Horizon 2020
European Union Funding
for Research & Innovation

In2Rail

In2Rail

Project Title:	**INNOVATIVE INTELLIGENT RAIL**
Starting date:	01/05/2015
Duration in months:	36
Call (part) identifier:	H2020-MG-2014
Grant agreement no:	635900

Deliverable D8.1

Requirements for the Integration Layer

Due date of deliverable	Month 18
Actual submission date	21-09-2016
Organization name of lead contractor for this deliverable	ASTS
Dissemination level	PU
Revision	Final

Authors

	Partner	Details of contribution
Author(s)	**Ansaldo STS (ASTS)** Gian Luigi Zanella Matteo Pinasco	This document, chapter(s): Executive Summary, 1, 2, 3, 5, 6, 7, and 9. Requirement Annex document, section(s): Topic Tagging, Security and Accounting, Availability and QoS, Data Access Patterns, Implementation of IL, Compliance with Existing Standards.
Contributor(s)	**AZD Praha (AZD)** Nováková Lenka Bojda Martin Růžička Martin	This document, chapter(s): Abbreviations. Requirement Annex document, section(s): IT Management.
	Bombardier Transportation (BT) Roland Kuhn Martin Karlsson	Requirement Annex document, section(s): Messaging.
	CAF Signalling (CAF) Carlos Sicre Vara de Rey Manuel Castro Viñas	This document, chapter(s): Abbreviations and 8. Requirement Annex document, section(s): Availability and QoS.
	HaCon (HC) Sandra Kempf Rolf Gooßmann	This document, chapter(s): Abbreviations and 8. Requirement Annex document, section(s): Communication, Security and Accounting, IT Management, Data Access Patterns, Implementation of IL.
	Siemens (SIE) Stefan Wegele	This document, chapter(s): 4. Requirement Annex document, section(s): Implementation of IL.
	Thales (THA) Hoi-Ting Chansavang Jean-Yves Friant	Requirement Annex document, section(s): Security and Accounting.

Executive Summary

The overall aim of the In2Rail project is to set the foundation for a resilient, cost-efficient, high capacity, and digitised European rail network.

The In2Rail sub-project Intelligent Mobility Management (I^2M) is one of the three technical sub-projects and comprising Work Package 8, which deals with, among other subjects, the definition of the functional specification of future TMS/dispatching systems.

This document is the second deliverable in WP8 and describes the first part of work done in Task 8.1 – Integration Layer – to produce a system requirements specification (SRS) for a standardised information exchange layer to be provided to TMS and external systems.

To have a better overall view, a functional requirement breakdown has been prepared before the research started (see Chapter 5). All requirements are stored within a list organised by the structure of the functional breakdown. The structure has been adapted during the whole research process.

Besides the analysis of deliverables of other I^2M Work packages and national projects, internal know-how has been included in the scope of the investigation to prepare the full set of requirements for a standardised integration layer.

The research has been conducted by all partners of WP8 and their inputs have been consolidated into a comprehensive set of requirements. The resulting requirements matrix has been subjected to a structured review process.

The actual requirements for the Integration Layer are shown in an external document (see document attachment “Requirements for the Integration Layer - Annex 1 - Requirement List”).

TABLE OF CONTENTS

Abbreviations and acronyms

Abbreviation / Acronyms	Description
AF	**A**pplication **F**ramework
AL	**A**pplication **L**ayer
API	**A**pplication **P**rogramming **I**nterface
CDM	**C**anonical **D**ata **M**odel
CENELEC	The European Committee for Electrotechnical Standardisation: responsible for standardisation in the electrotechnical engineering field
DB engine	**D**ata**b**ase engine
DMS	**D**ata **M**anagement **S**ystem
EU	**E**uropean **U**nion
HMI	**H**uman-**M**achine **I**nterface
ICT	**I**nformation and **C**ommunication **T**echnologies
IF	**I**nter**f**ace
IL	**I**ntegration **L**ayer
IM	**I**nfrastructure **M**anager
I^2M	**I**ntelligent **M**obility **M**anagement: Information developed as a strategically critical asset: • A standardised approach to information management and dispatching system enabling an integrated Traffic Management System (TMS). • An Information and Communication Technology (ICT) environment supporting all transport operational systems with standardised interfaces and with a plug-and-play framework for TMS applications. An advanced asset information system with the ability to 'nowcast' and forecast network asset statuses with the associated uncertainties from heterogeneous data sources.
IMDG	**I**n **M**emory **D**ata **G**rid
I^2R (*synonyms:* In2Rail, IN2RAIL)	**In2R**ail: Is to set the foundations for a resilient, consistent, cost-efficient, high capacity European network by delivering important building blocks that unlock the innovation potential that exists in SHIFT2RAIL
JSON	**J**ava**s**cript **O**bject **N**otation
KMS	**K**ey **M**anagement **S**ystem
LAN	**L**ocal **A**rea **N**etwork
MTTR	**M**ean **T**ime **B**etween **F**ailure
OS	**O**peration **S**ystem
SQL	**S**tructured **Q**uery **L**anguage
RU	**R**ailway **U**ndertaking
SIL	**S**afety **I**ntegrity **L**evel
SRS	**S**ystem **R**equirements **S**pecification

