Using Digital twins for complex mass transit system design and integration

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The EOLE Line Extension Project

- Congestion of the “Express Lines” (RER network) in Paris Area (Ile de France) (+30% to +40% in 10 years);
- A special need to relieve the Line A

Challenge: improve the service quality and capacity of the existing railway network
Application on Paris Line E
The EOLE Line Extension Project

EOLE is:

- a rolling stock project
- an infrastructure project
- a new rail traffic management system: NExTEO
The EOLE Line Extension Project - CBTC

NExTEO performances are based on CBTC technology
Introducing CBTC on existing infrastructure

CBTC and ATO, ATS technologies but in an open railway environment
Handle the complexity without forgetting the final users’ expectations
1 Enter NEXTEO section

Automatic driving under NExTEO

2 : Automatic driving activation
Our expectations from Digital twin/ Model based design

- enable a system approach clarifying functionalities, interfaces, interactions between different complex systems.
- enable Rail Operator / Final user to understand the system (evolution & changes compared to the existing one).
- allow a smooth transition from system level to the next steps of V cycle such as design, integration, validation.
- reduce on site testing (reduced amount of slots –e.g. 50 nights to save on site)
- reduce risk of disturbances on E line operations due to modifications on existing interlocking and on site testing
Our expectations from Digital twin/ Model based design

Model based design and system engineering

- Reduce technical risks
- Reduce NEXTEO project impact on operations
- Reduce overall project costs

Real hardware & environment Vs Model Based

Acceptance

Railway network integration

Operator

Maintainer

Network

Specifications

Sub-systems

Functional

Architecture & Interfaces

Validation
Our expectations from Digital twin/Model based design

System Integration Platform

- Reduce risks and costs
- Master the integration of the subsystems
- Increase knowledge
- Challenge system performance

Existing ATS: MISTRAL
New ATS NExTEO

Interlocking model (relay IXL PRCI 85)
Model overview

User’s interface (MMI allowing to set commands and to view)

Interlocking modeled

Neighbouring Interlockings are modeled as part of the environment

Modeling the field equipment:
- Point translation, response time, including failures...
- Signal aspect display including failures (dark signal)
- Track circuit (with virtual train movements)
- Other

User (for simulation purpose) can act on field behaviour (nominal train movements, insert failures...)

Simulate field behaviour

Field devices interface

Technical interface (not modeled)

Interlocking (hardwired)

MMI command & control

Neighb. Interlock.
Model overview
Build the models

1st STEP: build the digital twin based on all drawings of the PRCI Relay IXL
Build the models

2nd STEP : model track and devices
3rd STEP: simulate and validate using the models
Build the complete test bench

4th step: integrate and build the complete test bench with MIL & HIL
Perspectives & applications for the NExTEO project

Next steps: system wide test bench with MIL & HIL
Thank you! for your kind attention