ERJU SYSTEM PILLAR

T3-System Concept_CMS-TMS_Federated Model

T3-System Concept_CMS-TMS_Federated Model

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Abstract	Based on "Task 3 CMS/TMS Variant Analysis v2", this document deals with the specific variant which has been selected as reference context for CMS/TMS in EU environment.
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1 Preamble

1.1 Scope and intended audience

The scope of the document is a description on how a "Federated Model" for Capacity management and Traffic management is set up. The intended audience are experts in the area of Traffic management and Capacity management, both on national level as on EU level.

1.2 Purpose

This document is based upon the outputs of the “Task 3 CMS/TMS Variant Analysis v2”. The starting point are the variants “Federated Traffic Management” and “Federated Capacity Management”. These are further elaborated in this document: the relevant processes are described, the supporting IT systems -which support the execution of the processes- are described, and the roles of a federated governance body are described. The purpose is to give an overview of how the Federated approach will work.

1.3 Glossary

1.3.1 Terms and definitions

N.A.

1.3.2 Abbreviations

In this document, the abbreviations "IM" for Infrastructure manager" and "RU" for Railway Undertaking are used due to their widespread use in the rail sector. The equivalent terms are "RIM" for Rail Infrastructure Managers" and "ROC" for Railway Operating Company.

AB	Allocation Body
CBO	Common Business Objectives
CCS	Command Control Signalling
CMS	Capacity Management System
EC	European Commission
ECMT	European Capacity Management Tool
ENIM	European Network of Infrastructure Managers
EST	EU Supporting Tool
ETA	Estimated Time of Arrival
ETH	Estimated Time of Handover
ETM Network	European Traffic Management Network
ETMN	European Traffic Management Network
EU	European Union
FCM	Federated model for Capacity Management
FTM	Federated model for Traffic Management

IM	(rail) Infrastructure Manager
IT	Information Technology
NC	Network Coordinator
NTCC	National Traffic Control Centre
PCS -CB	Path Coordination System - Capacity Broker
R-CDM	Railway Collaborative Decision Making
RFC	Rail Freight Corridor
RIM	Rail Infrastructure Manager
ROC, RU	Rail Operating Company, Railway Undertaking
RTCC	Regional Traffic Control Centre
TCC	(IM) Traffic Control Centre
TCR	Temporary Capacity Restriction
TMS	Traffic Management System
TSI	Technical Specifications for Interoperability
TTR	Timetable Redesign
UI	User Interface

2 History Of Changes

Nr.	Date	Changes	Leaders/Authors
1.0	2025-02-03	First draft	Patrick Konix
2.0	2025-02-07	Updates via Track Changes; added EUC tasks and ECT functionality	Peter Sisolak
3.0	2025-03-03	Inclusion of CMS and modifications on the TMS part	Peter Sisolak Bence Jenofi
3.1	2025-03-12	Finalization of CMS part	Bence Jenofi

3 Introduction

This document is based upon the outputs of the “Task 3 CMS/TMS Variant Analysis v2”. The starting point are the variants “Federated Traffic Management” and “Federated Capacity Management”. These are further elaborated in this document, both for the process part and the IT part which supports the execution of the processes. **[**SPT3TMS-16538 **]**

An assessment of the status quo reveals that today's capacity management and traffic management suffers on different levels and overall are still rather nationally orientated. A perspective from the origin to the final destination of the train is not ensured. **[**SPT3TMS-16544 **]**

The Federated approach was chosen by DG MOVE in the PRIME Digital framework to be elaborated further. **[**SPT3TMS-16926 **]**

4 Main Goals of a Federated model

4.1 Federated model for Capacity Management (FCS)

The proposed concept of a Federated model for Capacity Management sets the goal to:

- Improve the utilization of the existing railway infrastructure capacity on a EU level
- Increase competitiveness with road and air traffic
- Provide more flexibility on the request side and more predictability on the allocation side, enabling IM/AB-s to better satisfy new needs and Applicants to plan their business logistics on a longer horizon
- Lower the administrative burden on all stakeholder
- Improve coordination of temporary capacity restrictions

[SPT3TMS-16542 **]**

4.2 Federated model for Traffic Management (FTM)

The proposed concept of an FTM sets the goal to:

- Efficiently utilise allocated capacity in the European perspective
- Improve the punctuality of international trains, especially on arrival to the destination
- Reduce dwell time at borders
- Improve the efficiency of the overall resource management of all railway stakeholders
- Increase network capacity via effective traffic management
- Support NTCCs or RTCCs in coordinating consequence management of unexpected temporary capacity restrictions
- Reduce recovery time in case of disruption with international impact

[SPT3TMS-16537 **]**

To improve the overall performance of the system, the federated model is based upon three main principles:

- Harmonisation of cross-border processes within Europe, including the communication
- Exchange and standardisation of the required data to support the processes
- Set-up of a Network Coordinator which supports the European IM in the TM

The added value of the model relies on the successful implementation of all three parts.
[SPT3TMS-16536 **]**

5 Harmonisation of cross-border processes

5.1 Capacity Management

To satisfy market needs, and utilize existing capacity more efficient, IMs and ABs should apply processes based on common principles during the capacity planning and allocation phases already. These are set out in the draft capacity regulation[1]. Be it freight or passanger, competitive services can only arise if a provider has guarantees of commercial viability. It is essential that potential entrants or existing players looking to expand their services are able to plan long-term capacity, gaining this reassurance as early as possible and within an international context. **[**SPT3TMS-16533 **]**

Before an answer to these requests can be provided, IMs/ABs need to plan on the long run themselves, and it is crucial that they do so with as much involvement of the market as possible. For now, capacity

strategies are aligned in a fragmented way between direct neighbours or those connected via an RFC. **[**SPT3TMS-16532 **]**

To improve on the status quo, based on the draft capacity regulation, capacity strategies will have a common structure aligning them on a pan-European level. **[**SPT3TMS-16535 **]**

Capacity Models will be drafted based on consideration of market needs via methods like -amongst others- “capacity needs announcements”. This way, what later will be available to the market would suit the demand much better. **[**SPT3TMS-16534 **]**

Probably the most impactful harmonization needed is a centralized way of capacity request , like a unified booking platform connecting each IMs/AB-s national one. **[**SPT3TMS-16540 **]**

The real innovation among harmonized processes is the response to the fundamental needs mentioned in the beginning. “Rolling planning” and “framework agreements” are new processes that enable multiannual planning for market actors. **[**SPT3TMS-16543 **]**

Hereunder an overview of the CMS processes that shall apply to a future FCMS: **[**SPT3TMS-16933 **]**

CMS Operational processes	General capacity allocation/capacity structuring (5 years - 1 year)	Create Capacity Strategy	Coordinating and Publishing TCRs
		Create Capacity Model	
		Create Capacity Supply Plan / Plan Capacity	
		Perform Feasibility Study	
	Path allocation (12 months - day of train run)	Handle Annual Requests	
		Handle Late Path Requests	
		Handle Rolling Planning Requests	
		Handle Ad-Hoc / Short Term Requests	
		Handle Capacity Modification Requests	
		Handle Capacity Alteration including Optimisation	

[SPT3TMS-16547 **]**

Table 1:*CMS related processes*

5.2 Traffic Management

Cross-border processes and communication should be harmonized to a greater extent to optimize the train run. This lack of European harmonization and coordination for information exchange, criteria for scenarios and tools becomes apparent, especially in cases of disrupted traffic. **[**SPT3TMS-16546 **]**

The relevant information which is needed to optimize the train run is not sufficiently passed on between the involved stakeholders, which implies that IMs further down the transport chain cannot forecast and adapt:

- There is a tendency to manage unplanned capacity restrictions and TCRs by non-harmonized processes which apply to regular traffic and are mostly defined nationally.
- Only rarely there are means in place how to better coordinate in cases of irregular traffic or even prevent such neighbouring influences from accumulating cross-border
- Cross–border agreements are not effective enough and are not systematically targeting these cross-border obstacles from the perspective of a European train run

- The lack of speaking a common language and weak working relationships also play a significant negative role in hampering the exchange of relevant information and dealing with more complex situations when coordination beyond regular traffic is required

