

# **MBSE in the railway industry sector: Alstom ASAP methodology**

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The ALSTOM logo is located in the bottom right corner of the slide. It consists of the word "ALSTOM" in a bold, blue, sans-serif font. The letter "O" is replaced by a red circle with a white dot in the center, resembling a stylized eye or a target.

# The only railway multi-specialist



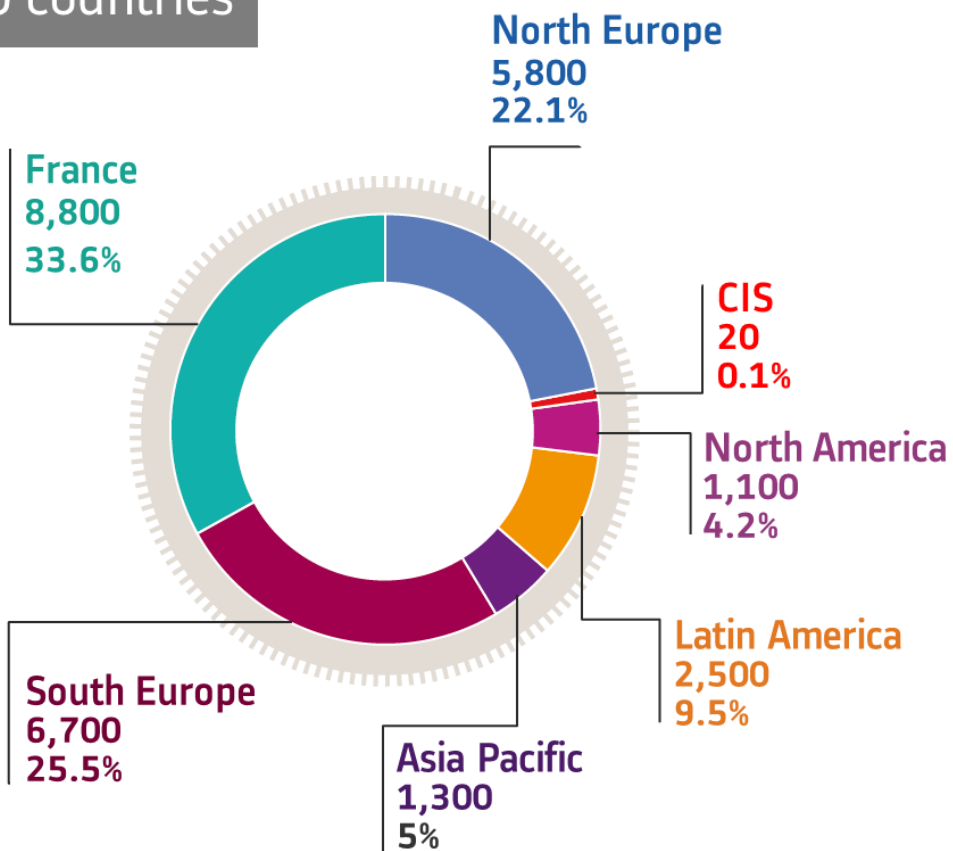
- The only manufacturer in the world to master all businesses of rail sector
- The most complete range of systems, equipments and services:  
Rolling Stock / Infrastructures / Signalling / Services / Turnkey transport systems
- N°1 in high and very high speed
- N°2 in urban transport (tramways, metros)
- N°2 in signalling
- N°2 in maintenance

