IN2DREAMS

Newsletter

AUGUST 2018

FOREWORD

In this 1st newsletter of the IN2DREAMS (INtelligent solutions 2ward the Development of Railway Energy and Asset Management Systems in Europe) project, you will learn more about the current developments now that the project has reached its halfway point. Through the various developments that are being described, you should also get an idea of what's to come in the next year, until the project concludes in the end of August 2019.

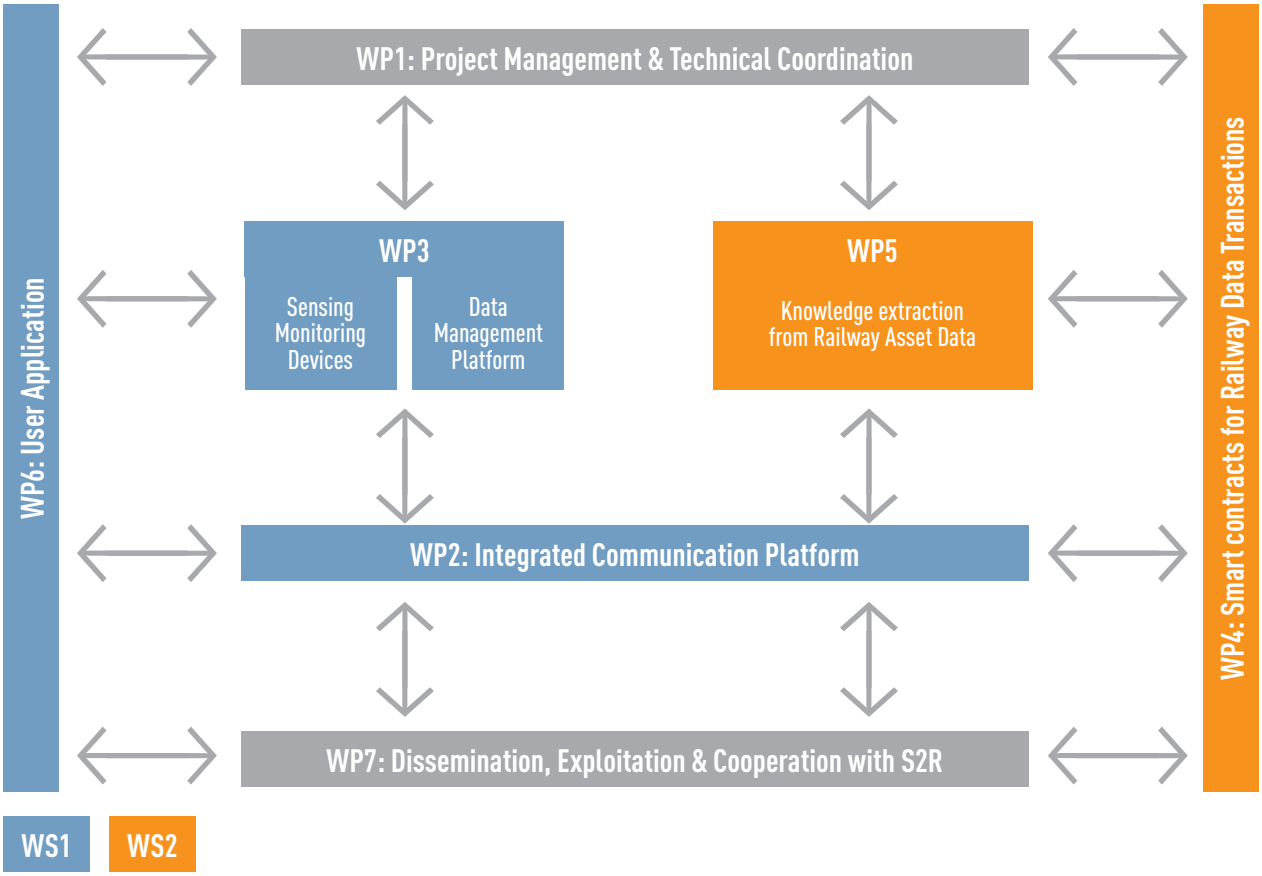
To find out more about IN2DREAMS and its objectives, to access the public deliverables and to get a closer look at the project partners, please visit our website on http://www.in2dreams.eu

This project has received funding from the Shift2Rail Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 777596

