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Digital Engineering Standards Development to Achieve SE Vision 2035

Abstract

The SE Vision 2035 states "the future of systems engineering is model-based, enabled by enterprise digital transformation". As organizations move towards a holistic, integrated digital engineering approach to systems development, there is a growing need in standardization to enable industries to share, cross-reference, integrate, reuse and extend models of various kinds. The Digital Engineering Information Exchange Working Group (DEIX WG) conducted an analysis of current Digital Engineering standardization activities and is currently working with ISO/IEC and IEEE in new standards to address the challenges of using digital engineering in systems engineering lifecycle activities. The presentation will provide an overview of current standard activities and roadmap to mature standards to enable SE Vision 2035.

Presenter Biography

- Celia Tseng
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Celia is the Director of A&D transformation accounts at Dassault systems, with 19 years of systems engineering experience from Raytheon Technologies, Lockheed Martin, and SAIC. Celia is a co-chair of the joint INCOSE/ NDIA/ OMG Digital Engineering Information Exchange Working group and INCOSE standard liaison in ISO/IEC JTC 1 SC 7 AHG 6 digital engineering. She has a masters in Systems Engineering from Cornell University, a certified systems engineering professional (CSEP), a certified system modeling professional (OMG OCSMP) and certified agile scrum master (SAFe).

- Missy Wallace
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Missy oversees the development of the Digital Engineering Guide for the Digital Engineering Information Exchange Standards Framework (DEIX SF). In this capacity, she leads INCOSE/ISO/IEEE members in developing a standard to guide the application of the Digital Engineering processes. Missy is an expert digital engineer with CSEP and SysML Model Builder Fundamental certifications, and has worked with various government and defense agencies including Raytheon, NAVAIR, General Atomics, and Northrop Grumman.

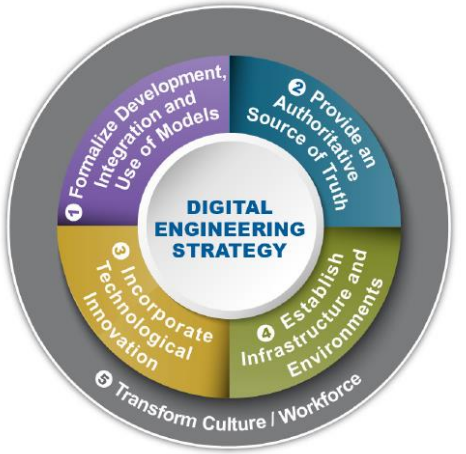
Bottom Line Up Front

Digital Engineering Working Group – Standards Framework is actively engaged in developing a range of products aimed at realizing the INCOSE Vision 2035

In this presentation we address the goals and hurdles of Vision 2035 in the context of these products

What is DEIXWG?

- Collaboration between the International Council of Systems Engineers (INCOSE), National Defense Industrial Association (NDIA), and the Office of the Under Secretary of Defense for Research and Engineering (DoD OUSD(R&E))
- The DEIXWG supports the strategic objective of accelerating digital engineering transformation by characterizing the content and relationships involved in the exchange of digital artifacts between stakeholders of various disciplines throughout the engineering lifecycle



Use the authoritative source of truth to produce digital artifacts, support reviews, and inform decisions

As the technical baseline matures, preserving the knowledge across programs and lifecycle phases is essential. Technical reviews can be conducted from the authoritative source of truth on a continuous basis. Stakeholders will generate digital artifacts, representing multiple views and various perspectives from the authoritative source of truth. Digital artifacts provide visibility of appropriate information across functional domains, disciplines, and organizations.

--- DoD Digital Engineering Strategy, 2018

Joint ISO- INCOSE Investigation

Resolution in SC 7 June 2021 Plenary

Ad hoc Group for Digital Engineering (AHG 6)

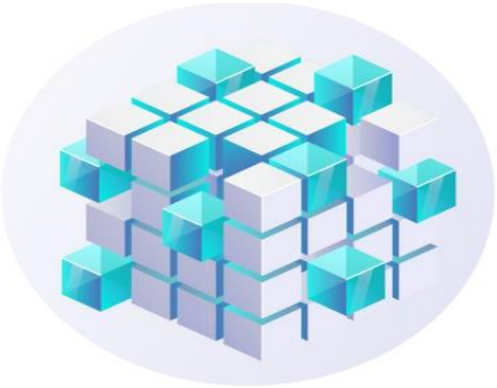
2568	Further to the Chair presentation (SC7N8622) done at its 2021 Virtual Plenary meeting, JTC1/SC7 instructs its Secretariat to create an Ad Hoc Group for the investigation of Standards on Digital Engineering and to explore the possibility of additional standards or guidance in the area of software and systems engineering within SC7. The terms of reference of this Ad Hoc Group (AHG) are to: • Provide an analysis of the requirements of the market and a status of current standardization activities, if any are available. • If pertinent, make recommendations for the creation of new standards or TR or initiate a NWIP Additional guidance for the Ad Hoc Group (AHG): •The AHG is free to invite external parties to contribute to its work. Schedule: •The Ad Hoc membership should be complete by July 31, 2021. •The first virtual meeting to be held in August 2021 to kick off the Ad Hoc, followed, as required, by other ones •Report to be made available 60 days prior to the start of the June 2022 SC7 Plenary meeting. The Ad Hoc Group will be chaired by Dr. Sundeep Oberoi (SC7 Chair).

