33rd Annual INCOSE international symposium
hybrid event
Honolulu HI USA

ASPICE compliance development of Cyber-Physical Systems by using Model-Based Systems Engineering

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3DPlay

Our company

A purpose-driven company

Combining Art, Science & Technology
for a more sustainable world

24,500 passionate people

From 135 countries
180 sites
One global R&D / 72 labs

Long-term driven

Majority shareholder control
Revenue: €4,86 billions*
Operating margin: 34,3%*

*Figures as of FY 2021 / Non-IFRS

+15,000 partners

Software, Technology & Architecture
Content & Online services
Sales
Consulting & System Integrators (C&SI)
Education
Research

+300,000 customers

11 industries in 140 countries
29 million users
Game-changing
3DEXPERIENCE platform

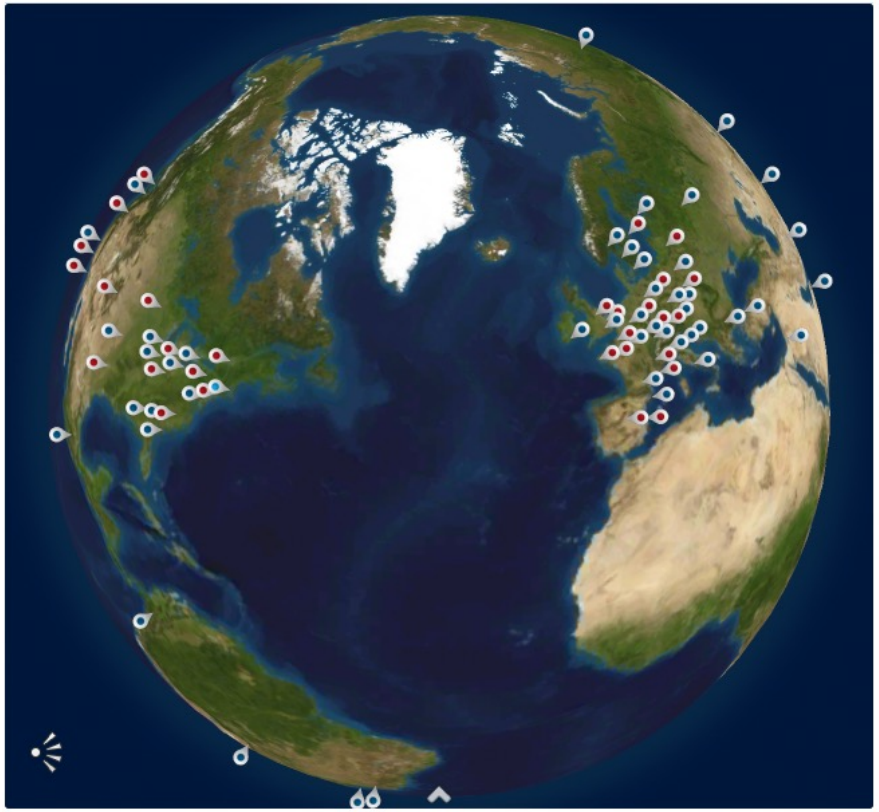
3DPlay

3DS_2022_OUR PRESENCE

Our Presence

- HEADQUARTERS
  - Paris / WW & EMEAR
  - Boston / Americas
  - Shanghai / Asia & Oceania
- 72 R&D labs
- 180 3DS offices

Globe Viewer



Automotive Industry is transforming

(source: mckinsey.com/auto2030)

20-year trend for Automotive industry: ACES

	Challenges	Facts & Figures
AUTOMATED AUTONOMOUS	• Regulation and Compliance • Safety OECD " Automated and Autonomous Driving: Regulation under uncertainty "	New norms impacting autonomous software certification: SOTIF (ISO/PAS 21448), ASPICE (ISO/IEC 15504), SAE J3061, UL4600, PEGASUS
CONNECTED	• Intelligent Transportation Planning • Communication Infrastructure • Vehicle to X communication • Regulation and Compliance TOYOTA, Ford, McKinsey&Company " Protecting the connected car in the era of new regulation"	5G as an enabler of mobility: 100+ billion connected devices in the world by 2025 Vehicle to X : X= Grid, Vehicle, Pedestrian, Infrastructure, Network
ELECTRIC	• Battery lifecycle management (inc. waste management) • Smart Grid Infrastructure (inc. energy storag • Regulation and Compliance T&DWorld, accenture EY " Why the EV battery life cycle is more important than the battery life "	Emission/efficiency regulation :EU 95 gCO2 /km, 2021; US 54.5 mpg, 2025, CA 15% ZEV 2025 Electric Car Batteries Recycling: as few as 5% of lithium-ion batteries are recycled
SHARED	• Competitive Mobility Service Delivery • Traffic • Multimodality Forbes " Integrating Shared Mobility into Multimodal Transportation Planning "	Mobility as a Service Investments: from $0.2B in 2010 to $67.4B in 2023 (+56% CAGR10-19)