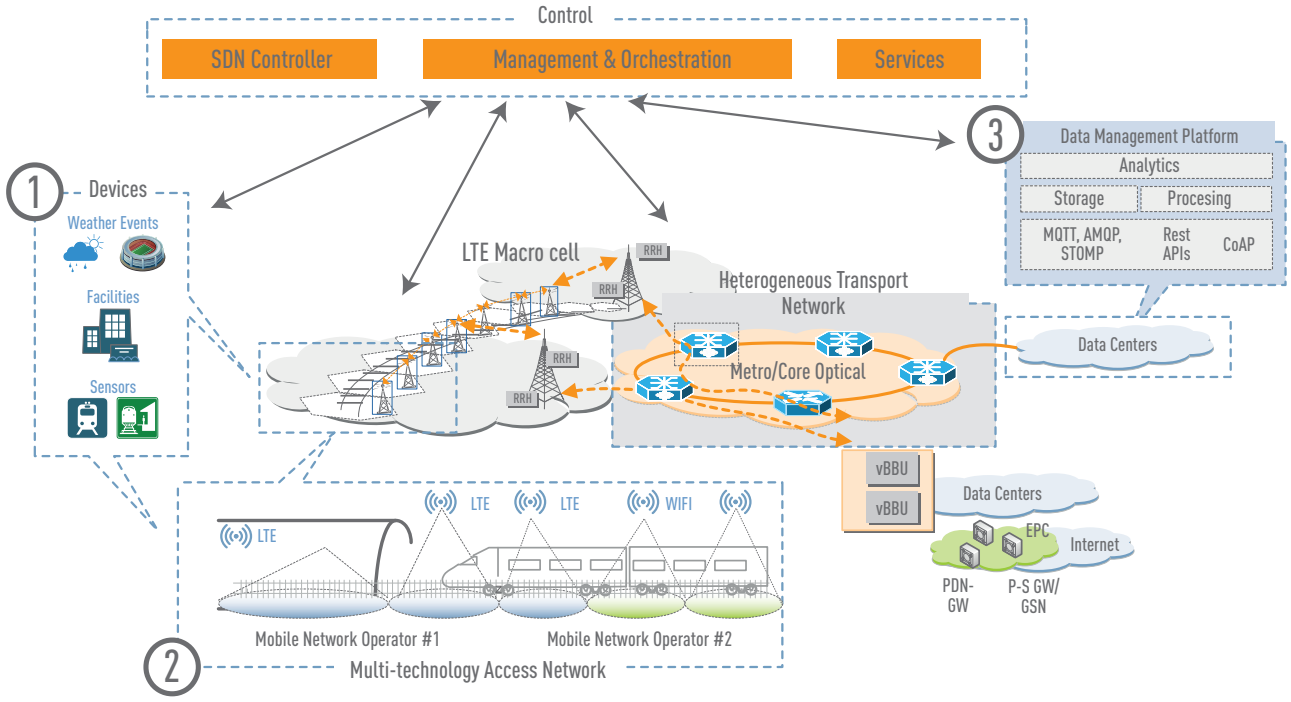
PROJECT SCOPE & STRUCTURE

The predicted growth of transport, especially in European railway infrastructures, is expected to introduce a dramatic increase in freight and passenger services by the end of 2050. To support sustainable development of these infrastructures, novel data-driven ICT solutions are required. These will enable monitoring, analysis and exploitation of energy and asset information for the entire railway system including power grid, stations, rolling stock and infrastructure. IN2DREAMS will address these challenges through two distinct work streams: Work Stream 1 (WS1), focusing on the management of energy-related data and Work Stream 2 (WS2), focusing on the management of asset-related data.

IN2DREAMS will develop and demonstrate a modular cloud-based open data management platform (ODM) facilitating ubiquitous support of both energy and asset services. WS1 will provide energy metering services through a dynamically reconfigurable platform offering improved reliability, ease of monitoring and on-the-fly optimisation for the entire railway system. This will include a heterogeneous secure and resilient telecommunication platform comprising both wireless and wireline technologies converging energy and telecom services. This infrastructure will interconnect a plethora of monitoring devices and end-users to the railway control centre and will include an ODM platform for data collection, aggregation and analysis, able to scale with the railway operators needs. This platform will be non-intrusive, exploiting advanced signal processing and intelligent learning algorithms. Within WS2, IN2DREAMS will concentrate on defining IT solutions and methodologies for business-secure decision support in the field of data processing and analytics for railway asset management. The general aim is to study and proof the application of smart contracts in the railway ecosystems, by addressing also legal and regulatory implications, and advanced visual and rule-based data analytics, including metrics for performance assessment.



