Operational and technical testing of the European Train Control System (ETCS)

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German Aerospace Center

Research Fields

- Aviation
- Space
- Transport
- Energy
- 6,200 employees working in 29 research institutes and facilities
  - at 13 sites.
- Offices in Brussels, Paris and Washington.

Funding

- 2009: 2.601 Mio. Euro
- 2010: 2.610 Mio. Euro

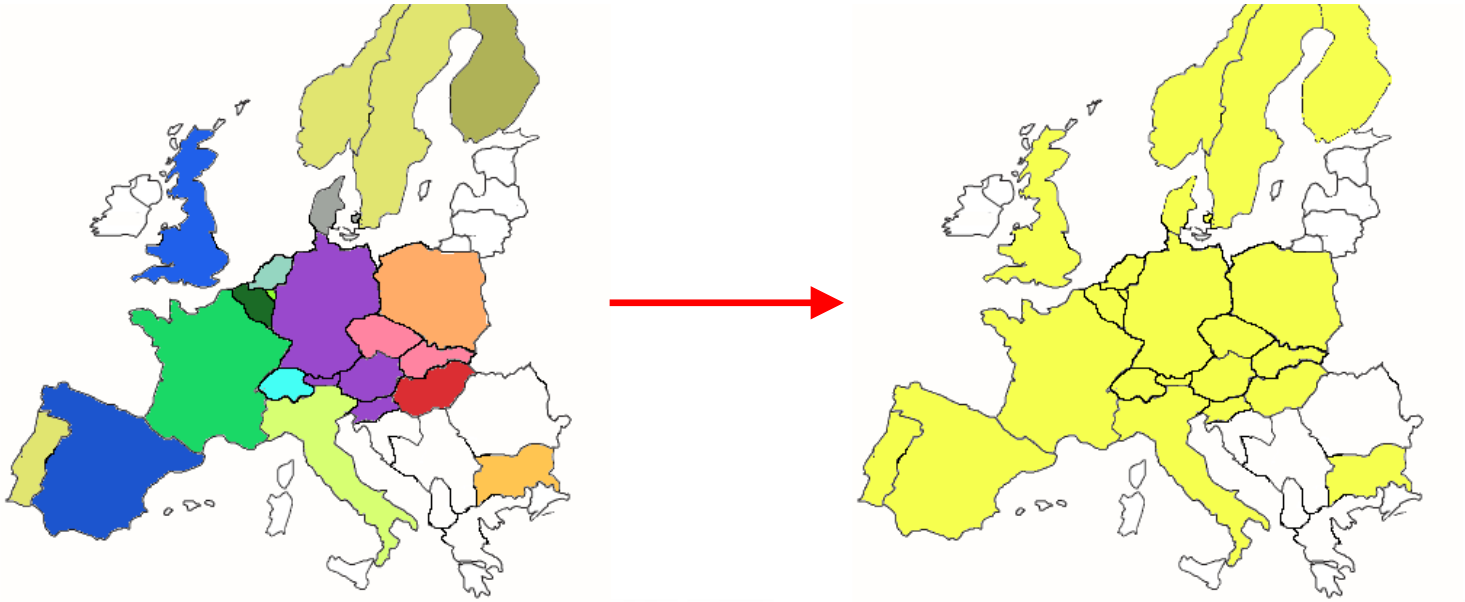




Introduction

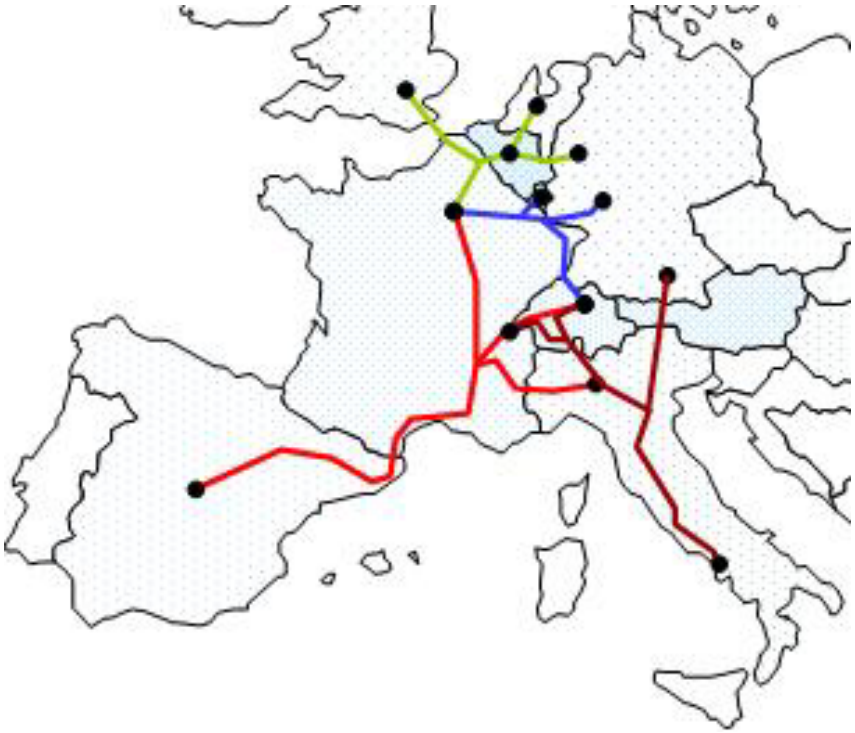
Goals of ETCS

- Establishment of ONE the train control systems in Europe, equipping trains with *one system* for *seamless cross border movements*
- Open access for trains to any trackside
- Open market for train control system components