Source
Leading the world to 5G:Cellular Vehicle-to-Everything(C-V2X) technologies
http://www.foeeurope.org/sites/default/files/publications/13_factsheet-lithium-gb.pdf
https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/start-me-up-where-mobility-investments-are-going

Software Defined Vehicle

System

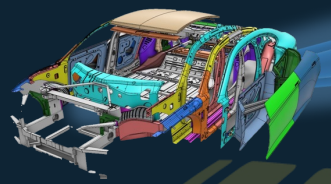
=

Vehicle + backend service Apps and infrastructure + fleet feedback loops

Source: Tesla's 2023 Investor Day
https://www.youtube.com/watch?v=f6nTLTl5Tms

Source: Mass over-the-air update of Tesla cars
https://youtu.be/wt2b_1Wi_DU

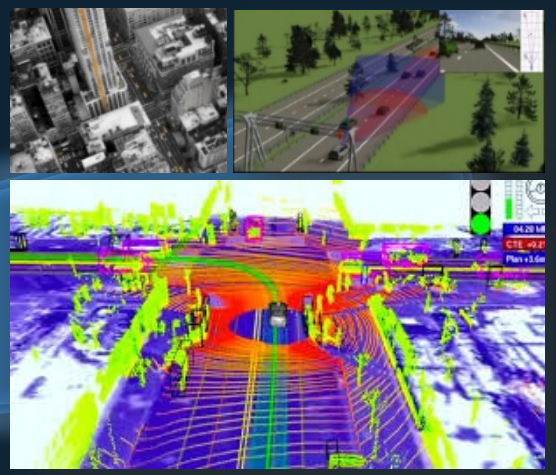
Evolution of complexity



Mechanical systems

Mechatronics systems

Multidisciplinary field that includes a combination of mechanical, electrical, control and software



Cyber systems

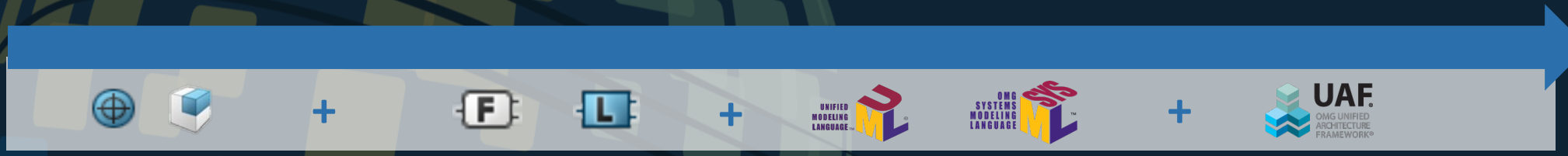
Populations of software-intensive distributed systems interacting together in an unpredictable world

Typical figures in T&M and A&D (one program)

- 0,5 – 1 M requirements
- 2 000 – 5 000 components
- 4000 – 15 000 functions
- 100 000 interfaces