Abbreviation / Acronyms	Description
TAF	**T**elematic **A**pplications for **F**reight trains
TAP	**T**elematic **A**pplications for **P**assenger trains
TMS	**T**raffic **M**anagement **S**ystem
TSI	**T**echnical **S**tandards for **I**nteroperability
UIC	**U**nion **I**nternationale des **C**hemins de fer (International Union of Railways)
UML	**U**nified **M**odelling **L**anguage
VM	**V**irtual **M**achine
WAN	**W**ide **A**rea **N**etwork
WP7	**W**ork **P**ackage **7**: System Engineering of Intelligent Mobility Management (I^2M) of In2Rail.
WP8	**W**ork **P**ackage **8**: Integration and Application Layer of the Intelligent Mobility Management (I^2M) of In2Rail.
XML	e**X**tensible **M**arkup **L**anguage
XSD	**X**ML **S**chema **D**ocument

1. Background

The present document, Deliverable D8.1 “Requirements for the Integration Layer”, constitutes one of the issues in the framework of the Project titled “Innovative Intelligent Rail” (Project Acronym: In2Rail; Grant Agreement No 635900).

The overall objective of Work Package 8 (WP8) is, in according to the findings of WP7, to address and develop a standardised integrated ICT environment capable of supporting diverse TMS dispatching services and operational systems. Additionally, WP8 deals with standard interfaces to external systems outside TMS/dispatching, and with a plug-and-play framework for TMS/Dispatching applications. The two main areas of WP8 are depicted in Figure 1.1.

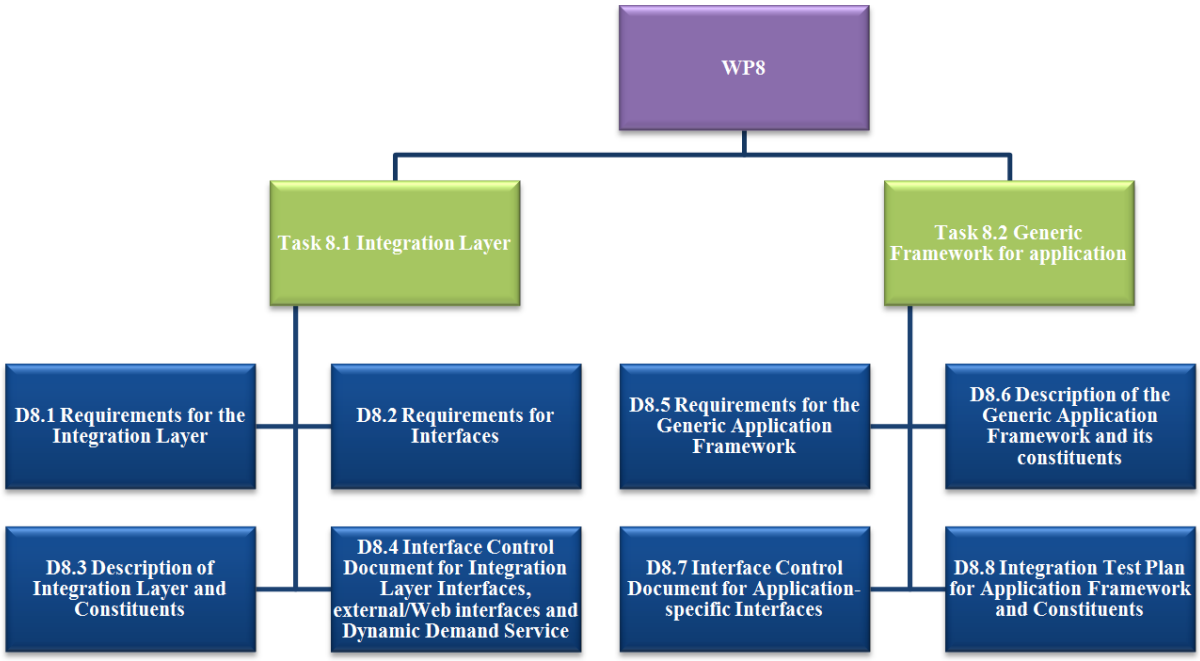


Figure 1.1: Subtopics of WP8

The goal of “Requirements for the Integration Layer” is to define and describe the Integration Layer: TMS applications leveraging on the Application Framework (part of WP8 effort, see Deliverable D8.5) and external systems shall integrate together via the Integration Layer.

