NIO

Transforming the PLM Landscape

The Gateway to Business Transformation

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PLM Road Map™ EMEA & PDT Europe 2023

The Digital Thread in a Heterogeneous, Extended Enterprise Reality

A call for PLM Professionals to share their knowledge & experience

15 & 16 November

CIMdata

eurostep

Company Introduction

Advanced Electric Vehicles

We produce advanced electric vehicles that empower joyful lifestyles and premium experiences for our users. Enabling them to explore new horizons through industry leading technology, unparalleled service, memorable activities and next-generation products.

A Connected Culture

We're growing together with our inspiring community to collaborate in building a connected culture of shared joy, reinventing the relationship a brand has with its users.

Optimism for the Future

Who are a forward-thinking, curious community who value novelty, the freedom of boundless worry-free journeys and share our optimism for the future of a global society.

A Full Product Portfolio Built On A Premium Brand

2015
FORMULA E
Formula E champion

2016
EP9
Fastest EV(1) in the world

2017
ES8
Flagship Electric SUV
(6-seater / 7-seater)

2018
ES6
Mid-size Electric SUV
(5-seater)

2019
EC6
Mid-size Electric Coupe SUV
(5-seater)

Jan 2021
ET7
Flagship Electric Sedan

Dec 2021
ET5
Mid-size Electric Sedan

2022
EL7(2)
Mid-large Electric SUV
(5-seater)

2022
EC7
Flagship Electric Coupé SUV

2022
All New EL8
Flagship Electric SUV

2023
ET5 Touring
Electric Tourer

2023
All New EL6
Electric All-Round SUV

Note: (1) Nürburgring Nordschleife electric vehicle lap record in 2016
(2) ES7 is renamed as EL7 in the European market

Content

1.0

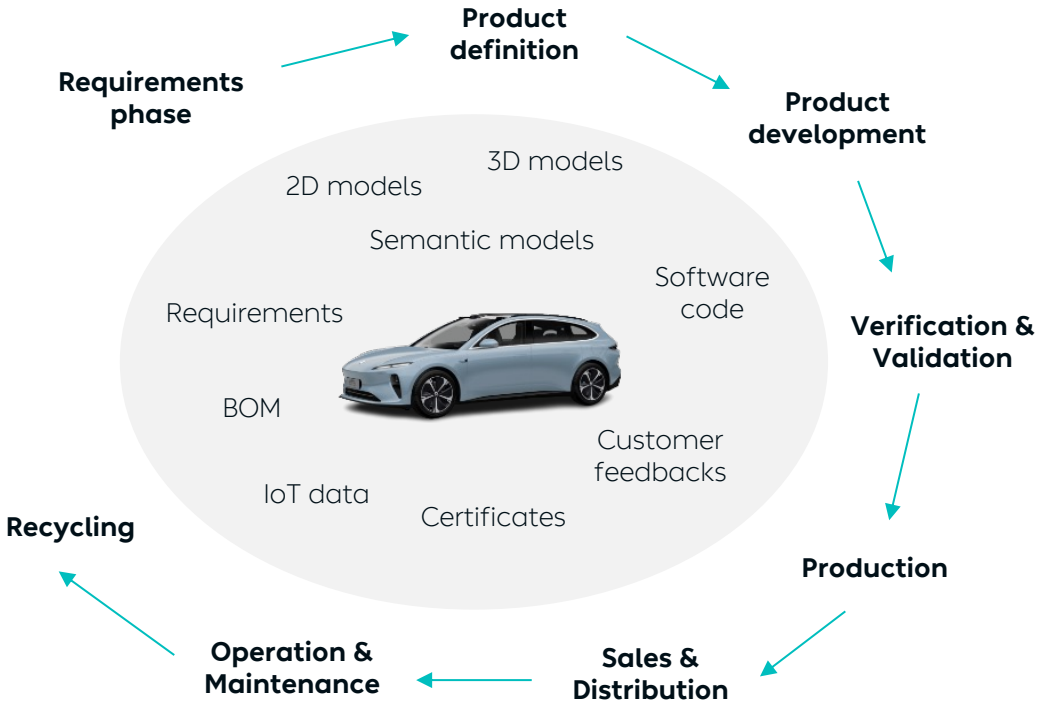
PLM – The What and the How of today

PLM Landscape
Business view

PLM is an approach to

- managing all product and process-related data along the product lifecycle
- seamlessly integrate all data and information generated within all phases of this process

PLM is the strategic Backbone of Manufacturing companies.



Adopted from Hooshmand, Y., Resch, J., Wischnewski, P., & Patil, P. (2022). From a Monolithic PLM Landscape to a Federated Domain and Data Mesh