INCOSE DE Working Group Standards invited to lead the investigation via ISO-INCOSE liaison agreements

SE Vision 2035 - Future State of SE

Future of SE is model-based, enabled by enterprise digital transformation

AI will drive major changes in SE methods and tools



Data Science will be part of an integrated analytic framework for SE

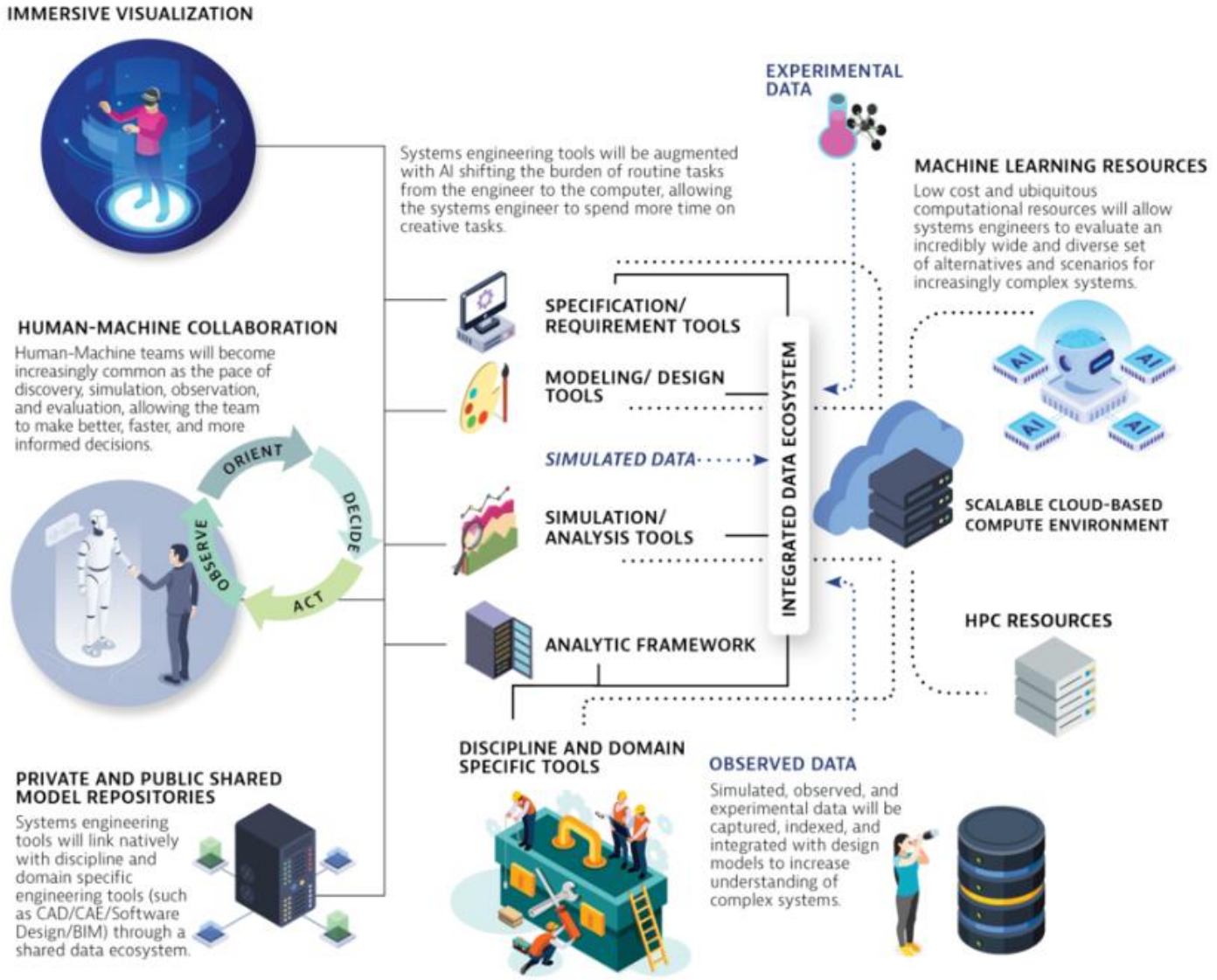
Human-System Integration will become essential to design smart systems

DEIX WG Standards concentrates on four of the six SE Future State areas outlined in SE Vision 2035

Ref 1

Impacts of Digital Transformation

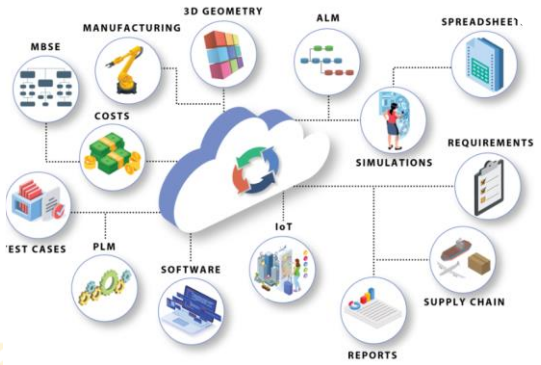
From:
Advancing digital technologies and standards development are enabling model-based systems engineering (MBSE) practices, but modeling-ecosystems are often rudimentary and incomplete



To:
Systems engineering environments fully leverage advances in digital technologies and modeling standards to enable rapid exploration of designs

Ref 1

Current SE Challenges



Tools and Data Integration

- Challenges due to fragmentation across specialized tools, proprietary data formats, and limited standardization

Software Complexity, Agility and Scale

- New approach to cyber-physical system development

Impact of AI

- Systems engineering tools and practices do not address complex systems that continue to learn and modify themselves during operation

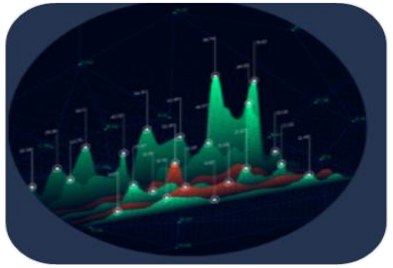
DEIX WG Standards addresses three SE Challenges from SE Vision 2035

Ref 1

SE Vision 2035 Recommendations

Solving Societal Challenges

- Digital engineering methods and tools enable integrated analysis of both technical and non-technical elements



Value of Systems Engineering

- Digital Engineering transformation integrates systems engineering practices and systems thinking across all disciplines

Addressing Dynamic Change and Uncertainty

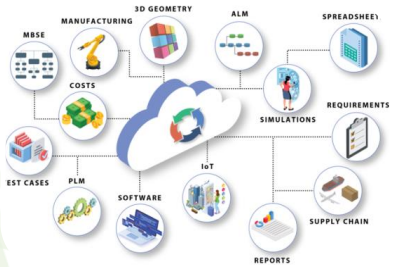
- Data standards are developed and adopted enabling effective data interconnection and exchange

Digital Transformation

- Use and management of models, architecture, and digital thread mature, including digital twins with trusted environments

Analytic Framework

- Standards and regulations are integrated in the framework.