WP8 is also a preparatory effort to the Shift2Rail programme, as stated in the following excerpt from [S2R, 2015]:

Task 2.9.1 Integration Layer

The objective of this task is the Development of functional requirements and architecture for the integration layer of the future traffic management system, interfaces able to integrate real-time status and performance data from the network and from the train (e.g. signalling, passenger information, fleet management and staff management systems) based on the specifications developed under IN2RAIL and to develop prototypes up to TRL3/4.

All Partners participating in this task will collaborate to specify the functional requirements and the architecture of the Integration Layer. This activity has started in H2020 IN2RAIL project and will be completed and enhanced within this Task.

Complementing System/sub-system prototypes TRL3/4 including Interfaces and Data Structures demonstrating a successful communication process will be developed and tested. Focus is on:

- Data exchange between Traffic Management System and Asset Management Centre
- Proof of Concept for Functional Interface between Traffic Management System and Signalling Wayside Infrastructure e.g. Interlocking, RBC ,
- Interfaces to link Traffic Management System with Passenger Information Systems, Time Table and Fleet & Crew Management ,
- Data exchange/communication between Traffic Management System and Operators Staff-Fostering Services ,
- Continuation of Analysis, Evaluation and Proof of Concept of Candidate Technologies for the Integration Layer based on the outcome of IN2RAIL.

~~~

Besides original contributions based on the knowledge and skills of each WP8 partners, further inputs for the definition of requirements came from In2Rail-WP9 ongoing work, CENELEC standards, well-known Enterprise Integration Patterns, ITU-T communication and security standards.
~~~

2. Objective / Aim

The present document contains an overview of the Integration Layer, information related to the aforementioned subject, and is also a companion to the document Deliverable D8.1 "Requirements for the Integration Layer – Annex 1: Requirement List".

The rest of this document is organised as follows:

- Purpose of the Integration Layer – this section provides some clarification on the purpose of the Integration Layer;
- Communication Use Cases – this section provides reference to communication use cases developed in the frame of In2Rail's WP7;
- Document Outline of "Requirements for the Integration Layer – Annex 1: Requirement List" – this section deals with the structure of the Requirement List;
- WP8 Common Glossary – this section contains the glossary shared by the WP8 members.

3. Purpose of the Integration Layer

The purpose of the Integration Layer is:

1. to provide communication based on a standardised data model between railway services, applications, and interface plug-ins communicating to external systems,
2. to provide a standard communication medium between the business applications (i.e. TMS applications) running in the context of the Generic Application Framework (see D8.5),
3. to support development and Verification & Validation during integration, system integration, and pre-commissioning activities,
4. to support suppliers, Railway Undertaking companies and third-party assessors in the compliance certification process (see previous point),
5. to provide administration and control capability for managing the communication platform and related interfaces,
6. to provide persistence functionality (Data-Silo) including access patterns.

The requirements listed in “Requirements for the Integration Layer – Annex 1: Requirement List” are not intended to be used as a Software Requirement Specification document for the development of the Integration Layer itself in the frame of In2Rail, but instead they will drive the selection of a middleware available on the market.

While the Integration Layer usage may be extended to support generic communication between any type of external systems, thus allowing the transmission of any kind of information, the focus of WP8 is on the communication between peers as described in the above point 1 and 2.

3.1. Integration Layer Design Concepts

The design of the Integration Layer revolves around the following concepts:

- Canonical Data Model;
- Information Item;
- Topic;
- Enterprise Integration Patterns.

3.1.1. Canonical Data Model

The TMS and the external systems exchanges data; each exchanged data shall belong to a data type defined inside the Canonical Data Model. Besides data types, the Canonical Data Model also contains the definitions of the relations between them.

3.1.2. Information Item

An Information Item is a unit of information exchanged within the TMS (i.e. between TMS business applications/services) or between the TMS and the external systems. Information Item has the following properties: it may be structured data, and it is atomic (i.e. irreducible in fields without loss of meaning).

Depending on the context, Information Item may also designate its own data type.

