Industrial Internet & Smart Manufacturing

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IIC Global Event Series, Beijing, November 16, 2018

Part I

IIRA, now & future

Industrial Internet - a simple idea, widely applicable

Closed-loop Optimization

an enabling technology for the digitalization process…

an data-driven optimization from assets to processes, through the value chains, across enterprises & industries, end-to-end

Industrial Internet – Key Common Technical Challenges

IIoT Systems:

complex,

large-scale,

heterogeneous,

distributed

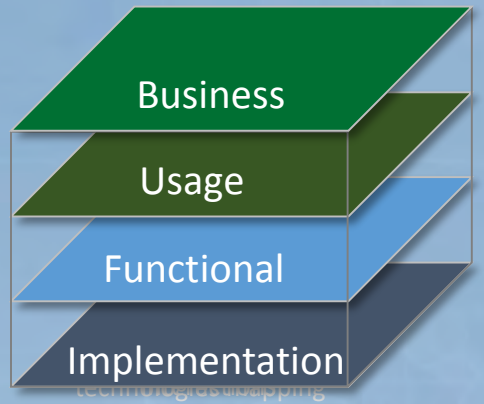
industrial systems

How to solve these shared challenges?

Need a systematic, architectural approach

Industrial Reference Reference Architecture (IIRA)

Shared Approach to Common Challenges



- Common architecture requirements & patterns
- Common architecture concepts & vocabulary

- Raise awareness on important concerns
- Provide high-level guidance on how to address these concerns

Identify interoperability requirements & developing standards

Spurs innovation in an open ecosystem

To share know-hows, encourage interoperable common building blocks & reusable technologies across industries

for building safe, secure & reliable IIoT systems at lower costs, risks and time to value

Industrial Internet Reference Architecture (IIRA)

A standards-based architectural template & methodology:

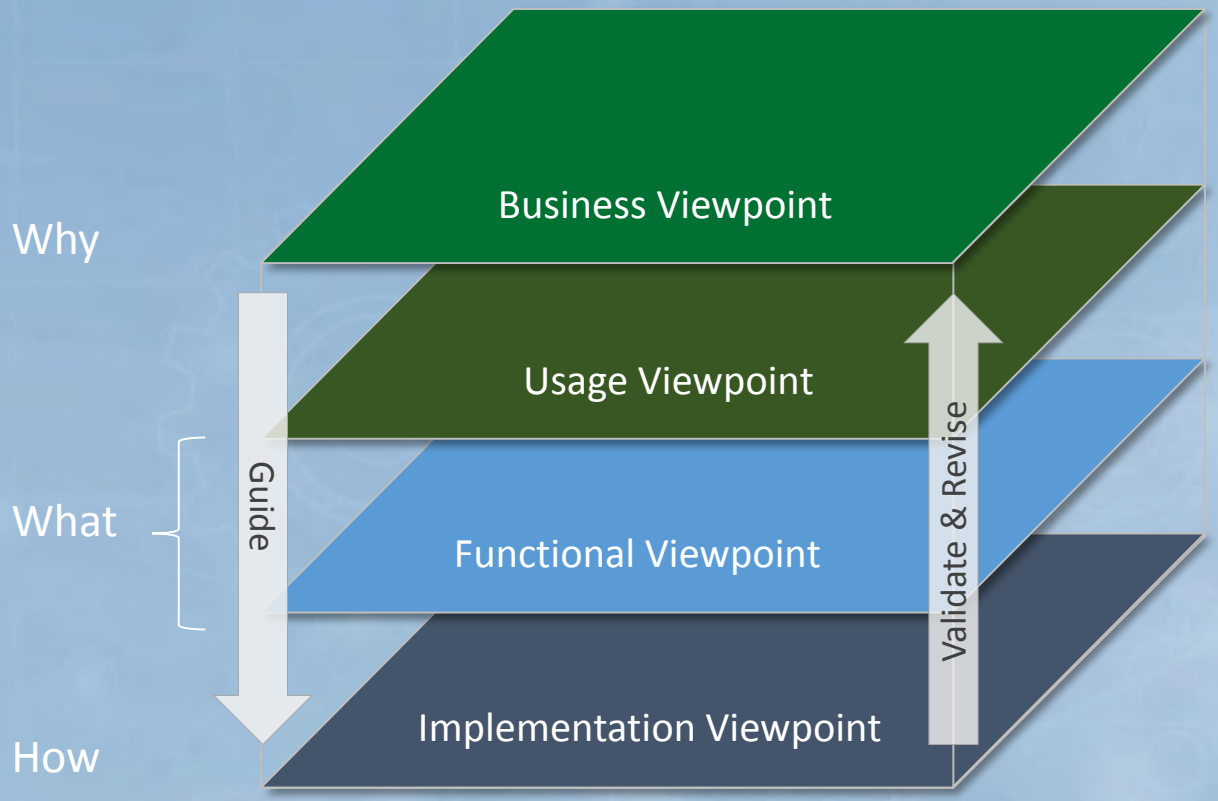
- addresses concerns about IIoT, emphasizing its broad applicability and interoperability across industries
- enables system design across the industries - based on a common framework & concepts

First edition published May 2015

First revision published February 2017; available in IIC Resource Hub October 2018