Integrated Communication Platform



The objective of the Integrated Communication Platform is to define, appropriately model and implement a dynamic network communication platform interconnecting a variety of on-board and trackside sensing/monitoring devices to the railway operations and support centre as shown in the figure above. More specifically the figure shows a use case where data is collected from various devices (1), transmitted over a 5G network (2) to the cloud based data management platform (3)

To achieve this, the railway services that IN2DREAMS can support were initially analysed, emphasizing on scenarios characterized by a large volume of metering devices installed on trains that operate in very diverse environmental terrains (including tunnels). Based on these results, a network architecture capable of supporting end-to-end service provisioning over an infrastructure that couples heterogeneous wireless networks (WiFi, LiFi, LTE and FSO) with high capacity optical networks and compute resources in a dynamic and seamless manner has been defined and is currently under implementation.

It is clear that the proposed ICT platform exhibits a large degree of heterogeneity in terms of technologies. To address the challenge of managing and operating this type of complex heterogeneous infrastructure, the integration of the Software Defined Networking (SDN) and Network Function Virtualization (NFV) approaches is proposed. In SDN, the control plane is decoupled from the data plane and is managed by a logically centralized controller that has a holistic view of the network. At the same time, NFV enables the execution of network functions on compute resources by leveraging software virtualization techniques. Through joint SDN and NFV consideration, significant benefits can be achieved, associated with flexible, dynamic and efficient use of the infrastructure resources, simplification of the infrastructure and its management, increased scalability and sustainability as well as provisioning of orchestrated end-to-end services.

In the SDN /NFV architectural framework adopted in IN2DREAMS, it is observed that network function virtualization infrastructures (NFVI) comprising LiFi and WiFi components together with traditional non-virtualized physical infrastructures (e.g. LTE deploying RRHs) are inter-connected with the pool of computing resources, through SDN based optical network domains. Each WiFi/LiFi administration domain may host multiple SDN data plane elements and expose its own virtualised resources through an SDN controller to the upper layer SDN controllers. In our case the upper layer refers to the optical layer. The hierarchical SDN controller approach adopted can assist in improving network performance and scalability as well as limit reliability issues. In the proposed architecture, the top network controller will manage network resource abstractions exposed by the lower level controllers that are responsible to manage the associated network elements. Orchestration of both computation resources necessary to support the IoT use case and network resources is performed by the NFV Orchestrator and can be used for the support of multi-tenant chains, facilitating virtual infrastructure provider operational models. It is also responsible to interact with third party or legacy resources and support systems (OSS).

Global optimization of the integrated and converged infrastructure will be targeted with the objective to increase functionality, capacity, and flexibility and decrease the capital and operational costs. These objectives will be targeted while at the same time improving other parameters of interest such as energy efficiency taking into account the specificities of the rolling stock in terms of mobility. In addition to the architectural design, operational considerations concentrating on the requirements for the provisioning of end-to-end services will be applied. The proposed architecture will be examined considering the specific operational characteristics and protocols available, per technology domain. The required modifications and extensions that need to be applied to existing mechanisms/protocols to optimally support the converged end-to-end solution will be also proposed.

Sensing/Monitoring Devices and Data Management Platform

The Sensing and Monitoring platform aims to build a functional system of real-time monitoring in charge of gathering the data from sensors and use the network infrastructure to send this data to a Data Management platform.

