Managing complexity in automotive development

Brett Hillhouse
Global Automotive Leader
AI Applications

Automotive companies continue to struggle with the increasing complexity

Business Goals	IBM Approach
Improve Vehicle Quality	Explicitly support process and safety standards including the ASPICE framework
Increase Reuse	Enable strategic reuse through IBM's unique global configuration capability
Improve On-time Delivery	Support SAFe for agile development in systems, sw and electrical engineering

ASPICE in a nutshell

***A**utomotive **S**oftware **P**rocess **I**mprovement and **C**apability D**e**termination (ASPICE)*

Governance

Maintained by Automotive Companies & required by Automotive OEMs

Assessment

Projects shall follow state of the art system & software engineering practices

Factors that accelerate relevance of ASPICE

Past	Today
Focus on Software development process	Focus on Systems and Software development
ASPICE primarily common among German OEMs	Accepted standard by Automotive OEMs worldwide
ASPICE burden for suppliers of single components	OEM‘s strive for ASPICE on vehicle level (System of Systems)

ASPICE

The ASPICE standard is about assessing process maturity

Acquisition Process Group (ACQ)

- **ACQ.3** Contract Agreement
- **ACQ.4** Supplier Monitoring
- **ACQ.11** Technical Requirements
- **ACQ.12** Legal and Administrative Requirements
- **ACQ. 13** Project Requirements
- **ACQ. 14** Request for Proposals
- **ACQ. 15** Supplier Qualification

System Engineering Process Group (SYS)

- **SYS.1** Requirements Elicitation
- **SYS.2** System Requirements Analysis
- **SYS.3** System Architectural Design
- **SYS.4** System Integration and Integration Test
- **SYS.5** System Qualification Test

Software Engineering Process Group (SWE)

- **SWE.1** Software Requirements Analysis
- **SWE.2** Software Architectural Design
- **SWE.3** Software Detailed Design and Unit Construction
- **SWE.4** Software Unit Verification
- **SWE.5** Software Integration and Integration Test
- **SWE.6** Software Qualification Test

Management Process Group (MAN)

- **MAN.3** Project Management
- **MAN.5** Risk Management
- **MAN.6** Measurement

Support Process Group (SPL)

- **SPL.1** Supplier Tendering
- **SPL.2** Product Release

Supporting Process Group (SUP)

- **SUP.1** Quality Assurance
- **SUP.2** Verification
- **SUP.4** Joint Review
- **SUP.7** Documentation
- **SUP.8** Configuration Management
- **SUP.9** Problem Resolution Management
- **SUP.10** Change Request Management

Reuse Process Group (REU)

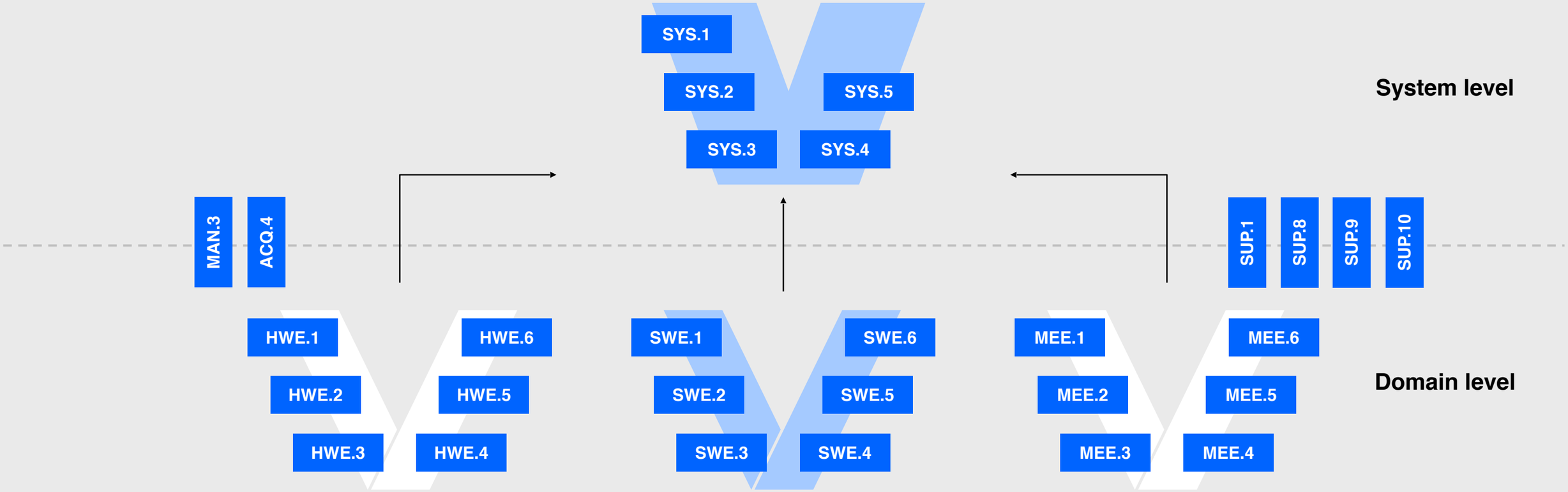
- **REU.2** Reuse Program Management

Process Improvement Process Group (PIM)

- **PIM.3** Process Improvement

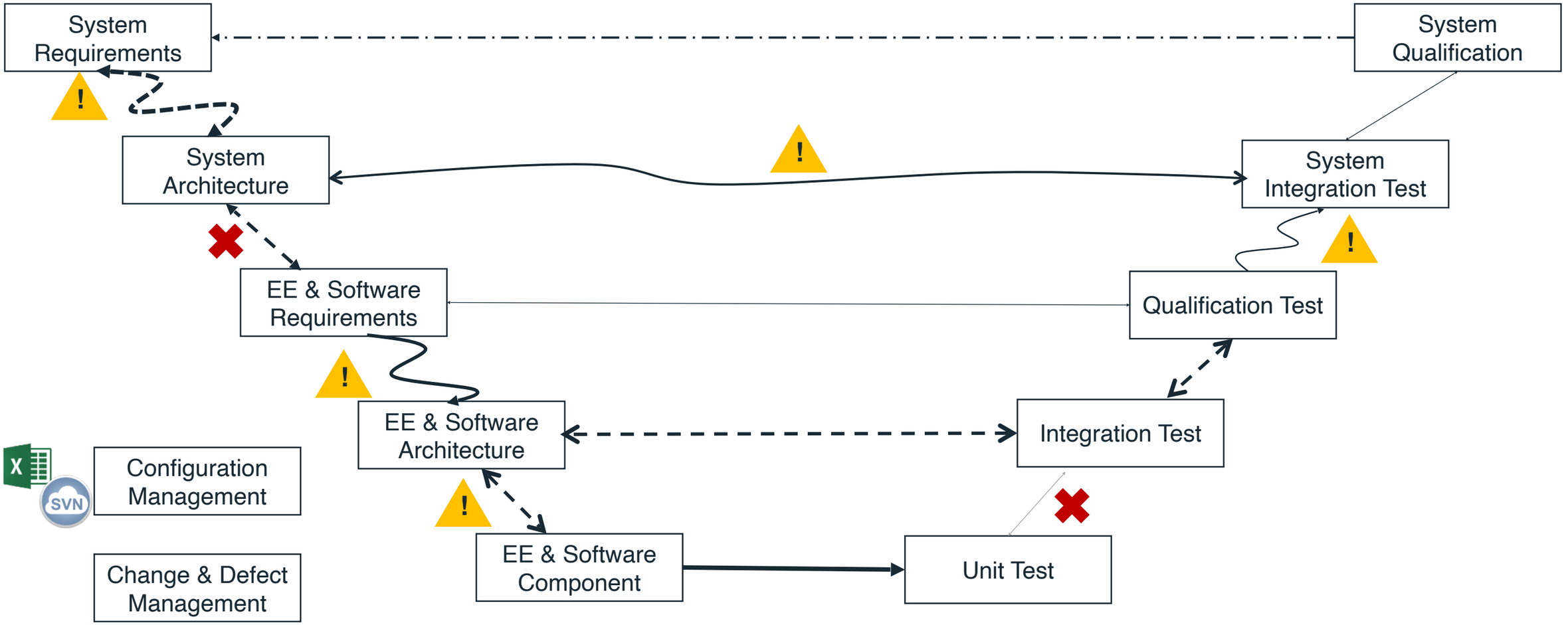
Primary life Cycle Processes | **Organizational life Cycle Processes** | **Supporting life Cycle Processes**

ASPICE defines a plug-in concept for different domains which makes it a good engineering process framework



SYS: System engineering
SWE: Software engineering
HWE : Hardware (electrical) engineering
MEE: Mechanical engineering

Traceability is a common issue Automotive Engineering



Automotive development requires adherence to a range of standards

ASPICE

ⓘ *Process Maturity Model derived from ISO 15504 (SPICE)*

☛ Maturity in development processes to achieve high work product quality (Usually, Systems and Software Processes require Level 2-3)

ISO-26262

ⓘ *Automotive functional safety standard based on IEC 61508*

☛ Safety concept based on Hazardous Analysis, Safety Goals to prohibit danger that originate from system operation

SOTIF

ⓘ *SOTIF term refers to ISO/PAS 21448 norm*

☛ Safety in the absence of fault (Functionality that relies on situational awareness - autonomous systems)

Cybersecurity

ⓘ *ISO/SAE 21434 to satisfy UNECE and EU Regulations*

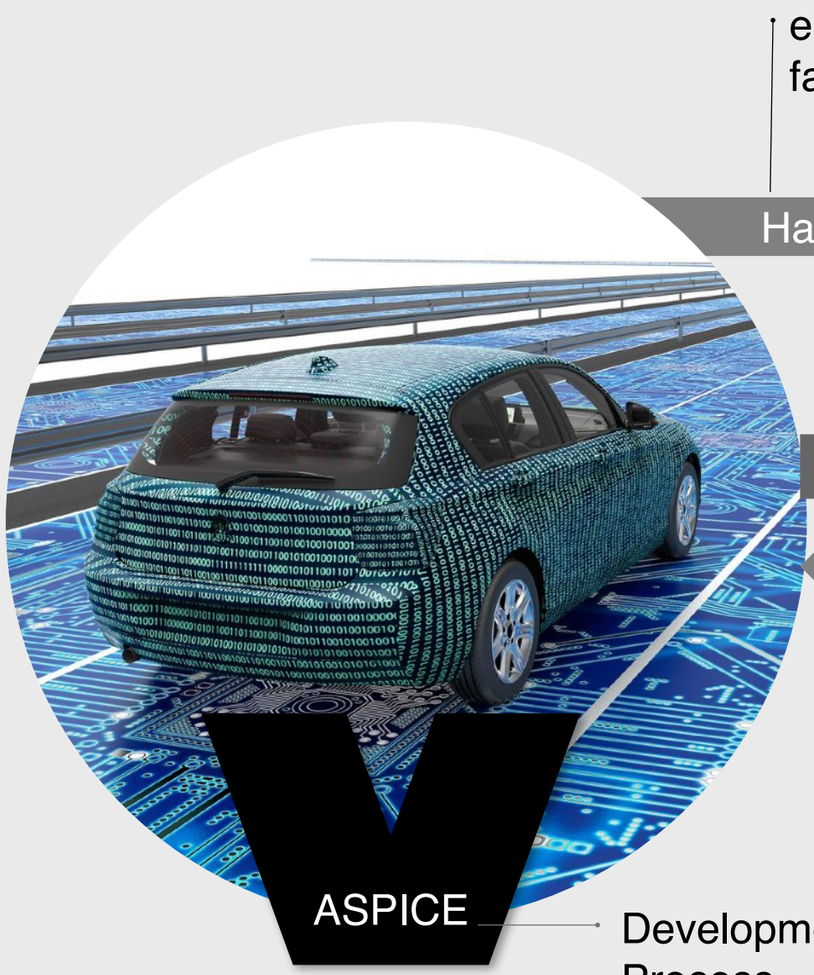
☛ Security measures to prohibit hacking vulnerabilities