TRANSPORT

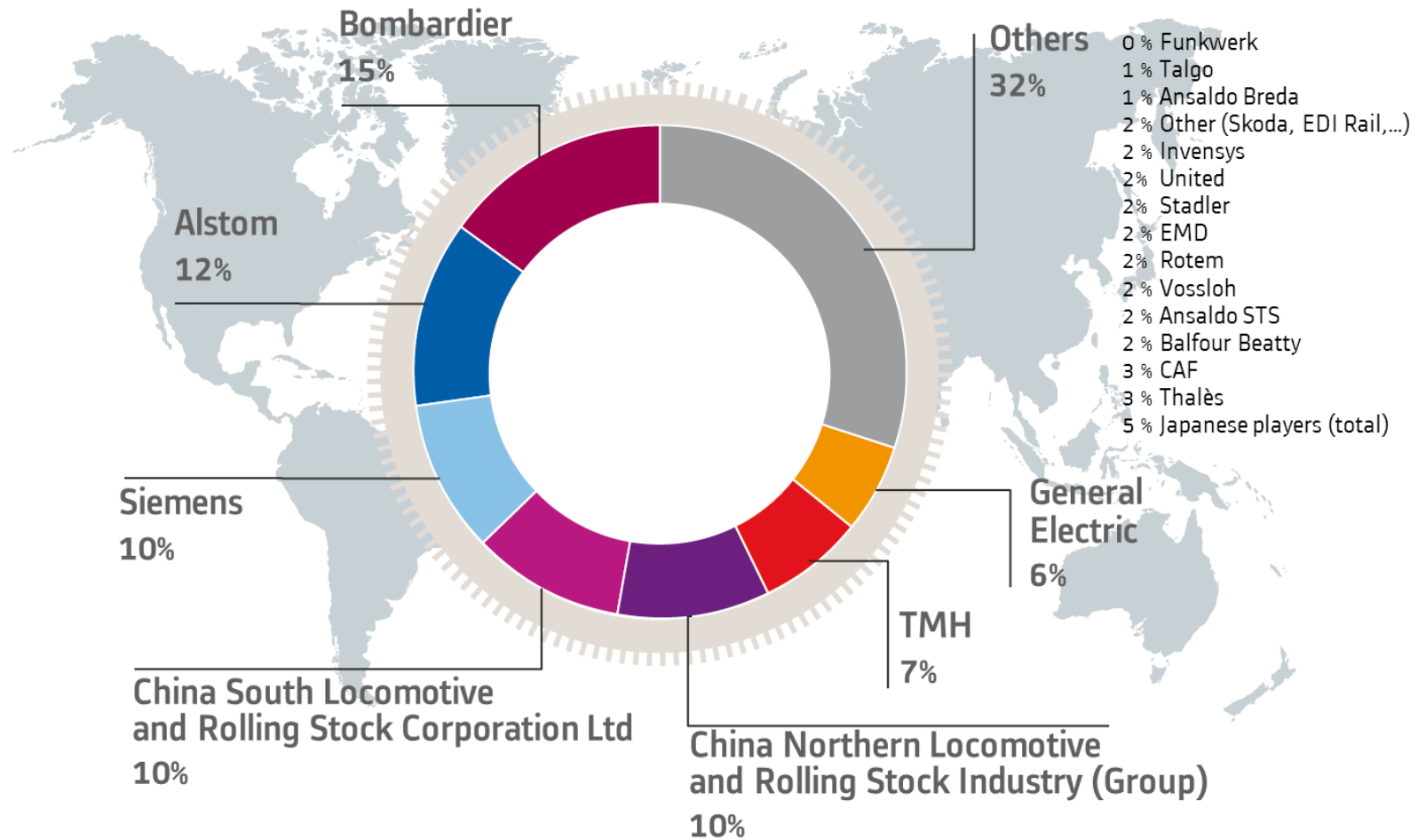
**ALSTOM**

# A worldwide local company

25,500 employees in more than 60 countries

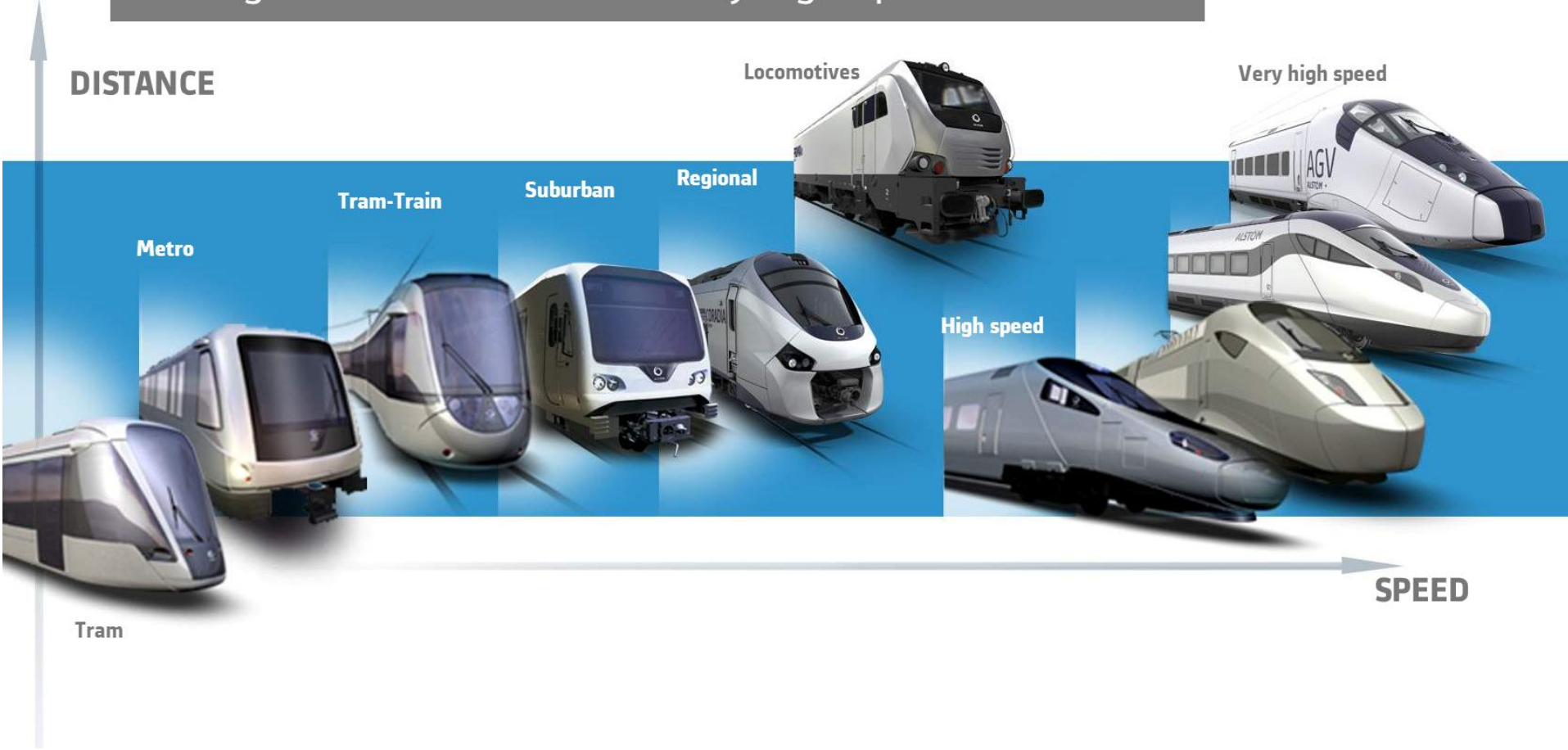


# The second manufacturer in the world



# A wide range of products and services

Rolling stock: from trams to very high speed



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# Evolution of Railway Operators:

Railway carbuilders shall develop a more structured design process in order to face the lack of technical background of the new railway operators

- Historically, railway traffic was operated by state owned national operators (SNCF, DB, Trenitalia, Renfe, ecc..) and they were mastering the full technical know-how to design a railway system. Carbuilder were just producing following the operators instructions...
- Today national railway operation market is formally open (in Europe due to a CEE directive) to other operators (private or not).
- New private operators have not any historical technical background and they're fully operational oriented
- Some Incumbent operators, are also changing their mind-set by becoming more operational oriented (and less technical) in order to be more competitive against the new private ones