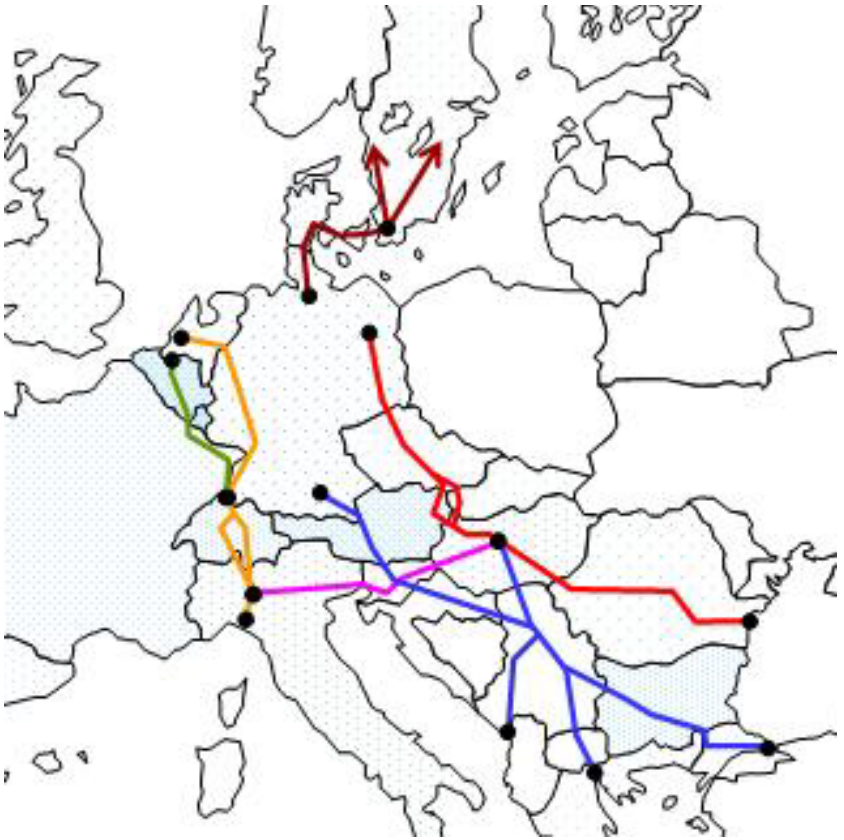


Trans-European Network

High-Speed Corridors

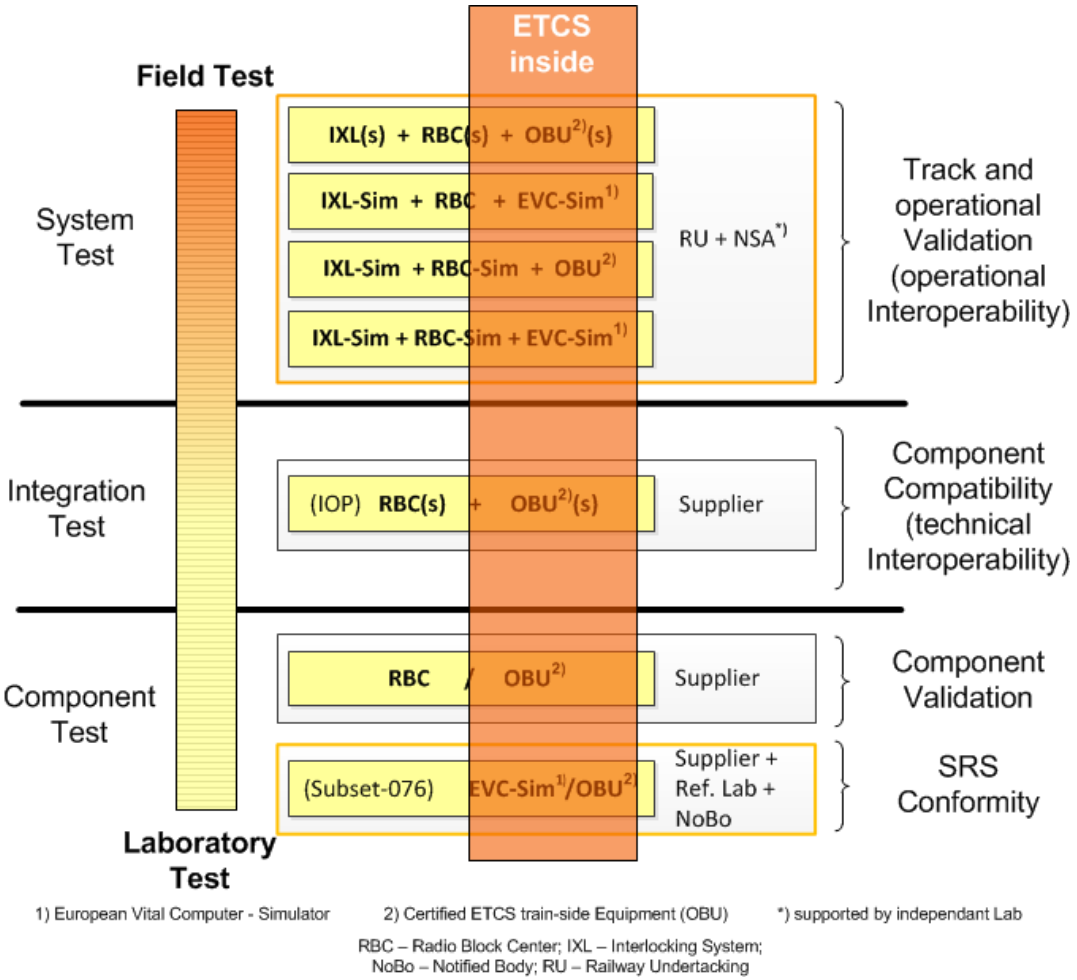


Conventional Rail Corridors



Source: P. Winter 2003

How to save development costs, time as well as how to ensure one unique interoperable ETCS?