https://www.iiconsortium.org/IIRA.htm

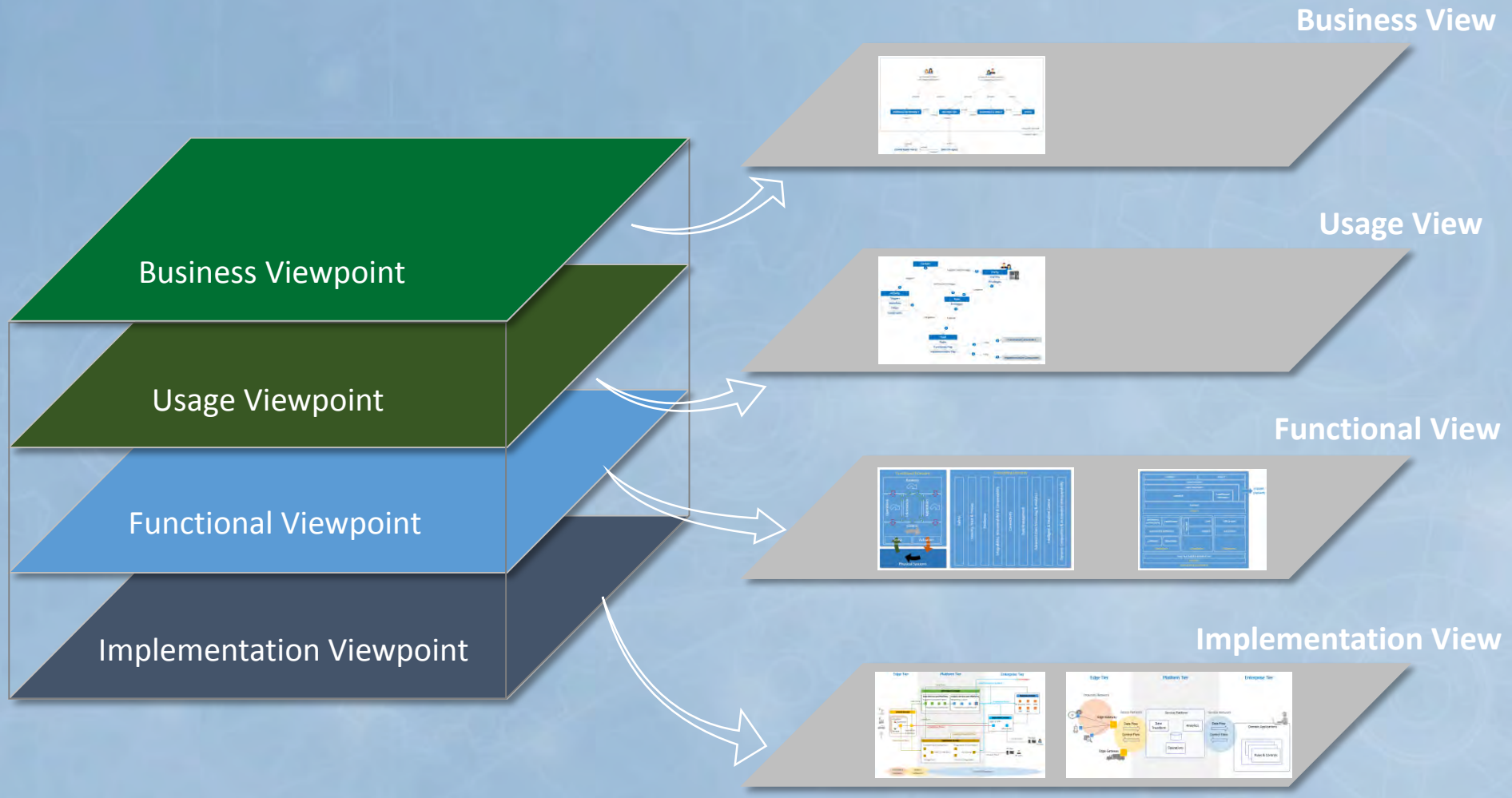
IIRA – Business-Value-Driven Methodology



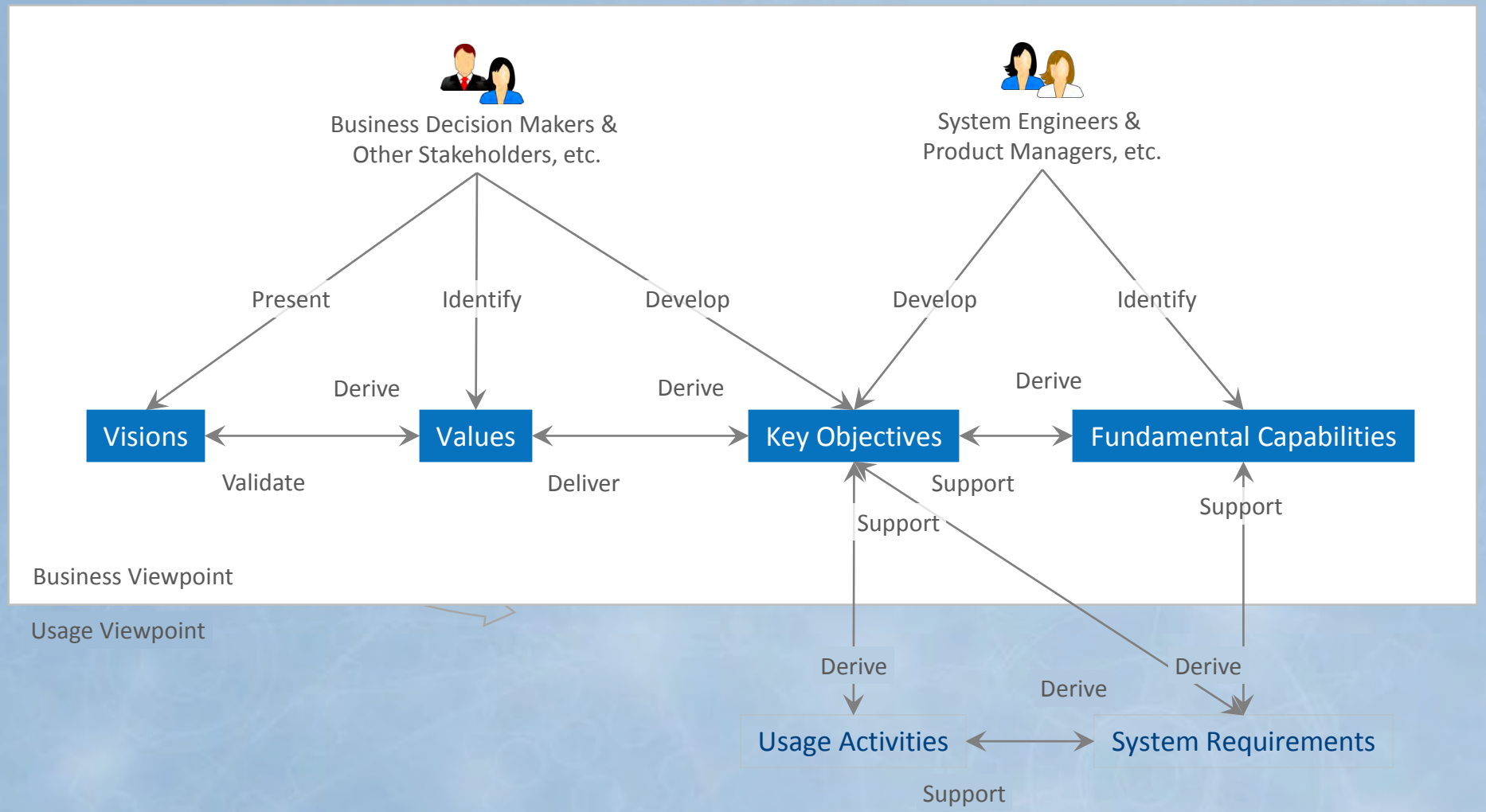
Identify & classify important system architecture concerns into related categories – viewpoints - for their analysis and resolution.

