REAL WORLD APPLICATION OF

MBSE AT BOMBARDIER TRANSPORTATION

Event: SWISSED 2015

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AGENDA

BOMBARDIER
Overview

Bombardier is the world's largest manufacturer of both planes and trains, with a worldwide workforce of **74,000*** people.

Bombardier is headquartered in Montréal, Canada. Our shares are traded on the Toronto Stock Exchange (BBD) and we are listed on the Dow Jones Sustainability World and North America indexes. In the fiscal year ended December 31, 2014, we posted revenues of **$20.1 billion USD.**

* As at December 31, 2014, including contractual and inactive employees

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Our evolution

1942-1973

- Company start-up
- Development of passenger and personal snowmobiles
- Vertical integration
- Energy crisis provoked market collapse

1974-1985

- Diversification into mass transit market
- Learning of new industry
- 1982 New York metro contract secured strong position in American market

1986-1993

- Entry into aerospace through Canadair acquisition
- Consolidation of North American mass transit position and reinforcement of presence in Europe

Strategic Acquisitions

- Aerospace: Short Brothers (UK), Learjet (US), de Havilland (CA)
- Transportation: BN (BE), ANF (FR), Deutsche Waggonbau (DE), Concarril (MX), Talbot (DE), Adtranz (DE)

1993-2003

- CRJ Series, Global Express, Challenger 300
- Tilting train, AGC (Autorail Grande Capacité)
- Sale of Recreational products business unit

2003-

- CRJ NextGen family, Learjet 85, Q400 NextGen, CSeries, Global 7000, Global 8000
- Hybrid AGC, ZEFIRO, ECO4
- Transportation's expansion into emerging markets

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System Engineering Challenges & Goals

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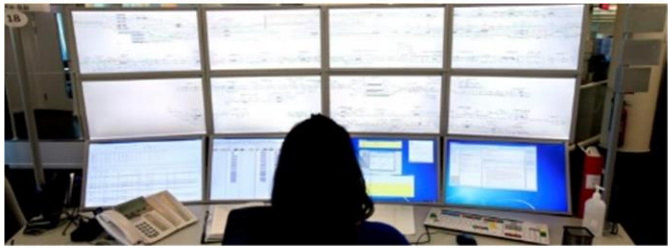
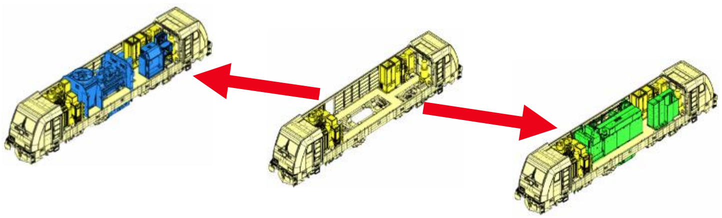
System Engineering Challenges & Goals
With respect to technology

Reduce development costs while increasing quality of the design artefacts.

Challenge	Goal	
Complex products	Manage complexity	
Distributed information sources	Share centralized information	
Opportunistic, isolated reuse (copy past)	Managed, integrated reuse of development artifacts	

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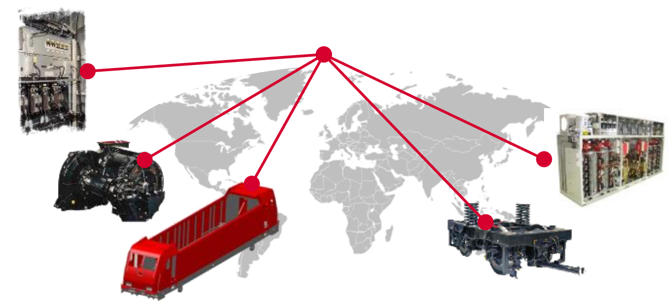
System Engineering Challenges & Goals
With respect to people

Reduce development costs while increasing quality of the design artefacts.

Challenge	Goal
Distributed development	Enable collaboration
Multicultural teams	Improve correct understanding



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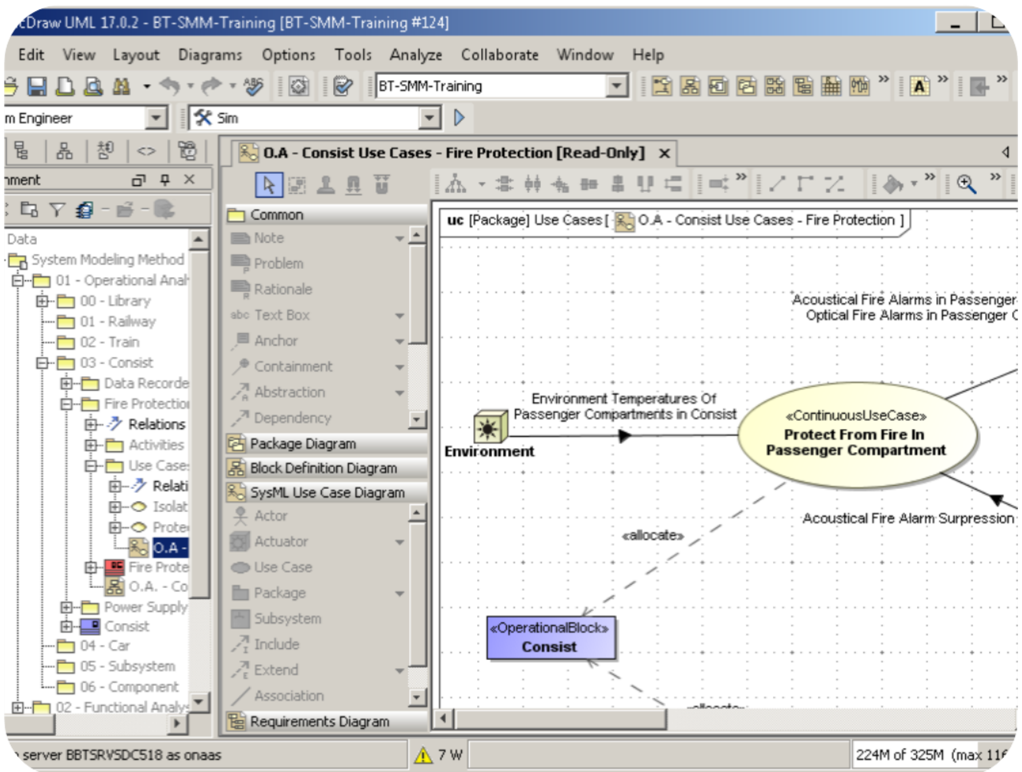

