



# In2Rail



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No: 635900



# In2Rail Mid Term Event

Andy Doherty – Chief Technical Officer  
Facilitated By - Mona Sihota

Submit further questions to: [In2Rail@networkrail.co.uk](mailto:In2Rail@networkrail.co.uk)



# Project Objectives

The In2Rail project 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: innovative technologies will be explored and resulting concepts embedded in a systems framework where infrastructure, information management, maintenance techniques, energy, and engineering are integrated, optimised, shared and exploited.



# Introductions



**Amanda Webster**  
WP1



**Ian Coleman**  
WP2



**Ian Dean**  
WP3



**Anders Carolin**  
WP4



**Federico Papa**  
WP5



**Henk Samson**  
WP6



**Stefan Wegele**  
WP7



**Roland Kuhn**  
WP8



**Carlo Dambra**  
WP9



**Tomas Greif**  
WP10



**Olivier Langlois**  
WP11



**Tom Tivey**  
WP12



**Andrea Demadonna**  
WP13





# Coordinator

## Railway Industry

<b>ALSTOM</b>	Ansaldo STS A Hitachi Group Company	<b>THALES</b>	<b>mermec</b>
<b>CAF</b>	<b>SIEMENS</b>	<b>Strukton</b> Rail	
<b>BOMBARDIER</b> the evolution of mobility	<b>ČD</b> PRAHA	<b>HaCon</b> Traffic • Software • Service	
<b>indra</b>	<b>vossloh</b>	<b>BRITISH STEEL</b>	
<b>COMSA</b> INDUSTRIAL	<b>EVOLEO</b> TECHNOLOGIES	<b>Datvision</b>	
<b>3Deling</b> LASER SCANNING	<b>GRIDNET</b>	<b>Sygnity</b>	
<b>FCC</b> CONSTRUCCION	<b>ERT</b>	<b>neelogy</b>	
<b>ineco</b>	<b>acciona</b>	<b>SYSTRA</b>	

## Associations

<b>unife</b> THE EUROPEAN RAIL INDUSTRY
<b>EFRTC</b> European Federation of Railway Technicians' Companies

## Consultants

<b>D'APPOLONIA</b> auditing, design, operations & maintenance engineering
--

# Consortium

## Research Centres

<b>Fraunhofer</b> IFAM	<b>DLR</b>	<b>virtual vehicle</b>
<b>SAPIENZA</b> UNIVERSITÀ DI ROMA	<b>UNIVERSITY OF BIRMINGHAM</b>	<b>E.ON Energy Research Center</b>
<b>University of BRISTOL</b>	<b>U.PORTO</b> FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO	<b>UNIVERSITÀ DEGLI STUDI DI GENOVA</b>
<b>University of HUDDERSFIELD</b>	<b>POLITECNICO DI MILANO</b>	<b>UNIVERSITY OF Southampton</b>
<b>Systemx</b> INSTITUT DE RECHERCHES TECHNOLOGIQUES	<b>RALENUM</b> STUDIOSYSTEM	<b>CHALMERS</b>
<b>The University of Nottingham</b>	<b>Loughborough University</b>	
<b>LULEÅ UNIVERSITY OF TECHNOLOGY</b>	<b>izt</b> Institute for Futures Studies and Technology Assessment	

## Infra Managers

<b>SNCF</b>
<b>OBB</b> INFRA
<b>DB</b> Mobility Networks Logistics
<b>RFI</b> RETE FERROVIARIA ITALIANA GRUPPO FERROVIE DELLO STATO ITALIANE
<b>TRAFIKVERKET</b>
<b>adif</b>



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# Smart Infrastructure

Sub Project Speaker: Henk Samson



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# Smart Infrastructure



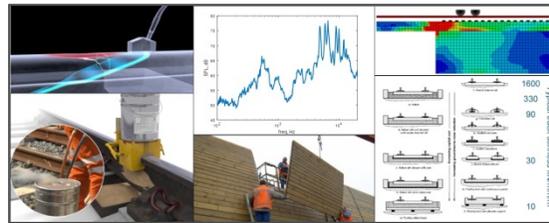
WP2: Enhancing Existing/Developing Next Generation Switch and Crossing Solutions



WP3: Innovative Track Solutions



WP4: Bridges & Tunnels



WP5: Commercial Off The Shelf (COTS) Monitoring



WP6: Maintenance Strategies & Execution



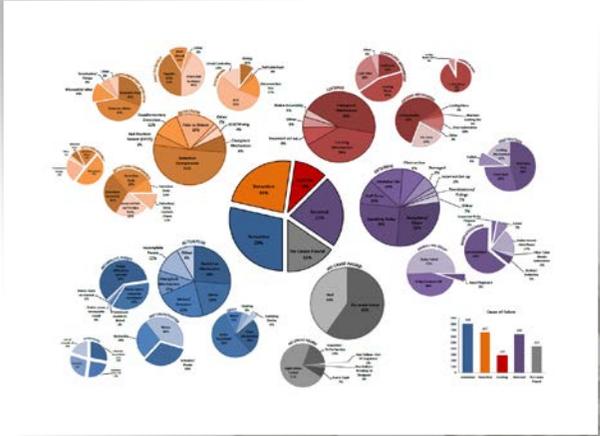
# Smart Infrastructure - Innovative S&C Solutions

Ian Coleman  
Network Rail

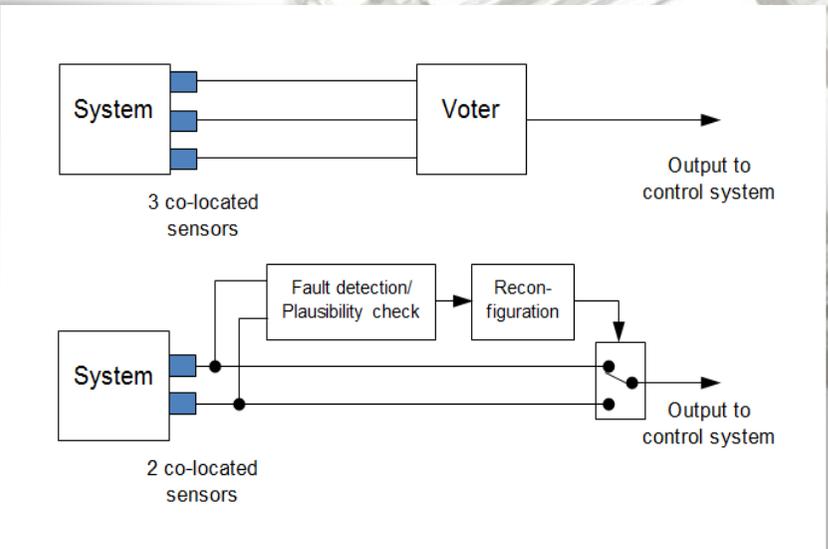


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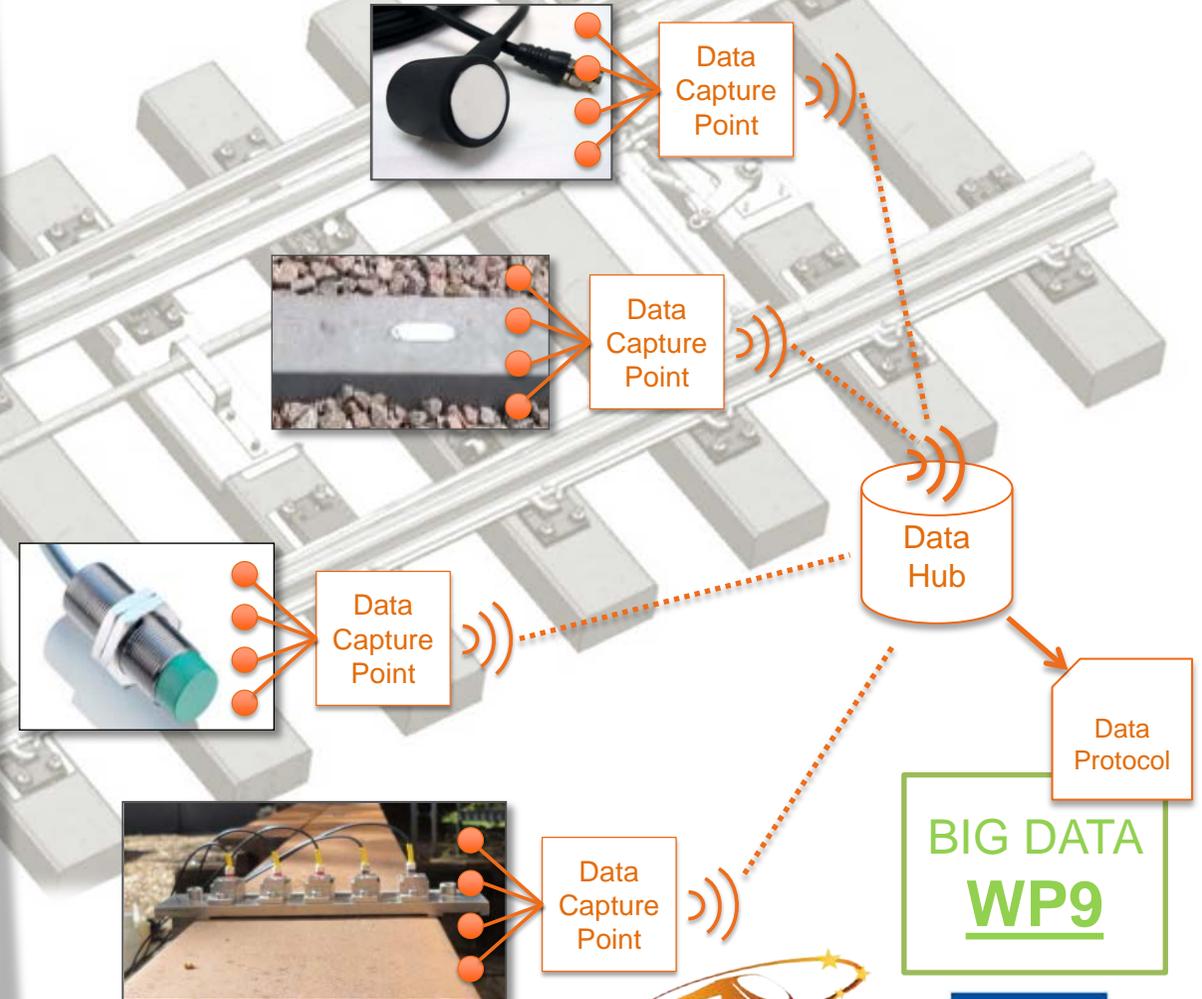
# Enhancing Existing S&C Systems



