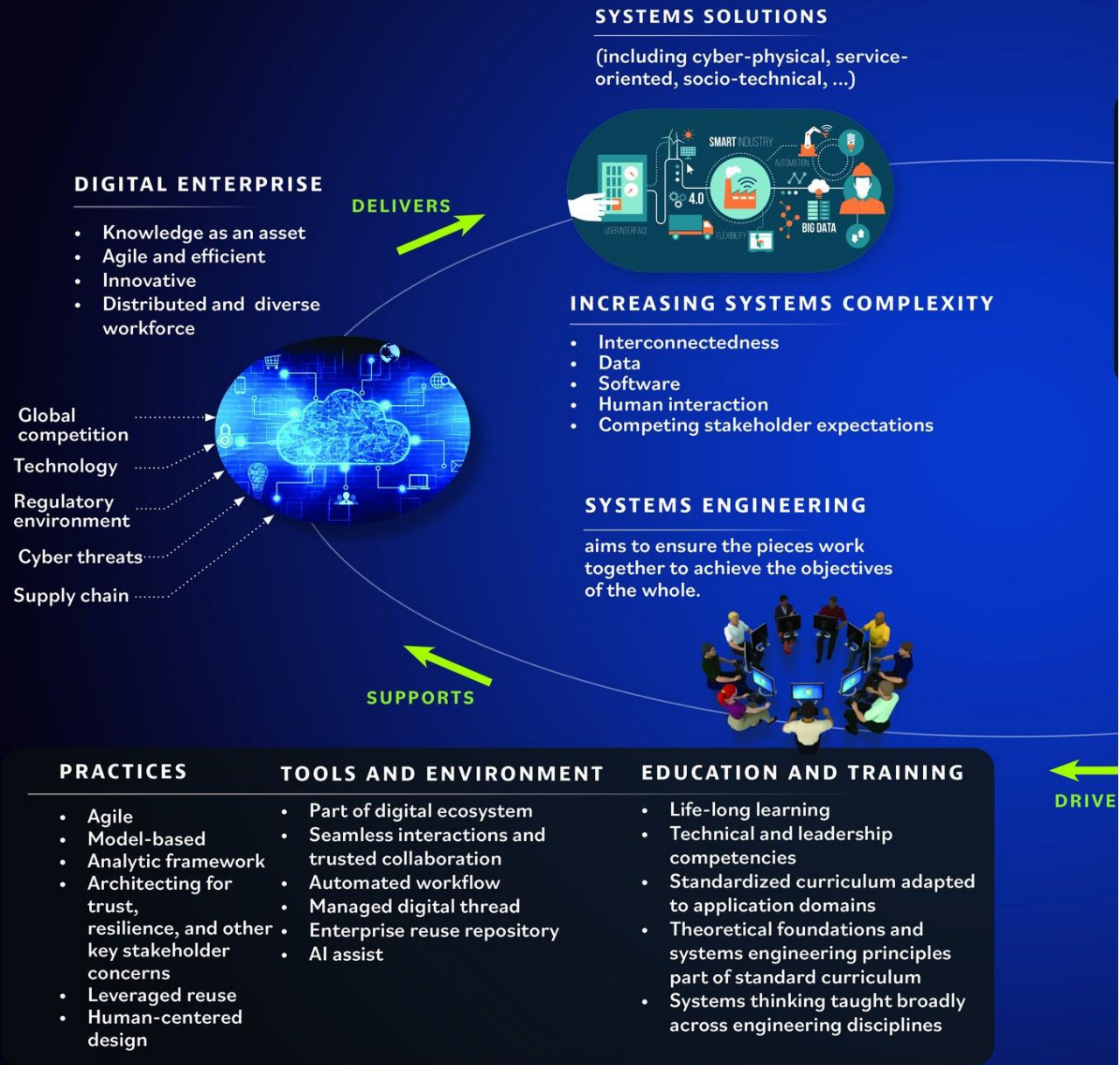


SUMMARY OF  
SYSTEMS ENGINEERING BY 2035  
ADAPTS TO CHANGES IN ITS GLOBAL CONTEXT

• Strong  
govern  
to pro  
comp



# Maturity Indices: MBSE, Digital Twin, Digital Enterprise, ...

Chris Hoffman, ESEP  
Cummins Inc., SEBoK, INCOSE

Purdue Digital Enterprise Center – Fall 2023 Center Meeting

# Chris Hoffman



Chris Hoffman thinks in systems and future effects, and defines value as a function of People, Training, Processes, Tools, and Data. He is a certified Expert Systems Engineering Professional, served as the INCOSE Technical Director of over 52 working groups, developed multi-disciplinary product systems for over 25 years at Cummins Inc., and currently manages the strategy and portfolio planning of over 1300 software tools and applications that enable product design & development for Cummins while leading the Future of Systems Engineering Methodologies stream for INCOSE and is the current sebokwiki.org Managing Editor.

