



CSD&m

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How to boost the extended enterprise approach in engineering using MBSE – a case study from the railway business

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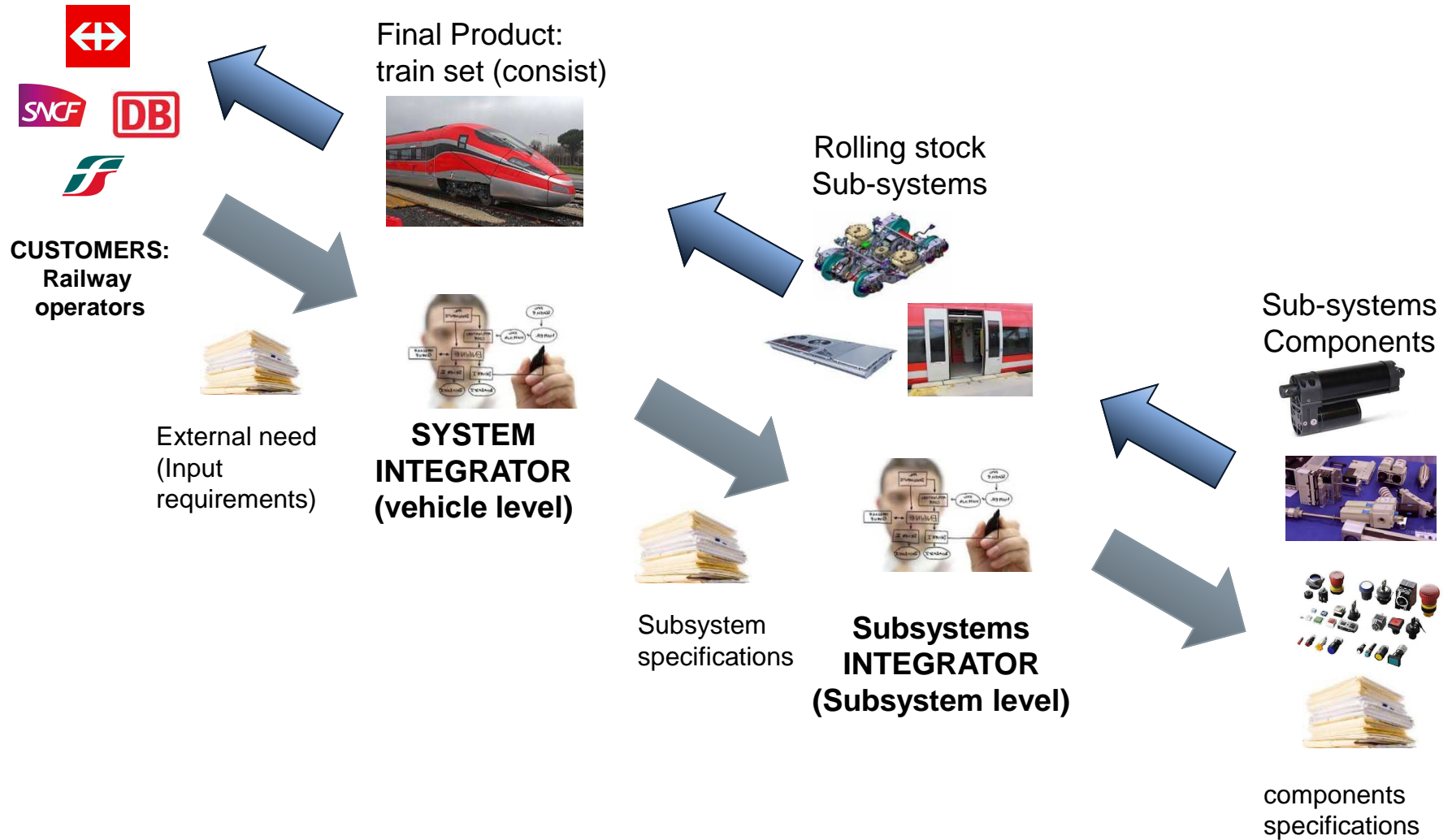
KNORR-BREMSE



BOMBARDIER
the evolution of mobility

Railway sector - business chain for rolling stocks systems

Role of system and subsystem integrators



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Product evolution – complexity growth