3.1.3. Topic

The concept of Topic is a broad one; depending on the point of view, it may refer to different aspects, as outlined below:

- **Information:** a topic is a category of information: business data are categorised into topics. Examples of topics are Position of Trains, State of Signalling Devices, Indications from Stations, Weather Information, etc.
- **Communication**: a topic is a channel of communication between applications: this channel conveys messages containing structured data of the same category.
- **Programming/API:** a topic is the end point of a connection between applications, used to establish a connection and transfer data, if possible after some filtering at sender and/or receiver side.

Business data referred to in the previous points are meaningful data made up of Information Items.

3.1.4. Enterprise Integration Patterns

Most of the functionalities to be provided by the IL are modelled on some of the well-established integration patterns described in [Hohpe, 2004].

Integration Patterns considered for the Integration Layer are:

- Integration Style: Messaging;
- Messaging Channel Patterns: Publish-Subscribe, Point-to-Point;
- Message Construction Patterns: Command message, Document message, Event message, Request-Reply, Message expiration;
- Messaging Endpoints Patterns: Event-Driven consumer, Competing consumer, Transactional client, Selective consumer, Durable subscriber, Idempotent receiver.

4. Communication Use Cases

The Integration Layer shall provide a communication platform for a number of systems. During the evolution of IL's specification, the amount of information channels will be increased allowing new functionality to be implemented around the TMS. There are two main approaches to define a communication system, see [Joshi, 2007]:

- Message driven architecture typically based on use cases: the communicating systems and channels are identified, and dedicated channels for every communicating pair are specified. The resulting system typically has a point-to-point communication structure;
- Data driven architecture requires the specification of the data model and provides a topic based publish-subscribe access for modification and distribution of the data model states.

The latter approach provides maximum flexibility as the number and the structure of communication participants are not specified in advance and can vary from system to system implementation. Therefore the use cases described in this chapter will just show a typical usage of Integration Layer, and they do not provide a basis for IL specification.

Typical use cases of a TMS were specified in the deliverable D7.2 defining the roles, workflow sequences and the required information at a high level:

- UC1 – Manage maintenance information;
- UC2 – Manage very short term request;
- UC3 – Manage Real time traffic plan;
- UC4 – Manage & monitor train traffic and infrastructure;
- UC5 – Manage train traffic information distribution;
- UC6 – Analysis and tracing of information;
- UC7 – Manage temporary traffic restrictions.

In this chapter the communication will be defined in more detail covering different aspects of the D7.2-Use cases:

- Way side communication:
  - Train position reports,
  - Route setting / Route states,
  - Automatic Train Operation,
  - Environmental conditions;
- RU communication:
  - Timetable change request from RU,
  - Management of major disturbances;
- Maintenance management;

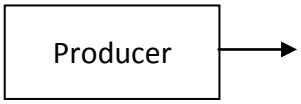
The following Use Cases (see sections 4.1, 4.2, and 4.3) depict how business logic components communicate through the Integration Layer topics.

Publish-Subscribe and Graphic Notation used in the following Use Cases

Publish-Subscribe refers to one of the Message Channel Patterns; it asserts that a producer generates topic data, and multiple (and different) consumers receive these topic data at the same time. Topic data are contained into messages.

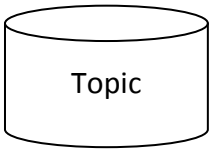
In the following Use Cases,

- a producers is represented by a square with an outwards arrow



- a consumer is represented by a square with an inwards arrow

- a Topic, including persistency level, is represented by a cylinder



~ ~ ~

Note to the reader: the following Use Cases represent simplified views; they have to be understood as samples, and they may vary in details and complexity for different implementations provided by different Companies.

4.1. Way side communication

Historically the wayside equipment installed along the railways in the EU are quite different, requiring different communication protocols and exchanging varying amount of information. The IL will have to specify a common part of the data exchanged in these cases.

4.1.1. Use Case Train position reports

Train position reports are used by several systems especially:

- Train run forecast to estimate arrival times of the train;
- Operator's Workstation to show the train position for the operator;
- Decision support system to define required modifications of the timetable in order to minimise the resulting disturbances;
- Possession management system to evaluate if any train is inside of the planned possession area before activation;
- Passenger information system to inform the passengers inside/outside of the train;
- Power supply system to forecast the power consumption for specific substations.

Depending on the installed track side equipment, the train position reports have different granularity, precision and available information. It spans from definition of train positions at the borders of track circuits every couple of km to position reports including current speed and train state bits every 5-7 seconds with ETCS level 2. To abstract the different behaviour of the track side a subsystem "Train position provider" is used for specification of this use case. In Figure 4.1 a simplified view on communication is shown.

