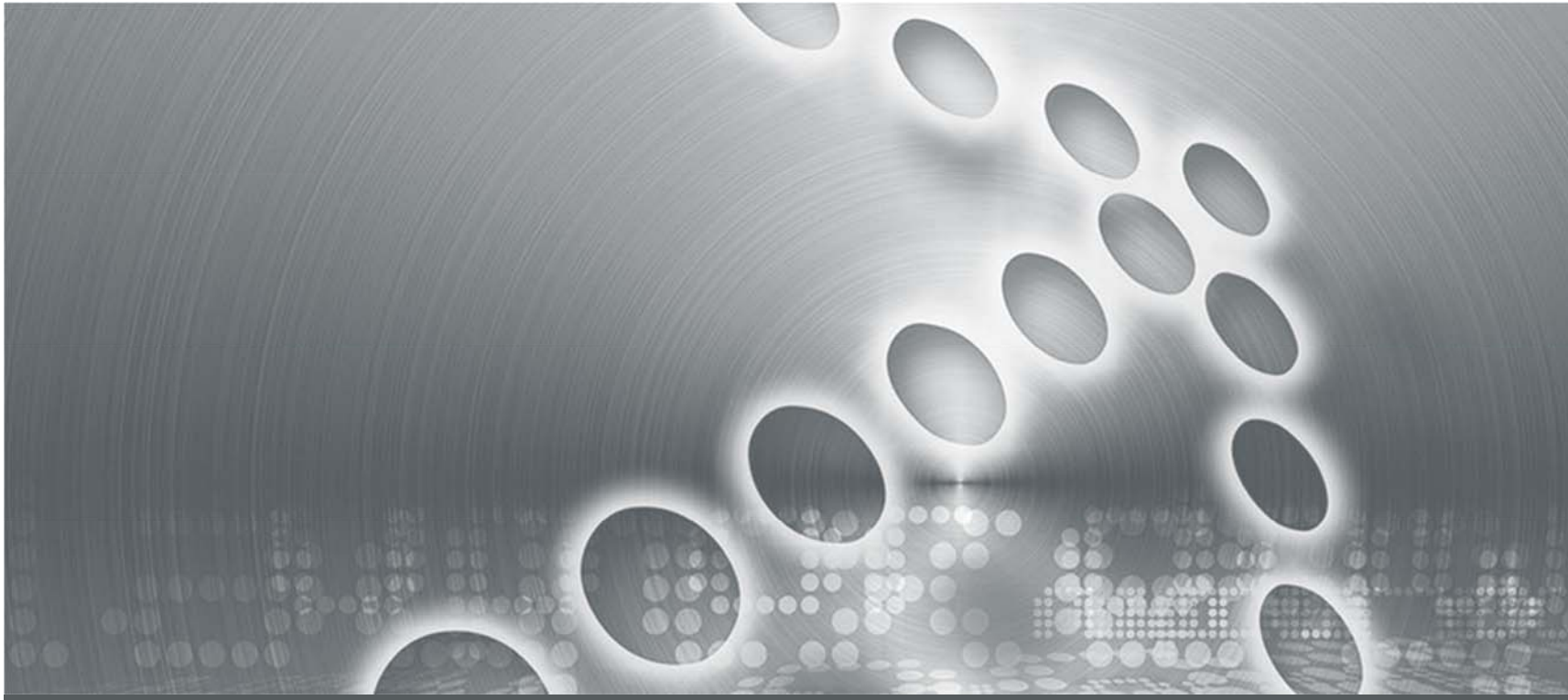

Agile Systems Engineering

Dr. Christof Ebert, Walter Bernet, Dr. Ulrich Bodenhausen, Vector
Frank Kirschke-Biller, Ford

V1.0 | 2018-03-13

Ford

- 62 plants worldwide
- 200 markets
- 203,000 employees, 53,000 in Europe
- $136 billion revenues, $ 29 billion in Europe
- 6.3 million vehicle units, 1.4 million in Europe
- $ 5.5 billion expenses for engineering, research and development

Frank KIRSCHKE-BILLER

Frank Kirschke-Biller is leading global core software processes at Ford.

Since 2000, he has been with Ford on different leadership positions in the area of Infotainment, Electrical Integration incl. Electrical Architecture, Networks, Diagnostics and Software Development.

Before he was leading the department of sensor and system technology at imech, a startup in the area of mechatronics.

Frank Kirschke-Biller graduated in electrical engineering at the University of Duisburg.

fkirschk@ford.com www.ford.com

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- Interim support,
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- Training on Agile, Requirements, Security, Safety, CMMI/SPICE etc.
- Part of Vector Group
  with over 2000 employees

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www.vector.com/consulting-career

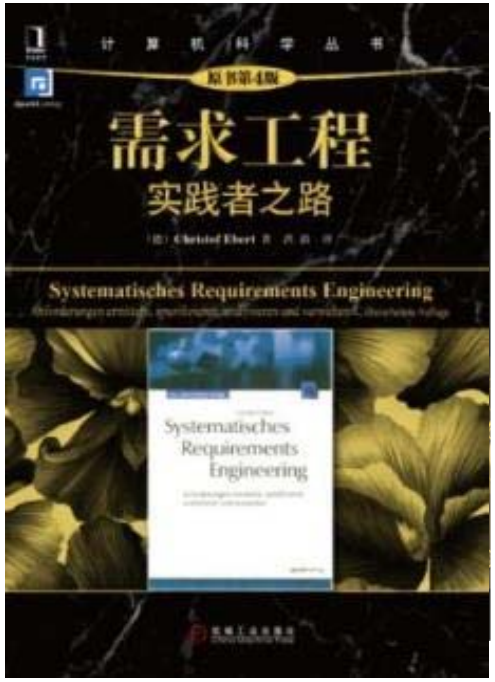
Christof EBERT

Christof Ebert is managing director at Vector Consulting Services.

He supports clients to improve product strategy and product development and to manage organizational changes.

Prior to that, he held senior management positions for ten years at Alcatel, with global responsibility for software / systems technology.

A trusted advisor for companies around the world, member of industry boards, and professor at the University of Stuttgart and Sorbonne in Paris, Dr. Ebert authored several books.



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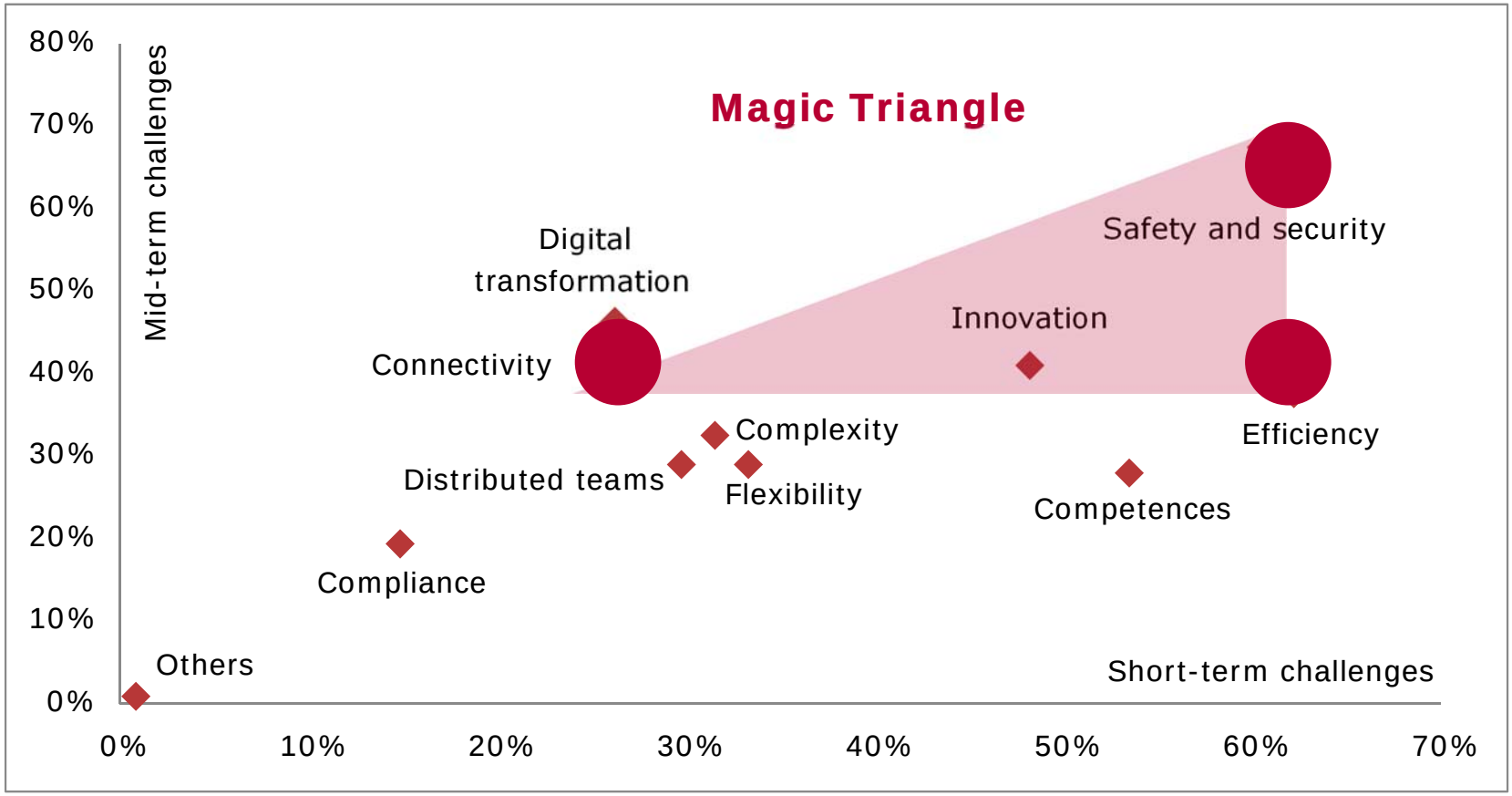
@ChristofEbert