[SPT3TMS-16545 **]**

These flaws prevent to serve an origin-to-destination perspective when cross–border traffic is concerned. The current traffic management requires a new more European-oriented network approach. Hereunder an overview of the CMS processes that shall apply to a future FTMS: **[**SPT3TMS-16552 **]**

TMS Operational processes	Real-time Monitoring
	Sense Deviations from the Operational Plan
	Sense Deviations in Infrastructure Availability
	Handle Deviation from the Operational Plan
	Perform Traffic Forecast
	Sense Operational Conflict between Operational Plans
	Handle Operational Conflicts + international coordination
	Log Cause of Deviations and Delays

[SPT3TMS-16551 **]**

Table 2:*TMS related processes*

To establish a functional FTM, a main prerequisite is the implementation of the concept of the “European Network Concept” on the IMs level. This implementation by the IMs is supported by the setup of a layer represented by the "Network Coordinator" on EU level (the "European Coordination" body) which covers support and integration. The activities of the "Network Coordinator " are supported by the IT tool "EU supporting tool" (EST)). **[**SPT3TMS-16550 **]**

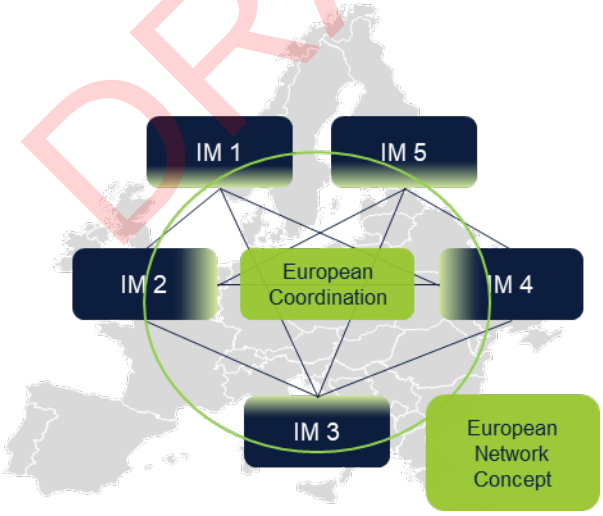


Figure 1: European Network Concept as a basis for the proces alignment

The main principles of the European network within FTMS are:

- All trains that cross at least one border are considered international trains and require coordination with neighboring infrastructure managers
- Support the development of a European mindset by taking a wider approach from national to international perspective

- Digital and automated information sharing as much as possible. As long as or where this is not applicable, manually typed data methods of sharing information are encouraged
- Domestic Traffic Control related systems are exchanging data (train run related data, train composition data,...) based on TAF/TAP TSI and mutually agreed information exchange formats
- The "EU supporting tool" (EST) serves as a complementary tool and offers additional information
- IMs prepare and take into account forecasts of train runs and events
- Cross-border monitoring is based on this information
- The ETMN elements (see “European Network Concept” and Appendix 1) allow the IMs to complement their existing processes and rules
- IMs agree to procedures and processes to perform internationally coordinated traffic management in a wide range of deviations from plan (from single delayed trains to major disruptions)
- Common risk management is based on information sharing and cooperation
- Regular meetings for risk management and improving the overall cooperation are established
- New communication and data-sharing platform integrates dispatchers into a common network

[SPT3TMS-16549 **]**

More details in the “European Network Conecpt can be found in Annex 1. **[**SPT3TMS-16553 **]**

6 Exchange of standardised data to support the processes

6.1 Capacity Management

In order to support cross border alignment and to ensure up to date data provision 24/7, as well as compliance, central tools are being developed. These will be introduced later in Annex 2, but it is important to highlight, that in line with the federated model, these tools are not meant to replace national ones, but instead to provide a platform for all to connect to. **[**SPT3TMS-16557 **]**

Stakeholders exchange the necessary data between their national and the central tools via a common interface. These data – attributes – are grouped into standardised messages. Whenever a new or amended process is needed, the sector stakeholders agree on potentially new messages, which then will be included in a new version of the communication schema[2] used between parties. These communication schemas follow the Telematics TSI standard, which is also currently under revision via a parallel regulatory process. Whenever the schema version endorsed to the European Railway Agency (ERA) complies with its standards, it will be adopted as official and mandatory, however, the sector can agree on its adoption prior to that as well. The list of messages specific for FCMS can be found below: **[**SPT3TMS-16559 **]**

TCR message	▪ TCR ID ▪ TCR harmonization status (preparation, published, closed) ▪ Temporal expansion ▪ Classification (minor, medium, high, major, unclassified) ▪ Validity period ▪ Circulation days (continuous, periodical) ▪ Calendar (dates) ▪ Traffic impact (various reasons for the reduced capacity and its impact on volume) ▪ Traffic measures (cancellation, re-routing, train/bus replacement, estimated delays ▪ Route (to, from, direction)
TCR response message	Contains the status and a report of the import

TCR cancelled message.	IMs are able to cancel the particular TCR that was sent to the TCR tool, (object) – TCR ID
Capacity Model Message	To provide data on Capacity Needs Announcements (CNAs) and Capacity Model Objects (CMO-s)
Capacity Product Search Message	shall be used to search all the capacity products (negative and positive as well
Capacity Product Message	is the response to the search capacity product message. Contains information about the TCRs, Capacity bands, Catalogue paths or pre-arranged paths.
Capacity Product Coordination Message	Used to exchange data about path requests.
Path Coordination Message	IMs can send all of their updates before the offer with Path Coordination message. Also, all notifications from the tool for Path Coordination (except RU originated) are sent via Path Coordination message.
Object Info Message	Facilitate the efficient information exchange with RU-s and IM-s (via CI)
Path Request Message	the EU Capacity Broker tool will deliver the path requests to the IM-s with this message. Relevant processes: New Path Request / Late Path Request / Ad-Hoc Path Request / Rolling Planning Path Request
Path Details Message	IMs can send all of their offers to the tool for Path Coordination with Path Details message
Path Details Refused Message	the tool for Path Coordination will deliver the information about the rejection of the Final Offer to IMs with this message
Path Cancelled Message	RU-s/Applicants can use this to forward their path cancellation intentions
Path Confirmed Message	the tool for Path Coordination will deliver the information about the acceptance of the Final Offer to IMs with this message
Path Not Available Message	IMs need an option to delete an existing path in the tool for Path Coordination. They can do it with this message

Receipt Confirmation Message	This is a message sent by the EU Capacity Broker tool (centrally) to the IM-s/AB-s as well as RU-s/Applicants. (Example could be a successful creation of a Capacity product upon sending the Capacity Product Coordination Message. For RU/Applicants this can mean Message exchange, however, from the other way around is not required /supported.
Error Message	In case there is any mistake regarding the update, the tool for Path Coordination will send back Error messages with PCS specific error codes inside

[SPT3TMS-16558 **]**

Table 3: O*verview of specific messages for Capacity Management*

6.2 Traffic Management

Even for normal traffic situations, there is in general a limited processing of reliable cross-border train run information since the existing IT systems are not systematically integrated, nor is the integration of data from central EU data hubs with operational train data done sufficiently. Open **[**SPT3TMS-16555 **]**

The potential of available information and intelligent applications to process this information for more foresighted traffic management connecting IMs to act complementary has by far not been tapped. As can be traced, the absence of a minimum set of information leads to a fragmented low quality in traffic management and hence leads to friction in the train run. **[**SPT3TMS-16554 **]**

A federated approach requires EU supporting tools to support the processes executed by the federated approach next to independent, individual IM-operated nationally (or regionally) owned and operated traffic management systems (TMS) **[**SPT3TMS-16556 **]**

The “future FTMS tool” mostly gather information from the connected stakeholders such as:

- train timetables
- train running information
- train delay causes
- incident information,
- train composition information,
- train running forecast information,
- referential data such as topology data, company lists, country list, rolling stock referential, etc

[SPT3TMS-16560 **]**

More information on the technical environment can be found in Annex 2. **[**SPT3TMS-16563 **]**

