

Steering future Engineering Processes with System Lifecycle Management

Patrick Schäfer | thyssenkrupp Steering

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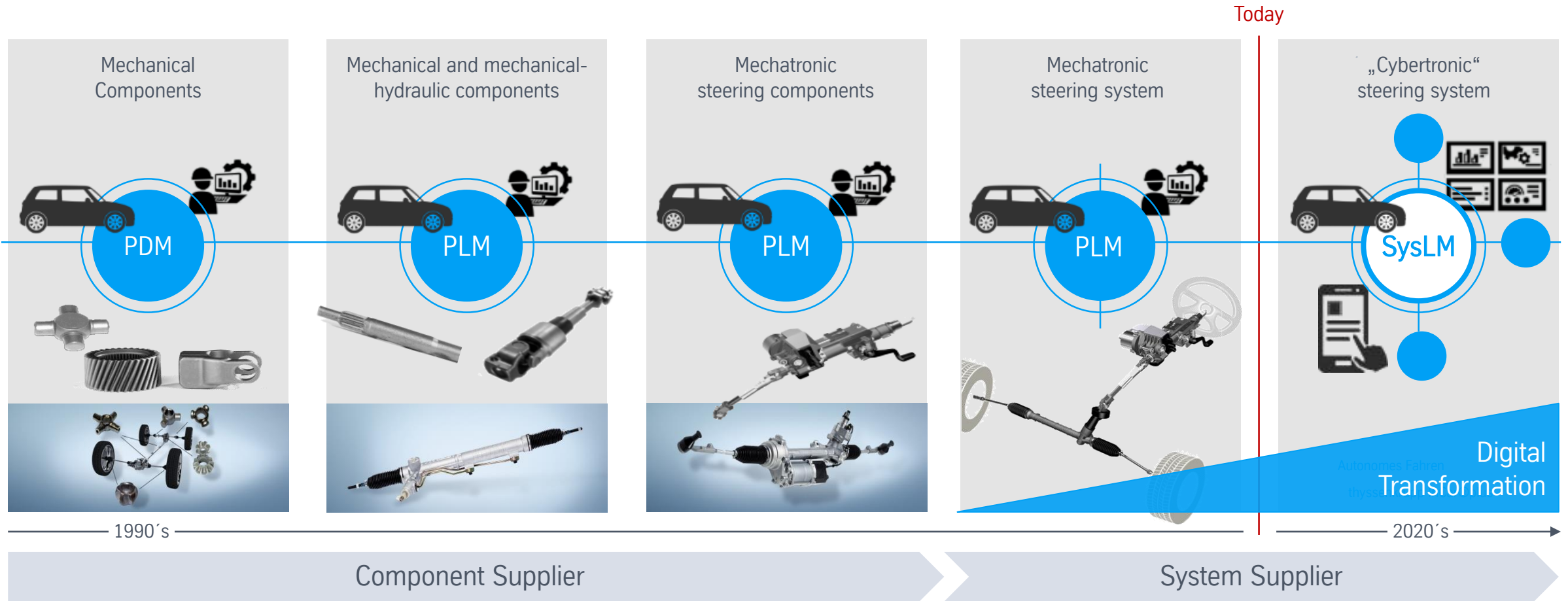
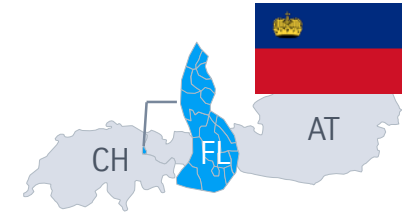


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From PLM to SysLM



Digital Transformation
Autonomes Fahren
thysen

WE can't design tomorrow's products with yesterday's engineering methods, processes and technology.

Source: SysLM Project @ thyssenkrupp Steering (2022) Based on: Eigner (2021) System Lifecycle Management

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 Digital Transformation

SysLM Project @ thyssenkrupp Steering

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Digital Transformation Roadmap

MAIN CHALLENGES

Digitized Enterprise & Business Model
Autonomous Driving, Steer-by-Wire

DIGITAL TRANSFORMATION

From Component Supplier to System Provider
Time-to-Market, Complexity

PROGRAM OBJECTIVES

Engineering Backbone
Modernization of Engineering IT Environment

DIGITIZED ENGINEERING

Closed-Loop Engineering Processes
Modularization and Standardization



Efficiency, Flexibility, Traceability
in Requirement Management,
System Architecture, MultiCAD Data Management,
Engineering and Manufacturing BoM Handling

thyssenkrupp steering strives for integrated engineering processes with an end-to-end view of product-related information.

Source: SysLM Project @ thyssenkrupp Steering (2022)

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System Lifecycle Management

Engineering IT Perspective

Current Engineering IT Architecture

PDM

- Limited functionality and process support
- Redundant data handling and heterogeneous tool landscape
- Document centric approach based on mechanical engineering

Past Engineering



Future Engineering IT Architecture

SysLM

- Advanced out-of-the-box functionality
- Efficient process support and consistent traceability
- Product information is managed in system models