SE Tools for Digital Environment

- Artifacts for communication are established, facilitated by modeling language and data interchange standards

Foundation and Research

- New principles, phenomena, concepts, heuristics, and technologies are integrated with existing knowledge

SE 2035 Vision Recommendations addressed by DEIX activities

Ref 1

The DEIX SF's Role in SE Vision 2035

Identify Standard Gaps:

Survey and assess the current standards landscape for digital engineering standard gaps.

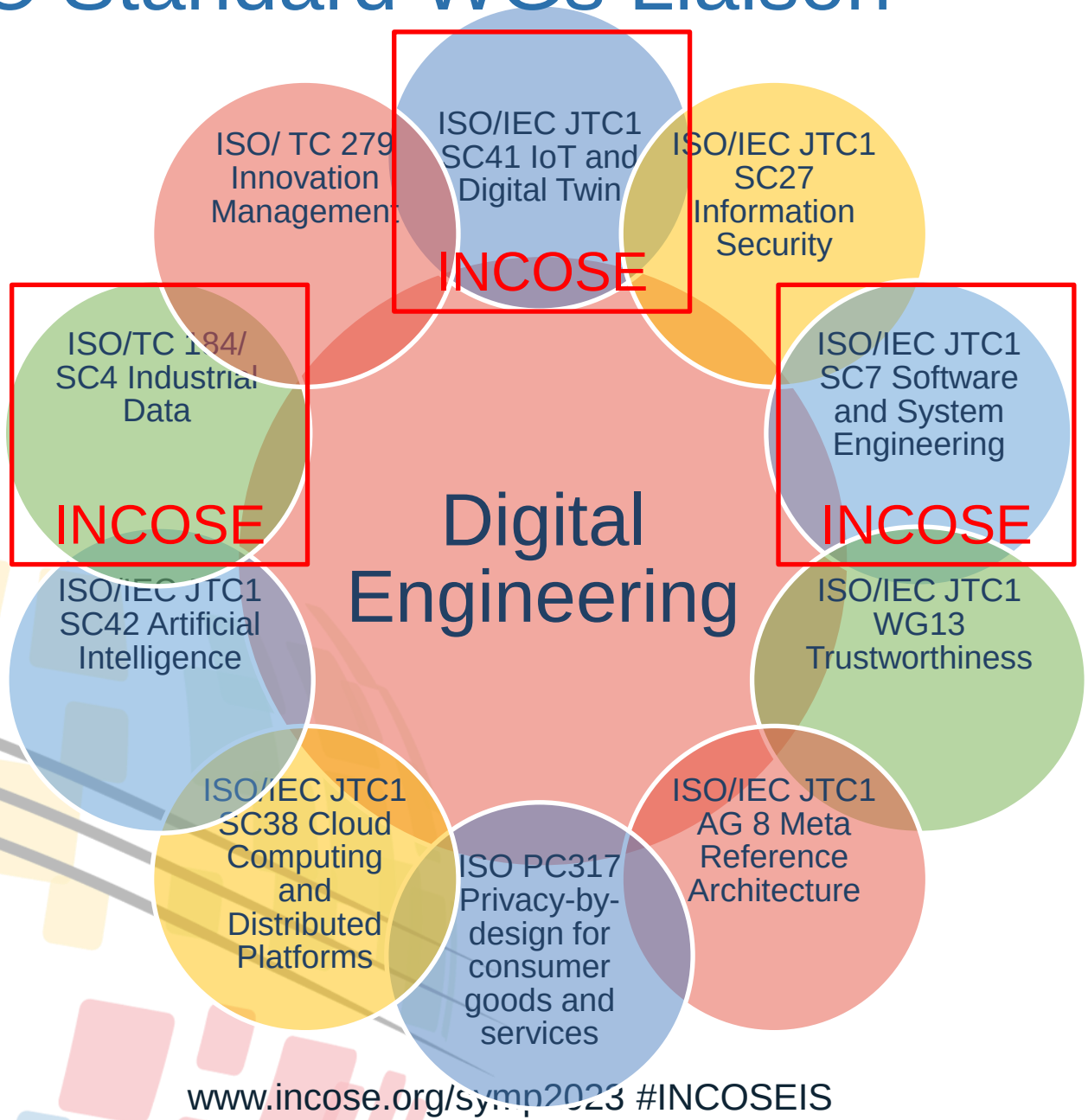
Explosion of Standards:

Many industries, bodies of knowledge, and standard communities are rapidly developing standards to address the growing field of digital transformation and industry challenges.

Address Complexity:

Difficulty in achieving dominant standards naturally with the degree of diversity among model information, stakeholders, and interrelationships