IATF-16949:2016

ⓘ *Quality Management standard is based on EN ISO 9001*

☛ OEMs who are members of the IATF (International Automotive Task Force) require their suppliers to be certified according to IATF 16949

Standards work complementary towards the joint goal: „Absence of unreasonable risks“



ASPICE

Development
Process
Quality

e. g. Dangerous
fault

Hazard

Functional
Safety

e. g.
Interaction
Hazard

SOTIF

Outside World

Cyber
Security

Hazard

e. g. Hacking

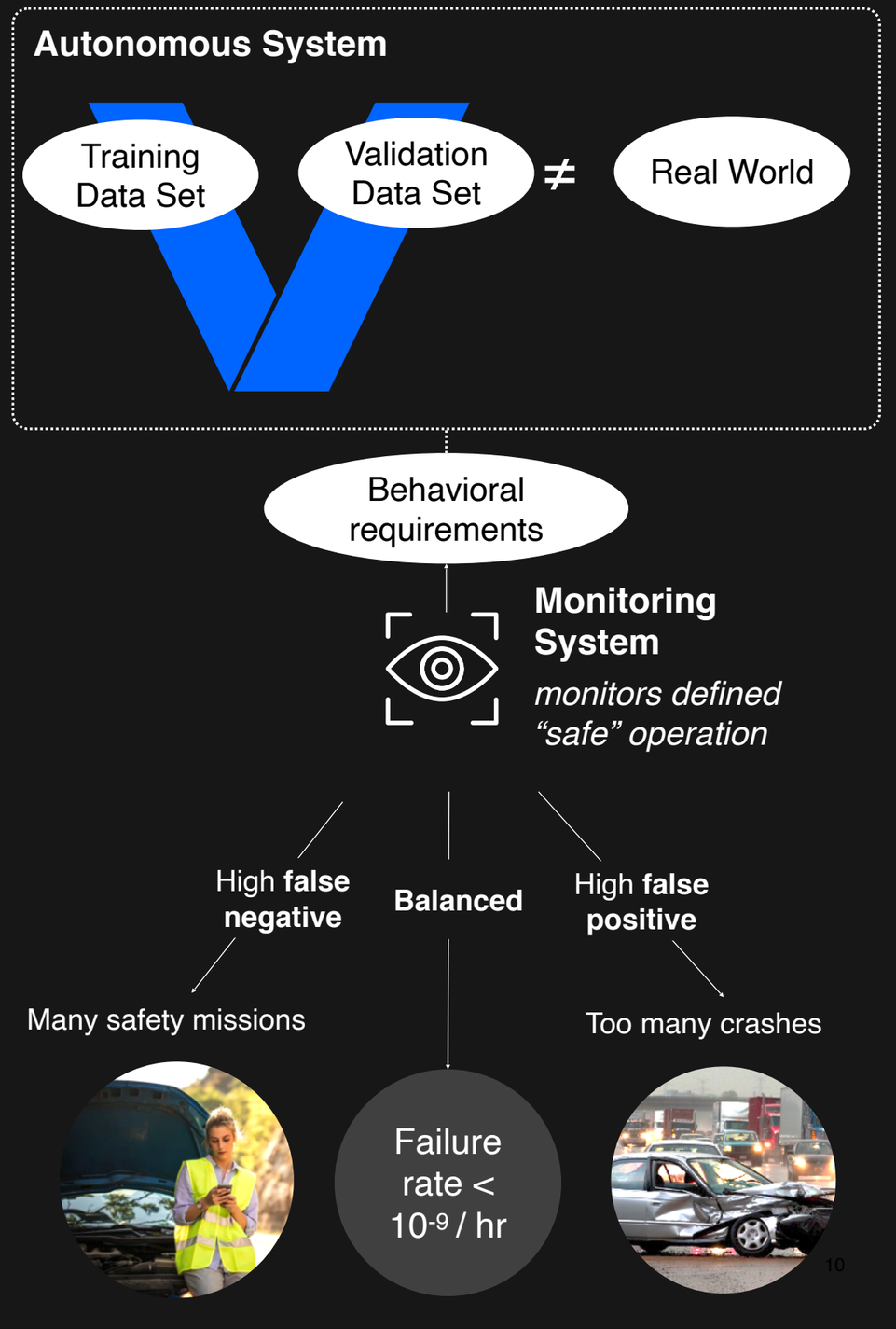
Example for a current challenge: Safety for autonomous systems

IEC 61508 Level 4 (ISO 26262 ASIL D) requires achieving low dangerous system failure rates of < 10^{-9}/hr

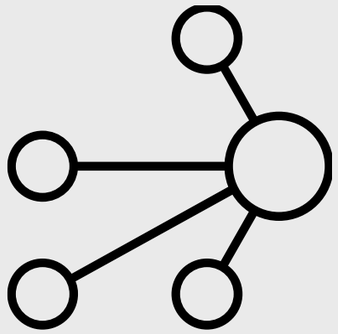
⚠ All strategies for producing safe software are vulnerable to

- ✖ Mismatch requirement and real world need
- ✖ Obsolete design (not considering latest requirements)
- ✖ Inconsistent design (vague / contradictory requirements)

☛ **Ensuring that design is using well defined & current requirements is more crucial than ever before**



AI in Engineering Example:
IBM Requirements Quality Assistant



Watson Natural Language Understanding

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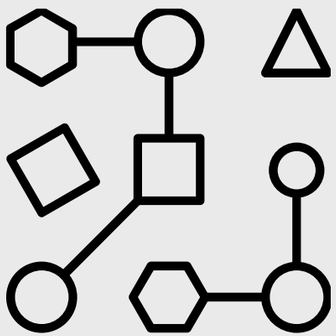

Requirements best practices and heuristics (from INCOSE Guidelines)

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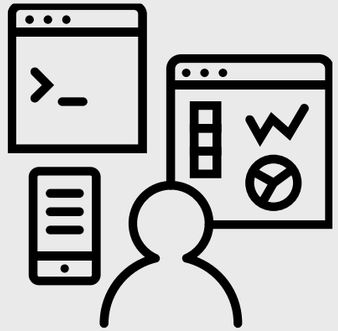
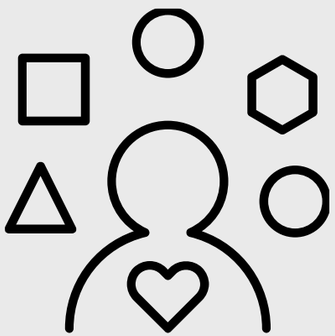