Connect at <https://www.linkedin.com/in/christopherdhoffman/>



**SEBoK** GUIDE TO THE SYSTEMS ENGINEERING  
BODY OF KNOWLEDGE



International Council on Systems Engineering

*A better world through a systems approach.*

# P.O.S.T.



## PURPOSE

There are numerous maturity matrices, standards, and road maps which attempt to illuminate whether an organization is on the right path in their evolution, as well as trying to describe the different levels of sophistication and fidelity of a model, but often without providing any useful direction or reassurance.



## OUTCOME / ASK

- Understand some of the complexities and purposes around maturity matrices
- Broadened perspectives
- Engaged conversations
- Additional advocacy towards SE Vision 2035



## STRUCTURE

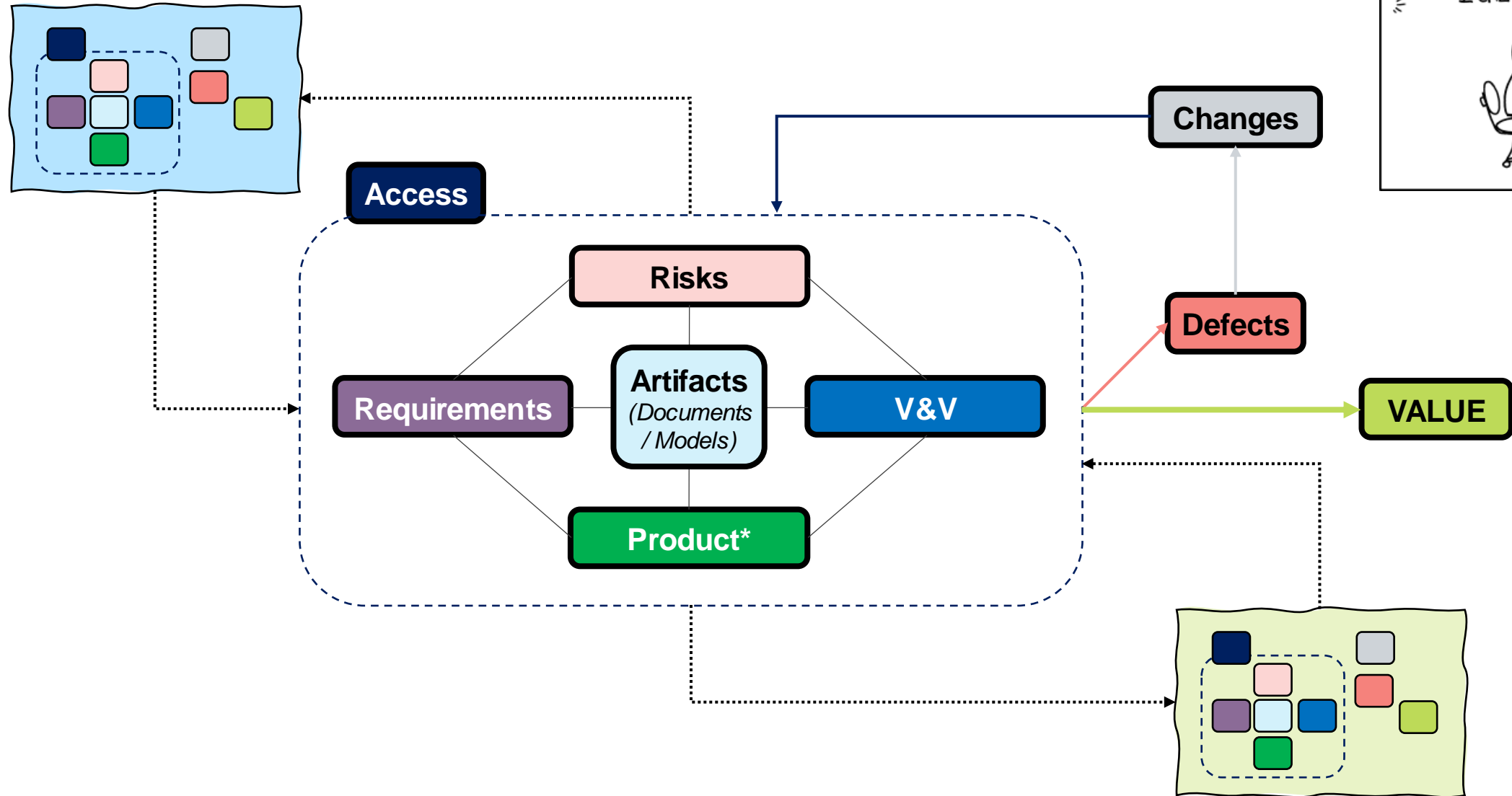
- An in-person presentation in sections to facilitate active discussion
  - A Core System Model
  - What are we measuring? Why?
  - SE Vision 2035 – MBSE, Digital Transformation, ...
  - Conclusions & Potential Actions