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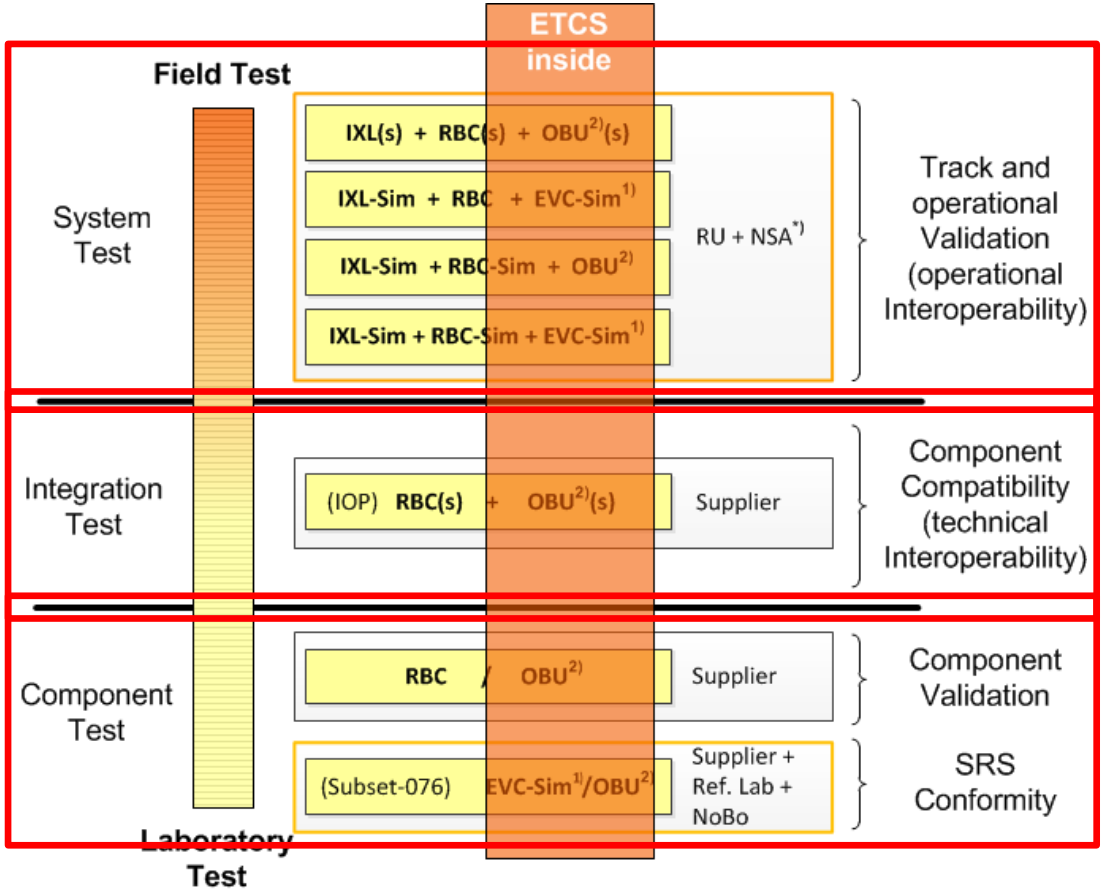