Related ISO/IEC Standard WGs Liaison



IEC Digital Twin Conceptual Standard Needs

Concept Standard

Architecture Standard

Application Need/ Use Case

System/ Ecosystem Standard

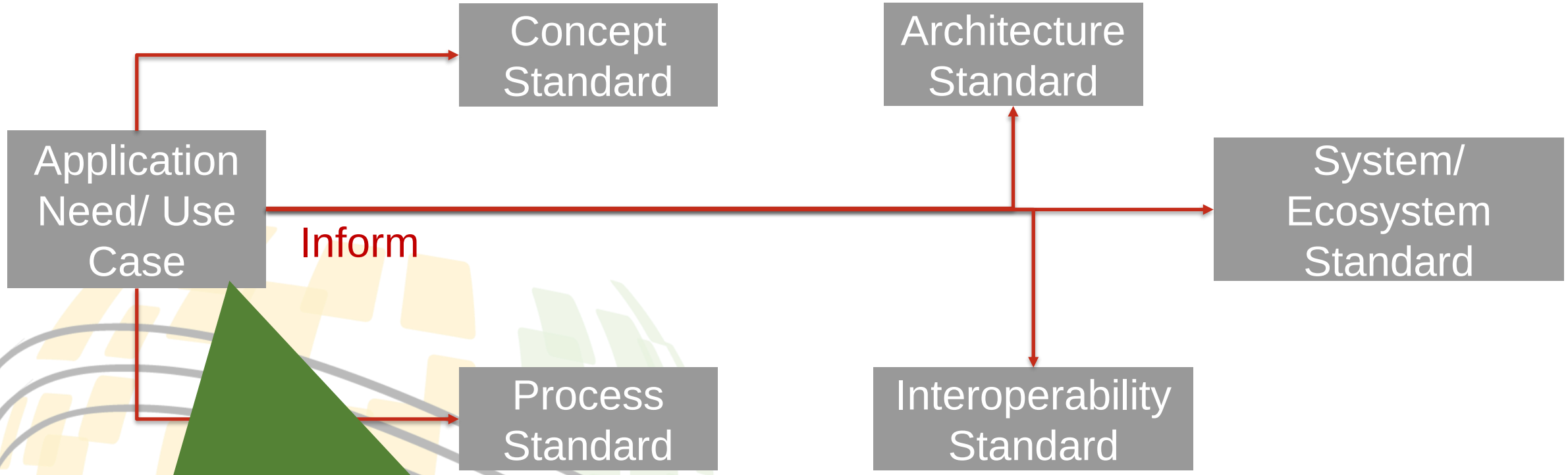
Process Standard

Interoperability Standard

Framework to Analyze Standard Categories and its Relationships

Ref 8

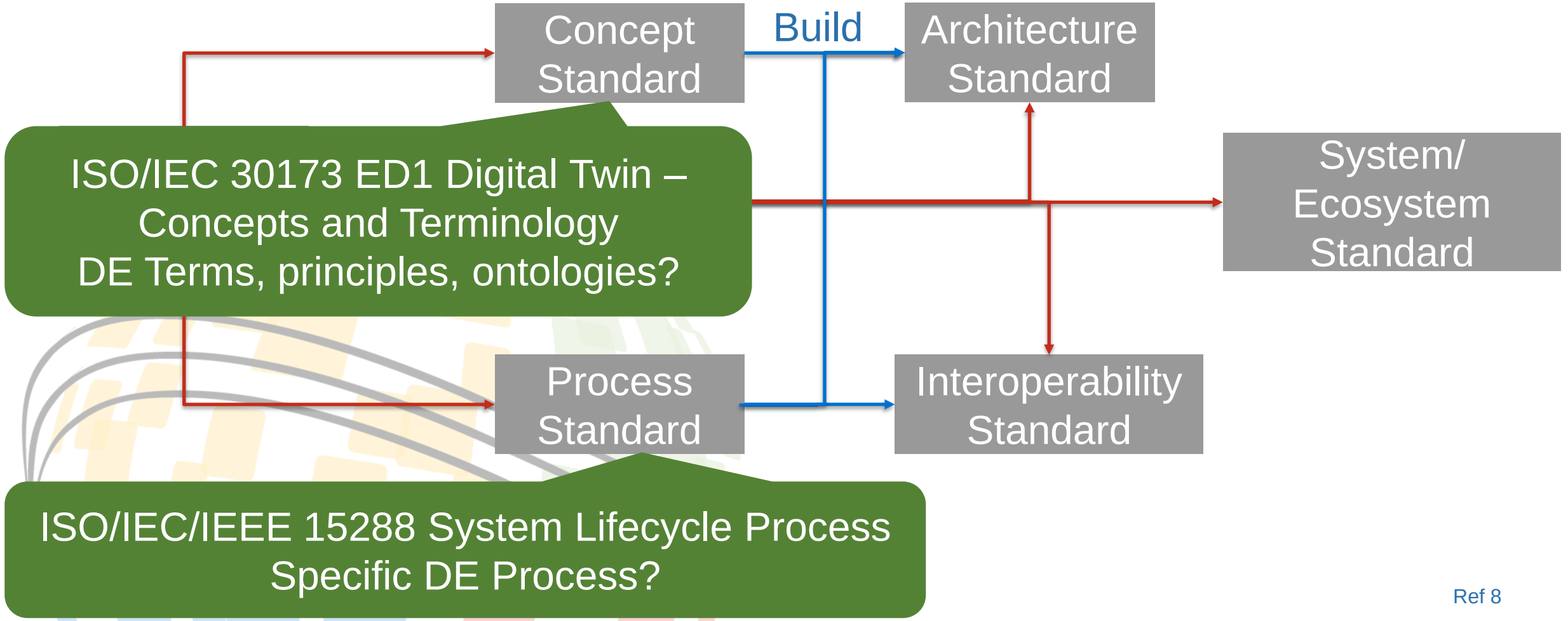
IEC Digital Twin Conceptual Standard Needs



ISO/IEC TR 30172 ED1 Digital Twin – Use case
Are DE use cases different?