Agenda

- Welcome
- **Challenges**
- Agile Systems Engineering
- Ford Case Study
- Summary and Outlook

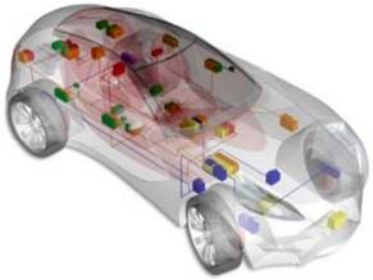
Industry Challenges 2018



Vector Client Survey 2018. Details: www.vector.com/trends. Horizontal axis shows short-term challenges; vertical axis shows mid-term challenges.
Sum > 200% due to 5 answers per question. Strong validity with >4% response rate of 2000 recipients from different industries worldwide.

Quality and Cost are the biggest short-term challenges across industries.
Connectivity and **Digital Transformation** evolved as a major challenge.

Challenge: Connectivity



Devices

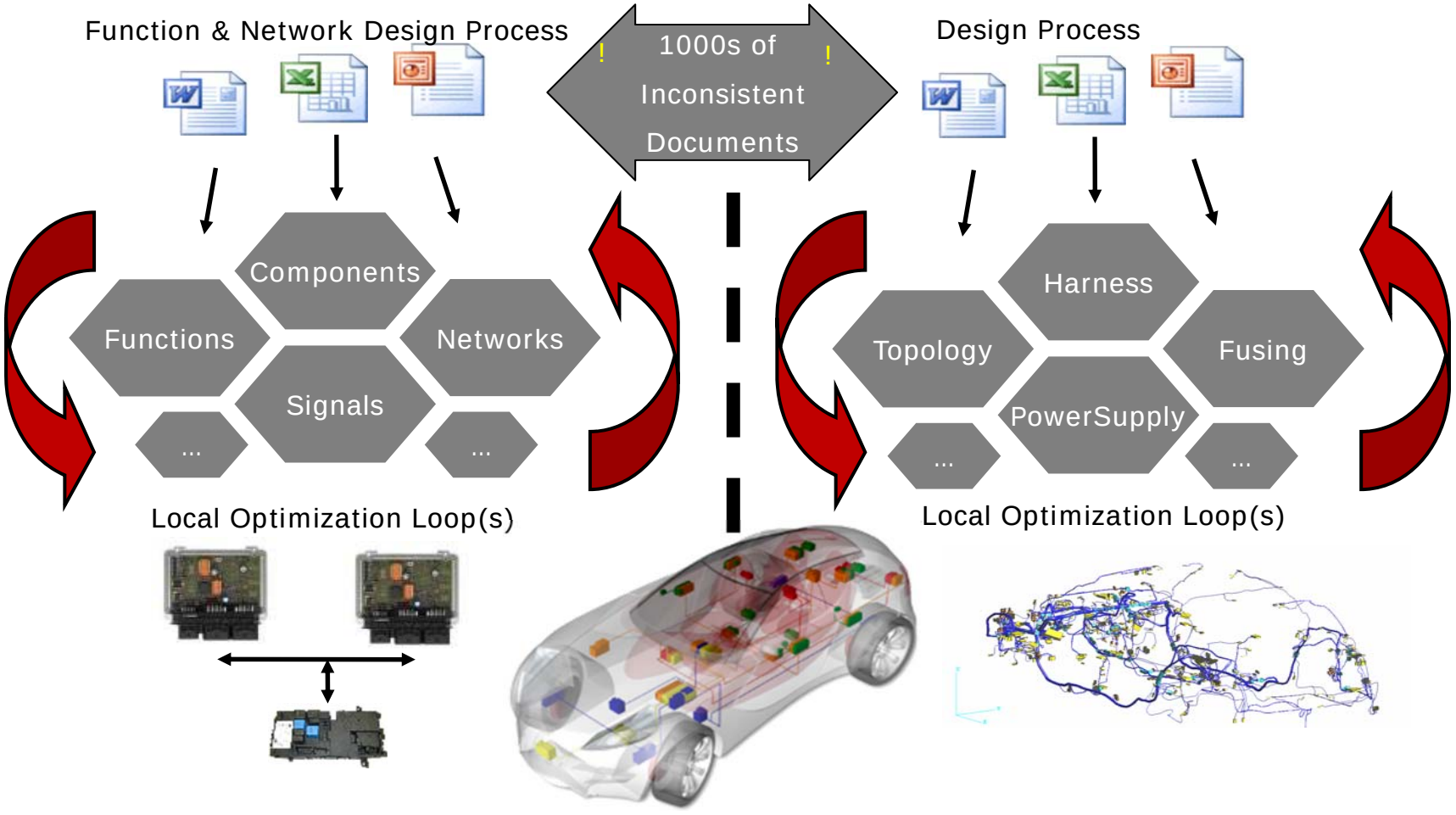
Systems

Infrastructure

1980 2000 2020

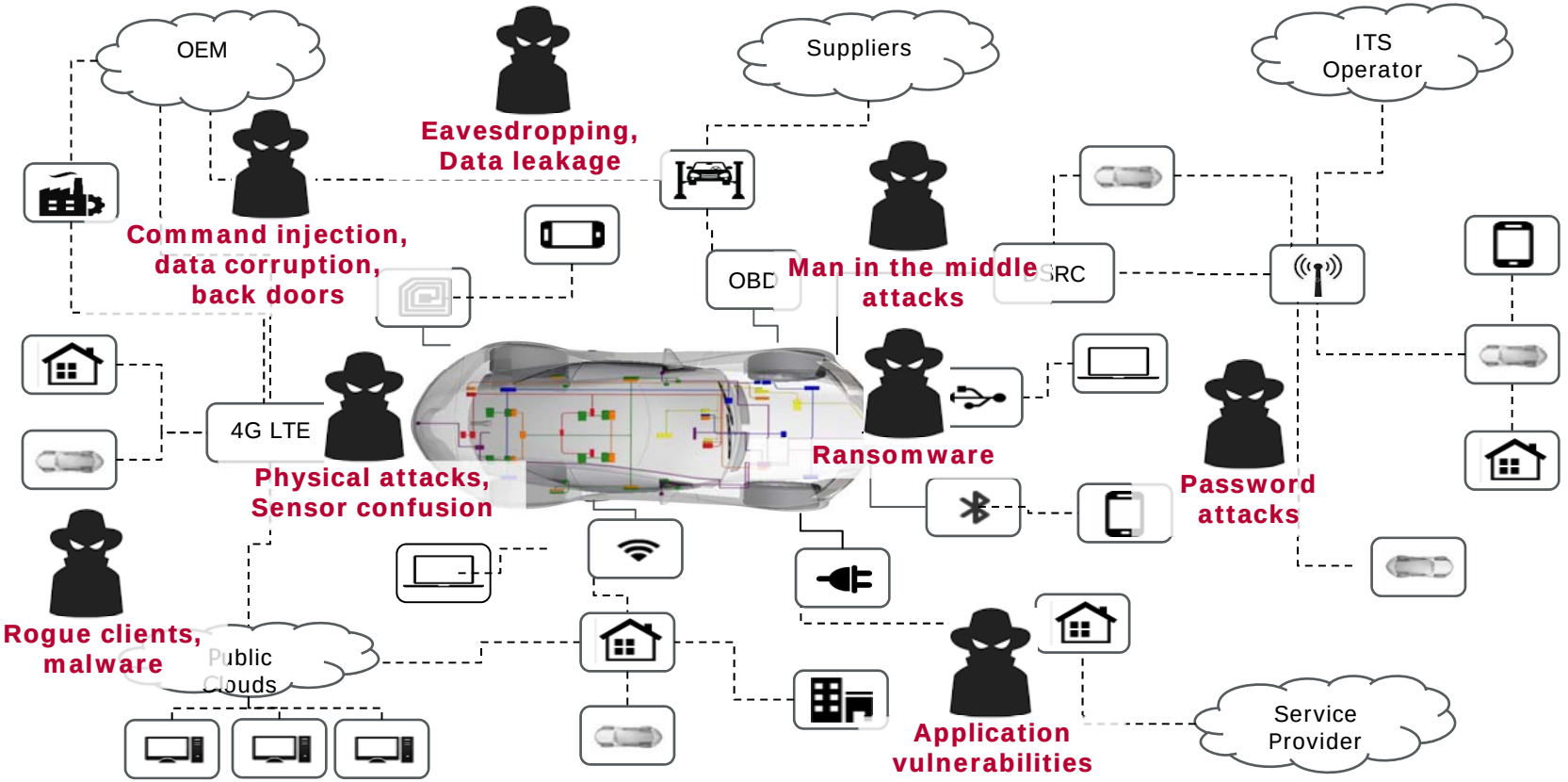
Need: Systematic dependency management

Challenge: Heterogeneity



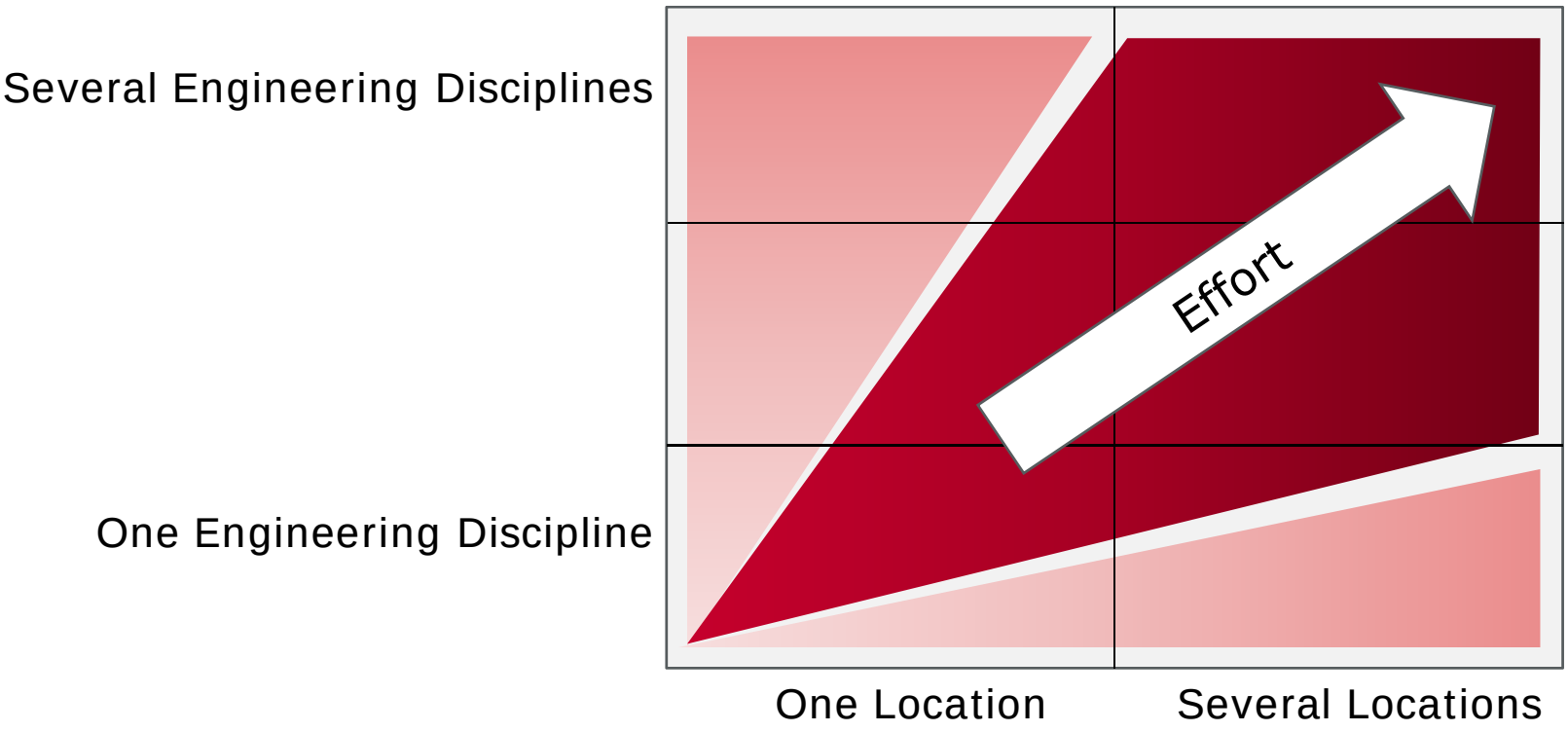
Need: System level cost optimization

Challenge: Cyber Security



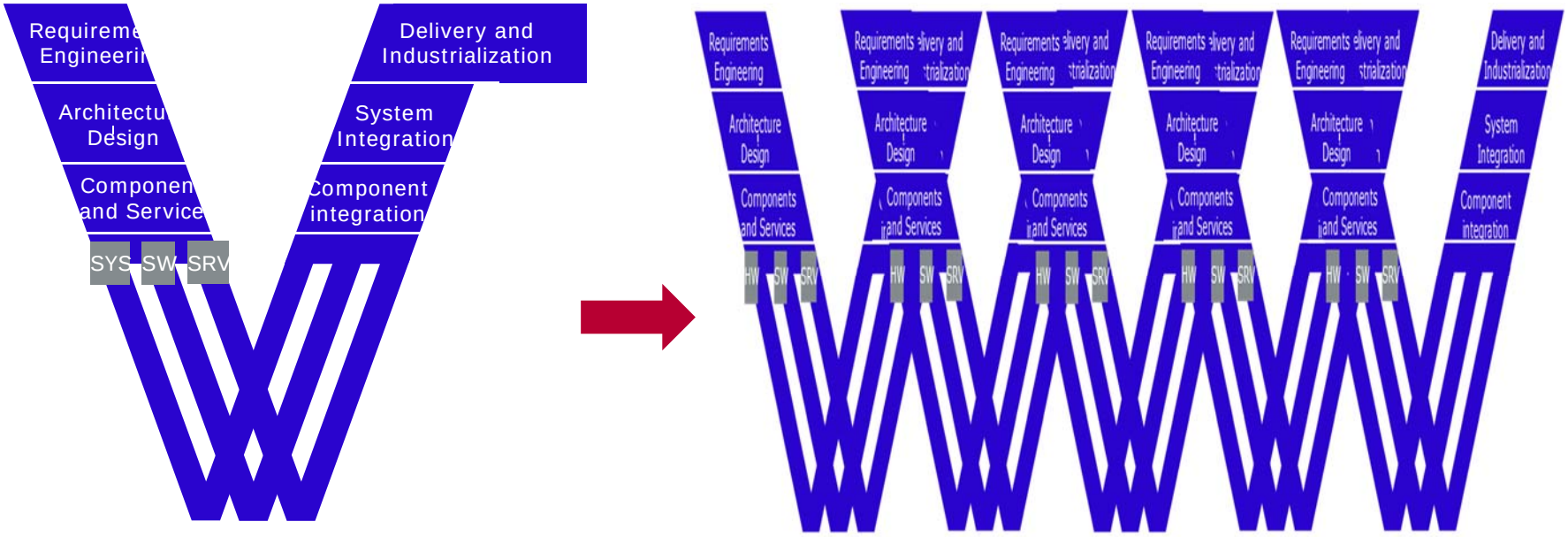
Need: Robust systems engineering for cyber security threats