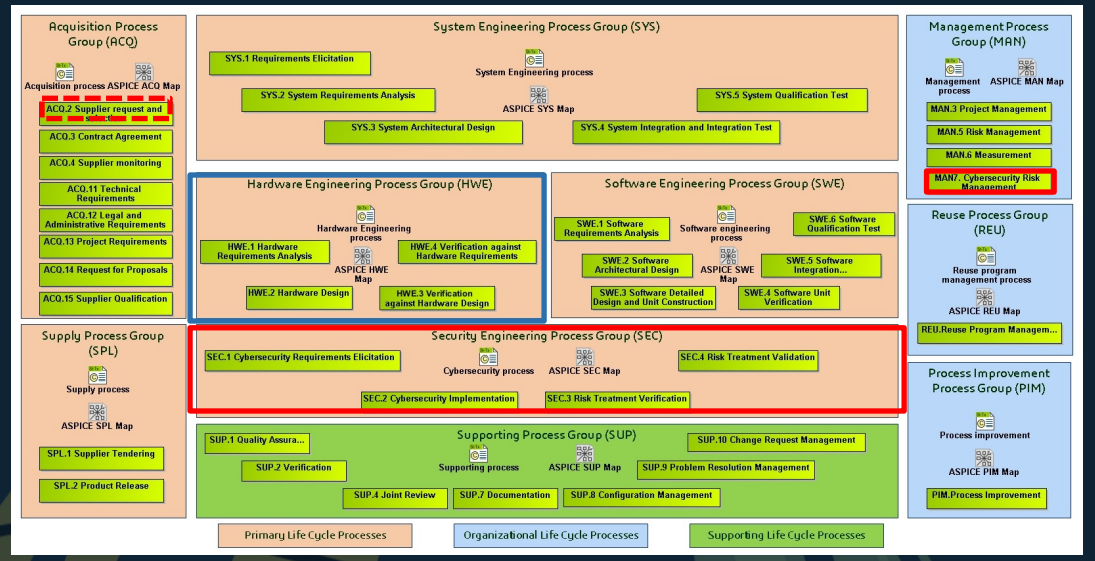
Projection

Volume & speed

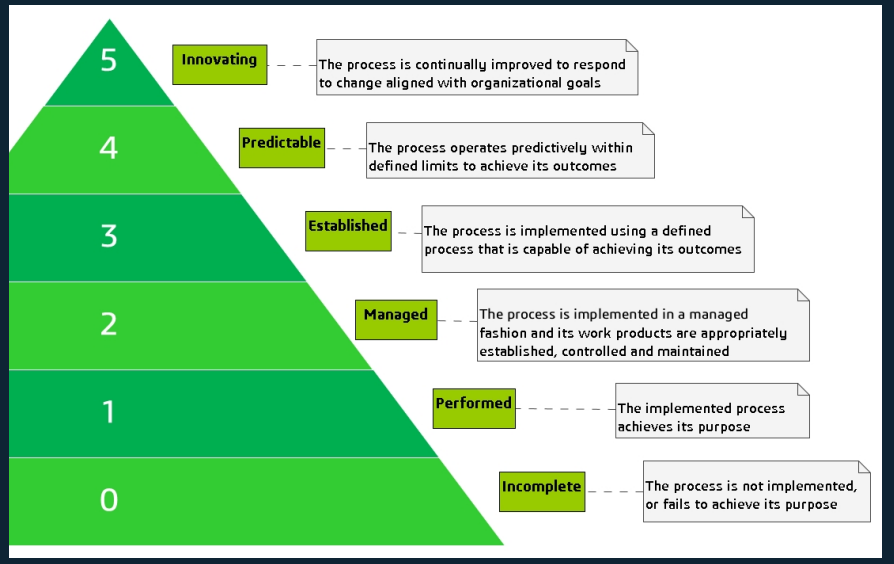


ASPICE

Automotive Software Process Improvement Capability Determination



Process reference model
(VDA scope + hardware & cyber security)



Process improvement model

Benefits: process evaluation by OEMs with ones from their suppliers to demonstrate end-to-end artifacts traceability across the value chain, and obtain necessary certifications

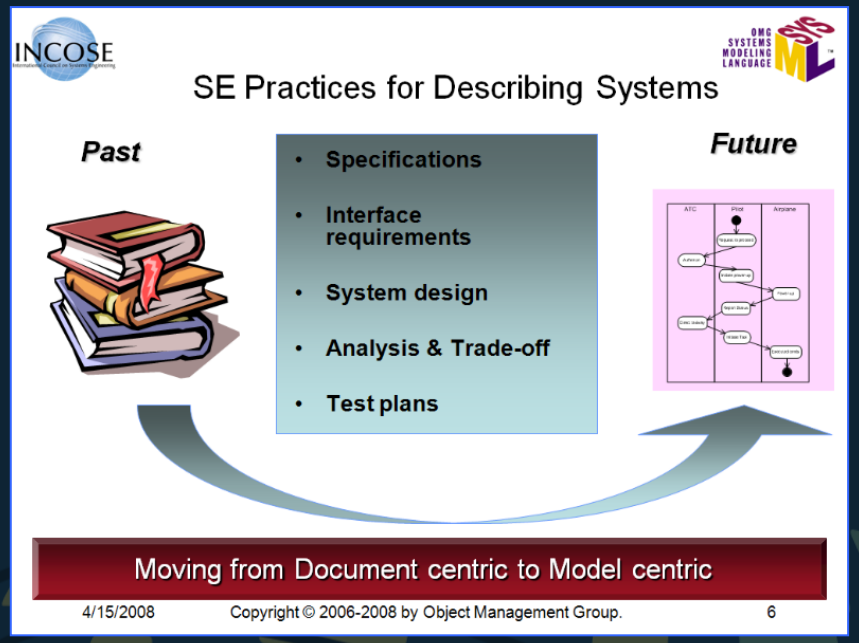
What is the big idea of MBSE?