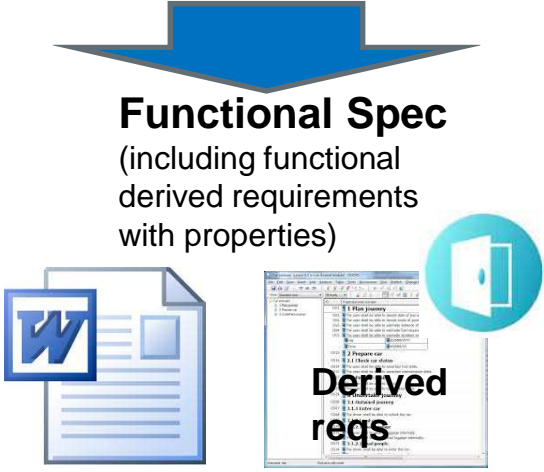
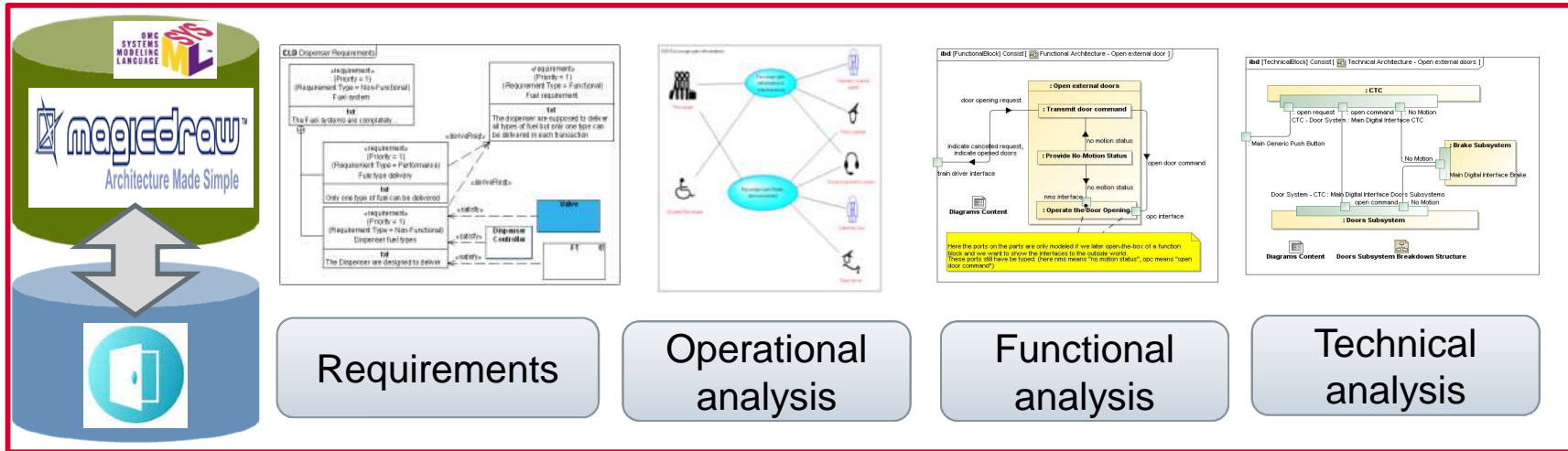
- **Technological complexity growth** by increased electronic and software driven system functionalities
 - Historically, railway vehicle were fully mechanical and once electronic appeared all the « non mechanical » functions to monitor and control the system were realized with wiring (relays logic)
 - Today the trend is to implement (when possible) more and more functionalities (also “safety relevant”) in software
- **Increase of required services** for improve passengers travel experience
 - public announcement, infotainment and multimedia, video surveillance, internet access
- **Increase of integration** with the system environment
 - The IoT revolution has huge impact on the train ‘as a connected thing”, more and more interactions with external systems require to implement new functionalities (e.g. drive from remote control center) with very high level of safety and security (cyber-security)
- **Increased performances**
 - lead to a more sophisticated and precise control of the subsystem.

Key values	Classic Trains	Today's Metros	Modern Trains
Boards with project-specific Application SW	~30	2 – 12	50 – 100
Internal signals between Brake Control units	~30	50 – 300	~15000
External signals from TCMS	~50	200 – 1000	~3500