Challenge: Global Collaboration



Need: Orchestrating distributed engineering across locations and disciplines

Challenge: Interdependencies



Need: Agile development and alignment of systems engineering, software/IT/EE and services

Agenda

- Welcome
- Challenges
- **Agile Systems Engineering**
- Ford Case Study
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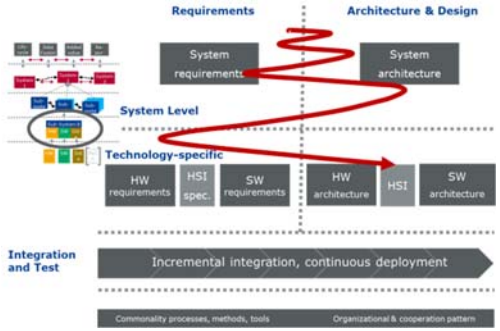
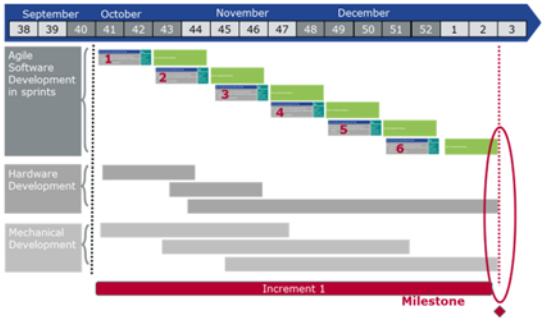
Levers for Agile Systems Engineering