## FAILURE ANALYSIS



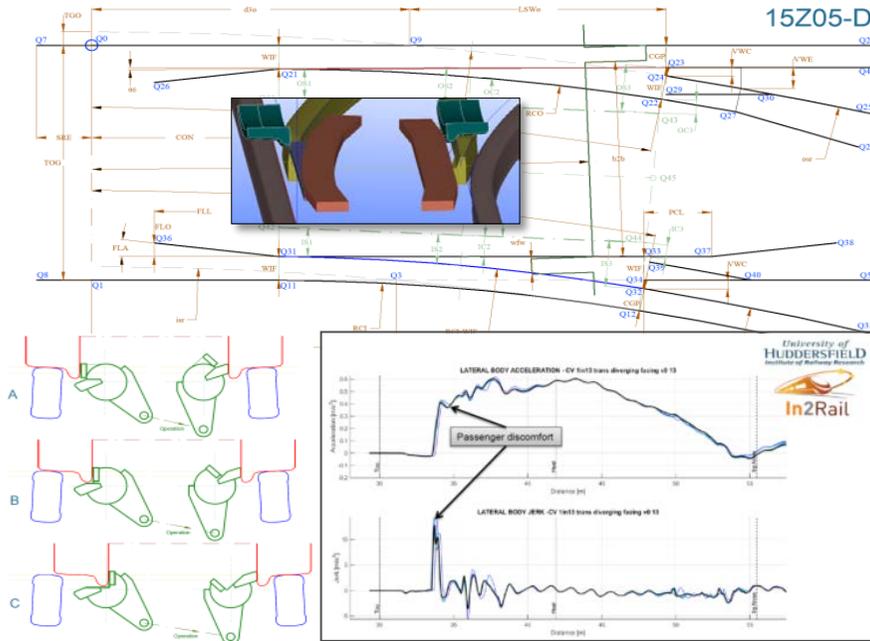
## SYSTEM REDUNDANCY DESIGN



**BIG DATA**  
**WP9**



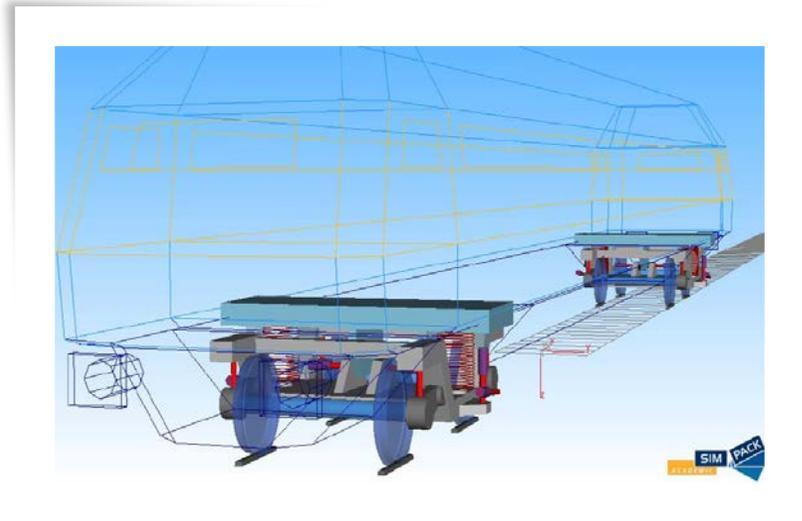
# Next Generation S&C Systems



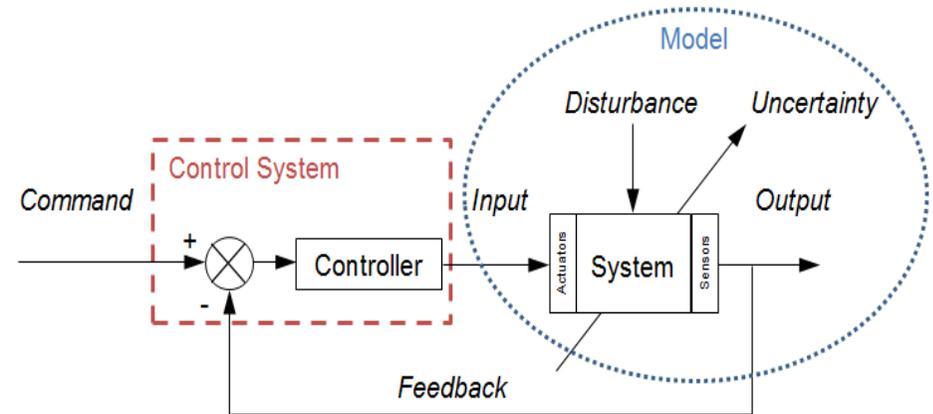
## NOVEL S&C CONCEPTS



## REDUCING COMPLEXITY



## WHOLE SYSTEM APPROACH



## ADVANCED CONTROL SYSTEMS

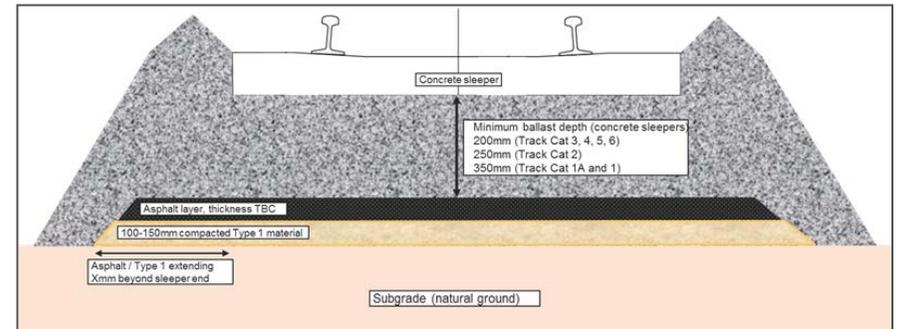
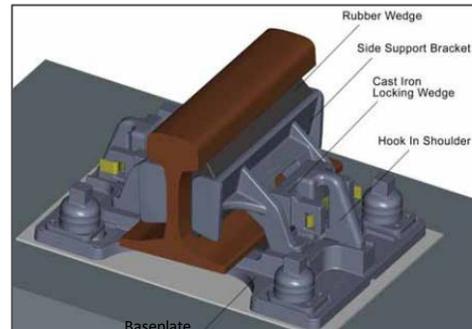
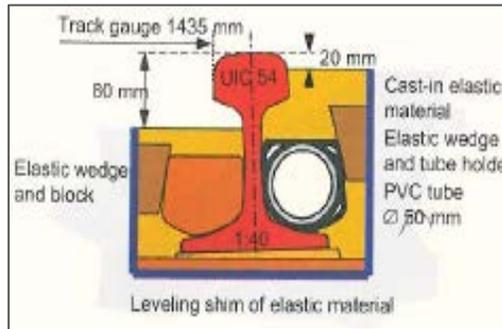
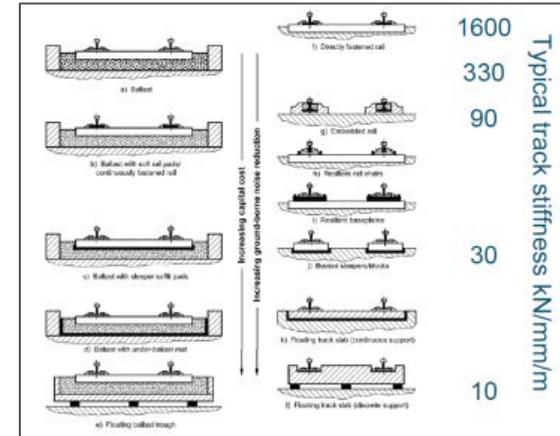
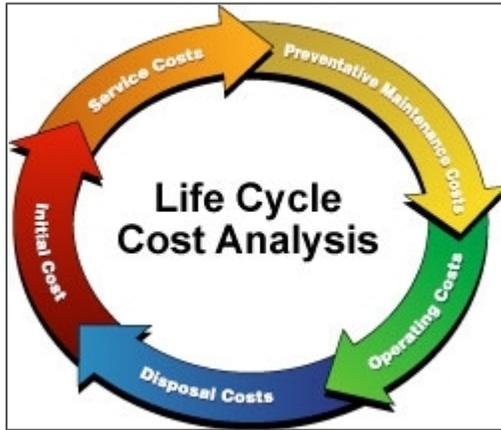
# Smart Infrastructure - Innovative Track Solutions

Ian Dean  
Network Rail



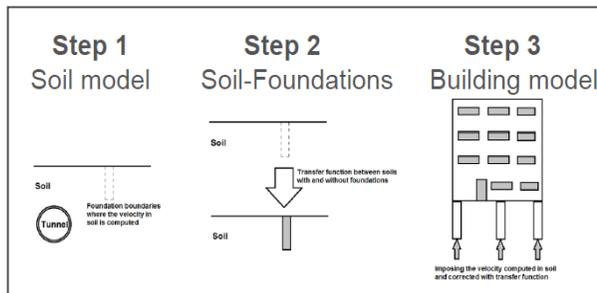
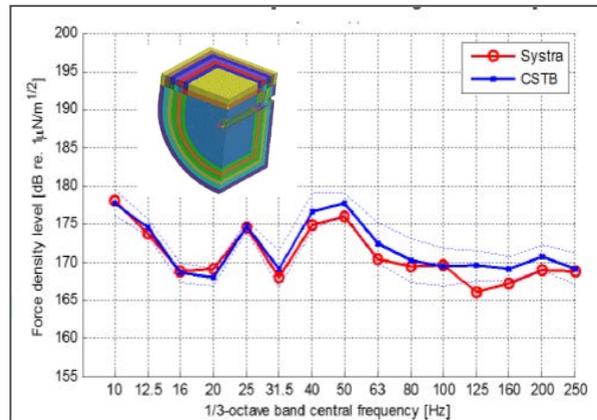
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# Innovative & Optimised Track Solutions



