ProRail

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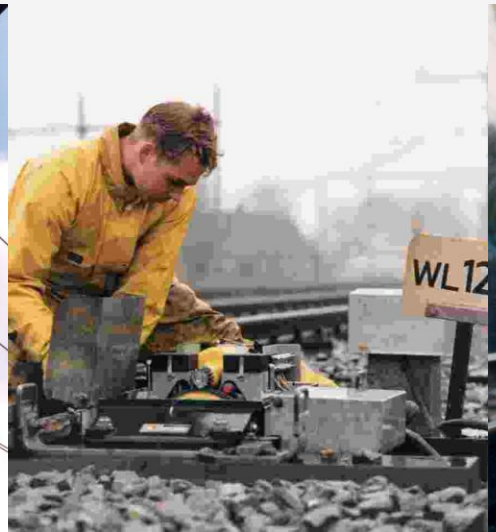
Inframanagement, head of projects and specifications


Agenda

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

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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

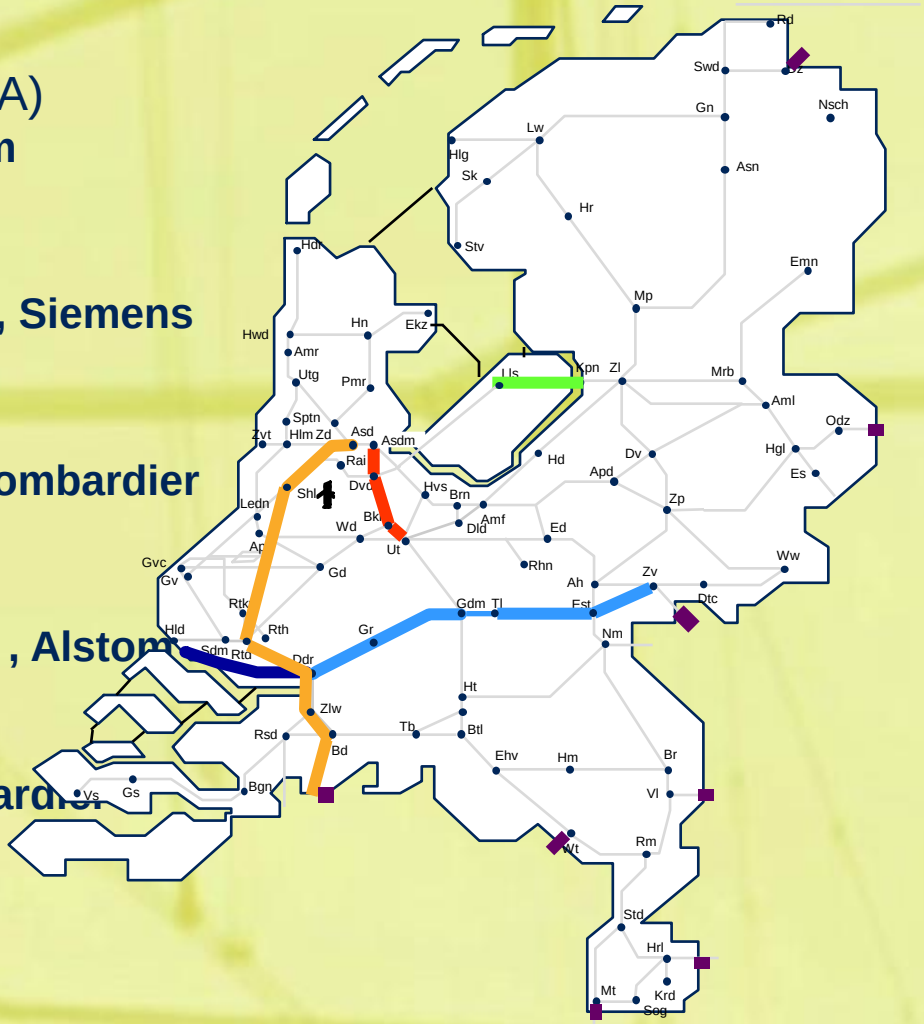
Betuweroute (part of Corridor A)
2008, level 2 + 1, Cargo, Alstom

