliverables given in the WBS will be handled as separate sub-projects with their own timelines, however, while taking care of the interdependencies of the modules on each other.

For the implementation of the deliverables, the contracting must be done, therefore, the WBS contains the contracting phases for different deliverables.

The deliverables D4 (Capacity Hub) and D5 (TCR) need to be developed first. When these modules are stabilised, D6 and D7 can be developed. According to the planned implementation, the contracting has been scheduled.

Due to the complexity of the deliverables and their different timelines in development, it is not feasible to carry out the contracting for all the modules at the same time.

The timeline according to the WBS is provided as a Gantt chart:

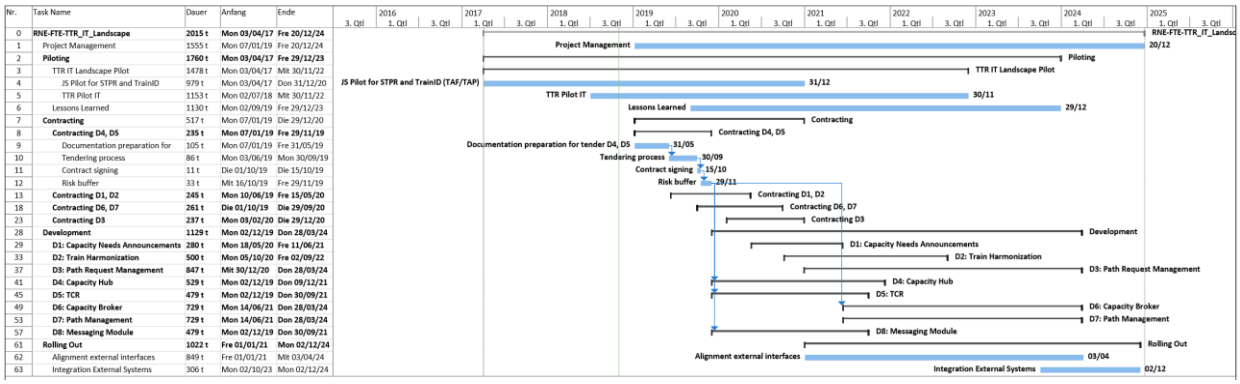


Figure 42 TTR IT Landscape implementation Gantt chart (visible with zoom). This Gantt chart is a simplified view of the whole project.

This is the table containing the tasks according to the WBS and the proposal for the duration (start/end date).

Task Name	Duration	Start	End
RNE-FTE-TTR_IT_Landscape	**2015 d**	**Mon 03/04/17**	**Fri 20/12/24**
Project Management	1555 d	Mon 07/01/19	Fri 20/12/24
Piloting	**1760 d**	**Mon 03/04/17**	**Fri 29/12/23**
TTR IT Landscape Pilot	1478 d	Mon 03/04/17	Wed 30/11/22
JS Pilot for STPR and TrainID (TAF/TAP)	979 d	Mon 03/04/17	Thu 31/12/20
TTR Pilot IT	1153 d	Mon 02/07/18	Wed 30/11/22
Lessons Learned	1130 d	Mon 02/09/19	Fri 29/12/23
Contracting	517 d	Mon 07/01/19	Tue 29/12/20
Contracting D4, D5	**235 d**	**Mon 07/01/19**	**Fri 29/11/19**
Documentation preparation for tender D4, D5	105 d	Mon 07/01/19	Fri 31/05/19

Tendering process	86 d	Mon 03/06/19	Mon 30/09/19
Contract signing	11 d	Tue 01/10/19	Tue 15/10/19
Risk buffer	33 d	Wed 16/10/19	Fri 29/11/19
Contracting D1, D2	**245 d**	**Mon 10/06/19**	**Fri 15/05/20**
Contracting D6, D7	**261 d**	**Tue 01/10/19**	**Tue 29/09/20**
Contracting D3	**237 d**	**Mon 03/02/20**	**Tue 29/12/20**
Development	**1129 d**	**Mon 02/12/19**	**Thu 28/03/24**
D1: Capacity Needs Announcements	**280 d**	**Mon 18/05/20**	**Fri 11/06/21**
D2: Train Harmonisation	**500 d**	**Mon 05/10/20**	**Fri 02/09/22**
D3: Path Request Management	**847 d**	**Wed 30/12/20**	**Thu 28/03/24**
D4: Capacity Hub	**529 d**	**Mon 02/12/19**	**Thu 09/12/21**
D5: TCR	**479 d**	**Mon 02/12/19**	**Thu 30/09/21**
D6: Capacity Broker	**729 d**	**Mon 14/06/21**	**Thu 28/03/24**
D7: Path Management	**729 d**	**Mon 14/06/21**	**Thu 28/03/24**
D8: Messaging module	**479 d**	**Mon 02/12/19**	**Thu 30/09/21**
Rollout	**1022 d**	**Fri 01/01/21**	**Mon 02/12/24**
Alignment external interfaces	849 d	Fri 01/01/21	Wed 03/04/24
Integration external systems	306 d	Mon 02/10/23	Mon 02/12/24

In the Gantt chart and in the table provided above, not all details of the project plan are shown, for simplicity reasons. The plan with all details is being provided separately. Each delivery D1-D8 has the sub-tasks of development and testing and ends with the milestone ‘deployment in production’.

4.2.1. Migration Organisation and Responsibilities

Organisations (stakeholders) involved in TTR IT landscape:

- FTE
- RNE
- IMs
- RUs

4.2.2. Migration Budgeting

To be defined by the stakeholders.