Requirements training data:
public data sets + additional client-specific data

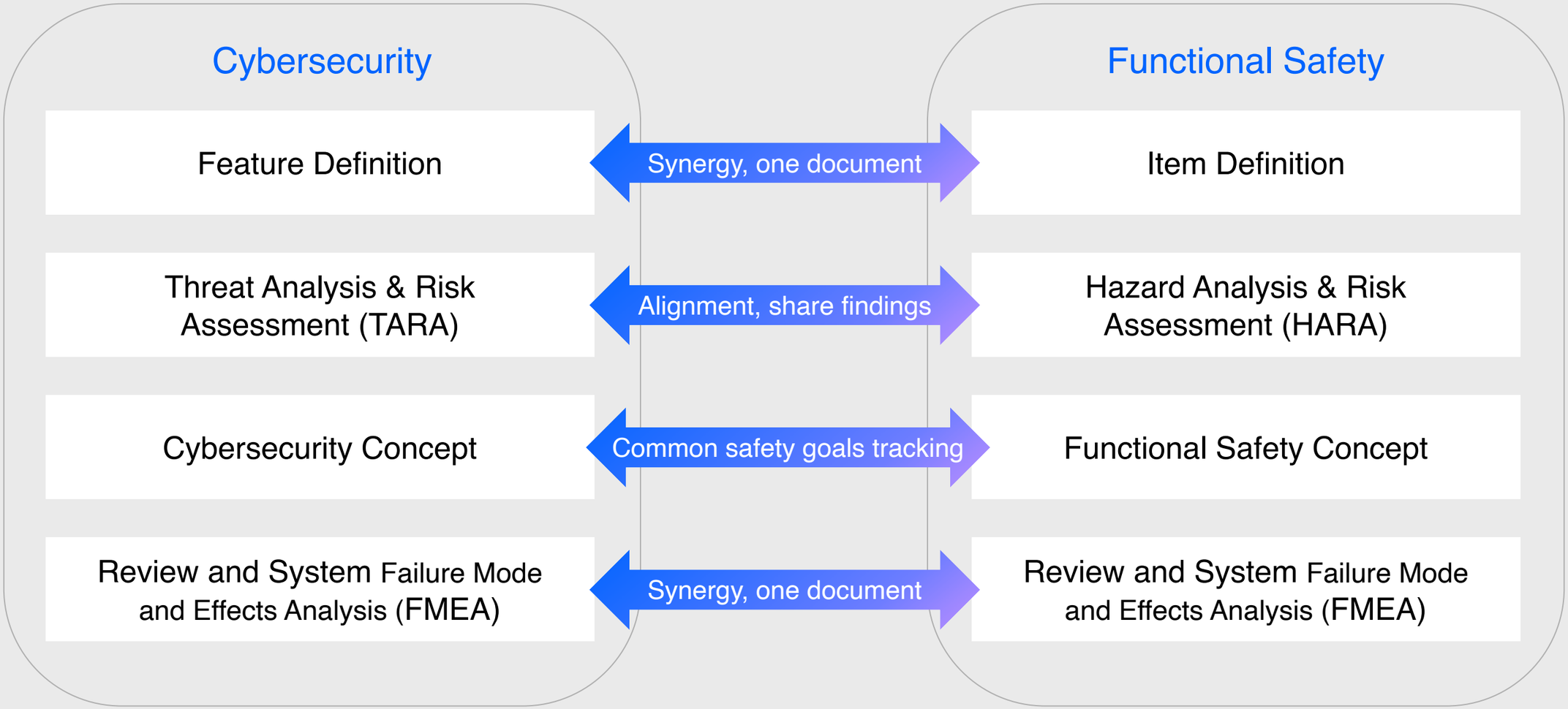


IBM Requirements Quality Assistant

Enterprise benefits

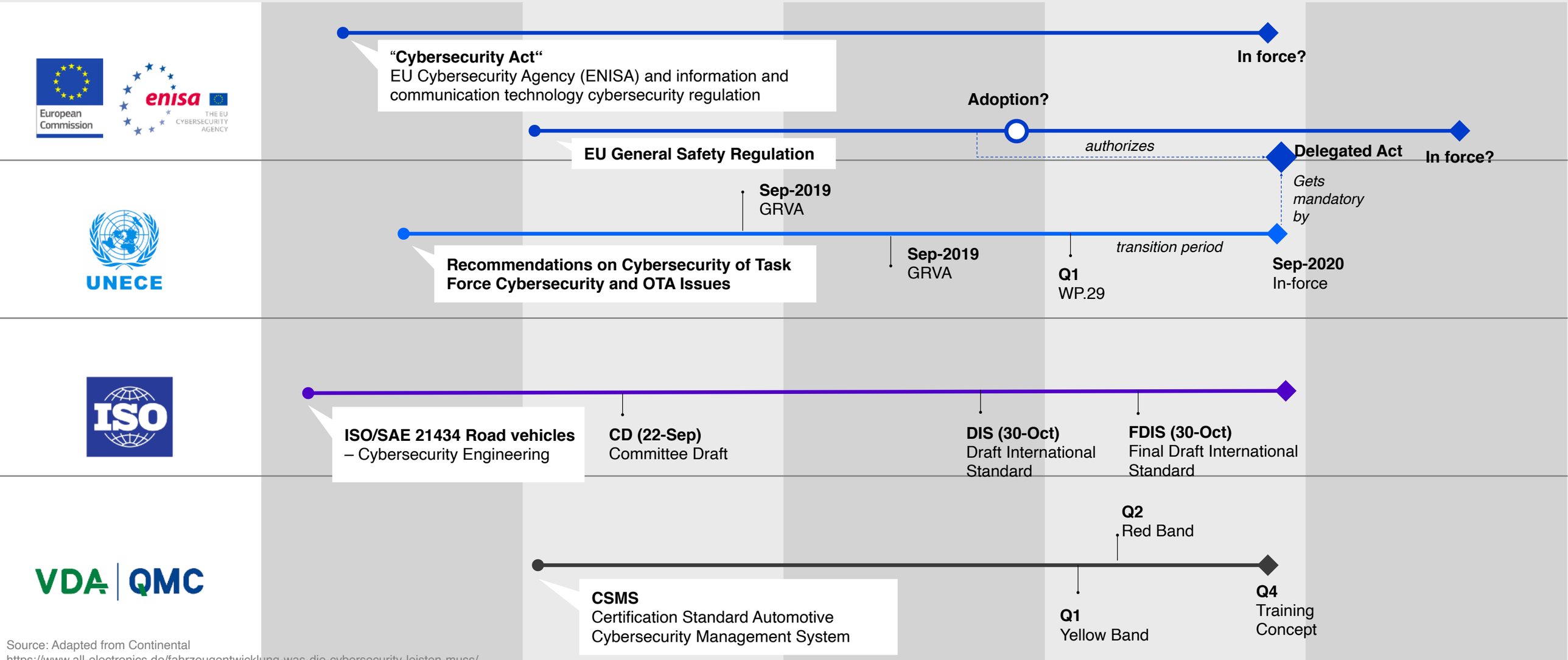
- Reduce the cost of defects by 60%
- Reduce cost of manual reviews by 25%
- Retain engineering expertise for junior engineers

In general, Cybersecurity and Functional Safety standards follow similar patterns



Source: Adapted from FEV Group, ELIV 2019

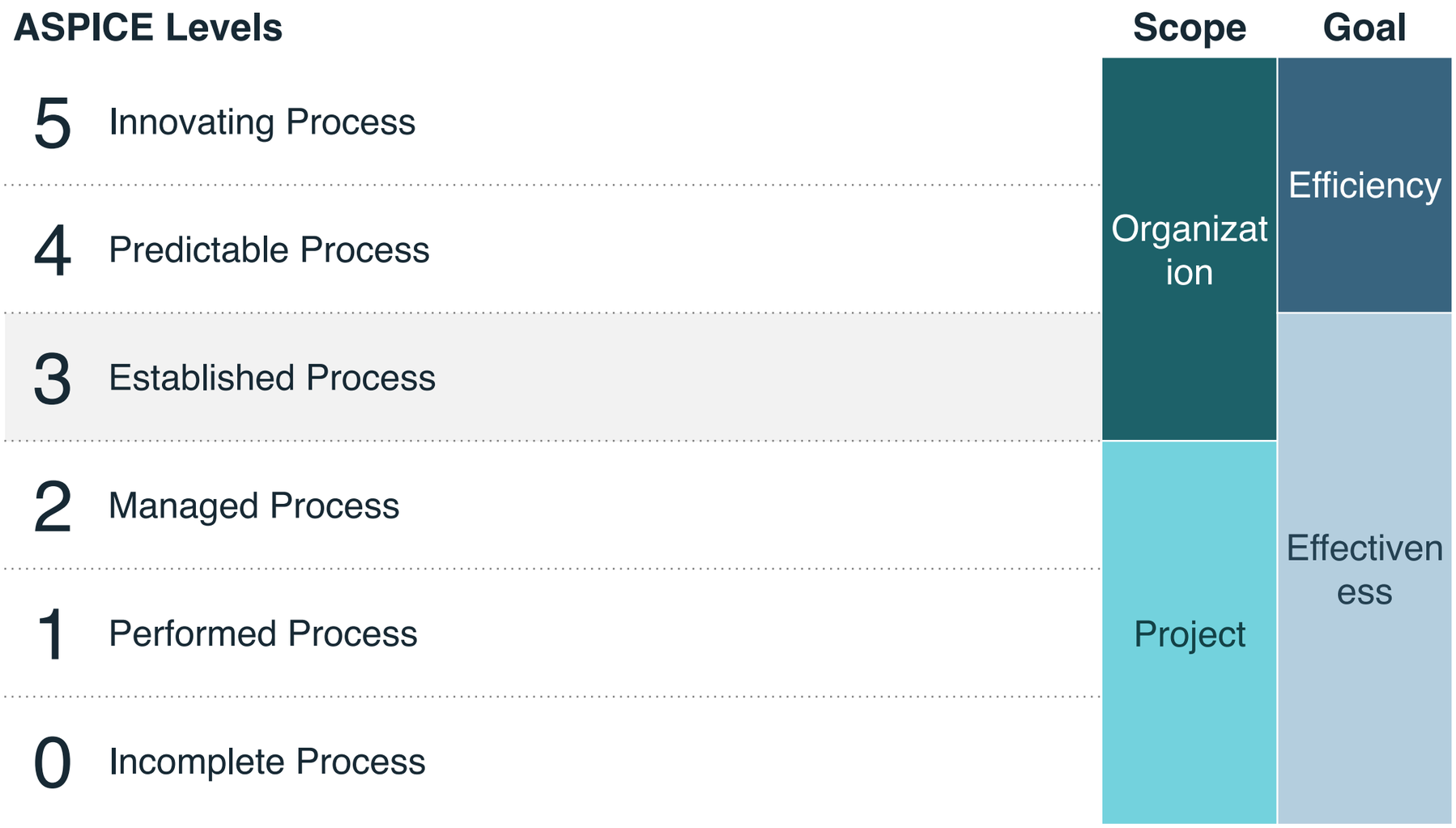
Cyber regulations are still evolving, with major milestones in 2020



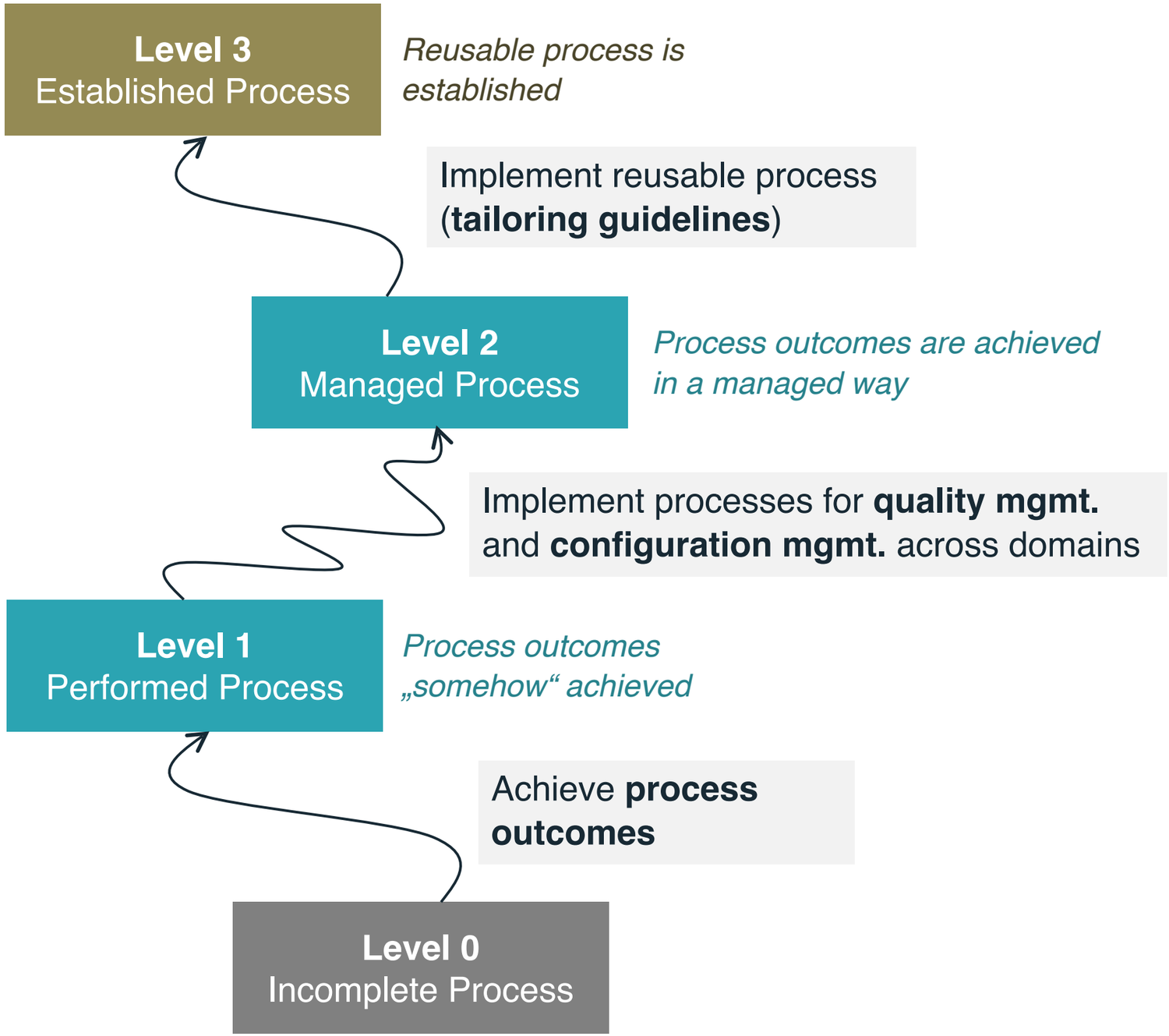
Source: Adapted from Continental
https://www.all-electronics.de/fahrzeugentwicklung-was-die-cybersecurity-leisten-muss/

