33rd Annual INCOSE international symposium

hybrid event

Honolulu HI USA

Brett Hillhouse (IBM), Sky Matthews (IBM)
Hans-Juergen Mantsch (Siemens)

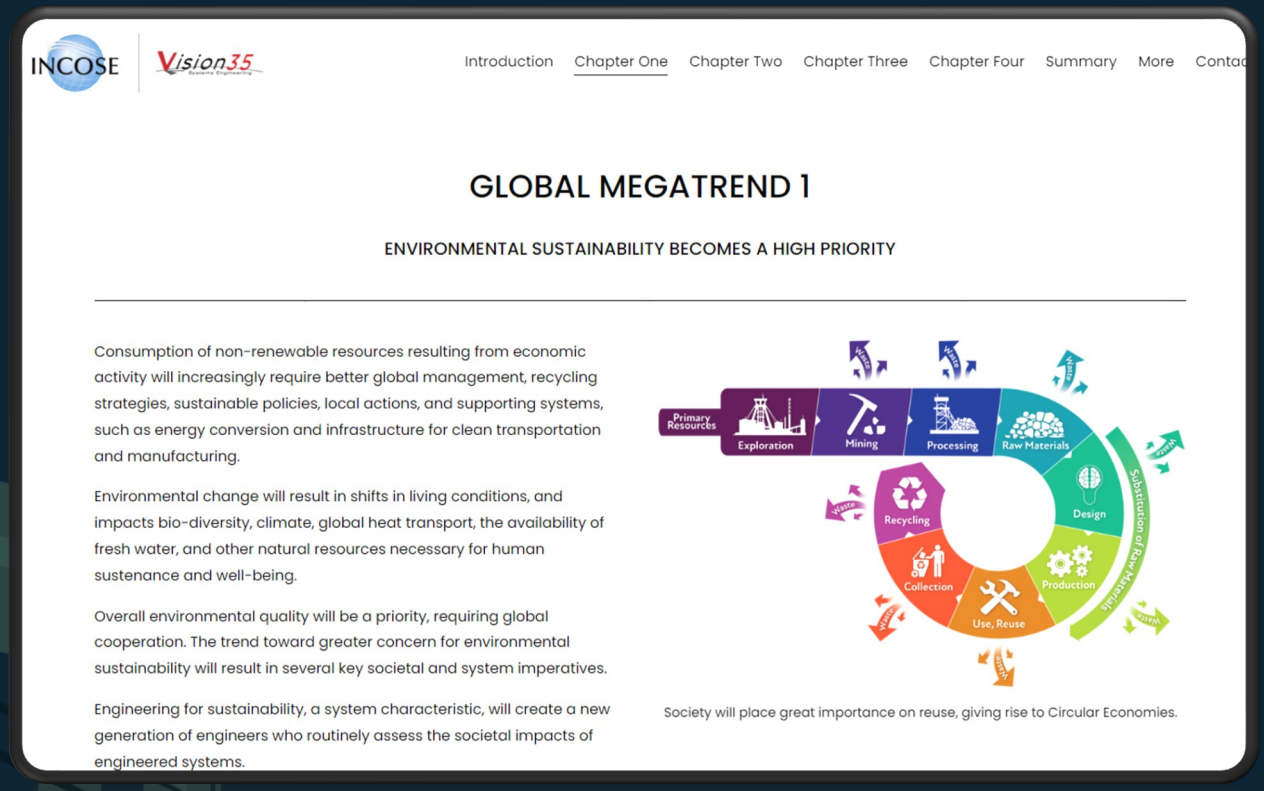
Engineering Sustainable Products with Collaborative Multi-Domain Modeling

Agenda

- Sustainability landscape and challenges
- Multi-domain collaboration
- Siemens and IBM joint announcement
- Model-based multi-domain collaboration
- Demonstrator
- Software & beyond - Future opportunities
- Q+A

Sustainability as Megatrend

INCOSE Vision 2035 mentions “sustainability” and related terms 105 times, more than any other topic area covered in the document!



Engineering Sustainable Systems & Products

Systems Engineering Challenges

- Sustainability characteristics
- Compliance and reporting
- Multi-discipline collaboration
- Full lifecycle

Sustainability as a Design Goal

Sustainability characteristics as design goals are not new

- Examples: mileage, materials, emissions, etc

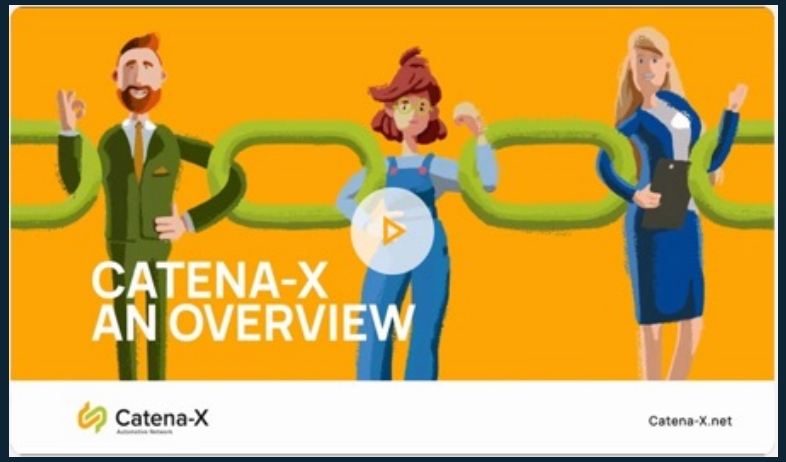
What is new?

- holistic system focus
- core engineering competency
- multi-disciplinary collaboration
- regulatory compliance
- supply chain reporting
- full lifecycle impact
- software as sustainability tool

Sustainability Regulatory Impact

Understanding Scope 1, 2 and 3

- First appeared in the Green House Gas Protocol of 2001
- The basis for mandatory GHG reporting in many countries
- **Scope 1 emissions**— Green House Gas (GHG) emissions that a company makes directly in operation (e.g., heating)
- **Scope 2 emissions** — These are the emissions it makes indirectly – like the energy it buys for heating and cooling buildings,
- **Scope 3 emissions** — All the emissions that the organisation is indirectly responsible for, from components provided by suppliers to final product in use by customers
- Mandatory scope 3 reporting is likely in multiple countries
- Scope 3 reporting includes **supply chain** impacts (e.g., GHG contribution for each supplied component)



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Emerging standards for scope 3 reporting

Product-Specific Sustainability Reporting

Corporate level ESG report

IBM 2022 ESG Report

Emissions Covered by IBM's Fifth-Generation Goal (Metric Tons of CO_2-equivalent)	2018	2019	2020	2021	2022
Scope 1 (direct emissions)*	105,000	100,000	74,000	79,000	79,000
Scope 2 market-based (indirect emissions)**	505,000	460,000	262,000	221,000	183,000
Scope 3 (indirect emissions)^	252,000	251,000	234,000	176,000	169,000
Total emissions covered by IBM's current goal	**862,000**	**811,000**	**570,000**	**476,000**	**431,000**
Reduction of GHG emissions against base year 2010	**26.6%**	**31.0%**	**51.5%**	**59.5%**	**63.3%**

*Emissions associated with IBM's use of fuels for building operations and transportation, as well as from the use of refrigerants and chemicals with a global warming potential.

**Emissions from IBM's use of electricity, cooling, heat and steam at IBM-managed locations, accounting for our purchases of renewable electricity.

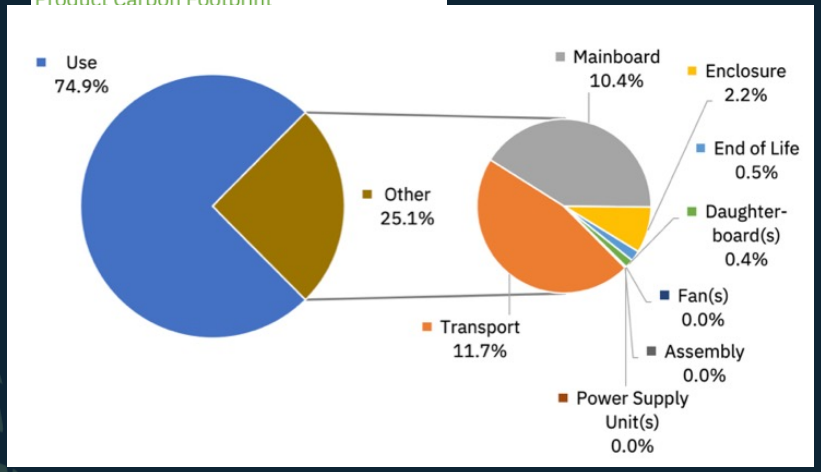
^Includes only those emissions associated with the generation of electricity consumed by IBM's data centers located in third-party managed facilities.