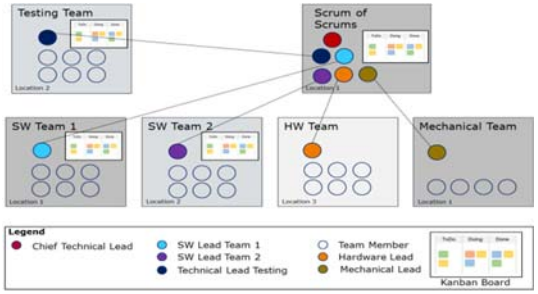
Quality and Efficiency



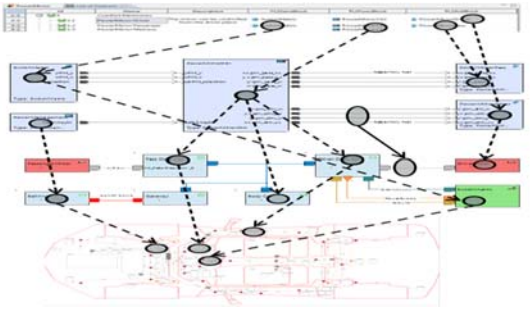
Agile Techniques



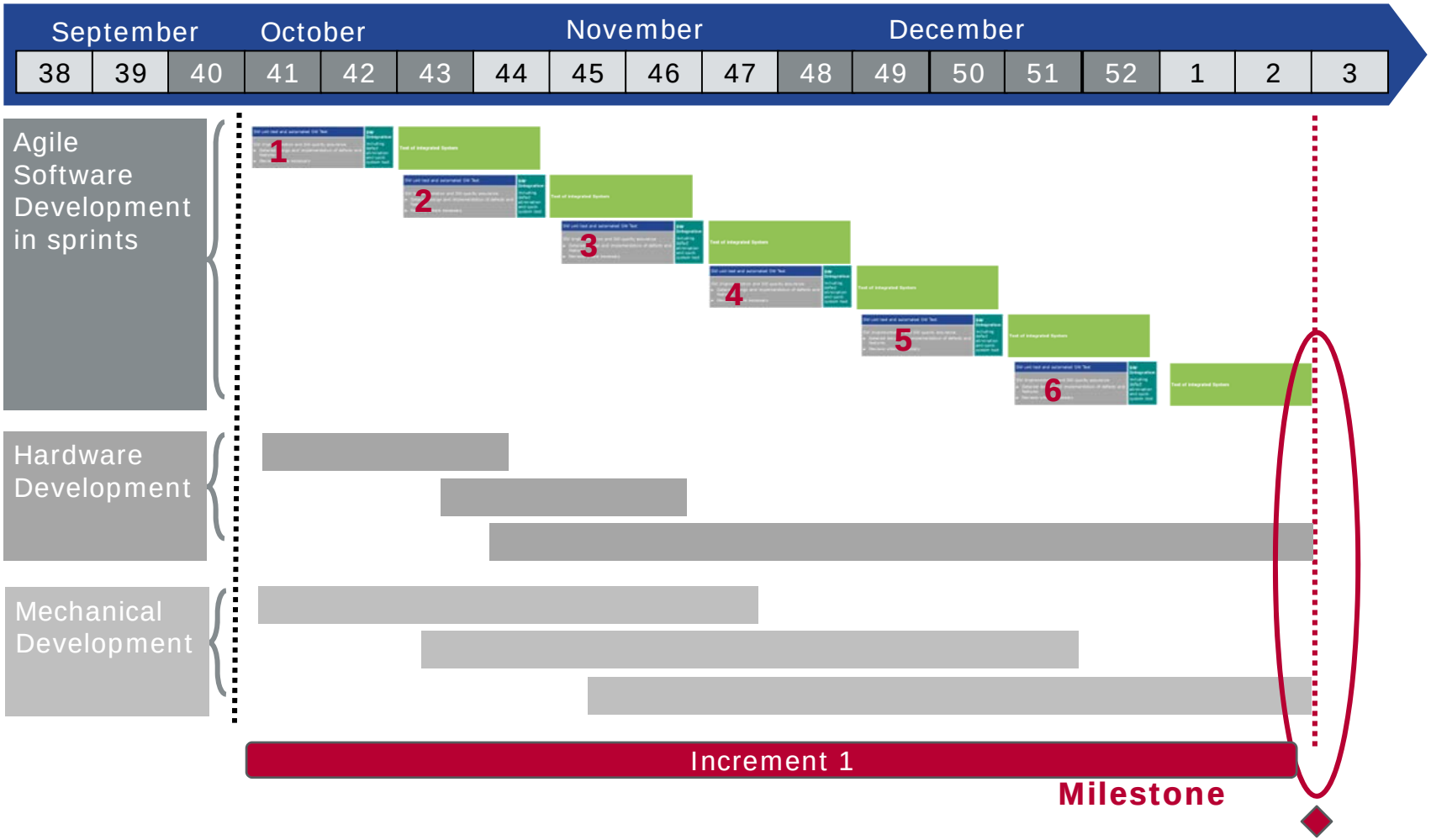
Collaboration and Cooperation



Modeling and Simulation



Lever 1: Agile Techniques



- Synchronize all domains on defined milestones

n: Sprint Number

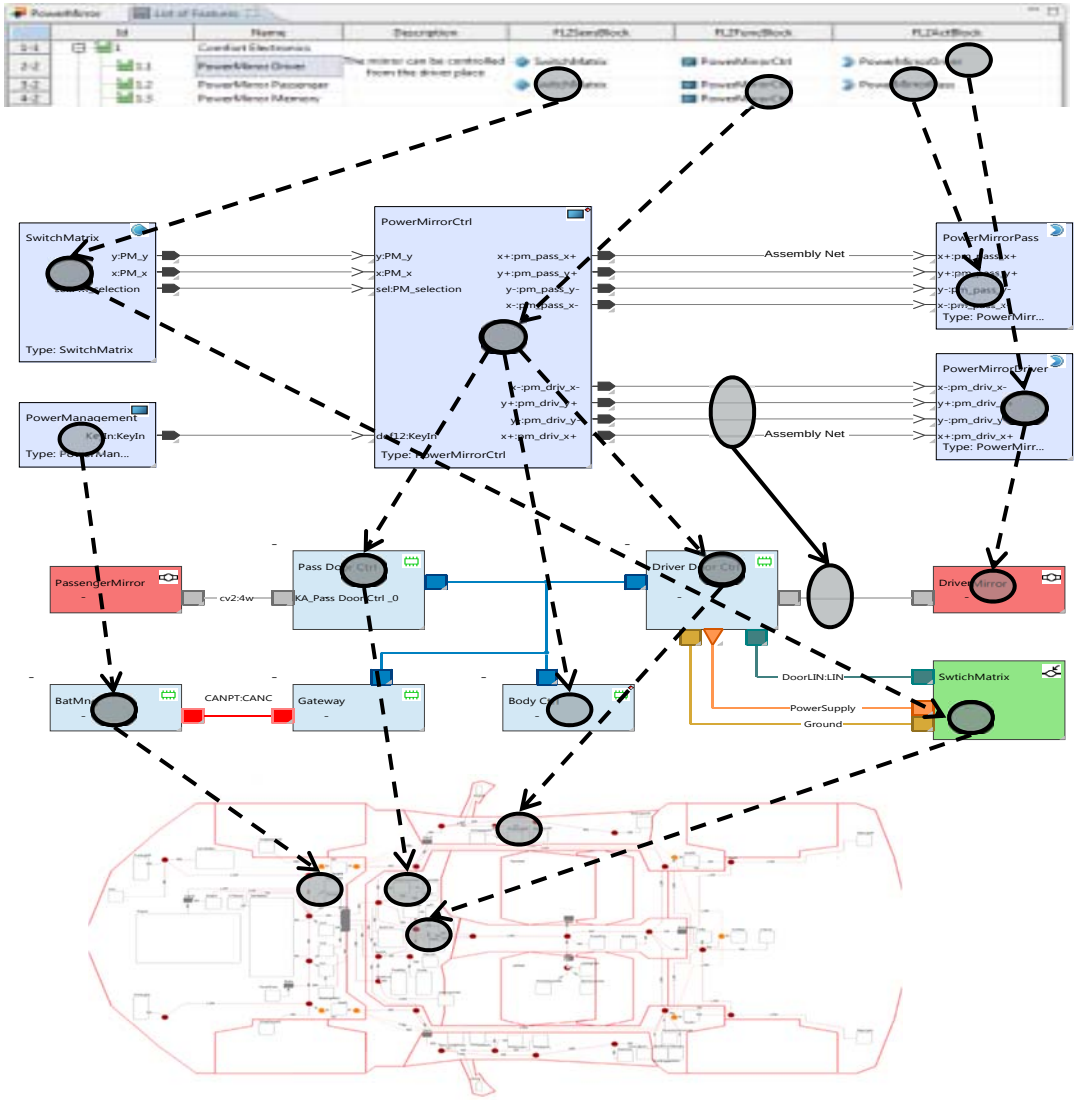
Lever 2: Modeling and Simulation

System Requirements

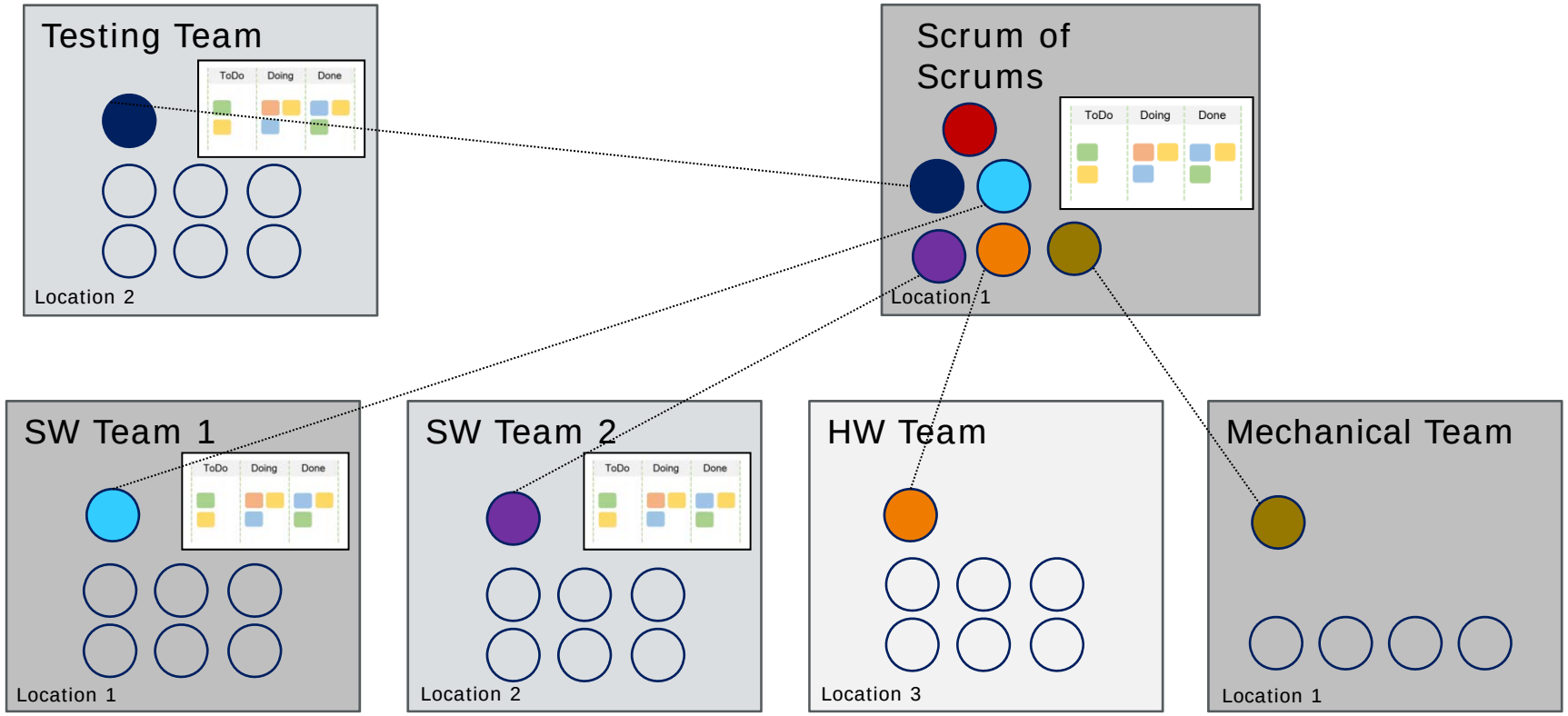
Logical System Architecture

Component Architecture

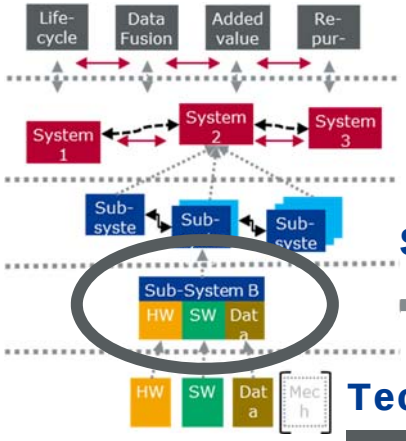
Simulation Implementation



Lever 3: Collaboration and Cooperation



Lever 4: Quality and Efficiency



Requirements | **Architecture & Design**

System requirements

System architecture

System Level

Technology-specific

HW requirements | HSI spec. | SW requirements | HW architecture | HSI | SW architecture