ASPICE defines Levels

OEMs commonly require and aim for Level 3

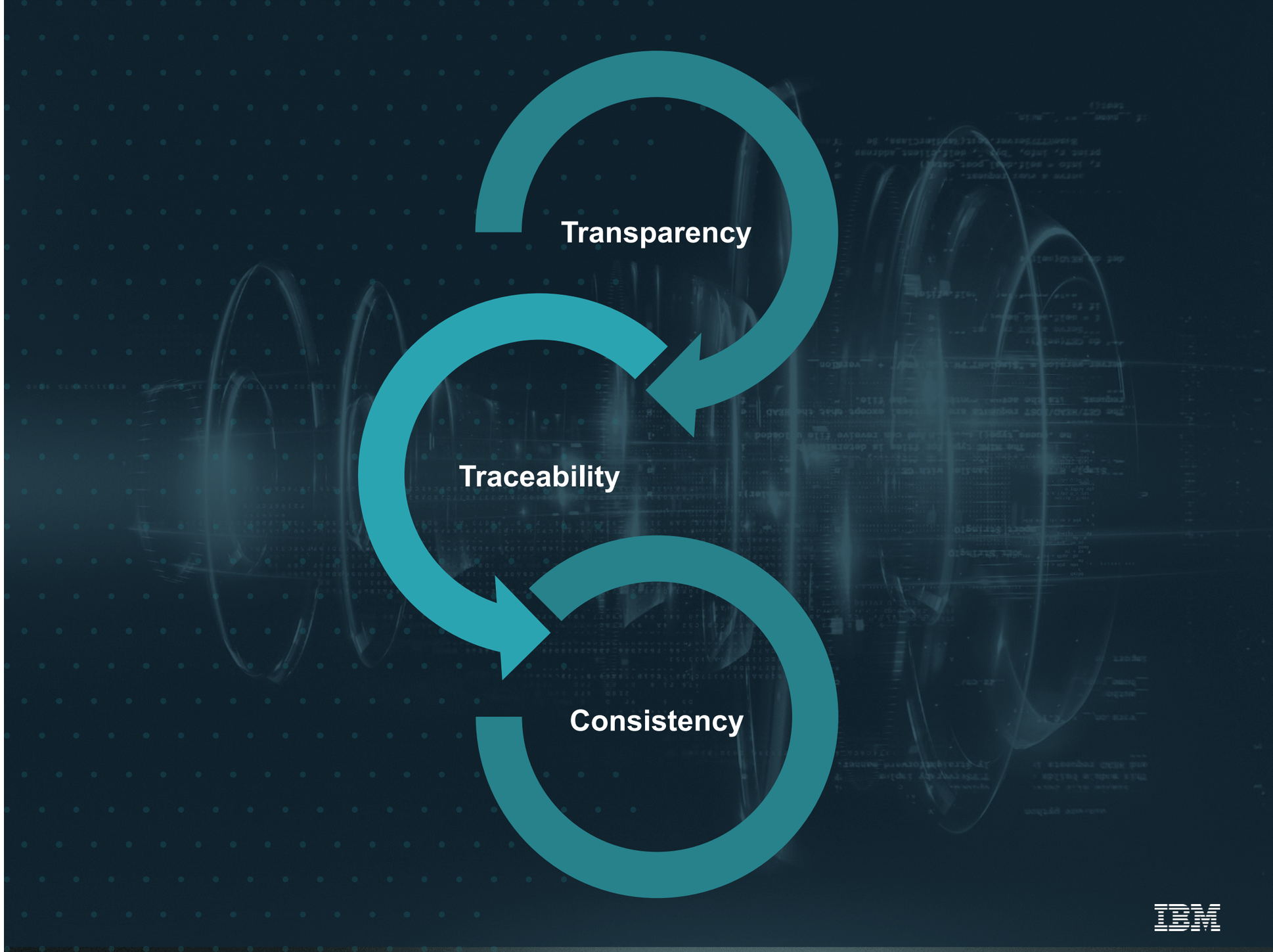


The Way to ASPICE Compliance

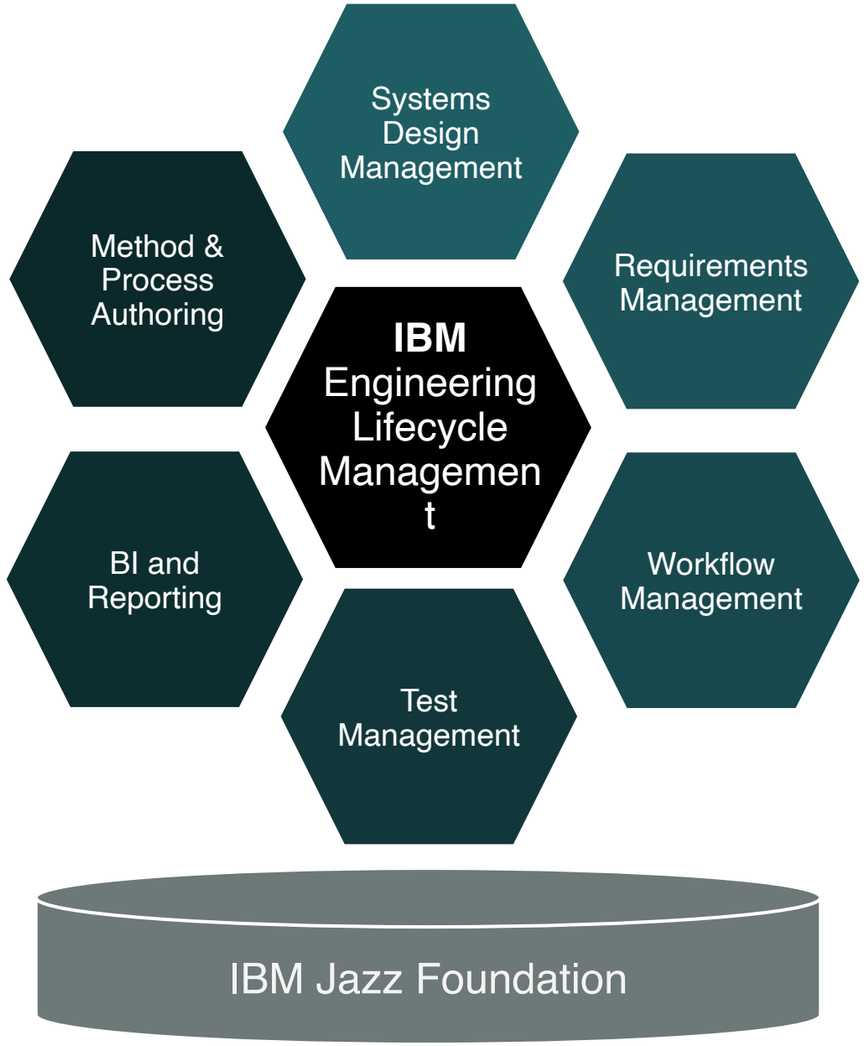


ASPICE key challenge

Handle dependencies of work products and processes



IBM ELM capabilities work with every methodology



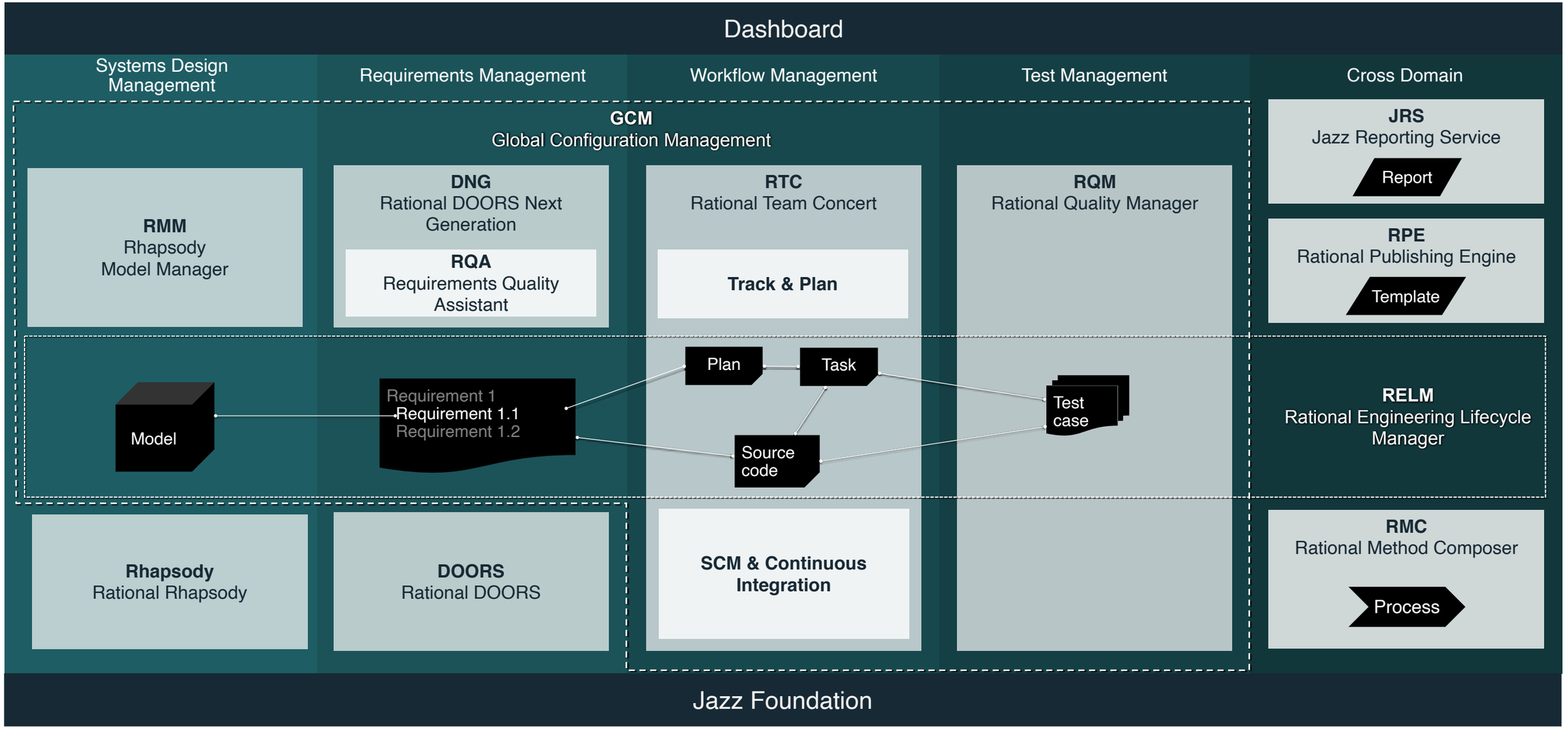
V Model ✔

Waterfall ✔

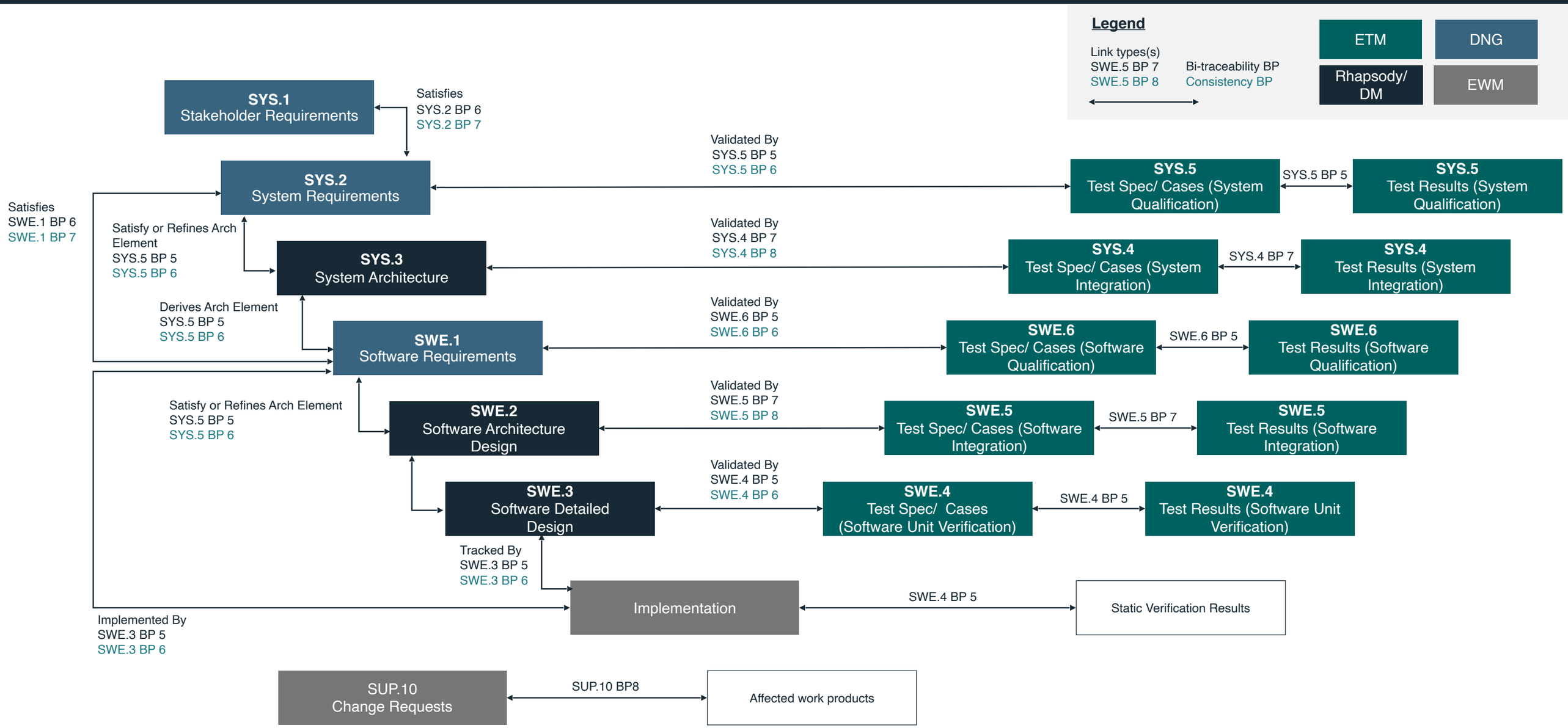
Scrum ✔

SAFe ✔