7 Set up of a Federated EU supporting body

7.1 Capacity Management

In the Federated model, capacity management is supported by a EU-body for coordination (“Network Coordinator”), which has the following tasks: **[**SPT3TMS-16562 **]**

- Be involved in the consensual conflict resolution mechanism (moderation between IMs) in case of a multi-network capacity request
- Collect information on network disruptions, analyse the response, draw conclusions on the effectiveness of the management of such incidents and consult operational stakeholders in accordance with Article 54 (Consultation mechanism for European cross-border matters) and report to ENIM and the Performance Review Body

- Be involved in matters having Union level relevance, in particular where coordination is required both at the Union level and within a more specific geograhical scope
- Contribute to the:
    - operational coordination between infrastructure managers in accordance with Article 53;
    - preparation of the European framework for capacity management referred to in Article 6, the European framework for the coordination of cross-border traffic management, disruption management and crisis management referred to in Article 44 and the European framework for performance review referred to in Article 50.
- Identify rules, procedures and tools within the scope of the capacity regulation and adopted at national or infrastructure manager level which create obstacles for multi-network rail services, as set out in the capacity regulation (COM(2023) 443 final / 2023/0271(COD))
- Act as:
    - secretariat and prepare ENIM's meetings, documents, decisions and opinions;
    - a contact point on behalf of infrastructure managers for enquiries related to capacity planning and allocation, in particular regarding potential requests for capacity, for information or contact points related to rail incidents and temporary capacity restrictions;
    - a first point of contact for stakeholders outside the rail sector interested in using rail services, providing contacts to relevant actors at infrastructure managers and other operational stakeholders;
    - a contact point on behalf of ENIM for applicants and other operational stakeholders on issues not explicitly covered by the capacity regulation ((COM(2023) 443 final / 2023/0271(COD))) in particular the launch or change of cross-border rail transport services or organising support for ad hoc activities, in particular to address the crisis situations referred to in Article 47.
- Supporting the implementation of these processes using digital tools

[SPT3TMS-16574 **]**

The Network coordinator, however, does not perform any Capacity Management related task on its own.
[SPT3TMS-16561 **]**

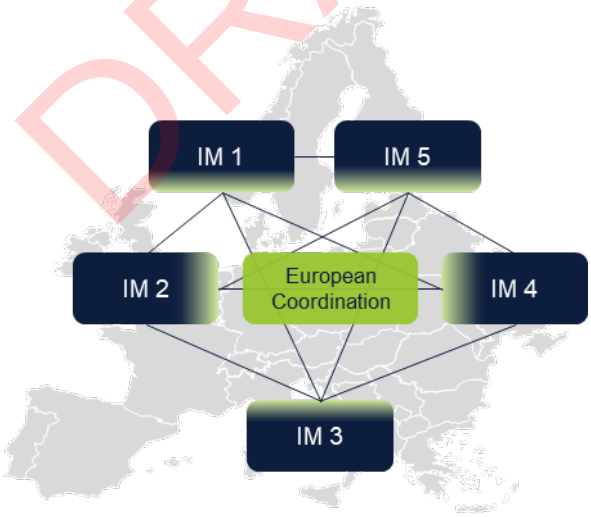


Figure 2: Process and communication harmonization via the FCM

7.2 Traffic Management

In a federated setup for Traffic Management, every IM is responsible for the management of all train traffic on its network. An EU supporting and monitoring function of NC facilitates/supports the following processes: **[**SPT3TMS-16566 **]**

- contribute to the operational coordination between infrastructure managers
- identify rules, procedures and tools which create obstacles for multi-network rail services,
- establish a platform for simple and direct cooperation of neighbouring and over-neighbouring traffic control centers
- Supports and leads to having the same level of dispatcher competence over Europe for effective cooperation and performance.
- Supports monitoring train runs, and propose measures to increase overall traffic and resource management
- Supports balancing priority rules over the European railway network respecting national particularities
- Support NTCCs or RTCCs in coordinating consequence management of unexpected temporary capacity restrictions
- Act as a first point of contact for stakeholders outside the rail sector interested in using rail services, providing contacts to relevant actors at infrastructure managers and other operational stakeholder

[SPT3TMS-16576 **]**

The Network coordinator does not perform any Traffic Management commando's. Harmonised processes (defined by legislation or by sector collaboration) assure the collaboration between IMs for cross-border traffic operations. **[**SPT3TMS-16564 **]**

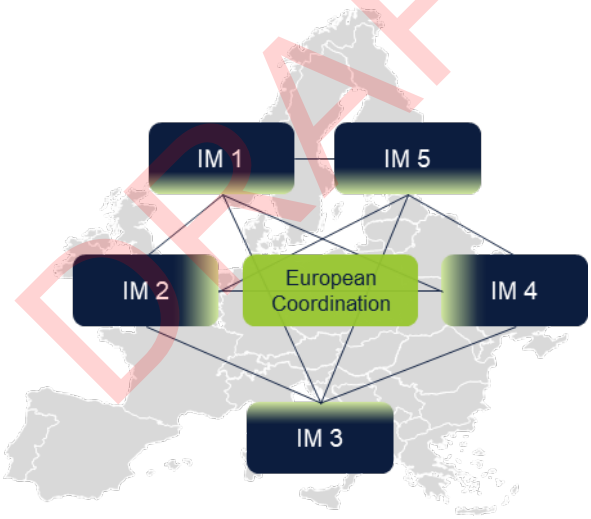


Figure 3: Process and communication harmonization via the FTM

The relation with the traffic management processes (see figure 1) for the "EU supporting and monitoring Body" is as follows: **[**SPT3TMS-16575 **]**

Real-time Monitoring

Real-time monitoring is the main task for the NTCCs. The NTCC dispatchers monitor the overall railway traffic of its network and support the RTCCs in the decision-making on their level of traffic management. More priority is being given to the European transport corridors and international trains. The main connection to the harbours and intermodal terminal should be involved as well. **[**SPT3TMS-16571 **]**

The overall monitoring of the traffic can be performed via a “EU Supporting tool” (EST) on data provided by mainly IMs and other stakeholders via TAF/TAP/Telematics TSI compliant data exchange through the TAF/TAP/Telematics TSI Common interface. The definition of the technical capabilities/functionalities of this tool must be defined. **[**SPT3TMS-16570 **]**

To be able to perform the monitoring task, the data quality of the information provided by the stakeholders must be of sufficient quality. A definition of the KPIs for data quality and measures of the overall data quality can be done. **[**SPT3TMS-16573 **]**

Sense Deviations from the Operational Plan

The focus of the NTCCs should be on the deviations from the operational plans represented by the received timetables of preferred (=with a higher priority) trains. Corrective measures for train runs will be performed as today by the RTCCs, advice/coordination will be given by the NTCCs after coordination with neighboring IMs or other operational stakeholders. The coordination will be carried out via agreed communication channels between National Traffic Control Centers (NTCCs). The NTCCs will provide the requirements to lower levels of national traffic management centres (regional and local ones). **[**SPT3TMS-16572 **]**

Sense Deviations in Infrastructure Availability

The deviations from the infrastructure availability can be divided into the planned, forecasted and unplanned ones caused by sudden malfunction of the infrastructure from various reasons (weather, technical failure, incidents, etc.), The planned one and incidents are shared with the EST via TAF/TAP/ Telematics TSI (Temporary Restriction message). The forecasted one will be indicated through a “EST Network Status module”. The task of the NTCCs in the international coordination on the international train runs in order to mitigate the negative impact of infrastructure unavailability using the EST modules. **[**SPT3TMS-16578 **]**

Handle Deviation from the Operational Plan

Handling the deviation from the operational plan is the task of RTCCs in cooperation with their national levels of traffic management. In case cross-border coordination is necessary, the NTCC will address neighbouring NTCCs and do collaborative decision-making with decisions on how to act on the international levels. **[**SPT3TMS-16582 **]**

To enable this, the recommendations on the framework for European priority rules should be defined. Once defined, approved and in force, these shall be taken into account to reach the most effective deviation handling for the advice of the NTCC. **[**SPT3TMS-16581 **]**