Add rigor and precision with a modeling language to enhance communication

Help manage complexity through system decomposition, behavior and interface definition

Digitalization → Mechanical CAD went through similar transformations over 30 years

What is MBSE?



Model-Based Systems Engineering a disciplined, rigorous approach to systems engineering that uses visual modeling and simulation to support requirements, analysis, and design, through conceptual, logical, and later phases of the system life cycle

PICTURE ≠ MODEL

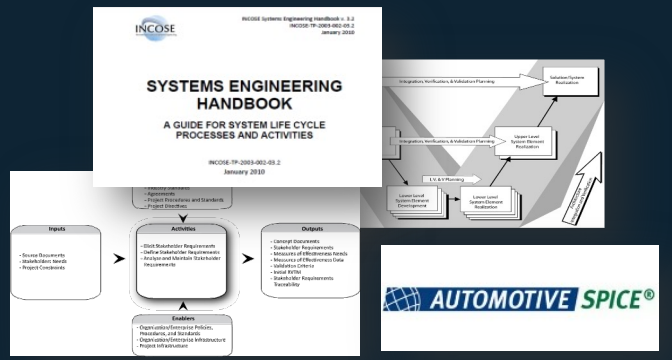
Model repository provides a single source of truth!

Need for a Systems Engineering Methodology

What to do?

Processes

Define activities to implement and expected results



supported by ↓ ↑ *support*

How to do?

Method

Defines technics & methodology to implement the activities

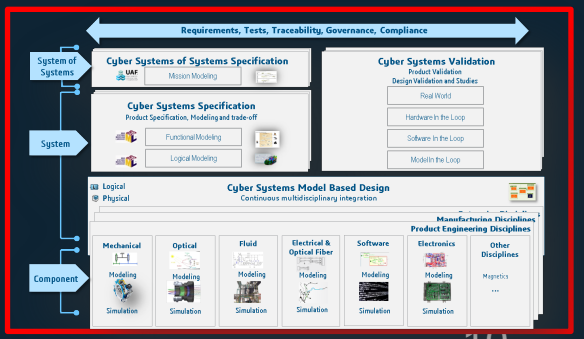
**MagicGrid extension*

supported by ↓ ↑ *support*

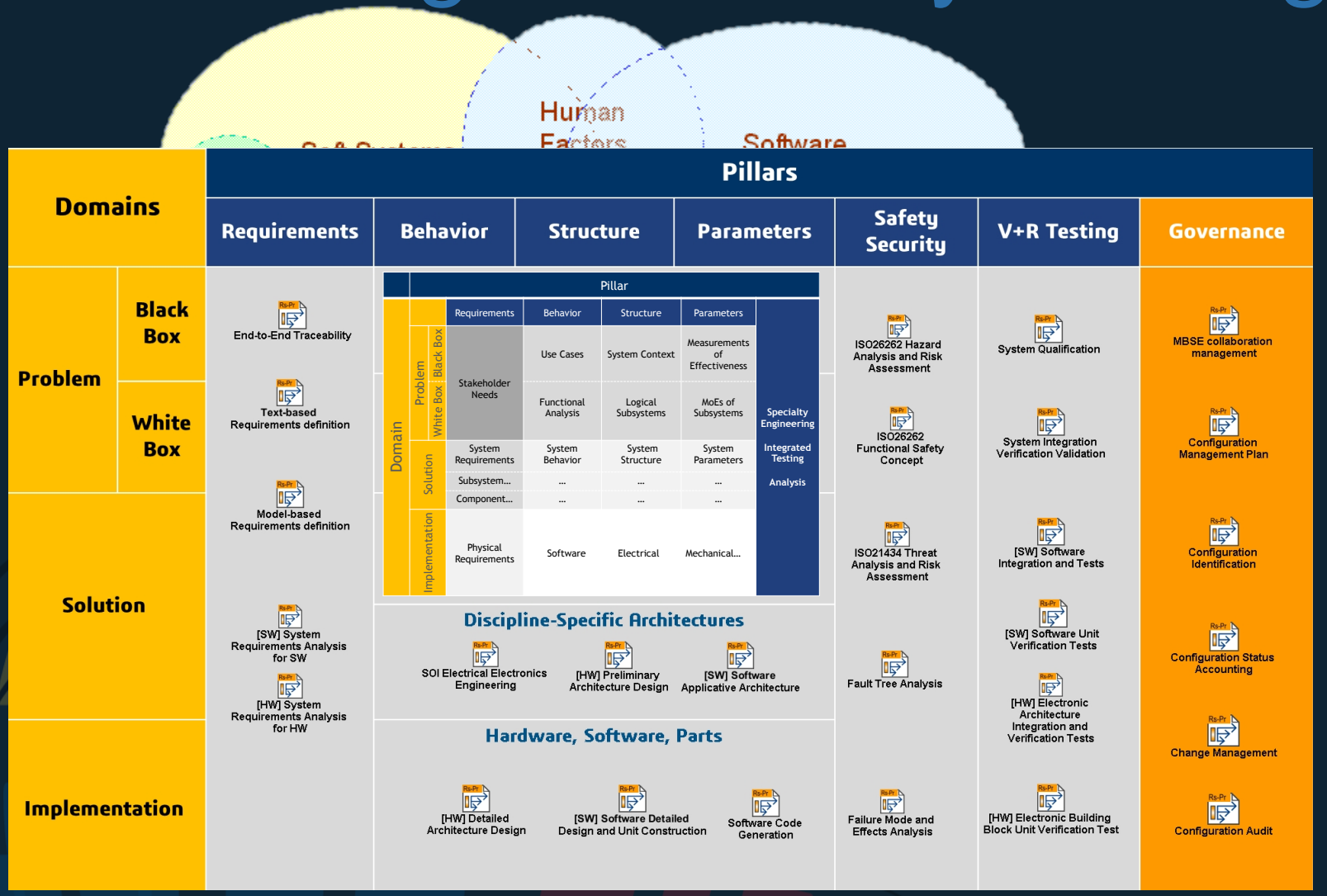
With what?