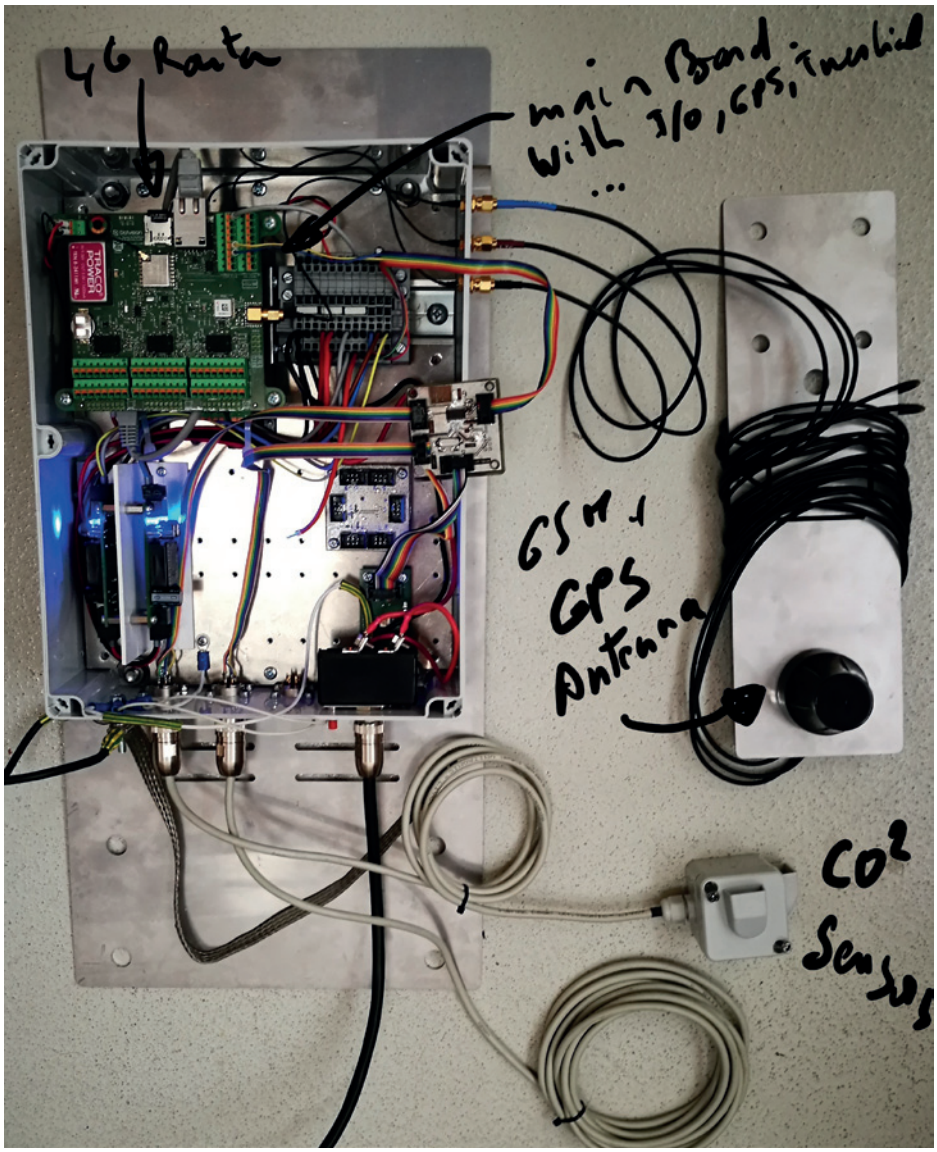
This platform MUST be able to receive and process a huge amount of data coming from sensors both on board and on track.

One of the main tasks will be to cloud-enable the rail infrastructure such as the locomotive and energy-substation. To do so, a new set of non-intrusive dedicated hardware sensors and gateway will be installed on-board, including: Global Positioning (GPS), Inertial (accelerometers, gyroscopes, compass), Energy related Sensor (Traction provided by LEM, and auxiliary by DV), Vibration, Temperature and luminosity.

Sensors on track will include, but will not be limited to: Energy related Sensor (Traction energy ingestion related and auxiliary).

Data management platform will oversee the gathering of data hitting the cloud. However due to network limitation and volume of data, some edge (local to sensor) data management MUST and will be provided.

To the date of this newsletter and after delivering the Architectural overview of the solution, we have so far launched the Data Management Platform, built the Monitoring On Board Rugged Gateway (MOBRUG) and sucessfully passed the first installation and security test on Reims Tramway.