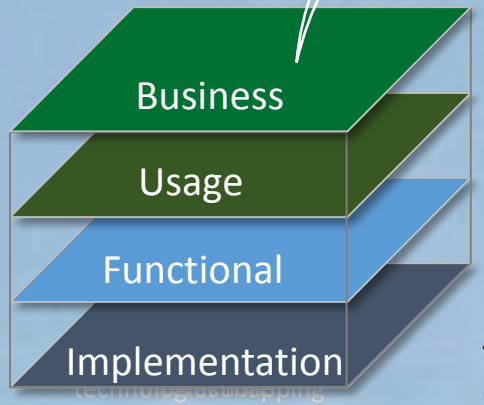
Business vision & value driven, concern-resolution centric, iterative design methodology

IIRA – Rich Architectural Templates and Models



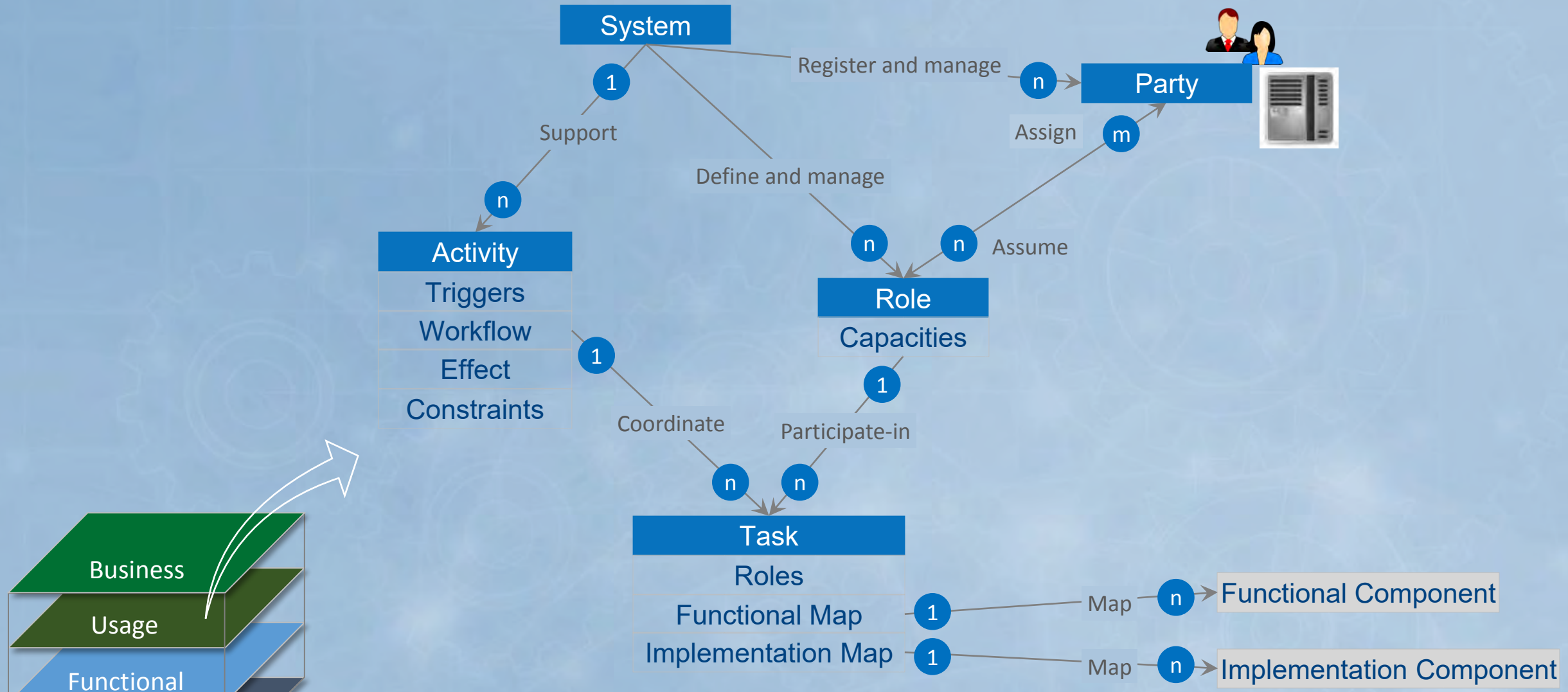
IIRA – Business Values Driven System Conceptualization





An architecture viewpoint that frames the vision, values & objectives of the business stakeholders in establishing an industrial internet of things (IIoT) system in its business & regulatory context

IIRA – Usage/User-Role-Based Design Paradigm



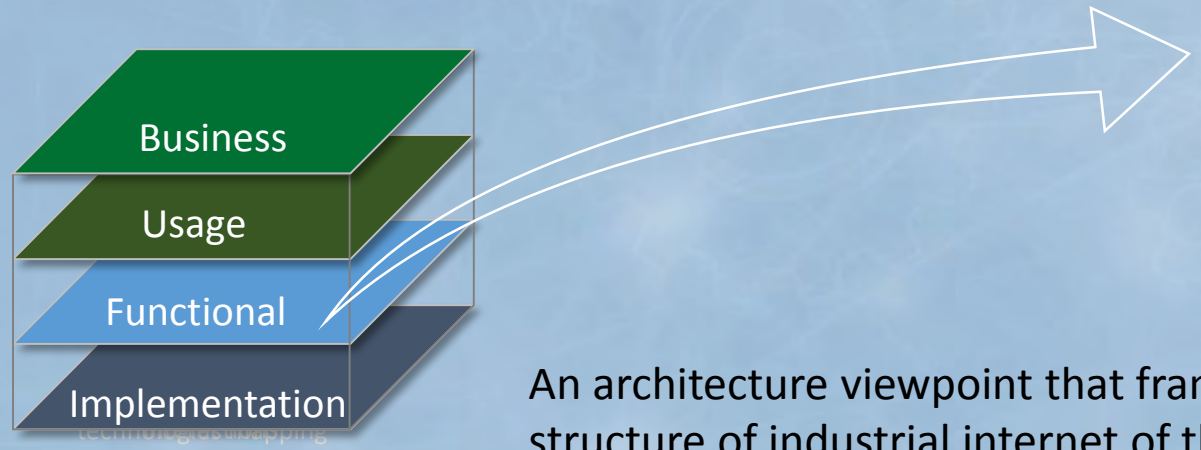
An architecture viewpoint that frames the concerns related to industrial internet of things (IIoT) system usage