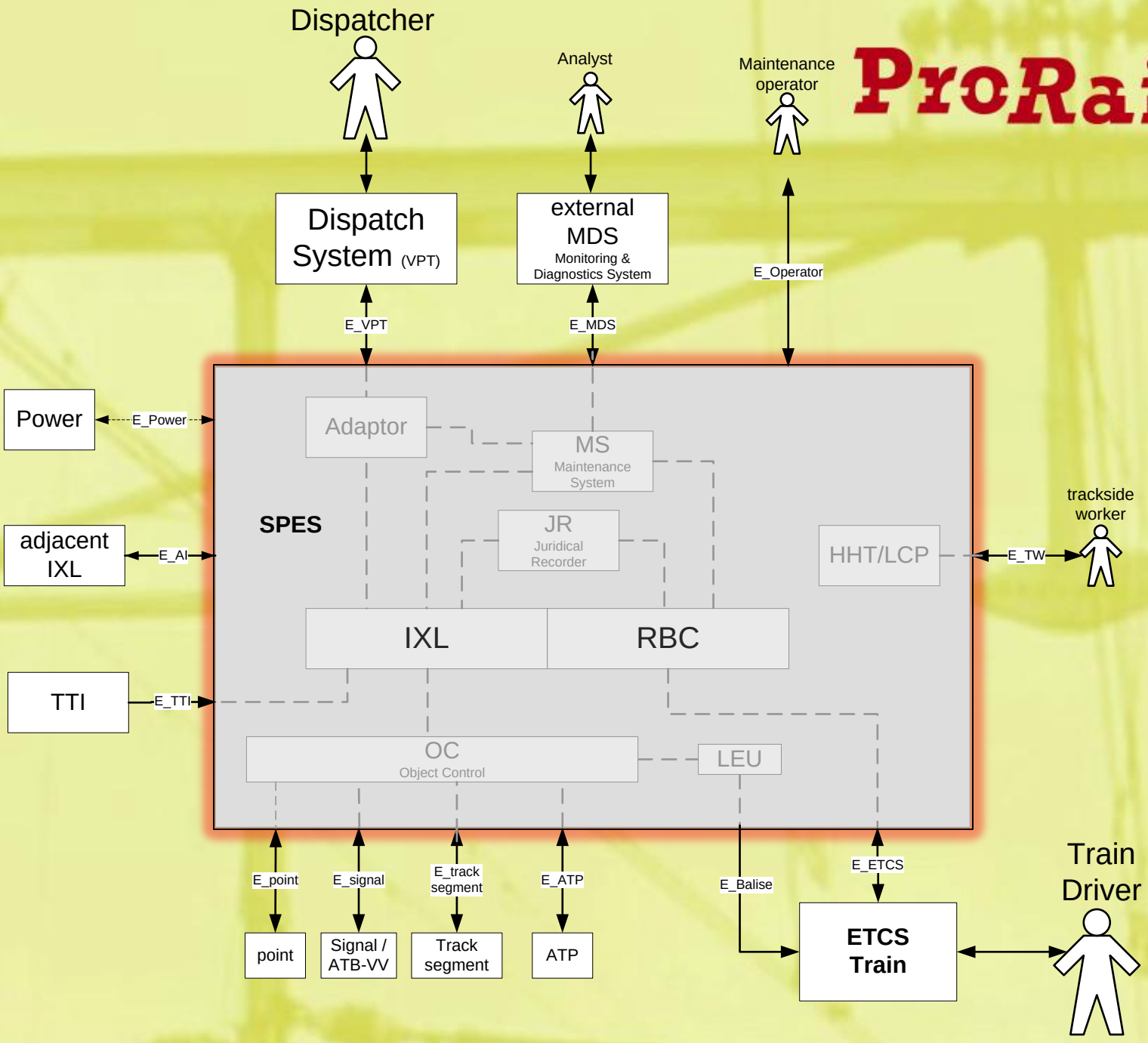
HSL Zuid
2009, level 2 (Level1), Highspeed , Siemens

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




Dispatcher
Analyst
Maintenance operator
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Dispatch System (VPT)
external MDS
Monitoring & Diagnostics System
E_Operator
E_VPT
E_MDS
Power
E_Power
Adaptor
MS
Maintenance System
SPES
JR
Juridical Recorder
trackside worker
adjacent IXL
E_AI
HHT/LCP
E_TW
IXL
RBC
TTI
E_TTI
OC
Object Control
LEU
E_point
E_signal
E_track segment
E_ATP
E_Balise
E_ETCS
Train Driver
point
Signal / ATB-VV
Track segment
ATP
ETCS Train