User Applications

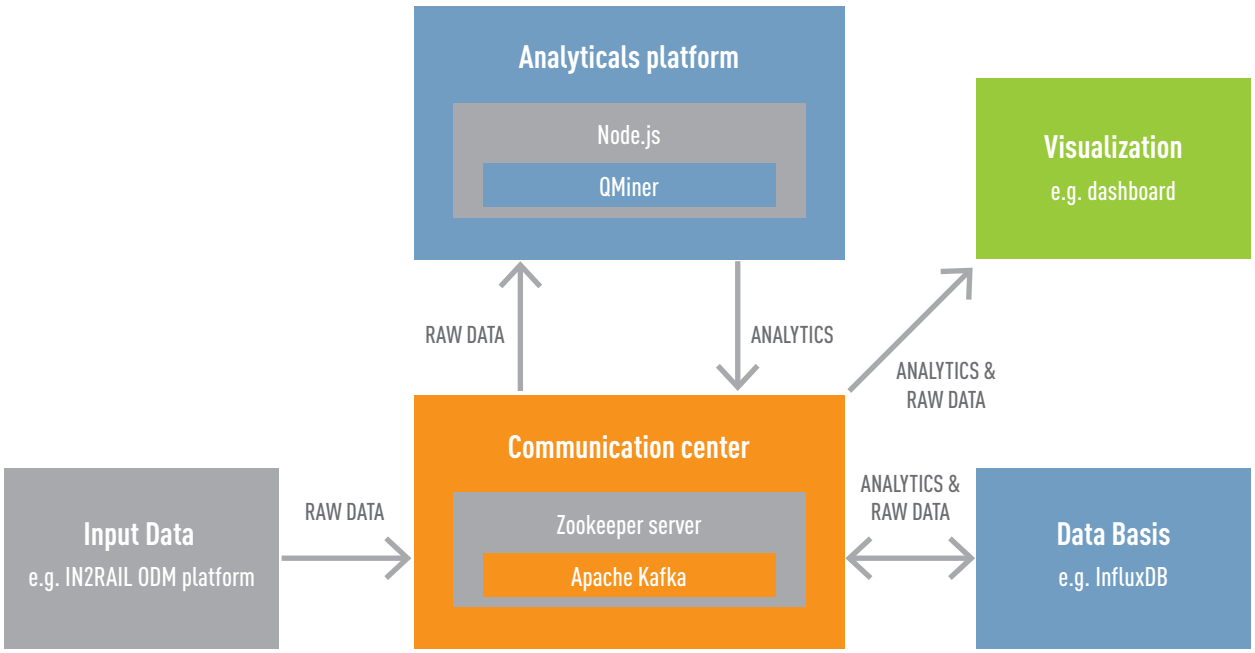
The objective of the User Applications Work Package is to develop a data analytics platform which will assist infrastructure managers and railway operators to select optimal strategies and resources in order to support in a cost effective and energy efficient manner railway applications addressing operational requirements and passenger's requests. Such analysis will require the process of a huge amount of data in real time. Thus, an efficient infrastructure is needed to develop specific applications.

The QMiner software was selected to develop the analytics platform. It is designed for scaling millions of instances on high-end commodity hardware, providing efficient storage, retrieval and analytics mechanisms with real-time response. The following figure shows a simplified overview of the developed architecture of the system.

With QMiner, a high level of flexibility and scalability can be achieved. Designed architecture and selected components offer modular structure with loosely coupled components. In such way, the analytical infrastructure will be able to support a plethora of use cases. We are currently working with the Reims tramway use case coming from the IN2RAIL project.

So far, the architecture has been deployed and QMiner software has been installed. Forecasting models of energy consumption for trains and sub-stations are under development and will be implemented within the software. Moreover, a task to model energy data has started. Due to technical complexity and high cost to install meters in a real train line, the goal is to model the energy data in order to eventually be able to enrich existing but limited data sets. The impact on the prediction accuracy resulting from the use of these enriched data sets will be tested applying the aforementioned forecasting models.

Finally, with this analytics platform it is possible to envisage the development of solutions enabling, for example, the operation of the rolling stock in an autonomous mode (driverless trains).



Smart contracts for Railway Data Transactions

One of the goal of IN2DREAMS is to experiment the employment of novel Distributed Ledger Technologies inside the Railway Ecosystem, to explore all the possibilities and benefits that these technologies may bring.