## TIME

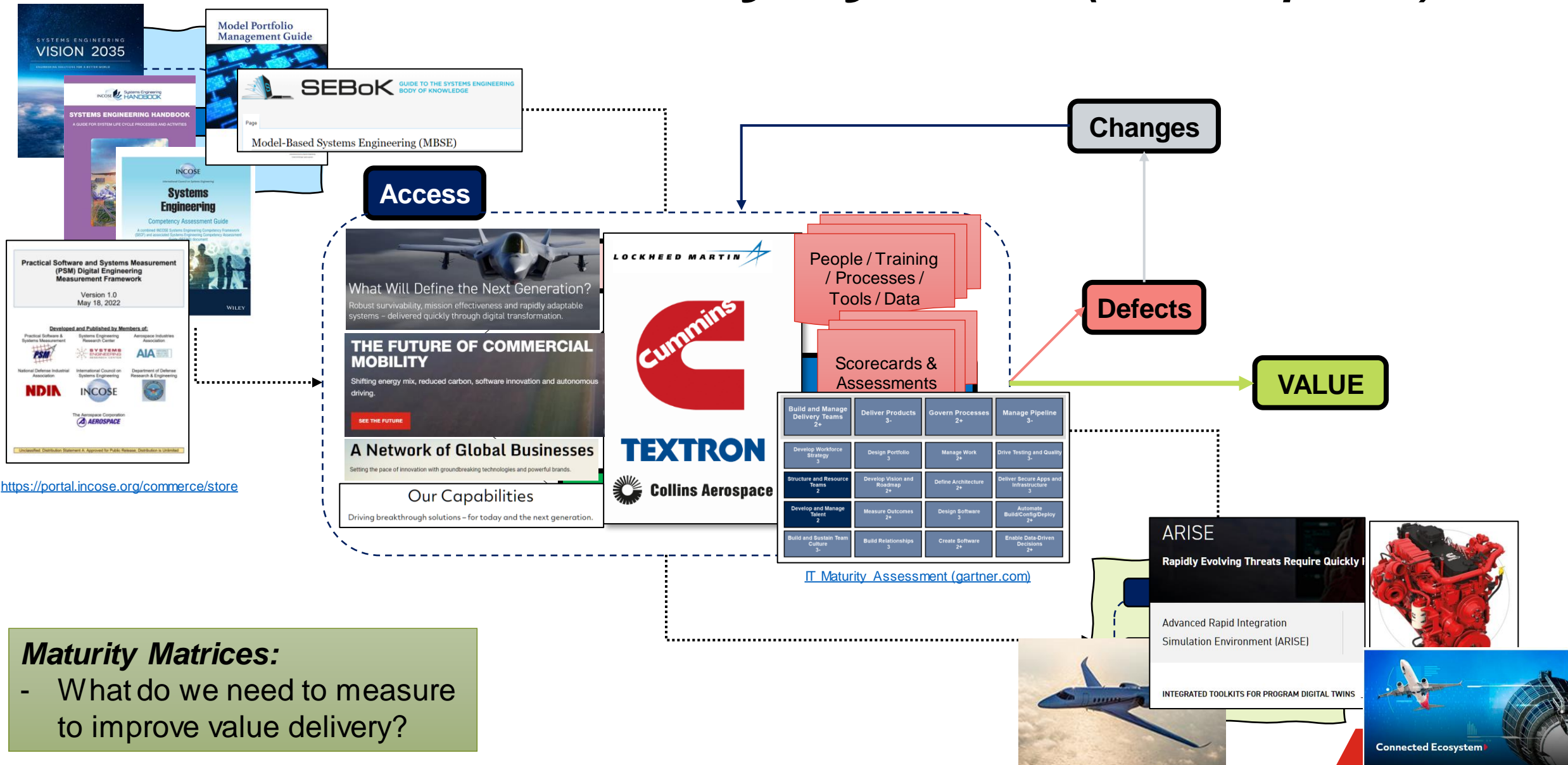
- 30 Minutes

# A core model of any system



xkcd.com

# A core model of any system (examples)





# What are we targeting to measure?

*a.k.a., Where are the problems & opportunities?*

## MBSE & Digital Twins

### Strategy & Transformation

O  
Objective

P  
Platform

I  
Initiative

### Business Architecture

O  
Organization

B  
Business  
Capability

C  
Business  
Context

### Application & Data Architecture

D  
Data Object

A  
Application

I  
Interface

### Technical Architecture

P  
Provider

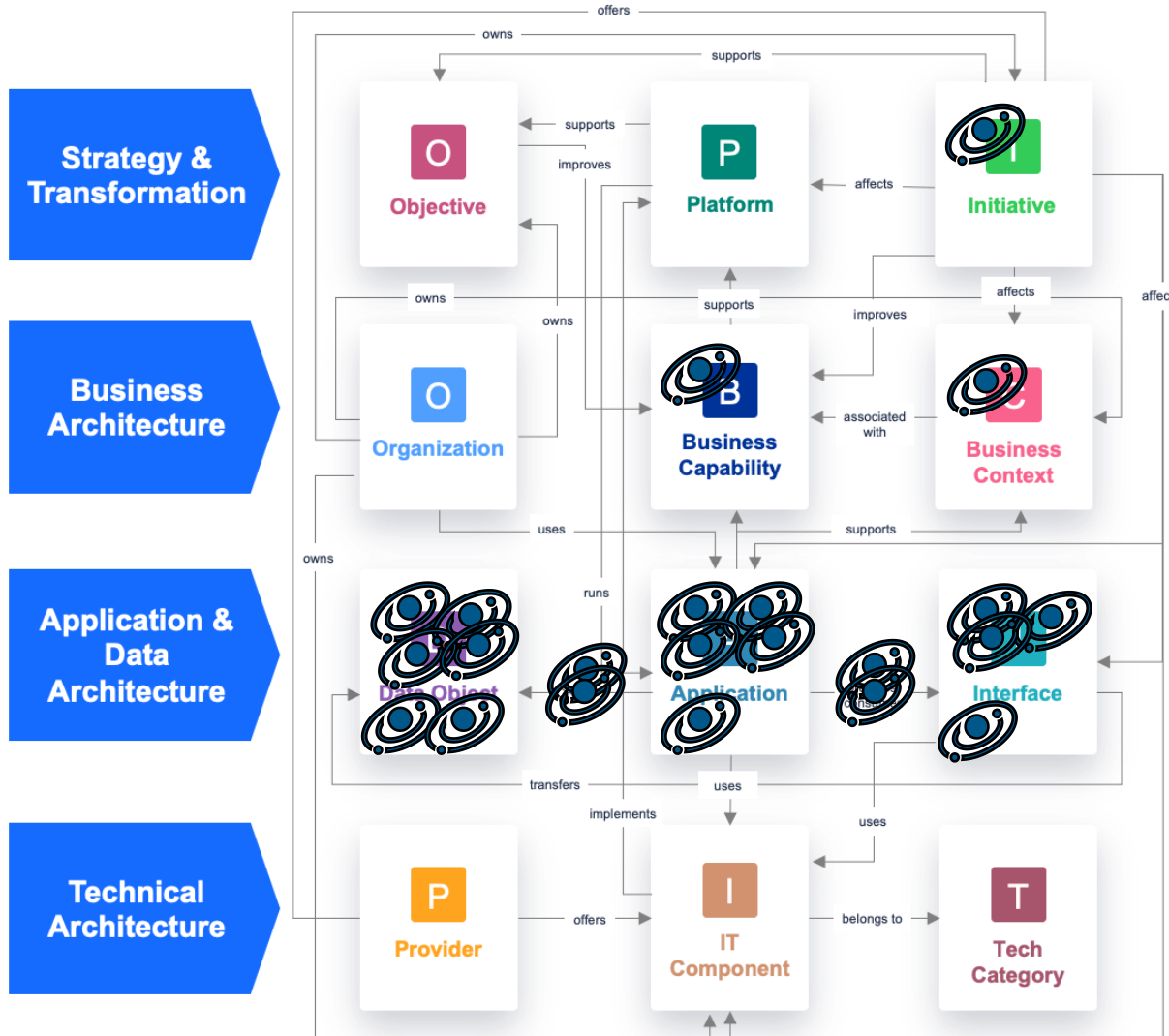
I  
IT  
Component

T  
Tech  
Category

- O Increase Direct-to-Consumer Sale by 20%
- P Digital Platform for B2B Commerce
- I Implement Customer Facing App
- O US, Germany, France, ...
- B Customer Relationship Management, ...
- C Order to Cash, ...
- A Salesforce, Workday, SAP, ..
- I Salesforce to Workday Interface, ...
- D Customer, Prospect, Employee, ...
- P AWS, Microsoft, Oracle, ...
- I EC2 Virtual Server, .NET, Postgres, ...
- T Service, Database, Servers, ...

- ❖ Execute better Systems Engineering
- ❖ Authoritative Source of Truth platforms
- ❖ Project to Product knowledge capture
- ❖ Business Unit A & B to start, others to follow
- ❖ Define Product System Architecture, ...
- ❖ Variant Decisions, Knowledge Capture & Reuse, ...
- ❖ SPDM, PLM, SysML App, ALM, FuSA, ...
- ❖ App 1 to App 2 Interface, ...
- ❖ Requirements, Risks, Models, Decisions, ...
- ❖ ANSYS, PTC, Siemens, Microsoft, ...
- ❖ SaaS, IaaS, PaaS, HW, SW, Services, ...
- ❖ Storage, Compute, OS, Orchestration, Integration Middleware, ...