IBM 2022 ESG Report: https://www.ibm.com/impact/files/reports-policies/2022/IBM_2022_ESG_Report_and_Addendum.pdf

Product level ESG report

IBM z16™ multi frame

Product Carbon Footprint

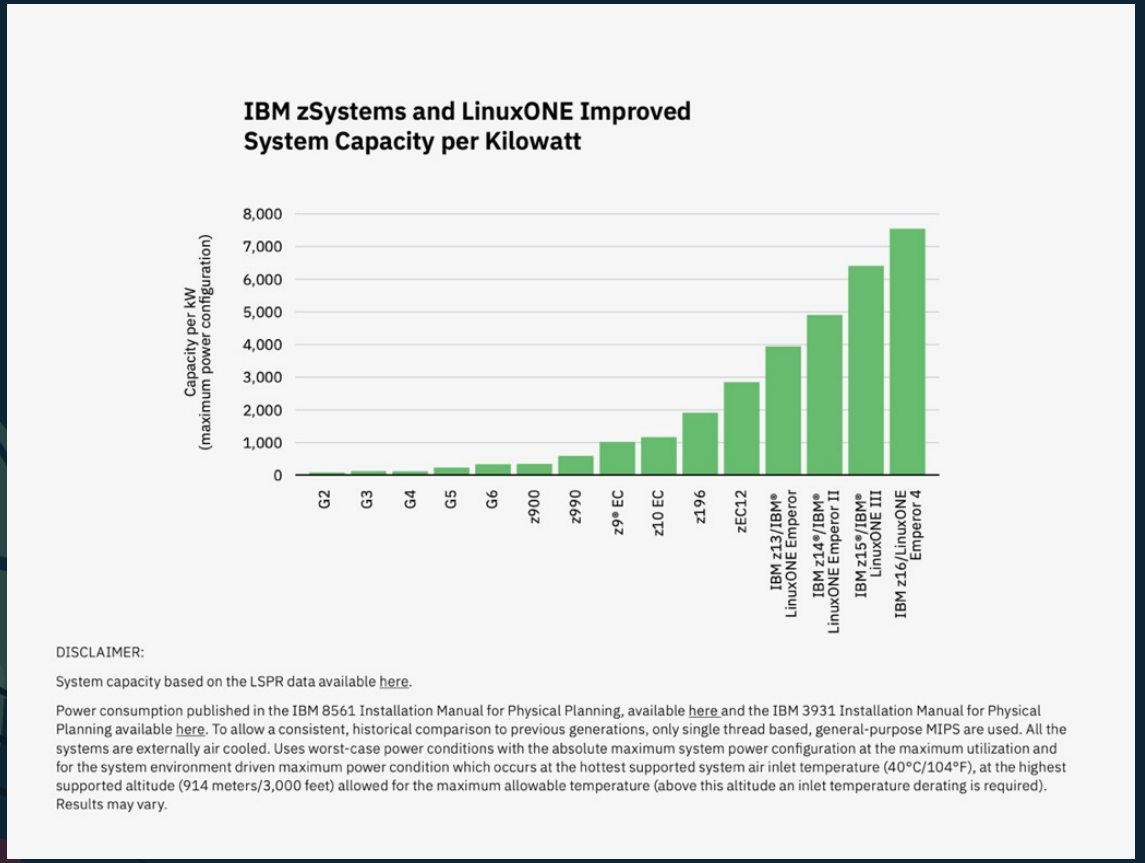


→Moving from Corporate to Product- Specific Sustainability Reports

Goals and KPIs

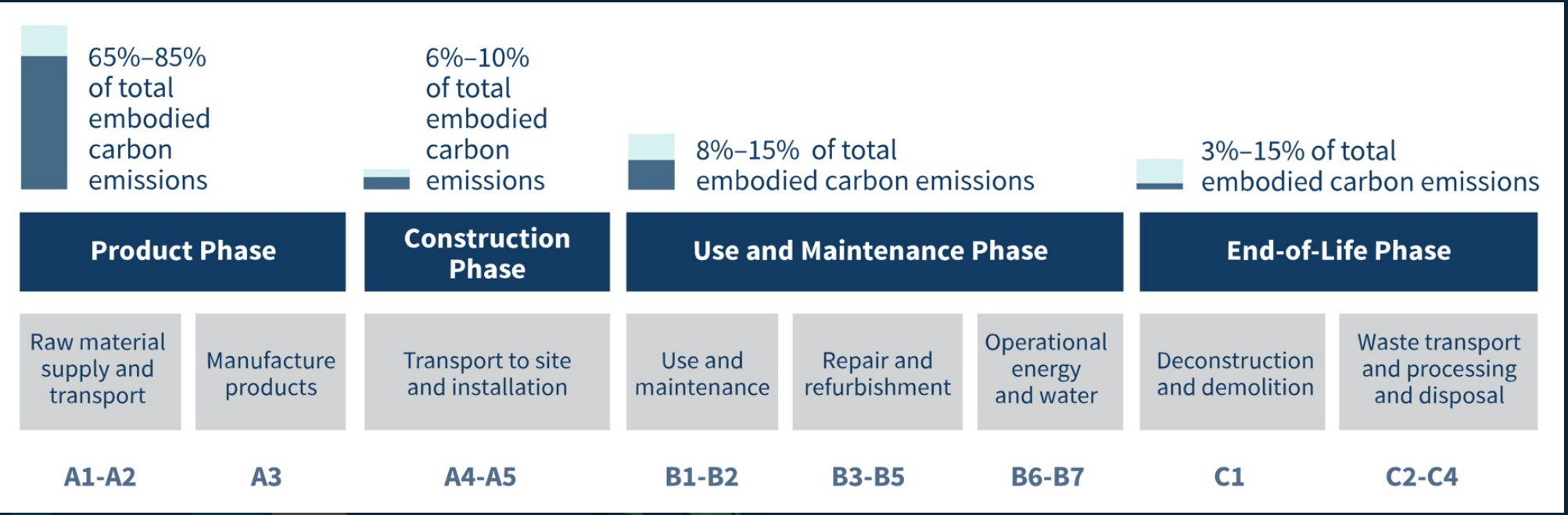
IBM Z16 Goal:
+15% improvement in capacity per KW

- Identifying sustainability related product objectives and measurements is an essential first step
- Understanding how to calculate, track and report over time
- **Continuous improvement** shouldn't stop at the factory door



Total Lifecycle Measurement

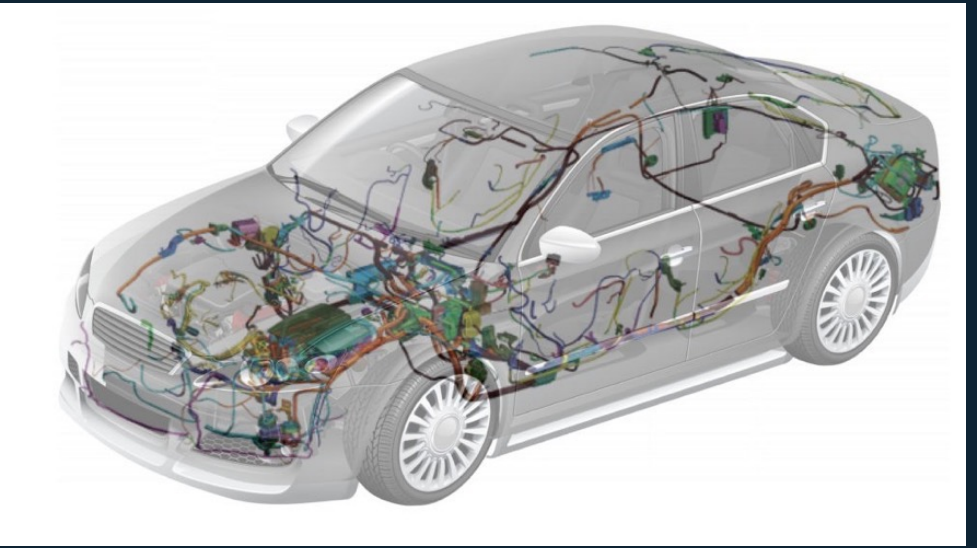
Embodied Carbon Emissions



Source: RMI (https://rmi.org/wp-content/uploads/2023/03/exhibit-6-embodied-carbon-life-cycle-assessment-phases.svg)

Example: Lower Vehicle Carbon Footprint

- Reducing weight is one of the most direct |ways to lower carbon footprint
- 10kg reduction in weight = 20kg of CO2 emission per vehicle (avg) per year (at 20.000 km driven)
- x 500,000 vehicles = 10M KG CO^2 savings
- Wiring harness in modern vehicle can weigh 70kg
- Changing connectivity and moving to thinner/ lighter wires can reduce harness weight significantly, but
  - every electrical change impacts mechanical, electronics and software
  - requires close collaboration across system, mechanical, E/E & software domains