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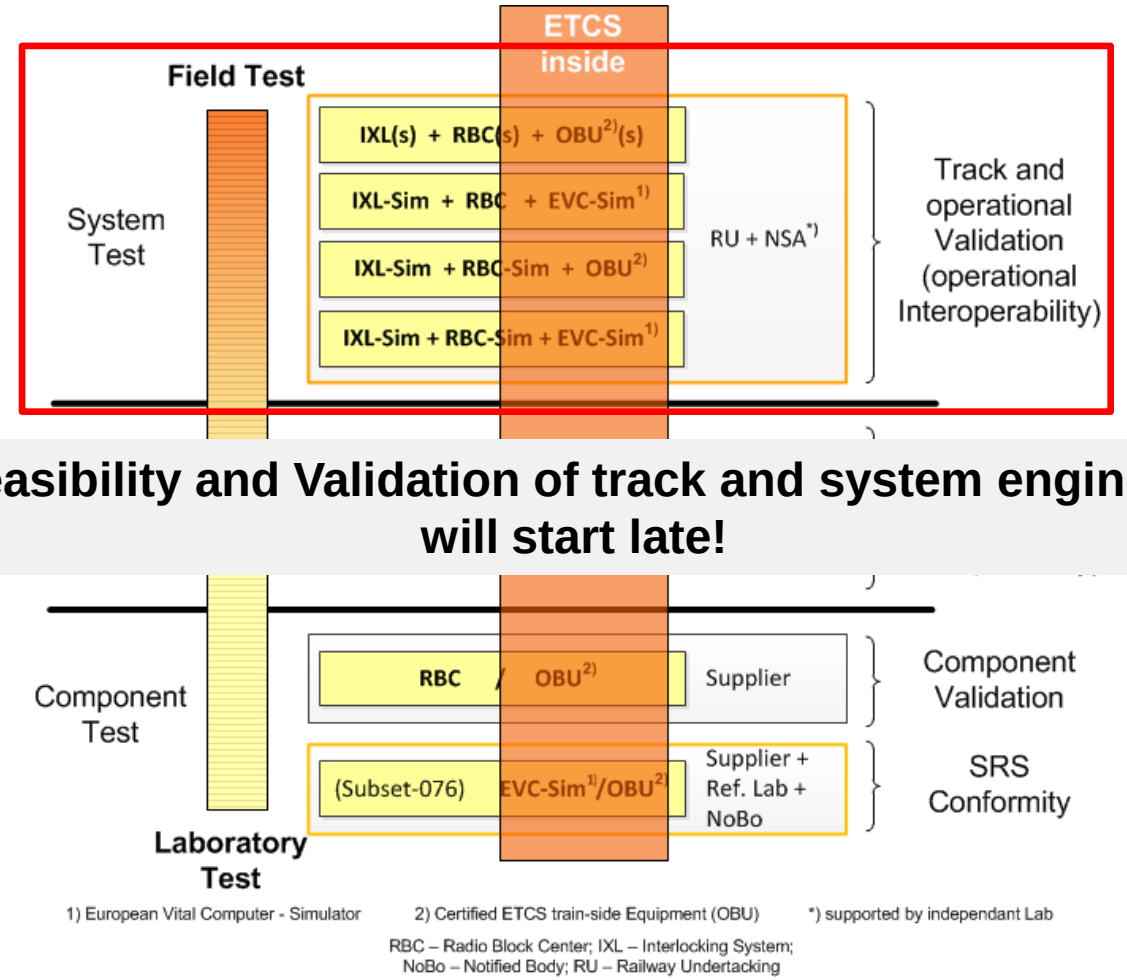
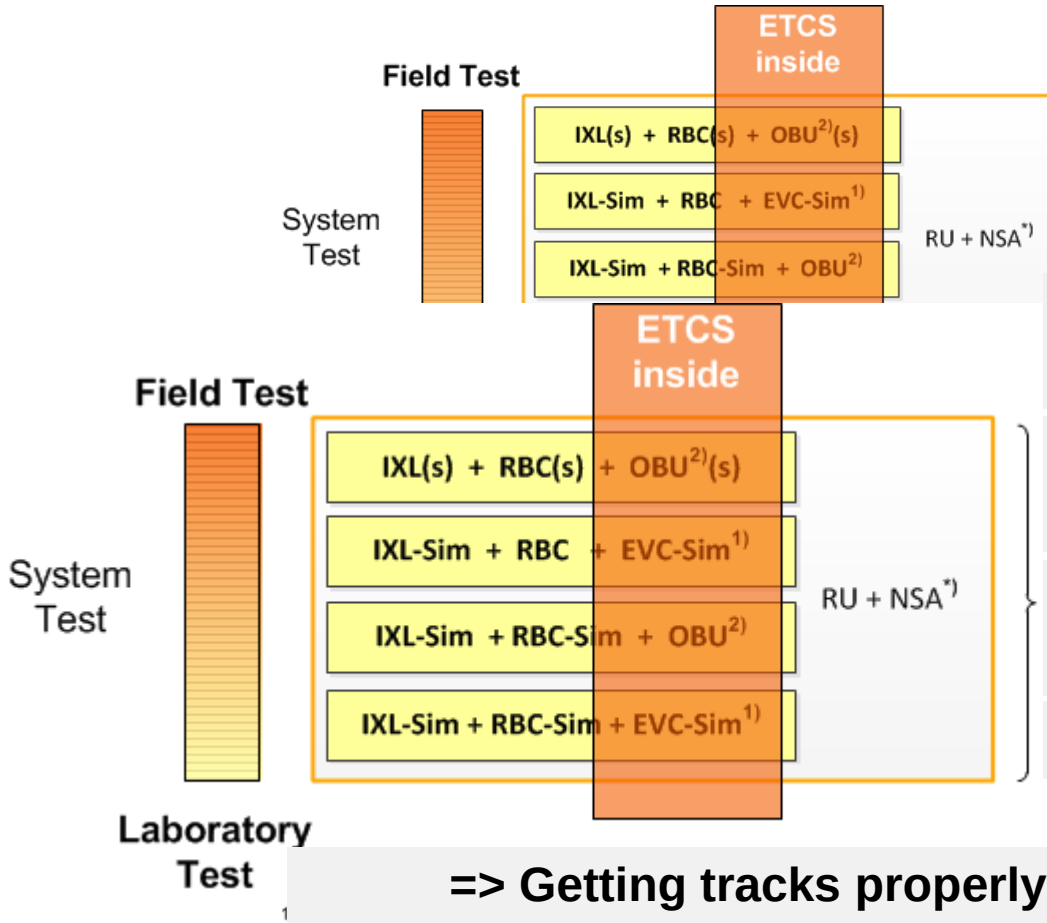


=> Feasibility and Validation of track and system engineering will start late!

How to save development costs, time as well as how to ensure one unique interoperable ETCS?