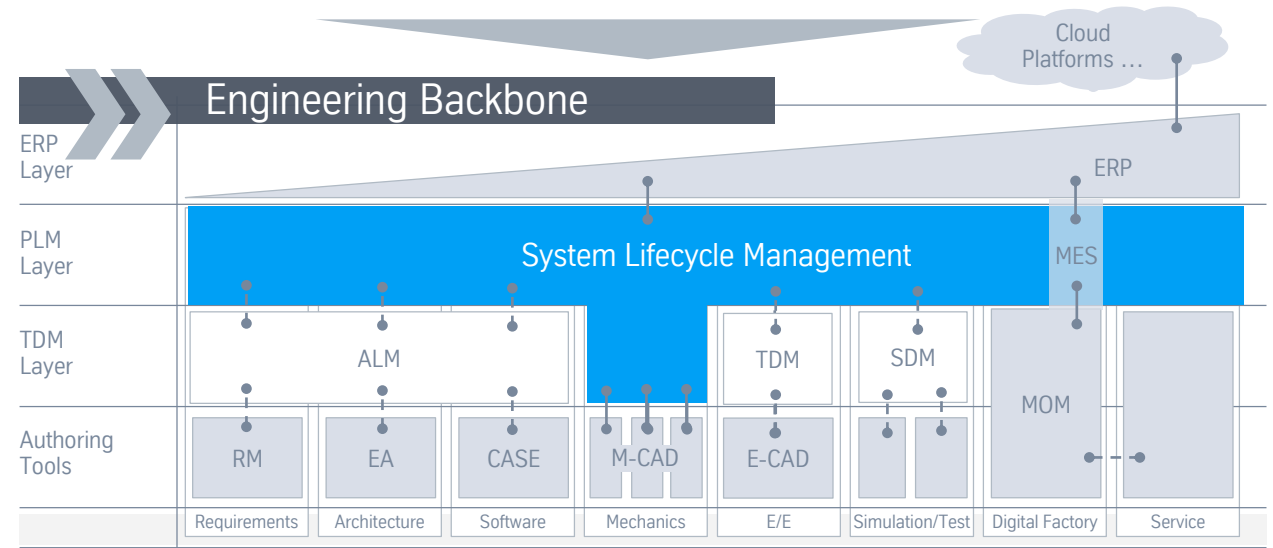
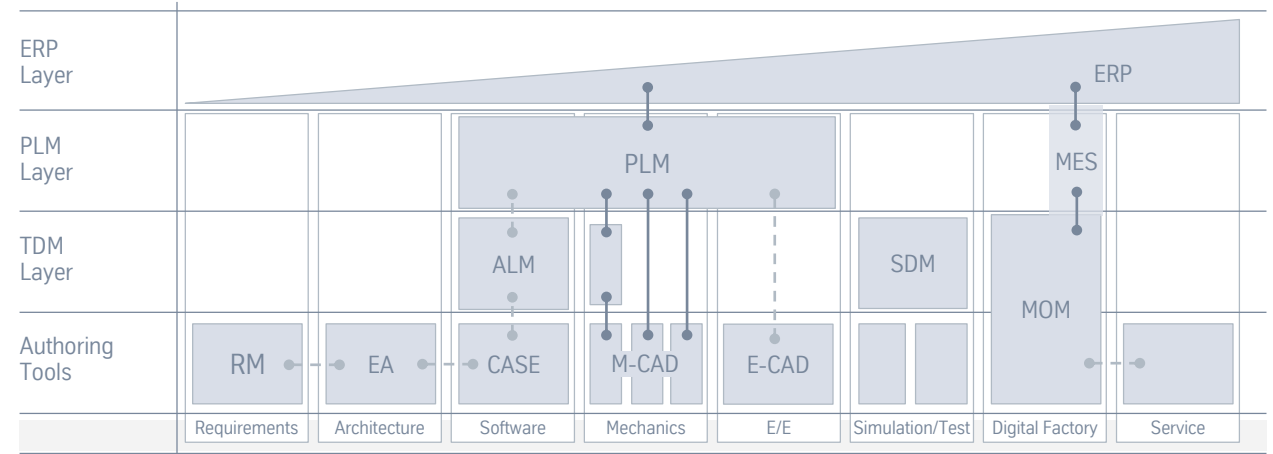
Future Engineering



Source: SysLM Project @ thyssenkrupp Steering (2022)

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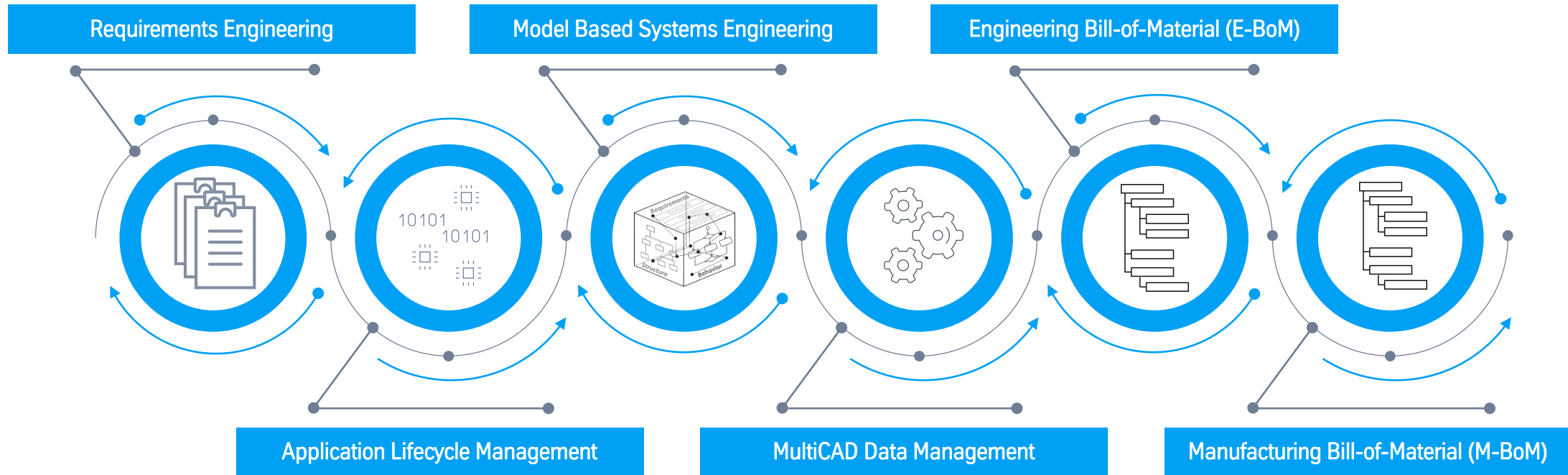
In Anlehnung an: Eigner (2021) System Lifecycle Management



