

PERSPECTIVES FOR DIGITAL TWINS IN RAILWAY SYSTEMS

PIERRE-ETIENNE GAUTIER
BIM AND DIGITAL CONTINUITY PROGRAM DIRECTOR
SNCF RÉSEAU

RIAMS CONFERENCE JUNE 10, 2021



PERSPECTIVES FOR DIGITAL TWIN IN RAILWAY SYSTEMS

1. DEFINING DIGITAL TWIN IN RAIL

- + WHAT DOES IT LOOK LIKE & WHAT ARE THE BOUNDARIES?

2. BENEFITS OF DIGITAL TWIN

- + INFRASTRUCTURE MAPPING FOR PREDICTIVE MAINTENANCE
- + REAL TIME PLANNING

3. DELIVERING LONG TERM INFRASTRUCTURE COMPONENTS COST SAVINGS

- + INTERCHANGEABILITY OF (DIGITIZED) SUBSYSTEMS
- + EARLY TESTING USING A SIMULATION MODEL BASED APPROACH

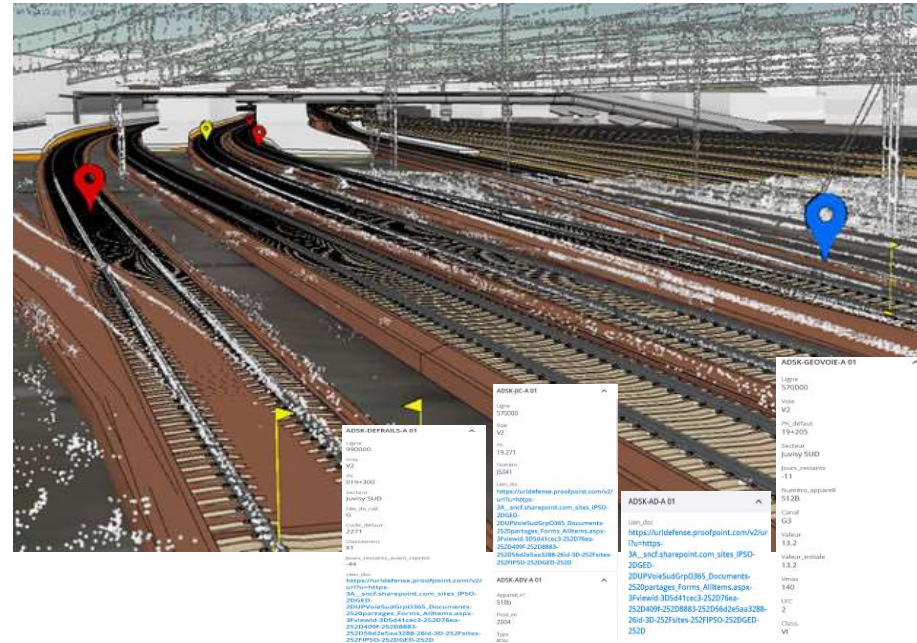
4. THE IMPORTANCE OF ARCHITECTURE AND DATA MANAGEMENT,

- + DEVELOPING AN ARCHITECTURE FOR THE RAILWAY SYSTEM : THE LINX4RAIL PROJECT
- + DEVELOPING A COMMON DATA STRUCTURE TO MODEL DATA FOR YOUR DIGITAL TWIN

DEFINING DIGITAL TWIN IN RAIL

WHAT DOES IT LOOK LIKE & WHAT ARE THE BOUNDARIES?