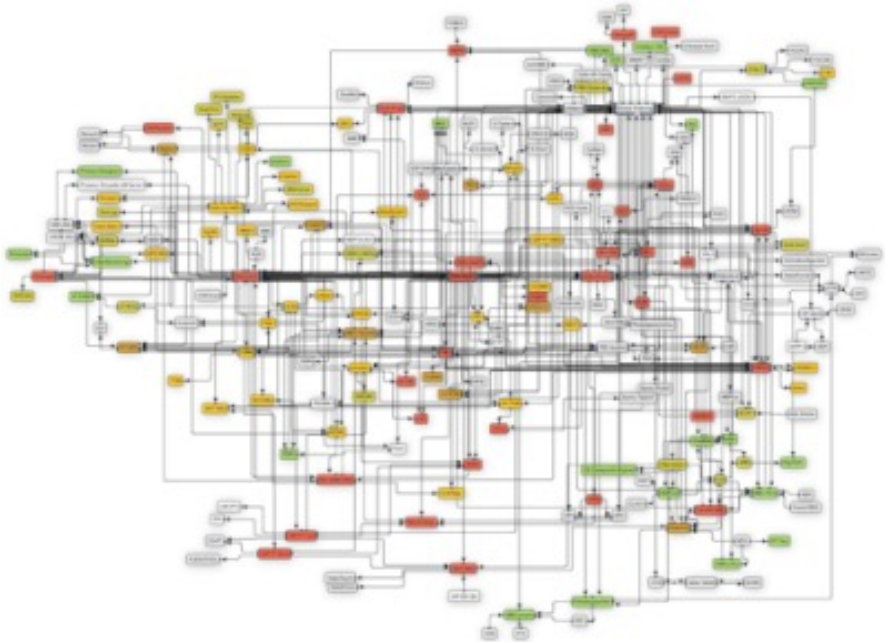
PLM Landscape
Technical view

PLM landscape of an OEM

- +150 Systems
- +250 Interfaces

Challenges

- Technical cut of the landscape
  - Poor user journey
  - Error-prone (manual) processes
- Inherently designed as isolated silos
  - Poor interoperability
  - Data as second-class-citizen
- Rigid and inflexible to change
  - Complex implementation of requirements
  - Difficult to estimate the change impact



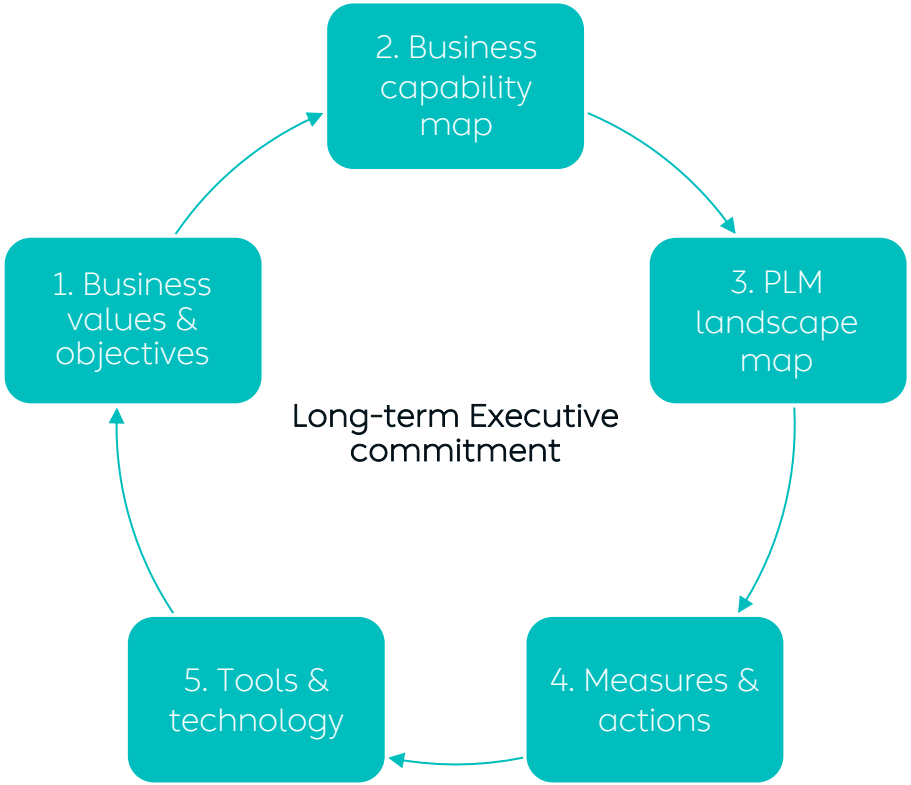
(Re-)Design and modernization of the PLM landscape as a whole

Adopted from Hooshmand, Y., Resch, J., Wischnewski, P., & Patil, P. (2022). From a Monolithic PLM Landscape to a Federated Domain and Data Mesh