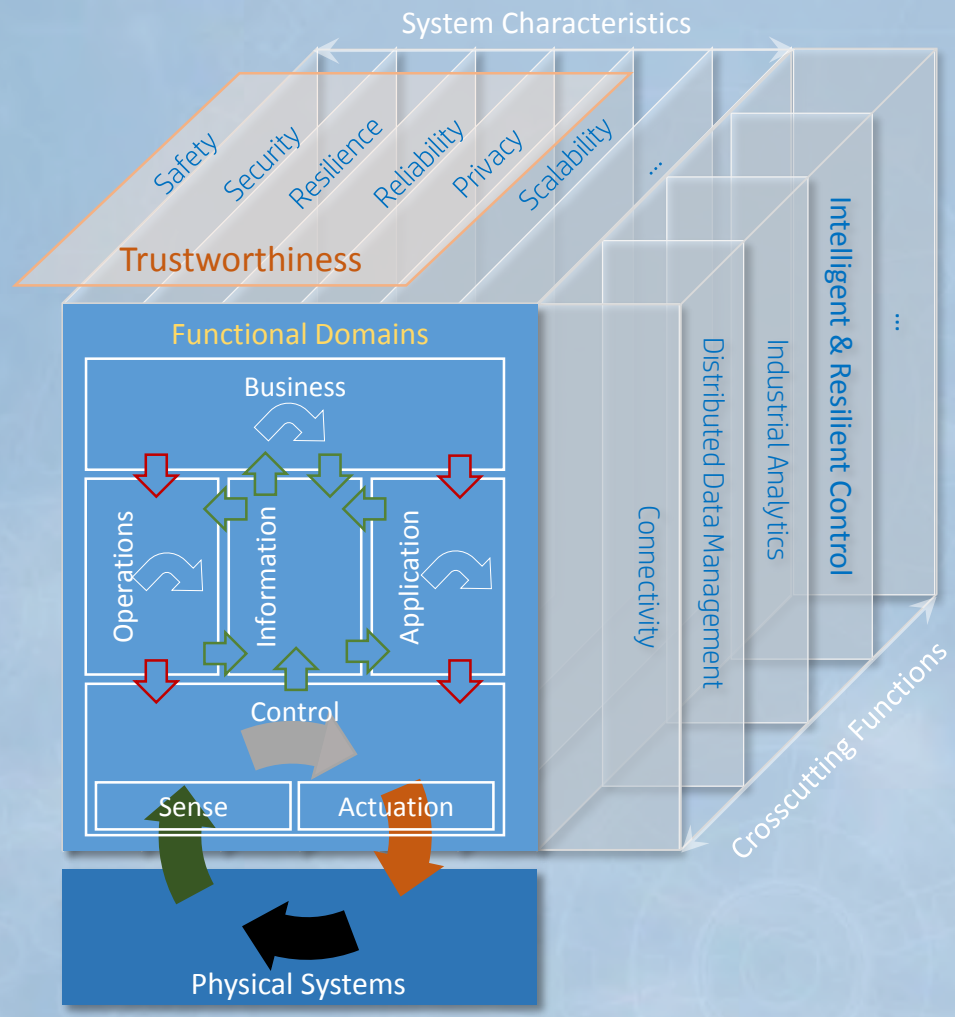
IIRA – Comprehensive Functional Design & Architecture Considerations

Identify major common functional domains & their relation and interaction.

Identify major cross-cutting functions

Identify major system characteristics as emerging system properties

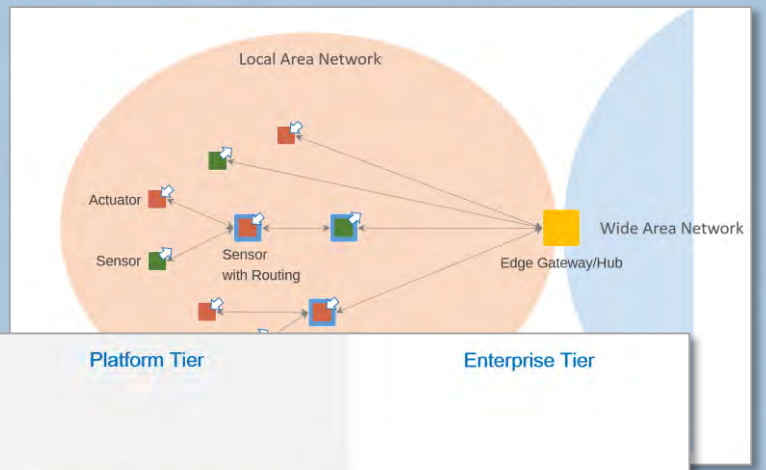


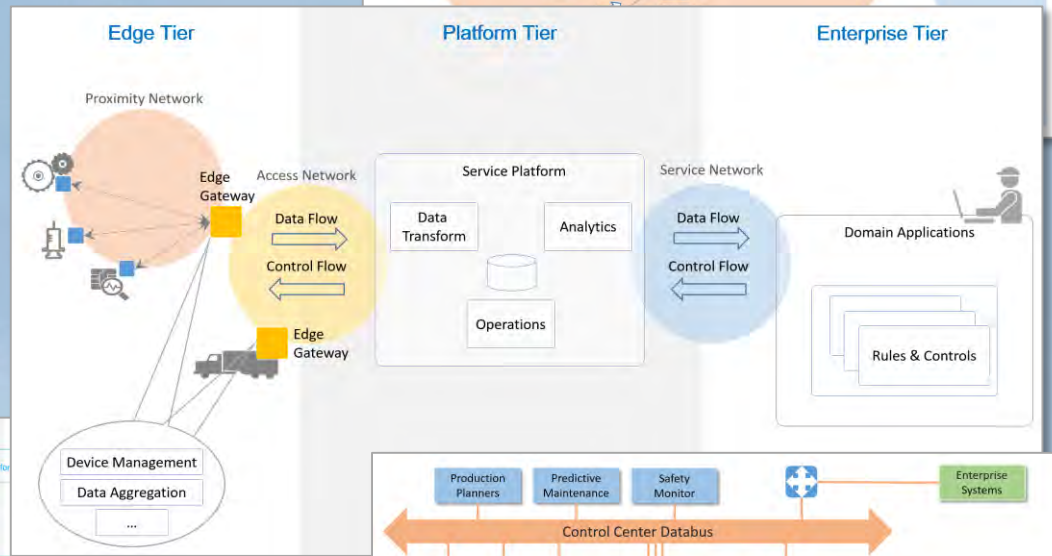


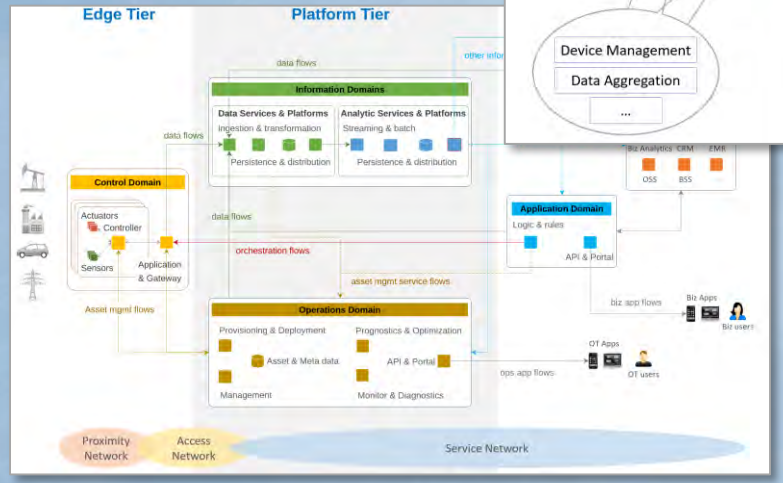
An architecture viewpoint that frames the concerns related to the functional capabilities & structure of industrial internet of things (IIoT) system & its components