Integration and Test

Incremental integration, continuous deployment

Commonality processes, methods, tools | Organizational & cooperation pattern

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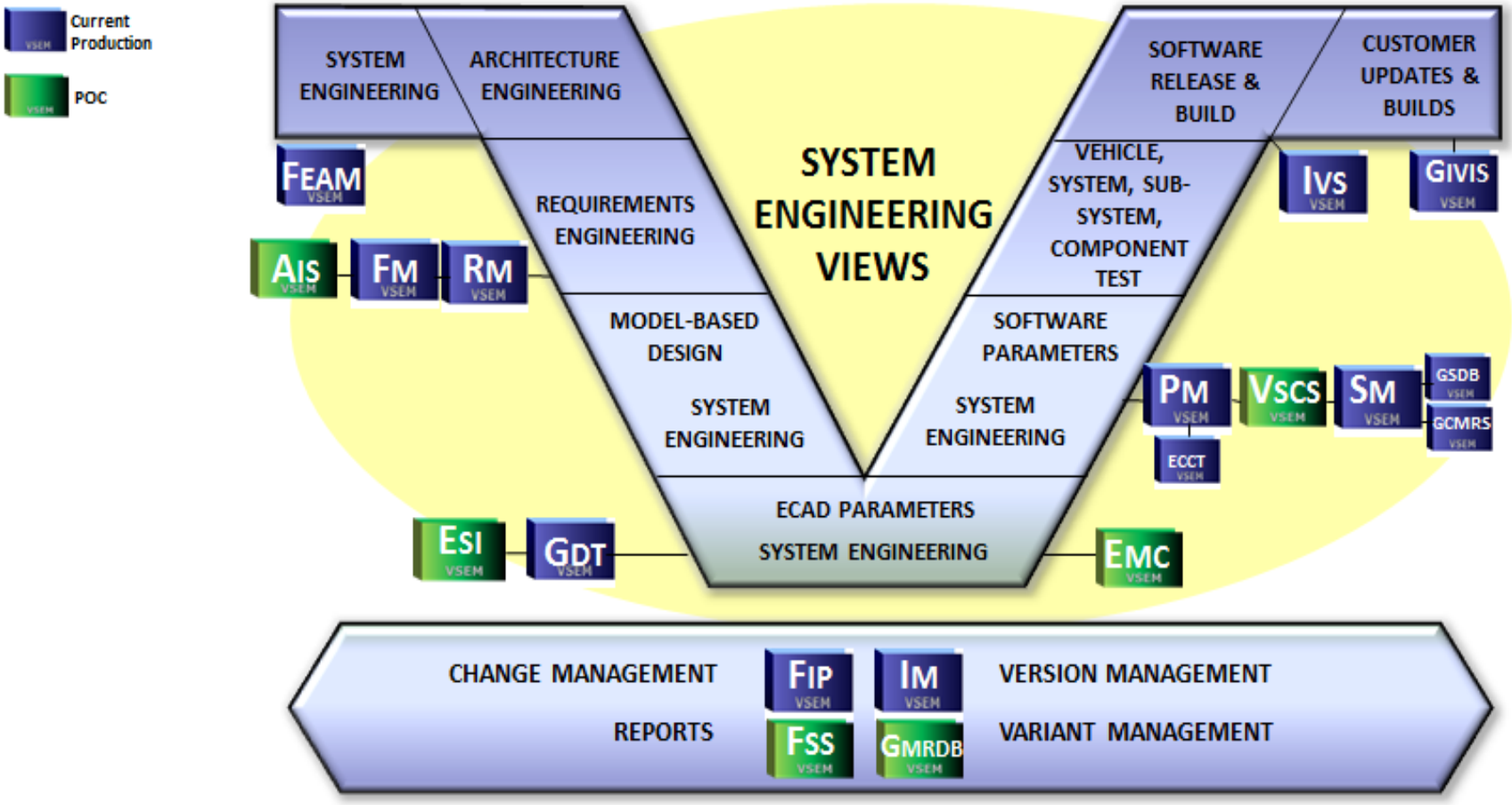
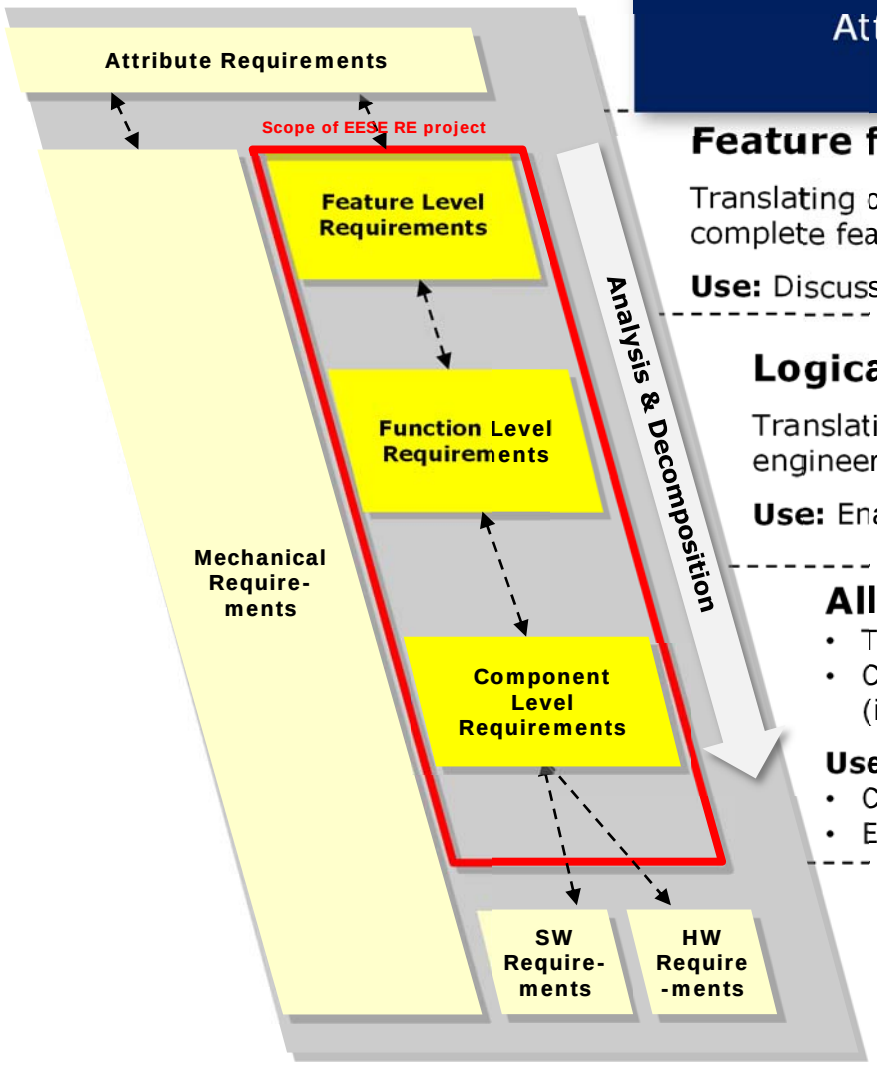
Systems Engineering Throughout the Life-Cycle



SW and System engineering requires comprehensive PLM solution

Information Model



The 3 abstraction layers close the gap between Vehicle Attributes and the Component Specification

Responsible: Feature/Function Owner

Feature from a customer perspective

Translating customer wants and market needs to stable, consistent and complete feature requirements

Use: Discussion/negotiation with customer representatives (e.g. marketing)

Logical functions necessary to implement the features

Translating customer requirements to **implementation independent** engineering requirements.

Use: Enable efficient reuse of specifications across ECUs and carlines (Core)

Allocated logical functions (platform / ECU)

- Technical interfaces of components (e.g. ECUs) are determined
- Component behavior is enhanced/refined by technical requirements (implementer)

Use:

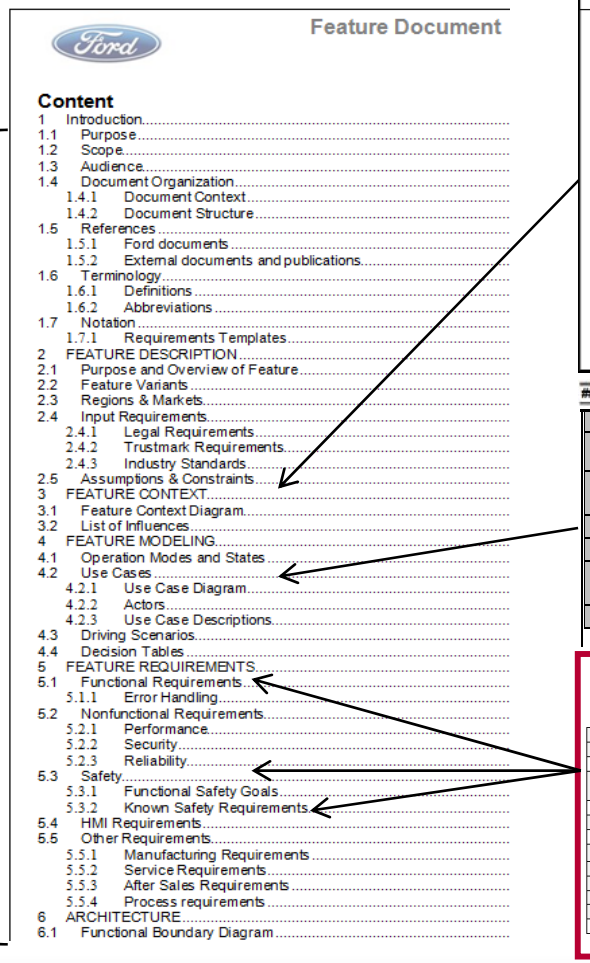
- Consistency of x-ECU interfaces enable interoperability
- Efficient data exchange with supplier