Software as Sustainability Enabler

Autonomous/ ADAS

Sustainability

Electrification

Digital Subscription

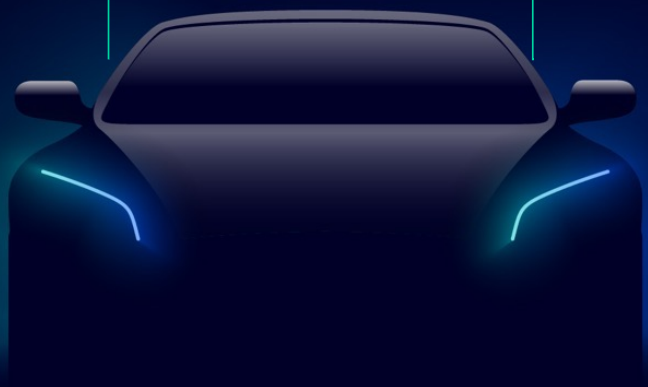
Connectivity

Full self-driving subscriptions

Over-the-air upgrades

Continuous optimization

Pay-for-performance



AI platforms

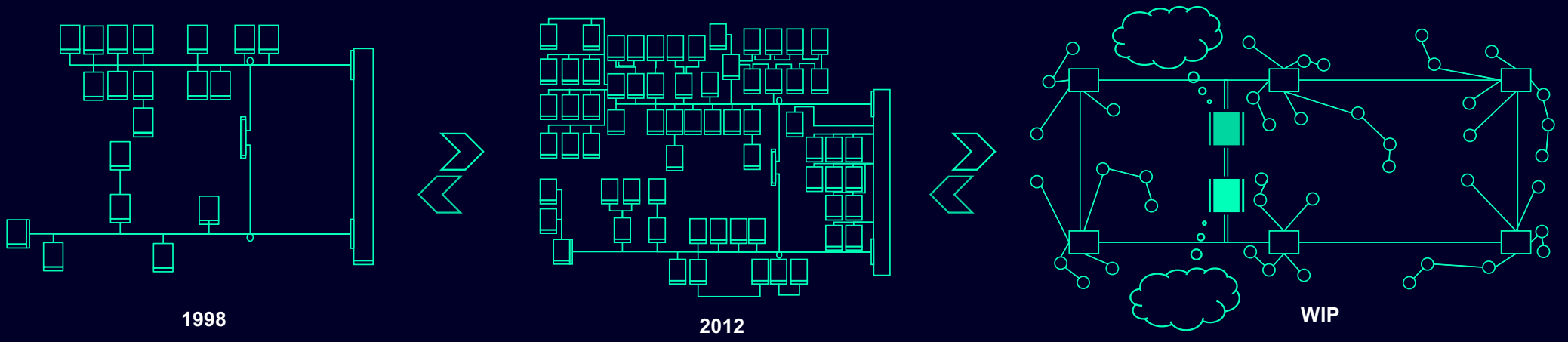
Level 4 fully autonomous

Mobility as a service

Vehicle-to-anything (V2X) enabled by 5G

”Software will account for **90%** of future innovations in the car”

E/E architecture revolution



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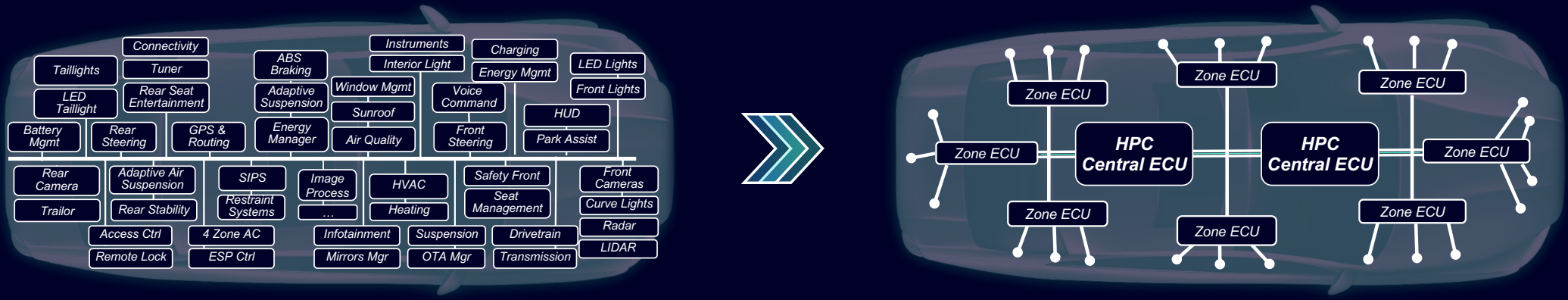
E/E architecture revolution



Function consolidation

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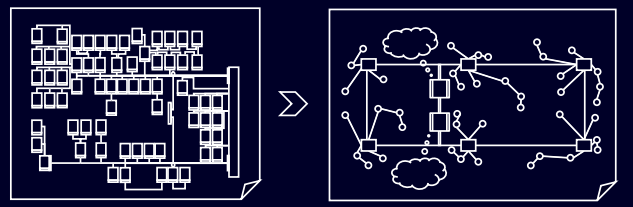
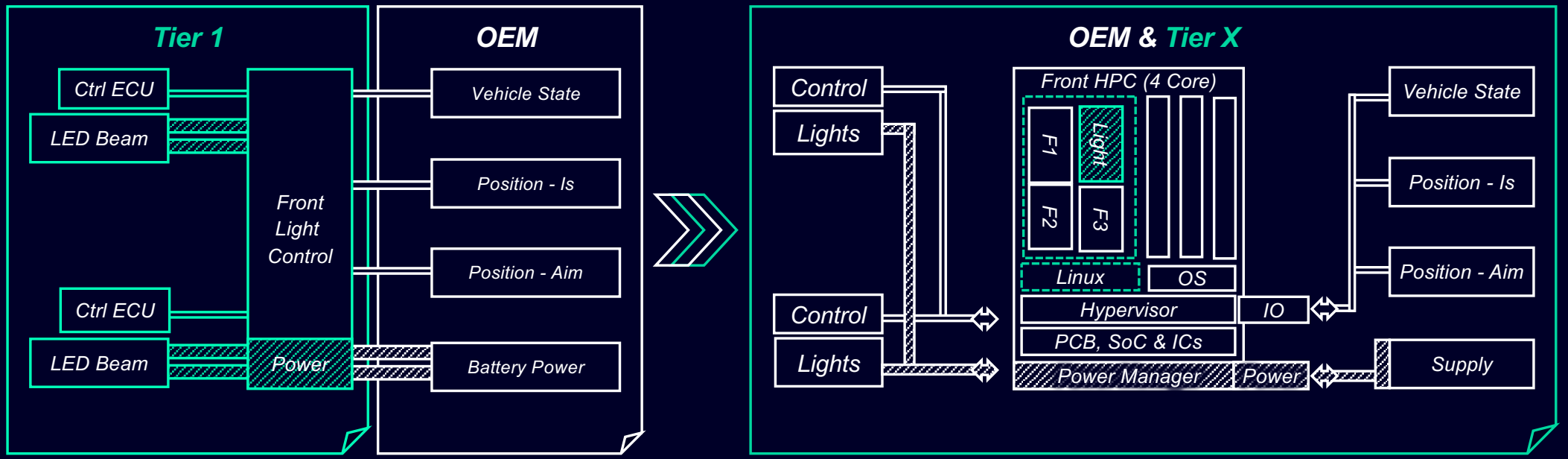
Function consolidation - driven & enabled by SDV





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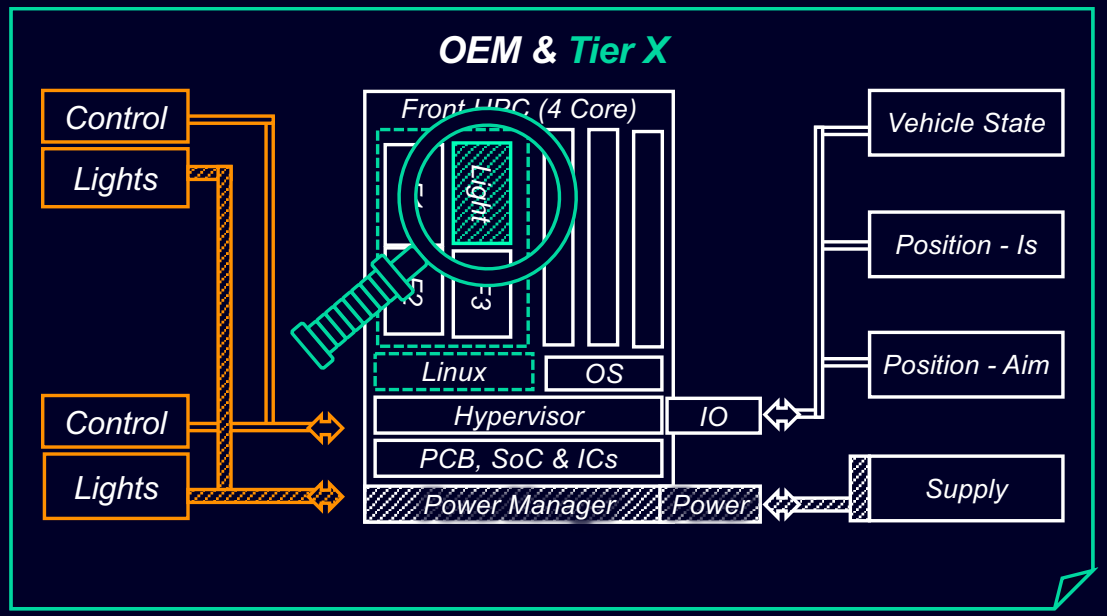
SDV driven changes in OEM & Supplier integration



