The Value Proposition for GS1 ID Keys and RFID in Rail

Transport & Logistics Workshop
GS1 Event 2015

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Seppo Mäkitupa, Liikennevirasto, Finland
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The need for monitoring

- each train of each operator will be monitored:
  - running temperatures of the axle bearings
  - defect wheels and pantographs
  - loading imbalance

- monitoring means
  - fewer derailments
  - lower maintenance costs
  - more effective use of the network
One track – many users

- Monitoring offered as a service

- Liikennevirasto (FTA) as the railway infrastructure manager provides the data to the railway operators

- WIN-WIN: track owner gets data about the track wear, operator gets data about its fleet
  → Result: maintenance in time, more available capacity, less severe faults, fewer disturbances, more predictability, …
Train composition – through borders

- Denmark
- Norway
- Train companies
- Industries
- Universities
- Etc…

Transaction: *Train x Information*

Object: *Vehicle 1 Information*

Object: *Vehicle 2 Information*

Object: *Vehicle 3 Information*
Rolling stock – Track interaction

- Track - rolling stock interfaces
  1. The wheel and the rail
  2. The pantograph and the catenary line
  3. Axle bearings
### Sites Finland

<table>
<thead>
<tr>
<th>Type</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Axle Box Detectors (HABD)</td>
<td>103</td>
</tr>
<tr>
<td>Pantograph Monitoring Systems (APMS)</td>
<td>9</td>
</tr>
<tr>
<td>Wheel Impact Load Detectors (WILD)</td>
<td>10</td>
</tr>
<tr>
<td>RFID Rail Reader Units (RRU)</td>
<td>120</td>
</tr>
</tbody>
</table>
Geography Sweden

183 Read points installed
   (176 matched with WTMS)

+150 planned installations -2017

> 3500 tagged vehicles
Devices Finland

- Sensys Traffic APMS II
- voestalpine Phoenix MB HABD
- Tamtron Scalex WILD
The required spice: RFID

- **Data** produced by the monitoring devices is converted into **information** by adding a simple spice: **RFID**

- **Information** is provided for the train operators, if their fleet carries RFID tags

- Prerequisites for the use of RFID are based on GS1 Guideline RFID In Rail

- A new, automatic centralized system (**VALTSU**) in production by the end of 2015
  - combines the monitoring data with the RFID reading
  - offers tools for analysis
  - enables tracking the defect rolling stock unit
Traditional use of WTMS (Wayside Train Monitoring systems) is based on actions on emergency alarms.
Goals – Preventive maintenance

If I knew my vehicles condition I could plan my work!
Goals – Track and trace

My vehicles position is vital for our business!
Why use Identification Numbers?

Identification of trains

- A train consists of wagons and a locomotive
- Wagons have numbers:
  Long ago ‘123’, now European Vehicle Number
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- Large scale identification: RFID tags
Global agreement, applied across Europe
AVI – Automatic Vehicle Identification

RFID reader/antenna
app. 3 m from nearest rail

Axle/Wheel sensors
- detects vehicles/wagons without transponders/tags
- speed
- direction
- distance between axles
Identification and positioning of rail vehicles

- GS1 standardised RFID-tag on vehicle (~ 4 €/pcs)
  - Vehicle number EVN
  - Company prefix

- EPCIS
  - Vehicle ID, Location, Time, Direction

- HRMS
  - Hotbox, Hot wheel, Wheel damage

- Subscription basis
  - To Whom, What, How
Requirements for coding the tags

- Air protocol according to EPC Gen 2 ISO 18000-63
- Data contents must meet the requirements of EPC GIAI-96
- EPC Tag Data Standard, v.1.9, November 2014, by GS1

<table>
<thead>
<tr>
<th>Position</th>
<th>Length</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-8</td>
<td>8</td>
<td>Header</td>
<td>00110100 (fixed)</td>
</tr>
<tr>
<td>9-11</td>
<td>3</td>
<td>Filter value</td>
<td>000 (fixed)</td>
</tr>
<tr>
<td>12-14</td>
<td>3</td>
<td>Partition</td>
<td>101 (5, 7-digit ownership mark)</td>
</tr>
<tr>
<td>15-38</td>
<td>24</td>
<td>Company prefix</td>
<td>7-digit</td>
</tr>
<tr>
<td>39-96</td>
<td>58</td>
<td>Individual Asset Reference</td>
<td>17-digit (see below)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Position</th>
<th>Contents</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Side indicator</td>
<td>0 = not in use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = not in use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 = A-end (e.g. hand brake end)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 = B-end (e.g. non-hand-brake end)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-9 = engaged</td>
</tr>
<tr>
<td>2-5</td>
<td>engaged</td>
<td>To be filled with zeros</td>
</tr>
<tr>
<td>6-17</td>
<td>EVN</td>
<td>12-digit vehicle number</td>
</tr>
</tbody>
</table>
Managing the four W’s

- What?
- Why?
- Where?
- When?