Tools

Improve the efficiency of tasks implementation, use of method

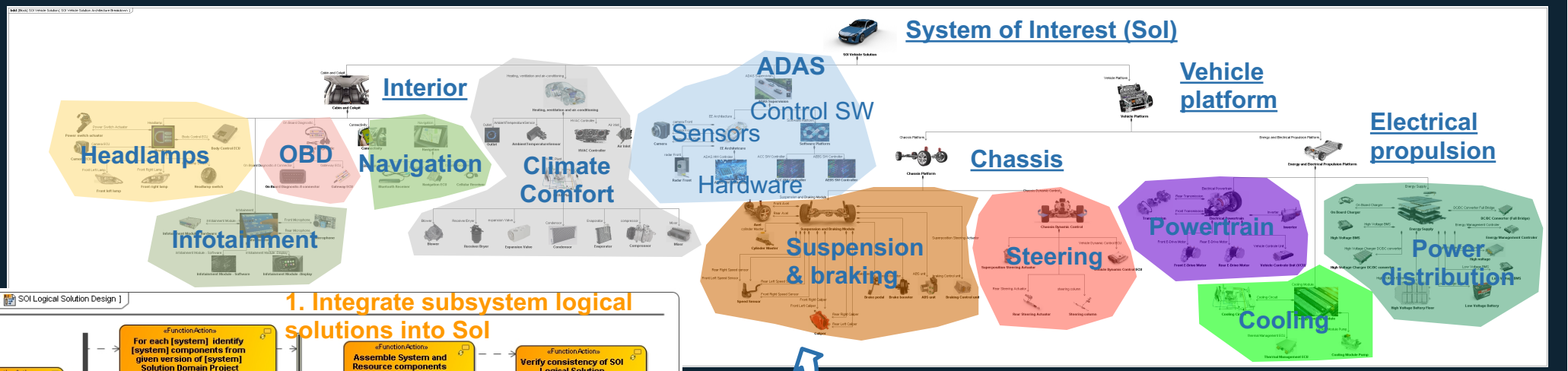


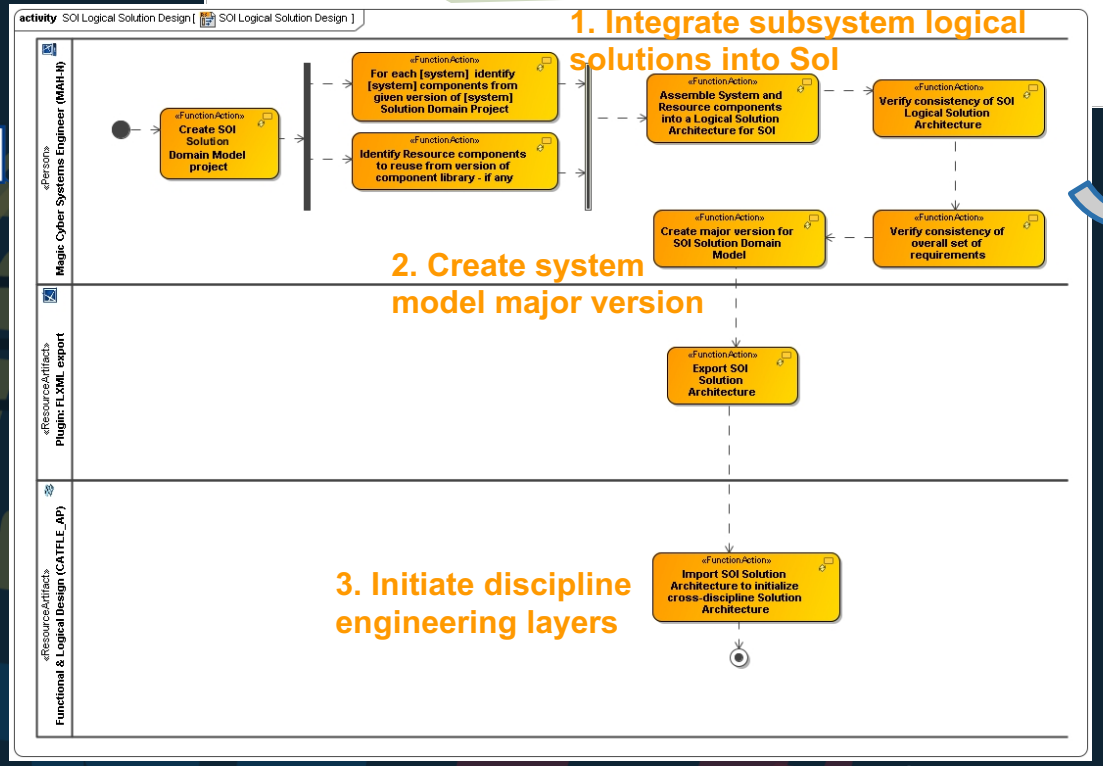
From MagicGrid to Cyber MagicGrid



- Requirements Engineering
- Systems Engineering
- Electrical & Electronics Engineering