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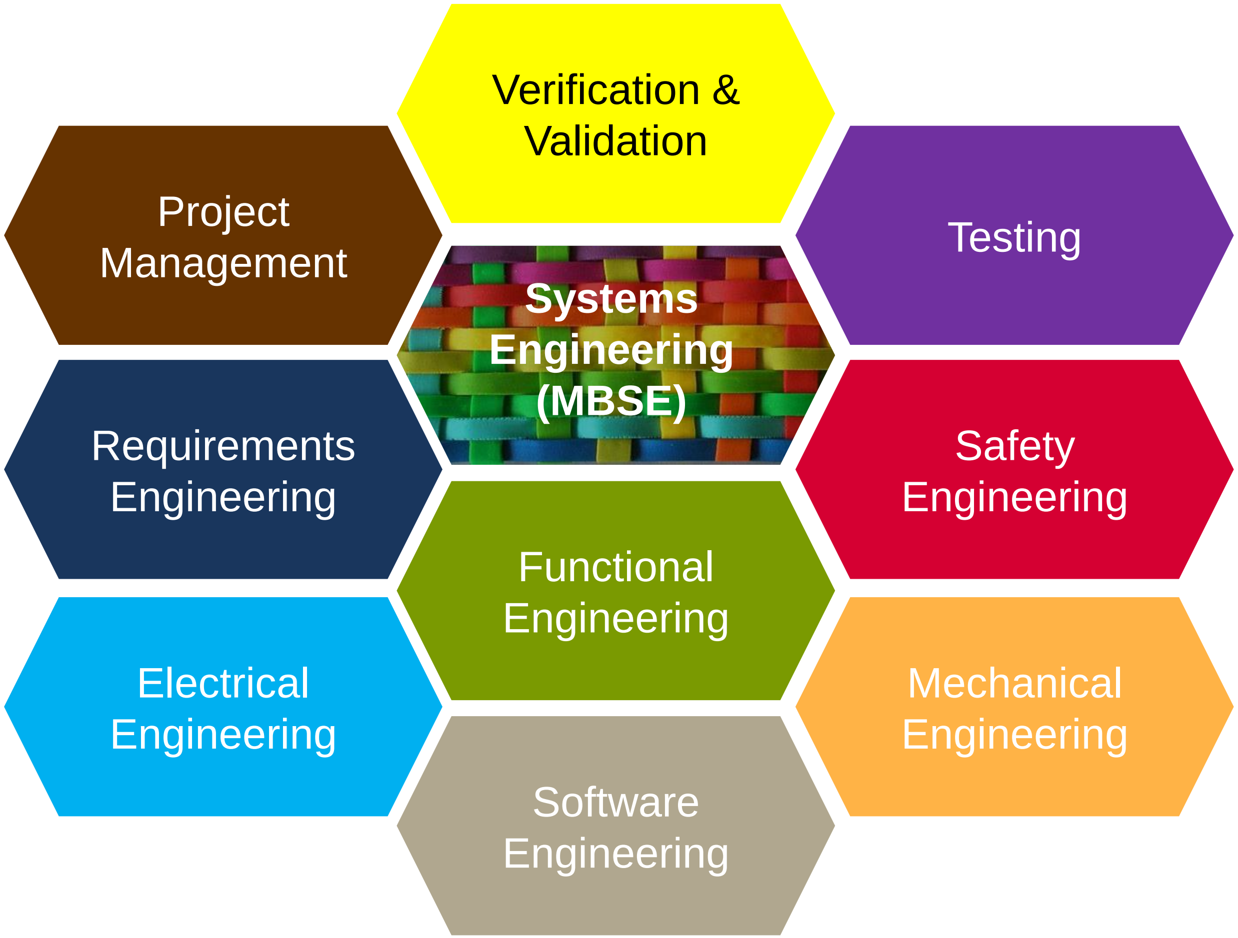
Engineering Domains



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BT System Modeling Method at a glance

The BT System Modeling Method describes **how** BT engineers shall analyze, define and represent their system of interest using a Model-Based Systems Engineering approach. The purpose of the method is to manage complexity and increase quality of the design artefacts to reduce development costs.

The BT System Modeling Method consists of three main tasks. Each of them to analyze the system of interest on a different abstraction level.