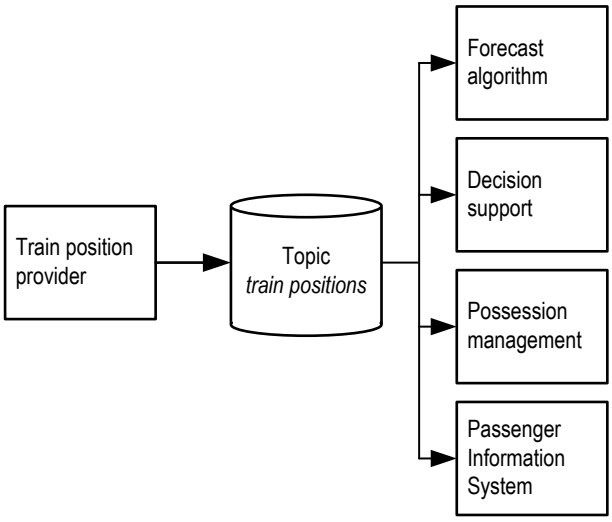


Figure 4.1: Simplified representation of communication structure for train position reports

The next step of complexity is represented by the limited bandwidth for communication of train position reports and by the fact that various subscribers require different amounts of information, e.g.:

- Passenger information system requires the last position of only passenger trains;
- Operator's workstation requires historical positions to be able to represent actual timetable in a time distance diagram;
- Specific railway undertakings require last train positions every 5-10 minutes for specific trains.

In addition, connection loss and (re)starts of new communication partners requiring historical information make the communication system even more complex. These aspects of communication are summarized under the term "Quality of service". Different kinds of quality of service are specified e.g. in [OMG, 2015].

4.1.2. Use Case Route setting / Route states

The next use case represents route setting functionality. There are in general two sources of route setting commands:

- Operator's workstation, where the user can issue the command manually;
- Automatic route setting, which issues route setting command in dependency on train position and online production timetable.

The issued route settings commands arrive at an interlocking interface, which also provides current route states per specific topic to the subscriber (typically operator's workstation, scheduling algorithms etc.).

The automatic route setting function also subscribes for the current production timetable.

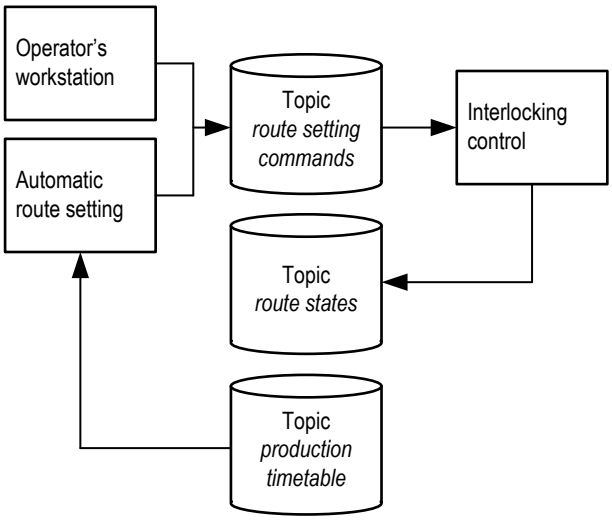


Figure 4.1: Communication use case "Route setting"

4.1.3. Use Case Automatic train operation (ATO)

To integrate TMS with Automatic train operation (ATO) the ATO-trackside module shall be supplied by the current production timetable, active and planned speed restrictions and the train position reports. The module itself identifies available deviations for the arrival and departure times and communicates with the ATO-onboard-side using an internal communication channel.

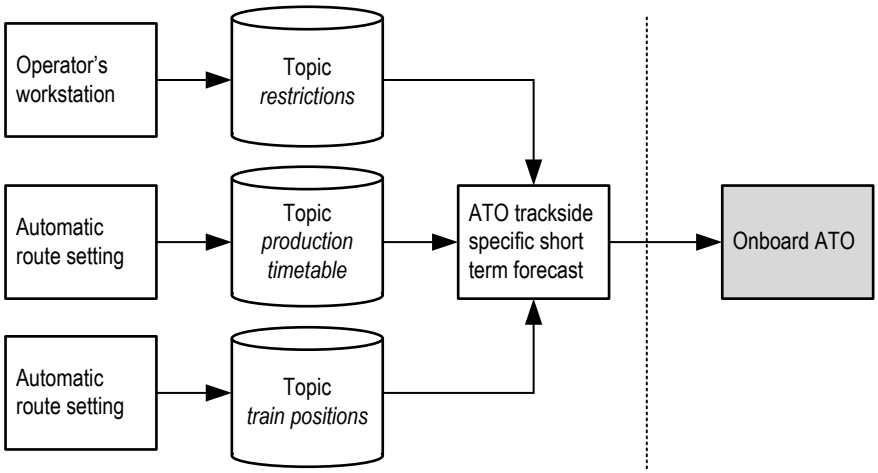


Figure 4.2: Communication use case "TMS→ATO"