# Solutions to Common Track Problems

## Noise & Vibration



## Rail Head Repair



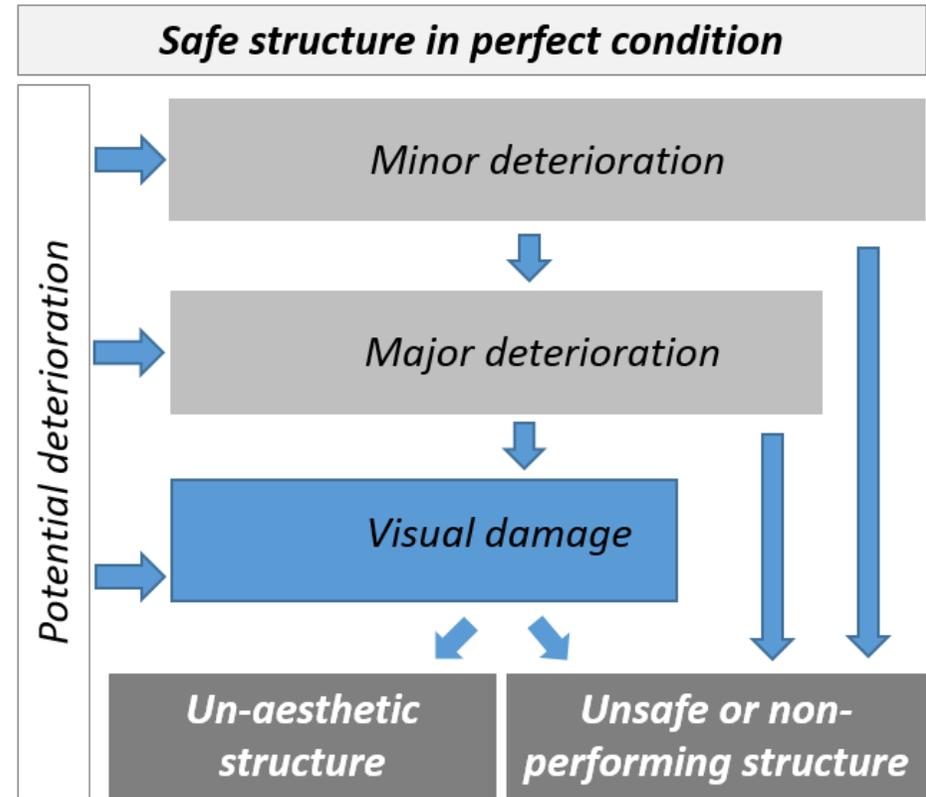
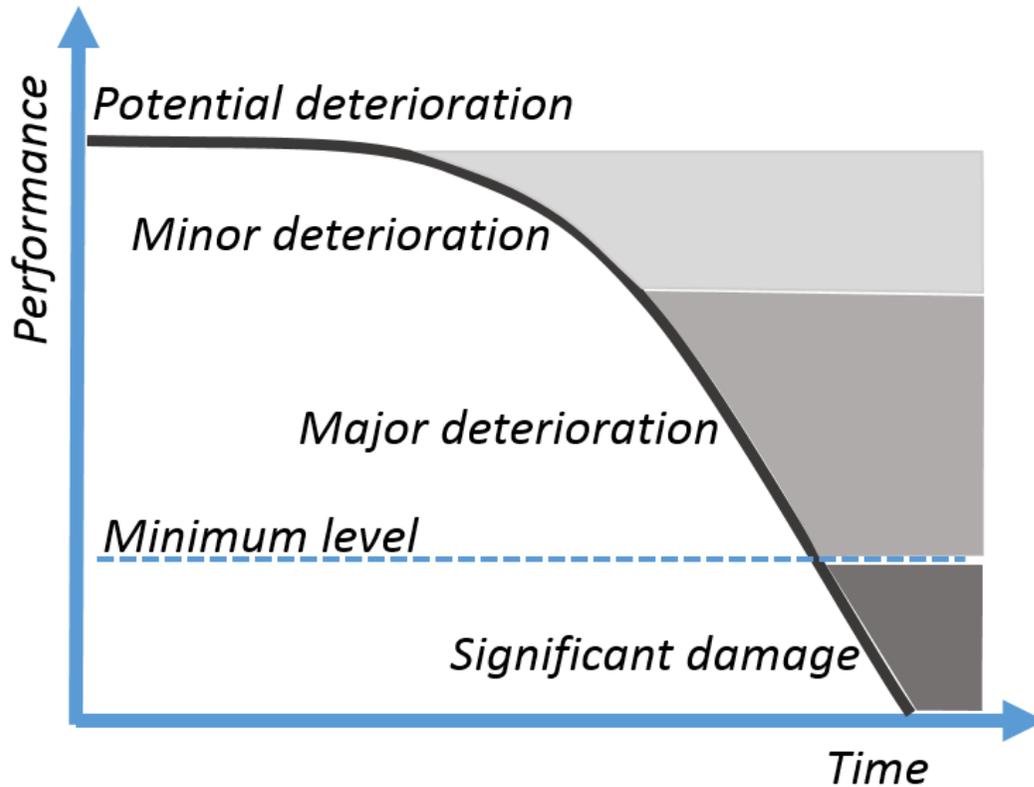
# Smart Infrastructure - Bridges & Tunnels

Anders Carolin  
Trafikverket



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# Bridges and Tunnels Deterioration



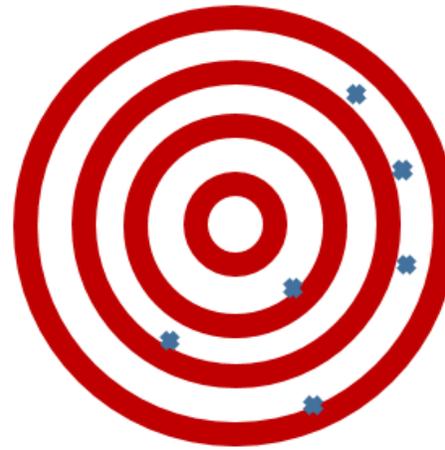
# Precision, Accuracy and Frequency can compensate for each other



✓ *Precision*  
✗ *Accuracy*



✗ *Precision*  
✓ *Accuracy*



✗ *Precision*  
✗ *Accuracy*



✓ *Precision*  
✓ *Accuracy*



# Smart Infrastructure - Commercial Off The Shelf (COTS) Monitoring (thermal stress and track geometry)

Federico Papa

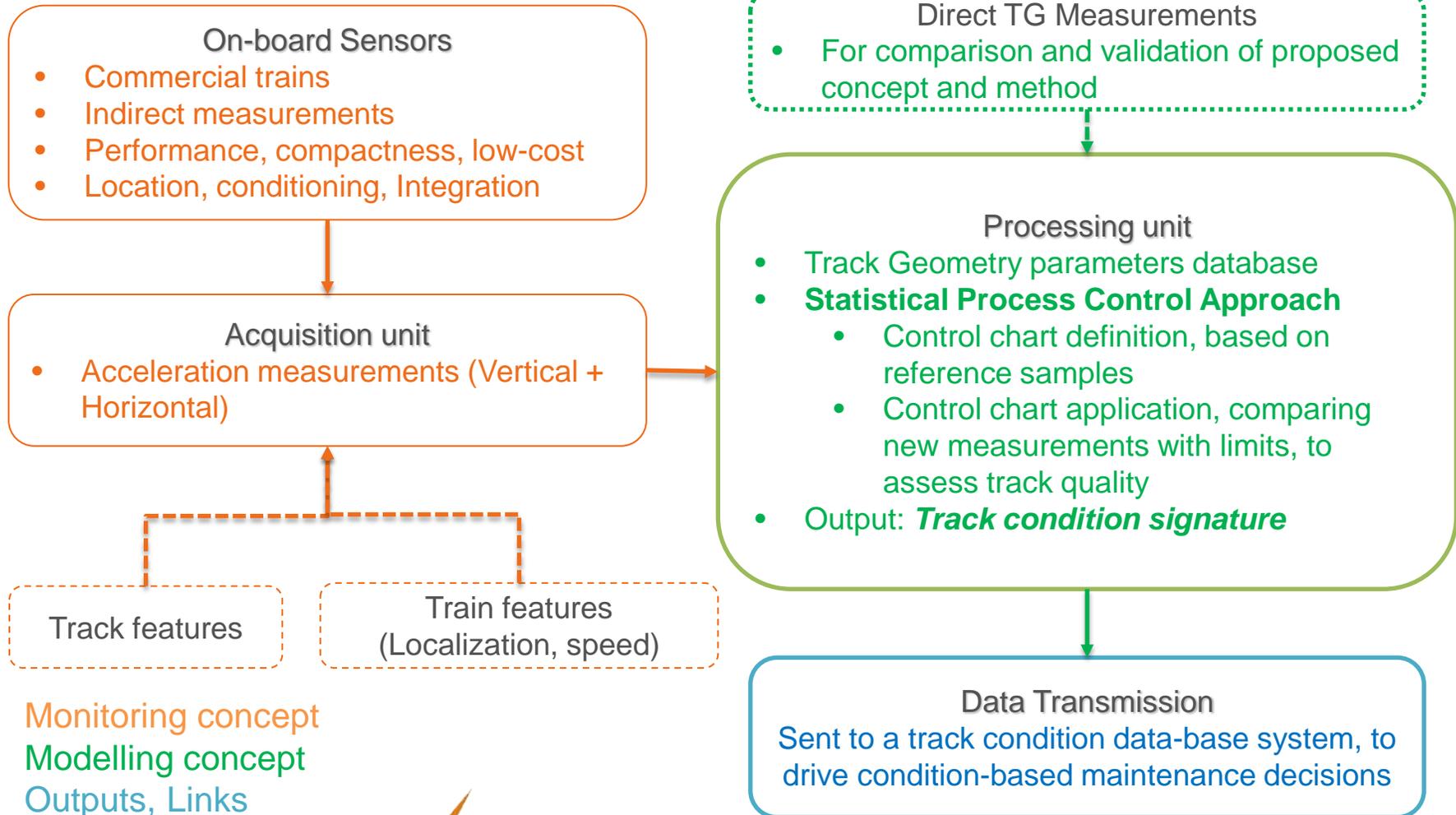
Ansaldo STS



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# Track geometry monitoring

Concept for innovative monitoring of track geometry used to perform the track condition analysis using accelerometers