# Evolution of Rolling Stocks:

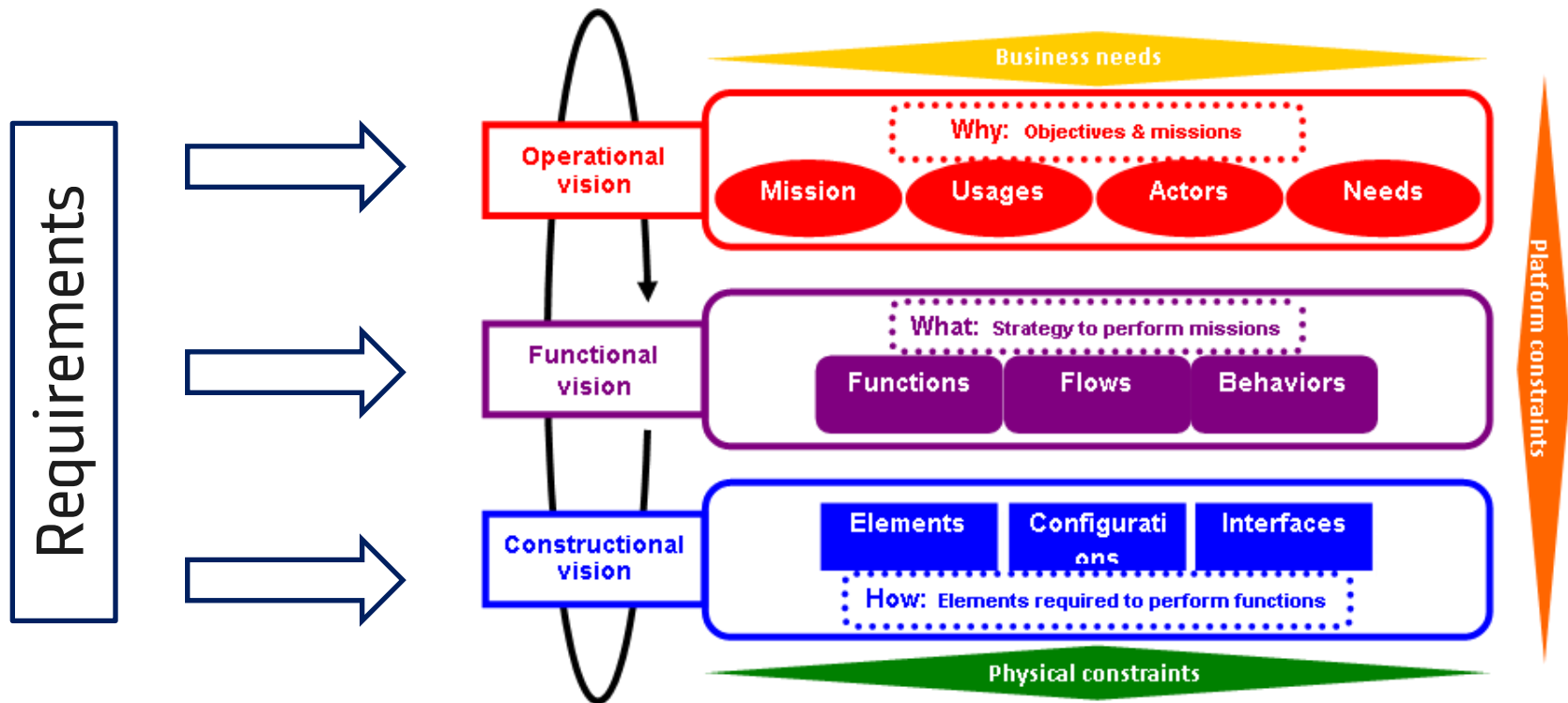
Rolling stock systems have increased the level of complexity due to additional functionalities / services to be implemented and due to the introduction of the software

- Historically, railway vehicle were fully mechanical and once electronic appeared all the « non mechanical » functions to monitor and control the system were realized with wiring logic (relays logic).
- With the introduction of the “train control and monitoring system” some “not safety relevant” function were implement with