Operational Analysis

OA - main deliverables

1. Context & scope
2. Interactions between SOI[1] and actors
3. SOI use cases including their detailed behavior

Functional Analysis

FA - main deliverables

1. Functional architecture
2. System of interest decomposition
3. Allocation of Functional Blocks to the SOI's parts

Technical Analysis

TA - main deliverables

1. Technical breakdown structure
2. Technical architecture
3. Allocation of functional blocks to technical blocks

[1] SOI is the system of interest

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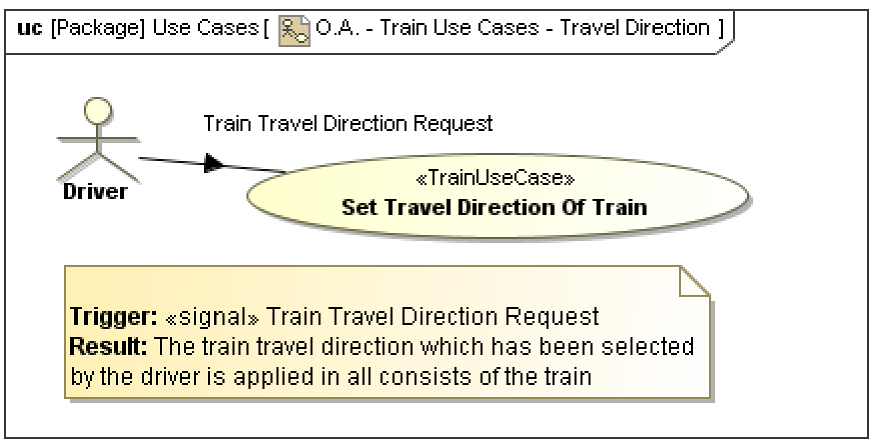
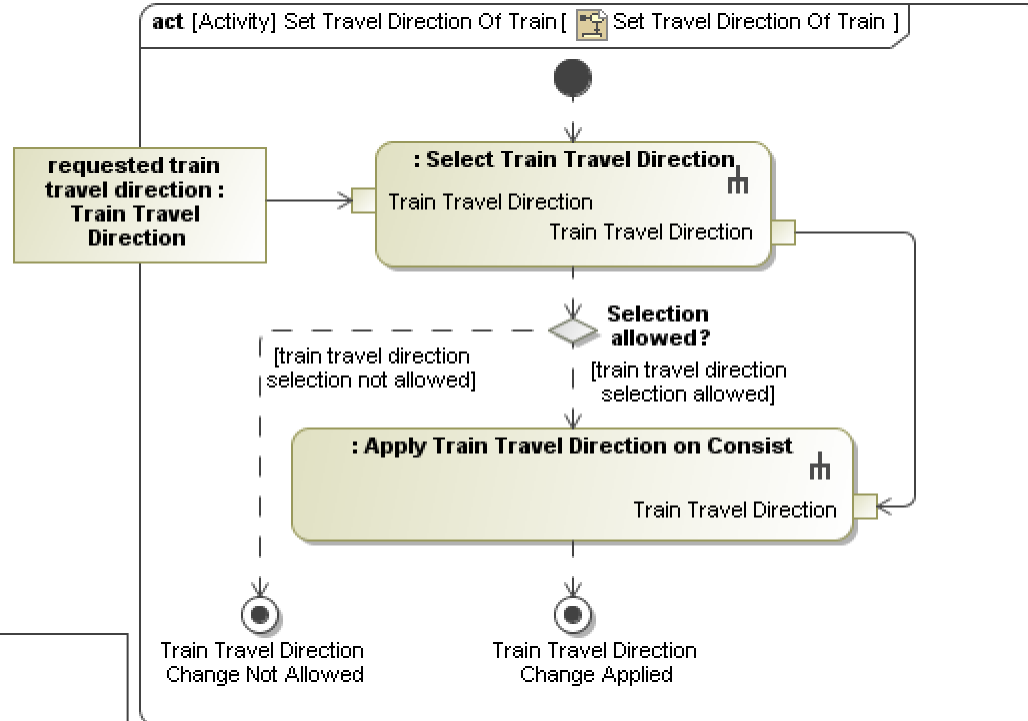
BT System Modeling Method – Operational Analysis Example

Operational Analysis | Functional Analysis | Technical Analysis

Definition of:

- Use cases
- Associated actors
- Use cases detailed behavior with their activities





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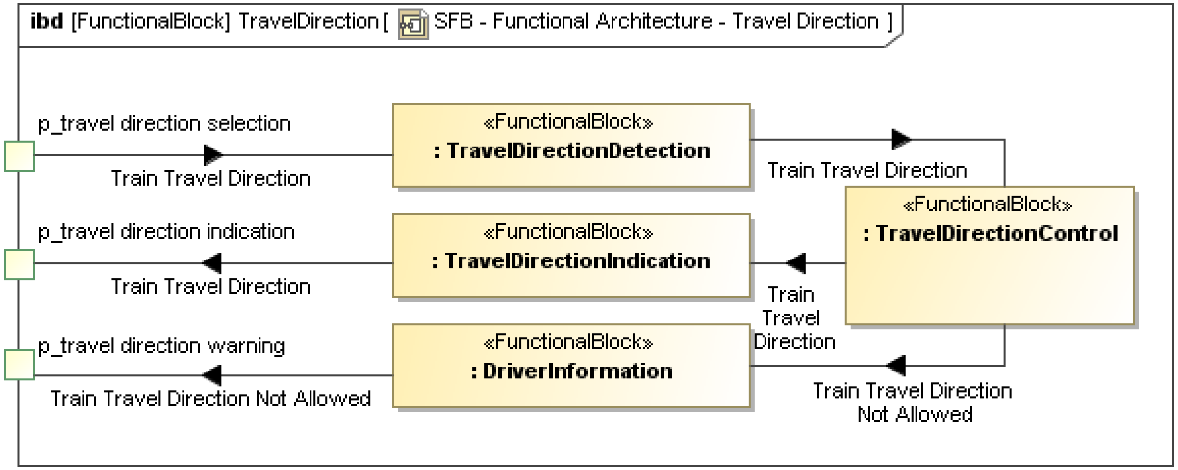
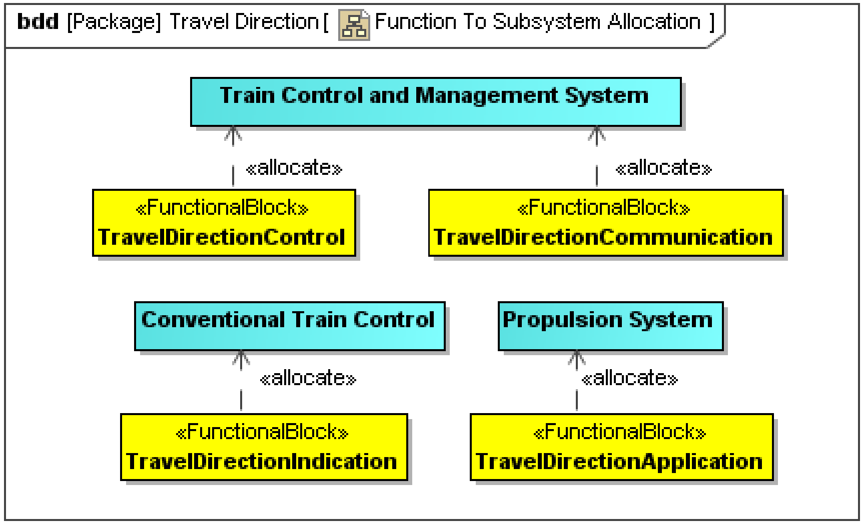
BT System Modeling Method– Functional Analysis Example