- **Digital Replica of the Railway System**
- “Real-time “snapshot of Railway System
- **Augmented with services enabling to:**
- Understand current state of the system
 - memory of past events
- Predict future behaviour
 - anticipation



BENEFITS OF DIGITAL TWIN

INFRASTRUCTURE MAPPING + INTELLIGENCE/ MODELS FOR REMAINING LIFE PREDICTION
> PREDICTIVE MAINTENANCE

Knowledge of current state of infrastructure

(actual load history

+

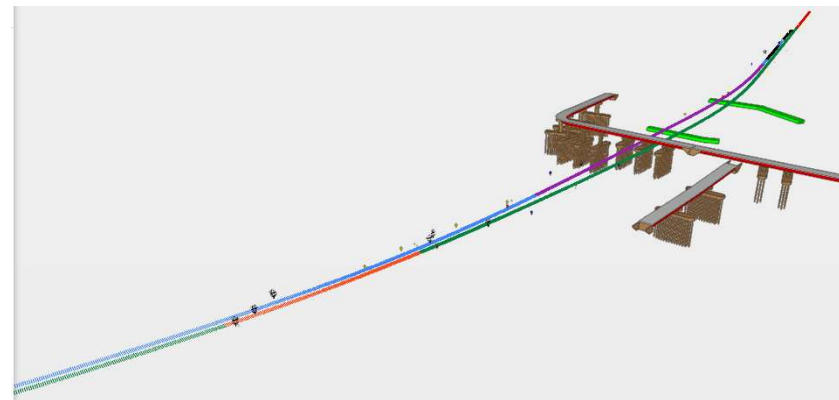
maintenance actions history)

+

improved degradation laws

=

Way to predictive maintenance



BENEFITS OF DIGITAL TWIN

REAL TIME PLANNING/RESCHEDULING IN CASE OF OPERATION INCIDENTS

**Real- time prediction of delays
(e.g) in case of incidents**