4.2.3. Migration Risks

Risk 1: Non-commitment to the process by the stakeholders

Risk 2: Failure of the TTR pilots

Risk 3: Non-inclusion of TTR IT implementation in the project portfolio of all stakeholders

Risk 3: Delay in TAF/TAP TSI technical implementation

4.3. Project Portfolio

In the project portfolio, we will consider the projects known to the community (not company internal projects) which may influence the landscapes. Nevertheless, the stakeholders are advised to investigate internally the influence of their domestic projects.

- ✓ TTR:
  - Timeline and milestones for the TTR Implementation Programme will be provided
  - The activities regarding IT improvement as well as the IT requirements specification and implementation for the TTR pilots within the programme will be provided
- ✓ TAF/TAP TSI
  The strong interrelation between TAF/TAP projects and TTR developments is expected and will be thoroughly investigated.
  - Comparison with the common master plans for TAF/TAP implementation must be drawn
  - Comparison with the domestic master plans for TAF/TAP regarding the short term path request will be done during the IT landscape investigation
  - TAF/TAP pilot for short term path request and TrainID
  - Joint sector pilot for TAF/TAP TSI short term path request and TrainID
    - The aim is to link this activity with the TTR pilots – this will be investigated and planned in detail
- ✓ RNE TCR tool development
  - The initial development plan will be communicated
  - The further development of interfaces to the central TCR tool will have to be established; for this purpose, the IT requirements specification, based on the TO-BE IT landscape analysis will be provided
- ✓ RNE PCS development / maintenance
  - The ongoing developments and the release plan of PCS must be provided and compared with the TTR activities; the result of the AS-IS IT landscape and TO-BE analysis may strongly influence the release planning of PCS
- ✓ RNE common application database Big Data
- ✓ Projects to fulfill the performance reference model: this model serves for delivering ‘numbers’. These ‘numbers’ are represented as Key Performance Indicators (KPIs). It will be necessary for TTR implementation to establish the measurement methods for process efficiency, including KPIs. For this purpose, there may be projects established within the TTR Implementation Programme, with their own timeline-streams.

TTR

The TTR project introduced an innovative approach to the timetabling process: the provision of information regarding available capacity ('Capacity Approach'). This capacity needs to be shaped – starting five years in advance – and it needs to be kept up-to-date in day-to-day business, thus providing the means to respond fast to international path requests.

The Capacity module would serve as a first module to contain all internationally available rail capacity. It would serve as a baseline for path requests and as a hub for all international coordination of available and restricted capacity. The Capacity module will be part of PCS and will closely interact with the TCR tool. Therefore, dynamic capacity calculations will be offered in real time to the user through PCS.

The TTR results have been agreed by RNE and FTE in May and June 2017 with several components to be implemented. RNE and FTE also agreed on conducting pilots in the implementation phase. The TTR project has five sub-projects:

- TTR Legal Framework
- TTR Pilots
- TTR Process Implementation
- TTR Workflow Implementation
- TTR IT Landscape

A major goal of the TTR IT Landscape sub-project is the definition of the content of the IT landscape – architecture, elements, connections/interfaces, national IT requirements, creation and execution of actions which will lead from the current state to the defined IT landscape and special focus to the further use of PCS within this TTR IT landscape.

All stakeholders use the same standards and connect to one single point while still using their national systems. All IT connects at one central point and uses TAF/TAP TSI as major IT pillars to support TTR.

TAF/TAP TSI

The purpose of the TAF/TAP TSI is to define Europe-wide procedures and interfaces between all types of railway industry actors. The TAF/TAP TSI framework represents and reflects the currently used timetabling process. In order to track trains across borders, from planning to operation, the sector agreed on the structure of the TrainID as a core identifier of the business. In a pilot project, the sector will prove the usability of the TrainID focusing on the short-term path request process.

As the TTR project will change the timetabling process, the TAF/TAP TSI framework (messages, workflow and data structure) should be reviewed. New steps, new actors, and new sub-processes will appear and might result in changes to the TAF/TAP TSI framework.

The common interface (within the TAF/TAP TSI framework) provides a standard connection possibility among legacy systems and international capacity tools (such a PCS, TCR). As these connections and synchronisation have a high priority for the Capacity module, an update of the process and structure of TSI messages (provided by the TAF/TAP TSI workflow) will be necessary. TrainID serves as a basic and unique identification for this process. The currently defined structure of the identifier could fulfil the core identification requirement even after the rollout of the TTR project.

End date of this project is November 2019.

TSI-Compliant PCS Mandatory Interface

Currently, in order to request a path for international service, an applicant may (in accordance with the RNE agreement) present its request through PCS and/or a national system. Even though some IMs/ABs implemented a possibility to automatically synchronise the international train path request data between national systems and PCS, in most cases, a data interface is manually processed by IMs/ABs/RUs. This double work leads to a waste of human resources of IMs/ABs or additional costs for RUs in case that it is provided as a paid additional service. For this reason, PCS is mostly used for new path requests only and just in the active timetable phase at the end of August. And this happens at the time when IT solutions are widely available in the era of digitalisation.