Operational Analysis | **Functional Analysis** | Technical Analysis

Definition of:

- Functional Blocks
- Functional Block behavior
- Interfaces between Functional Blocks
- Allocation of Functional Blocks to the subsystems





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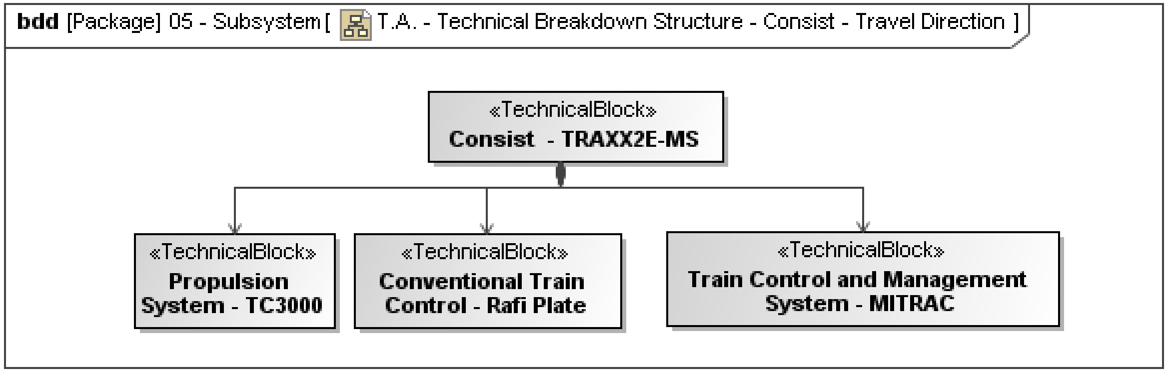
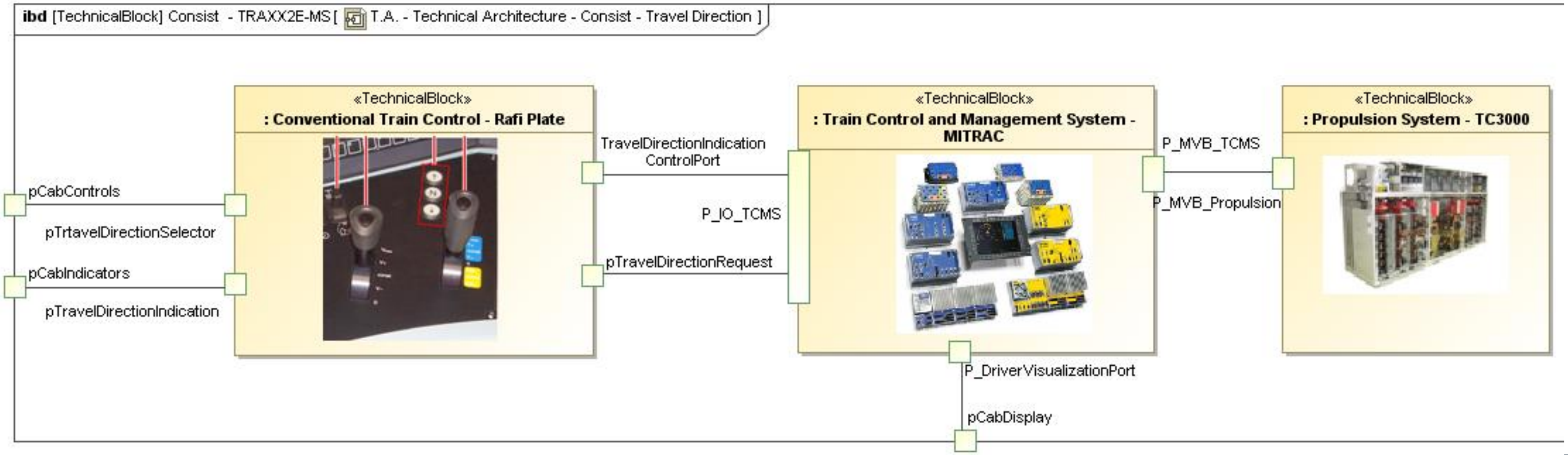
BT System Modeling Method – Technical Analysis Example