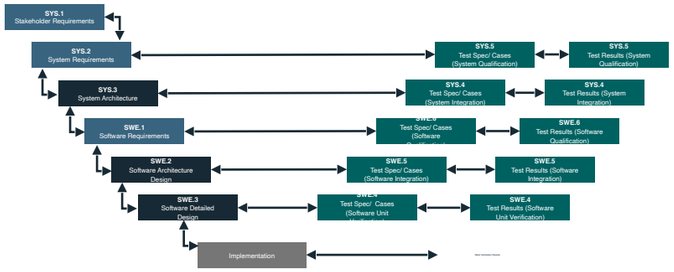
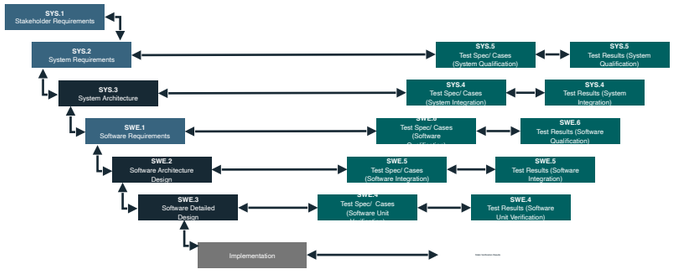
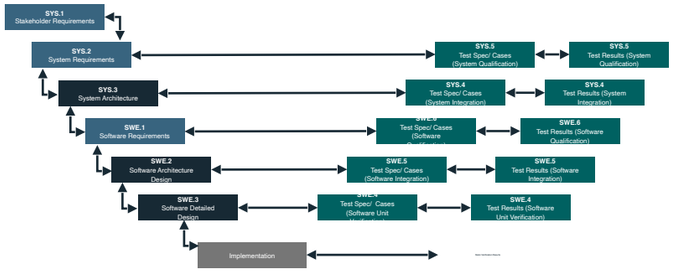
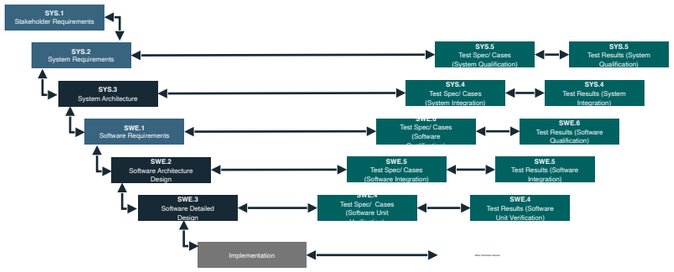
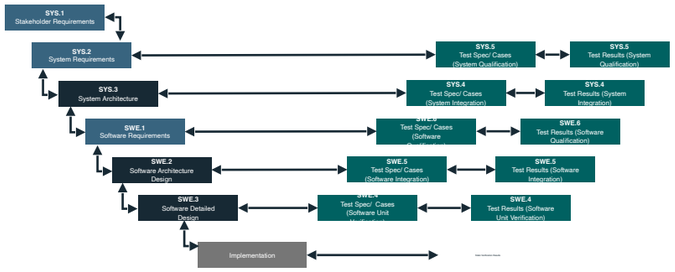
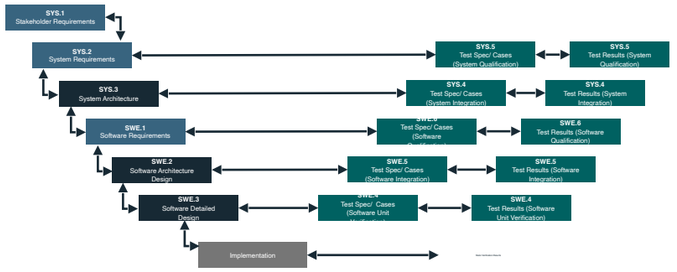
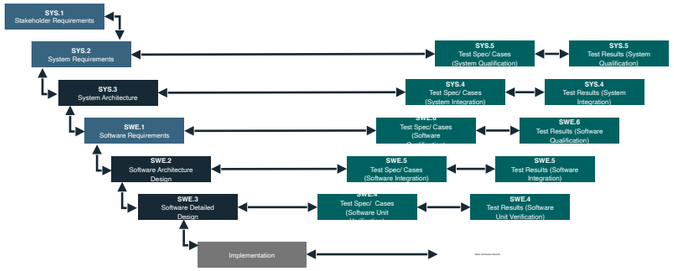
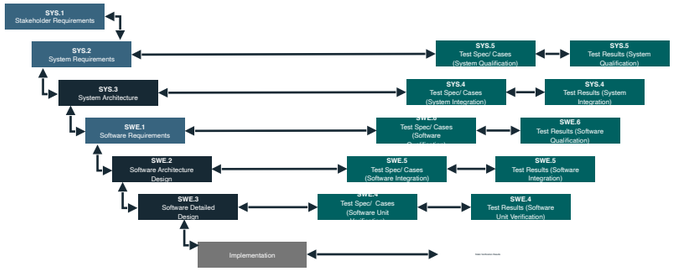
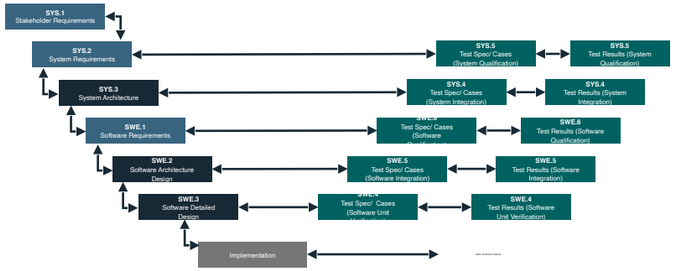
IBM ELM allows for integrated work product management