The main goals of this projects are:

- To develop a mandatory interface of national systems to PCS within the scope of the functionalities that are generally accepted starting with the TT 2022
- To ensure that an applicant is required to place its path request only once and data are up-to-date in both national systems and PCS, and continuously synchronised
- To lay down definite responsibilities & obligations of the involved parties and effective commercial & financial conditions in the PCS Interface Agreement for Users
- A common implementation timeline for the interfaces and process is in place to secure the full benefits

Benefits of this project are:

- The current double work, which is wasting human resources either of IMs/ABs or of applicants, will be significantly reduced
- Having PCS constantly updated, IMs/ABs/RUs will benefit from an international central common application, which provides up-to-date information and is in compliance with the TAF/TAP TSI standards. PCS would be the pilot system for TAF/TAP TSI implementation and the first step in the TTR IT landscape implementation and use of common design of process details
- RUs requested to enforce the use of PCS in the ‘Memorandum of Understanding for the planning of international rail freight’; this project will lay new ground for this intention
- Data consistency check together with data quality control is ensured; IM-IM and RU-RU communication would be more effective

By implementing the TSI-compliant PCS mandatory interface, the current double work will be significantly reduced. The interface development is not mandatory, where it has no economic justification (a very low level of performance). In this case, it will be obligatory to keep the data up-to-date manually by the IM/AB. A data consistency check and data quality control will help to have a more effective international timetable process.

The IMs/ABs that are committed to developing the interface to PCS, will develop it in the timeframe set by the implementation plan. In case of delay, the IM/AB keep the data in both systems up to date manually for this transitional period, according to an RNE recommendation.

End date of this project is November 2021.

RNE TCR Tool Development

Temporary capacity restriction (TCR), an umbrella term in the railway sector for various types of construction works and events which lead to a reduction of infrastructure capacity, are one of the main disrupting factors in timetabling: Even though they ultimately contribute to establishing a sound and stable rail infrastructure, as a short-term result numerous trains have to be re-routed, replaced or even cancelled on their account, and passengers as well as the freight traffic are confronted with delays. Particularly in an international context, TCRs play a major role as – due to a deployment of various planning systems and a lack of communication – the cross-border traffic is affected even more strongly.

It is very important to have a Europe-wide tool to harmonise the TCRs on the borders. The main objectives of the TCR tool are:

- Providing a graphical overview of TCRs (Europe-wide)
- Implementation of information exchange between IMs
- Harmonisation of TCRs between IMs

The main benefits of the TCR tool are: providing a harmonised platform for all RFCs and the rest of the international network, providing information for customers far in advance and finally, with fully working interfaces between national systems and the TCR tool, no parallel work will be needed. Further, IMs consult neighbours when deciding about new or modified TCRs to guarantee optimal use of capacity and the focus is on reducing the TCR impact on traffic at international level (and not nationally oriented on costs). The IMs plan their TCRs a long time in advance to avoid big changes before the start of the TCRs.

The TCR tool is developed and currently in the pilot phase on four RFCs. After finalisation of the pilot phase, the needed improvements in the TCR tool should be done, the technical interface to exchange data with national systems developed and the TCR tool ready for rollout on all RFCs.

End date for these developments is November 2020.

RNE PCS Development / Maintenance

PCS is the most important tool for the TTR project and will be the basis of the future TTR tool.

The current situation is that RFCs are not able to publish capacity bands in PCS but only identical paths. Infrastructure data of PCS is still stand-alone and not integrated with other RNE applications nor RNE Big Data. This creates additional maintenance effort for IMs and a gap for the coverage of the full train life cycle.

At the same time, the JS Short-term Path Request and TrainID pilot is running, and will be finished by the end of 2019. Preparation is needed for the deployment in production.

The main goals of this development are the following:

1. To increase the functionality of PCS
2. To make the new features available with the next PCS releases in April 2019 and November 2019
3. To increase the level of cooperation between all involved parties (RNE, IMs, RUs, RFCs)
4. To provide regularly updated release and rollout plans

The content of the major releases in 2019 is:

1. Integration to RNE Big Data
2. Deployment of PCS Common interface (CI) in production
3. Specification of Rolling Planning

Infrastructure data will be in permanent synchronisation with RNE Big Data and the CRD database. With this and the production-ready PCS CI, PCS gets a new endpoint for interface connection.

Developments in, and analysis of, the PaP and RFC areas and the specification of Rolling Planning are essential elements for a smooth implementation of TTR.

End date of these developments is November 2019.

PaP Migration to TTR

In order to meet market requirements, Rolling Planning should be created to enable requests for high-quality paths at any time. The railway sector uses the PaP Product in the timetabling process at this moment, however, TTR does not use the term PaP anymore and the functional state of PaP is even not entirely in line with the Rolling Planning approach. Therefore, the PaP product could not be used in the future desired timetabling process.

The main goal of migrating PaPs to the Rolling Planning is to avoid development of an entirely new product using a maximum of already developed ones (e.g. the implementation of bandwidths in the major PCS release 2019). Another goal is to fully adopt the PaP to the Rolling Planning concept by transferring it to the safeguarded capacity element of the TTR.

Benefits of that project are:

- All modification required by the TTR implementation would be provided within the established IT-tool (PCS), therefore, no significant investments are required from RNE side
- The safeguarded capacity for Rolling Planning element would be based on the current PCS environment, therefore, no significant investments are required from the RNE stakeholders, as they can use their already developed interfaces

RNE Common Application Database 'Big Data'

Currently, all RNE systems (PCS, TIS, CIP, CIS, TCR) have their own network topology database and are more or less independent of the Central Reference Files Database. Any changes provided by IMs to the CRD are not automatically synced with the databases of these systems. Because of this, there is a high level of data redundancy and topology changes must be applied independently on each system.