2.0

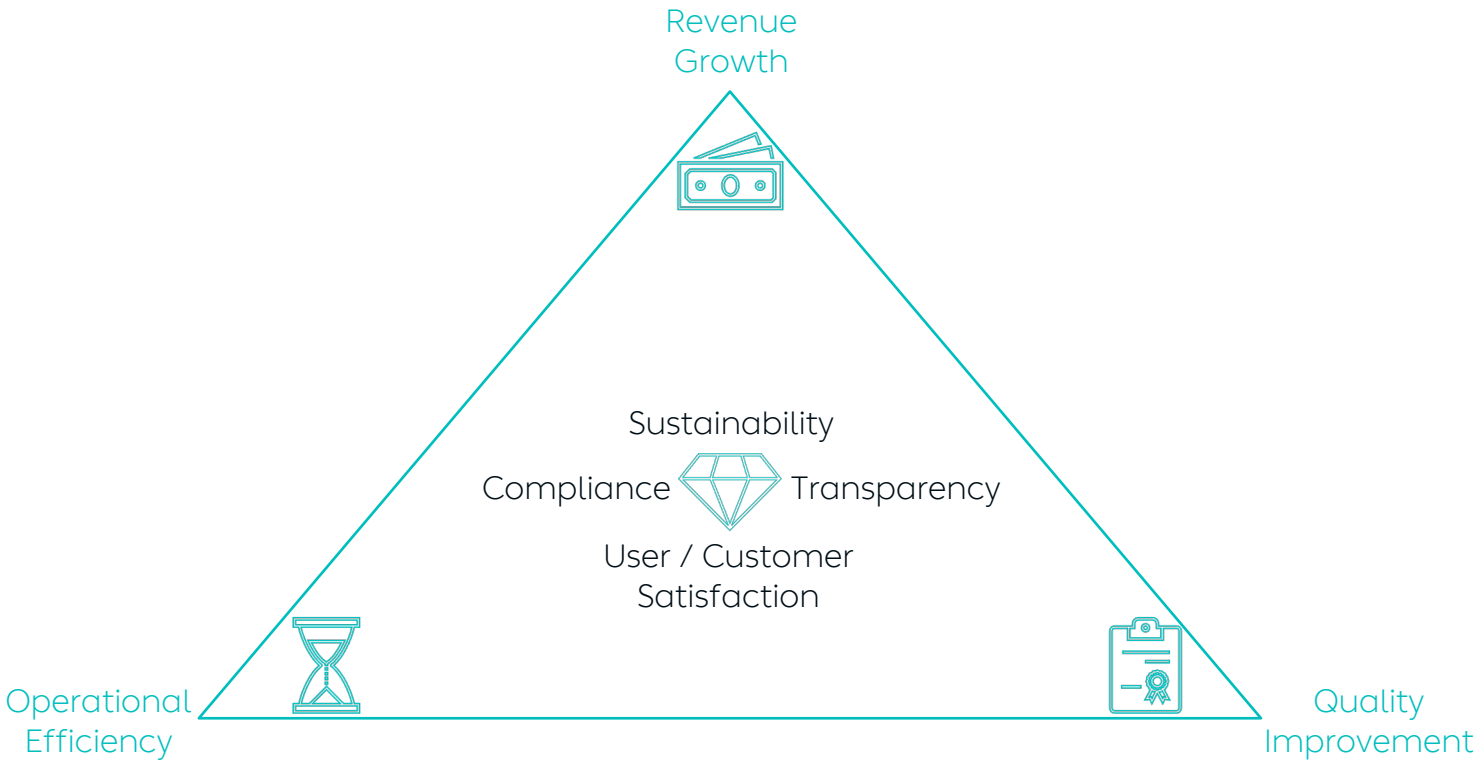
5 + 1 steps for resilient business transformation

Business Transformation
5 + 1 steps



Business Values & Objectives

Relevant in the context of PLM



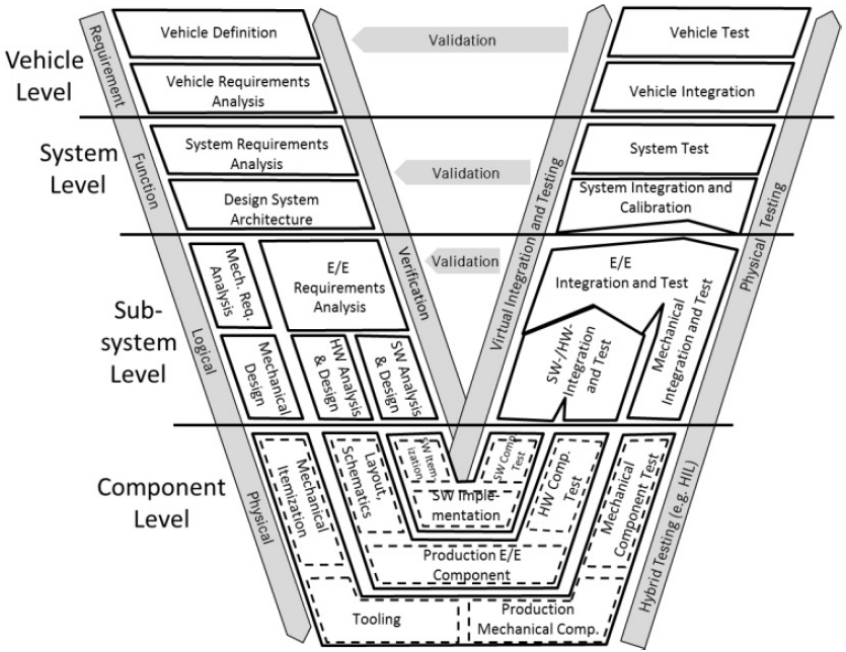
Business Capability Map

Capturing existing business capabilities and Identifying the missing business capabilities

Cross Domain capabilities

- Project management
- Security (incl. IS) & Access management
- Process and IT-Landscape Governance
- Audit and Reporting
- Knowledge Management
- Supplier integration
- Analytics and Decision Support
- Digital Twin & Digital Thread
- ...