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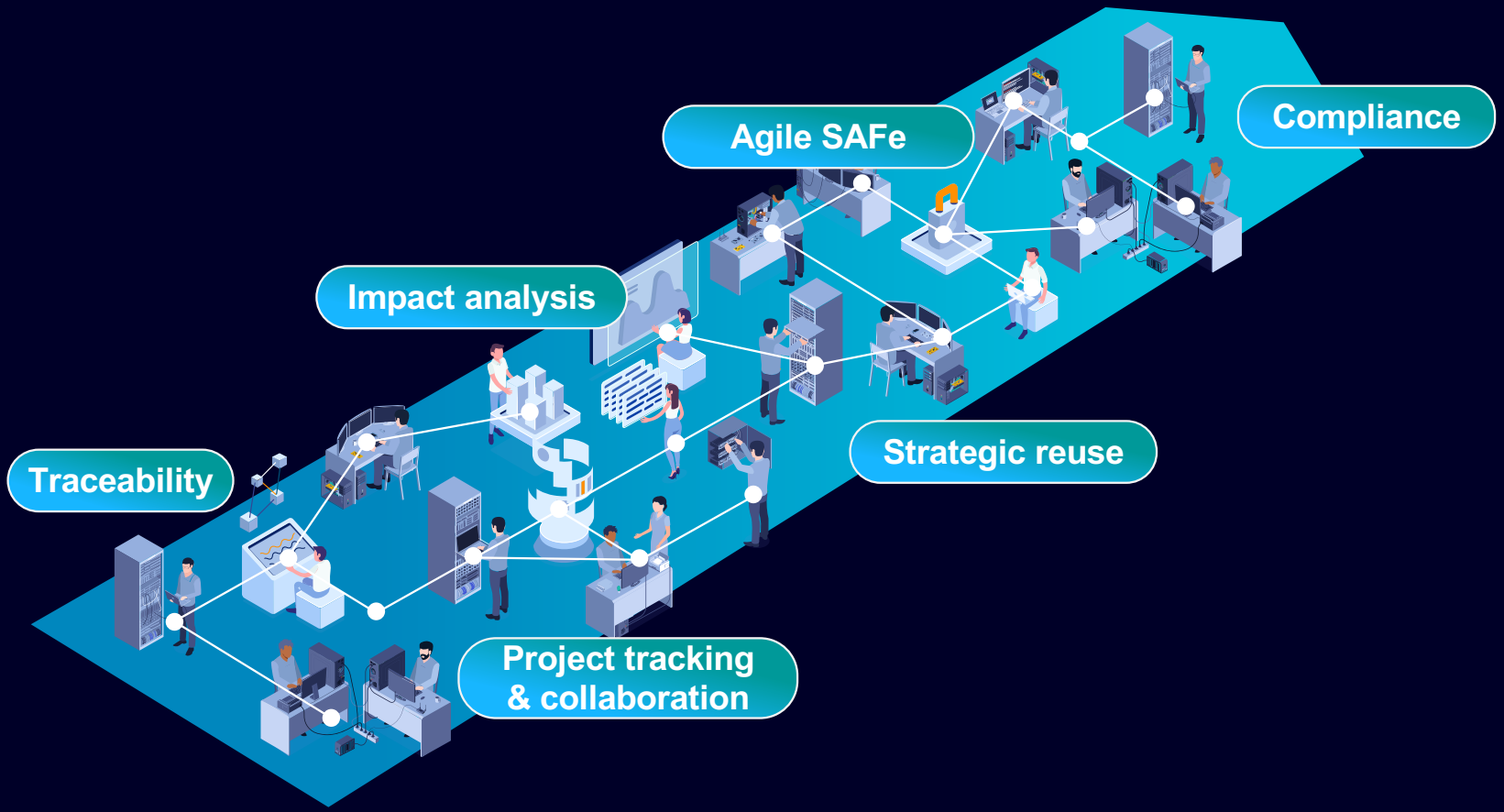
The IBM-Siemens partnership helps to break down silos and creates a comprehensive digital thread



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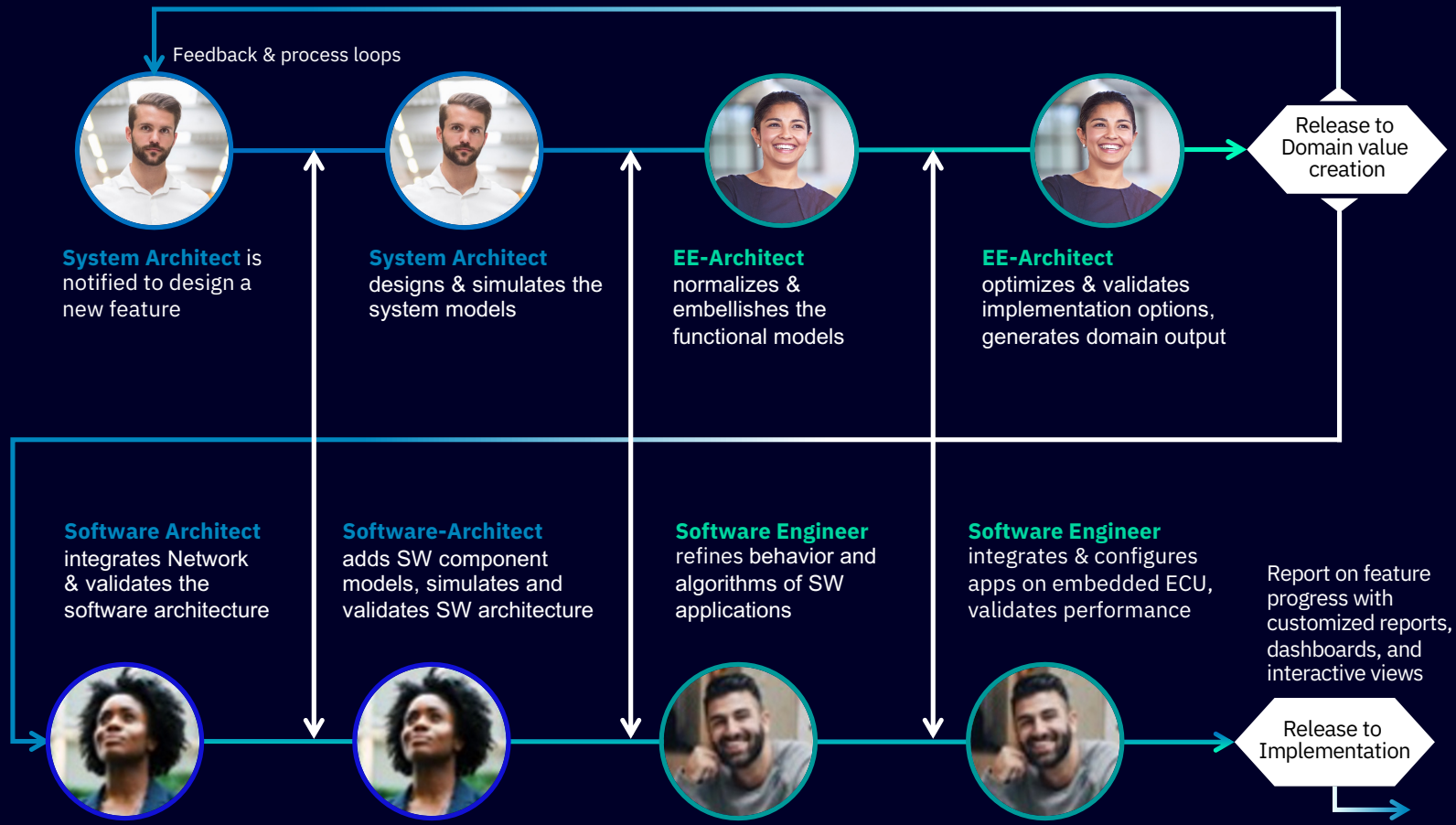
Engineering teams succeed when they collaborate across functional domains



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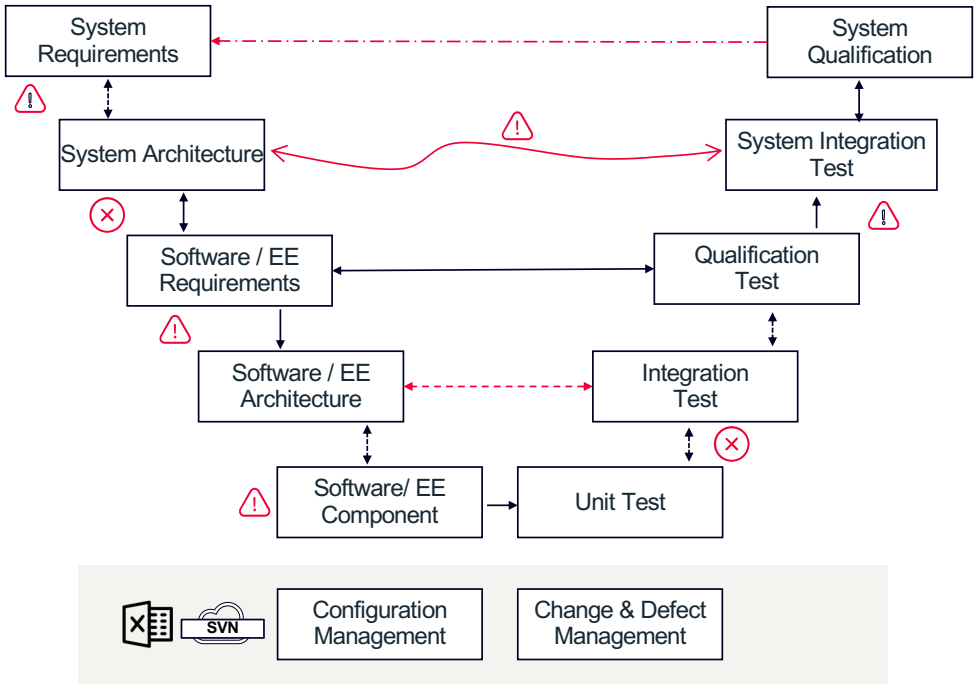
Modern engineering processes require an actionable digital thread connecting all engineering domains