The goal is to unify the network topology database for all RNE systems by making this database centrally available for them. All RNE systems will integrate with the Big Data database and be able to consume network topology data from it.

Integrating all RNE systems with Big Data would remove data redundancy, improve data quality in each of these systems and reduce the efforts of maintaining these databases.

The Big Data database integrates the CRD (all updates in CRD by the stakeholders are immediately mirrored in Big Data) and will integrate with RINF database in the future as well, to avoid the need that IMs deliver their data in more than one place.

End date of this project is January 2019.

Appendix 1 Figures of the Basic IT Analysis

The appendix will contain the content of the endorsement presentations of the TTR WG 4 (IT).

Appendix 2 Potential additional module

Sales Module

Commercial Conditions

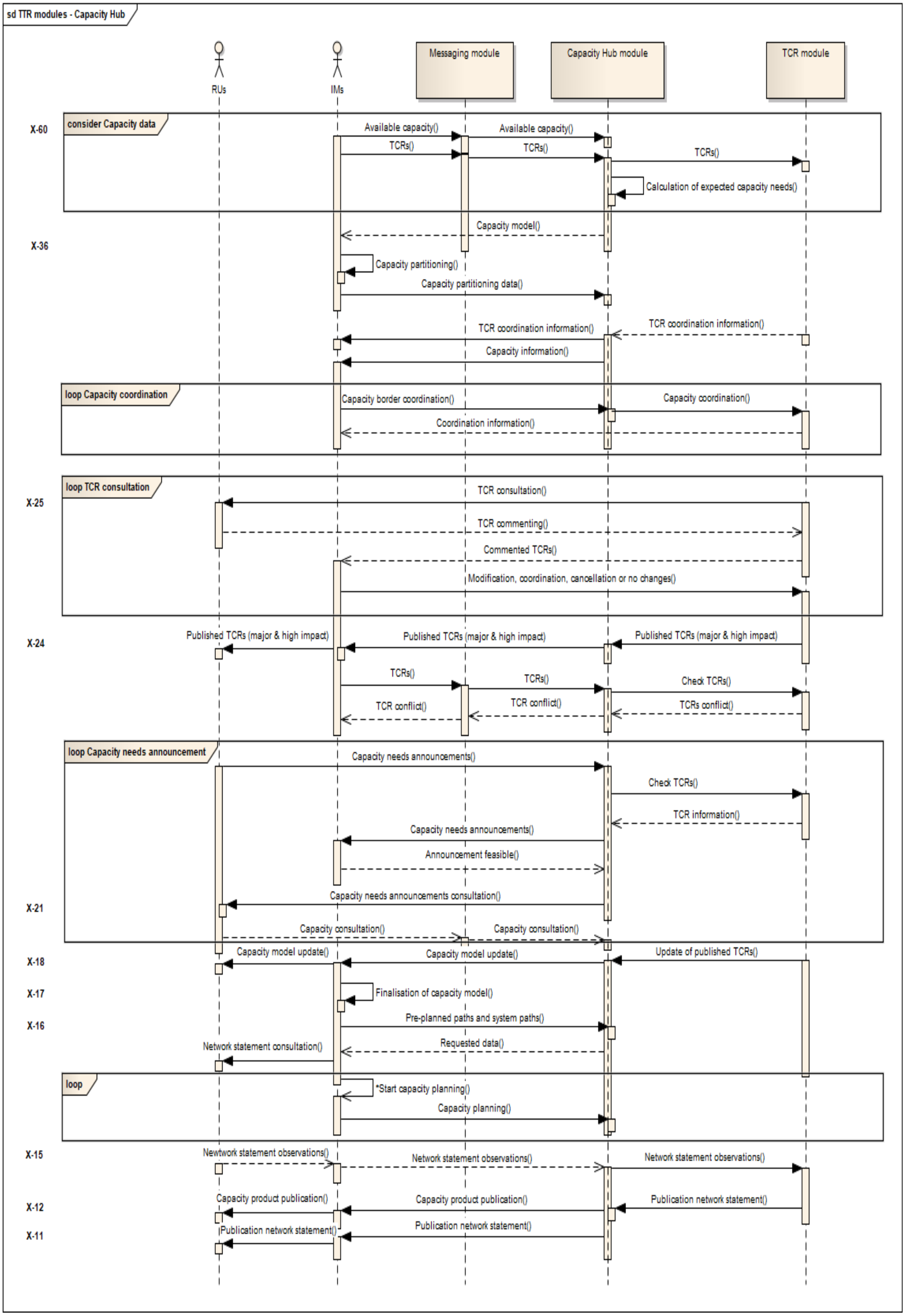
According to the commercial conditions project request and after completing all the necessary aspects of the commercial conditions, the document may be updated (or an annex could be created) to cover the following processes:

- Commercial conditions by tracking path cancellations, modifications and alterations (to be finalised by the TTR Commercial Conditions group by the end of May 2019)