Development phase capabilities



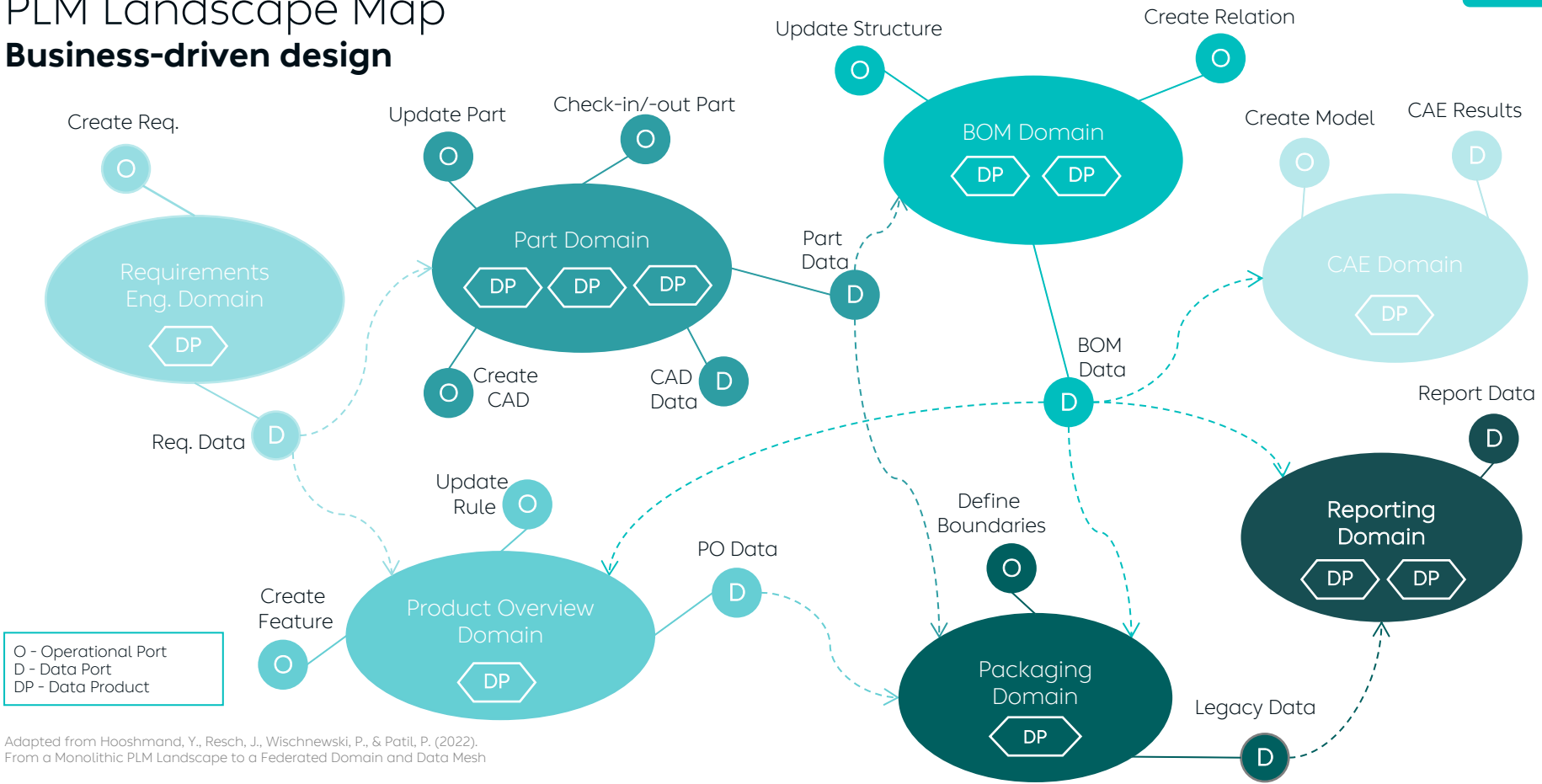
Groll, M. & Heber, D. (2016).
E/E-Product Data Management in Consideration of Model-Based Systems Engineering

Operation phase capabilities

- User Experience Feedback (closed-loop)
- User Data Security
- Documentation and User Guides
- Predictive Maintenance & Diagnostics
- Real-time Monitoring
- Remote Updates (OTA)
- Supply Chain for Spares
- Aftermarket Support
- ...

PLM Landscape Map

Business-driven design



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Measures & Action

Mid- and Long-term

- 3 to 5 years

No Big-Bang strategy

- The measures consist mainly of MVP Actions

Technology-Agnostic Measures

- Fundamental philosophies drive measures, not the limitations of existing tech

Linking measures to objectives

- Each measure should be designed to address at least one (sub)objective

Define KPIs that correlate with each objective to measure the progress toward desired outcomes

ID	Measures	O1 User / Customer Satisfaction				O2 Revenue Growth				O3 Quality Improvement		
			O1.1	O1.2	O1.3		O2.1	O2.2	O2.3		O3.1	O3.2
M1	Ensuring product quality in the digital phases of the PDP									x	x	
M2	Enhancing SE acroding to MBSE philosophy	x	x			x		x		x		x
M3	Providing cross-domain change impact analysis					x	x			x	x	
M4	Cross-domain configuration logic & solution									x	x	
M5	Integration of a closed-loop feedback in design & engineering	x		x								
M6	Enhancing seamless collaboration & co-creation with suppliers					x		x				
M7	Leveraging data-driven decision making & knowledge preservation & reuse	x	x			x	x			x		x
M8	Developing a holistic PLM & IT landscape architecture & roadmap	x				x				x		

Tools & Technology

Decision guard rails:

User-centric
design for higher user satisfaction

Data-centric
leveraging data as a first-class citizen

Build for change
inherently designed for change, not perfection

The fundamental principle:

~~Single source of truth~~

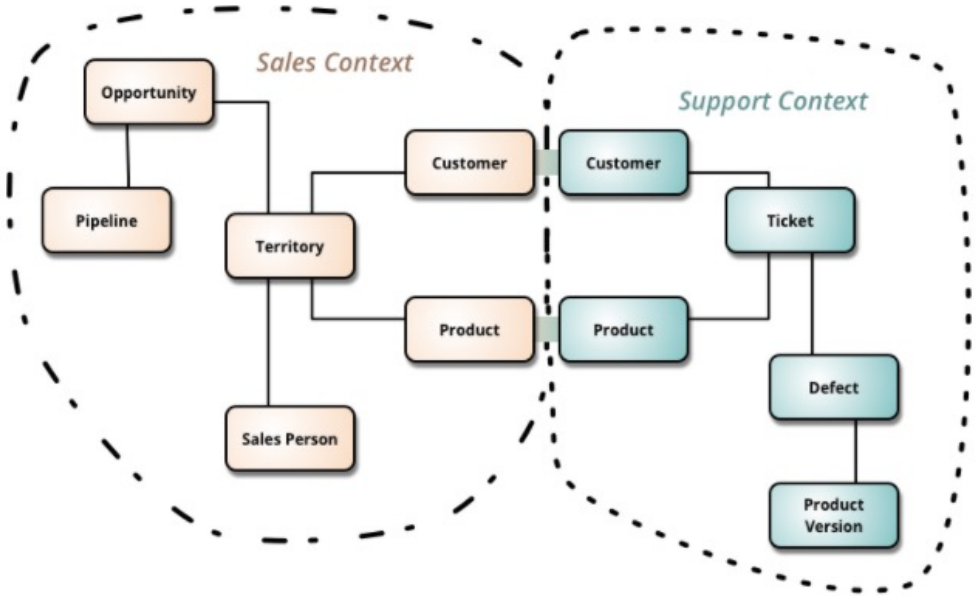
→

Nearest Source of Truth based on Single Source of Change

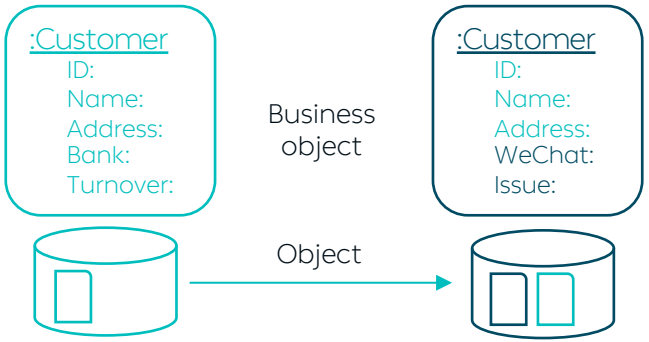
3.0

Selected technical operative aspects

Domain-Driven Design
Bounded Context in DDD



Nearest Source of Truth
based on
Single Source of Change



Source: https://martinfowler.com/bliki/BoundedContext.html

Domain-Driven Design
Key aspects

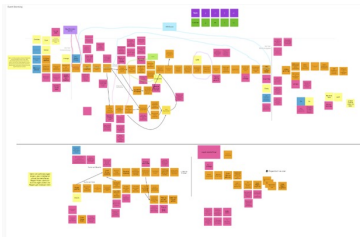
1. A Domain Model serves as the basis for the software development
   - The model contains information about the processes and rules of the business area
2. The Context Boundary defines the domain and its boundary with other domains
3. A Ubiquitous Language (common language) is used to define and embed the business terminology in the software systems
   - The ubiquitous language prevents ambiguities
4. A Context Map illustrates the relationships between bounded contexts (domains)
   - The context map makes interfaces and interconnections more transparent

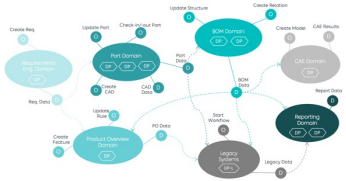
DDD helps to efficiently manage the complexity of software-coupling by focusing on domains with clear boundaries.

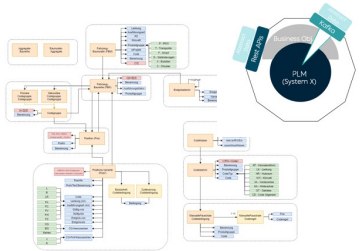
Source: https://martinfowler.com/bliki/BoundedContext.html

Development Steps
In accordance with DDD

1. Business Scenario Modelling
   Define a common language
2. Context Map
3. Domain Model
   SW Architecture
4. Code







Business Scenario

Event storming → Collaboratively model the business flow to develop a common language

Events

Events
e.g., Create part, Start CR, ...

Systeme

Involved systems
PLM, CAD, Excel, Email, ...

Actors

Actors
Part responsible, ..., ...