- Software Engineering
- Hardware Engineering
- Safety Engineering
- Security Engineering
- System integration, verification and validation
- Change and Configuration Management

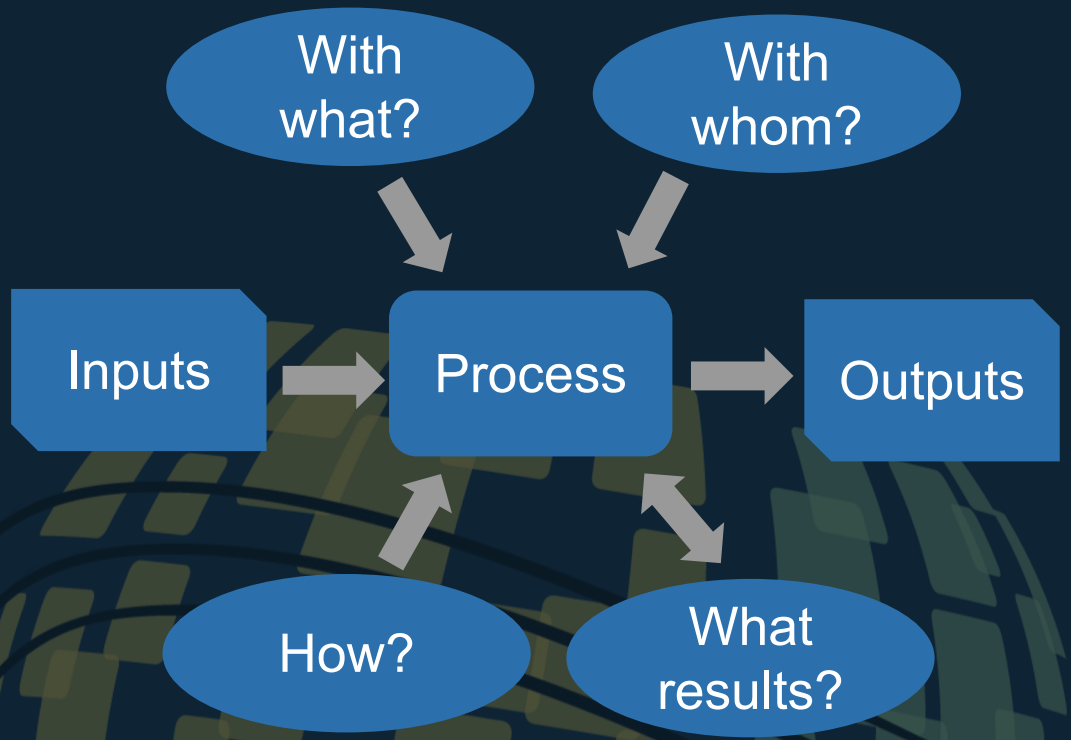
Best practices example | SoI Logical solution design