Operational Analysis | Functional Analysis | **Technical Analysis**



Definition of:

- Technical Blocks
- Technical Blocks breakdown
- Technical Blocks interfaces



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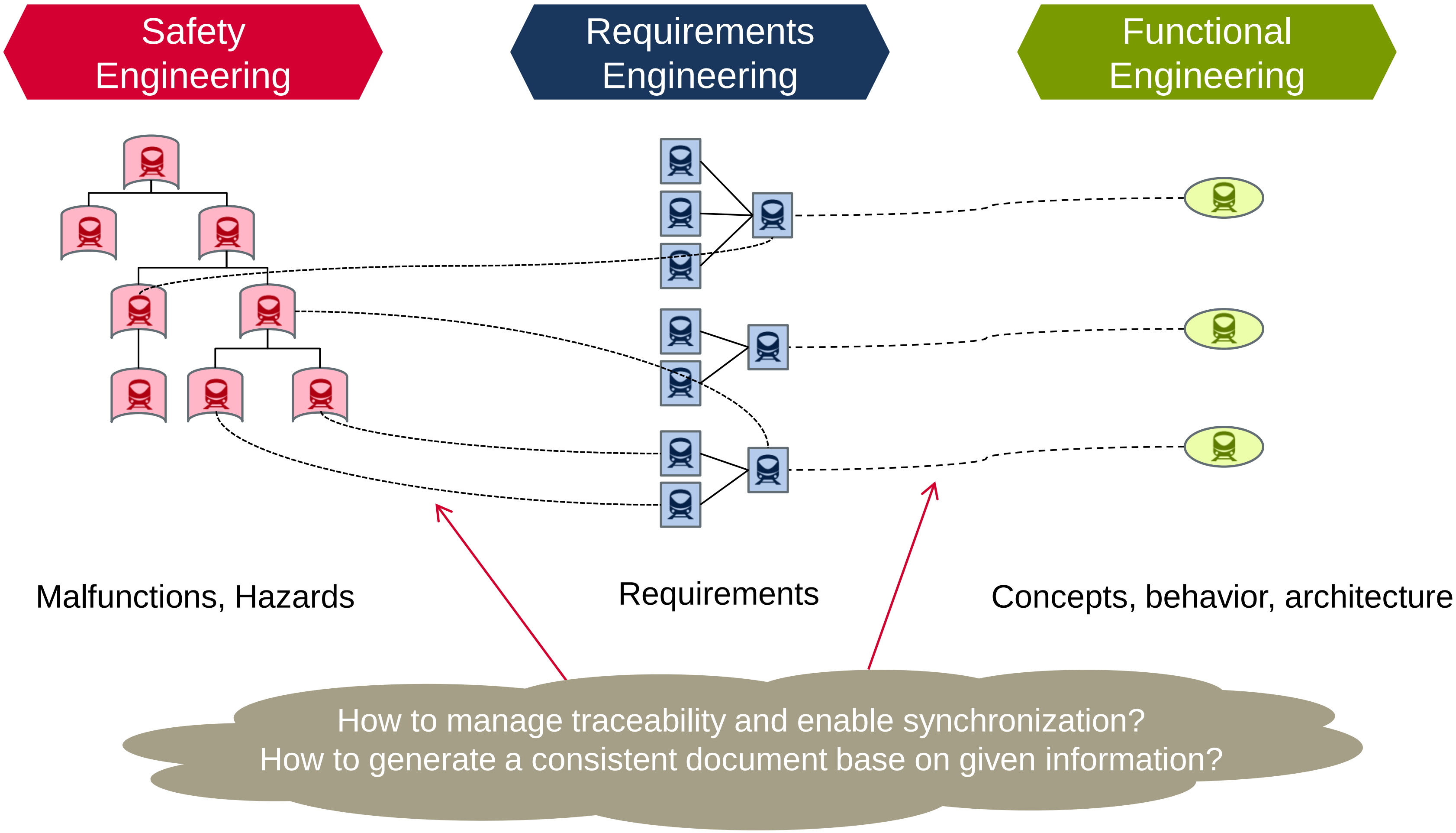
Integrated Engineering Approach