Offene Punkte/ Fragen

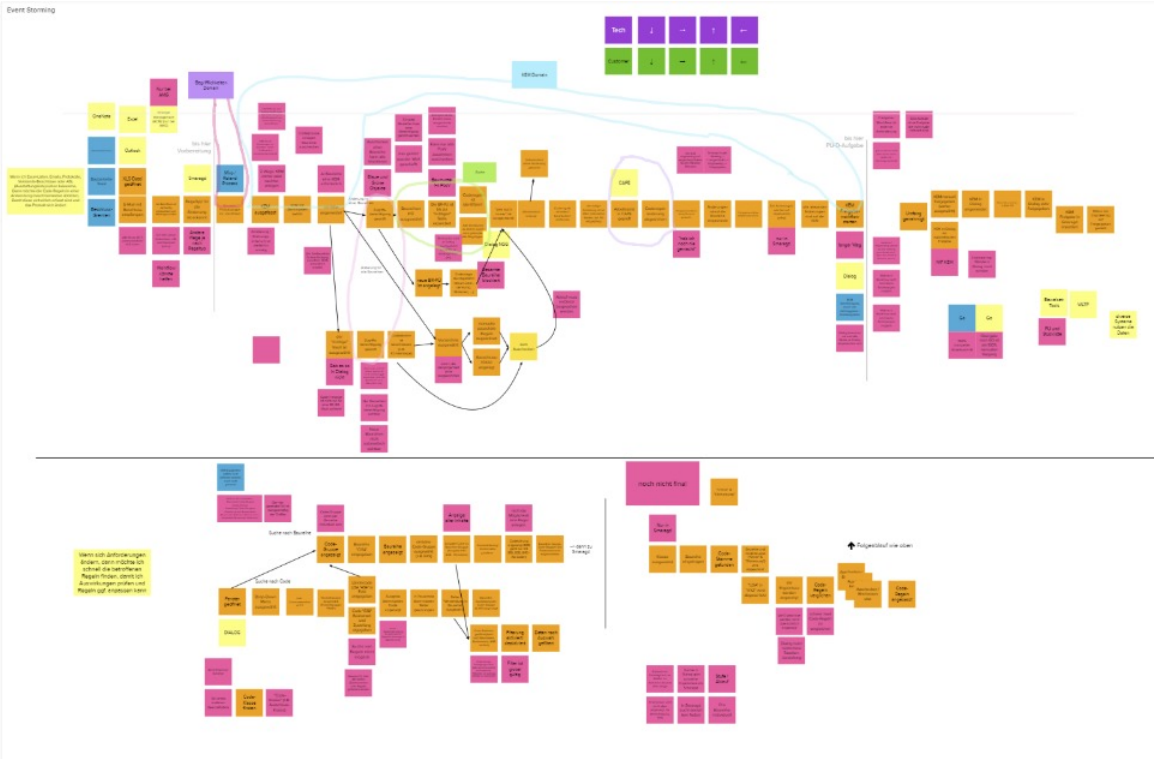
Questions/ open points

Pain Points

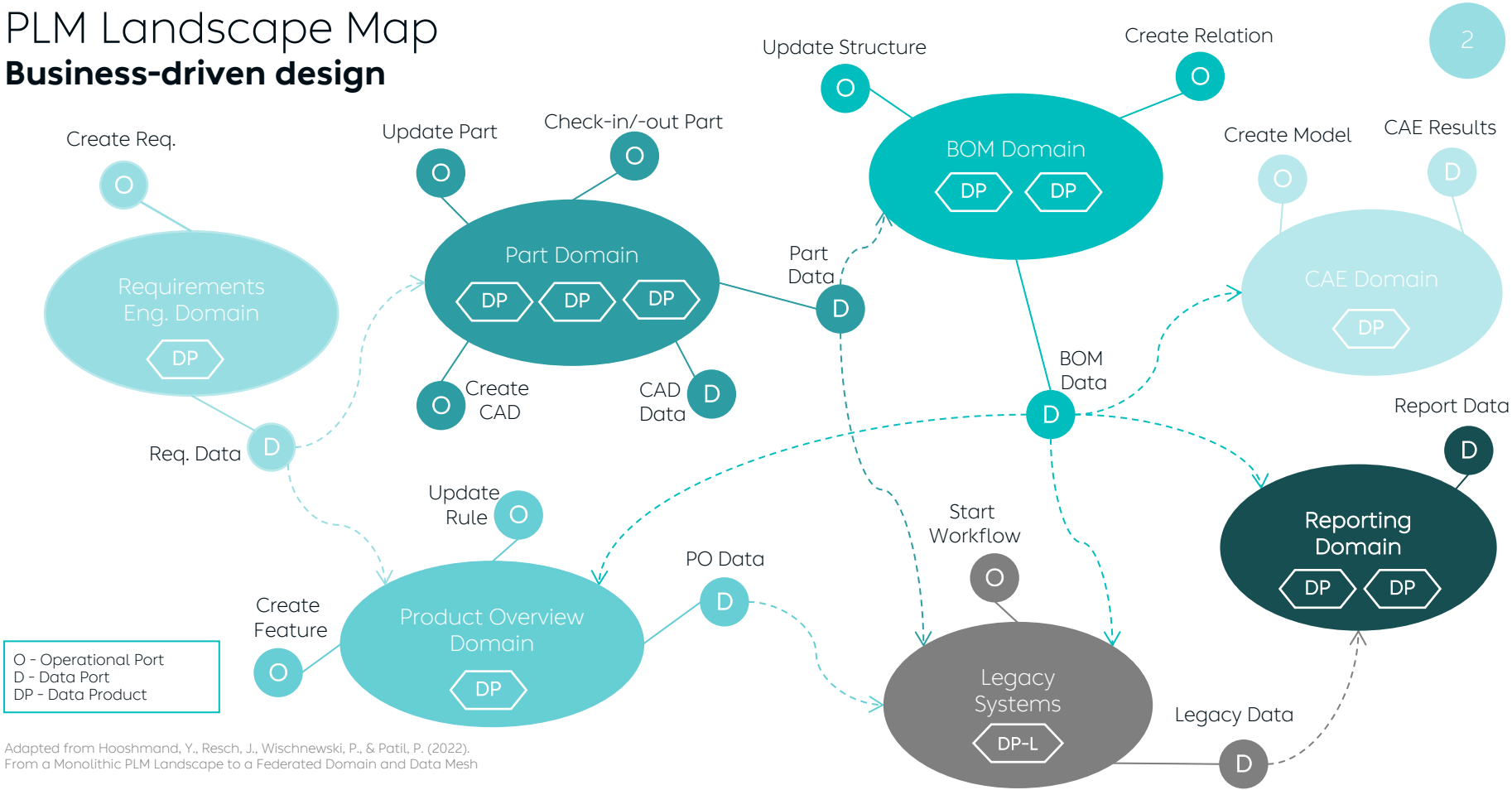
Pain points

Risks

Risks



PLM Landscape Map
Business-driven design



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Domain Model

- Business Model (Business language) driven Data Model
- Developed together with Business
- Integrated into the implementation source code
- Ubiquitous language (Business and Development)

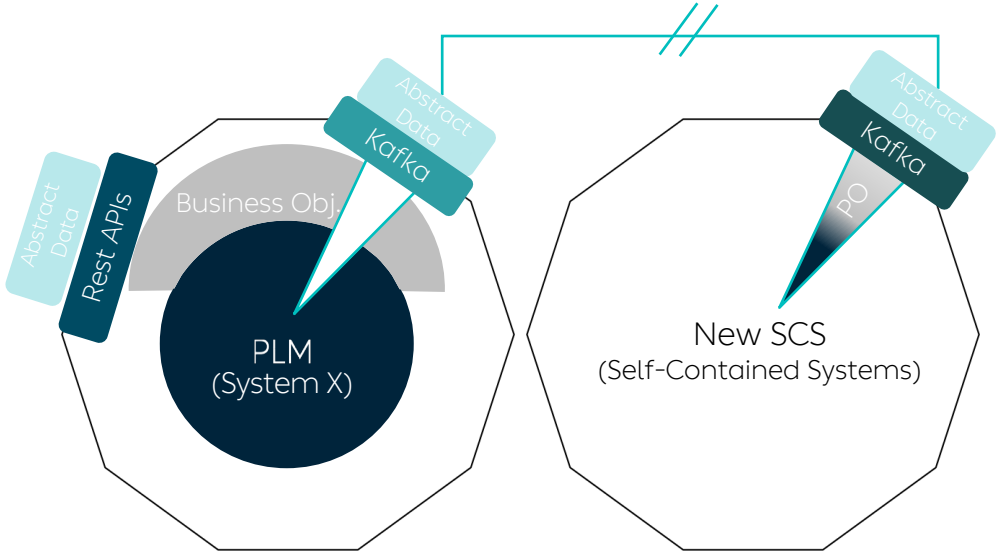
Design Principles