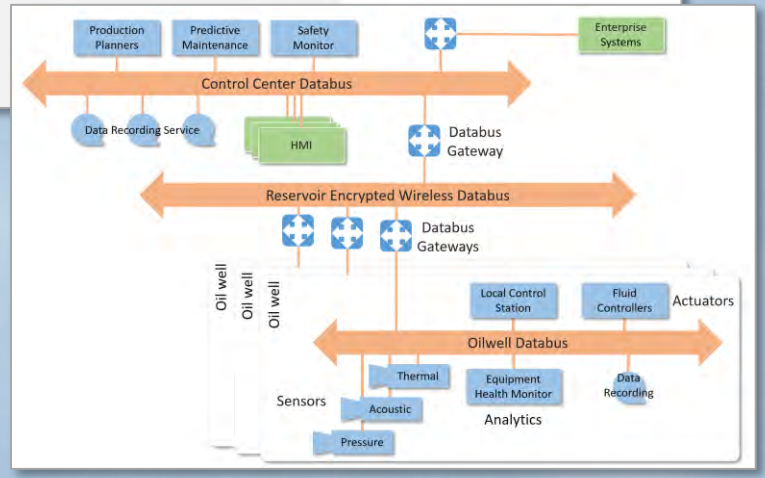
IIRA – Practical Architecture Patterns

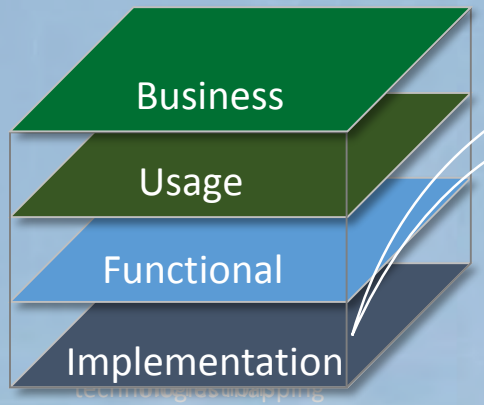
Growing numbers of practical architecture patterns for system architects to jump start their design conception





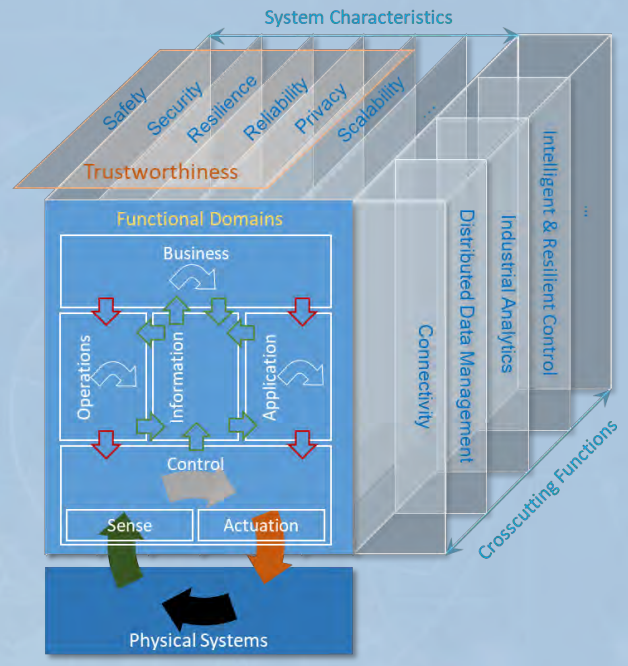






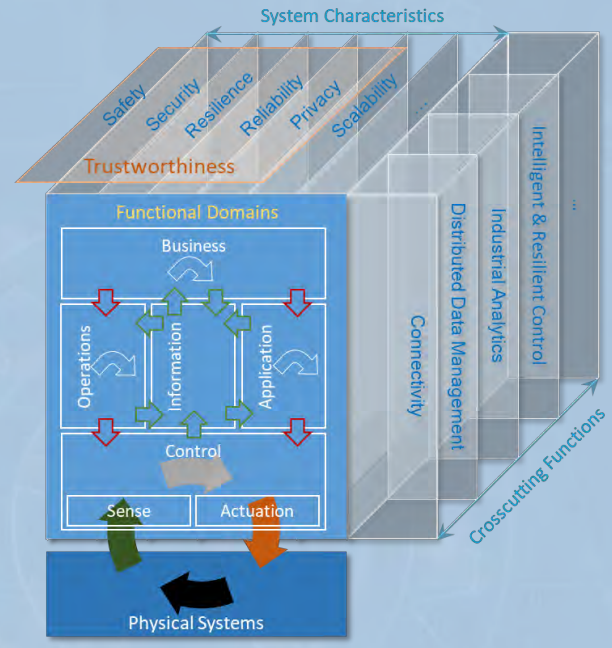
An architecture viewpoint that frames the concerns related to implementing the capabilities & structure of an industrial internet of things (IIoT) system

IIRA – Innovative IIoT system architecting



- concern/viewpoint oriented architecting;
- business-value-driven system conceptualization & design;
- usage/user-role-based design paradigm;
- data-analytic-centric core & cross-cutting functional design
- clear separation between functional and system characteristics as emerging properties
- implementation patterns

IIRA – Broad Influence Across the Globe



Guiding template for IIC testbed conceptualization & design

Basic framework for other IIC technical reports (IISF, IICF, IACF, …)

Aiding system architects in concrete IIoT system designs; educating practitioners & consultant…

Direct influence in many subsequent IIoT related architectures & standards – a base reference for reference architectures

Enabling exchange of ideas & encouraging architecture alignment (harmonizing architectures across industrial domains & geographical regions)

Major Industrial Internet Related Reference Architectures

- Industrial Internet Consortium (IIC), “Industrial Internet Reference Architecture –IIRA”， 2015.6/2017.2
- Platform Industrial 4.0, “Reference Architecture Model – Industrie 4.0-RAMI4.0”, 2015.7
- Cyber Physical System Public Working Group, “Framework for Cyber-Physical Systems”， 2016.5
- Alliance for Industrial Internet (AII), “Industrial Internet System Architecture”, 2016.8
- Edge Computing Consortium (ECC), “Edge Computing Reference Architecture”, 2016.11/2017.11
- Industrial Value Chain Initiative, “Industrial Value Chain Initiative Reference Architecture”, 2016.12/2017.11
- Open Fog Consortium (OpenFog), “ Open Fog Reference Architecture”, 2017.2
- China Cyber-Physical System Development Forum, “Cyber-Physical System Whitepaper， 2017.3
- ISO/IEC JTC 1/SC 41 CD 30141, “IoT Reference Architecture (IoT RA)”， under development
- IEEE P2413， IoT Architecture Framework Standard, under development

……

Major Industrial Internet Related Reference

Driving the digitalization of industries:

advances the adoption of the industrial internet on a global scale that transcends industry boundaries

coordinates the Industrie 4.0-driven digital transformation of the German industry