Monitoring concept  
Modelling concept  
Outputs, Links



# Thermal Rail Stress Monitoring Concept

## Ground-based info (TMS)

Traffic forecast

Vehicle types

Weather info

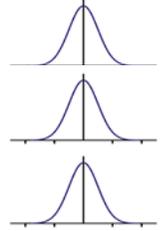
Critical site  
Register/records

## Probabilistic risk-based model

Stress Free Temperature

Lateral Resistance

Track Geometry



On-board  
continuous  
measurement:  
Rail Temperature  
+  
Geometry

Decision threshold identification

Decision-making

Dispatching



Maintenance



# Smart Infrastructure - Maintenance Strategies & Execution

Henk Samson  
Strukton



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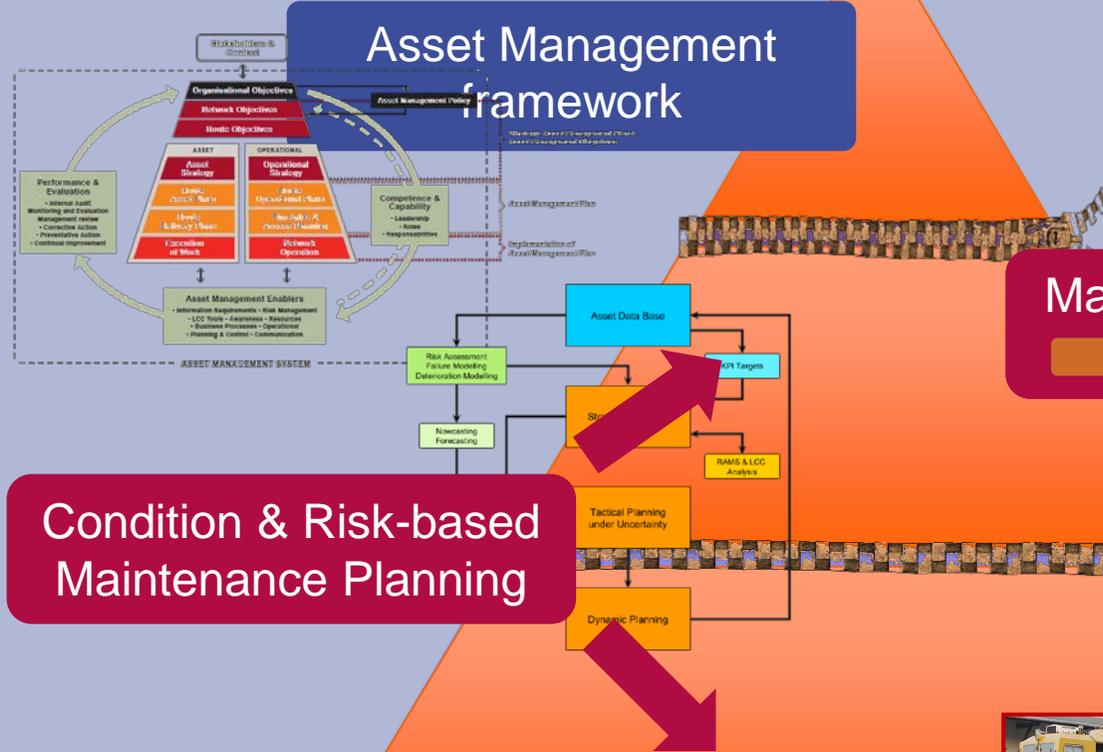
# WP6 – Overview

Strategic

Tactical

Operational

Asset Management framework



Maintenance Modelling

Dynamic model Track

Maintenance Modelling

Dynamic model Switch

Maintenance Execution

High performance tamping

Condition & Risk-based Maintenance Planning



# WP6 - High Performance Tamping

## Track geometry inspection

➔ Decision about maintenance



Track recording car

*During train-free periods !*

## Pre-run track alignment

➔ Input data for tamping machine



Track surveying car  
or  
Manual track surveying



*Relevant possession time  
and cost in both cases !*

## Maintenance - Tamping

➔ Restoring of track geometry



Tamping machine

*Relevant possession time  
and cost !*



# Smart Infrastructure - Questions & Answers

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to [In2Rail@networkrail.co.uk](mailto:In2Rail@networkrail.co.uk)



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# Lunch

13:00 – 14:00

Please return to the room ready to start at 14:00



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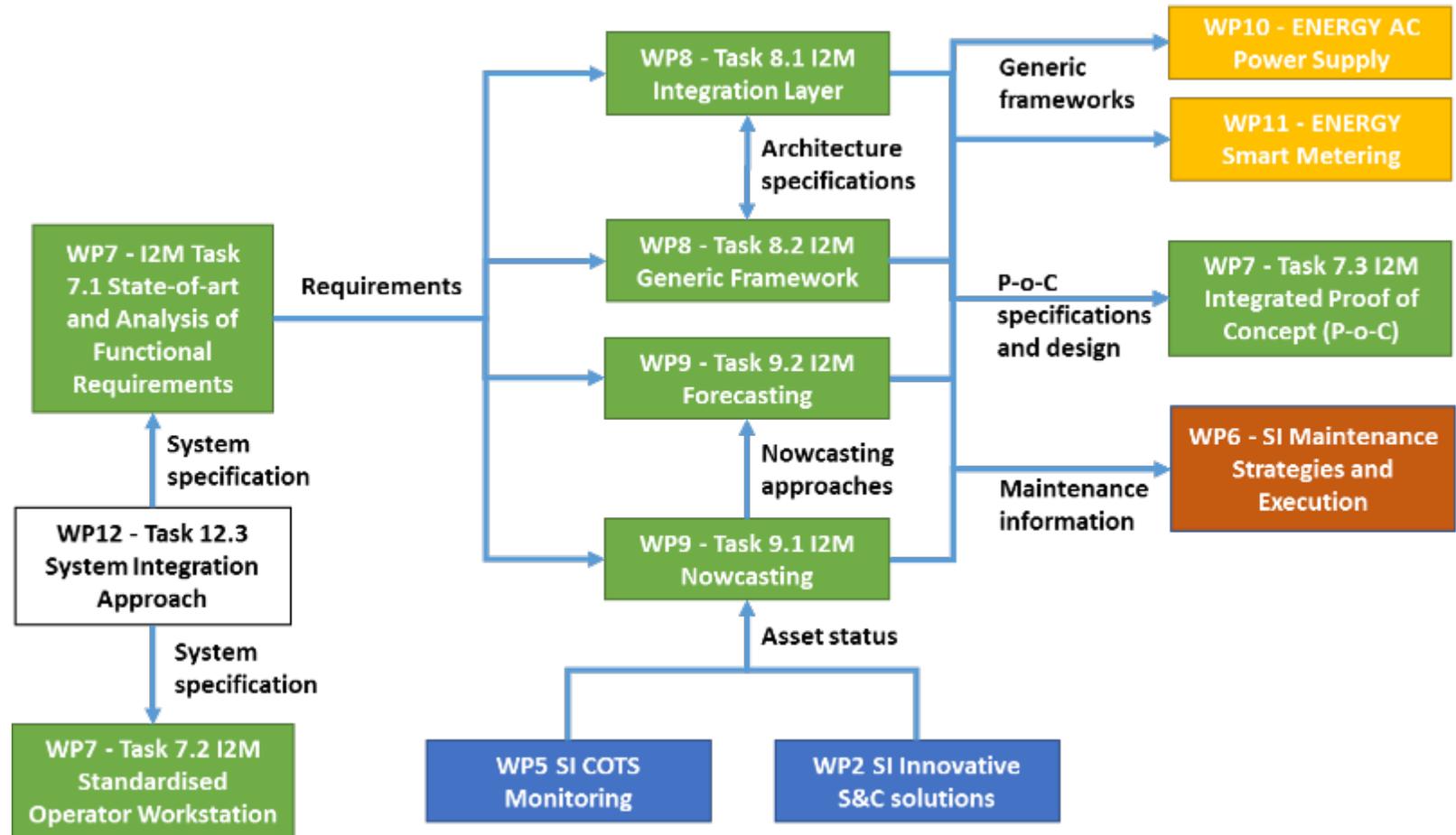
# Intelligent Mobility Management

Sub Project Speaker: Carlo Dambra



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# Intelligent Mobility Management (I2M)