Perform Traffic Forecast

A harmonised forecasting procedure must be elaborated. Once implemented on the EU level, the consolidation of forecasts is done in the EST. The national forecasting subjects provide prediction information to the EST via TAF/TAP TSI message Train Running Forecast. The bilateral data exchange defined in the TAF/TAP TSI is not affected by the EST and will continue according to the requirements in the legislation. **[**SPT3TMS-16580 **]**

The EST oversees the overall data quality as the forecasts are received by the EST and are evaluated, and accuracy indicators are calculated to enable assess the forecast quality. The EST itself provides predictions for each known train (based on timetable or running information) and covers the complete European network. The forecasting information from EST is available for all users involved in the train runs and helps in coordination and decision-making on each level of traffic and resource management. The RTCCs and NTCCs use the forecasting information for coordination and decision-making in close cooperation with other RTCCs and NTCCs. **[**SPT3TMS-16586 **]**

Sense Operational Conflict between Operational Plans

Cross-border coordination of operational conflicts between operational plans is usually detected on the national levels and should be primarily solved there via coordination of regional and national traffic control centers. The goal in this aspect is that the national TMSs implement a solution for overlapping data exchange in the horizontal deep of the national networks to reflect the operational situation of the neighbor and optimise the decisions and prevent operational conflicts. The operational plans should reflect what is

the situation on the neighbor networks up to e.g. 200 km from the border reflecting the type of traffic and priority of lines (e.g. core – comprehensive – regional). An example is as follows : the two regional traffic controls of Belgium and France who manage the cross-border traffic foresee both that for a distance of -for example- 30 km inland (meaning the Belgian post has the data/information for 30 km inlands in France, and vice-versa) there is a view on the operational plan of the neighboring network to allow for better decision making. **[**SPT3TMS-16585 **]**

Handle Operational Conflicts + international coordination

The handling of operational conflicts remains on the national level. However, the international coordination is a sense of selection from harmonised offered scenarios of neighbouring RTCCs, which will be the task within the ETMN concept. The detailed procedure and rules are defined in Annex I. **[**SPT3TMS-16584 **]**

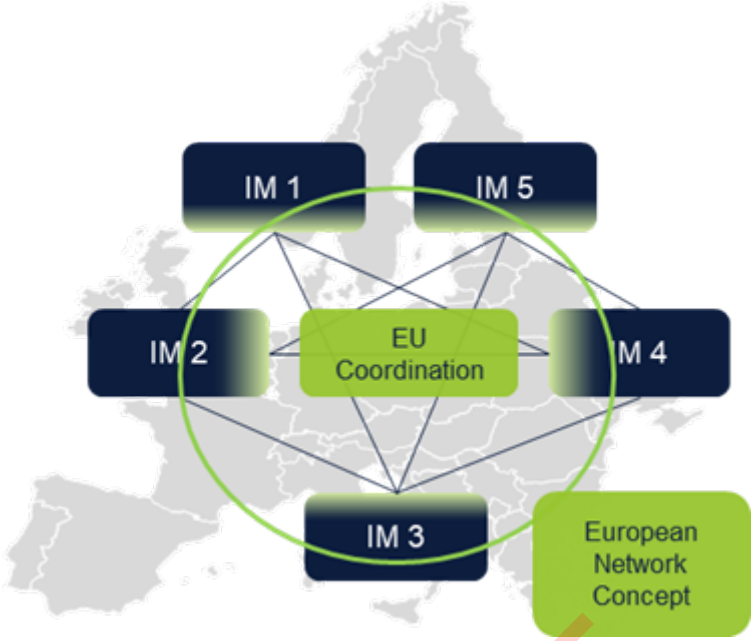
The added value of the ETMN concept is to assure balanced, collaborative decision-making reflecting NTCC priorities and particularities. The international coordination goal should always remain in the train punctuality and effective resource management of all stakeholders. It is recommended to perform the mutual coordination between IMs involving impacted operational stakeholders. The direct involvement of all operational stakeholders helps to reach an optimal acceptable solution. **[**SPT3TMS-16583 **]**

Log Cause of Deviations and Delays

The IMs should report on the train delay causes to the EST based upon a harmonised procedure. This system should log all the train running information, including train deviations from a timetable and relevant causes. The log of these data must be managed by a post-operational train performance group of experts to provide reports and dashboards to operational staff for corrective measures in traffic management. The provision of public reports and dashboards on the official Network coordinator website must be defined and implemented. The elaboration of detailed reports and dashboards for operational stakeholders and other relevant subject should be performed in a way that an agreed confidentiality rules should be valid. **[**SPT3TMS-16588 **]**

8 Annex 1 - European Network Concept

IMs must strengthen their cooperation in traffic management in the form of a European network. The network is based on the full commitment of each IM to implement principles which will allow a major improvement in the quality of international traffic management. On the one hand, this is realised by improving the quality of information sharing along the whole train ride as well as increasing the availability of information and, on the other hand, by assuring quick communication and coordinated actions between IMs. Overall, this improved cooperation will bring significant benefits to the international train run. The information exchange shall include the EU Coordination system to collect all necessary data for coordination and monitoring purposes. **[**SPT3TMS-16587 **]**



[SPT3TMS-16589]

Figure 4: European Network Concept

This European network acts in a decentralized manner based on a commitment of all traffic cells to one goal, on guidelines for daily cooperation (Process of International Traffic Management), information exchange (providing relevant TM-related data to the neighbouring IM), and communication (single communication module connecting all TCCs), to be prepared for the spectrum of traffic situations between regular traffic and ICM cases. A traffic cell represents the unit defined by an IM to dispatch the traffic within an area. They can reach from border areas to regional or national areas of responsibility and are controlled by a dedicated TCC. An IM consists of a minimum of one traffic cell but depending on the size of the IM, there is usually more than one. The core of a functioning European traffic management network is that traffic cells are connected by standardised ways of information sharing, the availability of common communication tools and commonly agreed procedures to handle minor deviations from plan as well as larger disruptions. The EU Coordination entity is situated a level above this IMs cooperation network concept and fulfils the supplementary role in traffic management. [SPT3TMS-16593]

Train-related data is shared digitally and automated and is available for all IMs in the network. This concerns not only data like current position, timestamps, delay along the train run and train properties like maximum speed, weight and length but also train running forecast information (for this guideline: ETx, i.e., Estimated time of departure, handover, run-through, arrival) as the essential information. [SPT3TMS-16592]

Event-related data for deviations from the plan as well as obstructions and disruptions with an international impact should be shared digitally in a standardised format and if deemed necessary by making direct communication with the concerned parties (neighbouring IM(s) or IMs farther away depending on the current case). In parralel, these data should be provided to the EU coordination subject to establish the functionality of FTMS. The aim is to move towards more digital information sharing over time, following TAF/TAP TSI and mutually agreed information exchange. In this regard, the development of the FTMS IT system, as a main concept pillar, will improve the availability and accessibility of information. However, the FTMS IT system shall not substitute or compete with nTMS, but rather serve as a complementary tool that enables IMs to access information beyond nTMS from the whole network. [SPT3TMS-16591]