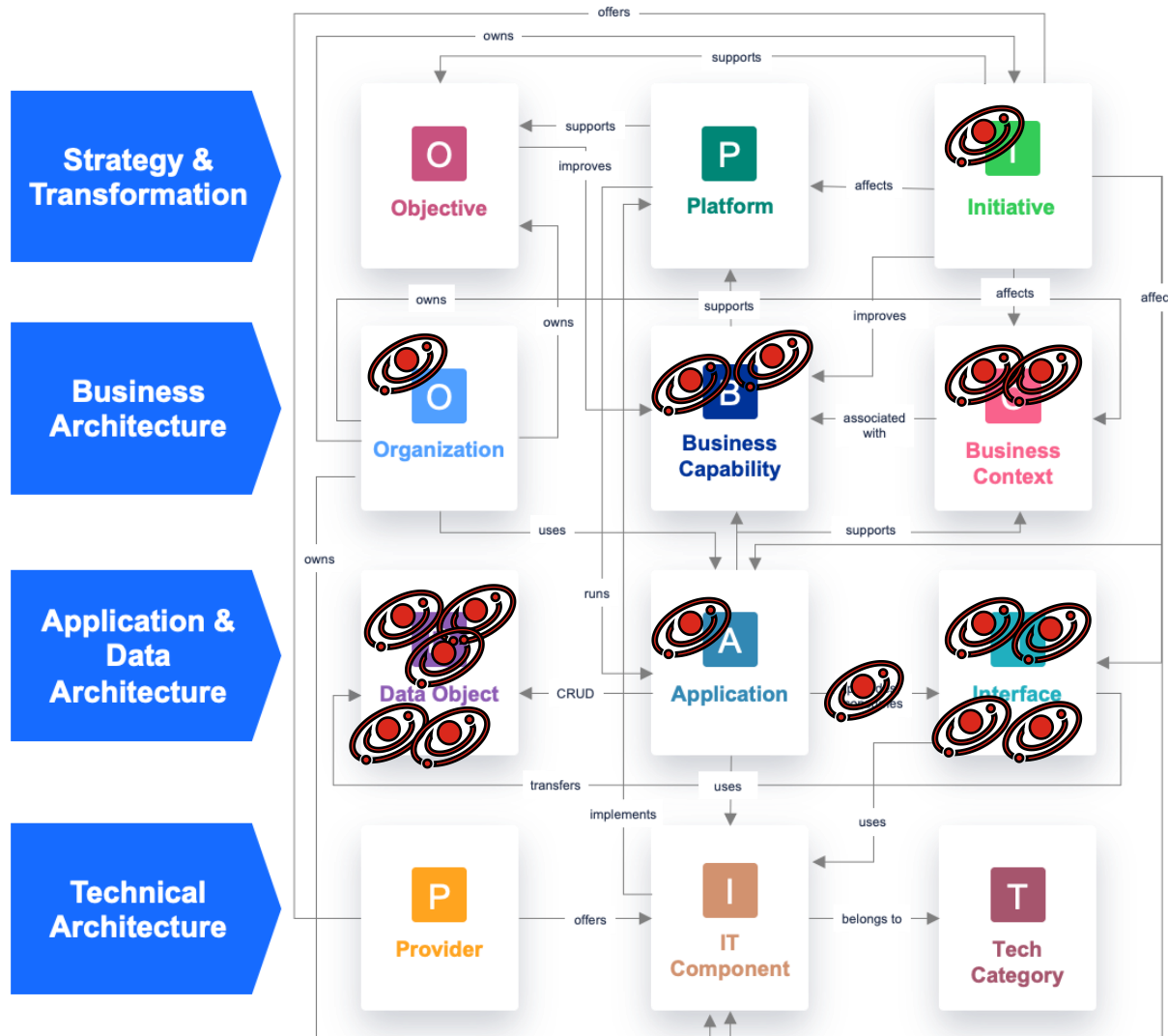
# An MBSE Maturity Assessment's 'EA Impact'



<https://docs-eam.leanix.net/docs/meta-model>

- Would this assessment accelerate the change and value delivery that MBSE and Digital Twin are promising?