+

Real time prediction of conflicts

+

Resolution of conflicts

=

Real time train operation rescheduling

DELIVERING LONG TERM INFRASTRUCTURE COMPONENTS

COSTS, DELAYS SAVINGS DURING EARLY TESTING USING A SIMULATION MODEL BASED APPROACH

(Model based) **Simulator of train operation**

+

Checking performance at each step of the design phase of the subsystem under development

=

Saving costs by:

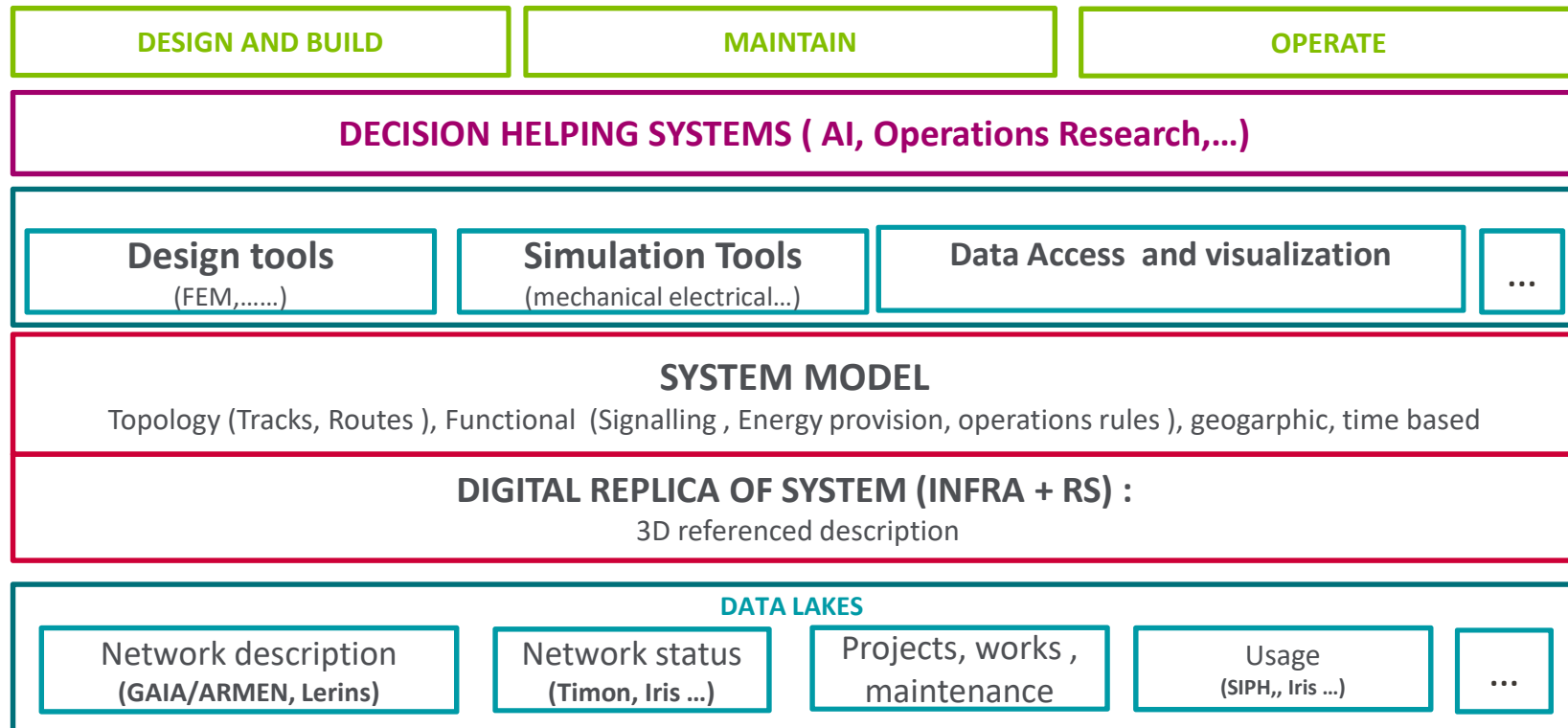
- **Anticipating loss of performance during design steps**
- **Enabling to adjust/ correct development at each step**
 - **Ensure specs will be met with minimal design iteration**
 - **Reduce development costs**
 - **Minimize delays**