software, and here the level of complexity arisen in a way to require a more structured approach
- Today the trend is to implement (when possible) more and more functionalities (also “safety relevant”) in software and in this case, to manage such complexity, it’s necessary to introduce a more robust system approach: **Alstom System Engineering Process**



# System Engineering Process: view points

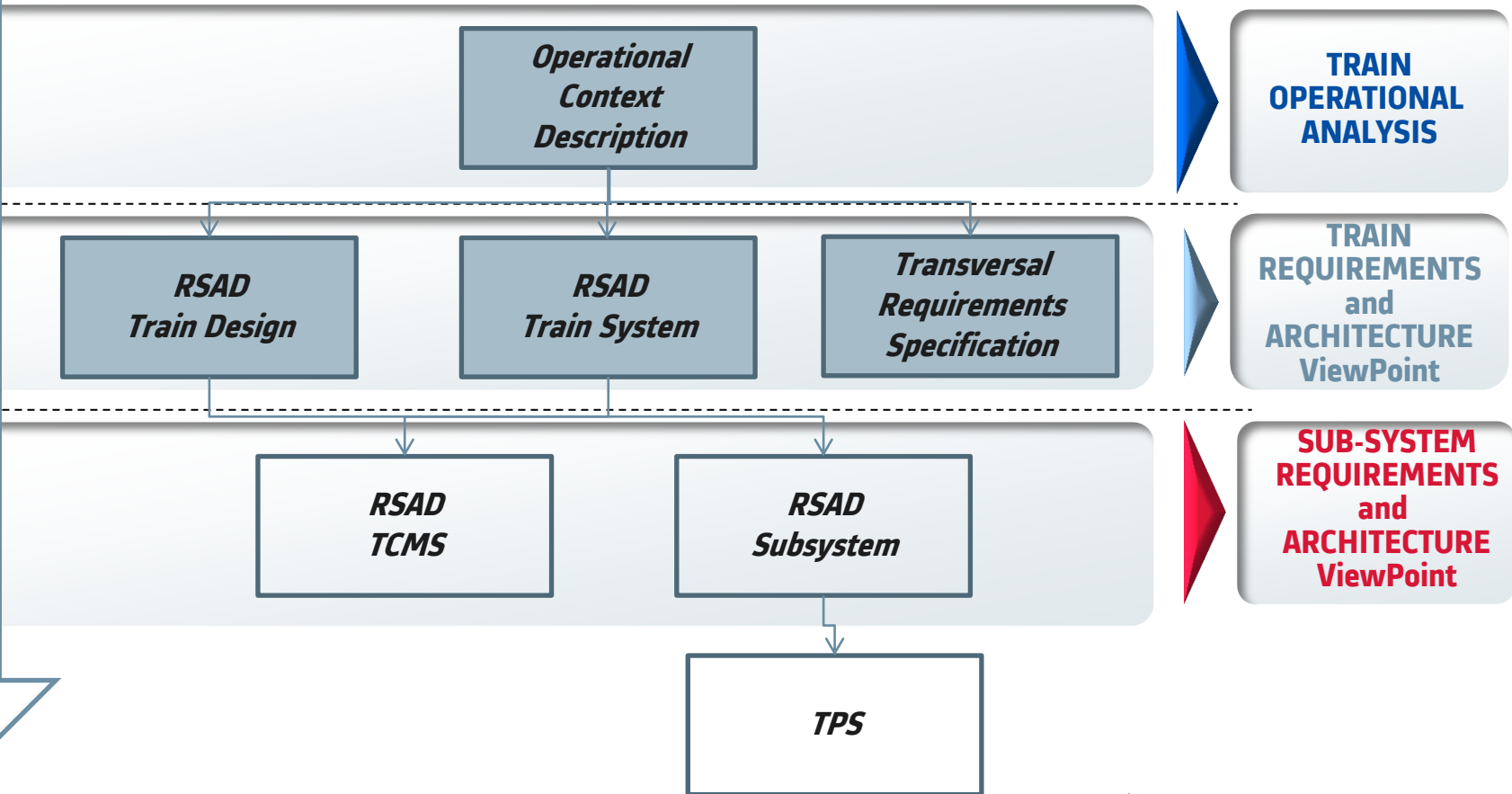
Alstom Advance System Architect Program is the new Alstom System Engineering approach which aim to reduce the “problem” complexity