Feasibility and Validation of track and system engineering

Using a real ETCS Radio block Center

Using a real ETCS on-board unit

Using the planning

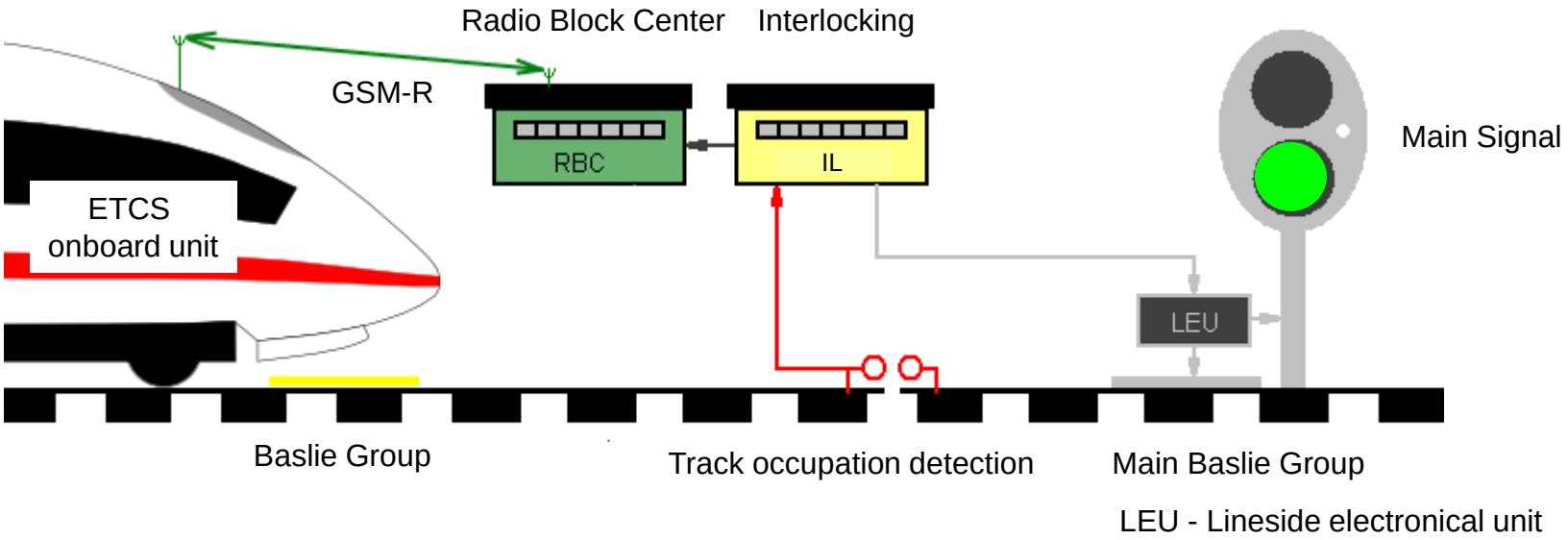
=> Getting tracks properly into operation!

Railway Simulation and Testing laboratory - RailSiTe®

Virtual reality lab for lab tests

Distributed simulation environment including:

- On-board units, Train behaviour, Drivers cabin, Track visualisation
- Air gap,
- Interlocking and RBC



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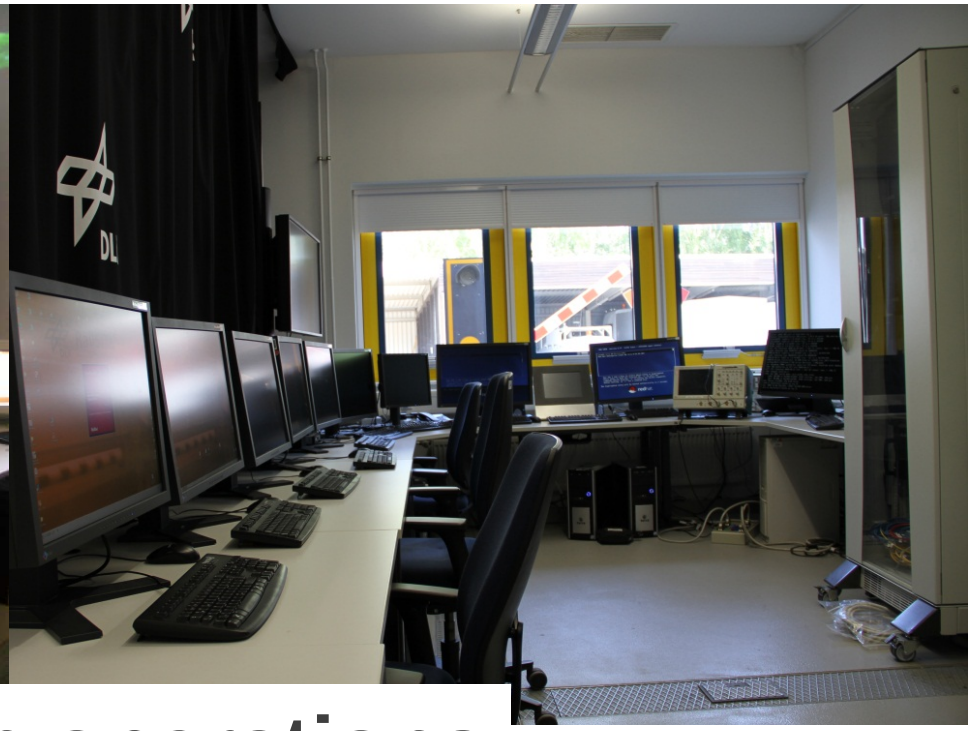
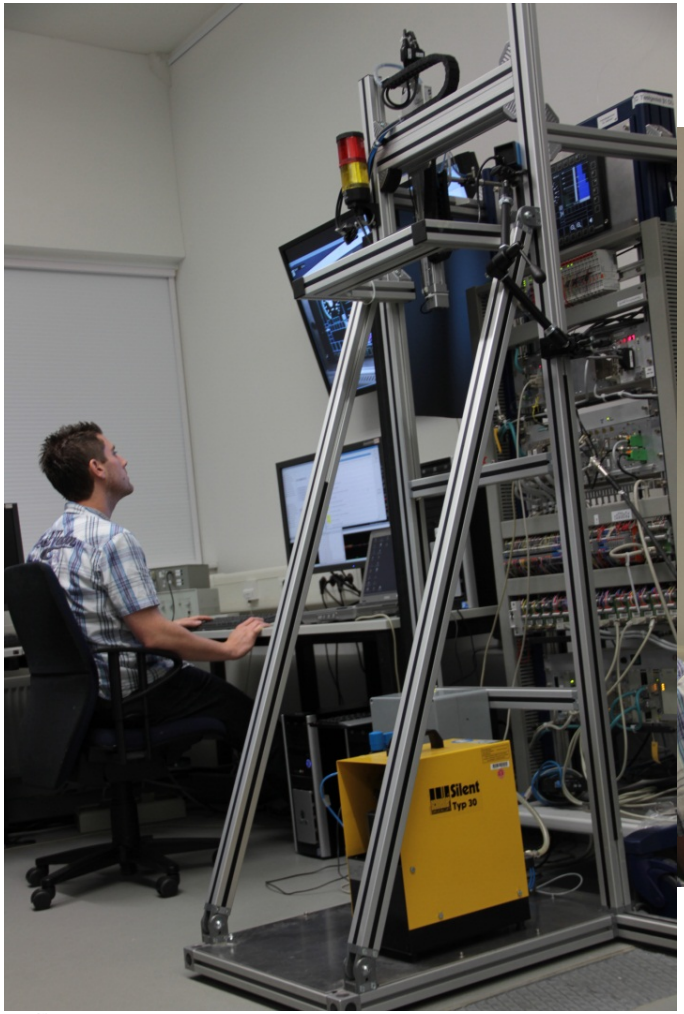