- What outcome might this assessment focus drive?
- What type of group may have created this MBSE assessment matrix?

# An Industry Maturity Assessment's 'EA Impact'



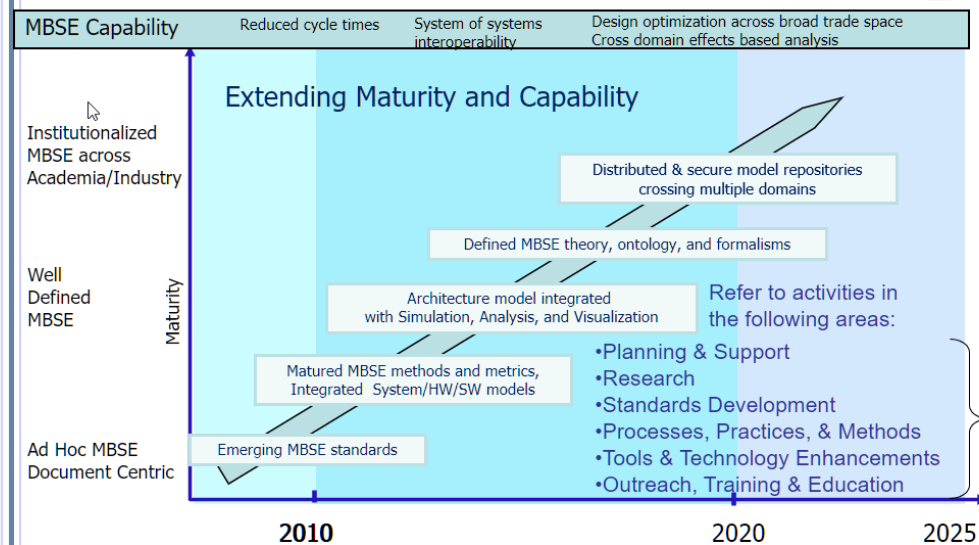
<https://docs-eam.leanix.net/docs/meta-model>

