ProRail

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Agenda

- Introduction
- Systems Engineering approach for Betuweroute
- Lessons learned Betuweroute
- The next project: Hanzelijn
- The way forward
Introduction

- Personal introduction
  - *In SE since 1986*
  - *Originally in air traffic control, (HSA, Thales)*
  - *In Rail since 1999 (ProRail)*

- System
  - *All future safety systems in NL*
  - *Migration of relay systems to electronic systems*
  - *Introduction of ERTMS*
  - *Signalling equipment as part of a bigger system*
ERTMS projects in The Netherlands

**Betuweroute** (part of Corridor A)
2008, level 2 + 1, Cargo, Alstom

**HSL Zuid**
2009, level 2 (Level1), Highspeed, Siemens

**Amsterdam - Utrecht**
2009, ATB / Level 2 overlay, conv., Bombardier

**Hanzelijn**
2013, ATB / Level 2 overlay, conv., Alstom

**STM-STM transities**
2008-2009, STM-STM, Alstom/Bombardier
Systems Engineering approach Betuweroute

- **At the start**
  - Only very rough user requirements from ProRail
  - SE approach non existent at ProRail side
  - Development process driven by supplier
  - Safety system was considered a stand-alone system

- **During the project**
  - Problems to judge supplier choices and implementations
  - Problems to judge proposed changes
  - Difficult discussions with users and stakeholders
  - No clear references to perform verification and validation

⇒ something had to change to become succesful
Systems Engineering approach Betuweroute

- Top down specification for traffic management and safety system
  - User process descriptions
  - System Specification
  - System Test Specifications
  - Hazard Log
  - Safety case
  - Traceability between user requirements, specifications and supplier documents

- Using reverse engineering and forward engineering at the same time

- Basis for systems engineering approach for BR project
ProRail

Systems Engineering approach Betuweweroute
Systems Engineering approach Betuweroute

- Systems engineering V-model was supported by:
  - Configuration management
  - Baseline management
  - Change management

- User process descriptions were used for:
  - System development
  - Training of train drivers
  - Development of dispatcher’s procedures and training

- The integral system engineering approach was successful

⇒ realisation of the BR safety system was completed in time
Lessons learned Betuweroute

- Systems engineering approach is successful
- Create a common reference for development and users/stakeholders activities
- Involve users and stakeholders early in the process
- Be sure that you are in control of the development process
The next project: Hanzelijn

- Some questions at the start:
  - *What do we contract?*
  - *Where do we find the information?*
  - *Where do we find the right people?*

- Some answers:
  - *Something like the Betuweroute and Amsterdam-Utrecht*
  - *In cupboards on the 5th and 9th floor*
  - *Somewhere near these cupboards*

⇒ Basic question: how do we re-use information and knowledge for repeating the systems engineering approach?
The way forward

- Create a specification baseline that is the basis for all coming projects
- Create project specifications based on this baseline
- Use this project specification as starting point for the systems engineering approach for each project
- Create a team to support this by people who know the specifications and know how to apply systems engineering

⇒ This is what we call the SPES-NL approach
SPES-NL approach

Hanzelijn

Mistral Plateau 1

New project

SPES-HZL

SPES-MSL P1

SPES-NL specification baseline

SPES-NL work packages

ERTMS activities

EuroIXL/INESS activities
Specification of Signaling (SPES)

- Harmonized specification
  - Best Practices former projects
  - To be used in new signaling projects

- Life cycle approach
  - Tendering
  - Design
  - Build
  - Test
  - Maintain
SPES structure

- The SPES-NL specification baseline contains:
  - User process descriptions
  - Functional requirements
  - Non-functional requirements (performance, RAMS…)
  - Interface requirements
  - Testing requirements
  - Safety analyses and hazard log
  - Process requirements
  - Traceability between the above mentioned items

- The SPES-NL specification baseline is supported by DOORS and a strict configuration and change management process
### SPES specification requirements

- Requirements: unique/traceable/testable
- Requirements database....
- Example:

<table>
<thead>
<tr>
<th>Req. Id.</th>
<th>Requirement</th>
<th>Source</th>
<th>Original Id.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>MA at Start of Route</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 245      | When the train is in mode SR OR the train is in mode SB or PT AND “'start” is selected, the RBC shall give an MA to a train with OS authorization until the next signal if:  
|          |   - The next signal is cleared  
|          |   - The train has a valid position                                                                                                           | [Uitg L2] | 5.021        |
| 246      | When the train is in mode SB or PT AND “'start” is selected, the RBC shall give SR authorization to a train if no MA can be issued.              | [Uitg L2] | 5.022        |
External relations

- INESS
  - Interlocking requirements where used for SPES
  - Participation in several INESS workgroups

- Operational Harmonization
  - User process description used in Corridor workgroups
  - Harmonization issue’s for TSI OPE

- Workgroups engineering rules
  - EIGG WG
  - ERA engineering workgroup

- TSI CCS (ERTMS Specification)
  - CR’s (transition, gradients, OS/SR, ..)
  - Subset-76 (test scenario’s)
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Your experiences?