Ref 8

IEC Digital Twin Conceptual Standard Needs



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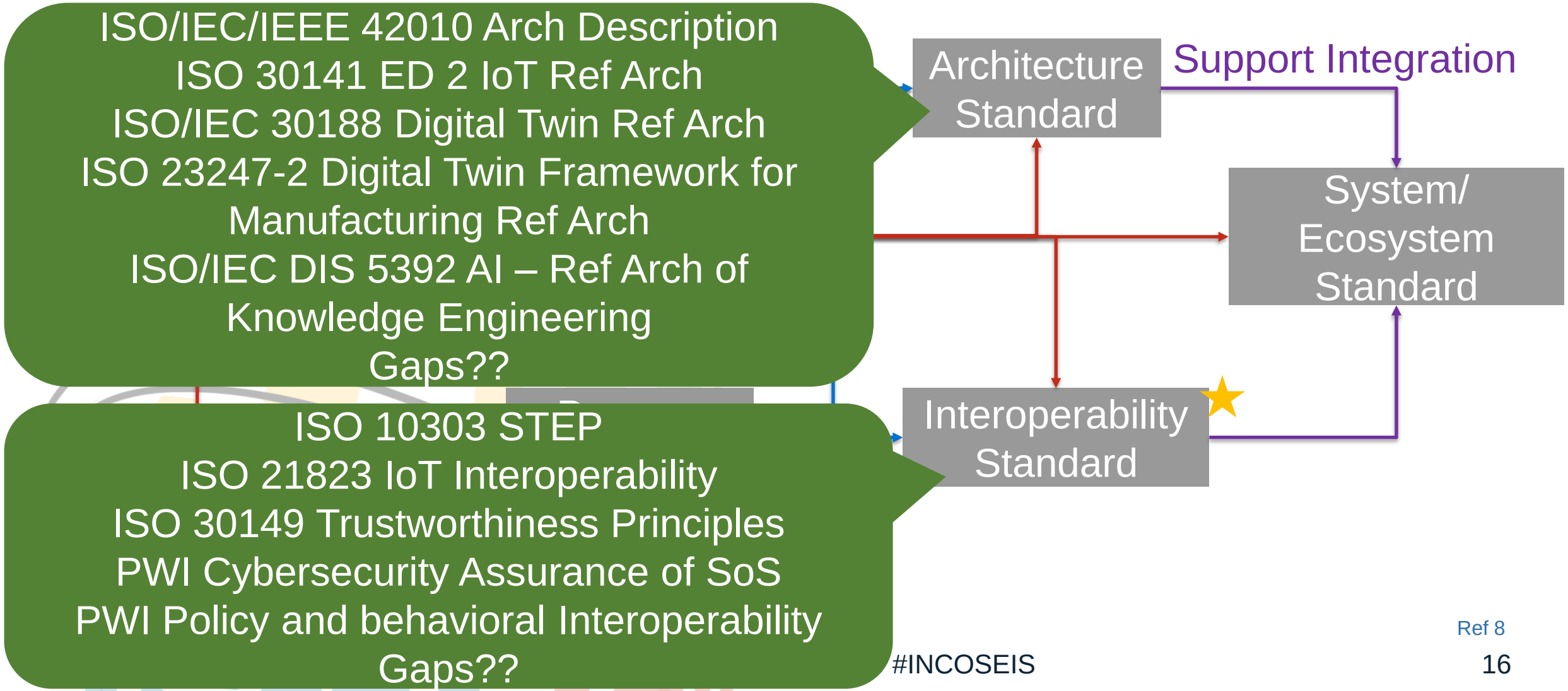
IEC Digital Twin Conceptual Standard Needs



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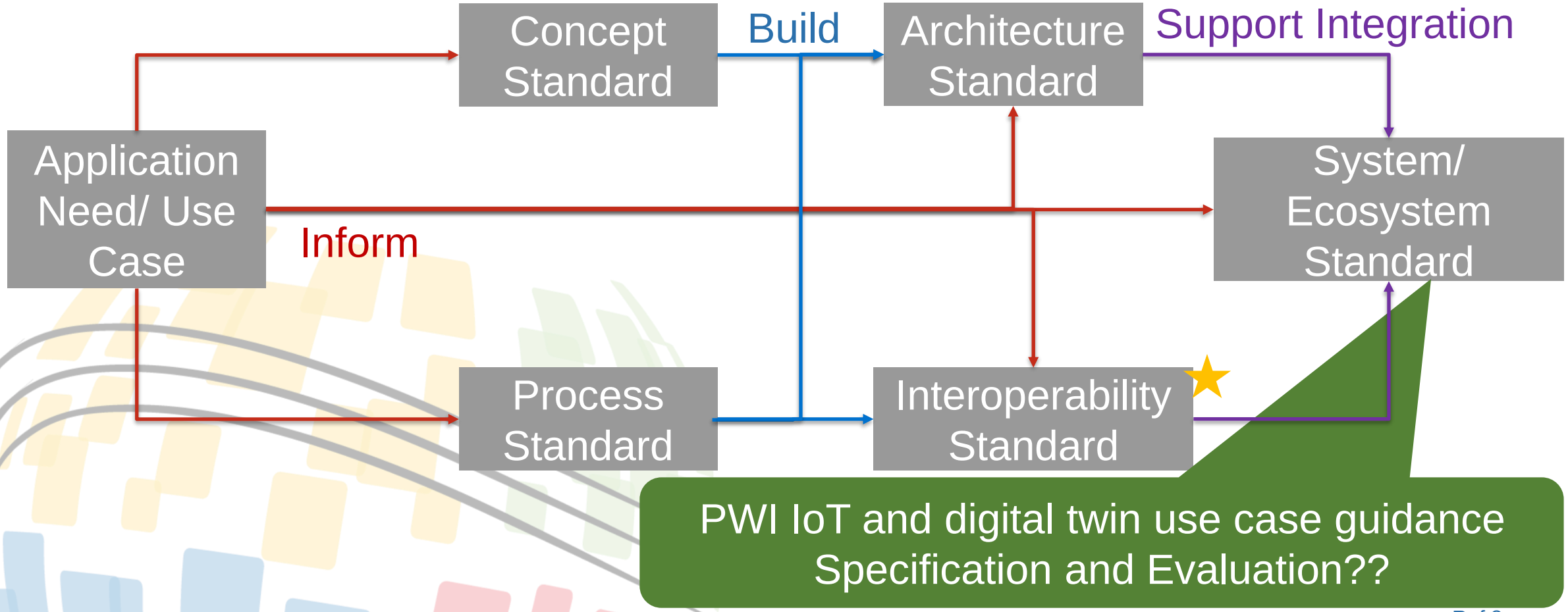
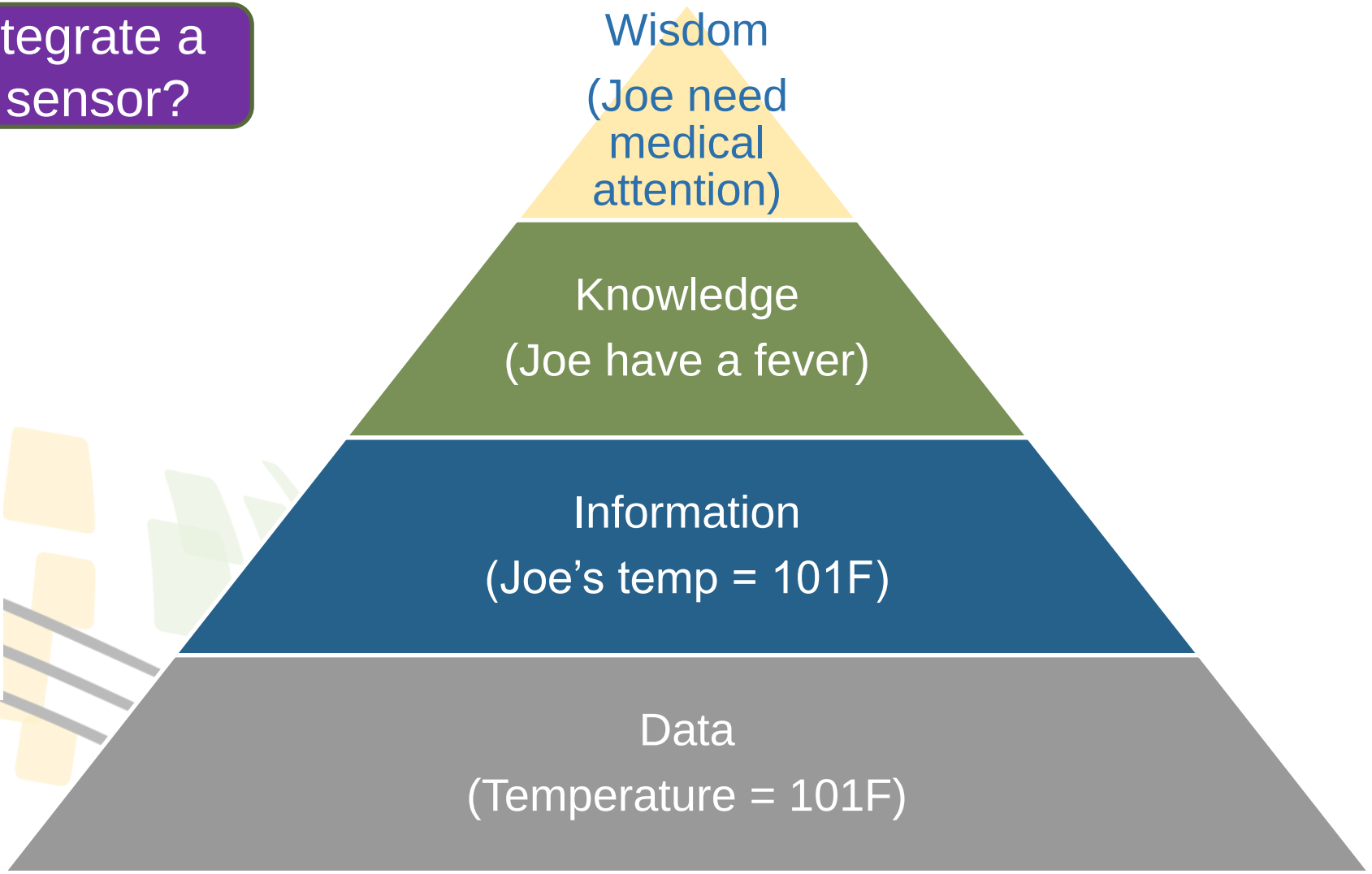