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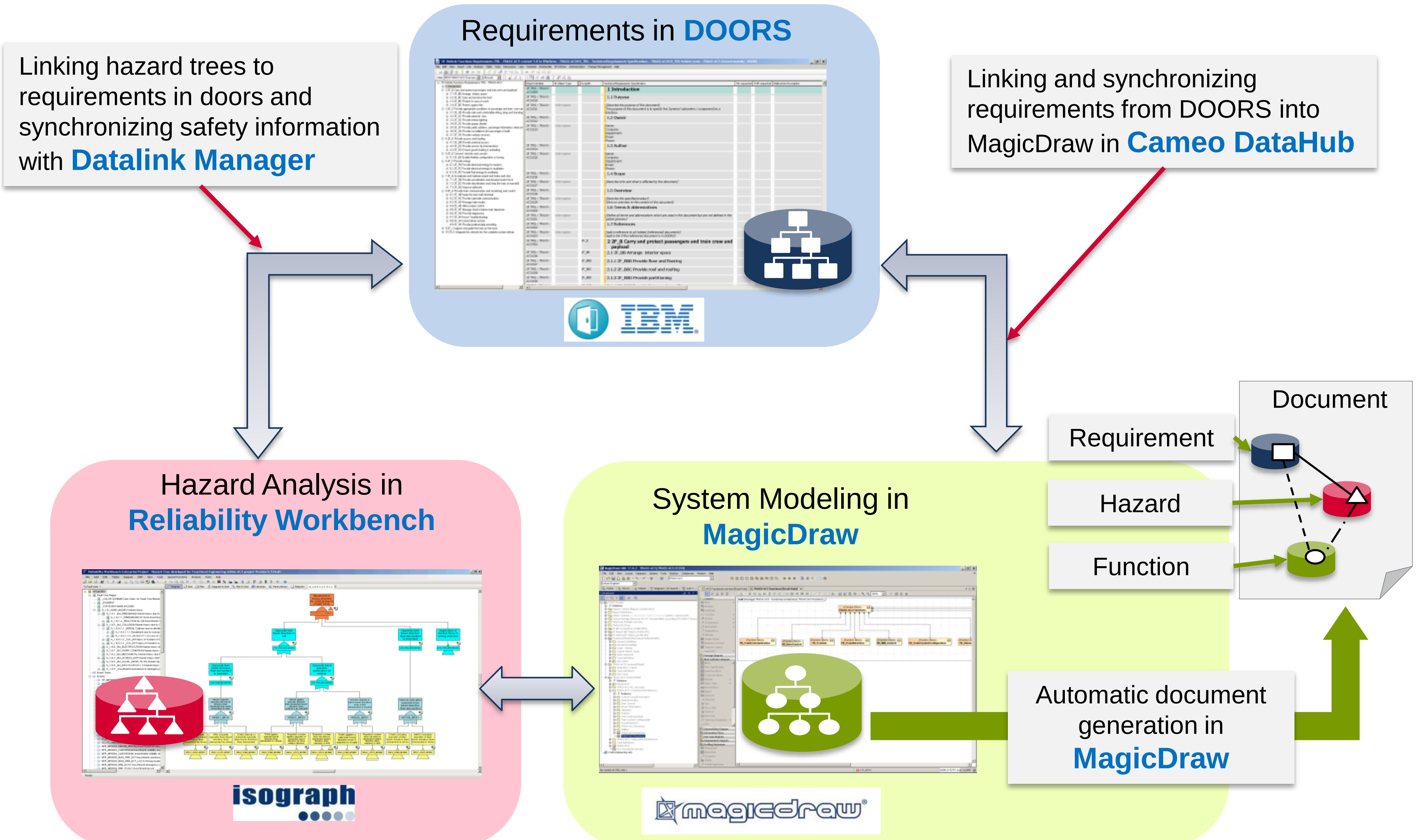
Integrated Tool Chain



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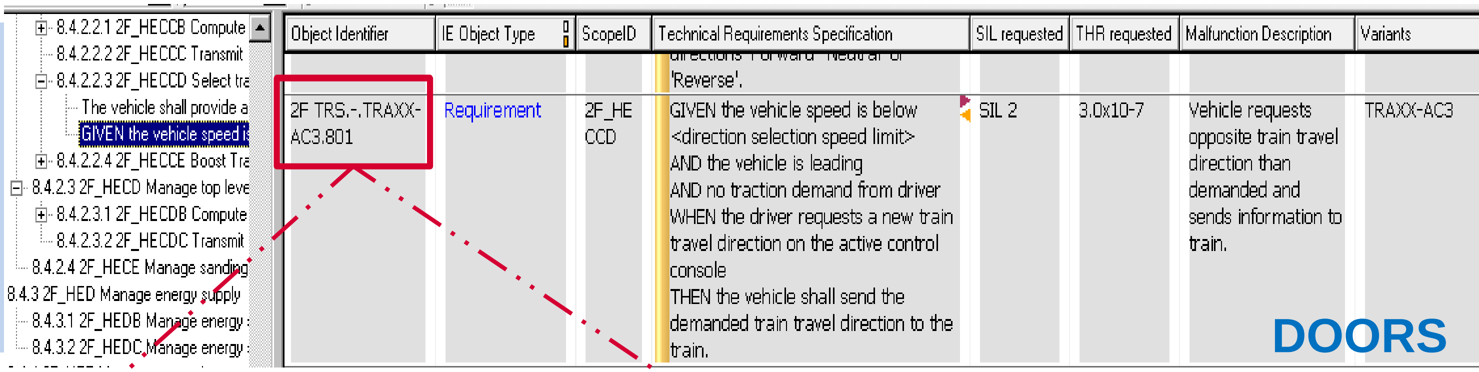
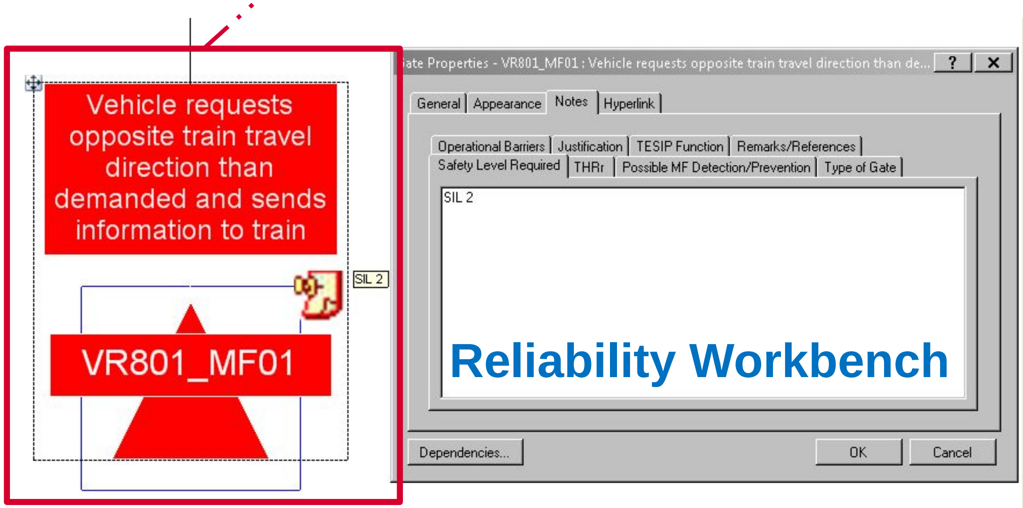
MBSE is an integrated approach – Example