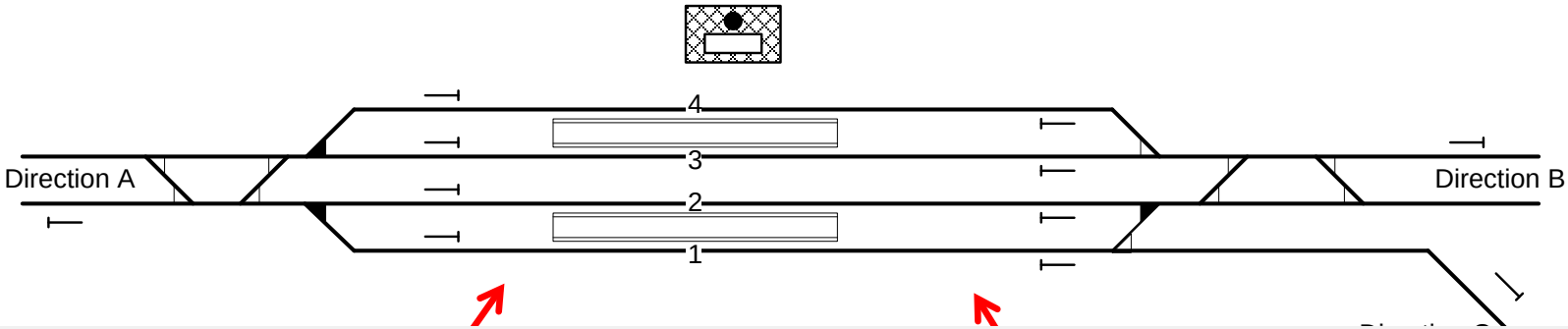
Virtual Train operations

Hardware in the loop Tests - here an ETCS OBU

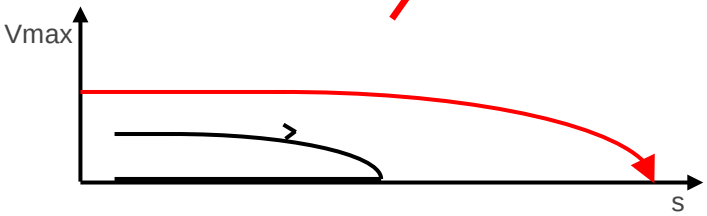


Application of System and Acceptance Tests in the lab

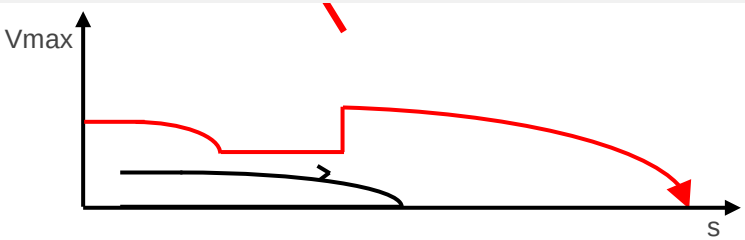
- Mapping of generic operational scenarios to a generic track layout or real project data



=> looking for a Format for the Description of Operational Scenarios!?