4.1.4. Use Case Environmental conditions

In long tunnels currently created e.g. in a London Crossrail, the supply of fresh air is essential for the health of train passengers and staff. Therefore the state of the ventilation influences the number of trains allowed in one ventilation section. In this use case a SCADA-system provides the state of ventilation sections (via the topic environmental conditions) and automatic route setting uses this information to limit number of trains per ventilation section.

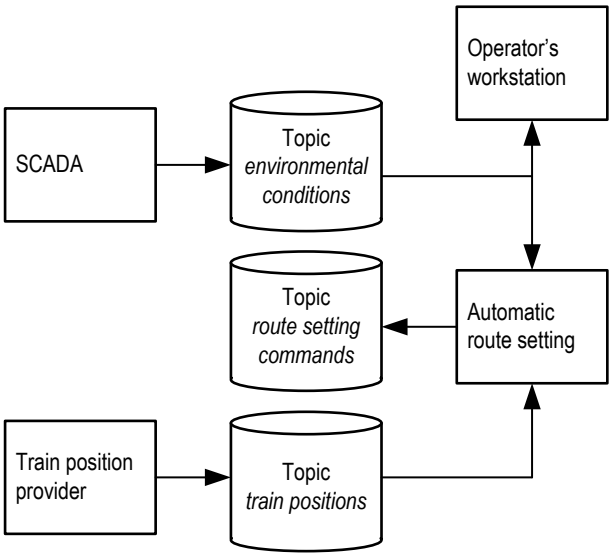


Figure 4.3: Communication workflow with a SCADA system

4.2. Railway undertaking specific communication use cases

4.2.1. Use Case Timetable change request from RU

A use case with change request coming from Railway Undertaking is published in D7.2 as UC2. From the communication point of view, the workflow is shown in following figure:

- The Railway Undertaking publishes the request on Timetable change request-Topic;
- The functionality on the Operator's Workstation represents the request together with the pre-calculated consequences from Decision support module and publishes the change request evaluation status. If the change request was accepted, the Operator's Workstation changes production timetable and the Railway Undertaker removes its Change Request from the topic;
- If the operator proposes modifications to the change request, RU either modifies published Change Request or removes it from the topic.

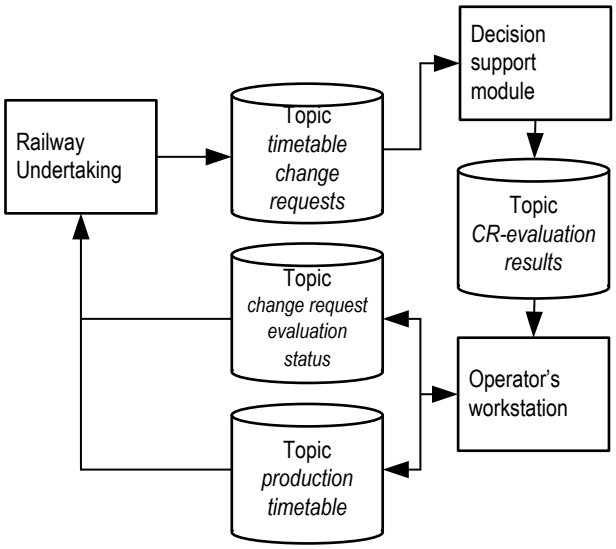


Figure 4.4: Communication workflow for short term requests from Railway Undertaking

4.2.2. Use Case Management of major disturbances

As opposed to smaller disturbances, where the operator can decide on dispatching measures on his own, disturbances the causing changes of the timetable must be approved by the involved Railway Undertaking.

The workflow is the following:

- The operator defines a new dispatching measure and publishes it as a change request on the specific Topic;
- Involved RU evaluates the proposal and publishes the result of the evaluation on the specific topic;
- If the change request was approved, the Operator's Workstation implements the modification on the current production timetable and removes the change request from the topic;
- If the change request is declined the operators provides a new proposal or makes a decision according to company specific rules;
- If the RU does not respond during time interval specified in the change request, the operator makes decisions according to company specific rules.