System Lifecycle Management

End-to-End Engineering Process View

Providing standardized Data Exchange and Information access along the Product Lifecycle to enable a Digitized Engineering:



Modernization of PLM environment towards System Lifecycle Management with connected and closed-loop Engineering

Source: SysLM Project @ thyssenkrupp Steering (2022)

PLM = Product Lifecycle Management CAD = Computer Aided Design BoM = Bill-of-Material

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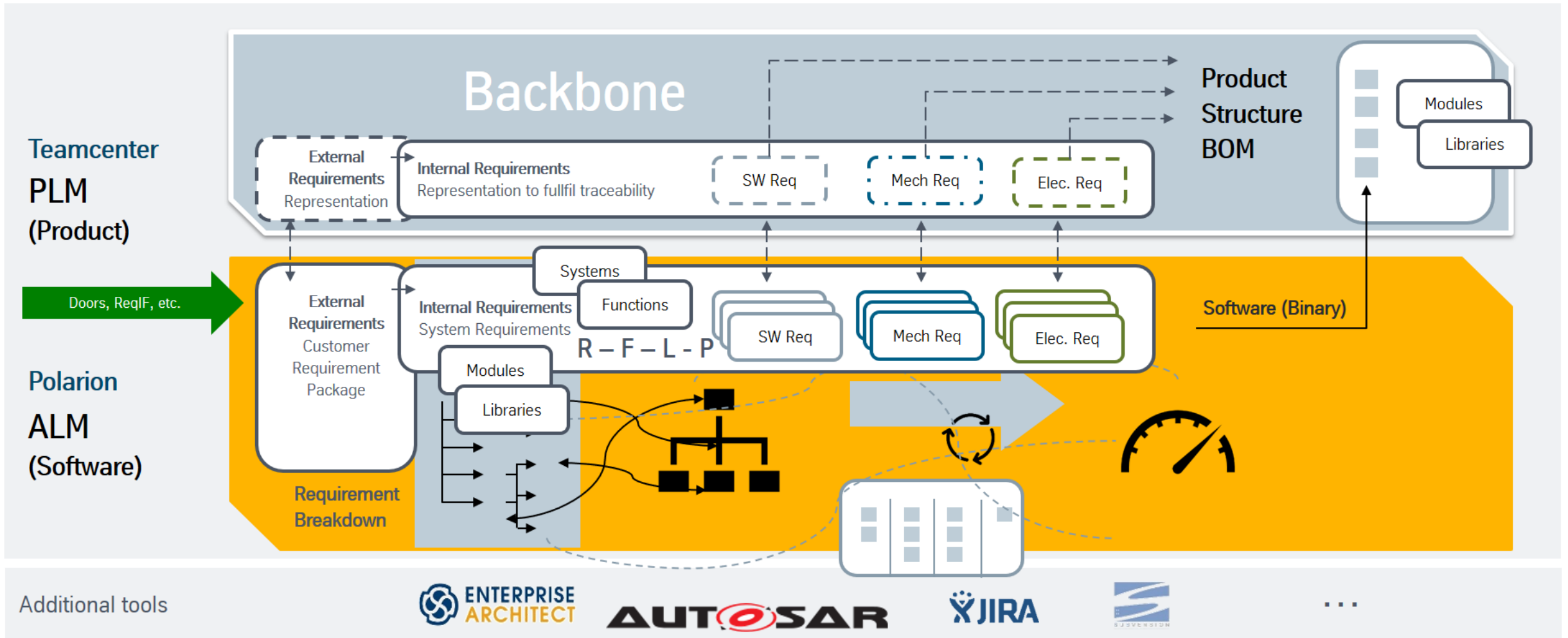
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End-to-End
- Requirements Engineering-

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Requirements Engineering – Overall Project Approach

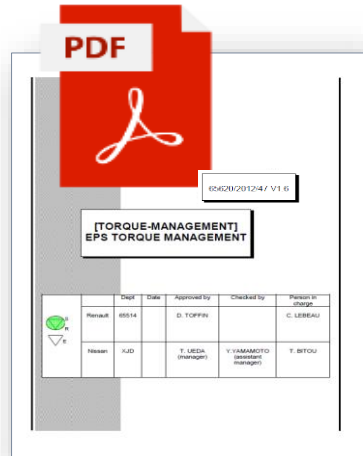


Source: SysLM Project @ thyssenkrupp Steering (2022)