Operational Scenario A

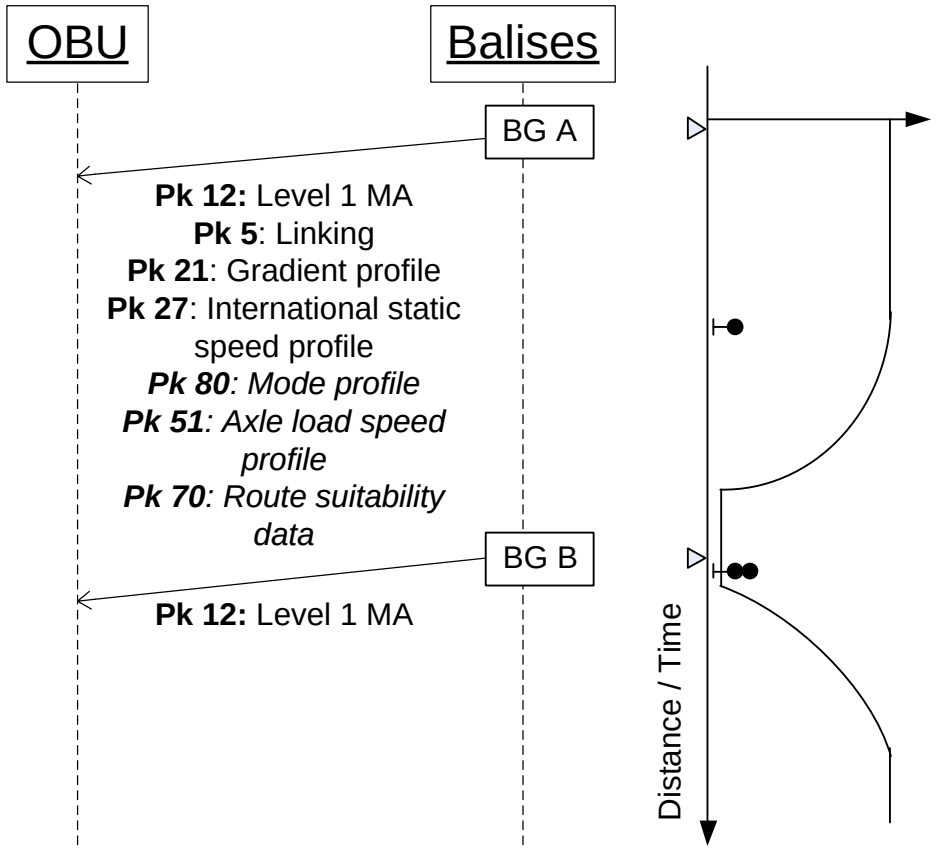


Operational Scenario B

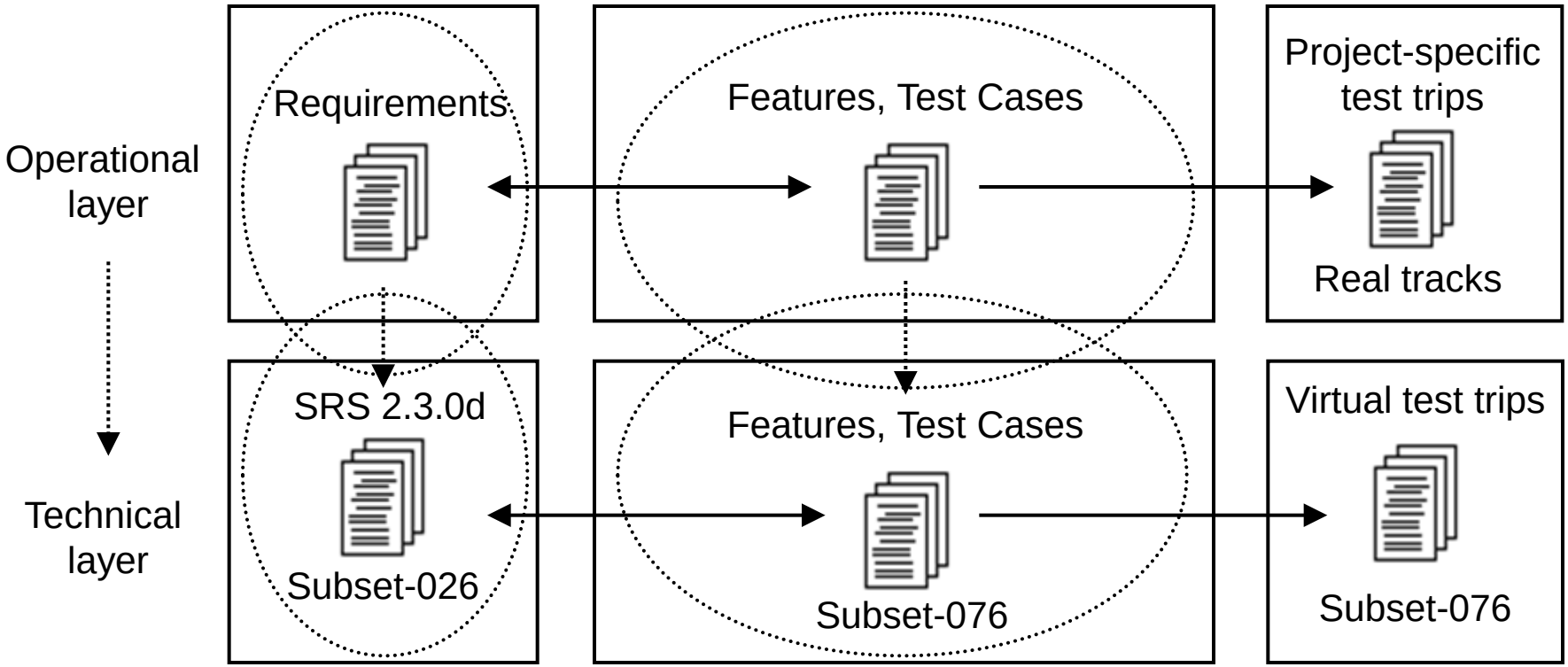
..