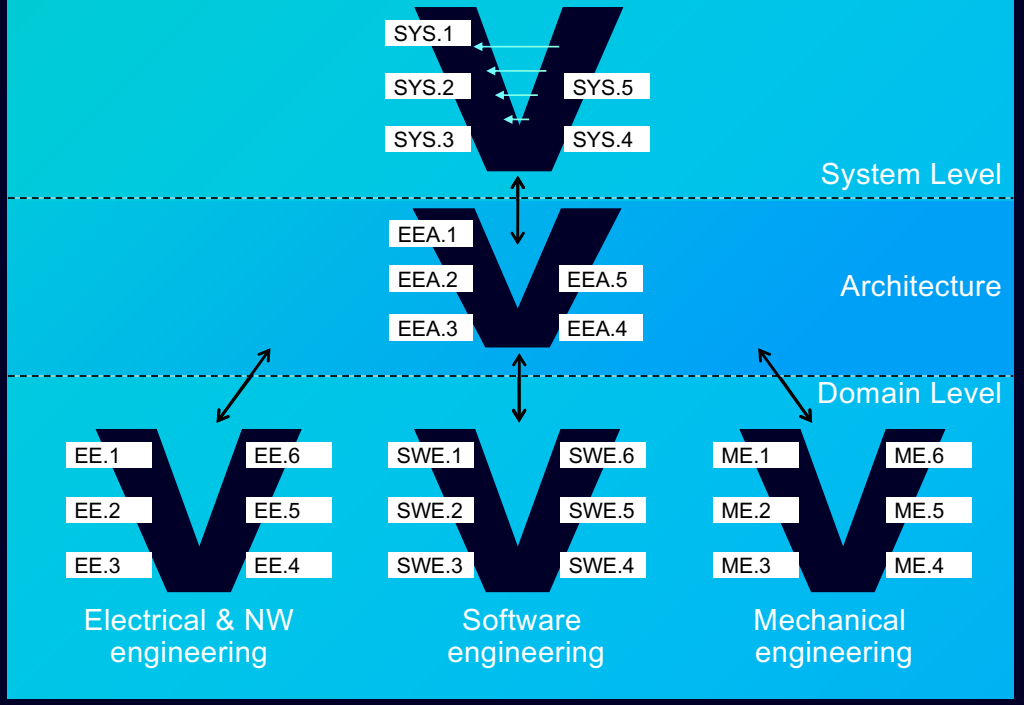
CURRENT

- Only covers one domain
- Even within the domain it is disconnected



FUTURE

- Connections are needed between domains
- Teams need collaboration, ability to track progress across multiple tools and stream-lined compliance/ regulatory reporting



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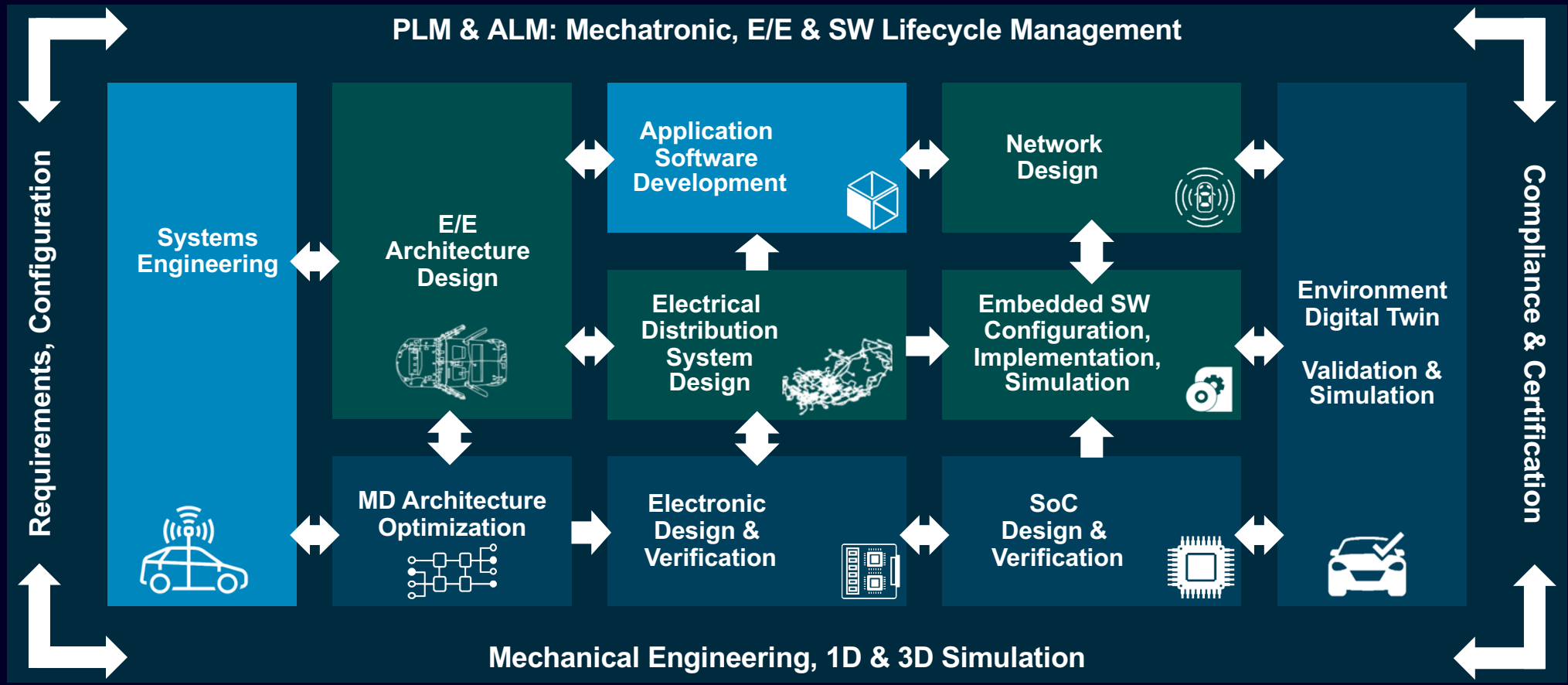
Model Based Design – Systems, E/E, Software, Compliance

PLM and ALM underpin seamless, open, closed loop engineering flow



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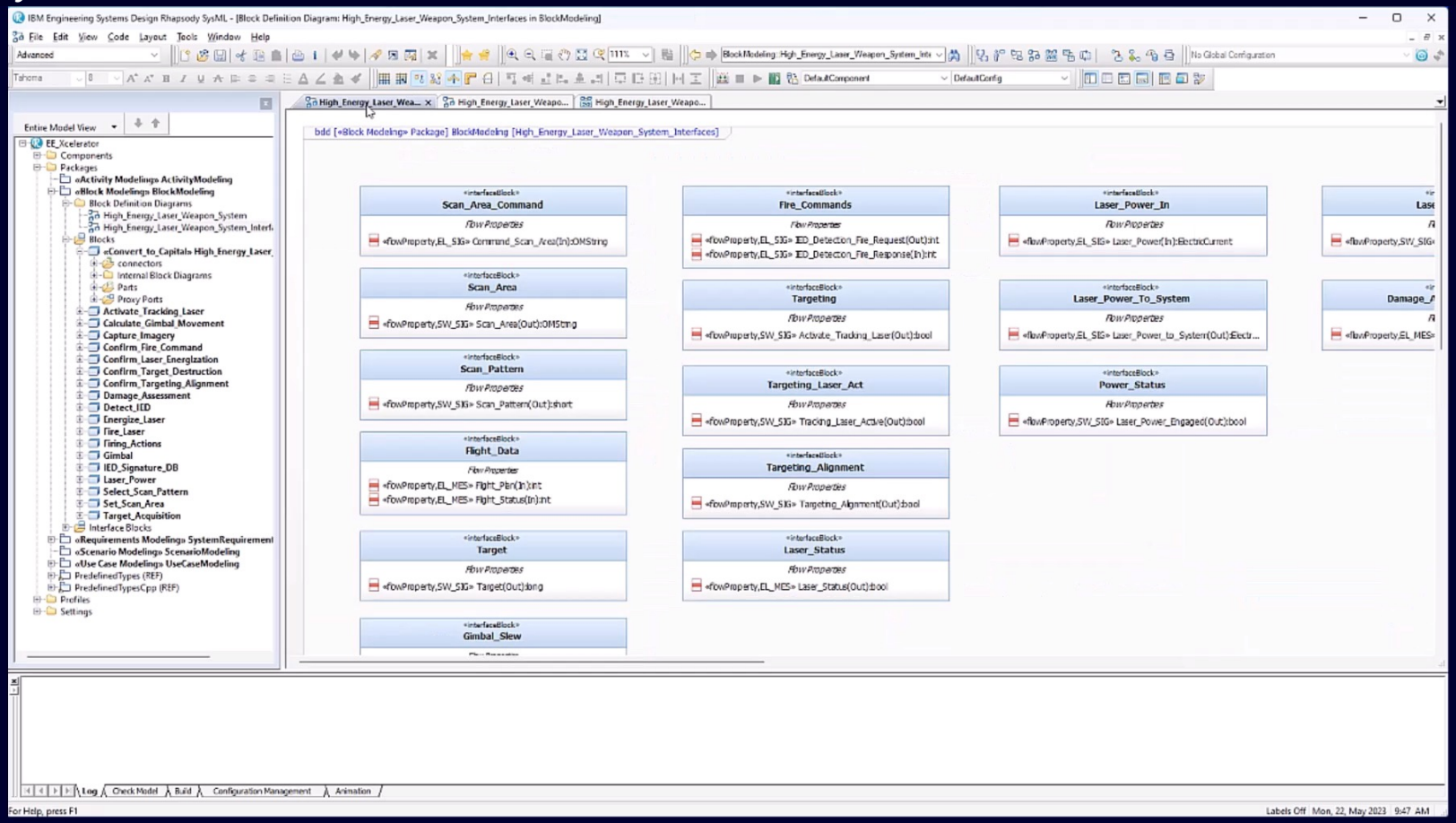
From multi-domain to E/E domain

Transform Systems into E/E

E/E architect



SysML systems modeling - Internal Block Diagram (IBD)