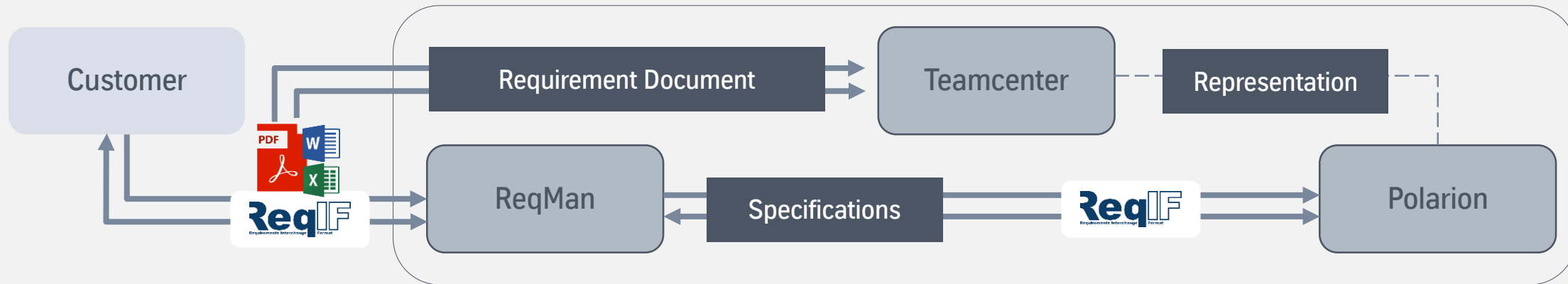
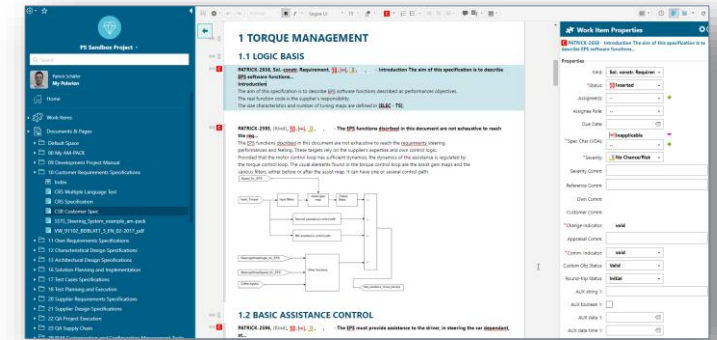
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Requirements Engineering – End-to-End Process Perspective



Example: «Line-by-line» import of a customer requirement specification into Polarion

ReqIF = Requirements Interchange Format is an XML file format that can be used to exchange requirements, along with its associated metadata, between software tools from different vendors.



Source: SysLM Project @ thyssenkrupp Steering (2022)



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Requirements Engineering – Breakdown Requirement Documents

“Increase efficiency and quality throughout the bidding process”

Customer



4/4 Ergebnisansicht: FUNC_EPS_TORQUE_MANAGEMENT - v1.6.pdf v0

FUNC_EPS_TORQUE_MANAGEMENT - v1.6.pdf

RENAULT – EPS torque management

Introduction
The aim of this specification is to describe EPS software functions described as performances objectives. The real function code is the supplier's responsibility. The size characteristics and number of tuning maps are defined in [ELEC-TS].

TORQUE MANAGEMENT

LOGIC BASIS
The EPS functions described in this document are not exhaustive to reach the requirements steering performances and feeling. These targets rely on the supplier's expertise and own control logic. Provided that the motor control loop has sufficient dynamics, the dynamics of the assistance is regulated by the torque control loop. The usual elements found in the torque control loop are the assist gain maps and the various filters, either before or after the assist map. It can have one or several control path.

BASIC ASSISTANCE CONTROL
The EPS must provide assistance to the driver, in steering the car dependant, at least on the driver torque and vehicle speed (example: boost curves) (Speed_for_EPS and Input_Torque as described in the [FUNC] specification).
EPS shall have minimum 8 maps tuned in different vehicle speed.
EPS starts to provide assistance torque, with Torque Dead zone : less than 0.1Nm
When driver input torque is zero, EPS keeps "assistance is zero" (ECU tolerance + Torque sensor tolerance < 0.1Nm).
"Nth assistance control path" shall integer a derivative action (steering wheel

#	Kapitel	Kundenkapitel	Kunden ID	Type	Text - de DE	Flexibility
1				Information	Introduction The aim of this specification is to describe EPS software functions described as performances objectives. The real function code is the supplier's responsibility. The size characteristics and number of tuning maps are defined in [ELEC-TS].	
2	1	1		Heading	TORQUE MANAGEMENT	
3	1.1	1.1		Heading	LOGIC BASIS The EPS functions described in this document are not exhaustive to reach the requirements steering performances and feeling. These targets rely on the supplier's expertise and own control logic. Provided that the motor control loop has sufficient dynamics, the dynamics of the assistance is regulated by the torque control loop. The usual elements found in the torque control loop are the assist gain maps and the various filters, either before or after the assist map. It can have one or several control path.	
4	1.1			Requirement	Provided that the motor control loop has sufficient dynamics, the dynamics of the assistance is regulated by the torque control loop. The usual elements found in the torque control loop are the assist gain maps and the various filters, either before or after the assist map. It can have one or several control path.	
5	1.2	1.2		Heading	BASIC ASSISTANCE CONTROL	
6	1.2		[EPS-ASSIST-10]	Requirement	The EPS must provide assistance to the driver, in steering the car dependant, at least on the driver torque and vehicle speed (example: boost curves) (Speed_for_EPS and Input_Torque as described in the [FUNC] specification).	0
7	1.2		[EPS-ASSIST-11]	Requirement	EPS shall have minimum 8 maps tuned in different vehicle speed.	0
8	1.2		[EPS-ASSIST-20]	Requirement	EPS starts to provide assistance torque, with Torque Dead zone : less than 0.1Nm When driver input torque is zero, EPS keeps "assistance is zero" (ECU tolerance + Torque sensor tolerance < 0.1Nm).	0
9	1.2		[EPS-ASSIST-30]	Requirement	"Nth assistance control path" shall integer a derivative action (steering wheel	1

Einträge 1 - 72 von 72

Requirements Authoring Tool



Import and breakdown the customer requirements document

Evaluation of customer requirement documents and specifications also with re-imports and comparison