Ref 8

Scenario: Taking Temperature

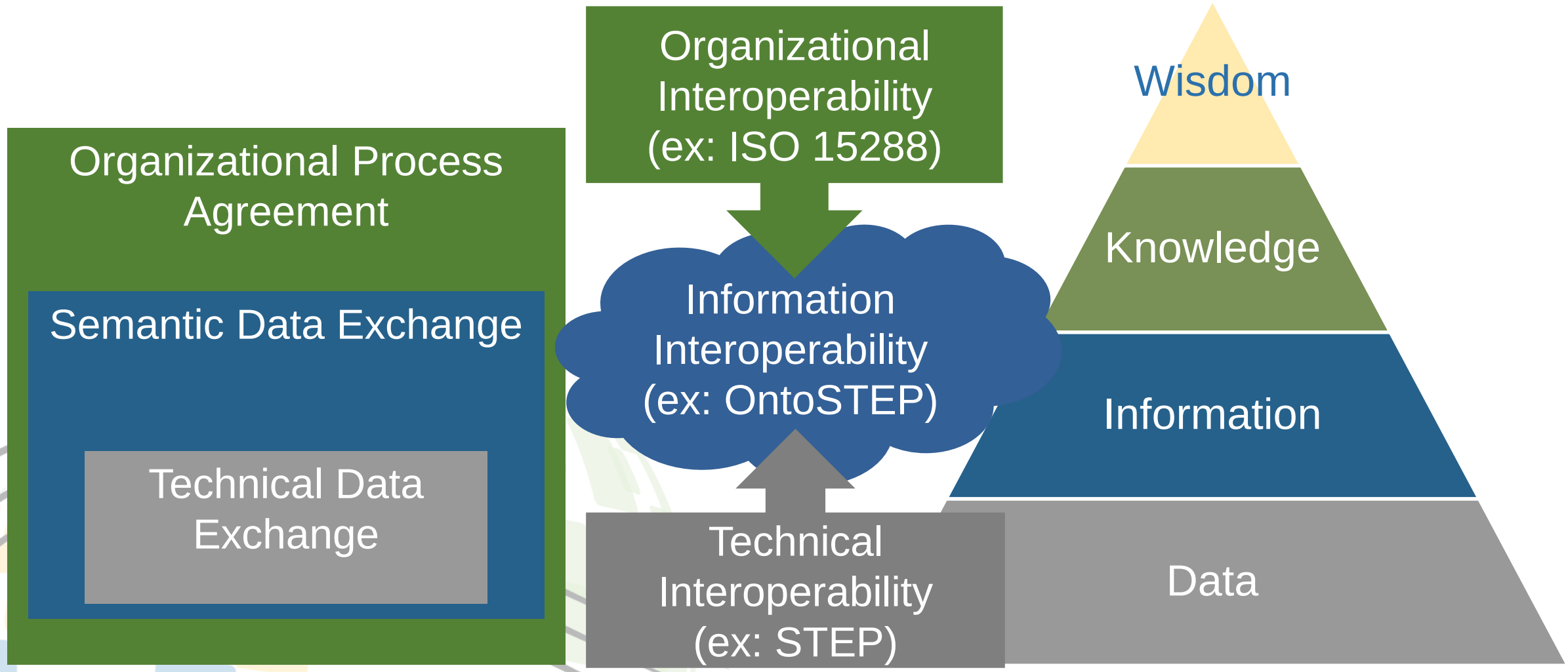
How to design and integrate a "smart" temperature sensor?