ASPICE Essential IBM Engineering Domain Model

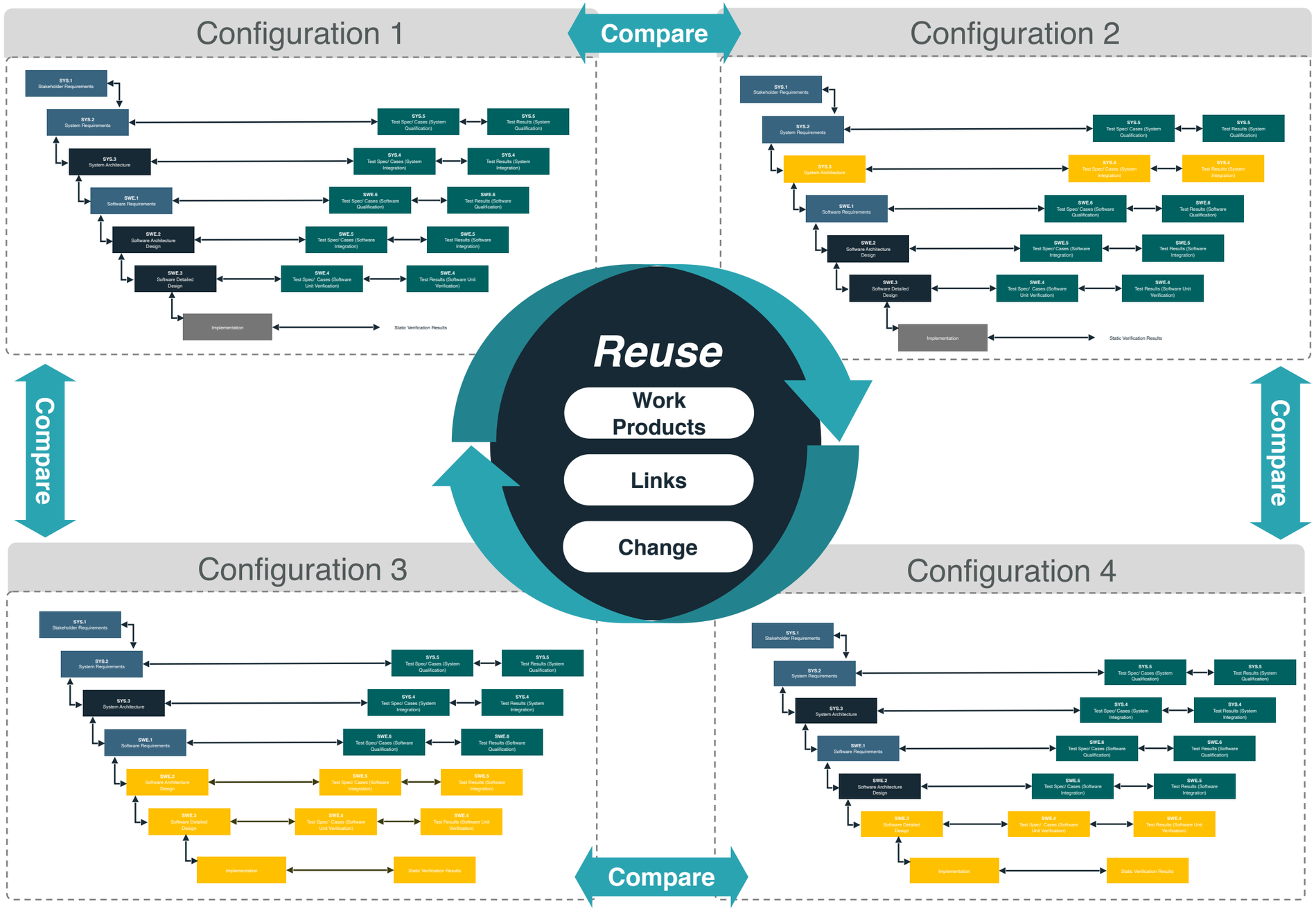


How to avoid cost explosion when dealing with multiple variants?

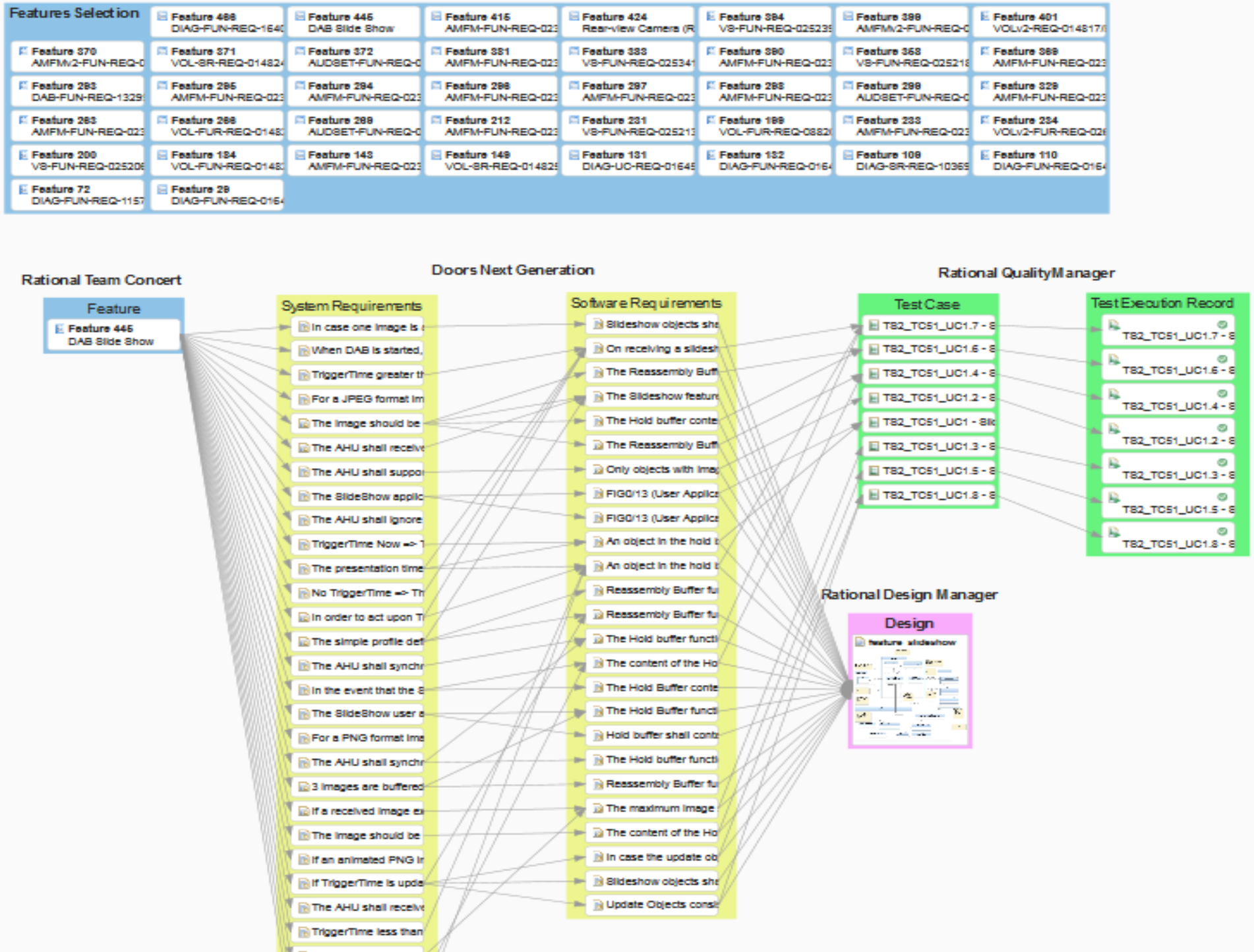
	Milestone Release 1	Milestone Release 2	Milestone Release 3
Variant A			
Variant B			
Variant C			