- Each assessment has defined stages to drive action:
  - Documents to Models
  - Document > Sim Based > Model Based > Full Systems Simulation
  - Uncontrolled > Controlled Documents > Isolated Models > Enterprise Integration > Continuous Engineering
  - Initial > Managed > Defined > Qualitative > Optimizing
  - Disintegrated > Integrated
  - Disconnected Silos to Virtual matches real
  - Pre-digital > Digital silo > Connected org. > Predictive org. > Adaptive org.
  - ...
- Each assessment has different purposes and outcomes to drive **beneficial** action to the **author's area**
  - Do they collectively move us towards the MBSE & Digital Twin 'ideal-final-result' future vision?

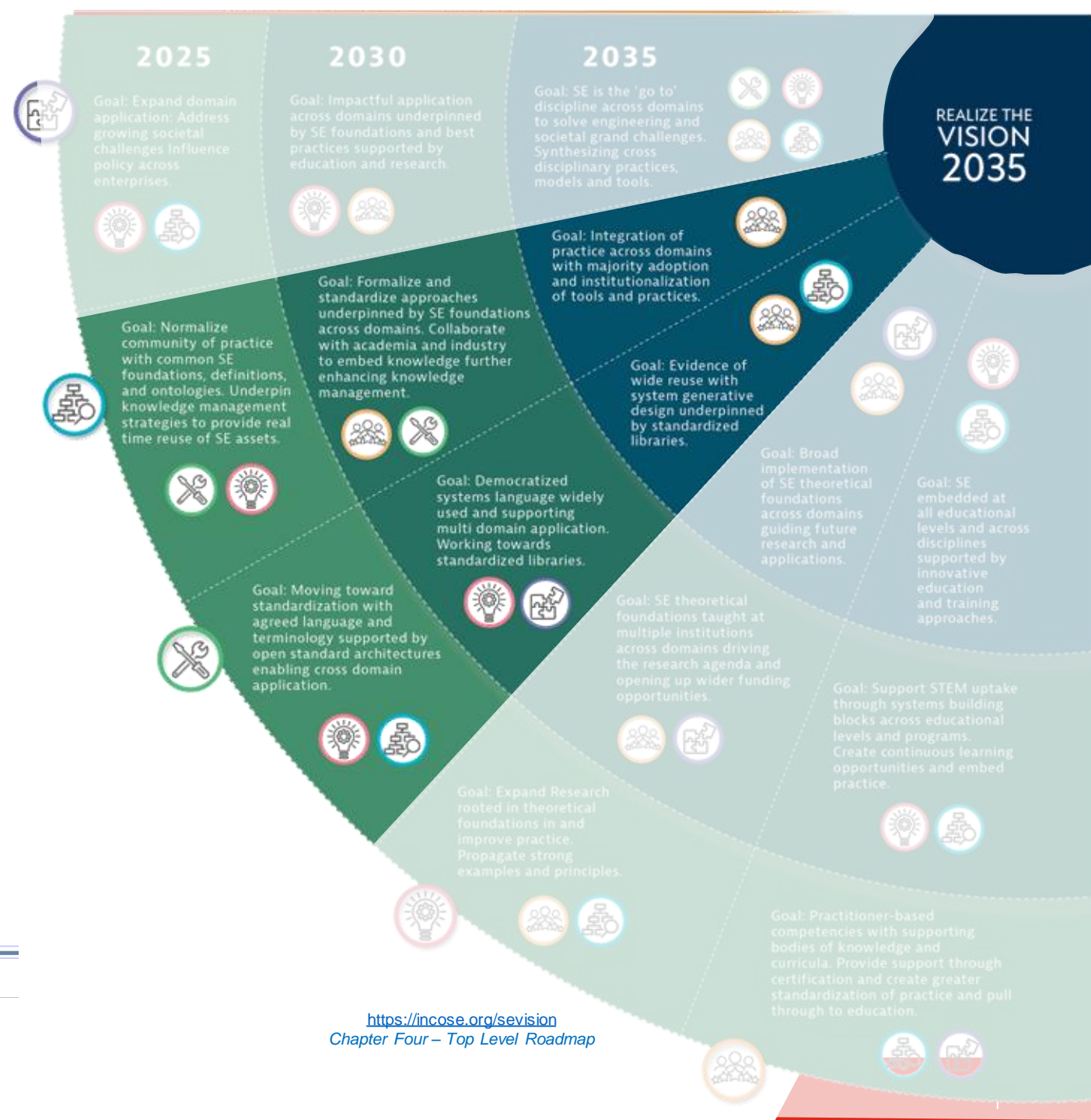


# INCOSE's (MB)SE Vision 2013 to 2022

# INCOSE MBSE Roadmap



<https://incose.org/mbse>  
from MBSE Initiative Summary presented at  
INCOS International Workshop 2013



<https://incose.org/sevision>  
Chapter Four – Top Level Roadmap

## Addressing Dynamic Change and Uncertainty

### *Changes Needed*

- Data standards are developed and adopted enabling effective data interconnection and exchange.
- Methods and tools for dealing with product variation and variability are widely adopted.
- Knowledge Management and incremental learning are integrated with systems engineering practices.
- Systems engineering incorporates dynamic feedback into solutions across the life cycle (such as Agile practices).
- Increasing technology assistance for human tasking is incorporated including automated workflows.

## MBSE– Digital Transformation

### *Changes Needed*

- Use and management of models, architecture, and digital thread mature, including digital twins.
- Immersive visualization with modeling and simulation is incorporated.
- Trusted digital environments with broad span are established.
- Trusted data is managed as an essential asset.
- Effective semantic integration of digital assets is applied, including knowledge representation.
- MBSE is supported by AI/ML to aid development of solutions.





## Systems Engineering Tools for Digital Environment

### Changes Needed

- Focus shifts to data/ information rather than tools.