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*

$\Rightarrow$ 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

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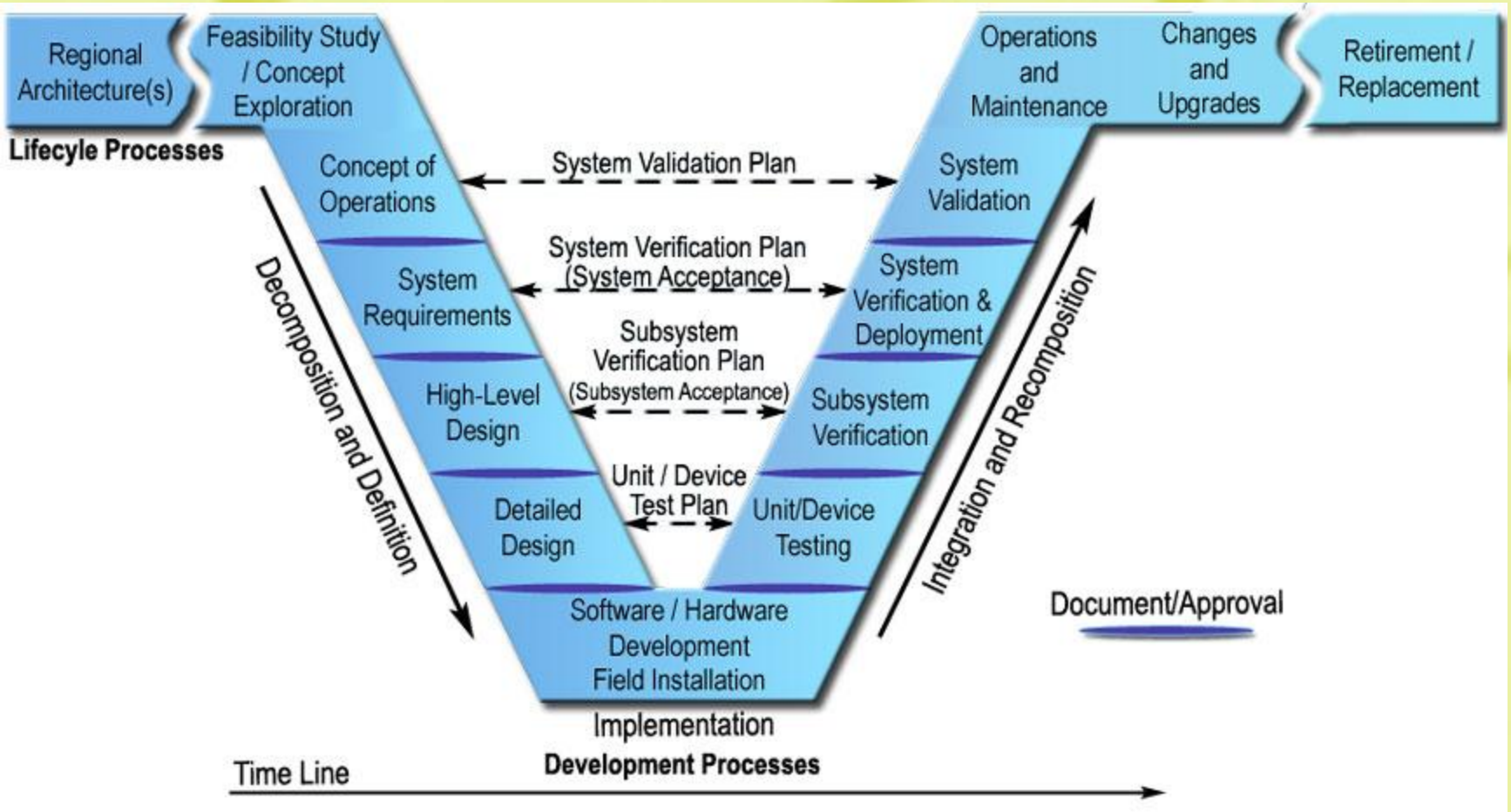
Systems Engineering approach Betuweroute



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 succesful

$\Rightarrow$ realisation of the BR safety system was completed in time

Lessons learned Betuweroute

- Systems engineering approach is succesful
- 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

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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?