Operations simulator

CCS model

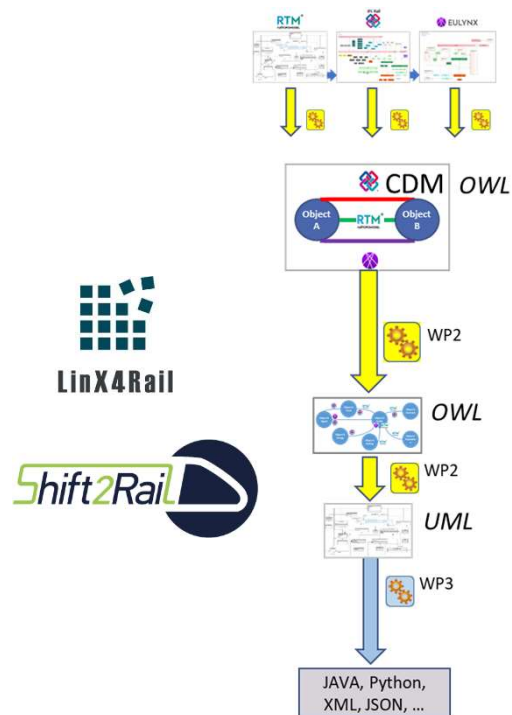
Digital system under development

DIGITAL TWIN STRONGLY RELIES ON INTERNAL DATA



THE IMPORTANCE OF DATA MANAGEMENT

DEVELOPING A COMMON DATA STRUCTURE TO MODEL DATA FOR YOUR DIGITAL TWIN

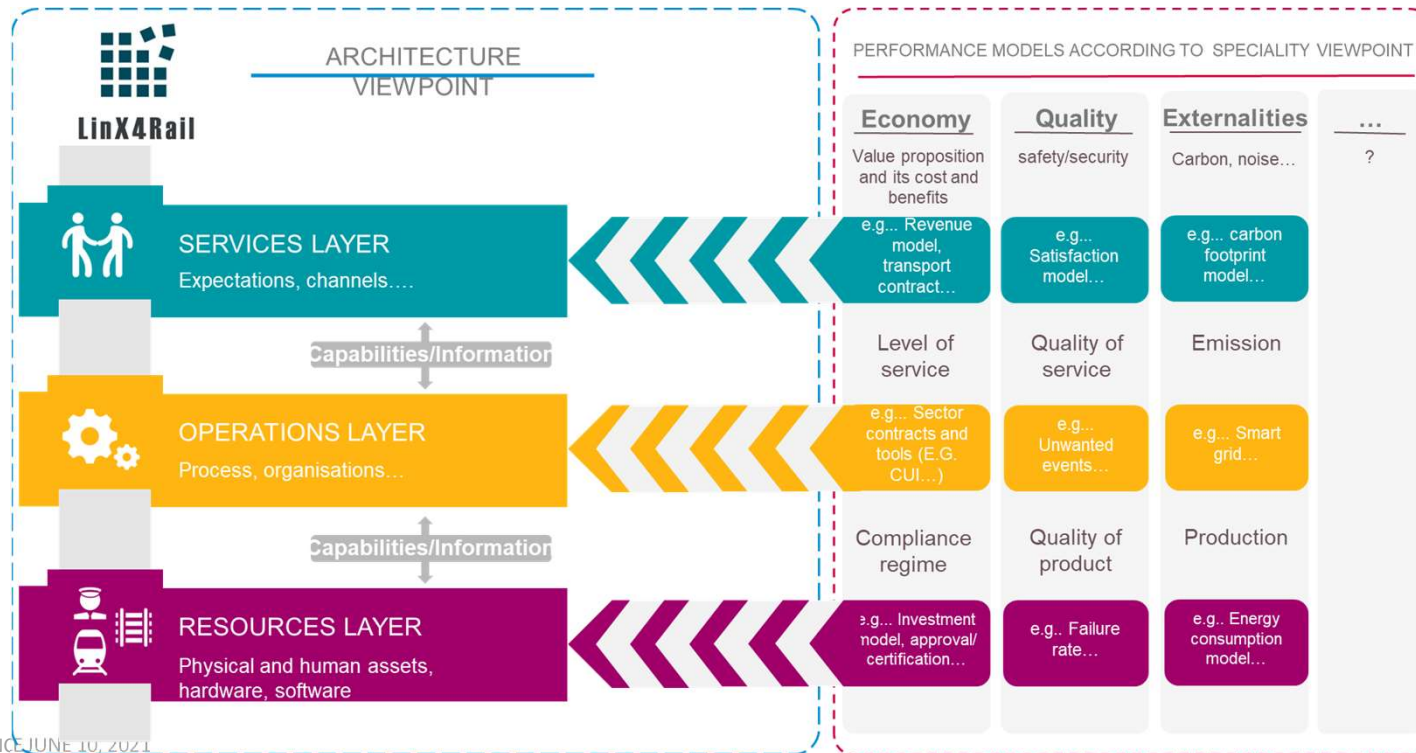


Need for standardized data and functional models:

- Object modelling (IFC)
- Functional model (Rail-TopoModel)
- Specific functional models (EULYNX for interlockings)

Towards a federation of models : LinX4Rail's Conceptual Data Model (CDM)

DIGITAL TWINS NEED ARCHITECTURES (SYSTEM ARCHITECTURE , NOT ONLY IT ARCHITECTURE)



CONCLUSIONS

DIGITAL TWIN IS NOT ONLY A DIGITAL REPLICA

Augmented with services enabling

- **Memory: Updated knowledge of health status and loading/maintenance history**
- **Anticipation :Prediction of remaining lifetime**
- **Involves analysis capabilities (AI, physical models)**
- **Involves prediction tools**
 - improved with respect of SOA
- **Relies on System Architecture**
- **Standard data and functional models for ensuring sustainability of DT over time and obsolescence**

THANK YOU FOR YOUR ATTENTION