# System Engineering Process: a Top-Down approach

System views are developed using a Top-Down approach starting from reqs

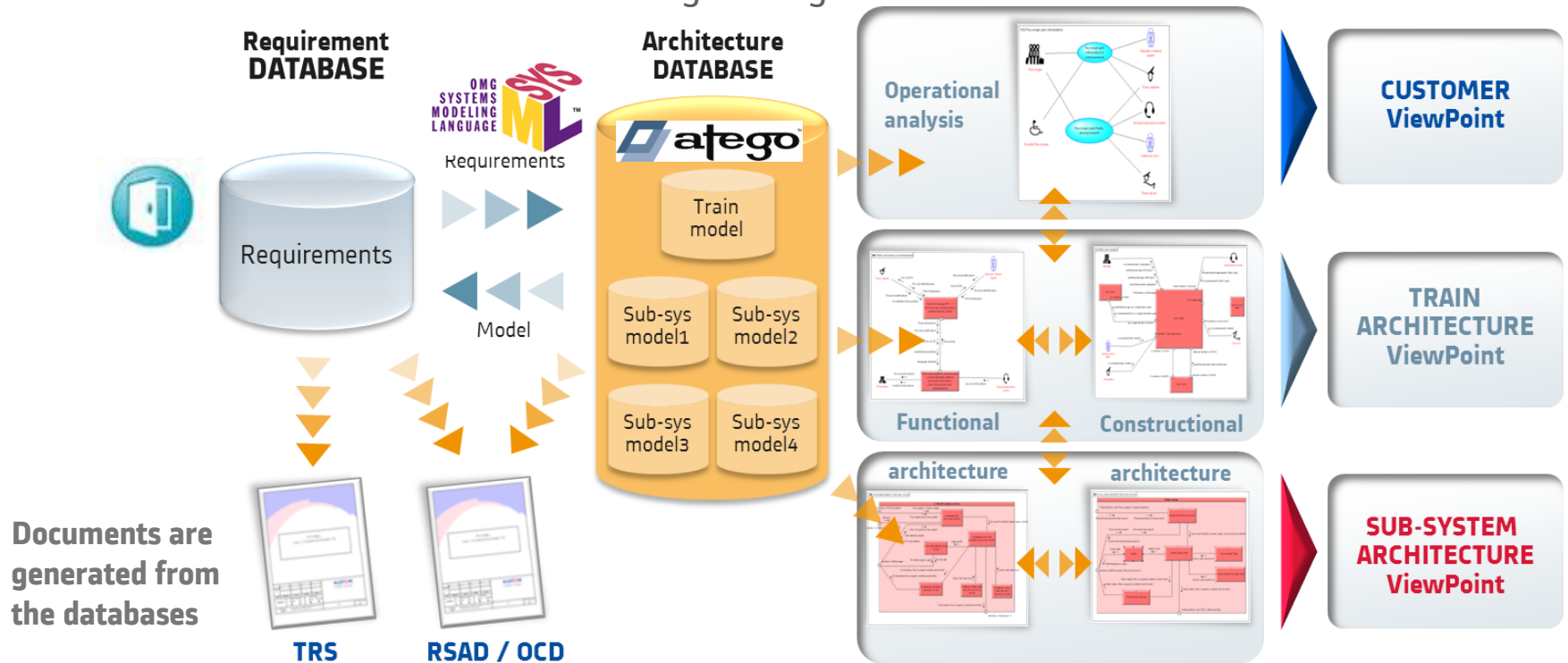
Requirement management and development



# MBSE tools architecture:

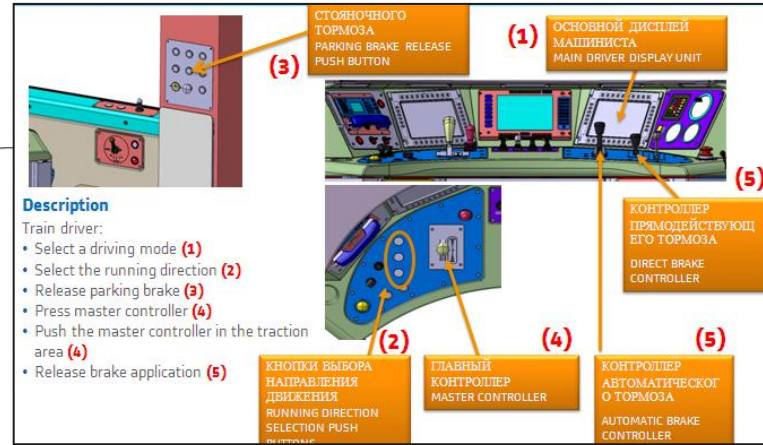
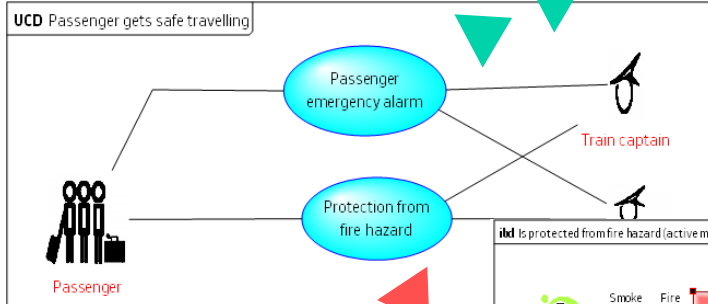
System model objects are stored in two synchronized database:

- Requirement database to enable requirement management and development activities in DOORS
- SysML system architecture database to enable operational analysis, functional and constructional architecture modelling in Atego Artisan