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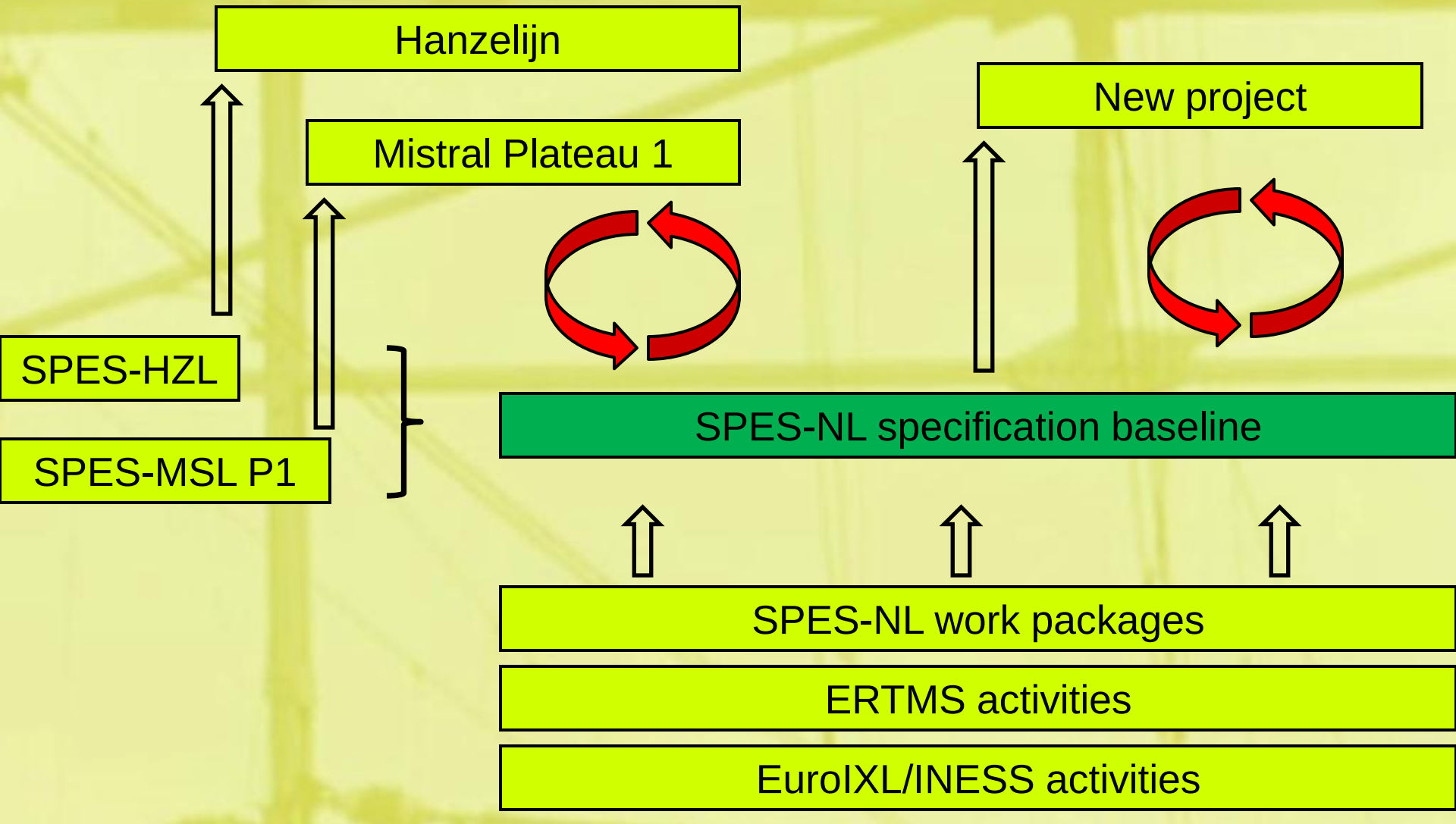
The way forward