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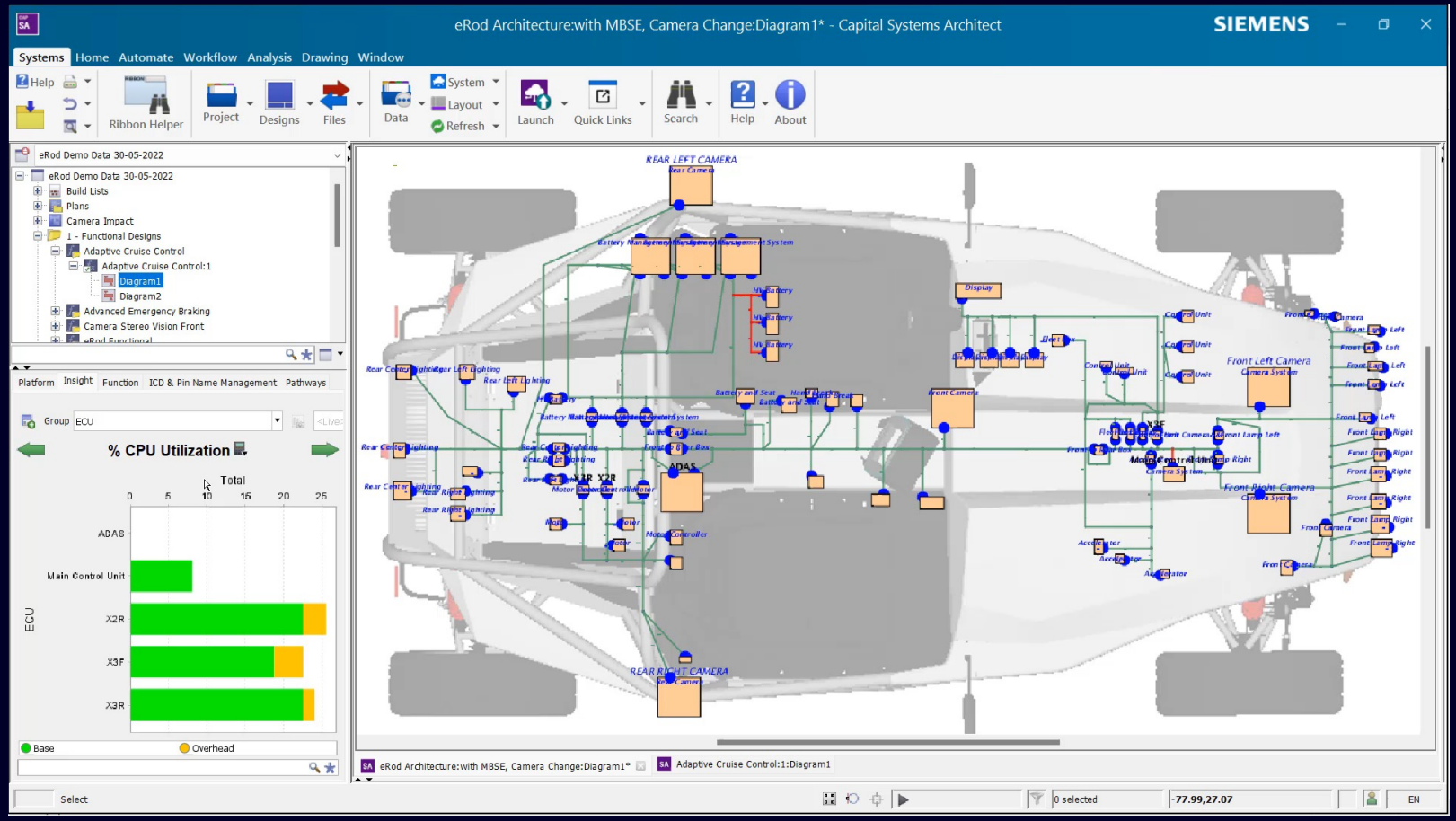
From multi-domain to E/E domain
Optimize E/E Architecture

E/E architect



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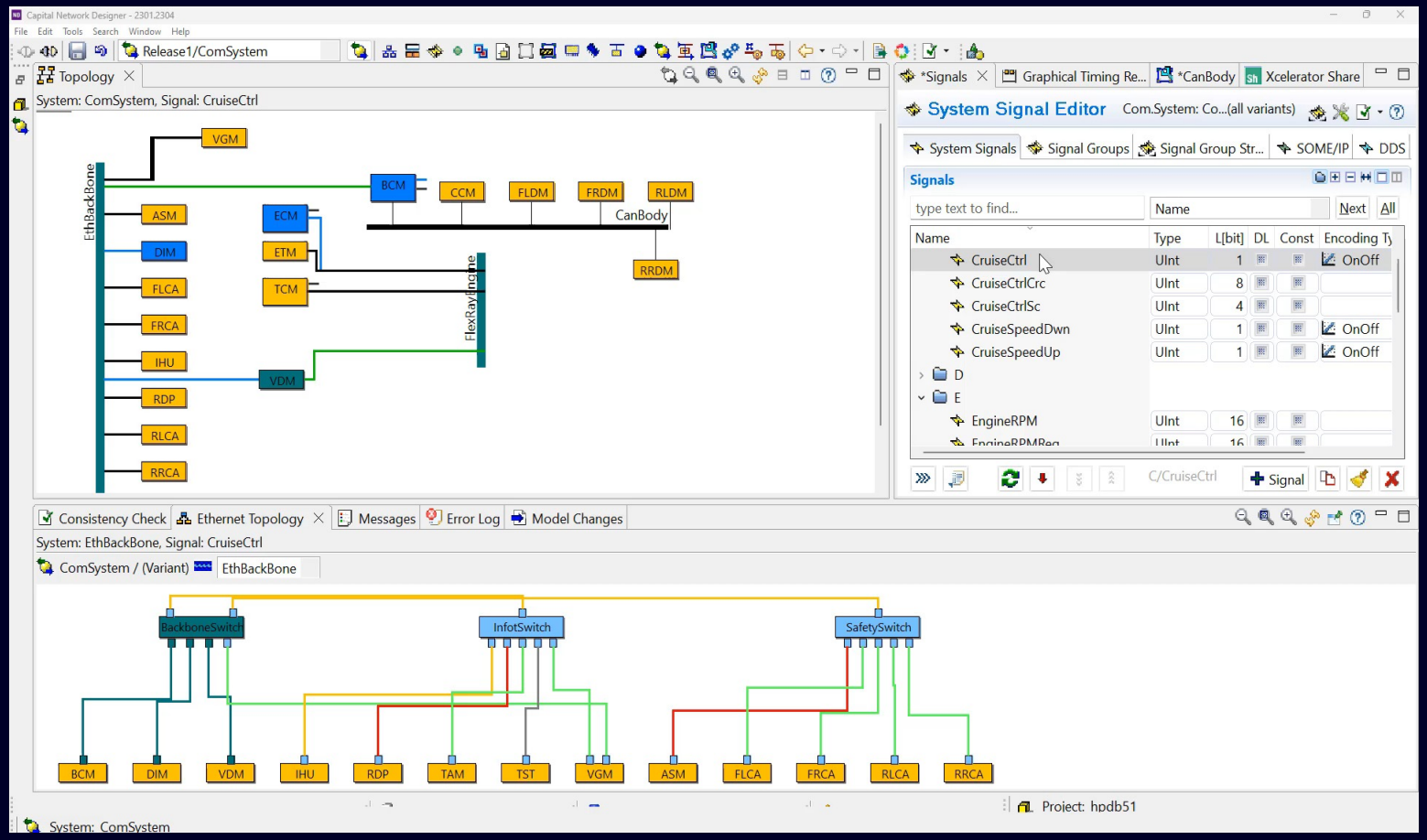
From multi-domain to E/E domain