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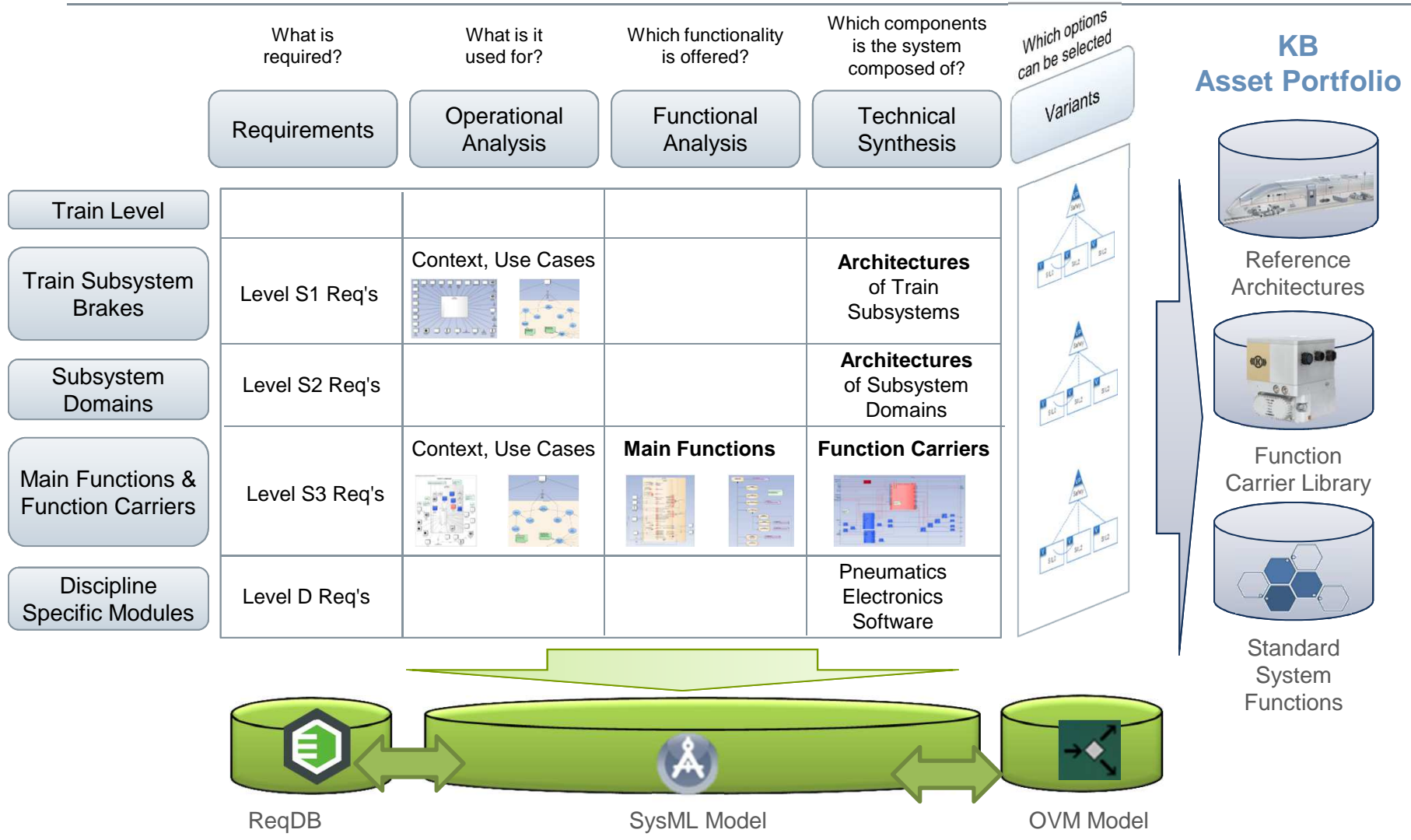