Global Configuration Management

provides sophisticated ***reuse*** capabilities

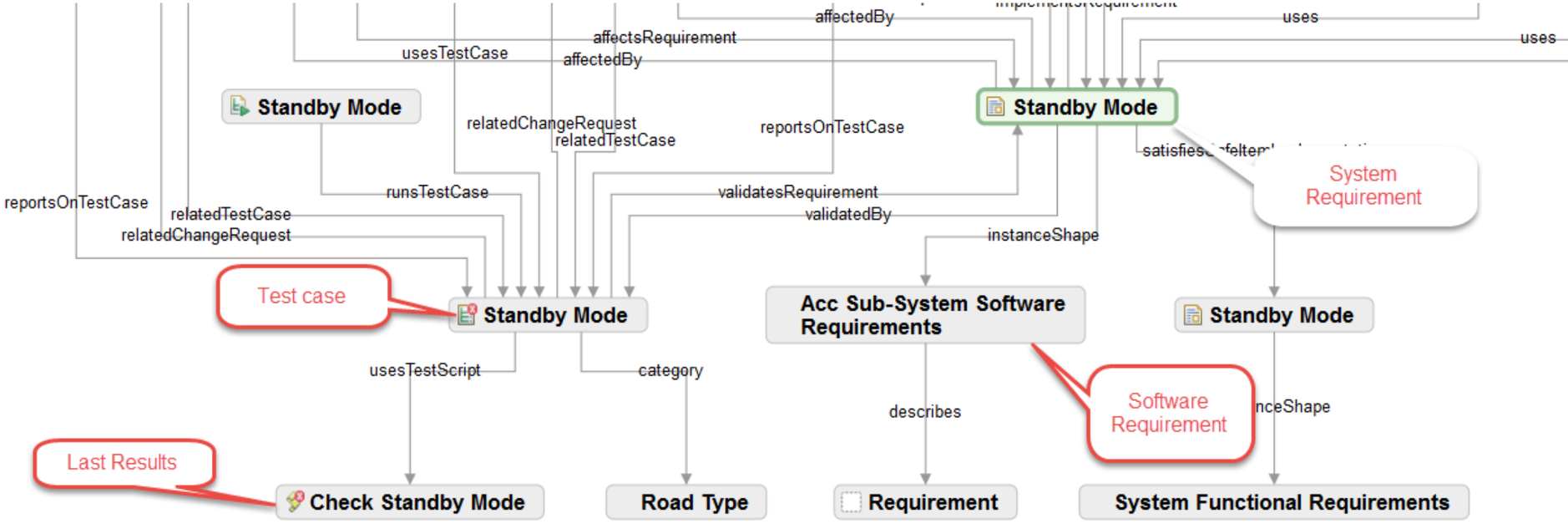


Engineering Lifecycle Management Autospice Views

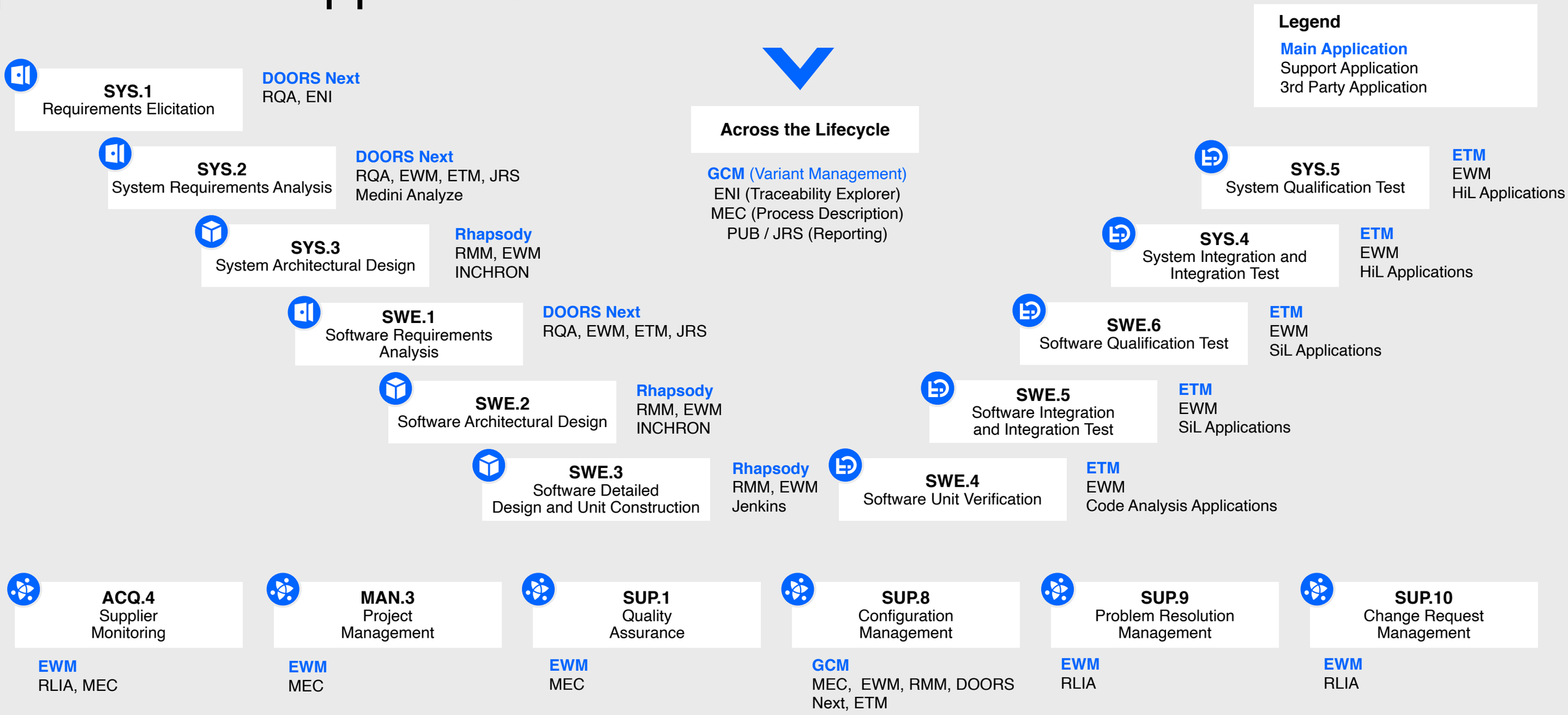


Engineering Lifecycle Management Autospice Views

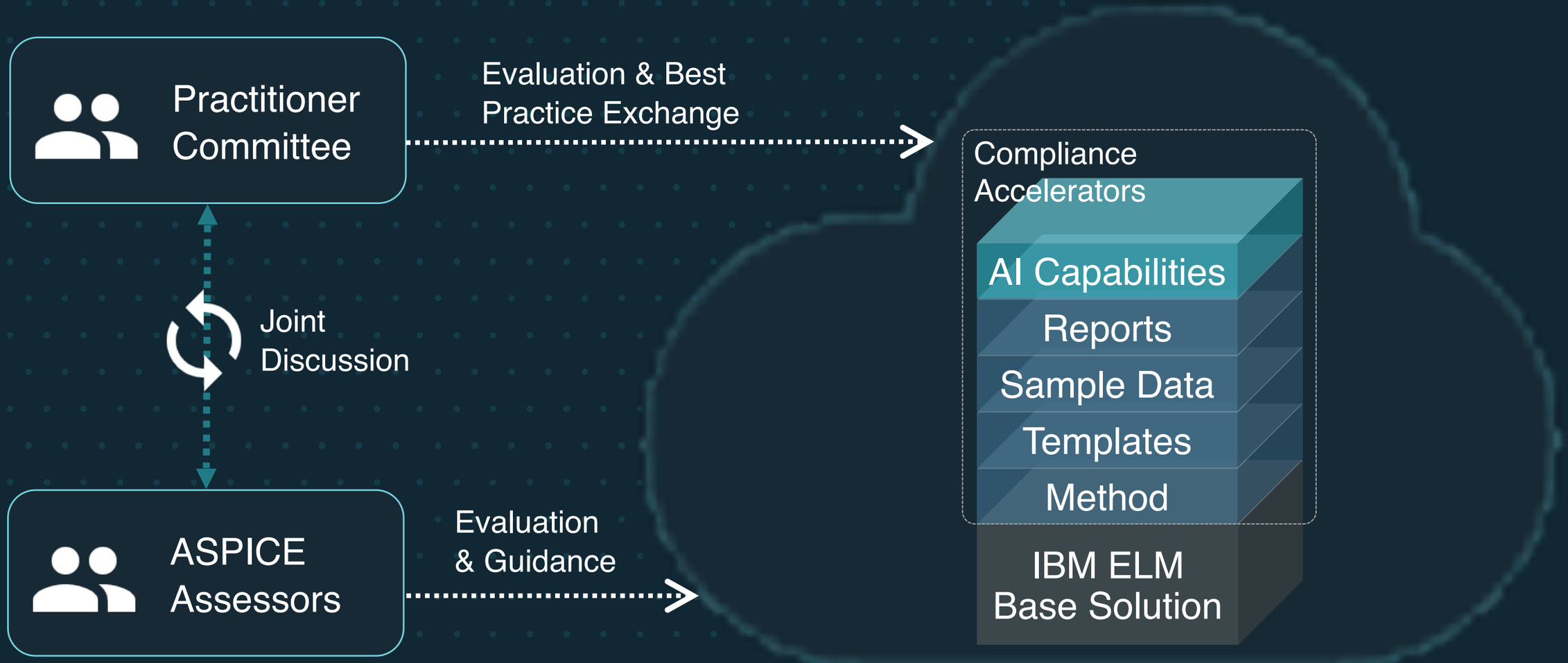
Impact Assessment



IBM ELM offers an end-to-end portfolio to support ASPICE

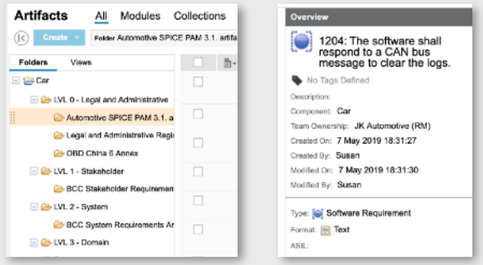


IBM ELM collaborates with industry experts to create a reference solution

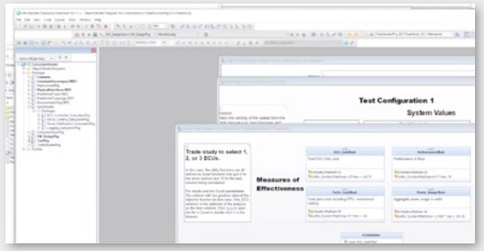


Six different kinds of deployable assets to tailor ELM for the Automotive Industry

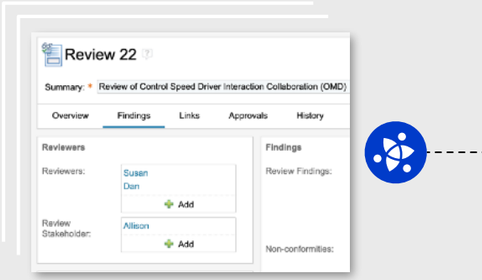
1 DOORS Next Template



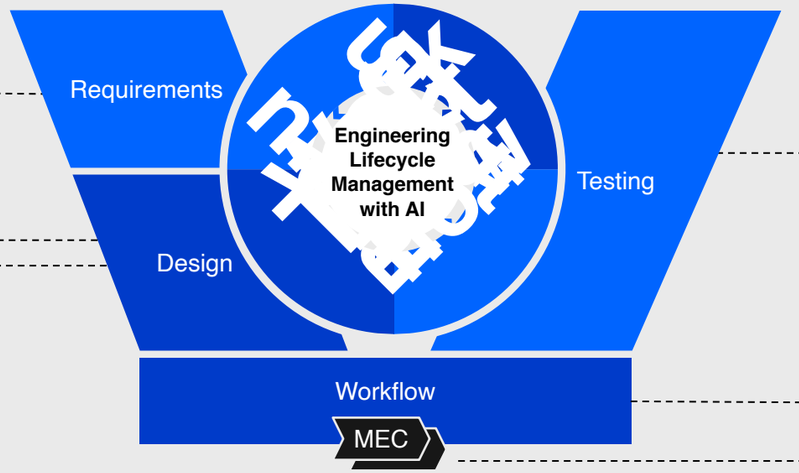
2 Rhapsody Profile



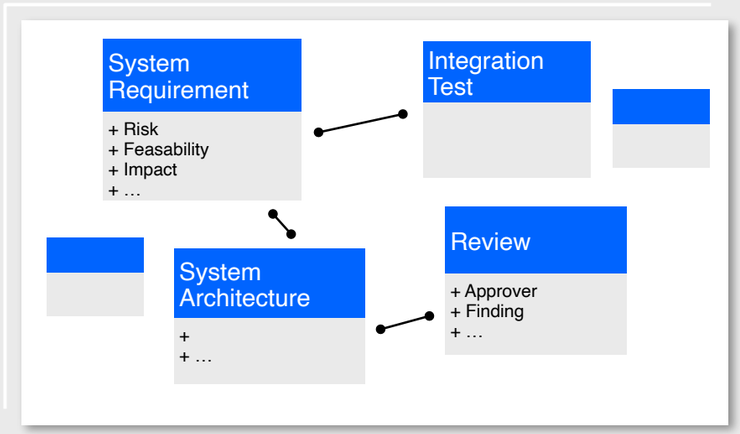
3 EWM Work Item Types



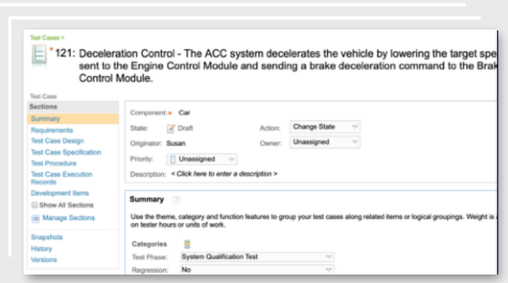
Organization Concept (Agile Process for ASPICE)



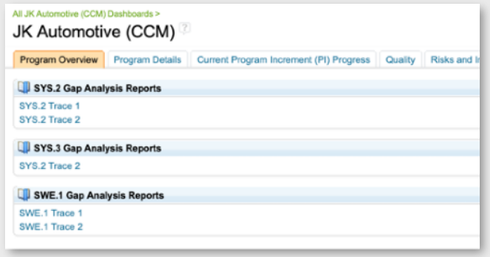
…built on one cross domain Data & Link Model



4 ETM Assets

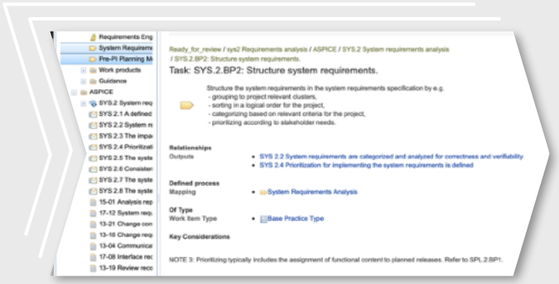


5 Reports (JRS, PUB, ENI)



MEC

6 Process & User Guidance



Refence discussion

IBM Engineering Lifecycle Management in Automotive

Industry leaders among 3,000+ IBM Engineering clients

“The number of customer functions are exploding. We need systems engineering. IBM is a close partner.”

“The next phase is to lift text-based requirements engineering to model-based systems engineering. This is a game-changer. We are doing this in close cooperation with IBM.”

Dr. Siegmar Haasis, CIO R&D, Mercedes-Benz

9 of the top 10 largest auto companies

13 of the 15 largest Tier 1 auto suppliers

“Continental will apply the full portfolio of IBM ELM. We are doing it with IBM ELM. We are convinced this will lead to implementation of our strategy.”