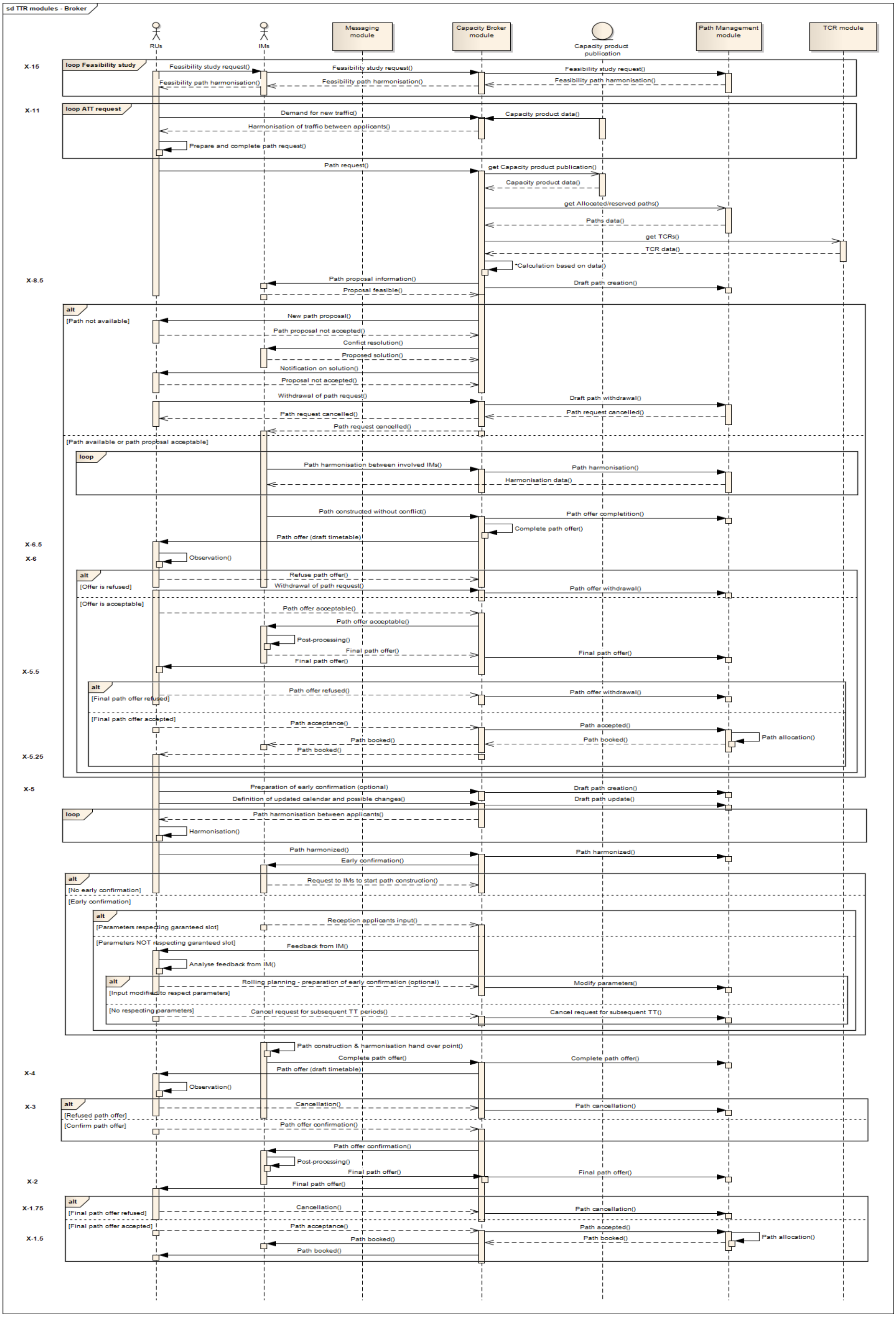
Charging Information Module

Provision of charge estimates. To be elaborated on by the CIS CCB and a final decision will be made by autumn 2019.

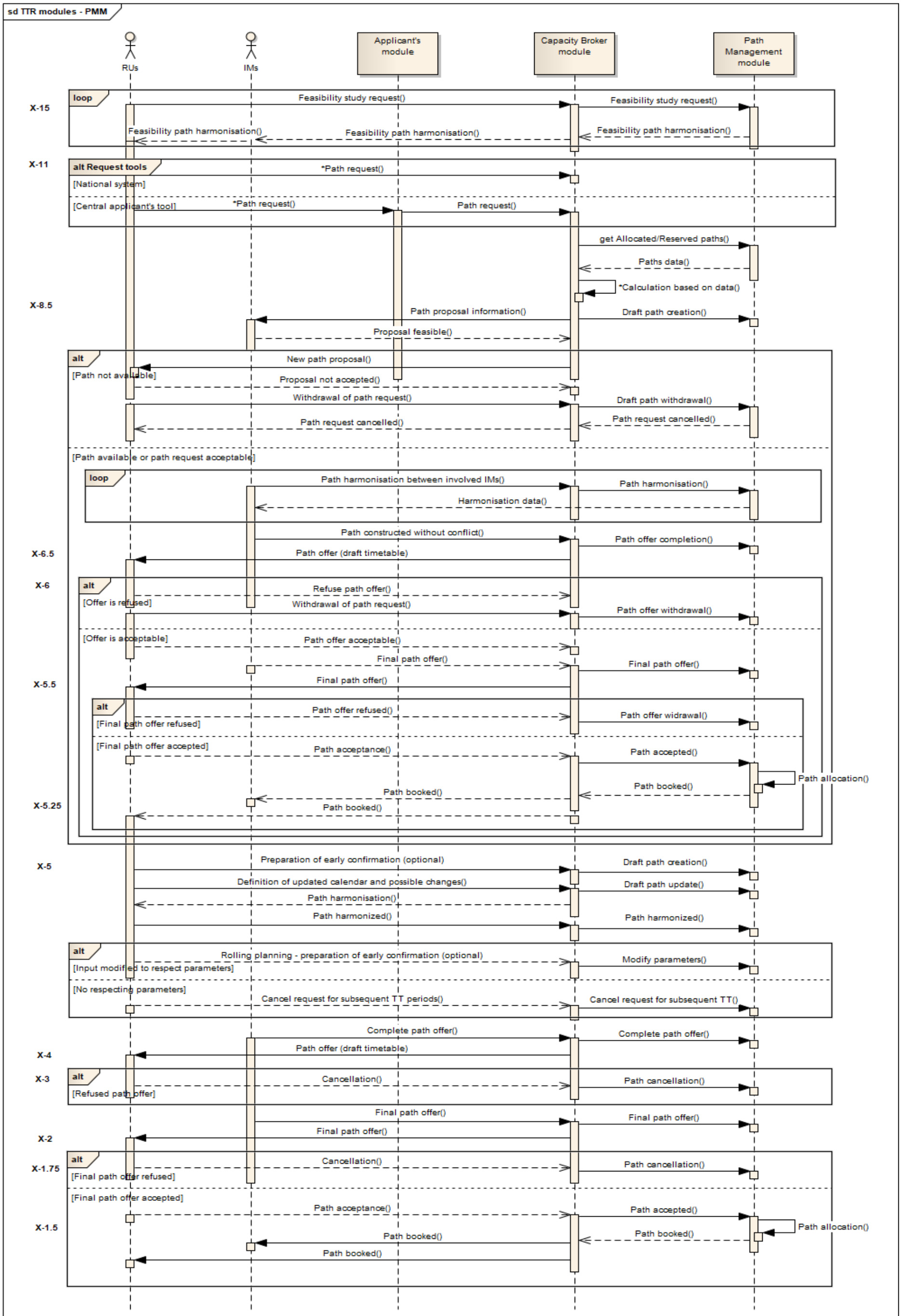
Annex 1: Capacity Hub module - sequence diagram