Functional architecture and MBSE @ Bombardier



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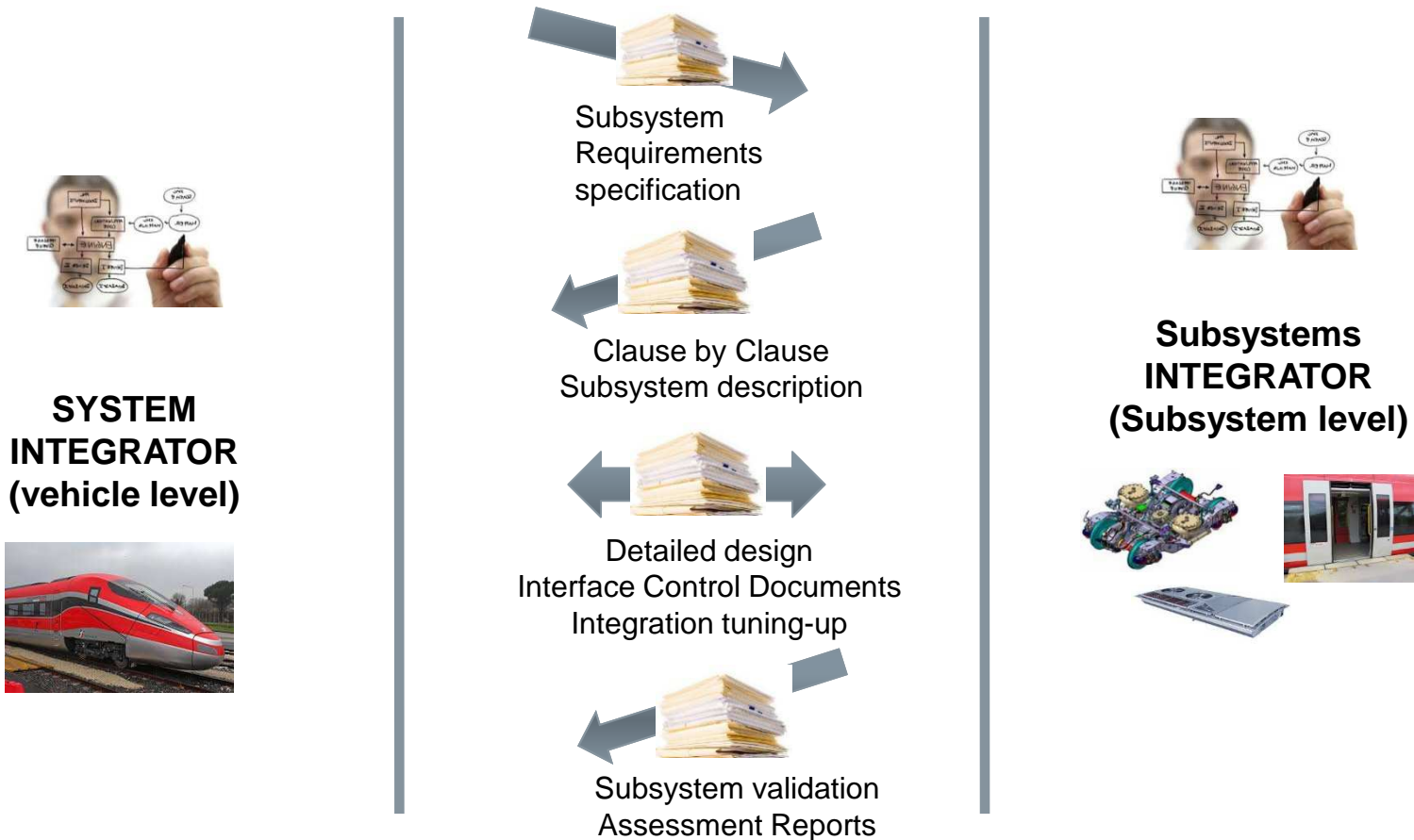
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Rolling stock integrator vs. Subsystem supplier a key and complex relationship

Traditional interface follow the classical V-cycle stages with many data exchanges between the two parties. Re-use of existing off-the-shelf existing solutions is difficult while this approach is mainly top-down oriented