Depending Business Model

- If SW is written by Ford, QPIP scope extends to SW specification details

Requirements Structure

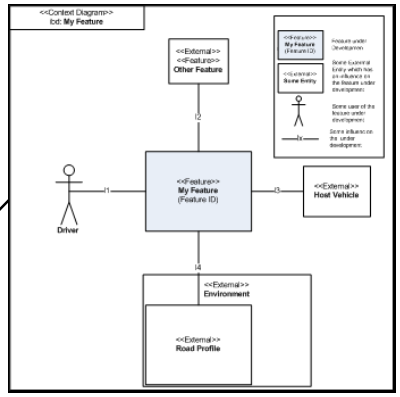
Specification
(a container with a defined structure to hold requirements and supporting information)



Feature Document

Content

1 Introduction
1.1 Purpose
1.2 Scope
1.3 Audience
1.4 Document Organization
1.4.1 Document Context
1.4.2 Document Structure
1.5 References
1.5.1 Ford documents
1.5.2 External documents and publications
1.6 Terminology
1.6.1 Definitions
1.6.2 Abbreviations
1.7 Notation
1.7.1 Requirements Templates
2 FEATURE DESCRIPTION
2.1 Purpose and Overview of Feature
2.2 Feature Variants
2.3 Regions & Markets
2.4 Input Requirements
2.4.1 Legal Requirements
2.4.2 Trustmark Requirements
2.4.3 Industry Standards
2.5 Assumptions & Constraints
3 FEATURE CONTEXT
3.1 Feature Context Diagram
3.2 List of Influences
4 FEATURE MODELING
4.1 Operation Modes and States
4.2 Use Cases
4.2.1 Use Case Diagram
4.2.2 Actors
4.2.3 Use Case Descriptions
4.3 Driving Scenarios
4.4 Decision Tables
5 FEATURE REQUIREMENTS
5.1 Functional Requirements
5.1.1 Error Handling
5.2 Nonfunctional Requirements
5.2.1 Performance
5.2.2 Security
5.2.3 Reliability
5.3 Safety
5.3.1 Functional Safety Goals
5.3.2 Known Safety Requirements
5.4 HMI Requirements
5.5 Other Requirements
5.5.1 Manufacturing Requirements
5.5.2 Service Requirements
5.5.3 After Sales Requirements
5.5.4 Process requirements
6 ARCHITECTURE
6.1 Functional Boundary Diagram



###UseCase_ID>### Use Case Title

Actors	Vehicle Occupant
Pre-conditions	The Driver Profiles feature is set to Off (ie enhanced memory feature is turned Off).
Scenario Description	The User accesses the Driver Profiles HMI from the touchscreen and chooses to enable the Driver Profiles feature (set to On).
	The system sets the Driver Profile feature to ON and indicates this to the user
Post-conditions	The Driver Profiles feature is now set to ON and a new profile can be created.
List of Exception Use Cases	
Interfaces	Personalization Interface

###F_FeatureName_00001### Requirements Title

<Description>

Requirement ID: F_FeatureName_00002			
Rationale			
Acceptance_Criteria			Verification Method
Notes			
Type	Choose an item.	Source	
Priority	Choose an item.	Owner	
Stability	Choose an item.	ASILLevel	Choose an item.

Change Log

Version	Date	Author	Change
1			Initial version

Supporting specifications / Artifacts

(Models, Use Cases, Explanatory text paragraphs)

Requirement

Defined structure for gathering individual requirements (e.g. Feature Document)

Improving Quality and Collaboration with Good Documentation

REQ-199754/A-Opt-In Create Driver Profile

Enhanced Memory shall require a user to Opt-in before enabling this feature and creating first Driver Profile. Without the opt-in step the user cannot create any Driver Profiles and the vehicle will operate as it does normally without separate Driver Profiles for different drivers. (*Example from Feature Document without attributes table*)

Combine text and graphics

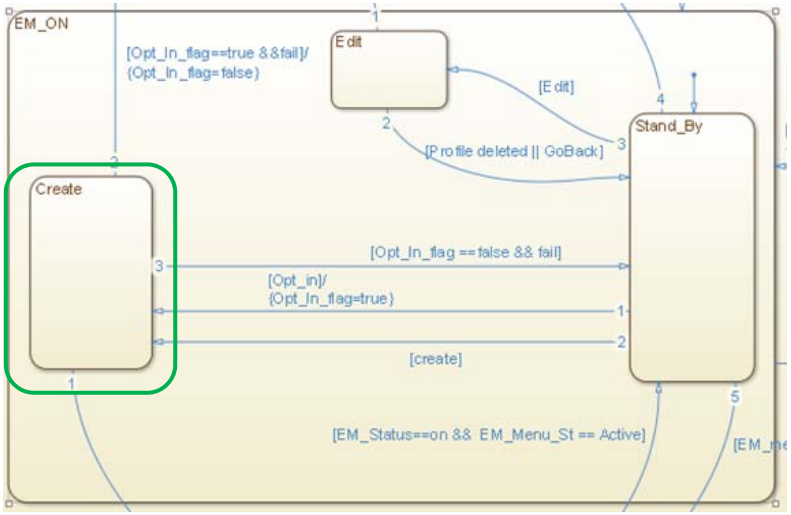


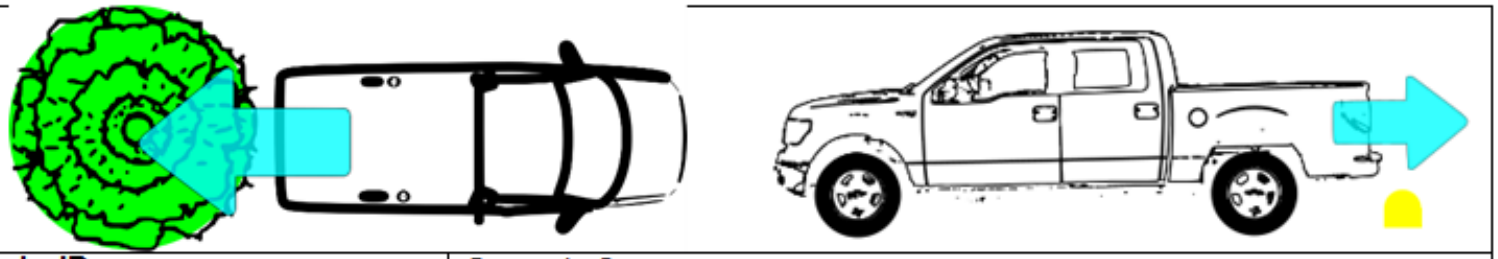
Figure –Operation Modes

ENMEM-REQ-199754/A-Opt-In Enhanced Memory Feature to Create Driver Profile

Creation of Driver Profiles is only allowed in state *Create* (refer to *figure 3)*. The vehicle will operate as it does normally without separate Driver Profiles for different drivers.

Example: System Level Requirements

Purpose: Complete understanding of feature by using scenarios and other modeling techniques



Scenario ID	Scenario 2
Reference	…. tbd
Short Description	Do not intervene if a stationary object is in the path of the host vehicle if the driver is backing toward it carefully (below feature activation speed threshold).
Condition (location, weather, street conditions, light, obstacles)	No specific conditions