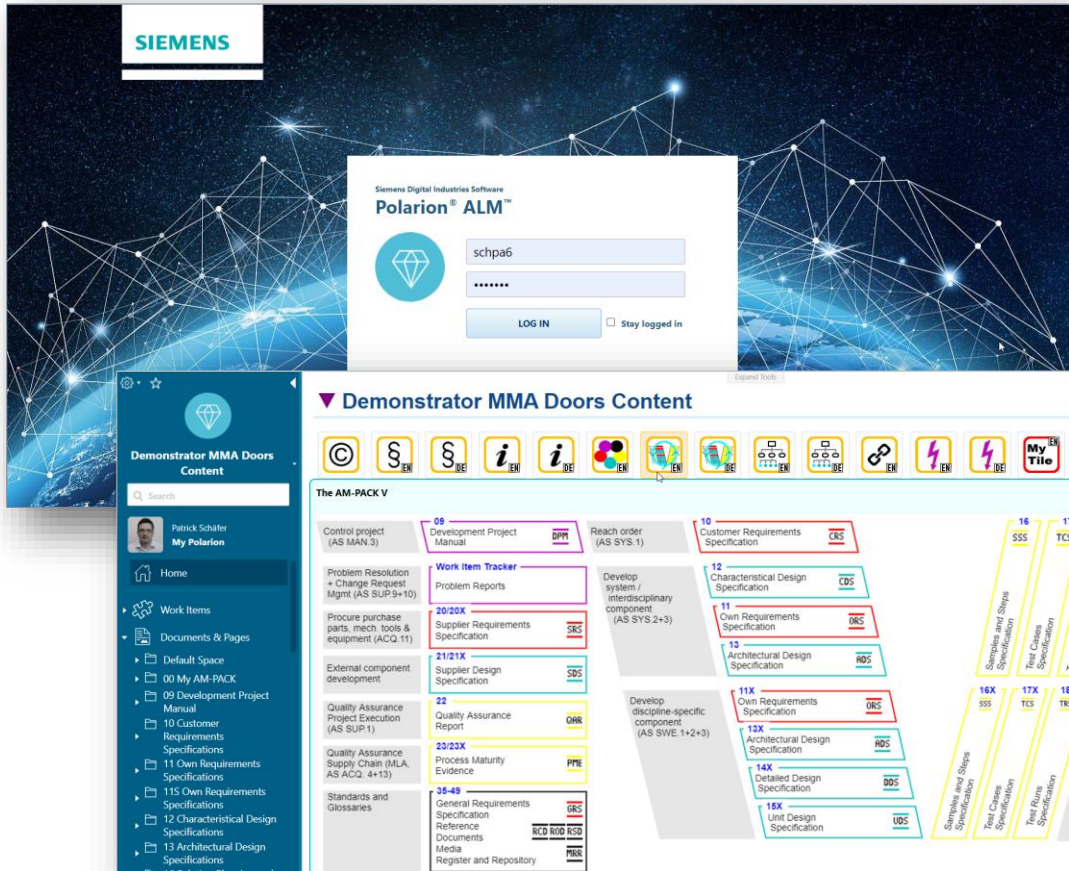
Provide «Line-by-Line» requirement specifications with stakeholders in downstream processes

Source: SysLM Project @ thyssenkrupp Steering (2022) [em (2022)]