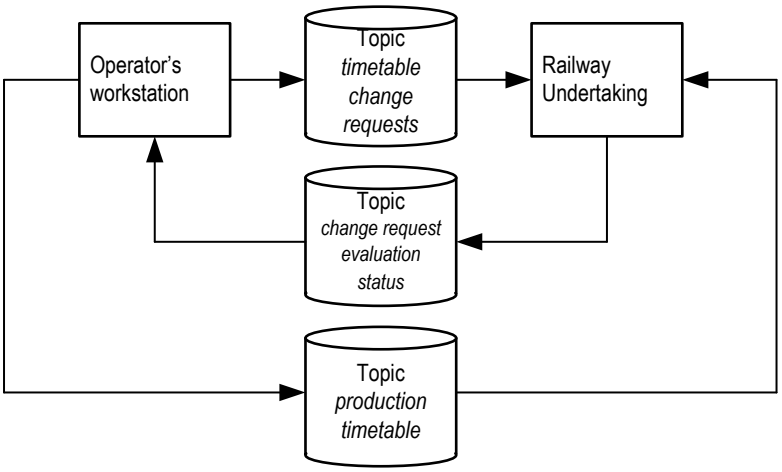


Figure 4.5: Communication use case "Management of major disturbances"

4.3. Use Case Maintenance management

In this workflow, the maintenance department interacts with the TMS by publishing/modifying planned possessions. They are presented to the operator using an operations restriction handling module, which communicates to Person In Charge Of Possession (PICOP) and e.g. via Radio Block Center (RBC) in a safety relevant manner.

The operator approves and activates possessions in the frame of restriction handling at appropriate points of time. The restriction handling publishes current and forecasted states of possession on specific topic “Possession states”.

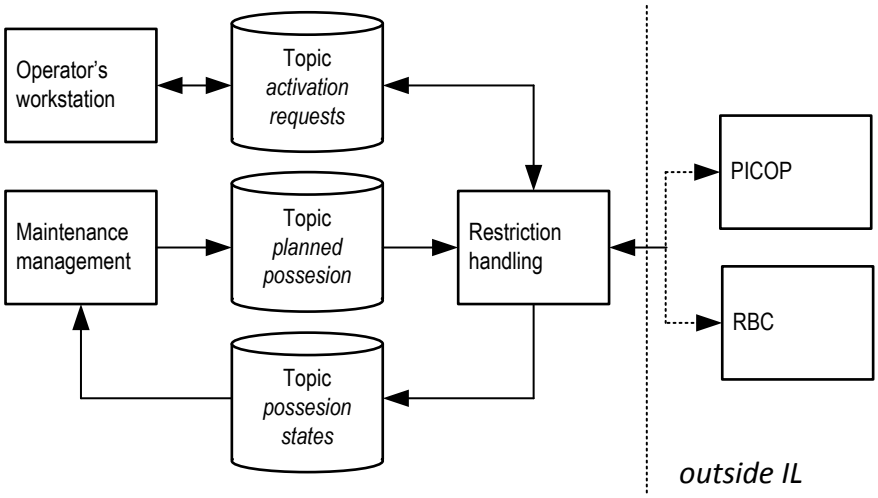


Figure 4.6: Communication use case "Maintenance management"

5. Document outline of "Requirements for the Integration Layer – Annex 1: Requirement List"

The description of the requirements for the Integration Layer is located in the matrix, which is divided into the following four sections:

- **Section 1** contains individual requirements, their short description and some other information (see below);
- **Section 2** is the list of documents used as input during the collection of the requirements;
- **Section 3** contains the description of the categories used to classify the requirements;
- **Section 4** contains definitions.

In **Section 1** the requirements are divided into several levels, which provide subsequent requirements and descriptions. In the matrix, five levels are used in total: level 1 contains high-level requirements.

For each collected requirement, the following information fields have been filled in:

- **Req. ID** (Requirement identification): an unique number in the matrix;
- **Level**: number of nesting sections;
- **Title**: a designation for the requirement;
- **In2Rail Requirement Description**: plain English description of the requirement;
- **Collector**: the initials of the collector's Company;
- **Date of collect**: date of creation or collection;
- **Collect from document:** from which documents was the information gained;
- **Status/Importance of the requirement**: description of importance by using letters, such as M (mandatory), R (recommended) etc.;
- **Comments**: any comments that allow clarification of the requirement or provide traceability of the requirement.