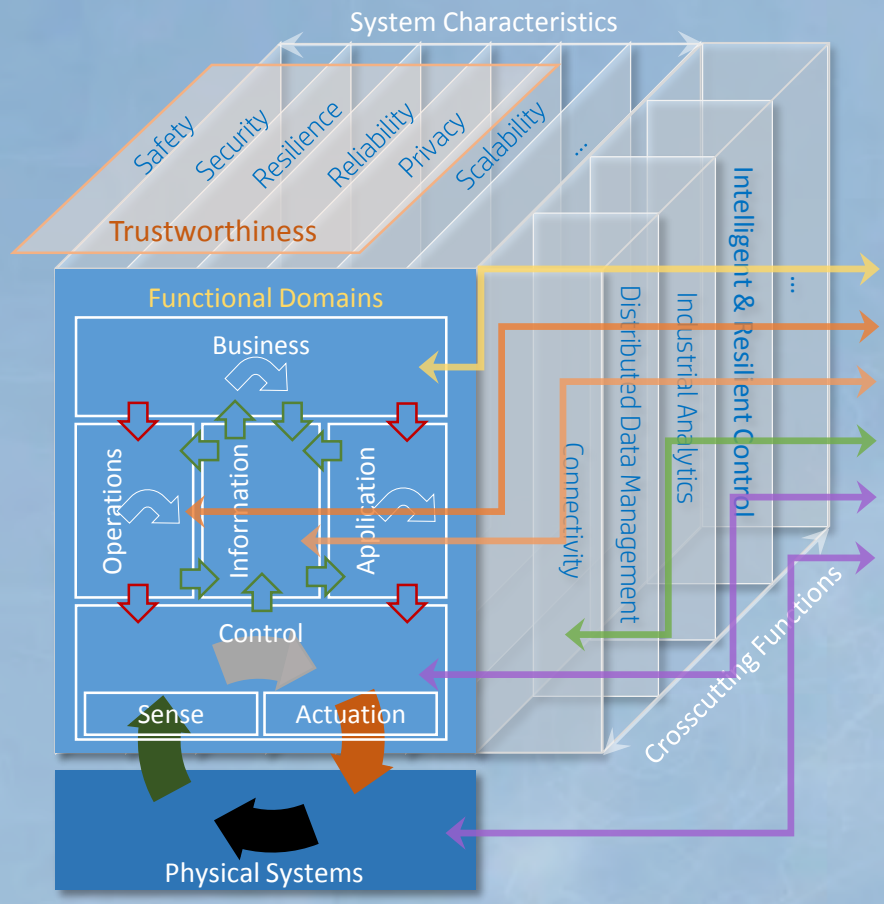
Zurich, Nov 2015

Chicago, June 2016

Heidelberg, Sept 2016

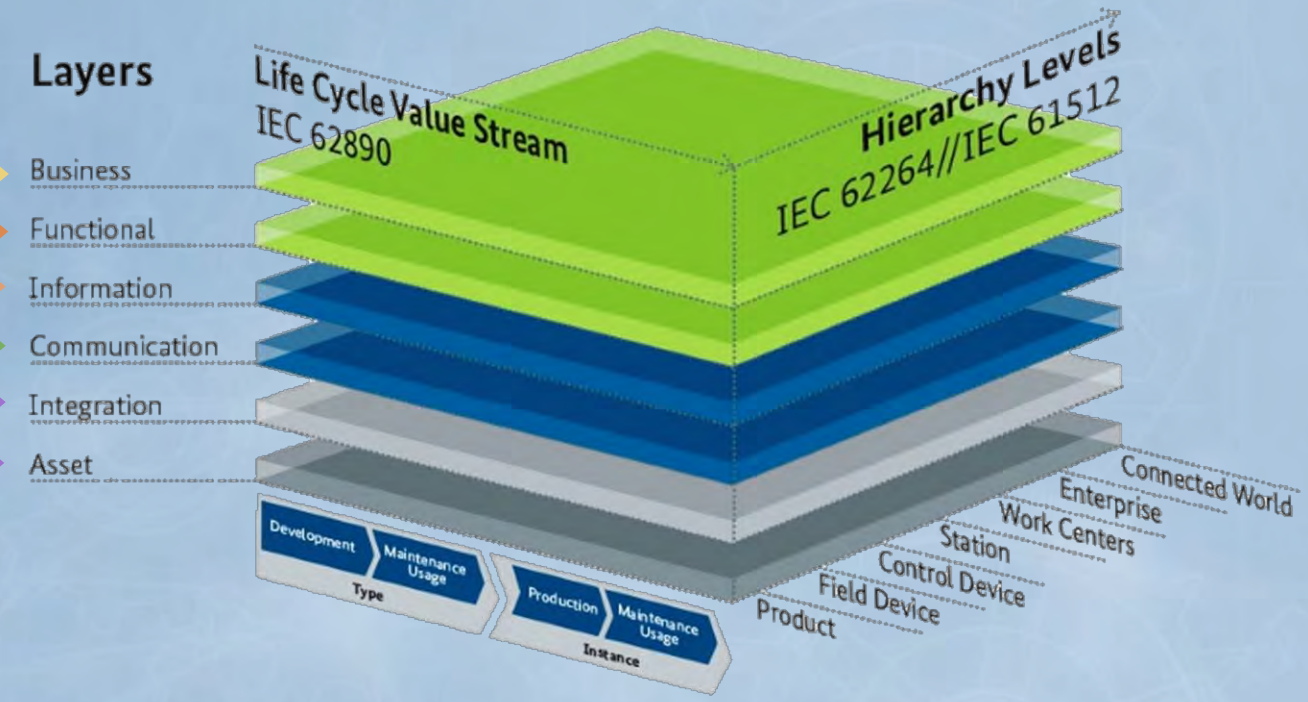
IIRA & RAMI 4.0

Industrial Internet Reference Architecture



addresses concerns about IIoT, emphasizing its broad applicability and interoperability across industries

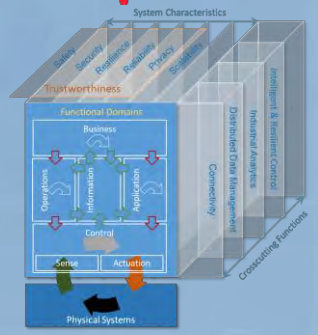
i4.0 Reference Architecture Model for Industrial 4.0



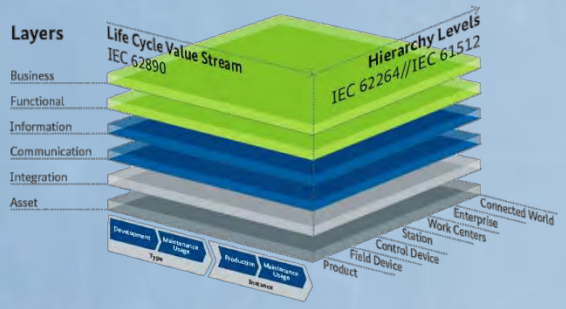
takes an in-depth focus on manufacturing and related value-chain lifecycles.