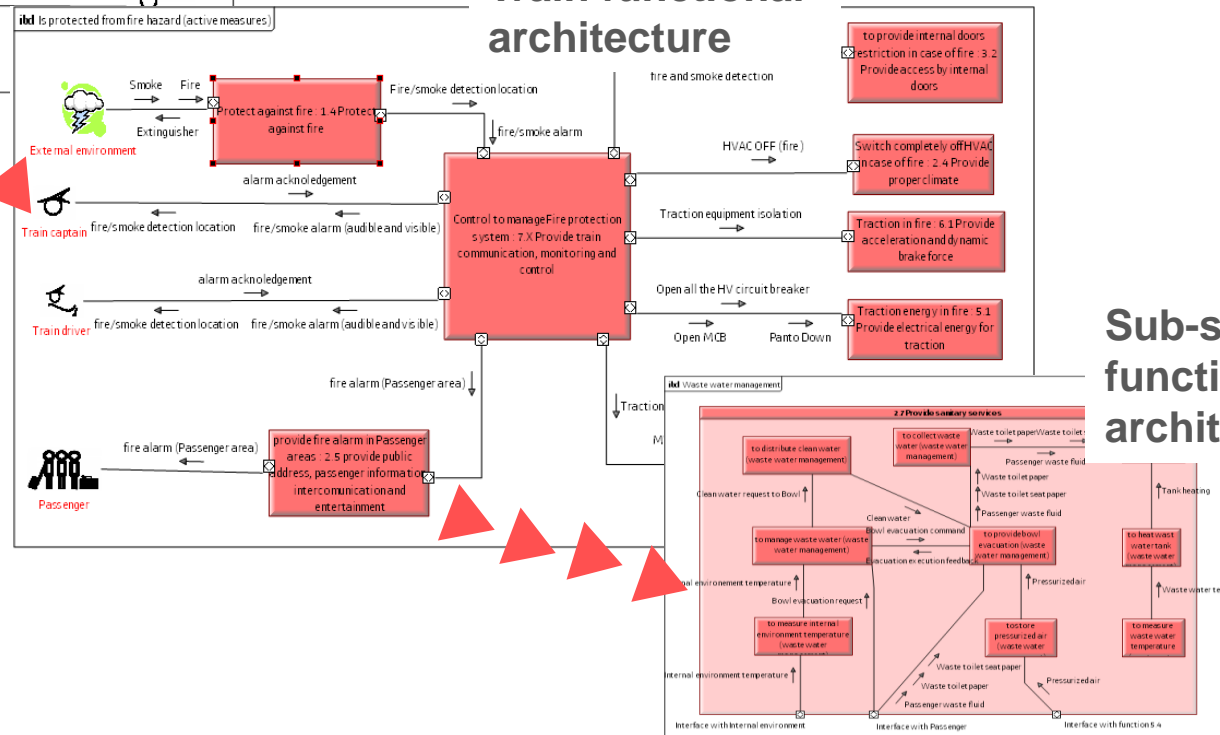


# SysML model:

## Train operational analysis



## Train functional architecture



## Sub-system functional architecture

# Gained benefits:

- **Improved design quality:**

- ✓ Rigorous traceability between requirements, their implementation into the systems architecture, Verification and Validation
- ✓ Enhanced design coherency and consistency (interfaces) between all the different subsystems
- ✓ Rigorous management of design change and system architecture configuration

- **Increased productivity:**

- ✓ Reuse of existing models to support design evolution
- ✓ Reduced errors and time during integration and V&V
- ✓ Enabled concurrent system architecture definition
- ✓ Documents generated automatically from the model

# Gained benefits:

- **Reduced development risk:**

- ✓ Rigorous traceability between requirements, their implementation into the systems architecture, Verification and Validation
- ✓ Accurate system development cost estimation
- ✓ Accurate system architecture impact analysis versus requirements/need change

- **Enhanced communications:**

- ✓ Shared understanding of the system analysis and architecture across tile development team and other stakeholders
- ✓ Ability to integrate views of the system from multiple perspectives

- **Enhanced knowledge transfer:**

- ✓ System architecture and choices justifications are captured in a standard format that can be easily accessed

# Deployment state:

## On **Rolling Stock** product lines:

- first pilot project involved 8-10 system engineers for 6 months (September 2011 – February 2012) where the scope was to prove the feasibility of the approach and to refine the process
- Today:
  - 15 projects are using the requirement management and development process with DOORS involving around 150 engineers
  - 4 major projects are already launched with the application of the full process (including SysML architecture modelling), involving around 40 MBSE system engineers.

## On **Information solution** product lines:

- first pilot project involved 5 system engineers for 1 year (September 2009) where the scope was to prove the feasibility of the approach and to refine the process
- Today several project (R&D and running projects) are launched with the application of the full process, involving almost 40 system engineers

# Trainings:

## **Advances System Architect Program - SysML modelling**

- Training program: how to act as system architect and learn basics of SysML, the modelling rules and best practices defined by Alstom Transport
- Trainees: around 250 trained people from 2009 up to today
- Trainers: 8 certified Alstom internal trainers

## **Requirement Management and Development**

- Training program: understanding of different process area and process task of the Alstom requirement management and development process, learn how to use the tools to implement the process on a project
- Trainees: 250 people from 2012
- Trainers: 4 certified Alstom internal trainers



# System engineering team feedback:

System Engineers which have worked following ASAP principles have perceived the **ADDED VALUE** and the **GLOBAL QUALITY IMPROVEMENT** improvement of their results.

Most of System Engineers trained with ASAP easily accepted the **System Approach** and the **SysML modelling** finding it as an **HIGH ADDED VALUE** way of working where the team working is boosted:

- all the architectural choices are discussed and agreed by the System Engineering team before to formalize them in the model, having a TSE (Train System Engineer) as responsible and “animator”
- Train and subsystem architecture definitions are done in parallel ensuring the consistency and the homogeneity
- Domains experts has injected their know-how in the model supported by the system engineers

# Key points for the new approach deployment:

The key points to deploy the approach is to **CLEARLY COMMUNICATE** and **MANAGE THE CHANGE!**

The following are key factors to be carefully considered in order to efficiently drive the change:

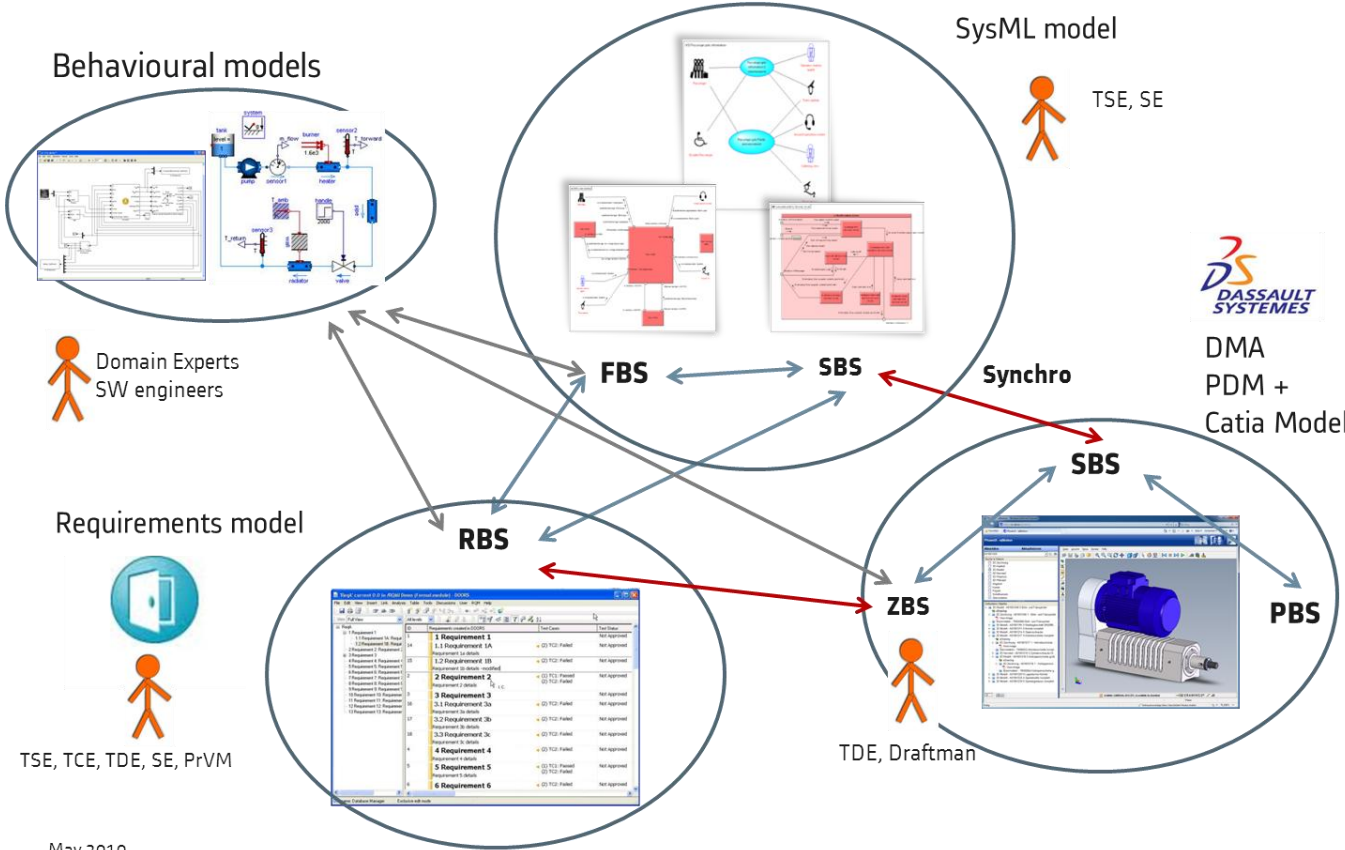
- Demonstrate the **feasibility** and the **benefits** of the new process with a real **full application** of the new methodology (pilot project)
- Provide a **well structured training**
- Provide a **strong support** during the deployment on site
- Management shall actively **support** the **change** of the way of working

## Next Steps:

- Develop, **improve** and **integrate** the whole **system engineering processes** and between the different tools:
  - Improve integration with the System Architecture definition process with the System Implementation process (detailed design process, e.g. software generation)
  - Develop integration of the System Architecture definition with the mechanical integration process (SysML model with digital mockup model)
  - Develop the integration with the FMECA process
  - Product to Project, Variants and Options modelling

# System Engineering integrated processes and tools::

Implementation of System Lifecycle Management to enable coherent and consistent system design through the different engineering disciplines and related tools



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