IN2SMART S2R project: first results towards an Intelligent Innovative Asset Management System (IAMS)

Session: Innovative approaches to Asset Management

Carlo Crovetto  Project Coordinator
Shift2Rail

IP1: Cost-efficient and Reliable Trains, including High Capacity Trains and High Speed Trains

IP2: Advanced Traffic Management & Control Systems

IP3: Cost-efficient and Reliable High Capacity Infrastructure

IP4: IT Solutions for Attractive Railway Services

IP5: Technologies for Sustainable & Attractive European Freight
In2Smart

Intelligent Innovative Smart Maintenance of Assets by integRated Technologies

- Official Start of the project: 01/09/2016
- Kick of Meeting: 15/09/2016
- Project’s duration: 36 months
- Global Project’s budget: 16.405.562,5€
- Funded Project’s budget: 7.290.632,50€

Proposal under preparation

Call: S2R-CFM-IP3-01-2019: Intelligent asset management finalisation
Deadline 18 June 2019
Strategies for asset management

Towards an Intelligent Innovative Asset Management System IAMS

Corrective Maintenance
Performed after failure occurrence

Preventive Maintenance
Performed at fixed intervals

Predictive Maintenance
Performed with the support of algorithms for data analytics within a digital platform

Prescriptive Maintenance
Decisions automatically made by the DSS

Human effort in decision making
Next generation of Asset Management process

- **Intelligent Asset Management Strategies (IAMS)**
  - methodologies and building blocks
    - RAMS/LCC analysis and risk assessment
    - Maintenance and interventions planning
    - Decision support for unplanned events
    - Maintenance Execution, Work Methods and Tools

- **Dynamic Railway Information Management System (DRIMS)**
  - An IT (Big Data) architecture and its interfaces
  - A set of algorithms compatible with (running on) the Big Data architecture

- **Railway Information Measuring and Monitoring System (RIMMS)**
  - A set of heterogeneous monitoring systems
1\textsuperscript{st} layer: RIMMS Monitoring and Data Collection

<table>
<thead>
<tr>
<th>TECHNOLOGY</th>
<th>ASSET</th>
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<tbody>
<tr>
<td>Infrastructure</td>
<td>System along the line for infrastructure monitoring</td>
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<tr>
<td>Train</td>
<td>Fixed System for train monitoring</td>
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<td>On-board System for infrastructure monitoring</td>
<td>On-board System for train monitoring</td>
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RIMMS Monitoring and Data Collection

RIMMS correlated technologies

- Drones
- Robotics monitoring application
- Satellite Technologies
- Asset digitalization
- IoT sensors
- Automatic video monitoring
- Load measurement systems
- Fiber optics monitoring
2\textsuperscript{nd} layer: DRIMS analytics

Data mining and predictive analytics

- Anomaly detection: Detect unusual states or indications of future failures
- Predictive models: Predict future asset status
- Process mining: Detect differences between planned processes and process executions.

RIMMS data sources

- Asset or process
DRIMS - The Standard Open Interface

The Canonical Data Model:
Definition of guidelines for building a CDM for Railway Asset Management.

Activity aligned with the S2R-CDM taskforce and the project that will be funded under the call S2R-CFM-IPX and CCA-01-2019: S2R System Architecture and Conceptual Data Model

Objective: Definition of a conceptual and structured representation of data that need to be shared between systems

Example developed within INzSMART for collecting diagnostic data from legacy signalling system:
• Static data of the railways and signalling equipment are modelled by using RailML
• Static details of the sensors deployed within the railway infrastructure is modelled by using SensorML
• Measurements and status are modelled by using O&M
Application of Data Analytics to In2Smart defined UCs

1. Earthworks
2. Bridges
3. Track Geometry
4. Rail Defects
5. S&C Signaling/Track Circuits
6. Track Equipment

<table>
<thead>
<tr>
<th>Anomaly detection</th>
<th>Process Mining</th>
<th>Predictive models</th>
<th>Demonstrator</th>
<th>IT architecture</th>
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Total 9 4 12 = 25 studies
### UIC Guidelines: AM practical implementation

#### Decision framework for an Intelligent Asset Management System

<table>
<thead>
<tr>
<th>Strategic Asset Management Plan</th>
<th>Asset Management Plan</th>
<th>Implementation of Asset Management Plan</th>
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<tbody>
<tr>
<td><strong>Strategic level</strong></td>
<td><strong>Tactical level</strong></td>
<td><strong>Operative level</strong></td>
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<tr>
<td>SAMP - how organizational objectives are to be converted into AM objectives, the approach for developing AM plans, and the role of the AM system in supporting achievement of the AM objectives</td>
<td>AMP - activities, resources and timescales required for a group of assets to achieve the organisation’s AM objectives</td>
<td>IAMP - activities that are undertaken at each stage of the asset lifecycle, including the application of risk control measures, as specified in the AMP including reaction to unplanned events</td>
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**Strategic Asset Management Plan**

- **SAMP**
  - How organizational objectives are to be converted into AM objectives, the approach for developing AM plans, and the role of the AM system in supporting achievement of the AM objectives.

**Asset Management Plan**

- **AMP**
  - Activities, resources and timescales required for a group of assets to achieve the organisation’s AM objectives.

**Implementation of the Asset Management Plan**

- **IAMP**
  - Activities that are undertaken at each stage of the asset lifecycle, including the application of risk control measures, as specified in the AMP including reaction to unplanned events.

Link to UIC Guidelines for Railways and ISO 55001 (requirements)
3rd layer, IAMS: Generic framework for DSS

Generic framework: covering building blocks from WP8, RAMS&LCC, Decision-making
IAMS: Generic framework for DSS

Particularised Frameworks:
- Input
- Output
- IAMS task
- Building blocks
### Application of the DSS to In2Smart defined Ucs

<table>
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<tr>
<th>Use cases</th>
<th>Significant Use Cases Identification</th>
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<tr>
<td>Validation procedure</td>
<td>Identification of the KPIs and the validation process for each UC</td>
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<tr>
<td>UCs Development</td>
<td>Development of each use case according to the identified needs and KPI to be achieved</td>
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The Use Cases

- Uncertainty analysis in life cycle costs
- RAMS/LCC for track geometry maintenance planning
- Smart Depot
- Earthwork asset management using Petri Net models
- Track circuits: false track occupancies mitigation
- Operational daily planning
- Optimizing inspection and maintenance planning
- RCM Intervention decision support

... investigate optimal intervention schemes so as to offset the effect of EW asset degradation under budget and resource constraints.

activities
Mapping the Use Cases within the Framework

- Uncertainty analysis in life cycle costs
- RAMS/LCC for track geometry maintenance planning
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- Earthwork asset management using Petri Net models
Mapping the Use Cases within the Framework

- Track circuits: false track occupancies mitigation
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The IT architecture of the DSS

IAMS system architecture has been finalized and will be used as a reference for the IN2SMART follow up project based on the ArchiMate standard developed by the OPEN Group (http://www3.opengroup.org/subjectareas/enterprise/archimate)
Conclusions

Main results

▪ **Increase in operational reliability** (less service disruptions) leading towards zero avoidable failures.

▪ **Homogenization of maintenance** by the identification and removal of most impacting root causes making use of condition based monitoring and analytics methods.

▪ **Access to heterogeneous multi-owner maintenance-related data with the adequate degree of privacy, security and quality** through the definition of **standard open interfaces**

▪ **Reduction of maintenance cost and complexity of maintenance processes and optimize maintenance execution**, thanks to (prescriptive) maintenance planning support systems
Thank you for the attention

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