Architecture Alignment & Interoperability

IIRA



i4.0 RAMI4.0



- Highly complementary
  - IIRA: broad applicability and interoperability across industries
  - RAMI 4.0: in-depth focus on manufacturing & value-chain lifecycles
- The concepts, methods and models map to each other well
- Different emphasis in scope & depth from different perspectives
  - together strengthen the digitalization of manufacturing and beyond
  - IIRA: analytics capability; RAMI 4.0: I4.0 Components
- Important to enable interoperability among IIoT systems that are based on IIRA & RAMI 4.0
- Common ground to enable connectivity/communication/semantic interoperability

industrial internet CONSORTIUM

PLATTFORM INDUSTRIE 4.0

Architecture Alignment and Interoperability

An Industrial Internet Consortium and Plattform Industrie 4.0 Joint Whitepaper

IIC:WHT:IN3:V1.0:PB:20171204

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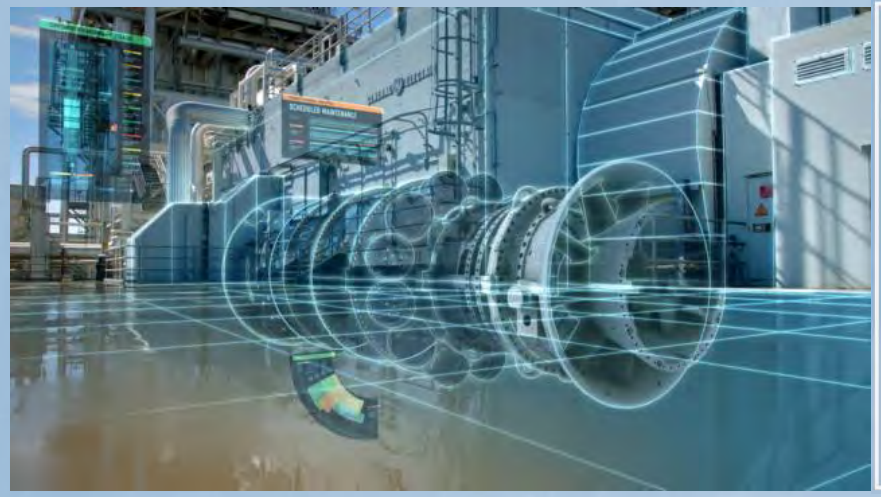
[1] Individuals who have provided valuable comments and inputs that have substantially improve the quality of this whitepaper.

IIC:WHT:IN3:V1.0:PB:20171204 - i -

http://www.iiconsortium.org/iic-i40-joint-work.htm

IIRA – Looking Forward



- Publish a revision (v1.9) by Q1/19 & in
  - to addressing some known issues
  - corporate some new contents
- Continue the collaboration between IIC & Plattform Industrie 4.0 on Digital Twin & Industrie 4.0 Components
- Continue the global cross-domain architecture alignment & harmonization:
  - Complete the on-going IIRA & oneM2M architecture alignment whitepaper
  - Continue IIRA & IVI-RA alignment analysis
  - Explore opportunity for IIRA & AII “Industrial Internet System Architecture” alignment
- Extending IIRA to specific industrial domains
- Evolution by taking inputs from IoT architecture work from other liaison organization and lessons from real-world implementation