This objective will be achieved through the following steps:

1 Identify suitable use cases and select the one that presents the highest success potential

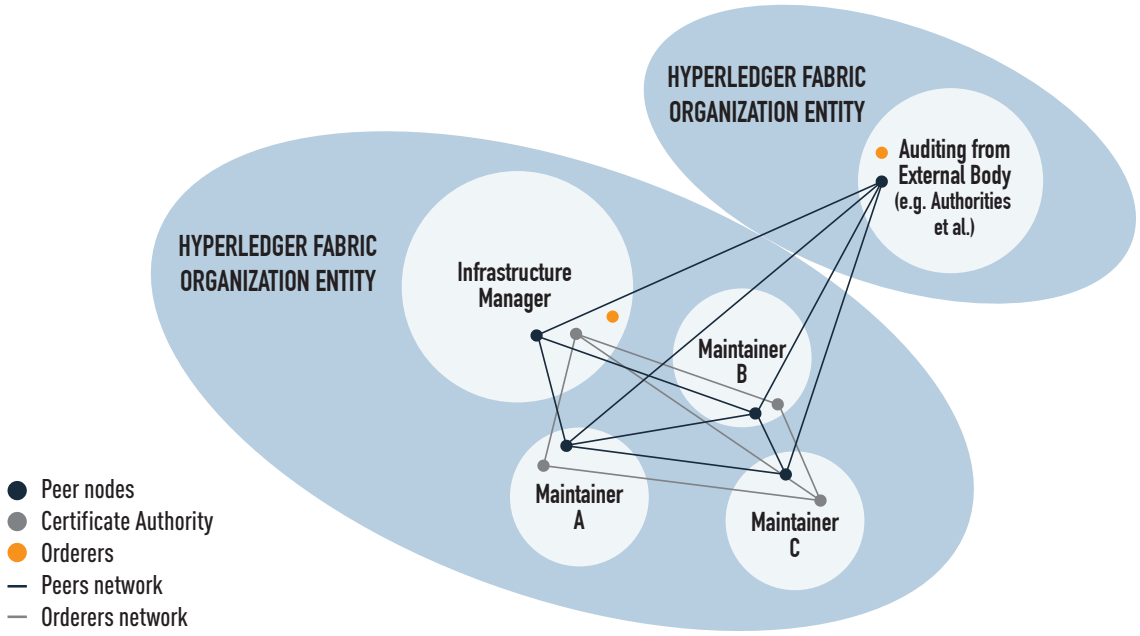
2 Perform a technology selection with the requirements of the selected use case in mind

3 Develop a Proof of Concept

4 Test and trials in a relevant environment

The first two steps have already been achieved. The selected use case is related to the asset maintenance, or more specifically to the management of the administrative workflows that take place between the different actors related to the Infrastructure Manager and the external Contractors. The Distributed Ledger Technology suits very well this scenario given its immutability feature, that guarantees in each moment the possibility to know exactly what is the status of each maintenance job and "who did what".

The Proof of Concept will be developed, in collaboration with the WP5 inside the WS2, in the second year of the project, using Hyperledger Fabric: the technology that obtained the highest score in the performed technology selection.



Knowledge extraction from Railway Asset Data

The general objective of the Knowledge extraction from Railway Asset Data Work Package is to study, design, develop, and assess the performance of data analytics solutions for knowledge extraction from railway asset data. This objective will be achieved through the following tasks:

- Definition of data analytics scenarios;
- Development and demonstration of tools and methodologies aiming at extracting knowledge from data analytics algorithms, and contemporarily making them interpretable in an easier way;
- Study and proof-of-concept of metrics and methods/tools to measure the accuracy of analytics algorithms.

The first step has already been achieved and seven scenarios have been developed.