Encapsulation – build a wall of „defense“ around your application
➔ Anti-Corruption Layers/ Adopters

Use standard integration patterns and technologies for communication with other applications and SCS
➔ REST APIs + Async APIs (Kafka)

Also try to use these techniques for communication within your application
➔ REST APIs + Async APIs (Kafka)

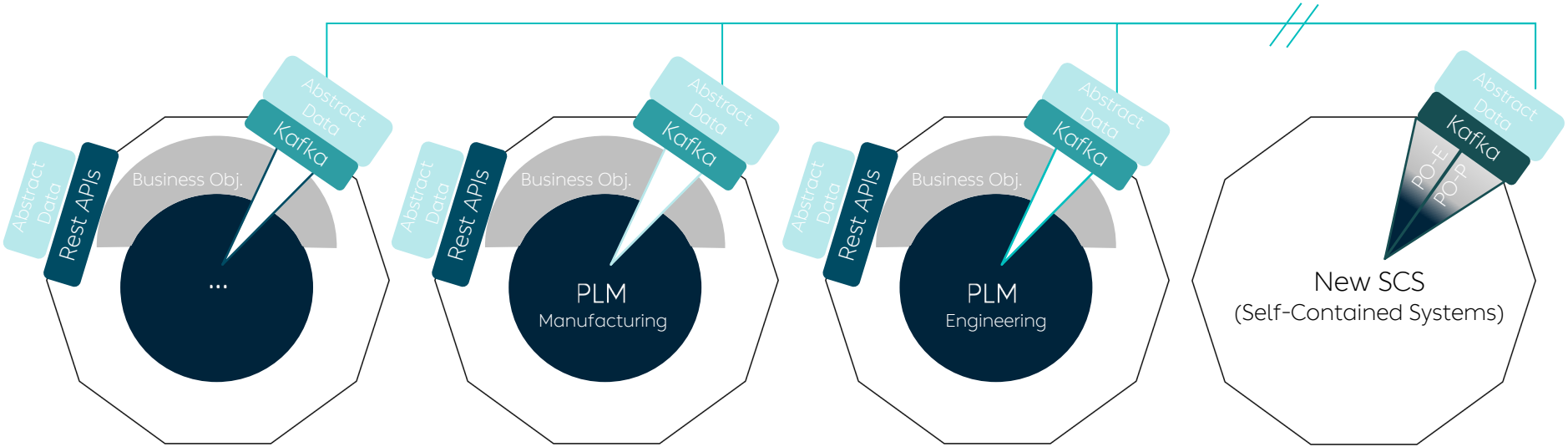
Strategy, Patterns and Governance for integration use cases have to be established
➔ @Frontend + @APIs for BOM and Change-Mgmt.