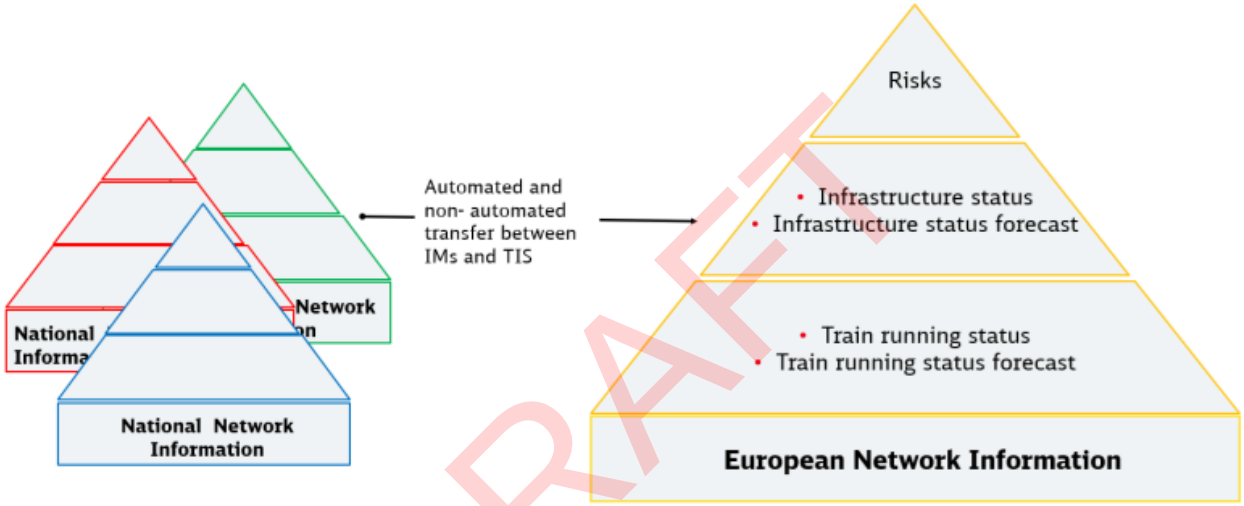
Risk management is based both on sharing digital information, e.g., on TCRs and situations that might develop into risks and other means of communication. This allows early detection and communication of risks and includes the development of commonly agreed plans. Risk management should be performed by regular data exchange on progress and conference calls based on the available information e.g., inclement weather conditions, strikes and TCRs. [SPT3TMS-16590]

The real benefit of the European network comes from actually operating as one unit without borders and being coordinated by the FTMS. The enabling elements described above allow TCCs to carry out cooperated traffic management in all situations, from handling delayed trains to dealing with obstructions and incidents in a way that brings benefits to international train runs. The new network is focused on national traffic control centres in synergy with regional centres involved in cross-border cooperation of neighbouring areas. To build a reliable European Network, IMs need to have strong contribution ties with other involved stakeholders, e.g., RUs, terminals, and ports. The goal of the proposed concept is to strengthen current practices and solutions on a more harmonised and developed level.
[SPT3TMS-16595 **]**

In order to unfold the leap forward by the interaction between the network members, it must be secured that three categories of information are made available:

- train running status and status forecast for all trains from origin to destination
- infrastructure network status and its forecast
- risks

[SPT3TMS-16594 **]**



[SPT3TMS-16596 **]**

Figure 5: The integration of the national data is a tool for the European operating base

A permanent and regular information flow is the backbone of the network approach and is supplemented by the European network status. This means that the IM can not only observe trains on its own traffic cell but also on neighbouring traffic cells and cells that are even further away (over-the-cell-vision).
[SPT3TMS-16579 **]**

To summarise, the main principles of the European network and FTMS are: **[**SPT3TMS-16577 **]**

- All trains that cross at least one border are considered international trains and require coordination with neighbouring infrastructure managers.
- Developing European mindset by taking a wider approach from national to international perspective.
- Digital and automated information sharing as much as possible. As long as or where this is not applicable, manually typed data methods of sharing information are encouraged.
- Domestic systems are exchanging data based on TAF/TAP TSI and mutually agreed information exchange formats.
- FTMS EU Coordination system serves as a complementary tool and offers additional information.
- IMs prepare and take into account forecasts of train runs and events.
- Cross-border monitoring is based on this information.
- The ETMN elements allow the IMs to complement their existing processes and rules.
- IMs agree to procedures and processes to perform internationally coordinated traffic management in a wide range of deviations from plan (from single delayed trains to major disruptions).

- Common risk management is based on information sharing and cooperation.
- Regular meetings for risk management and improving the overall cooperation are established.
- Supporting tools usage and European network status makes the cooperation more effective
- New communication and data-sharing platform integrates dispatchers into a common network.

9 Annex 2 : IT tools supporting a Federated TMS concept

A federated approach requires EU central supporting tools to assist the processes executed by the Network coordinator next to independent, individual IM-operated nationally (or regionally) owned and operated traffic management systems (TMS). The approach complements the regulatory multilateral information exchange via TSI messages **[**SPT3TMS-16603 **]**

The “Central tools for supporting TMS” in this variant largely acts as an “information broker” capable of consolidating different IMs’ data and thus of compiling an overarching view that transcends the boundaries of individual systems’ area of control. As such, the “central tool” is also capable of disseminating consolidated, end-to-end cross-border journey information directly to RUs, Terminals or other users requiring this type of information. Data can be consumed by users or systems according to the applicable European rules and regulations: in this sense, the “Central tools” as per this variant may be viewed as less of a “Traffic Management” and more of a “Traffic Information Brokering” system; any actions taken in response to the increased information transparency would be subject to agreement between affected IMs in this variant. The “Central tools” mostly gather information from the connected stakeholders such as: **[**SPT3TMS-16602 **]**

- train timetables,
- train running information,
- train delay causes,
- incident information,
- train composition information,
- train running forecast information,
- referential data such as topology data, company lists, country list, rolling stock referential, etc

[SPT3TMS-16605 **]**

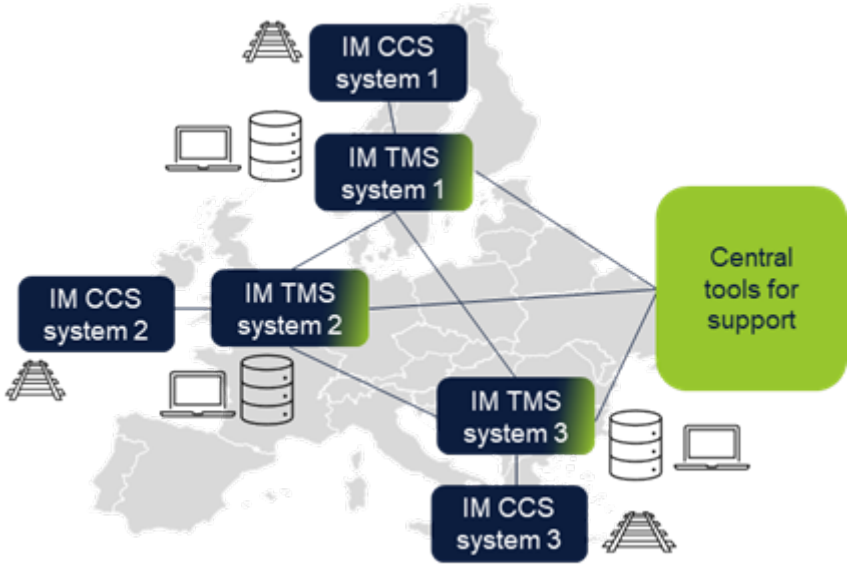
From the above listed information and implemented functionalities the “Central system”: **[**SPT3TMS-16604 **]**

- contains and shares actual train timetables, train running and incident information
- contains necessary reporting data to prepare performance reports and dashboards
- provide additional train running forecasts covering the complete European railway network
- display the European network condition with an expected view
- informs about capacity utilisation of the adjacent lines to the region of dispatcher responsibility
- is a platform for enhanced international contingency management
- ensure communication and cooperation of the European railway network national traffic control centers

[SPT3TMS-16598 **]**

The systematic establishment of virtual interconnections of NTCCs should be the cornerstone of ETM network concept, with direct support from other levels of traffic control centers. This approach reflects the existing vertical and horizontal structure and its roles and responsibilities. The new network involves national traffic control centers in synergy with regional centres involved in cross-border cooperation of neighboring areas. **[**SPT3TMS-16597 **]**

On the national level, the commandos for the CCS (Control, Command and Signaling system) will be managed by the national (or regional) TMS systems(s), and never through the European EST tool. **[**SPT3TMS-16888 **]**



[SPT3TMS-16600]

Figure 6: Arrangement of IM CCSs and Central tools supporting TMS

This subchapter will explain how the required information is to be made available and sourced into suggested IT systems and IT tools as part of the steps within the international traffic management process. [SPT3TMS-16599]