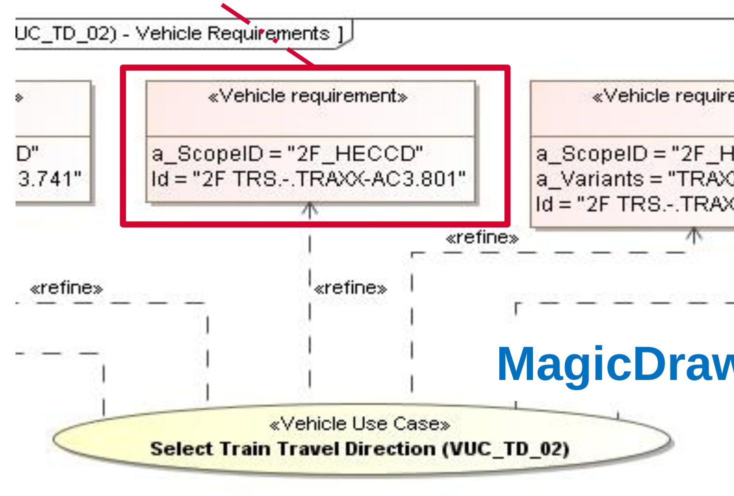
Definition of requirement in DOORS (visualized safety attributes)



Definition of safety attributes in Reliability Workbench based on requirement

Synchronized requirement in MagicDraw linked to use case





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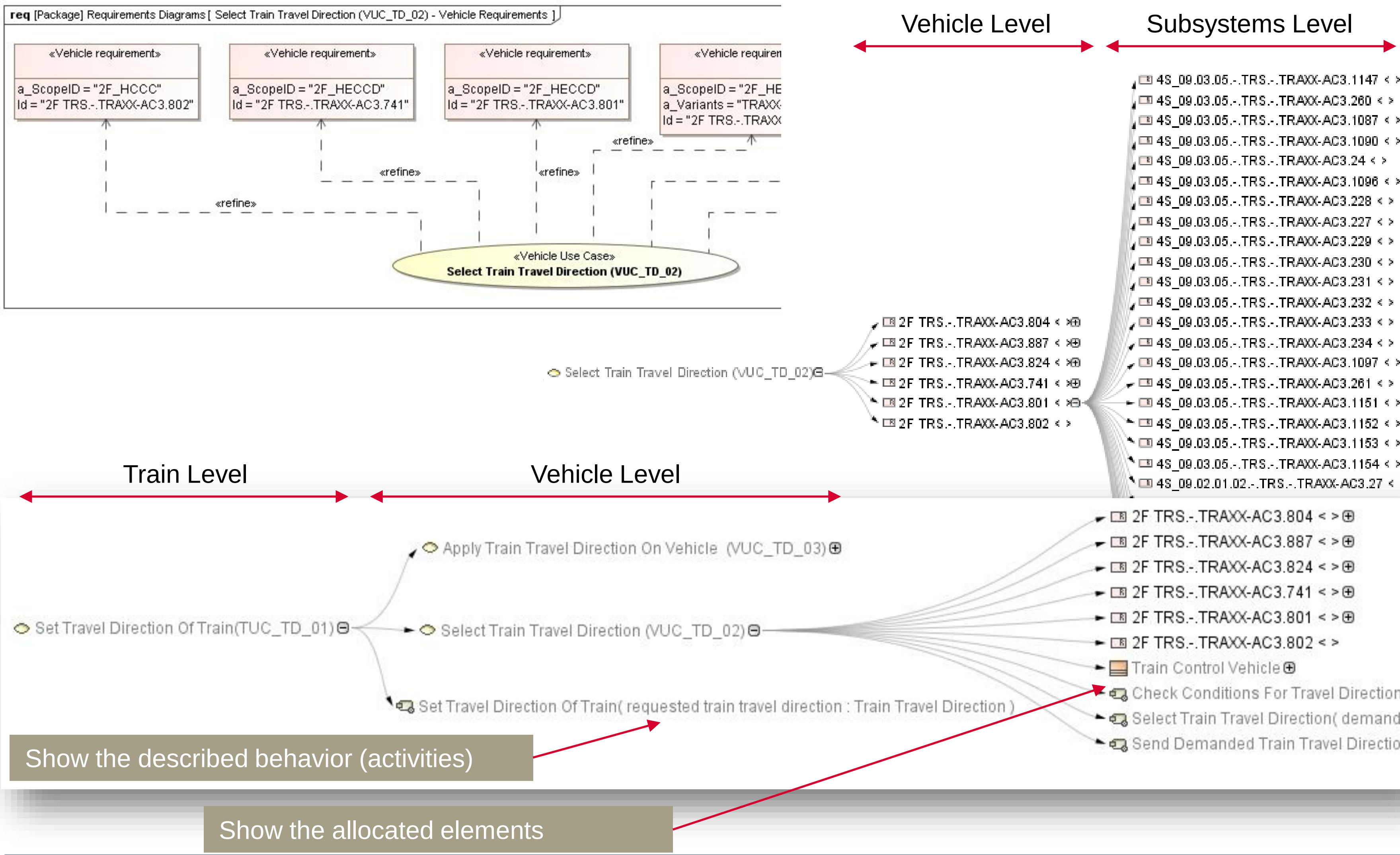
Change Analysis on Different System Hierarchy Levels