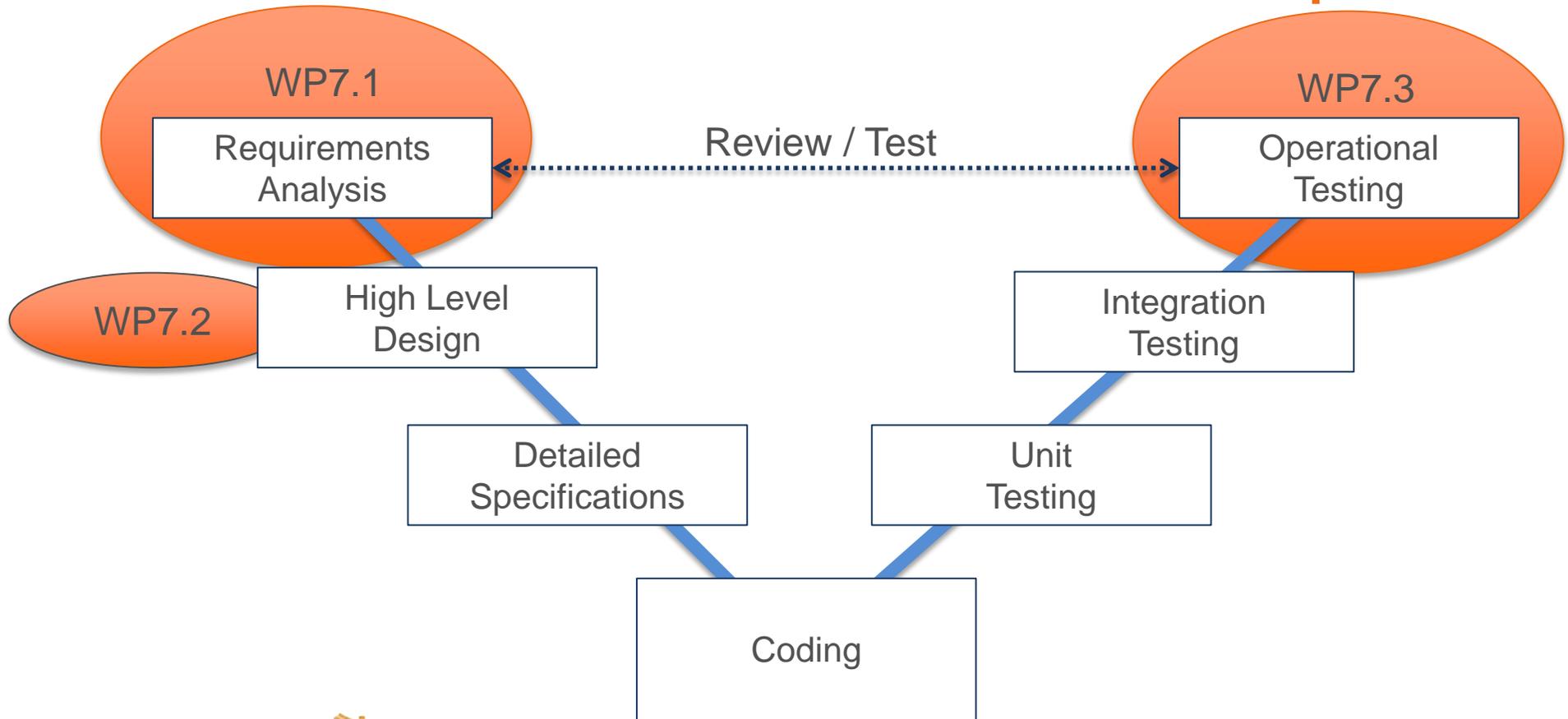
# Intelligent Mobility Management (I2M) - System Engineering

Stefan Wegele  
Siemens



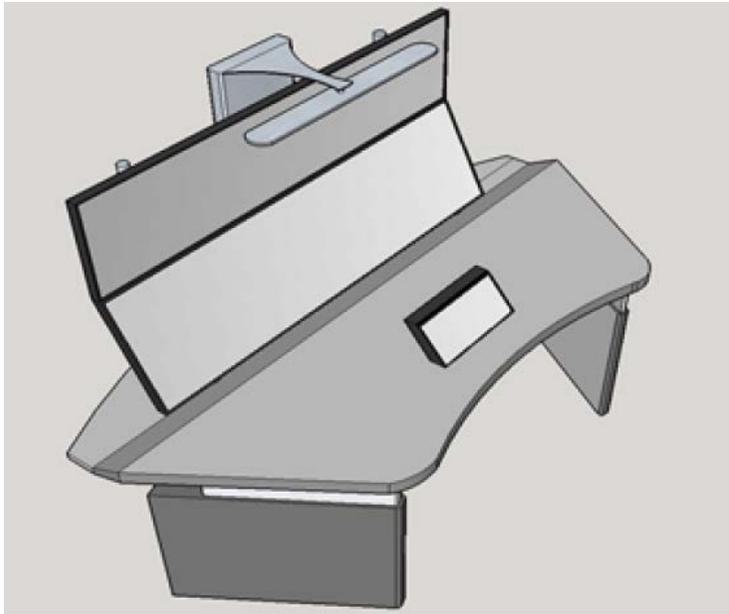
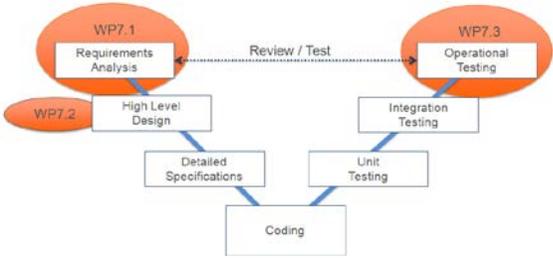
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# V-Model Software Development





# Design guidelines for a workstation



Widget view

Planning view

Alarms view

Date and time	Type	Description	Zone	Locat
07/07/2016	2	Operational	Ass DT 17 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 10 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 01 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 16 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 14 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 05 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 02 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 18 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 07 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 03 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 12 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 13 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 09 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 08 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 06 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 19 in U.L.	CRD
07/07/2016	2	Operational	Ass DT 15 in U.L.	CRD

CCTV view

Map view

Topology view



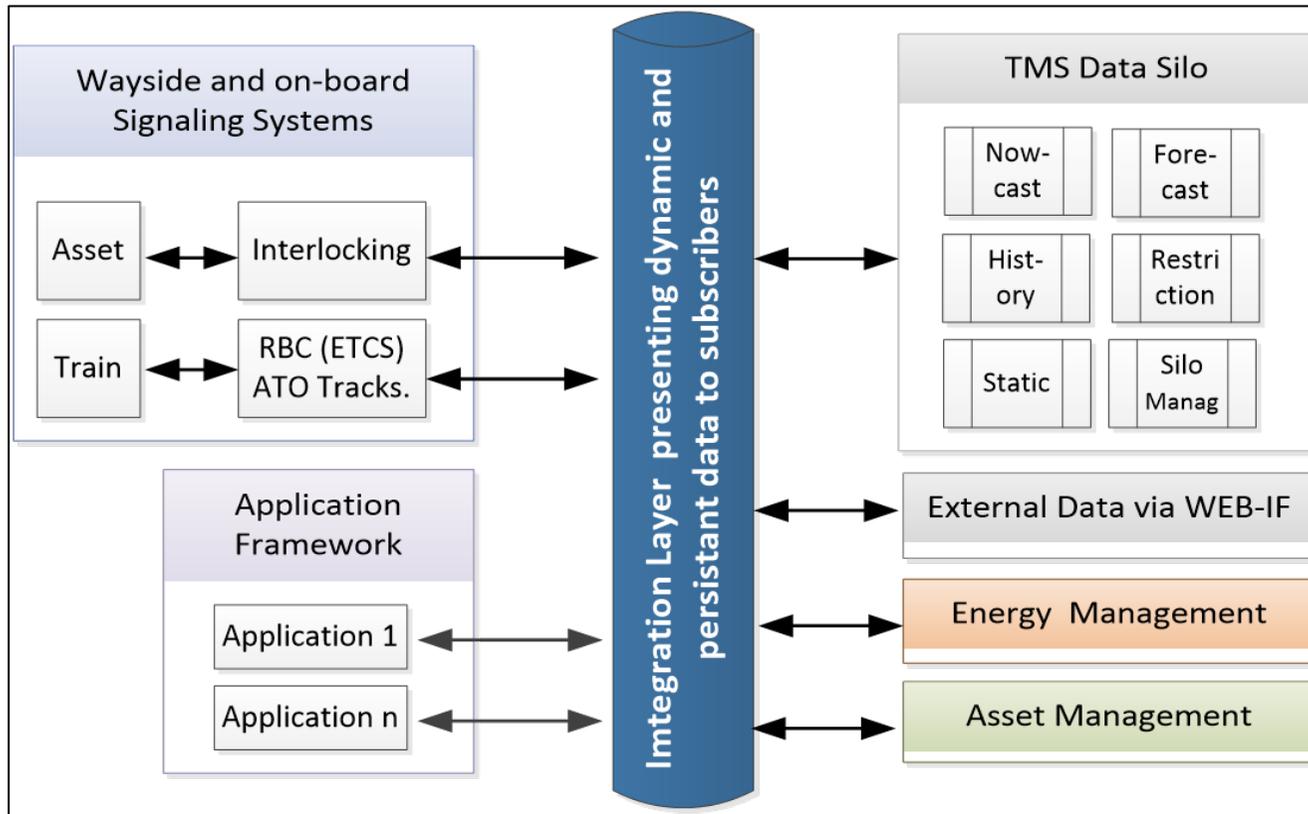
# Intelligent Mobility Management (I2M) - Integration Layer

Roland Kuhn  
Bombardier



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# Intelligent Mobility Management (I2M) – Integration Layer



Standardized  
Data Structure  
Standardized  
Interfaces  
Standardized  
Application Framework