From SoI logical solution architecture to discipline-specific design (Electrical/Electronics, Fluid, Software…)

Process standards compliance | Quality management process approach



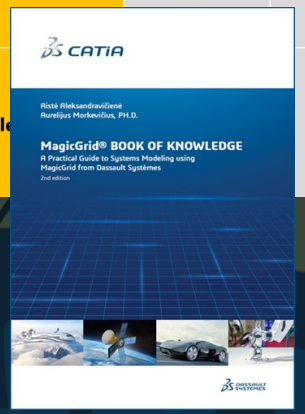
Source: ISO9001 Turtle diagram

- Quality Management System (QMS): focuses on process management, compliance and certification

Main risks

- Lack of relevance for MBSE application: process oriented vs method oriented
- Overemphasis of documentation vs Engineering

Process standards compliance | Systems Engineering methodology as reference



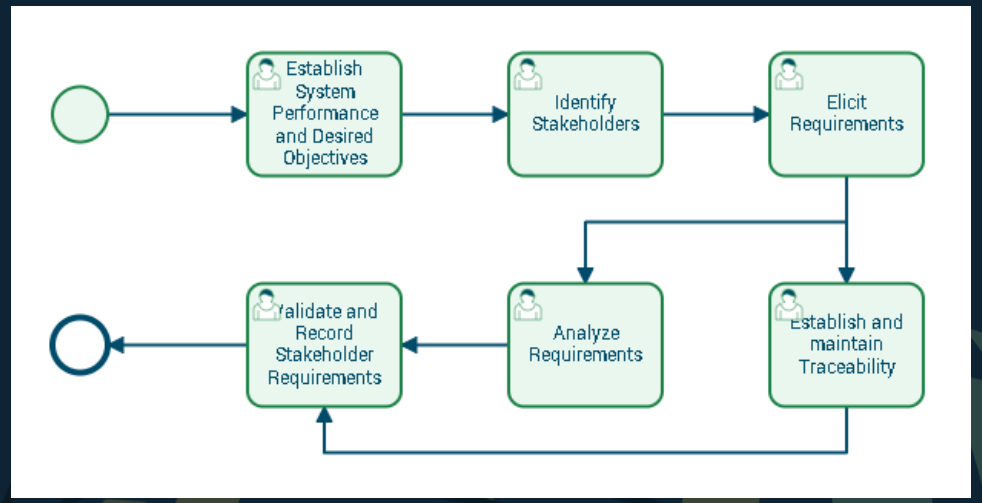
- MBSE: Focus on engineering systems using models throughout the system development lifecycle

Benefits

- MBSE methodology: improved understanding of complex systems behavior leading to more efficient and effective system development.
- Supports day-to-day engineering: effective application of processes