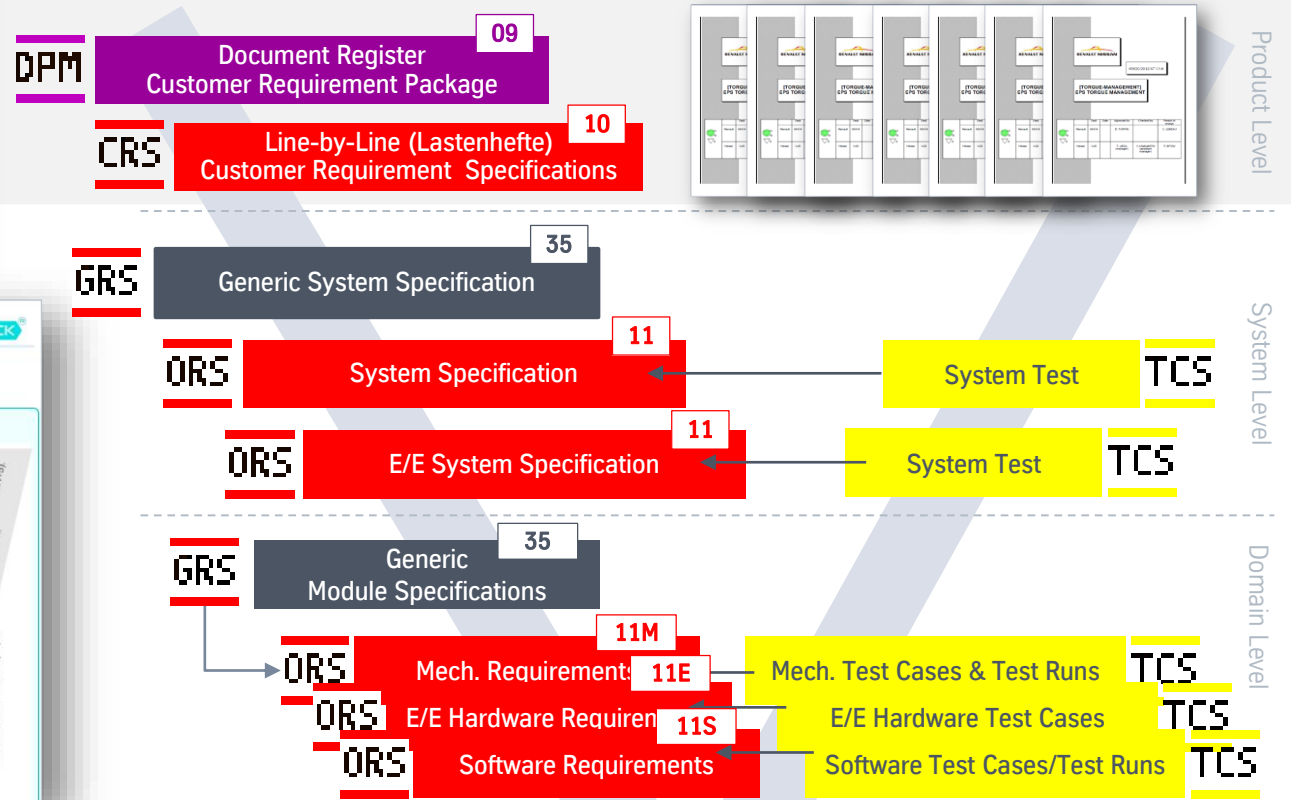


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Requirements Engineering – Critical Path along the mechatronic “V-model”



Critical Path along the Mechatronic «V»



AM-PACK - The Automotive and Mechatronics Package to POLARION

Source: SysLM Project @ thyssenkrupp Steering (2022); VDI 2206 (2021) and cip alpha (2022)



Steering future Engineering Processes

Requirements Engineering – Polarion LiveDoc Linkage

DPM

DPM 5 Doc. Register

Hide My AM-PACK Control Window

Table of Contents

- 1 Applicable Client and Third Party Documents
- 2 Information on this Live Document
 - 2.1 Legend
 - 2.2 Change History
 - 2.3 Statistical Reports

1 Applicable Client and Third Party Documents

IBK2-2304, 20, Document Reference - Daimler Test Specification

IBK2-2305, 90 - Daimler Test Specification

Orig. Doc. Version	Version 3
Doc. Storage Loc.	Teamcenter Document

MI

DP

CRS

C

C

10 Customer Requirements Specifications

Search

LiveDoc Name: CRS Torque Management Assignee: schpa6 (Unavailable) DueDate: 2022-08-31

CRS Torque Management

1 Requirements

- IBK2-2272, Sol.-neutral Requirement, 90, NA, 0 - Requirement 2
Description
- IBK2-2273, Sol.-constr. Requirement, 90, NA, 0 - Requirement 3
Description

2 Information on this Live Document

2.2 Change History

Select two versions to Compare New Baseline Show status progression

	Title	Revision	Document Status	Info
<input type="checkbox"/>	Version 1	3268	90 Responded	i
<input type="checkbox"/>	Version 2	3280	90 Responded	i
<input type="checkbox"/>	Version 3	3310	90 Responded	i

- IBK2-2279, 90 - Version 1
Version 1 of requirements specification.
Link to Teamcenter: Teamcenter Document
- IBK2-2280, 90 - Version 2
Version 2 of requirements specification.
Link to Teamcenter: Teamcenter Document
- IBK2-2281, 90 - Version 3
Version 3 of requirements specification.
Link to Teamcenter: Teamcenter Document

DPM

DP

DocVersion is represented in a DPM Register DocProxy

CRS

DV

DERIVE

DP

MRR

DocVersion is represented in a MRR Register DocProxy

DV

GRS

DV

DV

DV

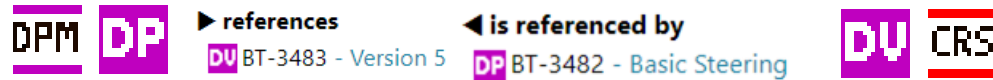
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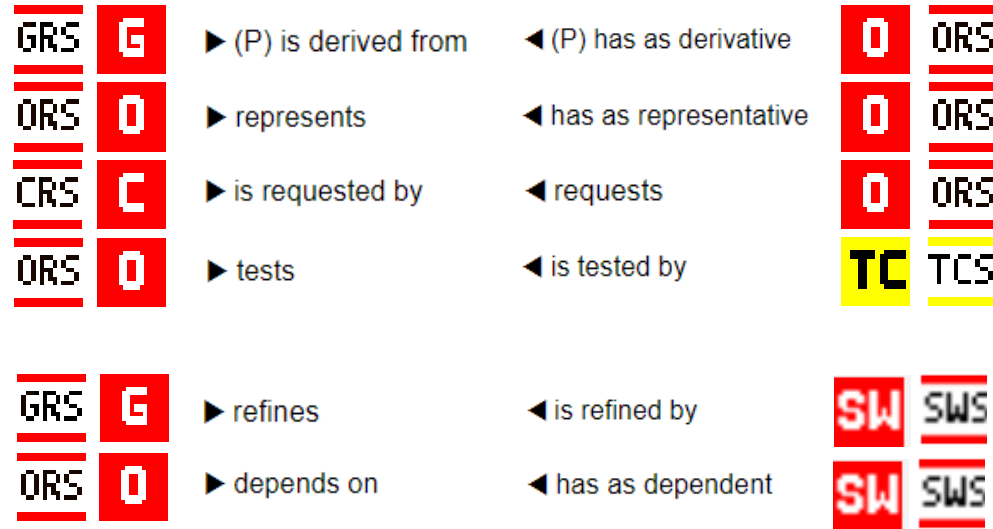
Requirements Engineering – Critical Path along the mechatronic “V-model”