- 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

$\Rightarrow$ This is what we call the SPES-NL approach

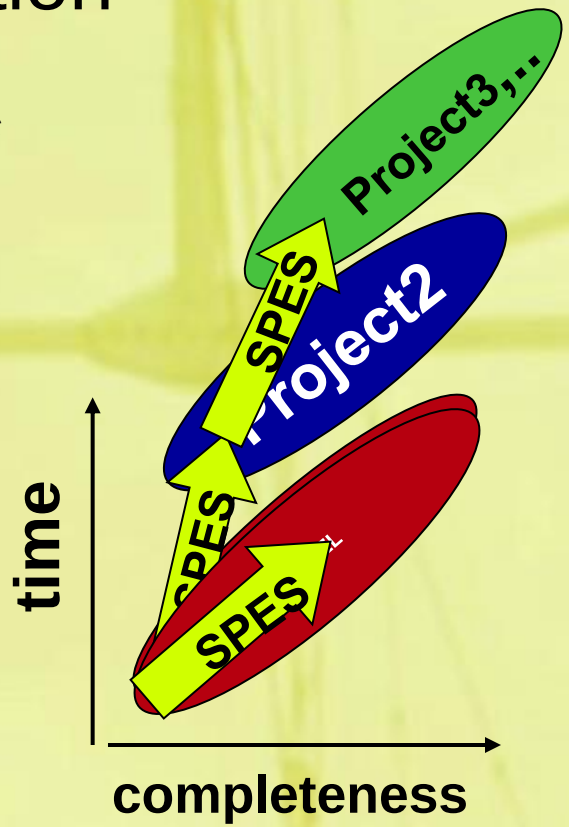
SPES-NL approach



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



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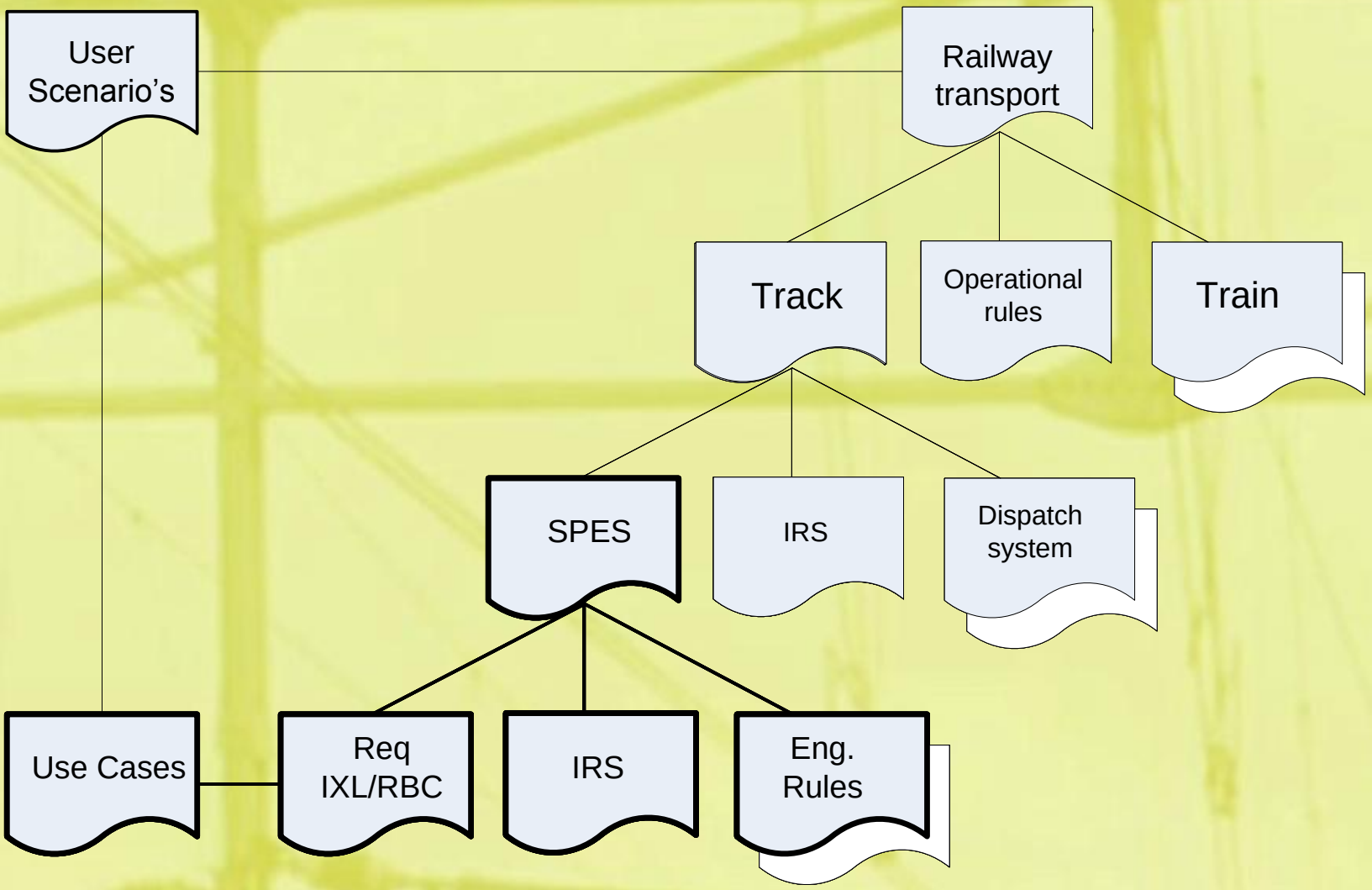
SPES structure



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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:

Req. Id.	Requirement	Source	Original Id.
	MA at Start of Route		
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 AND • 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?