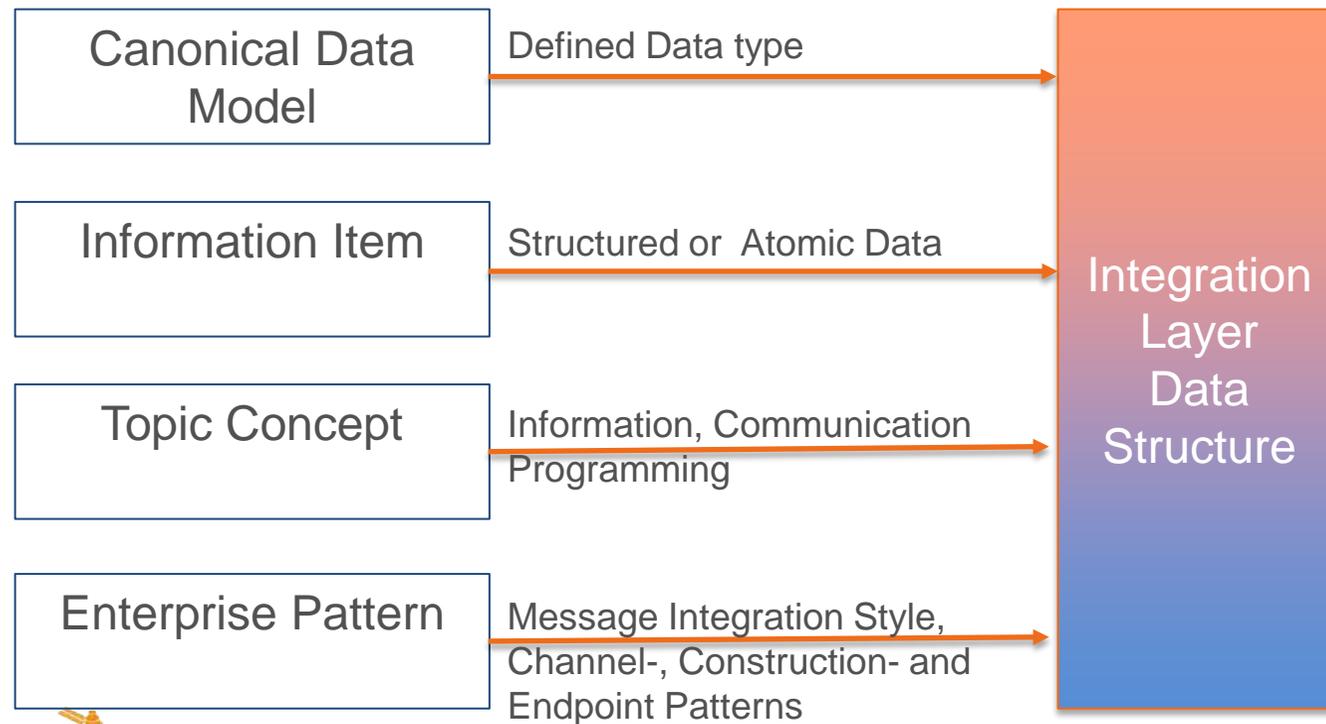
Now- and Fore-Cast  
Asset status integrated  
in automated decision  
process

Legacy Implementa-  
tions can be integrated



# Integration Layer – Design Concept

The design of the Data Structure of Integration Layer revolves around the following concepts



# Intelligent Mobility Management (I2M) - Nowcasting and Forecasting

Carlo Dambra  
Ansaldo STS



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# Asset status representation

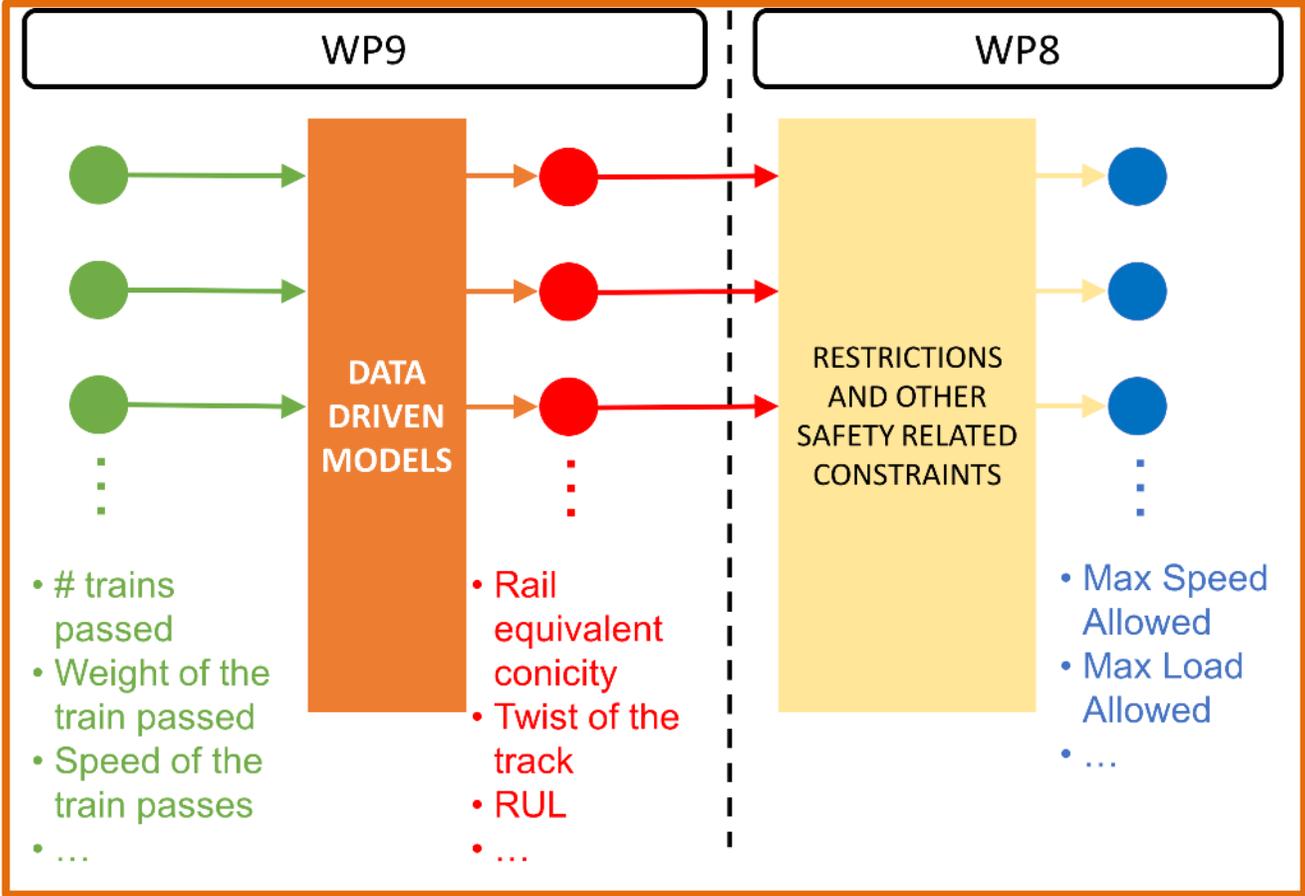
- Model based on:
  - railTOPOMODEL for the rail topology
  - railML for the static information
  - Sensor Model Language (SensorML) for the dynamic information



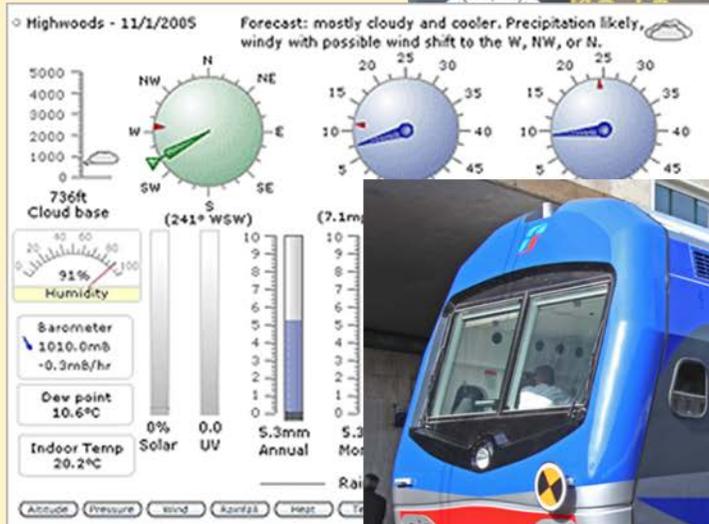
SensorML



# Nowcasting and forecasting



# Nowcasting and forecasting



**Nowcasting and forecasting train delays depending on train movements and weather conditions**



# Nowcasting and forecasting

NetworkRail

**Nowcast and forecast the delay attribution based on information about train movements**

TRAIN 1



TRAIN 2



TRAIN 3



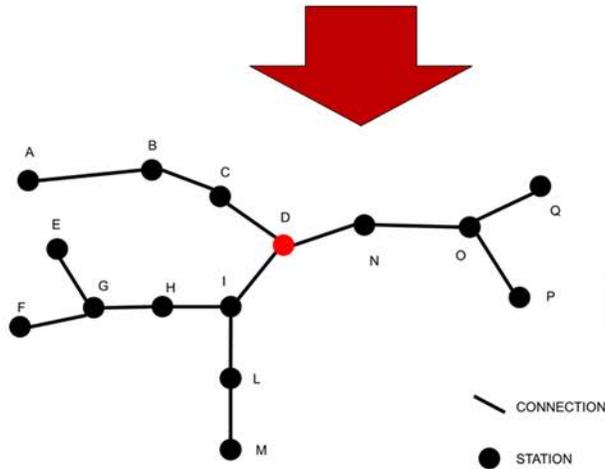
TRAIN 4



TRAIN 5



- Scheduled Time At Station
- Actual Time At Station



# Nowcasting and forecasting



**Forecasting possible assets' malfunctions based on**

- 1. maintenance**
- 2. weather conditions**

**Forecasting time to restoration based on repair activity data**

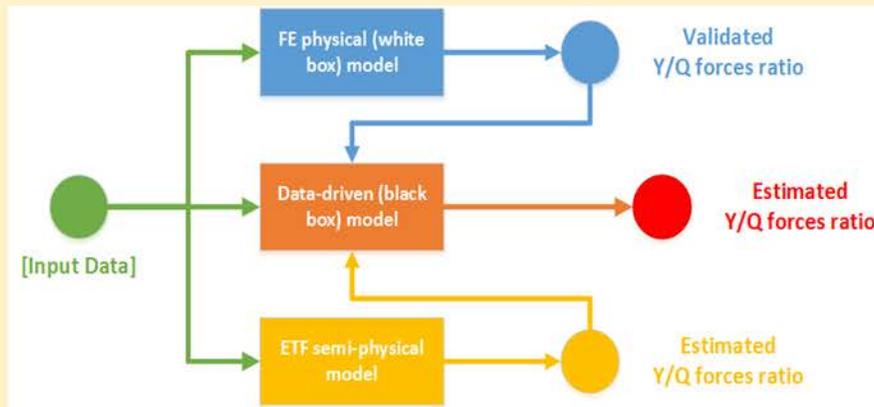
39



# Nowcasting and forecasting



**Nowcasting and forecasting models able to estimate the risk of derailment in reduced computational time**



40



# Intelligent Mobility Management– Questions & Answers

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to [In2Rail@networkrail.co.uk](mailto:In2Rail@networkrail.co.uk)



