Aims and Objectives

Develop a data architecture that is able to provide ubiquitous data for railway operations and supporting applications

- Understand the data exchange and integration requirements of railway operations;
- Provide extensions to existing data notations that support operational data;
- Develop new data model supporting autonomous data exchange and reasoning;
- Develop appropriate architectural frameworks for distributed processing in railway operations.
## Review of Existing Models

<table>
<thead>
<tr>
<th>XML-based Models</th>
<th>Non-XML Models</th>
<th>Emerging Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>railML 2</td>
<td>TAP TSI</td>
<td>Rail Core Ontology (RaCoOn)</td>
</tr>
<tr>
<td>RailTopoModel / railML 3</td>
<td>Google Transit (GTFS) and Real-time</td>
<td>Railway Infrastructure Ontology (RI*)</td>
</tr>
<tr>
<td>Register of Infrastructure (RINF)</td>
<td>OSM / ORM</td>
<td>Enriched GTFS (Transit ontology)</td>
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<tr>
<td>Infrastructure for Spatial Info. in the EC (INSPIRE)</td>
<td></td>
<td>Linked Open Data (NEPTUNE)</td>
</tr>
<tr>
<td>IDM&lt;sup&gt;VU&lt;/sup&gt;</td>
<td></td>
<td>Public Transport Ontology of Keller, Brunk, &amp; Schlegel</td>
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<tr>
<td>Network and Timetable Exchange (NeTEx)</td>
<td></td>
<td>Semantic Sensor Network (SSN)</td>
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<tr>
<td>Service Interface for Real-time Information (SIRI)</td>
<td></td>
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<tr>
<td>TAF TSI</td>
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<tr>
<td>ON-TIME (RTTP)</td>
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</tr>
</tbody>
</table>
### Alignment with Storyboard Requirements

<table>
<thead>
<tr>
<th>Data format</th>
<th>Data Granularity</th>
<th>railML 3</th>
<th>IDM&lt;sup&gt;VU&lt;/sup&gt;</th>
<th>INSPIRE</th>
<th>RINF</th>
<th>OSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor</td>
<td>Possible</td>
<td>Out of scope</td>
<td>Not available</td>
<td>Out of scope</td>
<td>Out of scope</td>
<td></td>
</tr>
<tr>
<td>Macroscopic</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
</tr>
<tr>
<td>Mesoscopic</td>
<td>Possible</td>
<td>Out of scope</td>
<td>Possible</td>
<td>Out of scope</td>
<td>Possible</td>
<td>Possible</td>
</tr>
<tr>
<td>Microscopic</td>
<td>Possible</td>
<td>Possible</td>
<td>Out of scope</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
</tr>
</tbody>
</table>

**Storyboard 1: Infrastructure data for operation and simulation**

- **Real-time data**
  - Transit Ontology / Linked GTFS for timetable
  - Transit Ontology / Linked GTFS for tariff

- ** Planned data**
  - Transit Ontology / Linked GTFS for network

- **Topology**

- **Topography**

**Storyboard 2: Effective usage of cross-mode capacity**
ESB Architecture for Conventional ICT

Best practice (ICT) is applicable
- Adopt recommendations from ON-TIME and others!
- Builds on a decade of work from InteGRail onwards
Ubiquitous Data is Removed from System Context

Understanding the Relationships
Understanding the Patterns
Understanding the Principles

Data
Information
Knowledge
Wisdom

Context Dependent
Context Independent
Architecture for Ubiquitous Data

- External data resources & services (low velocity)
  - e.g. traincrew mobile positioning & speed, OSM network data, connecting service schedules

- External service annotations (provenance etc.)
  - Interface Webservices

- RaCoOn ABox / TBox Data
  - Ontology Implementation
  - Triplestore - Stardog

- High velocity data cache (REDIS or similar)
  - Interface Webservices

- Data requests and responses (TMS as consumer)

- Traffic Management System

- TMS produced data feeds

- Data resources & services (high velocity)
  - e.g. TMS system positioning events, asset status events

- External service annotations (provenance etc.)
## Leveraging Open Data Resources for Improved Situational Awareness

<table>
<thead>
<tr>
<th>Data Resource</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social media data</td>
<td>Content, geolocation, time of creation, links to other content</td>
</tr>
<tr>
<td>IM public data</td>
<td>Live vehicle movements, train describers, notifications of TSRs etc.</td>
</tr>
<tr>
<td>Ordnance survey</td>
<td>Infrastructure layout</td>
</tr>
<tr>
<td>ATOC data</td>
<td>Timetables, fares and supporting information</td>
</tr>
<tr>
<td>NaPTAN</td>
<td>Information on access points / interchanges</td>
</tr>
</tbody>
</table>
Geolocated, Grouped Incidents

#GospelOak 17:56 to #Stratford is 6 minutes late.  
https://t.co/hEuEypkUD #Stratford 17:57 to #Richmond delayed.  
https://t.co/60lyqPhWIL

#GospelOak 17:49 to #Stratford is 17 minutes late.  
https://t.co/hEuEypkUD

Friday night I just wanna get home ?? pissing train delay!

#GospelOak 18:04 to #Stratford is 21 minutes late.  
https://t.co/hEuEypkUD
Thank you for your kind attention

John Easton
Work Package 3.4 Leader
University of Birmingham
j.m.easton@bham.ac.uk