Process standards compliance | Example

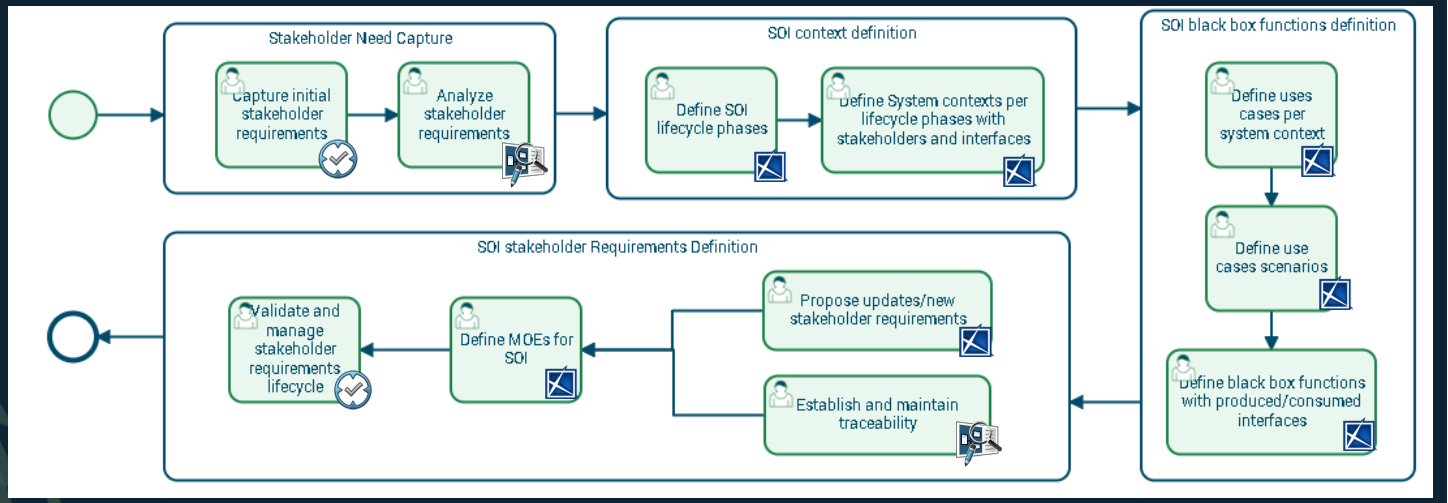
Requirements Elicitation Process



Quality Process

Proposes set of activities to achieve: what to do

System of Interest Black Box Analysis



MBSE methodology

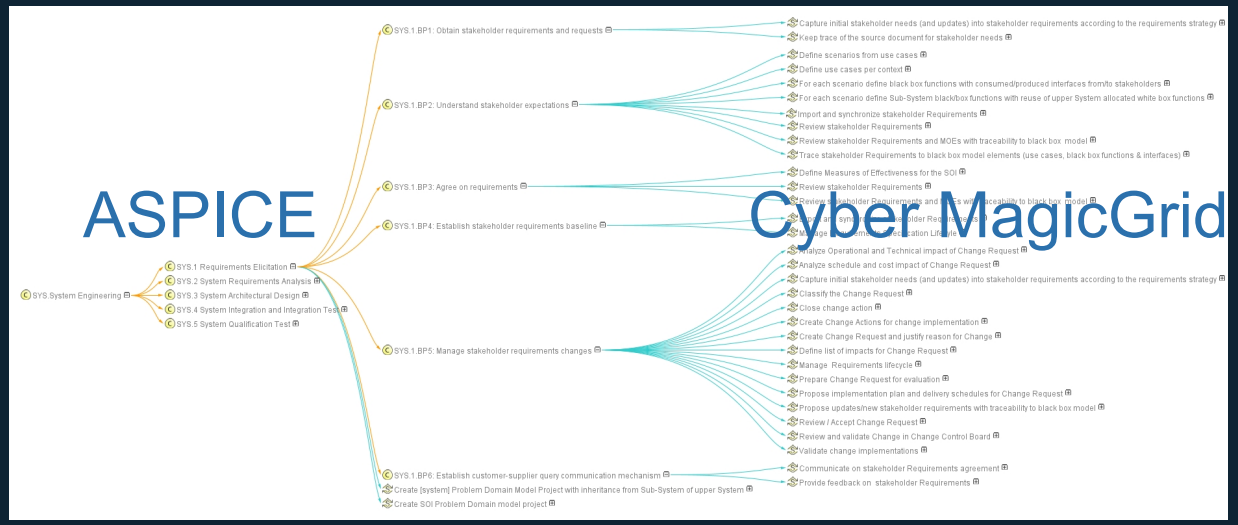
Proposes practical way to engineer systems: how to do, with what

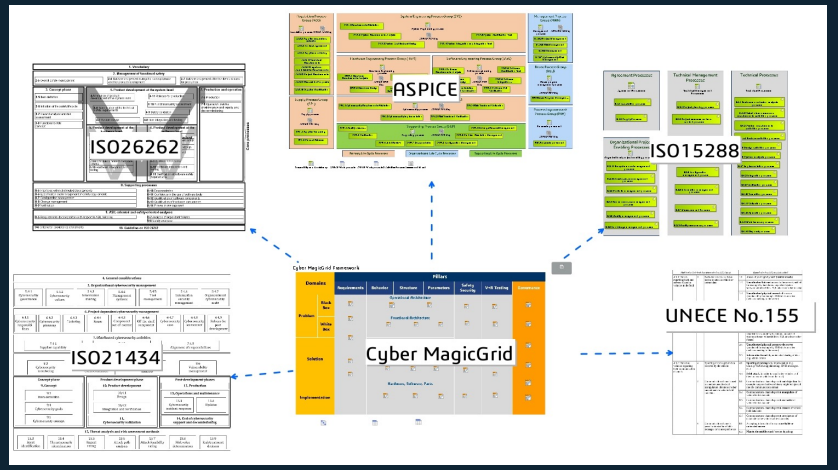
Conclusion | Value proposal

Use MBSE methodology to support process compliance for engineering

Benefits

- Effort focused on MBSE deployment and adoption
- Compliance evidence through traceability and document generation from models
- Scalability to cover multiple standards
- Continuous improvement with PDCA (Plan-Do-Act-Check)





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