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# Rail Power Supply and Energy Management

Sub Project Speaker: Olivier Langlois



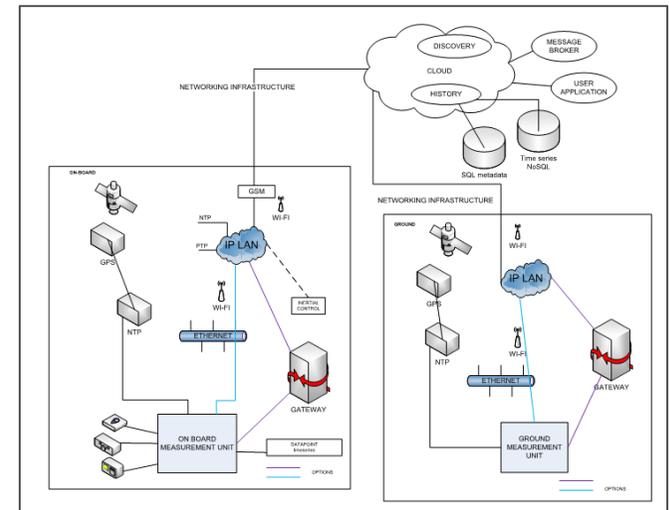
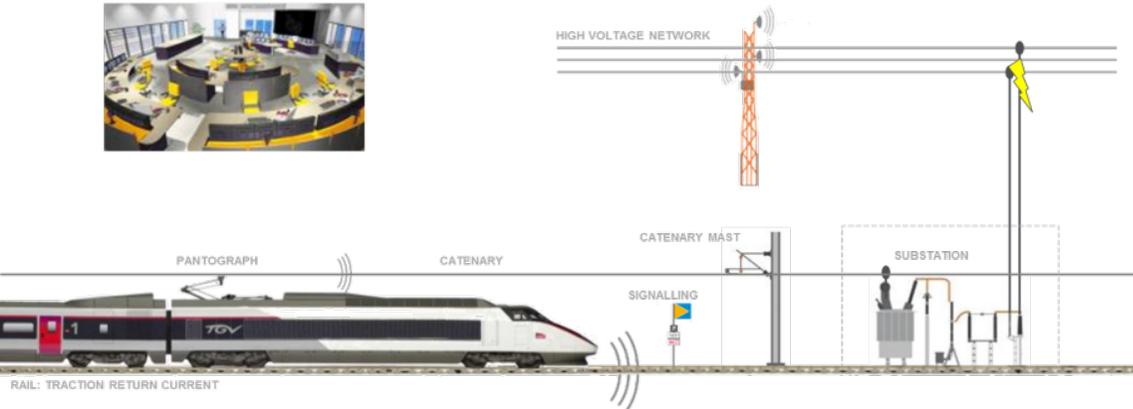
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# Rail Power Supply & Energy Management – Progress



WP10: Intelligent AC Power Supply

WP11: Smart metering for energy management



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# Energy Management - Intelligent AC Power Supply System

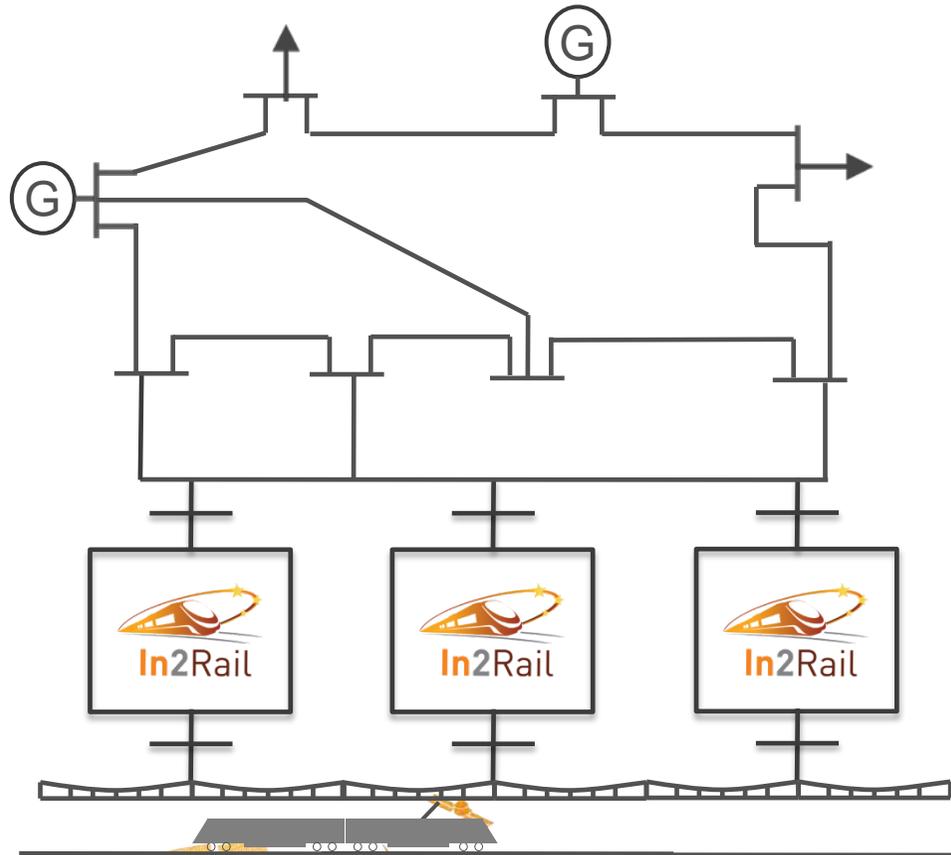
Tomas Greif  
Siemens



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# Intelligent AC Power Supply

Cooperation between traction network and public grid



grid  
model

- topology
- lines model
- simplified generator model

substation  
model

- transformer model
- frequency converter model
- balancer model

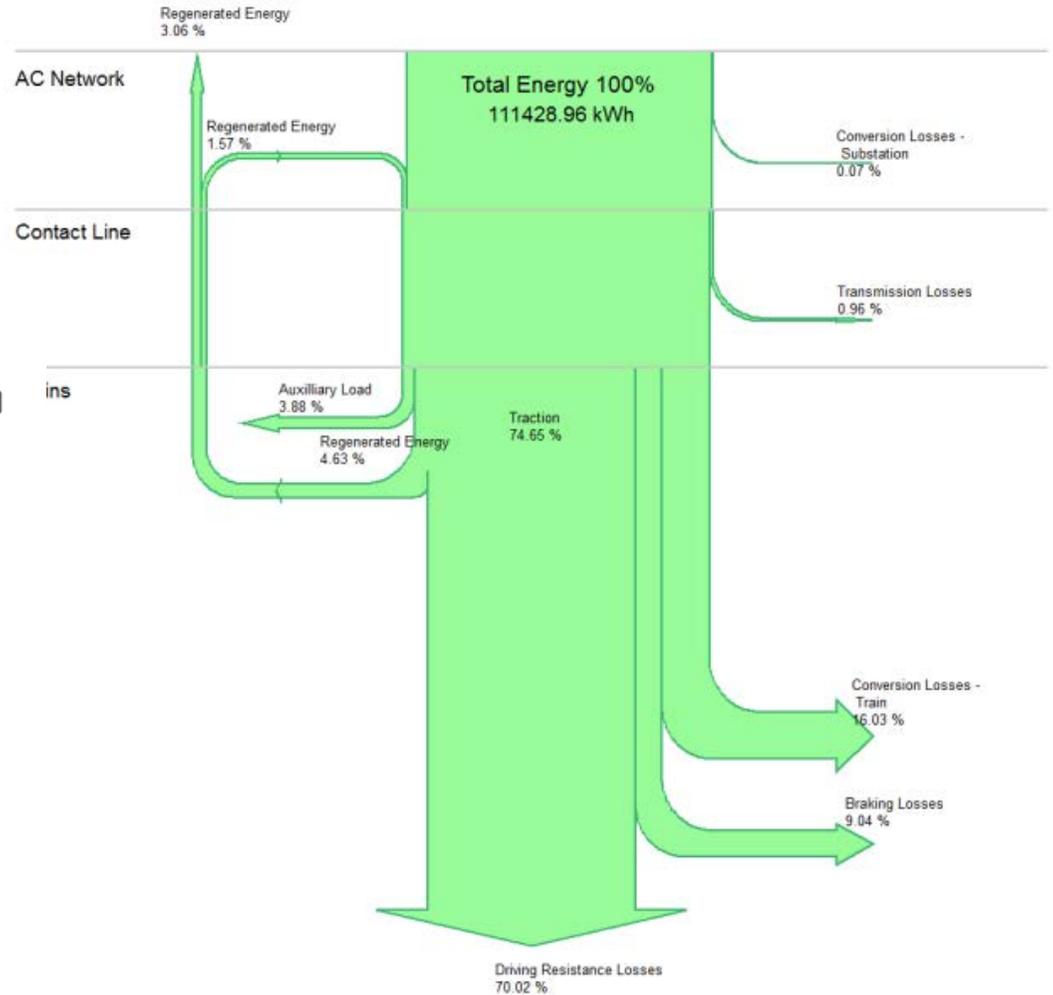
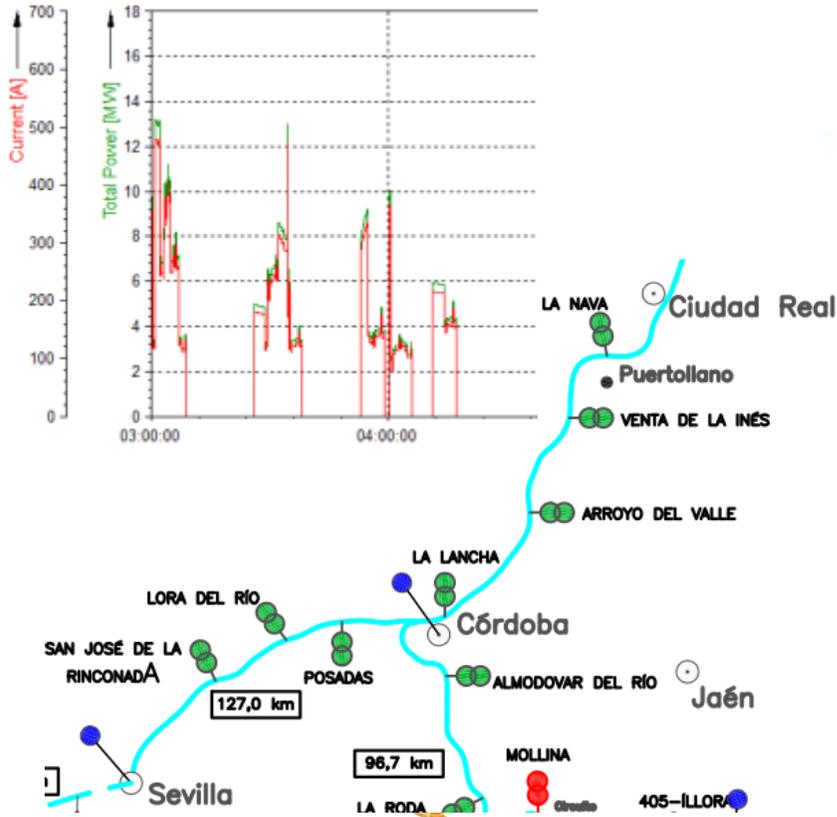
TPS  
model