Dr. Bernhard Rieger, Head of Processes, Methods, Tools Division Chassis & Safety, Continental AG

The Transformative Power of IBM Jazz

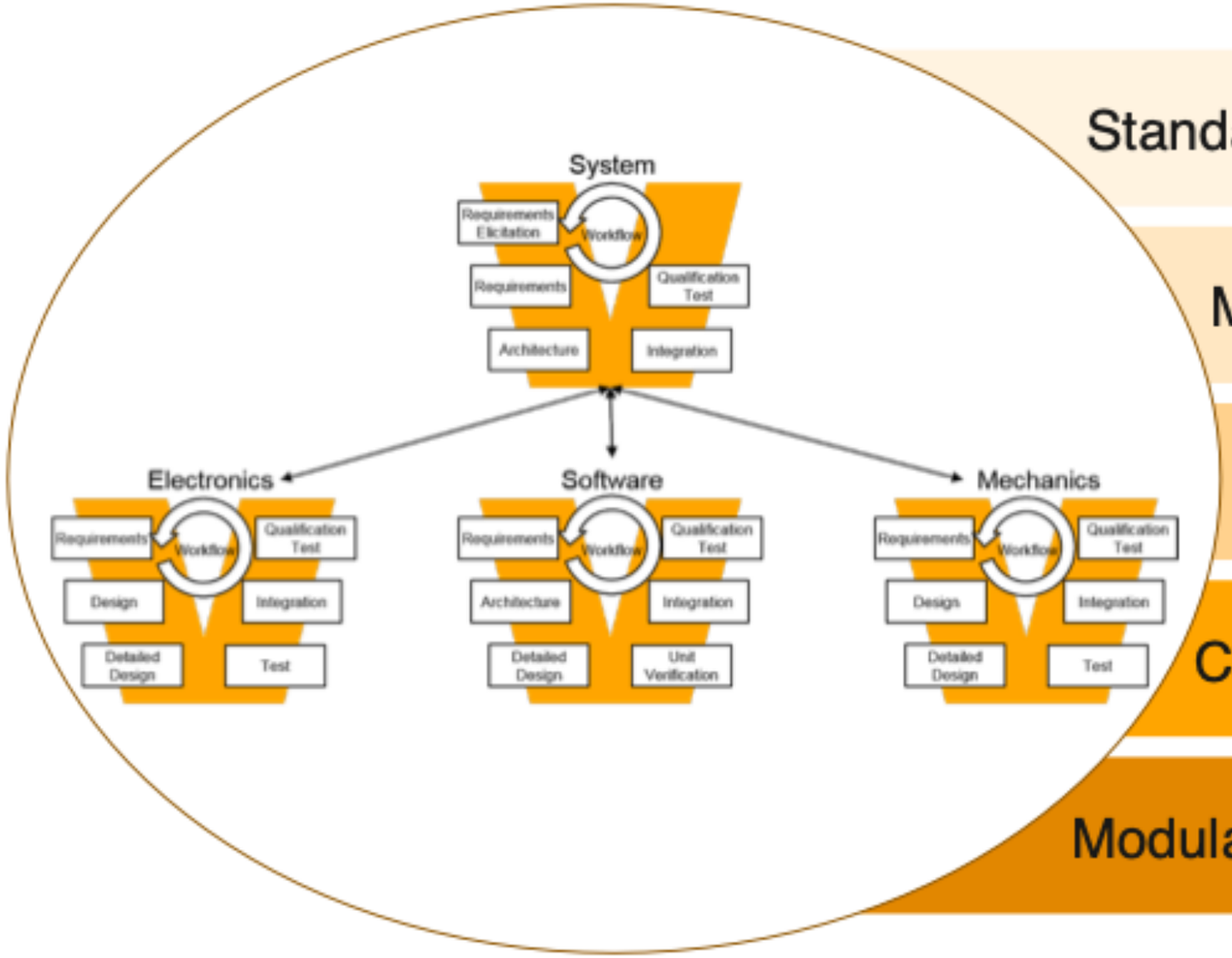
Dr. Bernhard Rieger

June 18, 2019

... But Autonomous Mobility Requires Approaches That Go Beyond

1. Growing importance of **industry standards.**
2. Growing quantity and complexity of **requirements.**
3. Growing structure and size of **architectures.**
4. Growing number and depth of **tests.**
5. “Exponentially” growing **lines of code.**

A Strong and Well-executed Strategy is Game Changing



Standardization & Collaboration

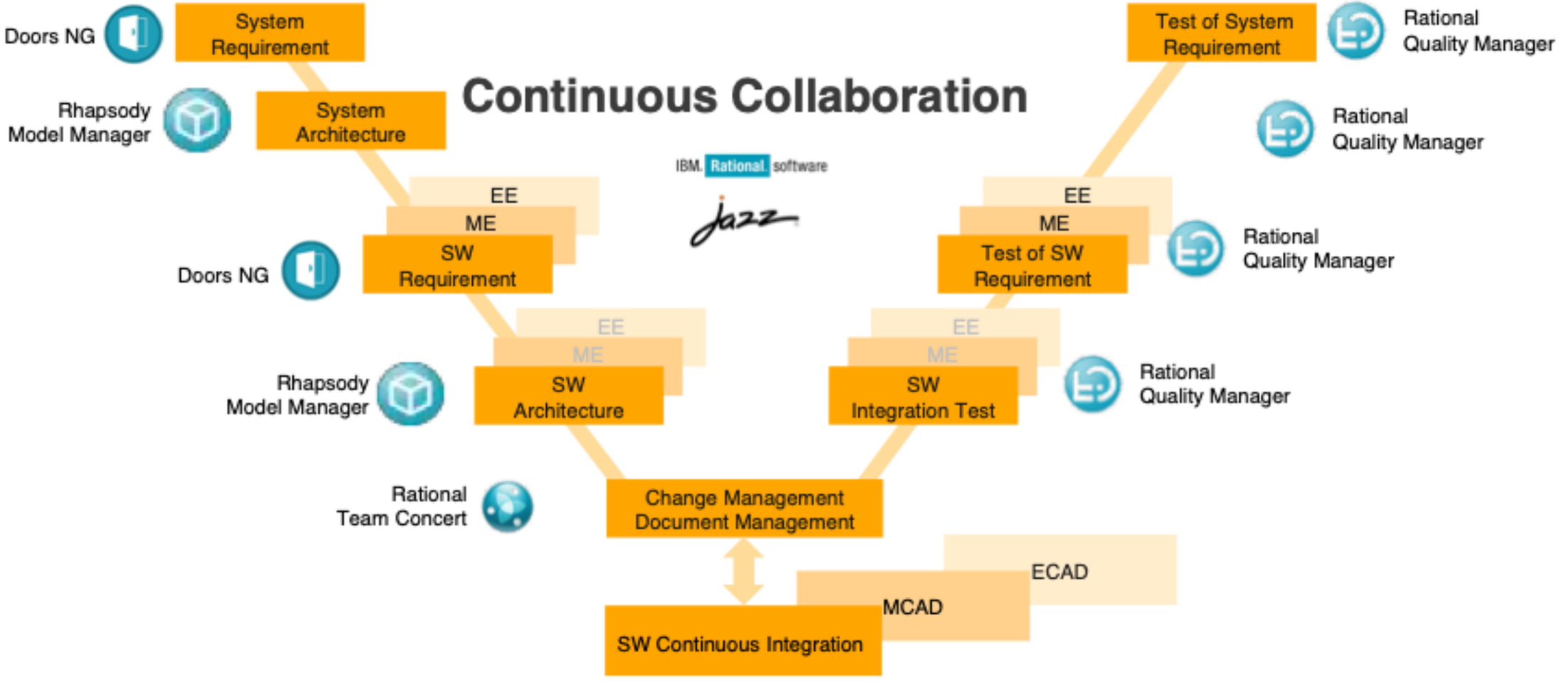
Management of Product Diversity

Consistent Development View

Compliance with ASPICE & ISO 26262

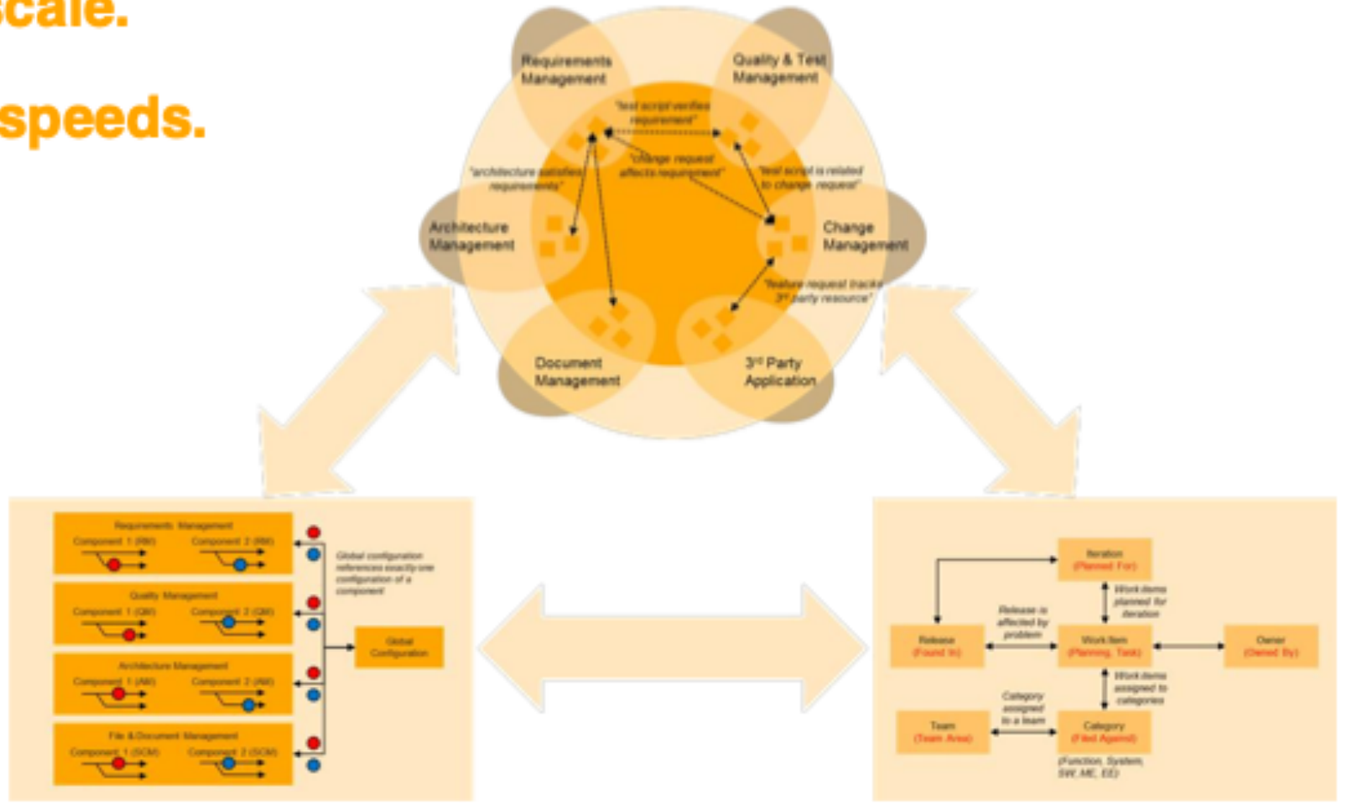
Modularity & Scalability

… And Vital for Our Future Success



IBM Jazz Key Concepts have Transformative Power

1. Promote **collaboration on a large scale.**
2. Orchestrate **processes at multiple speeds.**
3. Enable **strategic reuse.**
4. Maintain a **single source of truth.**
5. Automate **transparency and traceability.**
6. Support **compliance with safety critical standards.**
7. Provide **scalability.**




IBM