Architecture Design Patterns

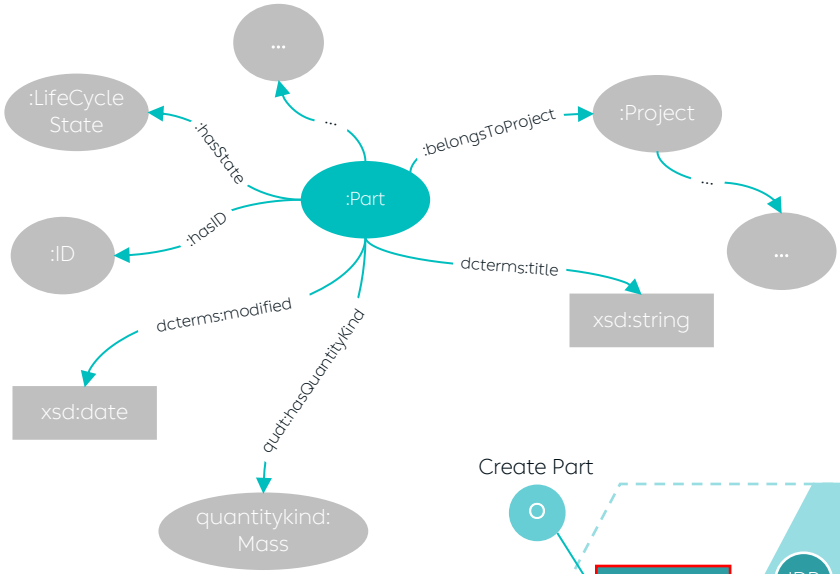
- Standardized DevOps & Toolchain
- Self-Contained Systems
- Domain-Driven Design
- Core-Satellite Architecture
- Reusable Model-Driven Components
- Platform thinking

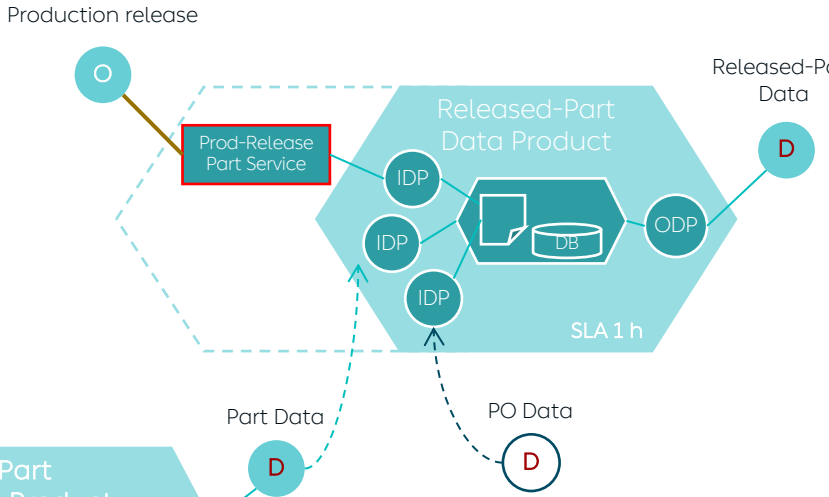
Design Principles

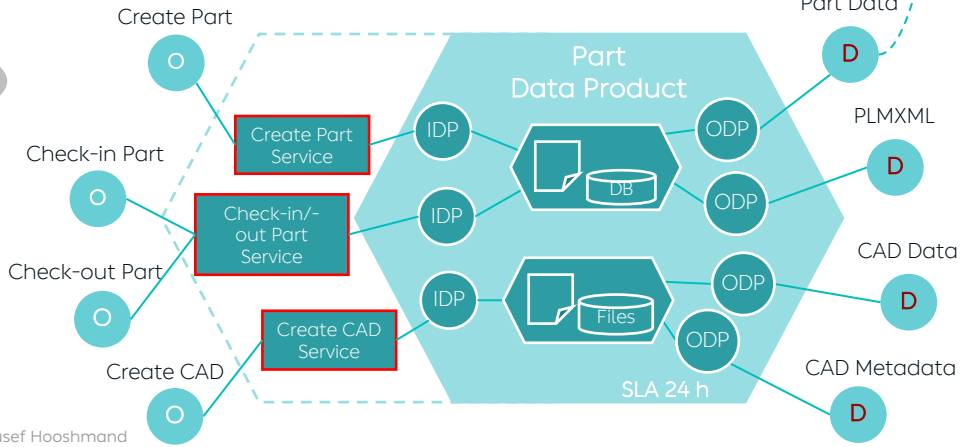


Extraction and consolidation of domain features & data scattered in legacy systems
(applies to both new COTs and in-house solutions)

Domain Building Blocks







O - Operational Port
D - Data Port
IDP - Input Data Port
ODP - Output Data Port

Summary

Strategic Imperative

"A Must-Do, Not a Nice-to-Have"

Leadership Alignment

"Top-Down & Bottom-Up Engagement"

Holistic Approach

"End-to-End PMT Transformation"

Iterative Approach

"Transformation is a journey with continuous refinement"

Technology-Agnostic

"Fundamental philosophies drive measures"

Industry-Wide Impact

"Raising the bar in the industry"

The guard rails

"User-centric / Data-centric / Build for change"

Next Steps

"Time to Act is Now"

Make sure you own the data - people and tools can leave!

Thank you