Scenario description using UML Sequence diagrams

giving a rough quick overview



Operational must respect technical Functionalities and Requirements



Comparison of operational and technical Functions
Examples

- Technical Tests focus on technical functions, like
  - Management of movement authorities or linking
  - Management of radio communication session
  - Start of Mission / End of mission
  - Modes: Shunting, Trip and Post Trip,..

- Operational Tests focus on major functions and error conditions
  - Management of train movements and route settings according to time schedules
  - Management of wayside components like switches, signals, axle counters and failures
  - Especially for entering ETCS from and leaving ETCS to national System (Class B)
  - Management of train hand over at operational boarders

Operational Test Cases derived from the Technical Test Specification for ETCS

- Extension of included technical Test Cases

operational Feature I	technical Feature A
	technical Feature D
operational Feature II	technical Feature C
operational Feature III	technical Feature B
	technical Feature E
	technical Feature F

Word Format for operational Tests

Train driver starts operation in Staff Responsible mode

SEQUENCE OF TEST													
Step	Previous Level	Previous Mode	Actor	Description of Actions/Events	11.1.3 effective reaction	I/O	Instance of Interface	Comments	Test step reference (FT.TC.st)	Next Level	Next Mode	Test Result	
Pre-ceded				Der Tf übernimmt und bestätigt vorhandene Zugdaten ODER				Verwende A0105.01 ODER					
2.													
3.			OBU	The driver selects "Start".		I	DMI		262.3.2				
4.			OBU	Driver's selection of "Start" is recorded on the JRU.		O	JRU	Triggered by : The driver acts on the on-board MMI.	262.3.4				
5.													
6.			OBU	An acknowledgement request for running in Staff Responsible mode is displayed on the DMI		O	DMI	The on-board equipment will then waits for the driver to acknowledge the acknowledgement request for running in Staff Responsible mode	262.3.5				
7.													
8.	L1	SB	OBU	The text message of acknowledgment for SR mode is acknowledged		I	DMI		552.1.1	L1	SR		
9.	L1	SR											
11.			OBU	Indication of SR mode is DISPLAYED		I	DMI		552.1.3				
12.			OBU	The transition to SR mode is RECORDED		O	JRU		552.1.4				
13.	L1	SR		-Fzg überfährt Balisengruppe und überprüft die nationalen werte - folge Testfall "Fahren unter "ETCS-Befehlsfahrt" (SR)"		-	-	Verwende A0108.aa		L1	SR		
Fol-lowed by								Verwende Ablauf 47					

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SEQUENCE OF TEST													
Step	Previous Level	Previous Mode	Actor	Description of Actions/Events	11.1.3 effective reaction	I/O	Instance of Interface	Comments	Test step reference (FT.TC.st)	Next Level	Next Mode	Test Result	
Pre-ceded				Der Tf übernimmt und bestätigt vorhandene Zugdaten ODER				Verwende A0105.01 ODER					
2.			Tf	wählt Start einer Zugfahrt								2.3.st076.010	
3.			OBU	The driver selects "Start".		I	DMI					262.3.2	
4.			OBU	Driver's selection of "Start" is recorded on the JRU.		O	JRU	Triggered by : The driver acts on the on-board MMI.				262.3.4	
5.			Tfz	fordert vom Tf die Bestätigung zum Start in der Betriebsart ETCS-Befehlsfahrt (SR)		-	-					2.3.st076.011 .1	
6.			OBU	An acknowledgement request for running in Staff Responsible mode is displayed on the DMI		O	D	running in Staff Responsible mode					
7.			Tf	bestätigt Start in Betriebsart ETCS-Befehlsfahrt (SR)		-	-					2.3.st076.012	
8.	L1	SB	OBU	The text message of acknowledgment for SR mode is acknowledged		I	DMI					552.1.1	L1	SR	
9.	L1	SR	Tfz	wechselt in die Betriebsart ETCS-Befehlsfahrt (SR)		-	-	Funktion "Override" ist nicht aktiv				2.3.st076.012	
11.			OBU	Indication of SR mode is DISPLAYED		I	DMI		552.1.3				
12.			OBU	The transition to SR mode is RECORDED		O	JRU		552.1.4				
13.	L1	SR		-Fzg überfährt Balisengruppe und überprüft die nationalen werte - folge Testfall "Fahren unter "ETCS-Befehlsfahrt" (SR)"		-	-	Verwende A0108.aa		L1	SR		
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Extensions - operational Test Steps

Conclusions of the approach for the Feasibility and Validation of track and system engineering in the lab

- Avoiding miss-investment and redevelopment due to
  - incompatibilities between operation and the train control system
  - incompatible components bound to a specific track when the network grows

- Save time and costs by testing
  - as early as possible
  - step by step in the lab with
    - simulated ETCS components and
    - real components
  - towards the approval in the field

- Maybe reducing the ETCS versions
  - By the evaluation and validation of the system specification performing simulations before starting real train and track implementation

Thank you for your attention

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