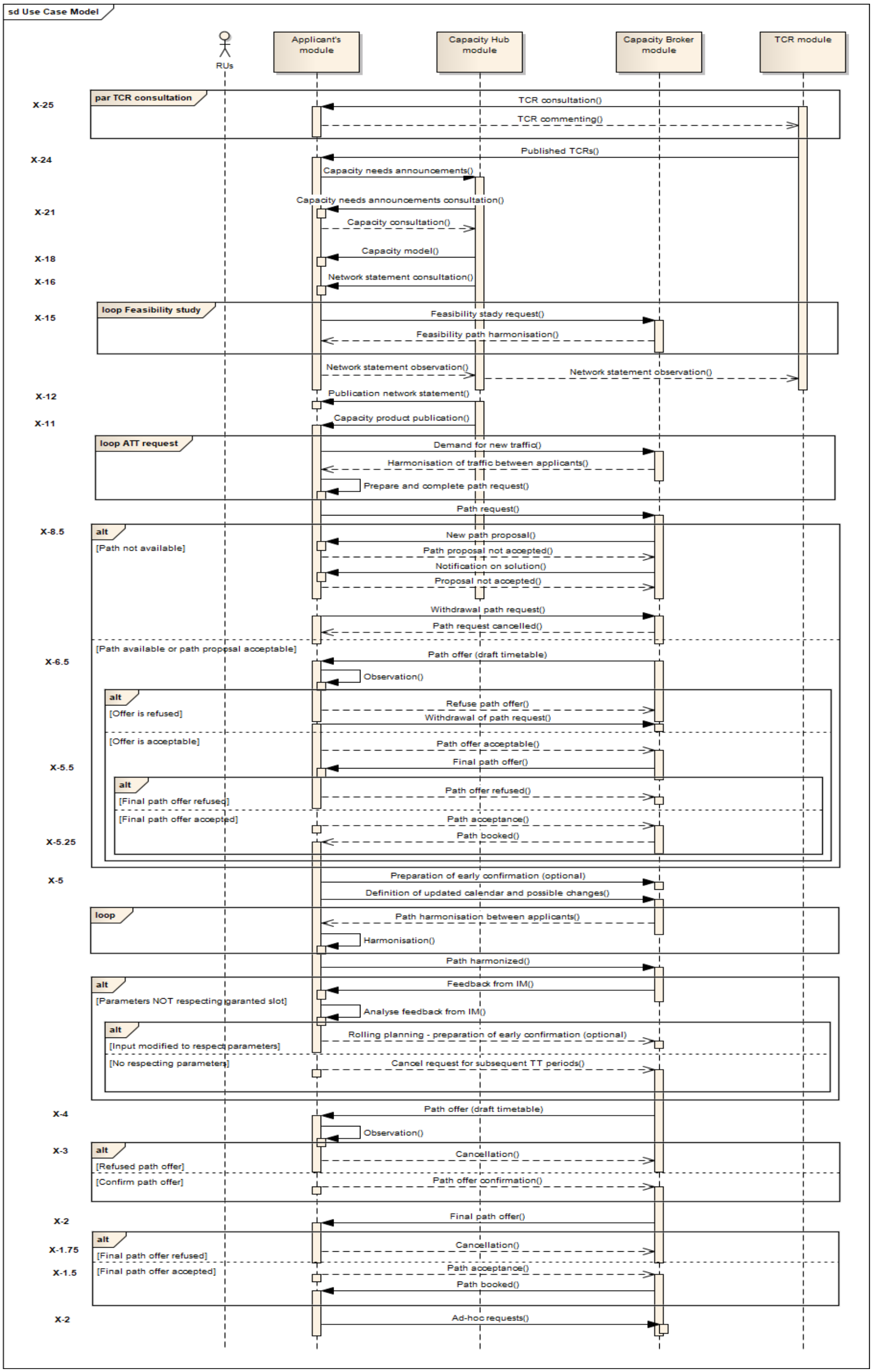
Annex 2: Capacity Broker module - sequence diagram