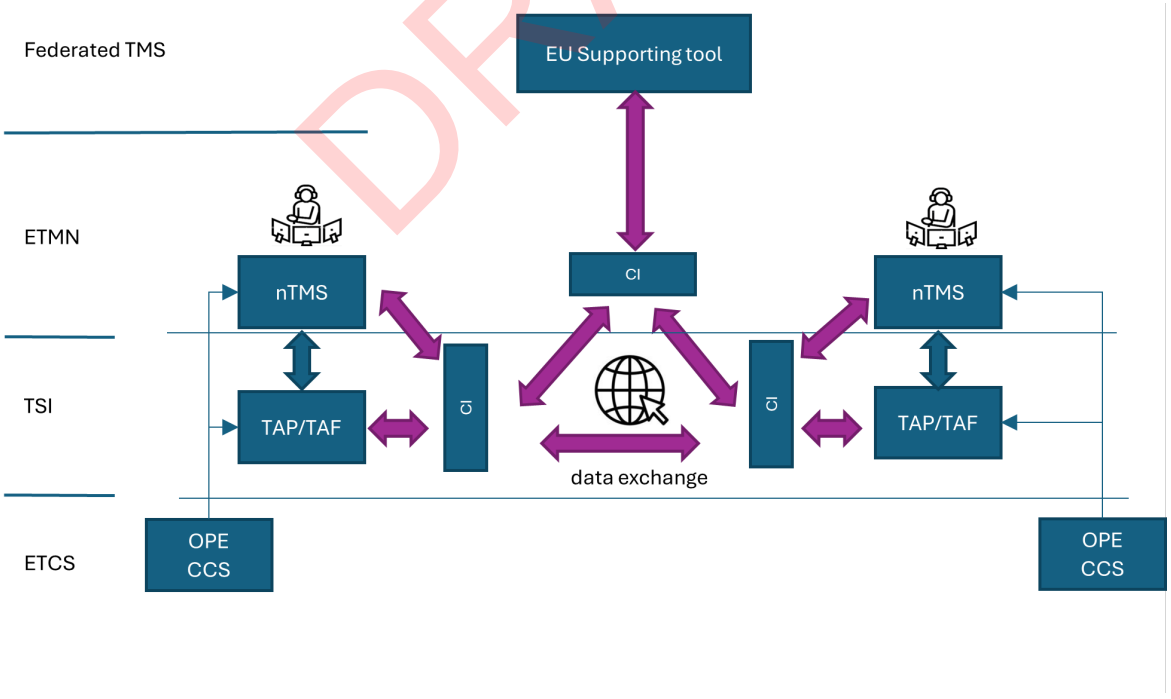


Figure 7: Data exchange within the ETMN and FTMS (EU supporting tool)

In order to create the network effect of information exchange, the EU supporting tool complements the regulatory bilateral data exchange to assure a effective ETM network and FTMS. For this reason, the IM should

- recognize the FTMS as a key enabler of improved cross-border rail traffic management in line with market needs and EU expectations.
- strengthening the role of FTMS as the supporting European tool for international rail traffic monitoring and as the data exchange platform
- strengthening the role of FTMS as the key tool for international contingency management

[SPT3TMS-16606 **]**

However, this does not mean preventing the bilateral exchange of information based on TAF/TAP TSI. By centralizing the data for further resharing and setting up a data warehouse, which can be accessed by stakeholders involved in the train run, it increases the overall efficiency of the network, such as facilitating coordinated actions. **[**SPT3TMS-16601 **]**

To reach the goal of more foresight and better-informed traffic management, the FTMS tool should be developed. To be more precise, the following requirements shall be met and are described in the chapters below:

- Planning
  - Train timetables
- Real-time monitoring
  - IMs should provide relevant train running data to FTMS from their national systems
  - Extending the use of FTMS as a support for incidents and disruptions with international impact
  - Train composition (if available)
- Other features
  - Forecast exchange
  - Extending the use of incident management tools for potentially upcoming obstructions
  - Information about the line capacity of cross-border sections
  - Overall network status provided by NTCCs

[SPT3TMS-16610 **]**

Access to EU Supporting tool

The EST should enable access to all TCC dispatchers, operational stakeholders and relevant users. The access to data should be restricted according to the agreed rules which are not part of this document. **[**SPT3TMS-16609 **]**

EU Supporting tool modules

The EST is composed of several modules which description follows. **[**SPT3TMS-16612 **]**

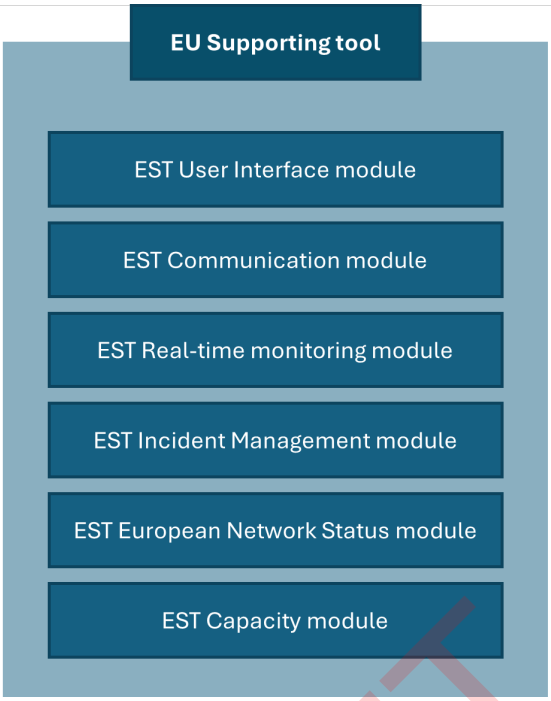


Figure 8: EU Supporting tool modules

9.1 EST – User interface module

To fulfil the goals and tasks listed above of a Federated TMS, the FTMS dispatchers could use the central tool, which collects information from national TMSs. All the data of EST should be provided by the IMs national TMS system in Telematic TSI format. The elementary set of messages shall come from the requirement of the draft Capacity Regulation and look like the following list **[**SPT3TMS-16611 **]**

- Train running number
- Train reporting
- Train composition
- Train delay cause
- Train Preparation
- Train Running Information and Train Running Forecast
- Service Disruption Information

The EST tool shall present train paths and running information on a map layer, enabling filtering and user-defined spacetime diagrams. The statistics of a selected train run with all available details should be available in the user interface as well. **[**SPT3TMS-16608 **]**

9.2 EST Functional Requirements

User login/registration:

EST gives the possibility to get access via a secure channel of login after completing a registration form. The registration passes the approval from an authorised “company administrator” for access from national users and from the EST administrator for Network Coordinator staff. **[**SPT3TMS-16618 **]**

Email templates:

In order for a user to register, a workflow should be in place with automated email templates. After registration, the user has to verify the credentials provided. Following that the company or EST administrator will approve/reject the user. In both cases, an email template will inform the user of the decision taken. If approved, the user will have to set the password. **[**SPT3TMS-16617 **]**

View Trains on Map:

After collecting/processing the TAF/TAP TSI messages from IMs, RUs and Terminals, EST visualizes the objects on the map based on certain unique characteristics such as Train Number (OTN), IM Network, Responsible RU and date. The IM user can see all the trains on the map while the RU and Terminal users can see the trains where its company is operating or participating in the train run. The company admin can determine the colour codes for the train types, train path and delta. **[**SPT3TMS-16620 **]**

Map auto refresh:

The map will refresh every 90 seconds. **[**SPT3TMS-16619 **]**

Search and filter trains:

EST gives the possibility to the user to apply various individual and simultaneous search filters. The user can set filters by delay, origin-destination, dates and hours, train numbers, running or non-running trains, stakeholders, and incidents. The user has the possibility to create, delete, edit and save filters. The user can also export in MS Excel file format the details of the train displayed on the map. **[**SPT3TMS-16614 **]**

View Train Details:

After selecting a train on the map or listed by applying a filter, the user is redirected to a new tab displaying all the train details including timetable information, actual running information, delay and forecast information and interruption information. Through various tabs, the user can also get information about detailed information on the forecasts, incidents, performance statistics and wagon & container information based on the TAF/TAP train composition message. **[**SPT3TMS-16613 **]**

Space-Time Connection Diagram:

A connection diagram gives the possibility to the user to visualize train runs within their combined connection context between multiple locations. Space-Time Diagram to visualize train runs within their combined space-time context for multiple locations. Users can define their own set of locations to be presented on the diagrams and save it for later use. **[**SPT3TMS-16616 **]**

Linking Regions:

The data to the EST are provided from national systems which not always represent the international train with a unique number during the whole train run. The EST should have the ability to allow users to connect trains at the border areas – linking regions - if it represents the same international train. In EST linking regions can be defined by the EST administrator to locate and combine locations between borders. Linking regions will be used by EST to flag trains for automatic or manual linking. The linking helps to connect international trains with different train numbers on a national level. This functionality is temporary, until the TSI PRID identifier is implemented. **[**SPT3TMS-16615 **]**

Email Notifications:

To help the users in providing information about train status changes as passing through a certain location, reaching a certain level of delay, approaching a border station and other conditions the users could define notification rules for trains that match certain user criteria. **[**SPT3TMS-16622 **]**

Forecasting module

The EST forecasting functionality should provide forecasting data from stakeholders for locations. The forecasts are presented in the main train detail window as selected ones based on accuracy indicators. The EST receives forecasts from stakeholders and, in parallel, calculates its own. **[**SPT3TMS-16632 **]**

9.3 EST – Communication module

To unfold the ETMN, a core prerequisite is to offer a Europe–wide centralised information and communication architecture enabling effective verbal and written communication. For effective cooperation of the ETMN, an integrated communication module should be established with the EU coordination tool of FTMS. The module is a centralised tool interconnecting all NTCCs in the first phase of implementation, and later, other stakeholders involved in the train run. Efficiency is facilitated as it will be possible to communicate directly once information is exchanged through more automated channels. In other words, this means taking as much information as possible from what is already sent out by the IM's national systems and aggregating it in a user-friendly way in a centralised platform. It also specifically requires an interface connecting other EU Supporting tool modules (e.g., Incident Management Tool). It allows an IM recipient who considers to be concerned can respond directly to a specific alert message and enter a discussion on the impact, etc. This includes, for instance, alerts on ICM cases and other obstructions. The main advantage of an integrated communication architecture is that the personnel of an infrastructure manager may refer to one interface only. **[**SPT3TMS-16630 **]**

The platform of EST Coordination communication module should fulfil at least the following criteria:

- Predefined contact list of responsible personnel for each IM/RFC
- Predefined contact groups e.g., related to the TIS modules as described below
- Private and conference calls/chats
- Chat function with built-in translation
- Log and record all communication
- Possible file exchange
- Possible processing of predefined formats either from other TIS modules or sourced in by email
- Call priority selection
- File repository

[SPT3TMS-16628 **]**

On a bilateral relation, other means of communication can be used as long as all parties involved agreed (e.g., phone/email/other). **[**SPT3TMS-16626 **]**

9.4 EST – Real-time monitoring

The network should enable better cooperation and communication between the NTCCs. For these purposes the EST application can serve as an interconnecting interface. EST shall be based on the TAF/TAP TSI data exchange format and be able to present train-related information shortly before they start, run and end their journeys across borders. This information is stored for further reporting purposes. **[**SPT3TMS-16639 **]**

The core function of the EST enables real-time monitoring of the complete international train run from origin to destination even when the train run has only been separately recognized on national sections. In attendance of the overall implementation of the TSI TRID identifier implementation, the widespread implemented "Linking of related train runs" creates a precondition for a network approach where TCCs can follow the train run from its origin to its destination and exchange necessary information in advance before the train enters new national networks. The general principles are predefined to establish the first level of national TM system interconnection via active TAF/TAP TSI message exchange. The national dispatchers can also use the EST web user interface or use the data from EST presented in their adapted national TM systems or to exchange it bilaterally. **[**SPT3TMS-16637 **]**

For effective network performance, predictions covering the whole European network are essential. **[**SPT3TMS-16635 **]**

A EST forecasting module covering the whole European railway network should have a goal to ensure at least one prediction for the most important locations labelled with accuracy indicators. As a precondition for effective network cooperation, the ETH information shall be available in any case. In parallel, the forecast information from IMs shall be sent to ETC where an accuracy calculation and further forwarding take place. This approach ensures a permanent train running prediction from different sources

accompanied by accuracy indicators. The possibility of monitoring the received train forecast information provides a basis for better decision-making. **[**SPT3TMS-16633 **]**

9.5 EST – Incident Management Tool

EST Incident management tool should cope with international contingencies and incidents which significantly helps NTCCs to reduce the impact of such events. **[**SPT3TMS-16642 **]**

The incident management functionality enables to identify and manage trains affected by incidents and inform all involved parties in an automated manner. **[**SPT3TMS-16641 **]**

The ETC IMT tool should exchange data with IMs to inform about and manage all incidents defined by the draft Capacity Regulation at least Multi-network disruption (Annex VI) **[**SPT3TMS-16643 **]**

It is recommended to be used for ongoing incidents and future expected obstructions. This means it could be used in a wider range of situations. In addition to this infrastructure managers may use other means of sharing information on such obstructions. **[**SPT3TMS-16649 **]**

The IMT is highly recommended to be used in the ETM Network to inform about and manage all incidents with the following criteria:

- Incidents affects traffic cells on other IM's networks
- Expected that it will last at least 6 hours, or as agreed by neighbouring IMs
- At least 10 international trains are affected, or as agreed by neighbouring IMs
- As soon as you have to apply restrictions on received trains
- Trains are rejected at the border
- Several trains are parked at the border

[SPT3TMS-16647 **]**

The IMT is recommended to be used in the ETM Network to inform about and manage expected obstructions with the following criteria:

- Obstruction expected to affect traffic cells on other IM's networks
- Potential duration of expected obstructions
- International trains may be affected
- Application of restrictions is expected

[SPT3TMS-16646 **]**

This tool should gradually substitute all other internationally exchanged documents on incident-related information, bringing benefits of structured digital data exchange. **[**SPT3TMS-16656 **]**

The NTCCs can benefit from automatic data exchange. For this purpose, in the future, mutually agreed new sector messages should be used. These messages would cover information about ongoing incidents and future expected obstructions. All members should provide this information in TIS and it can also be shared bilaterally. Afterwards, TIS can identify affected trains based on the received information, this exchange will automatize the current manual IMT usage. **[**SPT3TMS-16654 **]**

Incident management handling is done in IMT, where notification or publication of the incident will be performed automatically, or manually based on user preference. The relevant affected trains should be managed using the IMT application clearly defining their status on the network and presenting requested actions from RUs or neighbouring IMs. **[**SPT3TMS-16652 **]**

In case of potential obstruction, the same procedure is recommended to be applied. **[**SPT3TMS-16651 **]**

The tool shall allow a digital exchange of train data, their status and requested handling. **[**SPT3TMS-16658 **]**

9.6 EST – European Network Status

All the above-listed modules/information (automated train running information, train running forecast and incident management information) comprised will provide an overview of the status of the European

railway network to anyone it may concern at any given time to a chosen degree in a compact format. As it bases on the input of many sources, the module will evolve in the longer run. **[**SPT3TMS-16623 **]**

The addressees could be higher stakeholders as well as for NTCCs to coordinate. The latter may be especially interested in the possibility to zoom in a wider section beyond their own network to observe for instance not only the ETH but particular incoming trains and possible reasons for and duration for delays in neighbouring countries. **[**SPT3TMS-16621 **]**

European Network Status will enable better high-level decision-making and planning of the next dispatcher shift on a national level. The exact design will have to be developed, but the following are examples of what must or may be included:

- Ongoing incidents reported in IMT
- Risks/future disruptions reported in IMT (e.g., unplanned TCRs, bad weather, risk of strikes)
- TCRs with a substantial impact on international train traffic
- Sections with severe train delays based on train running information

[SPT3TMS-16631 **]**

Complementary to a status representing the current situation, a solution, which can offer a general prediction for the whole national network or regions should be beneficial for the network. **[**SPT3TMS-16629 **]**

The development of such a solution where the NTCCs report on the expected effects on the international train runs via the national network should allow more effective international traffic management. **[**SPT3TMS-16627 **]**

The “Network Status” will present the European network status and give the general picture how the international trains will be affected by the national network for the next twelve hours. **[**SPT3TMS-16640 **]**

Any forecasts on events which can affect train runs should be included in the report e.g., severe weather conditions, strikes or any situation which can cause deviation on the train run. The comprised presentation of each national network status jointly describes the European network situation which enables an overview of a complete expected traffic situation picture. Such information is just a base for the dispatcher's shift planning and creates a base for better cooperation to manage international train runs. This will have a positive effect on the national network, as well. **[**SPT3TMS-16638 **]**

The solution can have two modules. **[**SPT3TMS-16636 **]**

- Manual – NTCC reports

  Regularly filed on a half-day basis, or in case of an update to an agreed form preferably in EST user interface UI. The NTCCs present the general expected situation for the next twelve hours. The national data, put together, creates an overall picture of the European network status. This information can be presented and available in the form of a map or text.