All of the requirements are divided into the following categories:

ID	Category	Contributor(s)
1	Communication This set of requirements deals with high level functional requirements on communication.	HC
2	Messaging This set of requirements deals with functional requirements on messaging and integration patterns.	BT
3	Topic Tagging This set of requirements deals with functional requirements on tagging of information for integration, testing, and debugging activities.	ASTS
4	Security and Accounting This set of requirements deals with functional requirements on security in communication and accounting of information transmitted via the IL.	THA, HC, ASTS
5	Availability and QoS This set of requirements deals with functional requirements on availability of the IL and QoS for information delivery, and safe communication support.	CAF, ASTS
6	IT Management This set of requirements deals with requirements on IT management of the IL, configuration, alarm handling, and logging.	AZD, HC
7	Data Access Patterns This set of requirements deals with functional requirements on Data Access Patterns provided by the IL.	ASTS, HC
8	Implementation of IL This set of requirements deals with requirements on the design and implementation of the IL.	ASTS, SIE, HC
9	Compliance with Existing Standards This set of requirements deals with compliance with existing standards.	ASTS

6. Conclusion

The requirements specified in this deliverable provide the basis for the following:

- the document “Requirements for Interfaces” (deliverable D8.2), a detailed specification for the interfaces for internal and external communications;
- the document “Description of Integration Layer Constituents” (deliverable D8.3), a text describing functional processes and architecture of the Integration Layer;
- the document “Interface Control Document for Integration Layer” (deliverable D8.4), a document describing required data structure and interface data management processes to connect internal and external services to the Integration Layer;
- Shift2Rail development activities.

7. References

[Hohpe, 2004] Hohpe, G. and Woolf, B.: Enterprise Integration Patterns, Addison-Wesley.

[I2R, 2016] In2Rail project: REQUIREMENTS FOR THE GENERIC APPLICATION FRAMEWORK – MATRIX MANAGEMENT.

[Joshi, 2007] R. Joshi: Data-Oriented Architecture: A Loosely-Coupled Real-Time SOA. http://rtcgroup.com/whitepapers/files/RTI_DataOrientedArchitecture_WhitePaper.pdf.

[OMG, 2015] Object Management Group: Data distribution service. http://www.omg.org/spec/DDS/.

[S2R, 2015] Shift2Rail Joint Undertaking: SHIFT2RAIL JOINT UNDERTAKING - MULTI-ANNUAL ACTION PLAN, REV 3.

8. Common Glossary

Term	Definition
Application Framework	Common infrastructure that handles the system management of the applications; a communication framework that enables dynamic and flexible interaction between the TMS applications, an interface framework for implementing the application interfaces for interaction between the applications, a broker framework that allows for interaction of the TMS application with other systems via the Integration Layer.
Broker	Software that manages Information distribution amongst the connected components / services.
Data Warehouse	Central repository of integrated data from one or more disparate sources (services one of them being the TMS). The Data warehouse contains for each service specific data in different sections (data marts) presenting History, Now-cast and Forecast information.
Decentralised	Responsibility distributed, not one single entity has control over all the processing (See https://www.quora.com/Whats-the-difference-between-distributed-and-decentralised-in-Bitcoin-land).
Distributed	Physically distributed, not all the processing of the transactions is done in the same place (See https://www.quora.com/Whats-the-difference-between-distributed-and-decentralized-in-Bitcoin-land).
Forecast (Asset status)	The process of exploiting past and present data to make deductions about the future.
I2M	Subproject under In2Rail focuses on the research and development of the system requirements specification and architecture for key elements of a future integrated rail service operation system.
Integration Layer	Communication link between the different Business Services.
Middleware	Software that allows data transport, data transformation and data routing.
Nowcast (Asset status)	The process of exploiting past and present

Term	Definition
	uncertain or incomplete data to make deductions about the present.
Plug-in	A Plug-in is made up of: The interface to the Integration Layer. A functional module transforming application specific data structure and information into the standard Integration layer data format. Interface between IL and other services which shall contain a “Translating Unit” for Data and function mapping in case a different data model and structure is applied in the services.
Publisher	Entity that publishes messages to be consumed by one or more subscribers. Also, actor of a business process that publishes Topics (ie make available and updates).
railML	Data exchange format developed by the European consortium of railway companies, academic institutions and consultancy firms.
Silo	Repository of fixed data.
Static Data	Data that never change during time.
Subscriber	Entity that consumes messages sent by the Publisher. Also, actor of a business process that receives updates about one or more different topics it has subscribed.
Topic	Information specific to a business process. A topic is made up of a structured collection of operational data.
Traceability	Ability to verify the history, location or application of an item by means of document recorded identification.

9. Appendices

The actual functional and non functional requirements for the Integration Layer have been collected in the “REQUIREMENTS FOR THE INTEGRATION LAYER - ANNEX 1 - REQUIREMENT LIST”.