- Consistent artifacts for communication are established.
- Modeling language and data interchange standards are developed and used that facilitate information sharing.
- Effective distributed information sharing/interchange is common.
- Speed and capacity for analyzing alternatives and impacts increases (orders of magnitude).



## Foundations and Research

### Changes Needed

- New principles, phenomena, concepts, heuristics, and technologies are integrated with existing knowledge.
- Research to define and validate the systems engineering Theoretical Foundations is launched.
- Research on systems engineering practices, tools, and applications that address dynamic change and uncertainty is facilitated.
- Industry, government, and associations team with academia to further systems engineering research and incorporate systems engineering foundations into the curriculum.
- Systems engineering research encourages cross-disciplinary engagement to move towards integrated approaches.

# Conclusions & Potential Actions

- This group should advocate for balanced maturity matrices related to Digital Twin & MBSE that could be used for measuring an organization's journey.
  - Steps of the journey **and**
  - How well one is doing on that journey
  - The one being assessed is the beneficiary
- Open question: What is an 'agile' representation and approach of a maturity index (stage gate-ish)? Is it a spiral continuous-improvement cycle? What is your representation?
- Any measurement device will need to be tailored to each organization to drive engagement. A common matrix is just a start!

## Potential Actions

- Research the current landscape of maturity matrices & related metrics (student?).
- Associate those items with the full system model. Find gaps, propose mitigations.
- Align your efforts with SE Vision 2035.
  - ...this may not be 'actionable' enough!
  - Please share improvement proposals and your perspectives with Chris Hoffman [Christopher.hoffman@incose.net](mailto:Christopher.hoffman@incose.net) so the vision and roadmap may be improved!
- ...

Q+A



# Today's Observations