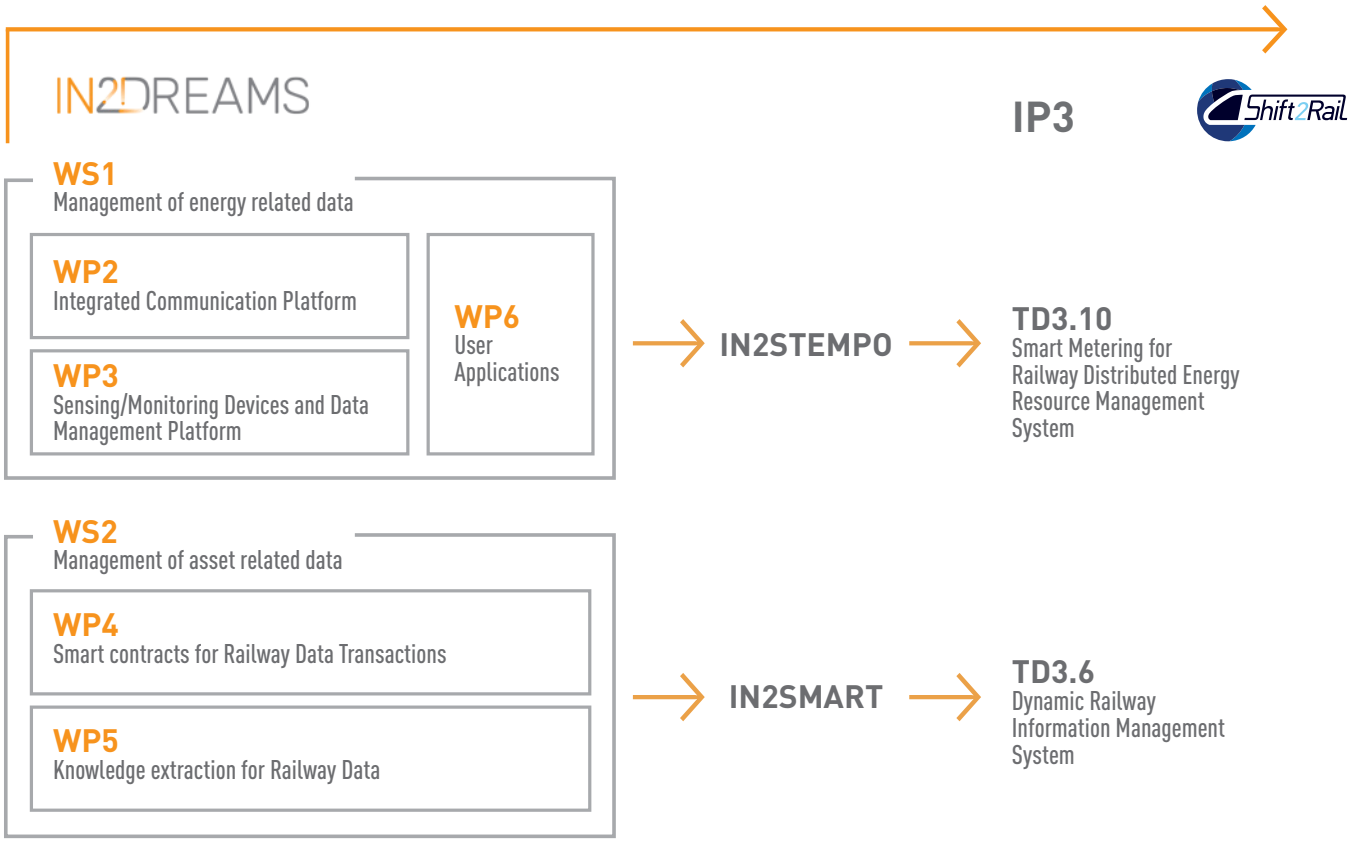
Two of them are cross-scenario in the sense that they cover, in some way, many aspects of the railway ecosystem (Visualization and Monetization of data produced in the Railway Ecosystem) while five of them are scenario- specific in the sense that they focus on a single particular aspect (Track Circuits, Train Delays and Penalties, Restoration Time, Switches, and Train Energy Consumption).

The selected use cases are related to the asset maintenance. Metrics and tools for data analytics algorithms assessment are in development in order to assess the performance of the developed data-driven knowledge extraction solutions based on visual and rule-based analytics.

A proof-of-concept will be developed in the second year of the project, in collaboration with the WP5 inside the WS2, in order to enrich to the management of the administrative workflows that take place between the different actors related to the Infrastructure Manager and the external Contractors.

IN2DREAMS INTERACTION WITH SHIFT2RAIL

As depicted in the diagram below, the two Works Streams of IN2DREAMS are closely linked with two other IP3 projects, IN2Stempo and IN2SMART. In this respect the necessary collaboration has already been established during the first half of the project and will continue until the conclusion of the project.



FACTS & FIGURES

Total Budget
2.2M€

Partners
14

Duration
24 Months

Start date
01 09 2017

CONTACT US
Stefanos Gogos (UNIFE) Project Coordinator
stefanos.gogos@unife.org
www.in2dreams.eu

PARTNERS

PROJECT COORDINATOR

TECHNICAL LEADERS

BENEFICIARIES

This project has received funding from the Shift2Rail Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 777596