DIKW Pyramid

Ref 5

Interoperability Challenges and Role of Standards



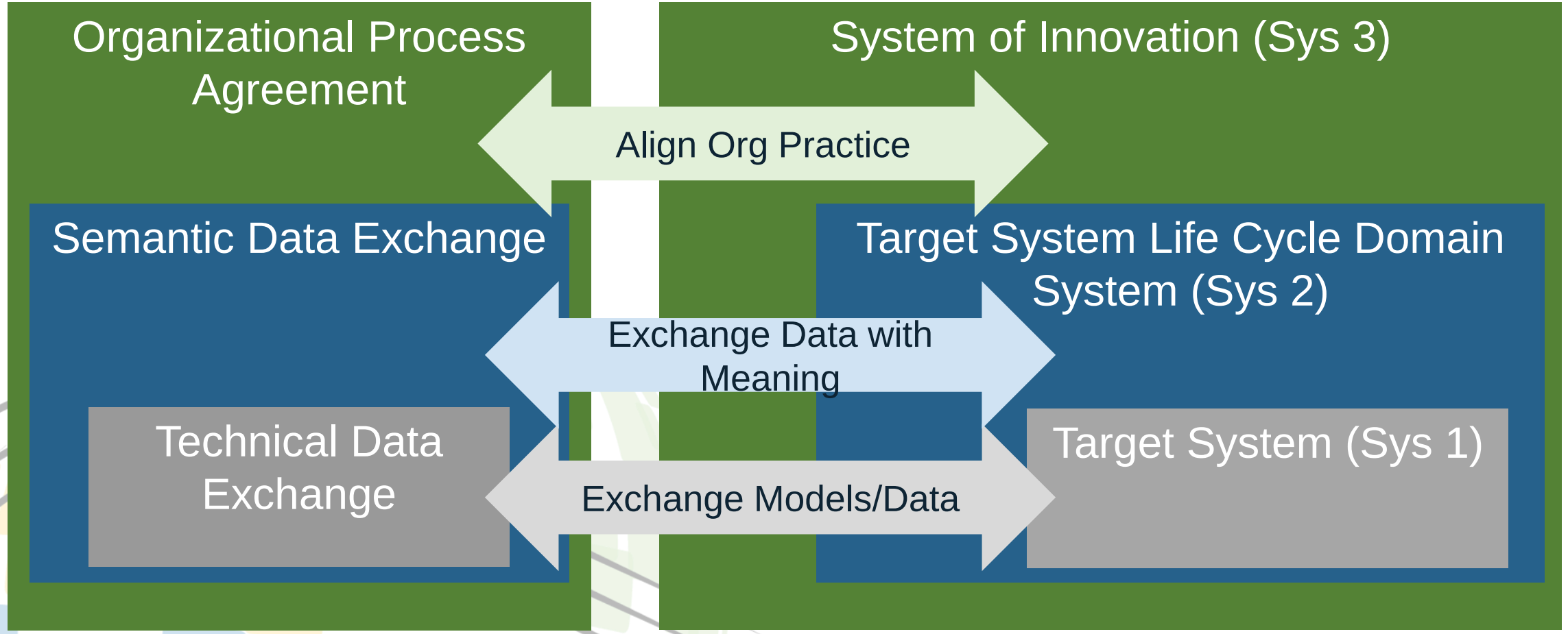
Interoperability level

Ref 6, 7

DIKW Pyramid

Ref 5

Interop Challenges and System Pattern



Interoperability level

Ref 6, 7

Agile SE Life Cycle Model (ASELCM)

Ref 3

Standard Landscape

Interoperability Level[6]	Definition	Current State	Example Standard
Organization	Align business processes, responsibilities and expectations to achieve commonly agreed goals[7]	Document-centric contracts and acquisition process, including SE processes	ISO/IEC 15288 (SE lifecycle process) ISO/IEC 12207 (SW lifecycle process)
Semantic	Exchange data with unambiguous, shared meaning[9]	Typically developed in-house, satisfy enterprise functional requirements but no more interoperable than traditional data models[1]	ISO 19650 (BIM)
Technical	Applications and infrastructures linking systems and services[7]	Many standard activities, slow standard cycle time and legacy system present obstacles[7]	ISO 10303 (STEP) ISO/IEC 19514 (SysML)

SE Vision Enablers & DE Standard Activities

Application

- Systems engineering demonstrates value for projects and enterprises of all scales, and applies across an increasing number of domains.

Process/ Practices

- Model-based systems engineering, integrated with simulation, multi-disciplinary analysis, and immersive visualization environments is standard practice.

Tools and Environment

- Systems engineering tools and environments enable seamless, trusted collaboration and interactions as part of the digital ecosystem.