Rapid design of validated and correct networks

Network designer



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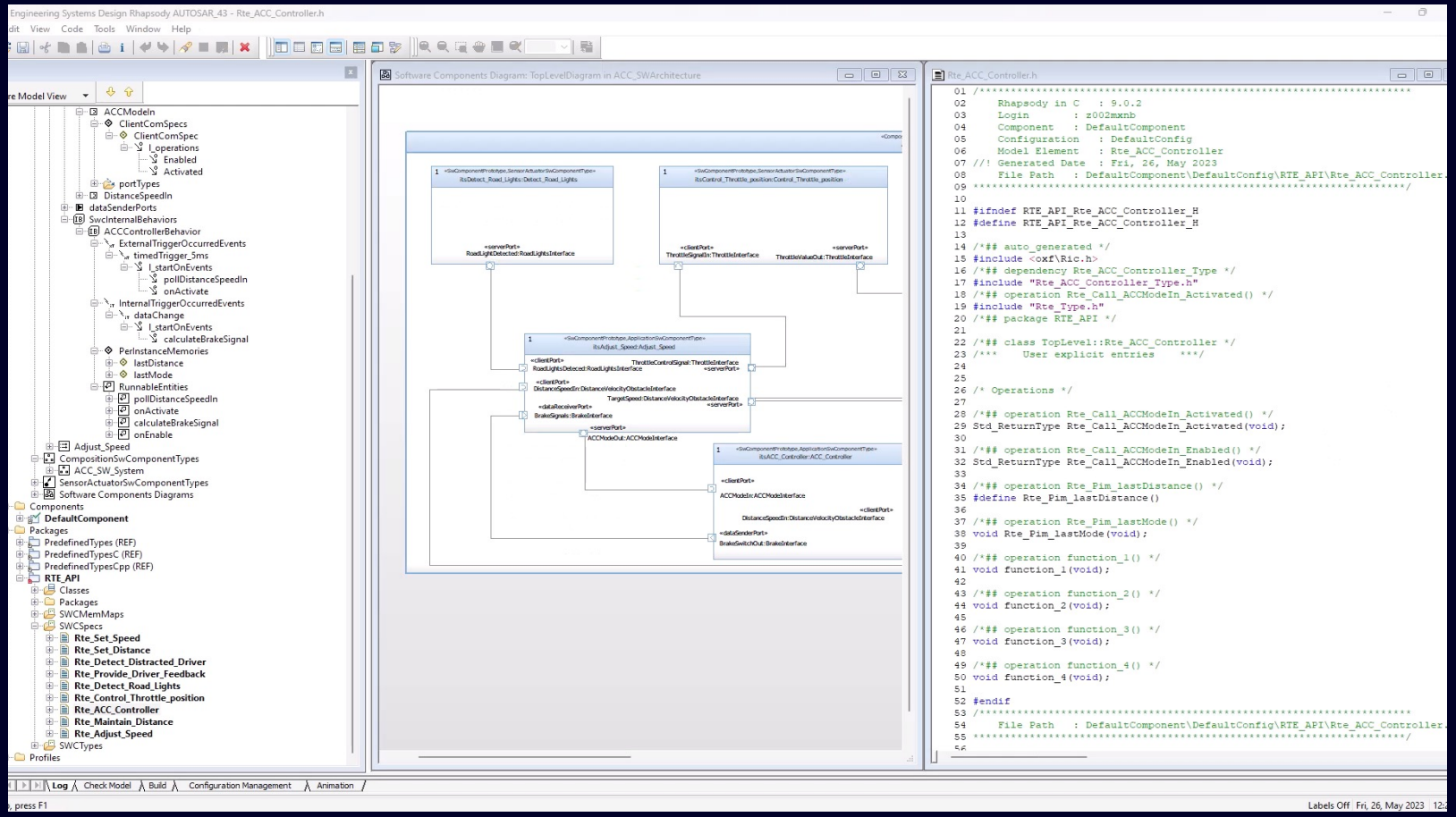
From multi-domain to E/E domain

Model-Driven software architecture on rails

Software architect



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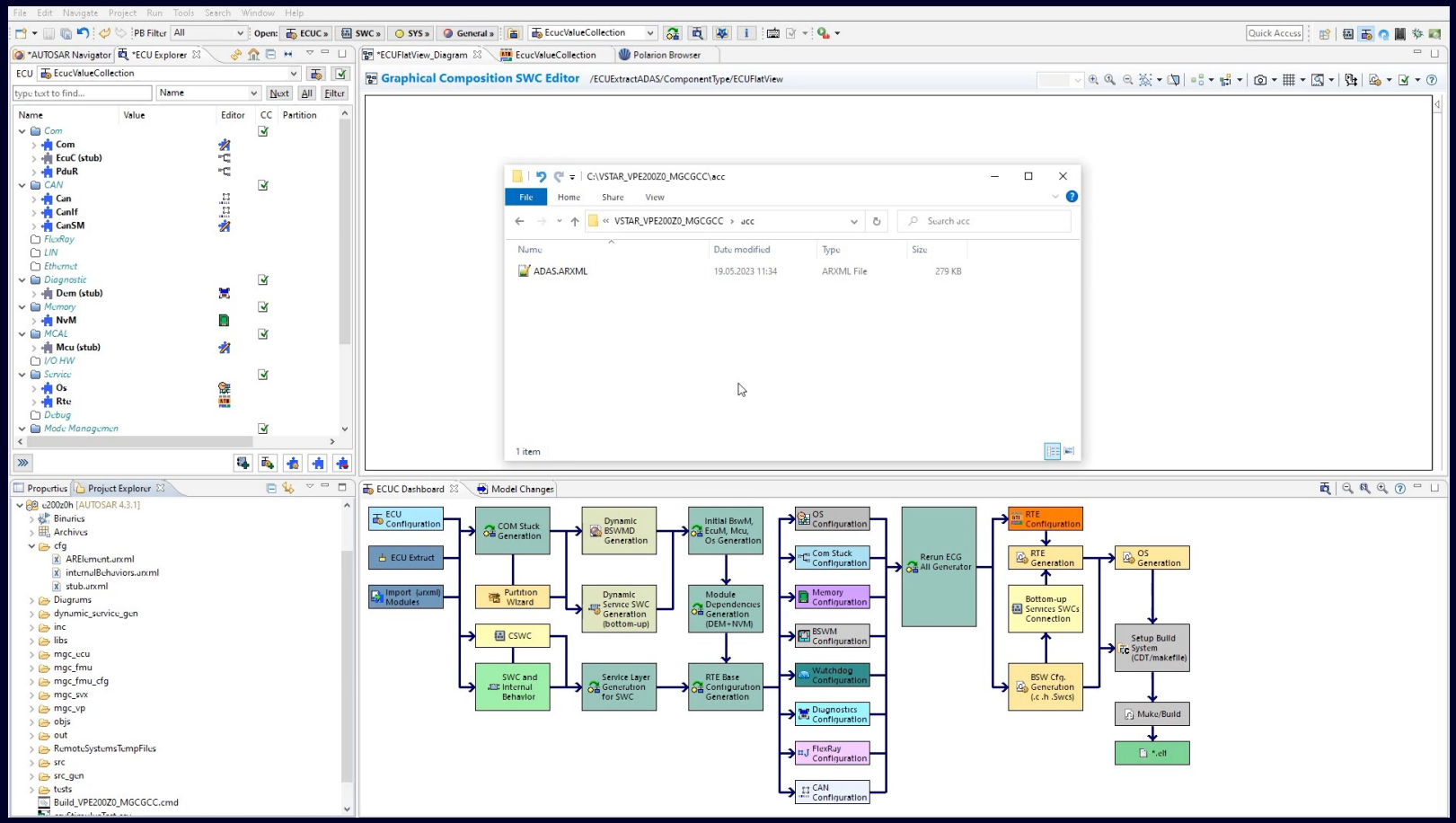
From multi-domain to E/E domain

Integrated software configuration & validation

Software implementer



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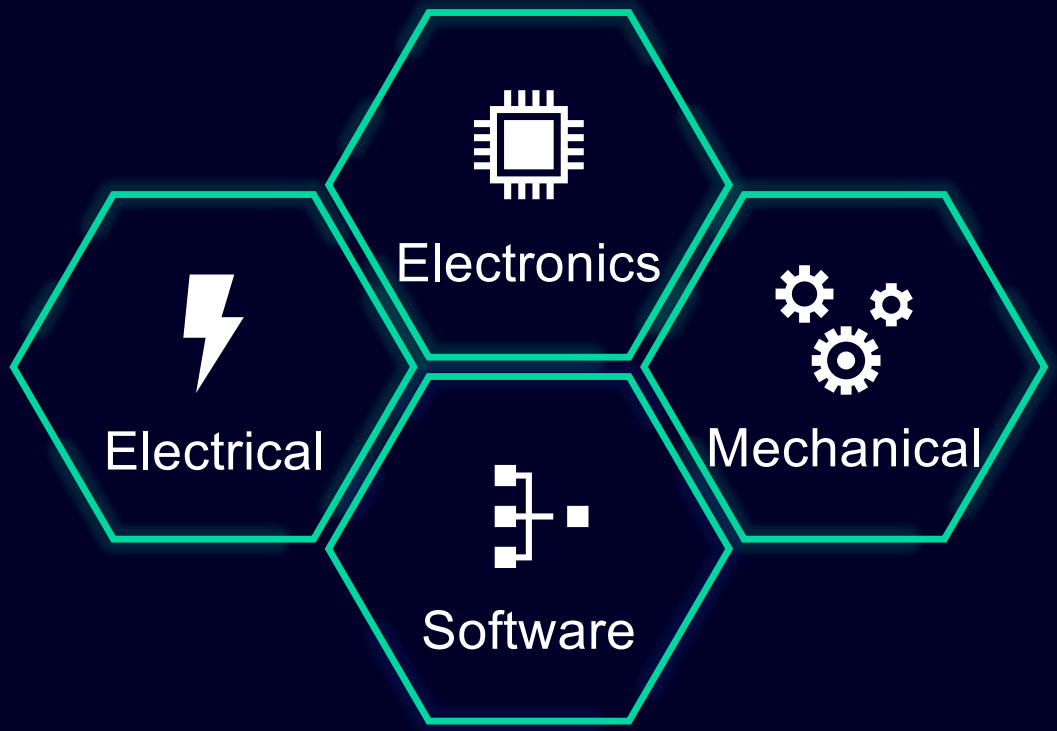
Software & beyond



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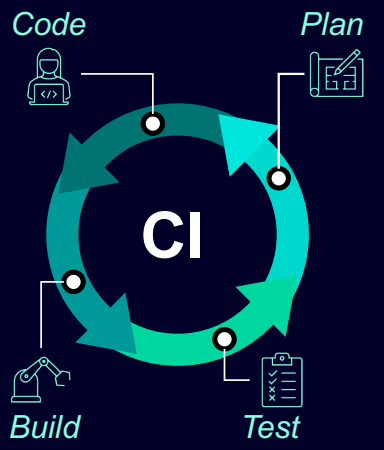
The path to CI / CD / CC
Continuous integration



Continuous software integration

- Iteratively develop tested applications
- Continuous Application SW integration
- Plan and requirements driven throughout