Annex 3: Path Management module - sequence diagram



Annex 4: Applicant's module – sequence diagram



Annex 5: Draft TTR implementation plan

First use		ID	Element	Change Management		Legal		IT		Commercial Conditions	
Capacity strategy	X-41	1	Capacity Strategy form	yes	A short document describing the main principles of capacity planning including all types of capacity needs.	no		no		no	
	X-41	2	Input data	yes	Demand forcast, capacity analysis, capacity investment scenarios	no		yes	National tool and Capacity Hub incl. Messaging module receiving inputs from stakeholders x-30	no	
	X-41	3	IM harmonisation	yes	Agreement of the parameters (incl. volume).	no		yes	National tool and Capacity Hub supporting exchange of information between IMs x-30 incl. Messaging module	no	
	X-41	4	Involvement of stakeholders	yes	Preceadures for consultation with neighbouring IMs, further possible involved IMs, applicants, RFCs, MoT, Terminals	no		yes	National tool and Capacity Hub supporting communication between stakeholders incl. Messaging module x-30	no	
Capacity model	X-30	5	Form	yes	List of relevant files showing capacity description, published description of the CM and CP process with the tasks and involvment of stakeholders	yes	FCAs as an input to the Capacity Model	yes	National tool and Capacity Hub supporting visualisation of capacity x-30	no	
		6	Types and needs of capacity (i.e product portfilio) have to be defined			no				no	
	X-30	7	IM harmonisation	yes	Institutionalised procedure of intra-IM coordination, meetings, exchange of information	no	Annex VII already in place	yes	National tool and Capacity Hub supporting communication between IMs	no	
	X-30	8	Involvement of stakeholders	yes	Institutionalised procedure regarding the involvement of stakeholders (X-36 until X-16)	no	Annex VII already in place	yes	National tool and Capacity Hub supporting communication between stakeholders and to indicate their future needs	no	
	X-30	9	TCRs (with major impact)	yes	Institutionalised procedure of Major TCRs publishing x-24 ÐX-26 start coordination, X-25 consultation with stakeholders.	no	Annex VII already in place	yes	National tool and Capacity Hub supports displaying TCRs, TCR module and intefaces between hub and TCR tool	no	
		10	Items describing the capacity model			?	?	yes		no	
	X-30	11	Capacity partitioning	yes	First partitioning at X-36, the final one at X-16	yes	Legally mandatory for all networks (at least for lines with cross-border and important national traffic flows)	yes	National tool and Capacity Hub supporting visualisation of capacity models and decision procedure ÐpartitioningÐ()	no	
	X-12	12	Safeguarding of capacity	yes	The fact that the RP capacity is safeguarded is communicated to applicants, ExBo, TT planners etc.	yes	Legal solution for protection a part of the capacity for the Rolling Planning traffic for up to 36 months, EU 913/2010 Rail Freight	no		no	
	X-30	13	Regular updates of Capacity Model	yes	Awareness that CMs needs to be updated at least once a year, (X-36, X-24,X-16...)	no		no		no	
Capacity request	X-16	14	Path planning: prepartion of system paths/capacity bands for Rolling Planning and pre-planned paths for Annual TT	yes	Preparation and elaboration of the capacity, early advanced path planning	no		yes	National systems to be ready for preparation and elaboration of the capacity, Capacity Hub interface developed to recieve the paths and updates from national systems, path managmen module	no	
	X-16	15	Border harmonisation (pre-planned, system-path and capacity band planning)	yes	Early stage and constant harmonisation with other involved IMs, leading entity to be established (only from feasability study?)	no		yes	National IT system constantly updated, border harmonization information available, automatic notification process with the neighbours, confirmation of the finalization, path managmen module	no	
	X-15	16	Feasibility studies	yes	X-13 > X-15	no		yes	feasability stud modul as part of the path managment module and capacity hub, leadinig entity, capacity broker???	no	
	X-16	17	Consultation of applicants for upcoming Network Statement	yes	Procedure prepared for consultation with stakeholders. (Can be implemented immediately, procedure exists already in several countries)	no	No obstacles in 2012/34/EU	no		yes	According to the SERA di
	X-12	18	Publication of pre-planned paths for Annual TT	yes	X-11 > X-12 ?	no	Annex VII prescribes no later than X-11	yes	IT tool supporting a publication of pre-planned paths with detailed relevant parameters (speed, lenght...), broker	no	
	X-12	19	Publication of slots for Rolling Planning (up to 36 months prior) for every calendar day	yes	X-11 > X-12 ?	?	to be checked TTR LF, Annex VII prescribes no later than X-11	yes	National systems and centralised capacity broker support publication of slots, broker	no	
	X-4	20	Ongoing update of slots for Rolling Planning	yes	A first update may come with a first request	no		yes	National systems and capacity broker supports blocking of requested capacity (slots), capacity return x-12	no	
	X-1	21	Converting non-requested Rolling Planning capacity into residual capacity	yes	Daily basis converting by IMs	no		yes	National systems and capacity broker supports the conversion to the residual capacity x-12	no	