Research

- Systems engineering practices are based on accepted theoretical foundations

Application/ Use Case/ System Standard

Process Standard

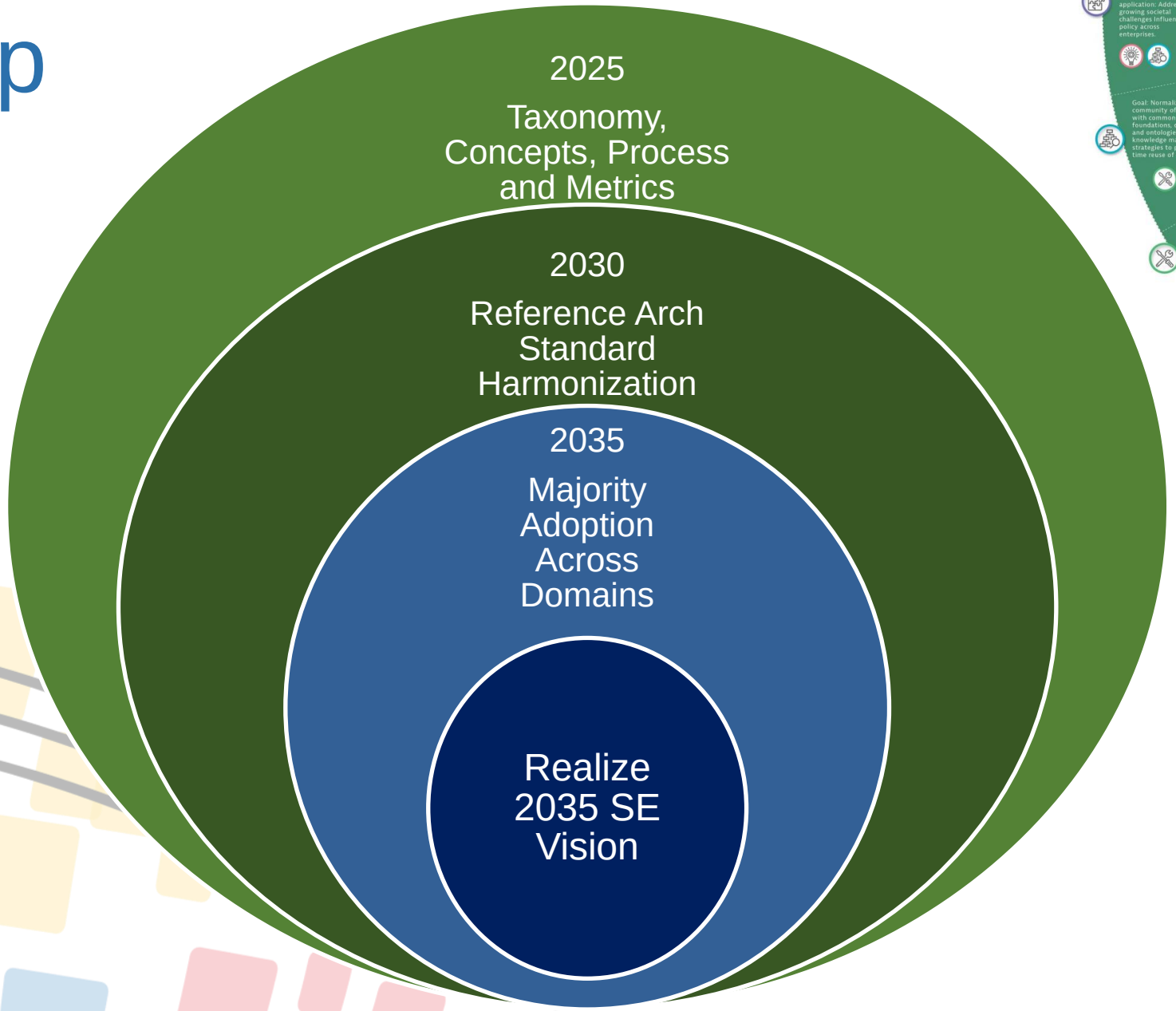
SETDB
SYSTEMS ENGINEERING TOOLS DATABASE

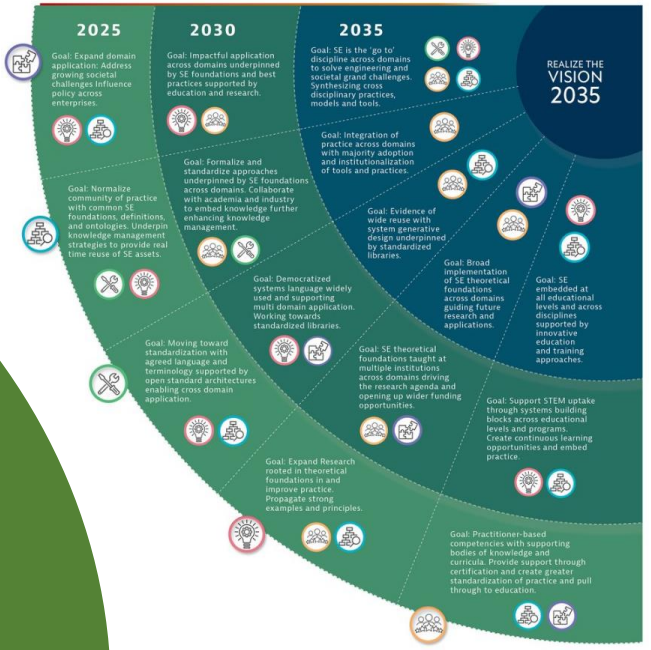
Interoperability Standard

TIMLM WG

Concept Standards

Roadmap


2025
Taxonomy, Concepts, Process and Metrics
2030
Reference Arch Standard Harmonization
2035
Majority Adoption Across Domains
Realize 2035 SE Vision


2025
2030
2035
REALIZE THE VISION 2035

Takeaway: Journey to Digital Transformation

Document Based

- Unconnected data systems, artifacts, and processes.

Model Based

- Transition artifacts and deliverables to model-based format for digital traceability, archiving and retrieval.

Vision 2025

Organize Models

- Organization structure with metadata to manage model development, versioning and reuse.

Automate Process

- Automate process and exchange across ecosystems for accountability, quality and scale.

Optimize Process

- Perform process improvement using data analytics, business insights and data governance.

Vision 2035

Transform Practice

- Radical innovation to transform business objectives, value proposition, and flawless execution.

Ref 4

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www.incose.org/symp2023
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9. IEC, “IEC White Paper Semantic Interoperability:2019” IEC, 2019

KEY QUESTIONS

- What is digital engineering?
- Why should we apply digital engineering?
  - May vary between industry and organization, deed to define goals and objectives
- How do we do it effectively and efficiently?
  - What are the common reasons for implementation failure?
    - People don’t understand what it is
    - Unrealistic expectation on time and effort to implement
    - People does not understand the “why” or intended benefits – implementing a solution to a ill-defined problem
- How do we implement in our industry?

NEAR TERM AND LONG TERM RECOMMENDATION

IMPLEMENTATION

- People
  - Who is it apply to
- Process
- Tools