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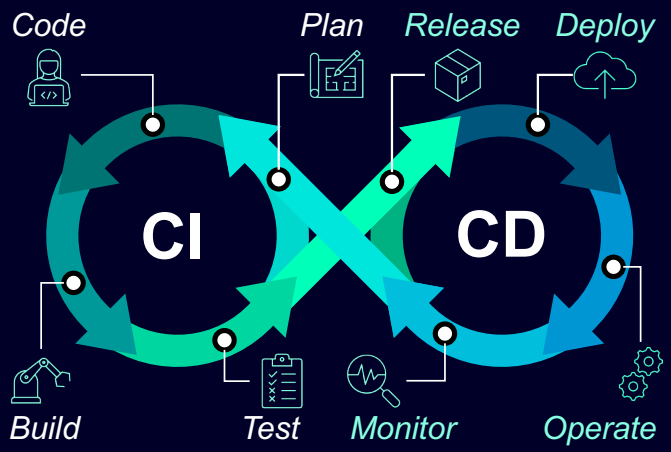
The path to CI / CD / CC

Continuous integration, continuous delivery



Continuous delivery of verified software

- Automated integration, build pipeline
- Rapidly deploy validated applications
- Requirements traceability throughout

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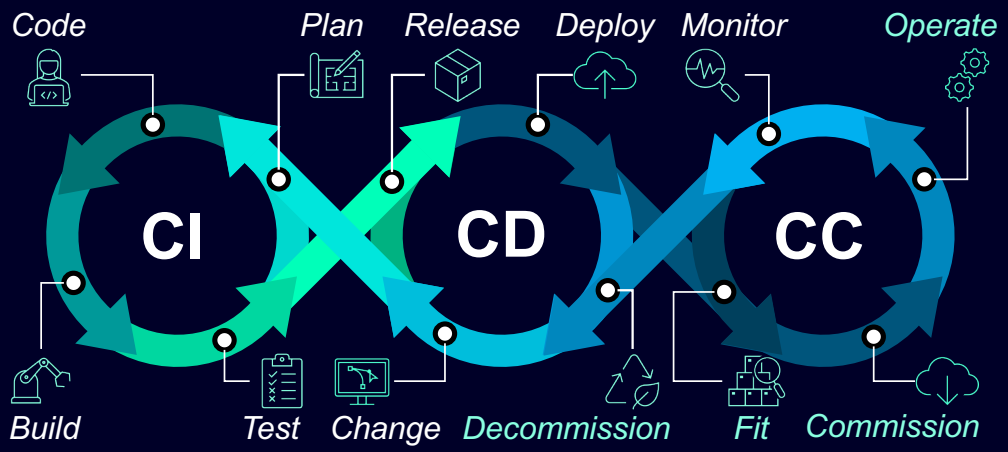
The path to CI / CD / CC

Continuous integration, continuous delivery, continuous commissioning



Continuous Commissioning

- Capability compatible vehicle record & timeline
- SaaS enabled through OTA deployment & order fulfilment
- Automate decommissioning, monitoring, charging, change

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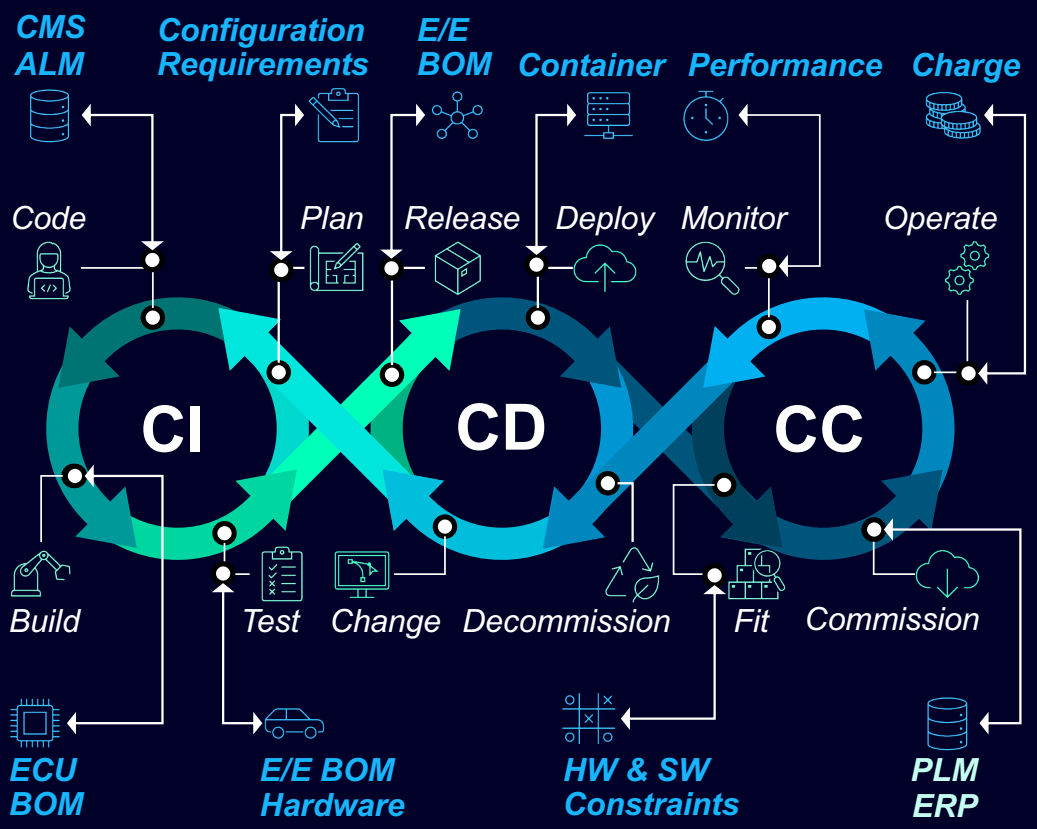
CI / CD / CC integrated: Enabling the software warehouse

Continuous integration, continuous delivery, continuous commissioning



Continuous Commissioning

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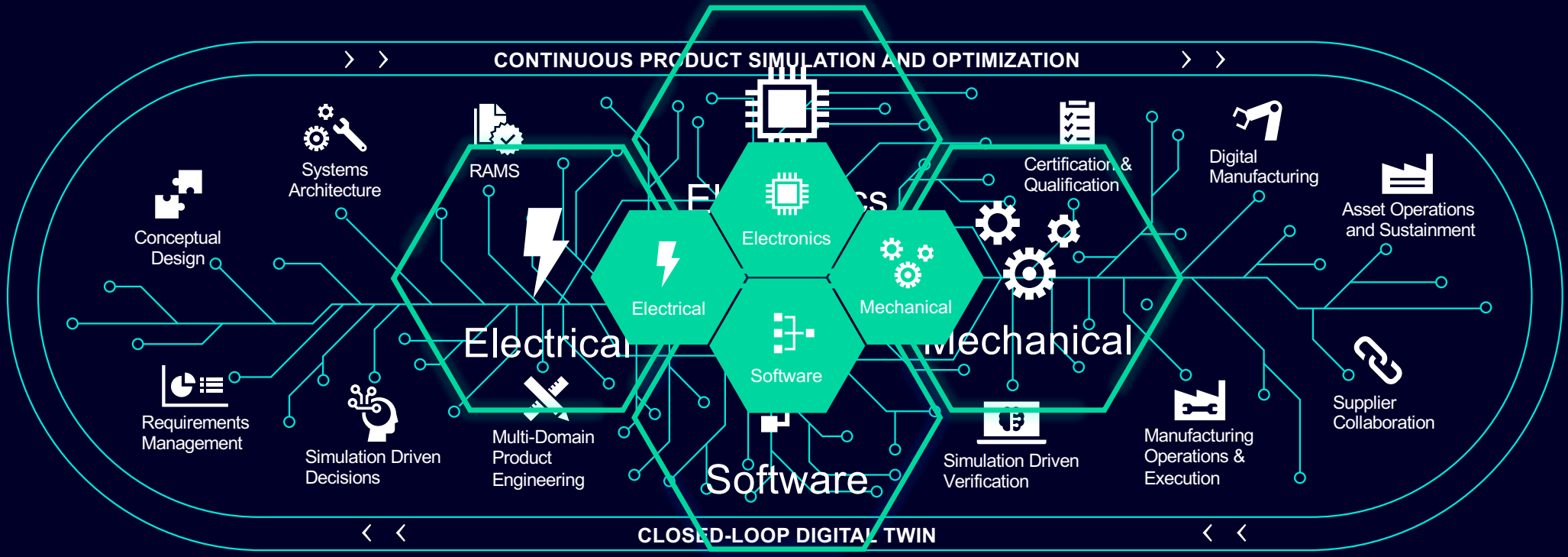
Multi-domain E/E systems architecture

Start integrated. Stay integrated.- Multi domain, multi discipline, full lifecycle



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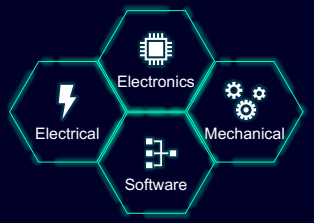
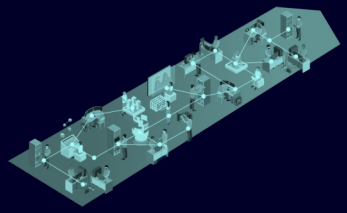
Conclusion

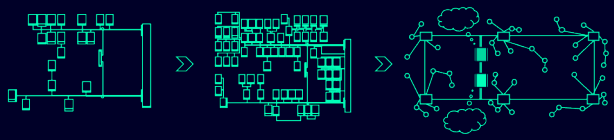
Software & beyond



IBM & Siemens for sustainability



E/E architecture



Sustainability paradigm shift

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