Exemplary linking of wokitems

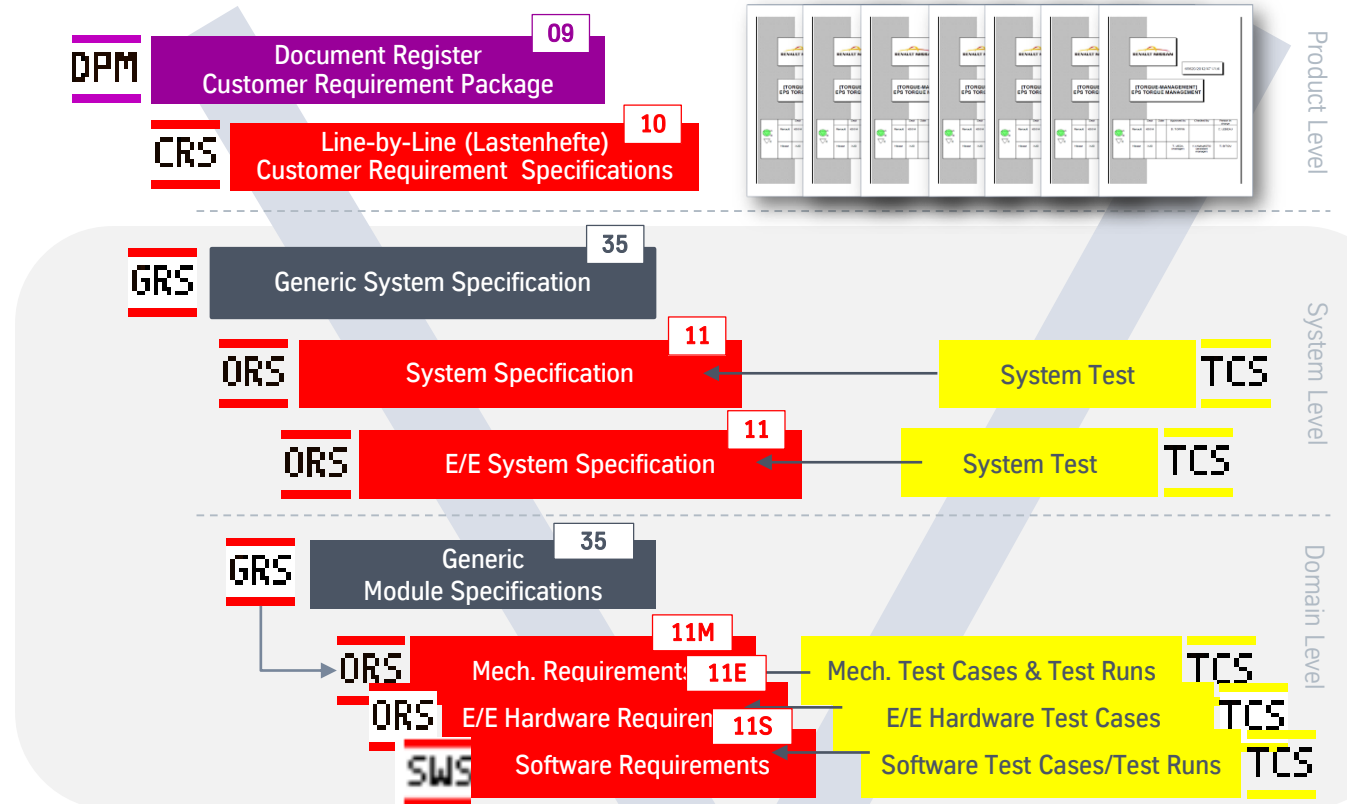
LiveDoc Level



Workitem Level



Critical Path along the Mechatronic «V»



AM-PACK - The Automotive and Mechatronics Package to POLARION

Source: SysLM Project @ thyssenkrupp Steering (2022); VDI 2206 (2021) and cip alpha (2022)



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Requirements Engineering – Workflow and Status Network in Polarion

The screenshot displays the Polarion software interface. On the left is a navigation sidebar with 'Basic Training' and 'My Polarion' sections. The main area shows a document titled 'CRS Torque Management' with a 'Table of Contents' and a 'Table of Contents' section. A 'Work Item Properties' panel is open for item 'BT-3559', showing details like 'Kind: Information', 'Status: 21 Under appraisal', and 'Assignee: Katja Tiring'. A 'Status Network' diagram is overlaid on the right, showing a flow of states: '11 Updated' (top), '21 Under appraisal' (middle), '50 Requirement assessment requested' (left), '50 Prospectively accomplishable', '51 Prospectively unaccomplishable', '52 Conditionally accomplishable' (bottom), '90 Accomplishable', '91 Accomplishable off product', and '97 Not to be'. A 'Transition' panel at the bottom right shows the current status as '21 Under appraisal'.



Source: SysLM Project @ thyssenkrupp Steering (2022)



Steering future Engineering Processes with System Lifecycle Management

Requirements Engineering – Requirement Documents managed in Teamcenter

The screenshot displays the Siemens Teamcenter interface for managing requirement documents. The top navigation bar includes search filters for 'Any Owner', 'Any Type', and 'Any Status: Working'. The left sidebar contains navigation options like Home, Assistant, Discussions, Folders, Active Folders, Inbox, Reports, Favorites, and Quick Access. The main content area is divided into three sections:

- Filters:** A 'Filter By Property' section with expandable categories: Category (Documents (13)), Type (Requirement Document Revisi... (13)), Owner (Schäfer, Patrick (10529065) (12), Tiring, Katja (tirkat) (1)), Group ID (Engineering (10), Requirements Engineering (3)), Document Type (CRP (13), CSR (27), LA (5), CPM (4), CRS (4)), Release Status (Released (5), Unassigned (8)), and Language (EN (7)).
- Document List:** A table of documents with columns for ID, Name (EN), and Name (DE). The selected document is CRP-000006113-000-A, titled 'EPS TORQUE MANAGEMENT'.
- Document Properties:** A detailed view of the selected document, including:
 - DOCUMENT PROPERTIES:** ID: 000006113, Revision: A, Name (EN): EPS TORQUE MANAGEMENT, Name (DE): EPS TORQUE MANAGEMENT, Description: Requirement Document Revision, Type: Requirement Document Revision, Release Status: Released, Date Released: 27-Sep-2022 14:12, Owner: Schäfer, Patrick (10529065), Group ID: Engineering.TK Presta, Last Modifying User: Schäfer, Patrick (10529065), Checked-Out By: (empty), Checked-Out Date: (empty).
 - VIEWER:** A PDF viewer showing the document content, including an introduction and a technical diagram.
 - REQUIREMENT DOCUMENT PROPERTIES:** Document Type: CRP, Document Number [Default]: 000006113, Document Number: (empty), Counter: 000, Identifier: CRP-000006113-000-A, Language: EN, Reference: (empty).

The technical diagram in the viewer shows a block diagram for 'Speed_for_EPS' control. It includes an 'Input_Torque' input, 'Input filters', an 'Assist gain map' block, 'Output filters', and a 'Second assistance control path' block. The diagram illustrates the flow of torque through these components to generate the final speed output.

Example: Customer Requirement Document in Teamcenter

Requirement Document

Teamcenter

Source: SysLM Project @ thyssenkrupp Steering (2022)

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Requirements Engineering – Representation in Engineering Backbone

The screenshot displays the SysLM software interface for the project 'EPS TORQUE MANAGEMENT'. The left sidebar shows a tree view of the project structure, including '1 TORQUE MANAGEMENT' and its sub-items. The main area shows a list of documents, with one document selected and its details displayed on the right. Annotations highlight key features:

- Requirement Document:** A blue box points to the selected document in the list.
- Linked Data based on OSLC:** A blue box points to the 'LINKS' section, which shows a relationship between 'Independent application of bra...' and 'Affected By'.
- Dataset with File:** A blue box points to the 'DOCUMENT CONTENT' section, which shows a list of files, including a PDF file named 'FUNC_EPS_TORQUE_MANAGEME...'.

The OSLC logo and a diagram of linked data are also visible at the bottom of the interface.

Representation of Customer Requirement Specification

Linked Data based on OSLC

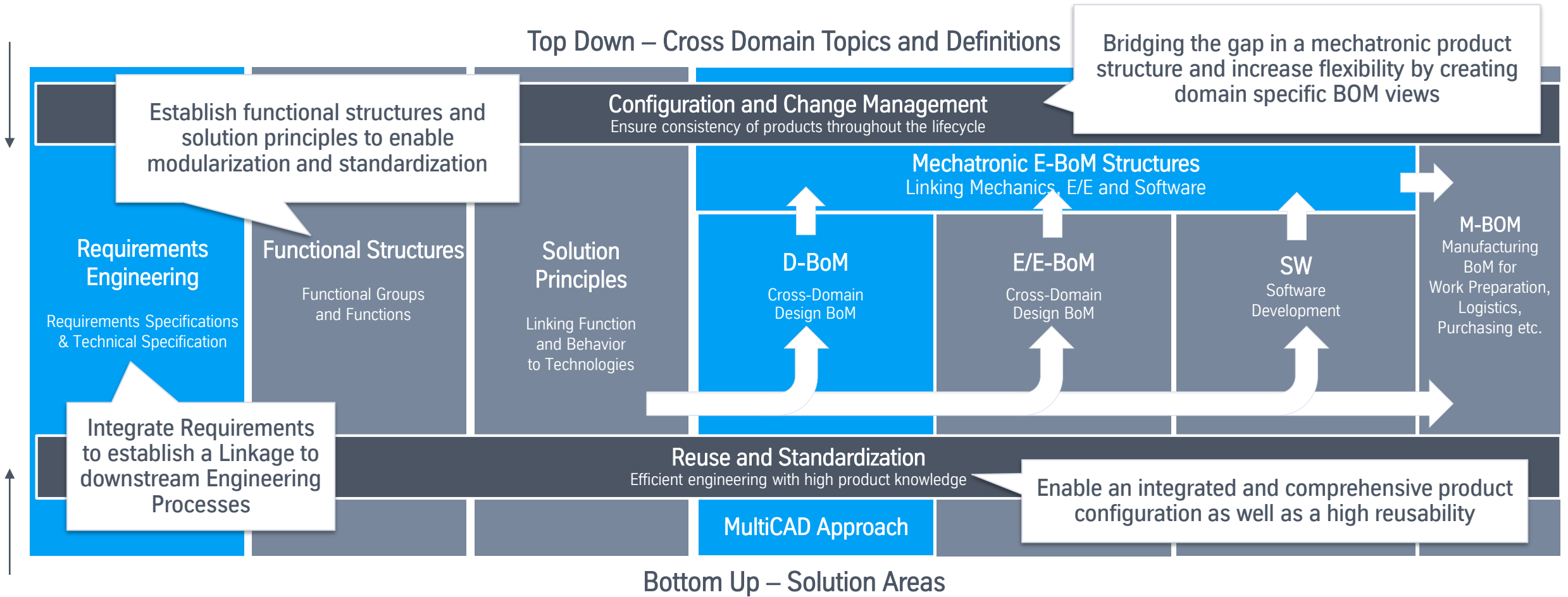
Dataset with File

Source: SysLM Project @ thyssenkrupp Steering (2022)



Steering future Engineering Processes with System Lifecycle Management

Integrated Product Structures to enable Closed-Loop Engineering Processes



Source: SysLM Project @ thyssenkrupp Steering (2022)





Thank you for your kind attention.

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