- Automated – using artificial intelligence technology

  This approach can have two steps when the reporting analytical tool automatically works with the recent data, available information, and forecasts and presents the situation with train runs for areas or national networks. In the future, an enhanced approach could use Artificial Intelligence technologies to predict the network status for a preferred time period.

9.7 EST – Capacity Status

The idea of a capacity overview is considered beneficial for the efficiency of the network concept and FTMS. The proper capacity offer and its effective utilization are the main preconditions for the success of the railway business and customer satisfaction. A constantly available accurate overview of the capacity that is available for traffic management combined with the current status of traffic and infrastructure allows dispatchers to optimize traffic. This constitutes the core responsibility of traffic management. **[**SPT3TMS-16634 **]**

The national, and especially regional dispatchers should be aware of the current and expected available capacity of the border lines under their responsibility and about the situation on the neighbouring cell up to a reasonable point. This would allow them to be more integrated with traffic management on the

neighbouring cell and cooperate on the optimal train run. This approach can bring benefits for cooperating neighbours in better capacity utilization with the need of direct communication and negotiations for each case. This is especially the case during incident management and the subsequent re-routing of trains. **[**SPT3TMS-16645 **]**

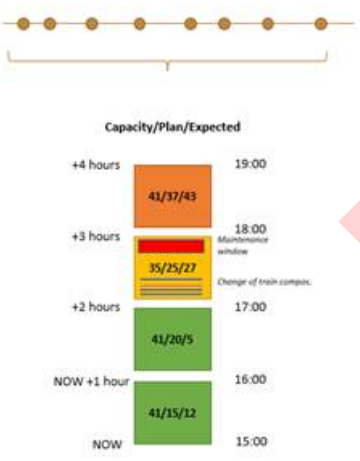
Description

- Agregaded presentation of hourly capacity utilisation for the next time period (6/12/24 hours)

Benefits

- Overview of the situation on own and neighbouring section
- Information enables better assess the overall situation on the network
- Insight to work of possible communication party

Figure 9: Representation of the capacity situation in the next four hours of the borderlines



Aim

- Provide dispetchers with overview of avalable capacity for the agreed time periods

Presented data

- Avalaible capacity for the line
- Planned capacity accordinfg to the timetable
- Occupied capacity according to the train run forecasts (Network ETA)

Source of the information

- National overview of the lines capacity
- Train run forecasting ETH & Network ETA

[SPT3TMS-16644 **]**

Figure 10: Details of the capacity situation in the next four hours of the borderlines

The output of the related TTR project should contribute to the tool presenting capacity overviews for dispatchers in the ETM network with all necessary information to assess the situation and better manage the traffic, reflecting the wider perspective of the lines' capacity. The current state of the art brings this benefit nationally for advanced traffic management systems, however, a proper presentation of currently known capacity data could be a gap-filling solution. **[**SPT3TMS-16650 **]**

9.8 EST – Summary of information modes and exchange

For the FTMS the guideline is that,

- Information exchange as described above is a prerequisite for the FTMS and ETM Network Concept
- EST is used to exchange train running data, forecast information and information about ongoing disruptions
- It is recommended to use EST also for future preconditions (risks).
- For the exchange of non-standardized data, a common tool should be used, namely the new communication platform. The platform should have functions to support both text-based and verbal communication between individuals and groups and should also support coherent communication for single events.
- The information exchange described is mainly aimed at IMs national and regional TCCs but may concern other parts depending on the internal organisation.
- Besides the TAF/TAP TSI message exchange regulations, IMs may access information in the EST from the above-mentioned modules directly via the EST web-UI, or via interface interconnecting EST and national traffic control systems (nTMS). The decision is on each IM.

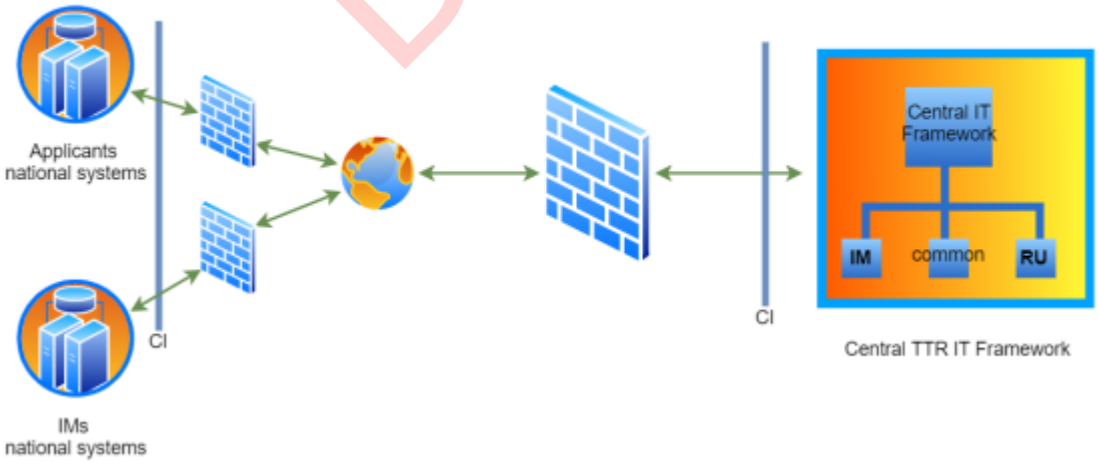
[SPT3TMS-16648 **]**

10 Annex 3: IT tools supporting a Federated CMS concept

This annex gives an overview of some of the EU IT solutions currently in place of under development in the area of capacity management. The IT tools to support the Federated CMS concept on EU-level are: TCR tool -ECMT (Temporary Capacity Restriction tool-European Capacity Management Tool), PCS (Path Coordination System) and CB (Capacity Broker) and RIS (Railway Infrastructure System). The approach complements the regulatory multilateral information exchange via TSI messages

10.1 TCR – ECM functionalities

Advance Capacity Planning happens in national tools, however, ‘capacity objects’ are uploaded via the common interface. **[**SPT3TMS-16655 **]**



[SPT3TMS-16657 **]**

Figure 11: IM/Applicant national systems versus Central TTR IT Framework

This enables all other IMs and RUs affected to see the status of a submitted CNA, the congestion level of a line, or the publication of a Capacity Model, or Supply. Also, as will be introduced on the below graph, the Capacity Supply Objects published will be the “a la carte” for the request submitted via the tool for Path Coordination. **[**SPT3TMS-16653 **]**

10.2 Path Coordination functionalities

An EU tool will cover the functionalities for Path request, Path allocation, and Post allocation processes like modification, alteration, or cancellation. Rolling planning will also be supported in this tool in the future. The abbreviations on the lines connecting the systems above refer to the messages mentioned in chapter 6. - Exchange of standardised data to support the processes. **[**SPT3TMS-16625 **]**

10.3 RIS (Railway Infrastructure System)

Actually a database rather than a tool, this system is the base pillar for all other functions to work properly. Acts as a single source of truth when it comes to topology data for instance. In the Federated modell, all locations with a Primary or Secondary Location Code are identified in a standardised way. **[**SPT3TMS-16624 **]**

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