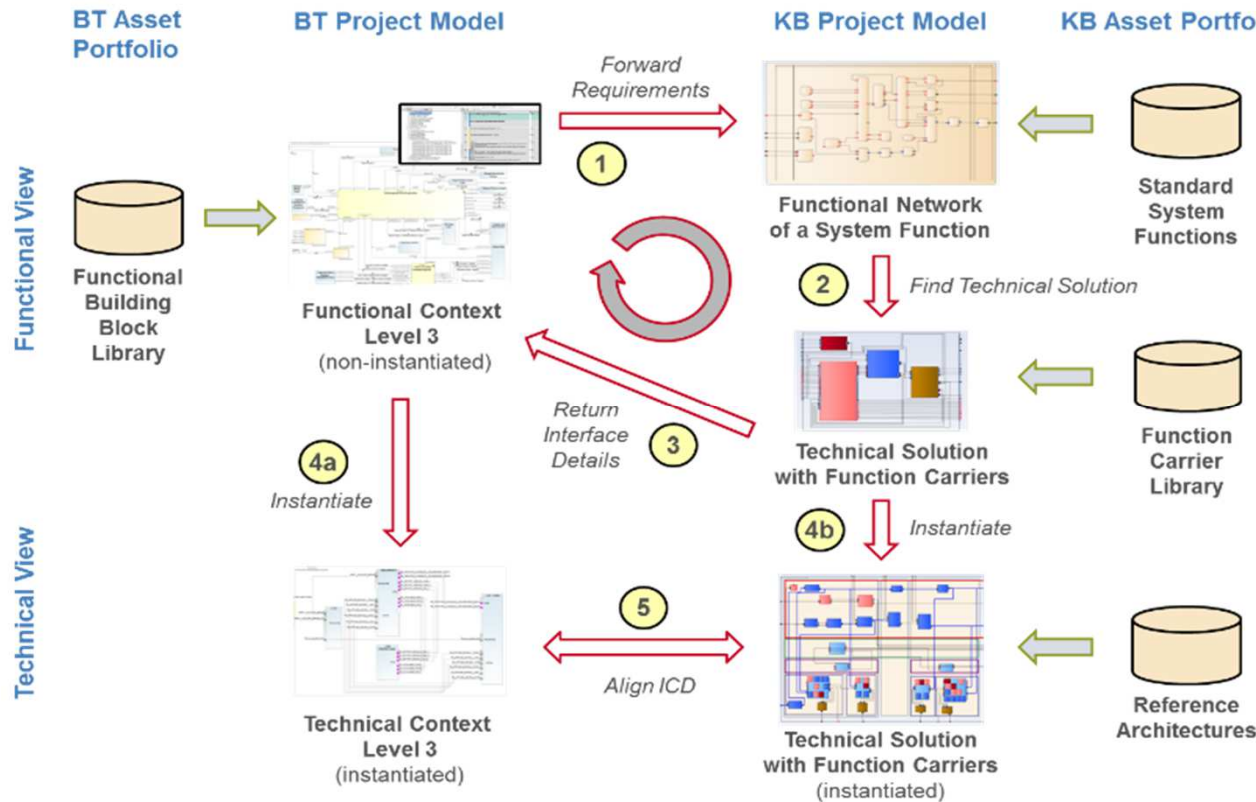
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The extended enterprise approach

- What is **Extended Enterprise**? is when a company goes **beyond its traditional perimeter** and may include its business partners, its suppliers, and its customers in it. For instance, when focusing suppliers, this might be translated into virtual integration, outsourcing, joint global R&D programs, partnership agreements and preferred supplier approach.
- To tackle the railway market evolution challenges:
 - product development life cycle duration dramatically reducing
 - the competition intensifying
 - the level of risk of not delivering on time increasing
- **smart organizations are considering to implement the extended enterprise approach.**
- According to Jan Duffy and Mary Tod, the authors of the article "The Extended Enterprise: Eliminating the Barriers", the extended enterprise can only be successful if all the component groups and individuals have the information they need to do business effectively.
- In the specific case of rolling stock integrator and subsystem supplier for what concern the functional architecture development, **MBSE can be a great booster to implement the extended enterprise approach efficiently.**

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The BT-KB MBSE Cycle



The Goals of the BT-KB MBSE Cycle are:

- Simplifying the definition of interfaces
- Generating interface control documents based on consistent models
- Traceability of functional requirements and design decisions across company borders
- Facilitating iterative refinement and change management
- Effect analysis across company borders
- For subsystems (e.g. Brakes, Doors, etc.): Using standardized products taken from a portfolio of standard system functions, function carriers and reference architectures
- For vehicle level: Integration of standardized subsystem products into standardized functional building blocks

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Conclusions

- Railway market evolution is requiring **improved collaboration and communication between vehicle integrators and subsystems providers** to share the end goal, the related risks and to remain competitive.
- The extended enterprise approach answers to that need, but it requires some enablers, while MBSE can definitively be the one for the functional content of the product.
- Unfortunately, the only available and widely adopted standards in the MBSE domain are the generic system modelling language SysML and generic modelling methodologies, for what concerns the railways sector, **no common industrial standards has been developed yet.**
- The lack of such standards requires companies that want to implement an MBSE approach (like Bombardier and Knorr-Bremse) to **develop by their own specific profiles of the SysML language and related modelling methodologies.** As major consequences it's very difficult to interlink models across companies,
- The case study presented here is an **exceptional lucky case** where the lack of those standards hasn't been impeding Bombardier and Knorr-Bremse to explore the feasibility of implementing a real MBSE based extended enterprise approach and to appreciate all the possible benefits of it.
- **Both companies strongly believe in MBSE** and in the potentialities to enable an efficient extended enterprise approach, and wish that a **modelling methodology open standard for the railway industry** will be developed providing a **common MBSE framework** across it.

Thank you for your attention!

Q&A