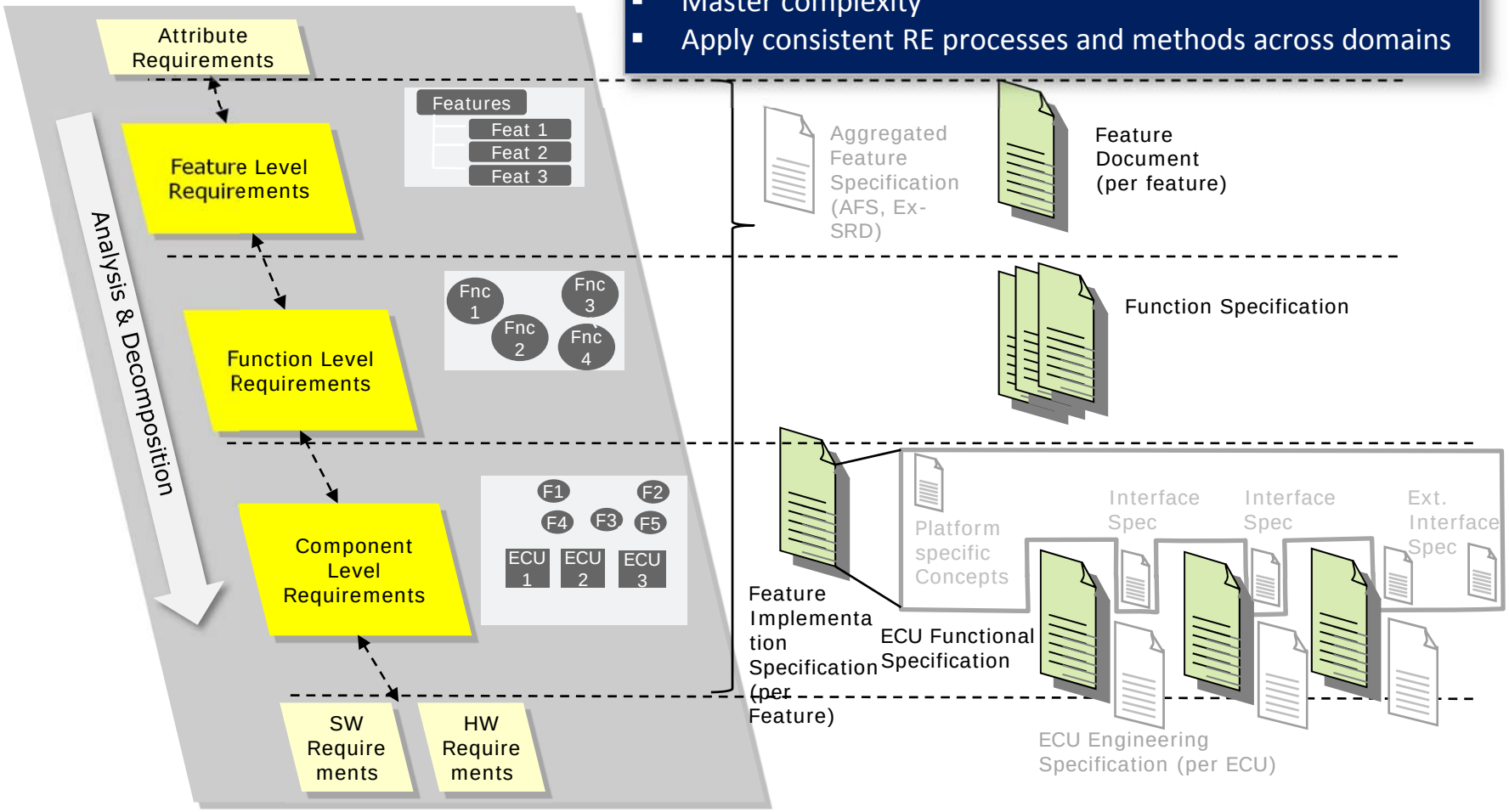
Flow of Actions	
1	The Driver is actively backing the vehicle.
2	The vehicle is approaching a stationary object behind the vehicle.
3	Driver is attentive moving slowly toward object.
4	The feature RBA does not intervene.
5	Feature RBA sends a message to the driver that the system is inactive.
6	The Driver responds by manually applying the brakes at the appropriate time.
7	Scenario ends.

Driving scenarios technique has been developed in pilot projects.

Consistent Documentation and Tool Support

QPIP RE work stream defines 1 template per abstraction level (on component level 2) to

- Master complexity
- Apply consistent RE processes and methods across domains



Benefits – Examples from Ford Projects

- Ownership: Self-organization reduces collaboration effort significantly compared to classic project management approach.
- Transparency of project status is significantly improved.
- Velocity and quality are improved. Management and teams recognize and value improvements and agile team spirit.
- Improved design speed and reuse.
- Product complexity is better managed and controlled.
- Architectural complexity control.

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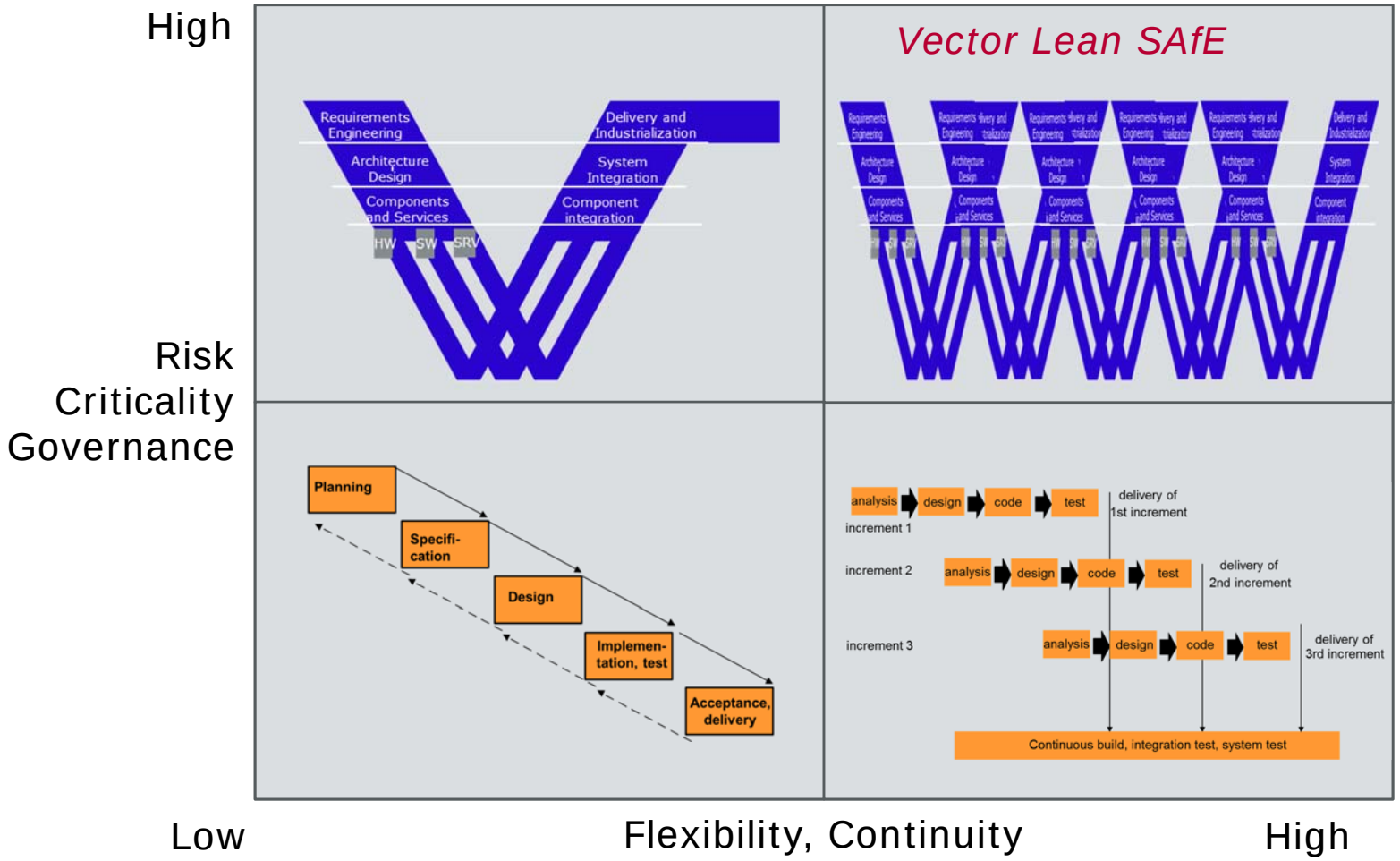
Agile Systems Engineering



Source: Ebert, Requirements Engineering, 2017

VECTOR

Benefits – Vector Examples across Industries

- **Collaboration**
  - Collaboration effort has been reduced by over 20% with agile systems engineering.
- **Predictability**
  - Availability of results
  - Project transparency
- **Velocity and product quality**
  - Customers, management and teams recognize and value improvements and agile team spirit.

Customer (Component Supplier):

"I simply open the Kanban Board of the Scrum of Scrums meeting. If I see no progress after 3 days, I know the team has a problem. But I do not see this often."

End Customer (Systems OEM), 2 weeks after start:

"Now we see progress!"

Introduce agile systems engineering before complexity gets overwhelming.

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Vector Forum: Agile in Practice

28. June 2018
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