Capacity allocation	X-12	22	Requests for Annual TT placed on time	yes	X-8 > X-8.5	yes	deadline to be changed in NSs and national law	yes	**National systems and capacity broker support Annual Requests from X-12**	no	x-12
	X-8.5	23	Requests for Annual TT placed after deadline	yes	X-8 > X-8.5	yes	deadline to be changed in NSs and national law	yes	**National systems and capacity broker support Late Path Requests from X-8.5**	no	
	X-4	24	Requests placed for Rolling Planning cap.	yes	Rolling Planning as a new request method to be introduced	yes	NS to be adapted, Philipp Koiser mentioned that the EC had concerns about X-4 (a legal problem?)	yes	**National systems and capacity broker support RPand realtive deadlines**	no	
	X-8.5	25	Path elaboration	yes	For ATT in place, RP to be introduced - quick communication and cooperation procedures to ensure quick conversion of a request to an offer	no		yes	**National systems and capacity broker support RP and relative deadlines**	no	
	X-8.5	26	Border harmonisation (Annual TT requests placed on time and placed after the deadline)	?	All already exists?	no		yes	**National systems and capacity broker support quick communication and cooperation**	no	
	X-8.5	27	Border harmonisation (Rolling Planing request)	yes	Procedures for daily communication and cooperation in meeting the relative deadlines	no		yes	**National systems and capacity broker support communication quick harmonisaton of path offers**	no	
	X-8.5	28	Conflict resolution for Annual TT requests placed on time	?	All already exists? Or new AR?	no		yes	**National systems and capacity broker should detect conflicts and support conflict resolution**	no	
	X-8.5	29	Approach in case conflict resolution procedure is not successful	yes	New Allocation Rules apdopted	no		yes	**National syst. and capacity broker support the coordination process of AR application**	no	
	X-6.5	30	Draft offer for Annual TT requests placed on time	yes	X-5 > X-6.5	yes	deadline to be changed in NSs and national law	yes	**National syst. and capacity broker support draft offers at X-6.5**	no	
	X-5.25	31	Draft offer for ATT requests placed after the deadline	yes	After X-3 > After X-5.25	no		yes	**National syst. and capacity broker support draft offeres for LPR at X-5.25**	no	
	X-4	32	Draft offer for Rolling Planning requests	yes	Introduction of relative deadlines and procedures how to constantly meet them	no	deadline to be changed in NSs and national law	yes	**National syst. and capacity broker support draft offeres for RP and realtive deadlines with proper filtering, sorting and notifications**	yes	? (CC mentioned in the A
	X-8.5	33	Observations related to draft offer	yes	4weeks > 2weeks	yes	2012/34/EC foresees 4 weeks; needs to be reduced to 2 weeks for ATT	yes	**National syst. and capacity broker support 2 weeks timeframe for consultations**	no	
	X-8.5	34	Observations related to offered slot for upcoming TT period(s) in case of Rolling Planning	yes	Introduction of relative deadlines and procedures how to constantly meet them	?	needed?	yes	**National systems and centralised capacity broker support RP and relative deadlines**	no	
	X-6.5	35	Post-processing	yes	X-6 >X-4, X-5.5 > X-3.5	yes	to be checked if deadlines in national NS has to be changed.	yes	**National syst. and capacity broker supporting new timeframes (relative in case of RP)**	no	
	X-6.5	36	Final offer	yes	X-5.5 > X-3.5	yes	NS has to be adapted to the new system and deadlines. *why not national law?	yes	**National syst. and capacity broker supporting new timeframes (relative in case of RP)**	yes	N.A.
	X-6.5	37	Acceptance / final allocation	yes	X-5.5 > X-3.5	yes	NS has to be adapted to the new system and deadlines.	yes	**National syst. and capacity broker supporting new timeframes (relative in case of RP)**	yes	N.A.
	X-5.25	38	Residual capacity from ATT	yes	Precedures how to treat non-used capacity	yes	NS has to adapated to explain "rules of the game" regarding the treatment of non-requested, remaining capacity	yes	**National syst. and capacity broker in place**	no	
	X-8.5	39	Withdrawal of requests	no	already placed?	no		yes	**National syst. and capacity broker supporting TAF/TAP TSI message framework in place**	yes	N.A.
	X-8.5	40	Soft/strong changes to the path request	yes	N.A.	yes	NS to be adapted. The way to differentiate the types of changes shall be described in a harmonised way in the NS	yes	**National syst. and capacity broker supporting the possibility to submit soft or strong changes to the path request before the final allocation**	yes	N.A.
After allocation	X-16	41	Path modification (ATT)		N.A.	?	N.A.	yes	N.A.	yes	N.A.
	X-16	42	Path modification (Rolling Planning)		N.A.	?	N.A.	yes	N.A.	yes	N.A.
	X-16	43	"Slot" modification Rolling Planning		N.A.	?	N.A.	yes	N.A.	yes	N.A.
	X-16	44	Cancellation (ATT)		N.A.	?	N.A.	yes	N.A.	yes	N.A.
	X-16	45	Cancellation Rolling Planning (path in current TT period)		N.A.	?	N.A.	yes	N.A.	yes	N.A.
	?	46	Cancellation Rolling Planning (slot for upcoming TT period(s))		N.A.	?	N.A.	yes	N.A.	yes	N.A.
	X-16	47	Path alteration (ATT & RP)		N.A.	?	N.A.	yes	N.A.	yes	N.A.
	?	48	"Slot" alteration for Rolling Planning (upcoming TT period(s))		N.A.	?	N.A.	yes	N.A.	yes	N.A.