- railway power system model
- train traction system model



# Intelligent AC Power Supply

## Use cases of ADIF



# Energy Management - Smart Metering for a Railway Distributed Energy Resource Management System (RDERMS)

Olivier Langlois

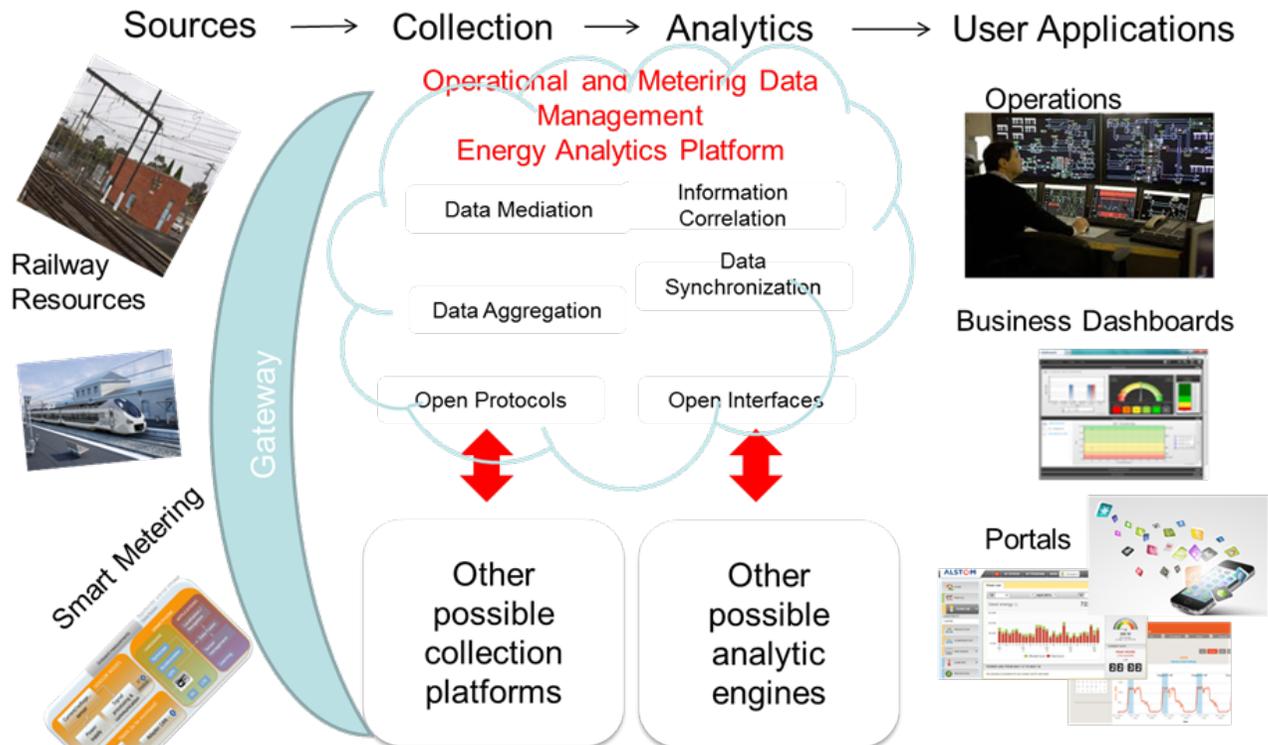
Alstom



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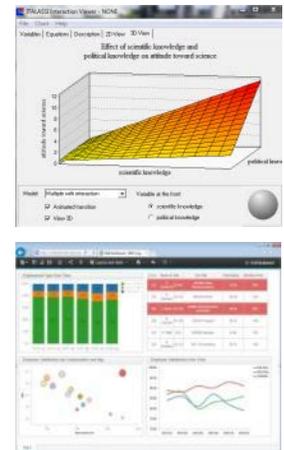
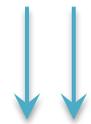
# Smart Metering

- Aim: design an open system dedicated to the fine mapping of energy flows within the whole Railway System



# Smart Metering

- Experimentation in Reims



# Rail Power Supply and Energy Management – Questions & Answers

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# In2Rail - Event Summary

Andy Doherty



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# More Information Available

## 1. Visit [www.in2rail.eu](http://www.in2rail.eu)

Events

Deliverables

Project description

## 2. In2Rail newsletter

**The next 20-30 years will see unprecedented demand for growth in transport. European railways have to deliver increased productivity to fulfil the growth demand across all modes in freight and passenger services by 80% and 50% respectively by 2050.**

In2Rail will make advances towards Shift2Rail objectives by the adoption of a whole system approach linking infrastructure re-design with asset maintenance, and energy management, through the high level Shift2Rail objectives:

- Capacity
- Reliability
- Life Cycle Cost

In2Rail will 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. Innovative technologies will be explored and resulting concepts embedded in a systems framework where infrastructure, information management, maintenance techniques, energy, and engineering are integrated, optimised, shared and exploited.

In2Rail is one of the lighthouse projects of Shift2Rail and will contribute to Innovation Programmes 2 and 3.

In2Rail will pave the way for the optimisation of the design of core infrastructure elements, as well as improving the management of the railway system by adopting a holistic approach, through three sub projects.

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# Questions

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Maintenance Strategies  
Technology transfer

Capacity  
Reliability

Radical Innovation

New technology

Adaptive control

Low noise and vibration

Smart Infrastructure

Efficient

Switch & Crossings

Sustainable  
Mechatronics

Data telemetry

Performance improvement

Safe by design

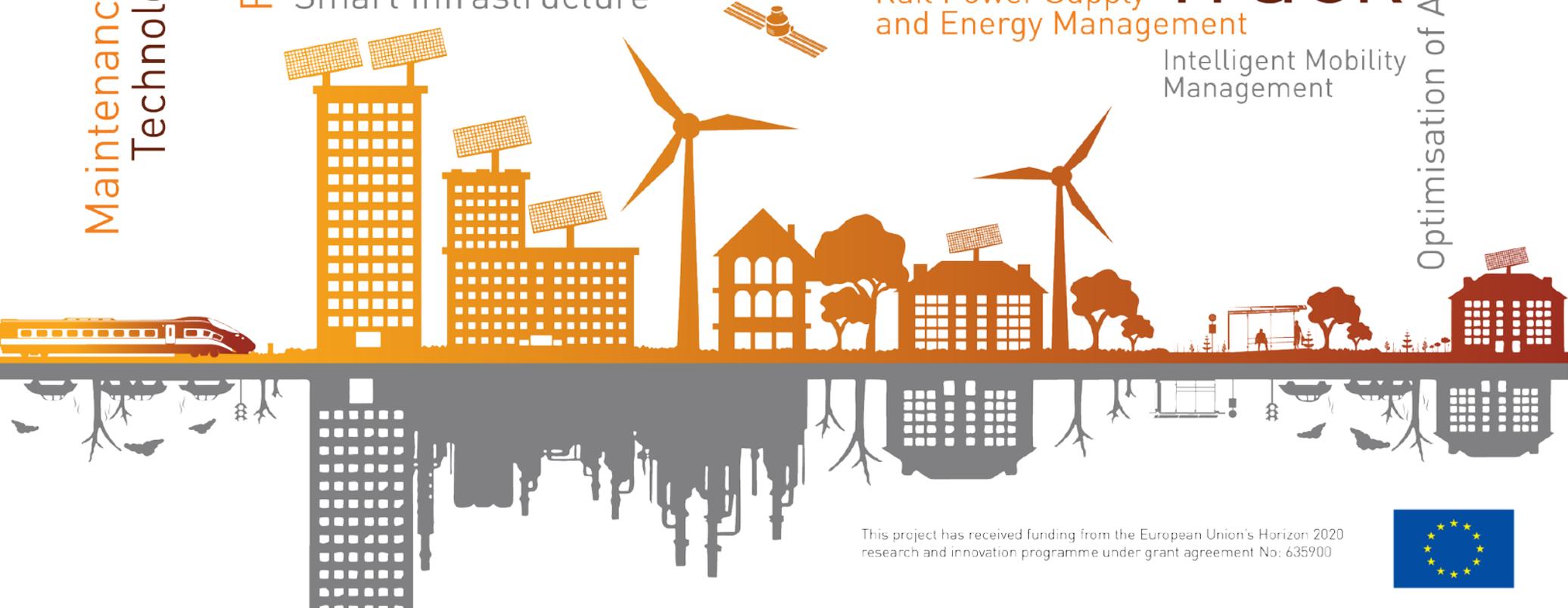
Life Cycle Costs

Rail Power Supply  
and Energy Management

Track

Intelligent Mobility  
Management

Optimisation of Asset Management



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