+ Monitoring process
+ RFID reading

condition report
Steel train
Luleå-Borlänge
Train composition changes during the journey
How does Vehicle Identification help Rail?
Dutch example

• Fall 2002: Square wheels (caused by falling leaves)…
• Flat surfaces on wheels causing damage on bearings with risk of derailment
• Monitoring wheels with Gotcha/Quo Vadis, immediate repair using kuilwielbank
How does Vehicle Identification help Rail? Dutch example

- Result: drastic reduction of damage to both wheels and tracks
- In turn costs and risks are also significantly reduced
An example: Wheel Impact Load Monitoring

Impact force 224 kN
force variation 763 %
## Results vs. limits:

<table>
<thead>
<tr>
<th>Alarm</th>
<th>Level</th>
<th>Limit</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dynamic impact force</strong> $Q_{imp}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q5</td>
<td>&gt; 500 kN</td>
<td></td>
<td>To be removed from the train ASAP; speed limit of 50 km/h until removal</td>
</tr>
<tr>
<td>Q4</td>
<td>&gt; 450 kN</td>
<td></td>
<td>Speed limit of 50 km/h after alarm; wheelset shall be fixed before the next loading</td>
</tr>
<tr>
<td>Q3</td>
<td>&gt; 350 kN</td>
<td></td>
<td>No speed limit, wheelset shall be fixed before the next loading</td>
</tr>
<tr>
<td>Q2</td>
<td>&gt; 300 kN</td>
<td></td>
<td>Wheelset shall be fixed during the next service</td>
</tr>
<tr>
<td>Q1</td>
<td>&gt; 250 kN</td>
<td></td>
<td>ECM schedules the corrective actions</td>
</tr>
<tr>
<td><strong>Dynamic factor</strong> $f_{dy}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f3</td>
<td>&gt; 800 %</td>
<td></td>
<td>Wheelset shall be fixed before the next loading</td>
</tr>
<tr>
<td><strong>Bold</strong> f2</td>
<td>&gt; 600 %</td>
<td></td>
<td><strong>Wheelset shall be fixed during the next service</strong></td>
</tr>
<tr>
<td>f1</td>
<td>&gt; 400 %</td>
<td></td>
<td>ECM schedules the corrective actions</td>
</tr>
</tbody>
</table>
A wagon needs maintenance:

Tamtron Train Information System

Check point: Lautiosaari = where
Train: 03.09.2013 01:35:58 = when

Total weight: 627.361
Speed: 80 km/h
Direction: TO NORTH
Train type: CARGO
Locomotives: 1
Wagons: 25
Air temperature: 8
Track temperature: 11

Wheel fault alerts: (In alert order) 

Wagon order

Critical

<table>
<thead>
<tr>
<th>WNR</th>
<th>Wagon id</th>
<th>WTYPE</th>
<th>Wagon weight</th>
<th>Axle weight</th>
<th>FF</th>
<th>FV</th>
<th>EFL</th>
<th>IF</th>
<th>FT</th>
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Warning

<table>
<thead>
<tr>
<th>WNR</th>
<th>Wagon id</th>
<th>WTYPE</th>
<th>Wagon weight</th>
<th>Axle weight</th>
<th>FF</th>
<th>FV</th>
<th>EFL</th>
<th>IF</th>
<th>FT</th>
</tr>
</thead>
</table>

Answers to the four W’s!

= why

= what

WNR = Wagon number
FF = Wheel faults in wheels
FV = Force variation %
EFL = Estimated flat length
WTYPE = Wagon type
IF = Impact force kN
FT = Fault type
A long-term follow-up of one wheel

21 passings, 3 sites, loaded wagon;
Gross weight 57… 80 tons
Speed 57 … 79 km/h
Advantages of combining RFID with the data

RFID in use

Day 1, alarm:
- time
- site
- cause
- direction
- # of axle

Day 2, alarm:
- time
- site
- cause
- direction
- # of axle

Day n, alarm:
- time
- site
- cause
- direction
- # of axle

• ID + data = information
• Unique history
• Even unique alarm limits
• Less repeated alarms
• Simple tracking
• No misspelling

RFID-Reading = ID

Train Dispatcher

"Faulty wagon 12345678901-2"

Train Driver

Check

VALTSU system

→ wagon 12345678901-2 + results for a wheel

Technical Control Room

Train Traffic Control

Maintenance

RU’s operative services
Manual monitoring of wheel-damages

Saves about 2 million euro/year in real process just avoiding delays (less maintenance not included)

Januari 2013
Selection group
19
Validation group
15
Januari 2014
Selection group
7
Validation group
20

Saves about 2 million euro/year in real process just avoiding delays (less maintenance not included)
Service introduced 2017:
Identification and positioning of rail vehicle

2017
- Maintenance based upon WTMS
- Less traffic disturbance
- Track and Trace
- Correct train composition
- Efficient logistics

2018
- Automatic reporting
- Satellite positioning
- Introducing Business location
- Etc…

Contract

- EPCIS
- HRMS
- Web application
Standardisation wanted…

- EIM (European Rail Infrastructure Managers) support including/transferring the GS1 guideline in a new standard
  - Cooperation between EIM, CEN/CENELEC and GS1

- CURRENT:
  Finland has sent out a work item request for a new EN standard through Finnish Standards Association SFS at the end of September
  → evaluation and voting arranged by EN TC225/WG4
Other uses for RFID in Rail?

The concept also works ‘upside down’

- The same world – but in reverse:
  - Instead of Trains passing readers
  - Readers pass along the track (capturing ID’s from RFID tags).
Other uses for RFID in Rail?

They enable capturing and processing massive datasets.

- **Action = Reaction**: bad tracks cause damage to wheels
- Finding small defects before they become serious **using detectors in normal trains** with same result as before: reduction of cost and risk
- **Feasible only through automated** capture and processing of data

Other uses for RFID in Rail?
Thank you!

Questions?