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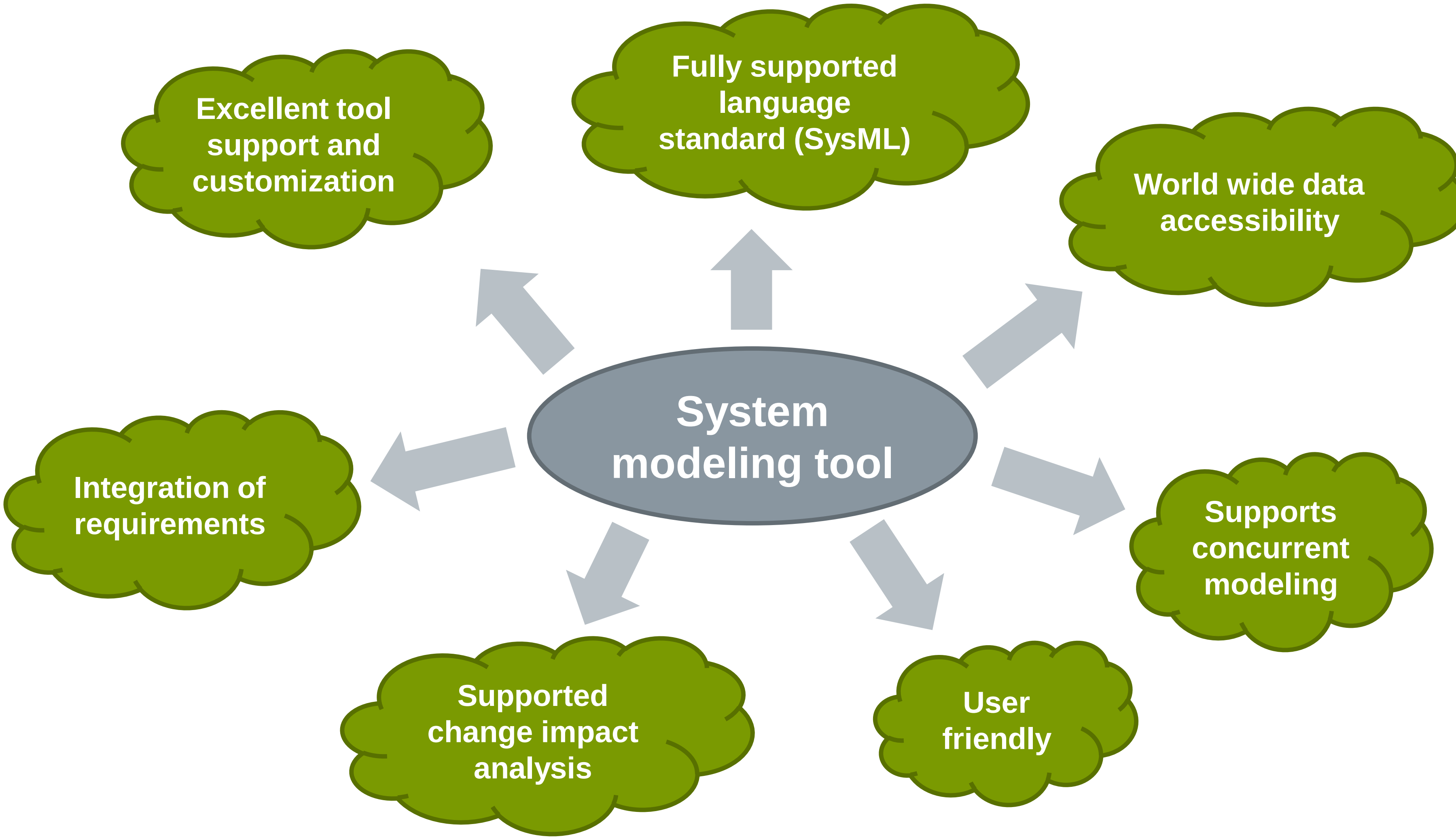
System Modeling Tool Criteria



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MBSE Lessons Learned

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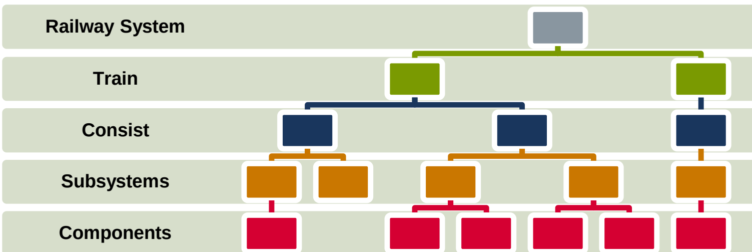
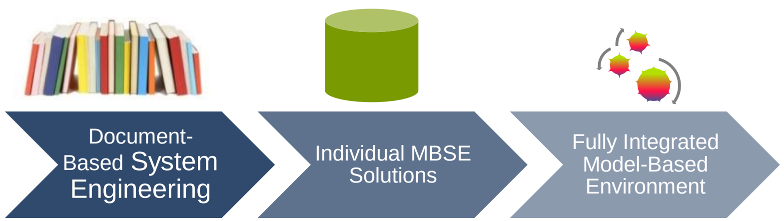
MBSE Lessons Learned





Provide practice oriented methods

Think big but start small

Provide suitable tools to do the job

Provide trainings, coaching and guidelines

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Looking Forward

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Looking Forward
BT MBSE Targets

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Q&A

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