☞ http://www.iiconsortium.org/iic-i40-joint-work.htm

Part II

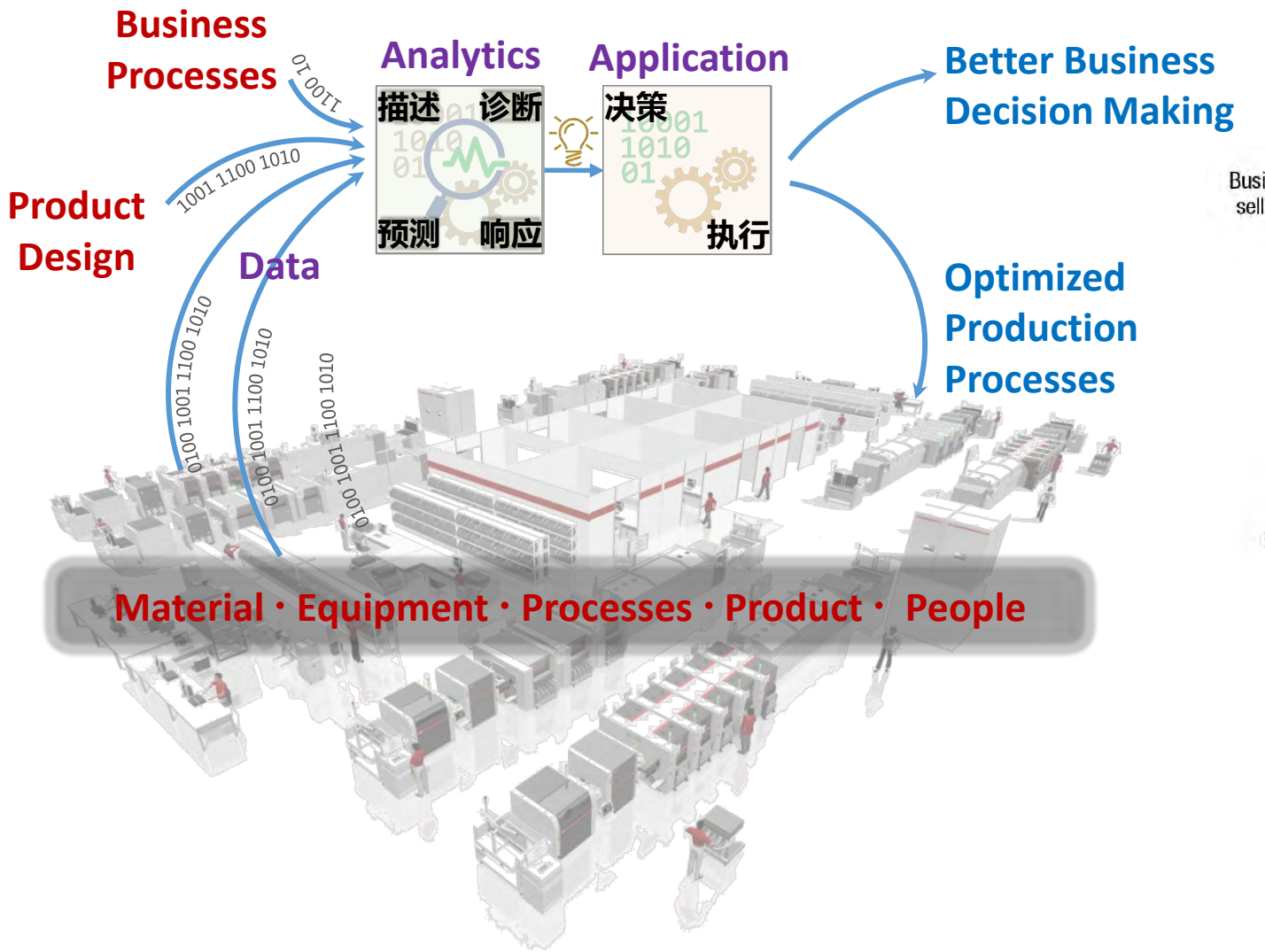
Applying IIRA in Smart Manufacturing

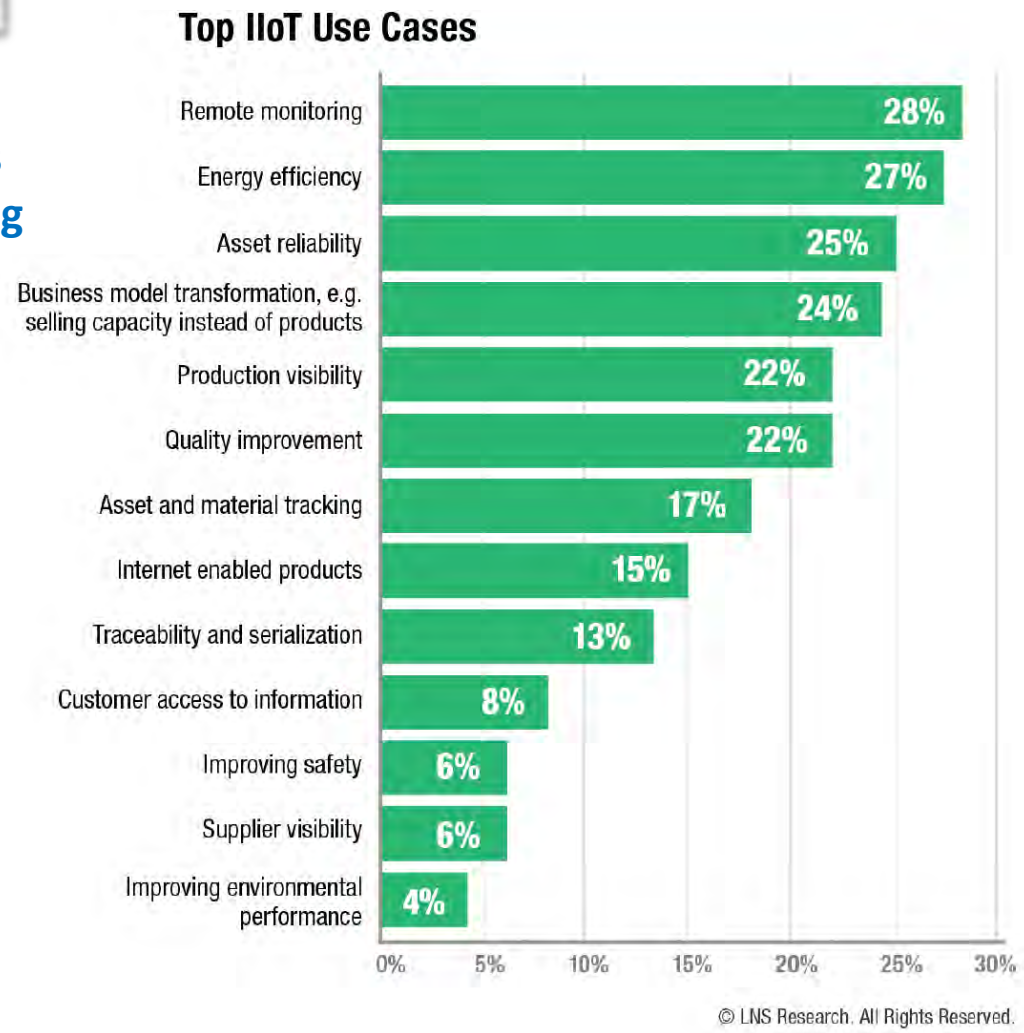
IIoT for Smart Manufacturing (ARC - Industrial IoT/Industrie 4.0 Viewpoints)

- https://industrial-iot.com/2017/09/iiot-smart-manufacturing/
- https://industrial-iot.com/2017/09/iiot-smart-manufacturing-part-2-digital-thread-digital-twin/
- https://industrial-iot.com/2017/10/iiot-smart-manufacturing-part-3-new-digitalization-architecture/

Industrial Internet in Smart Manufacturing

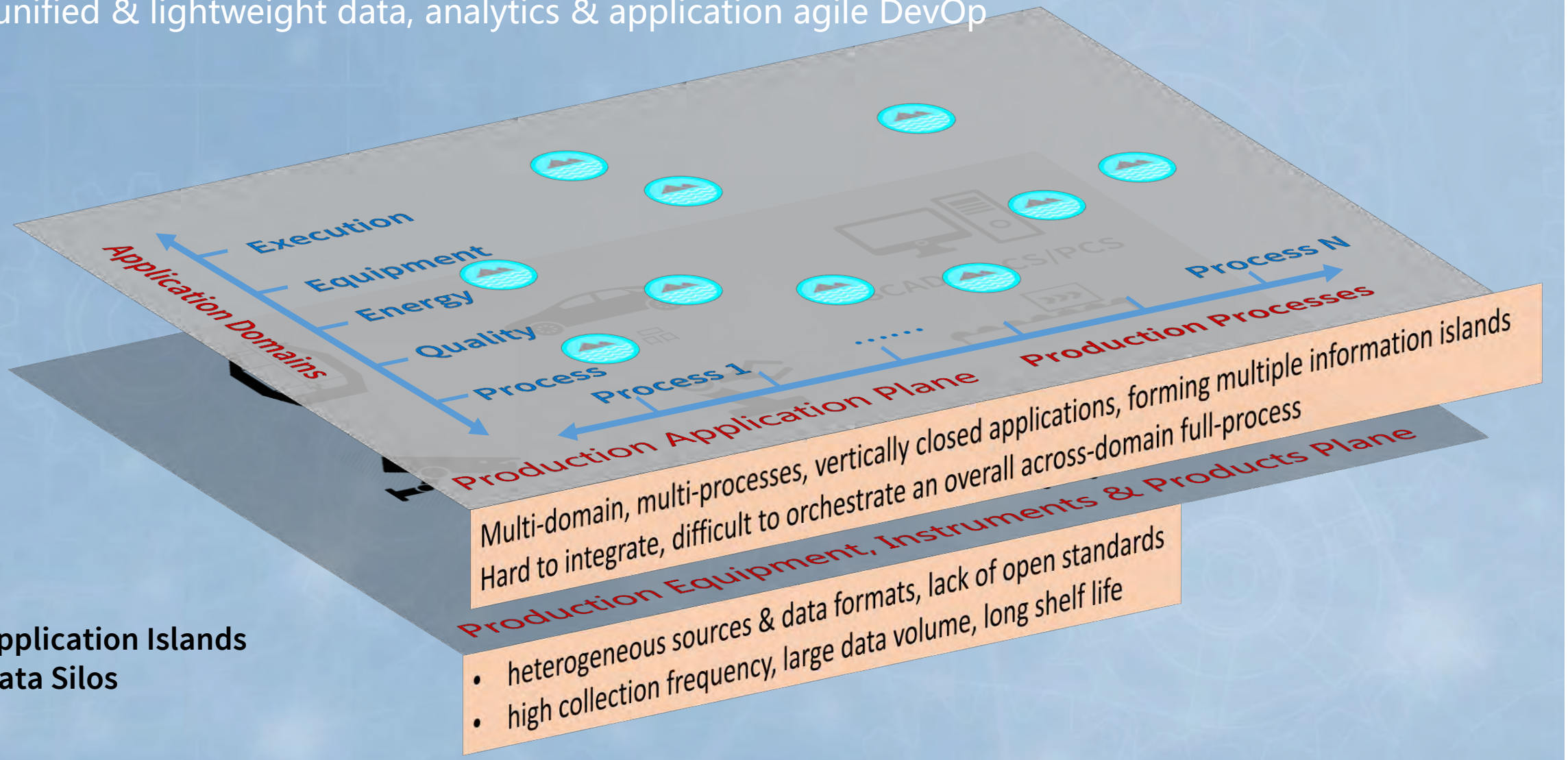
Digitalization of industrial technologies & know-hows through analytic models & software





Data-Driven Optimization for Manufacturing
- Challenges & Requiems

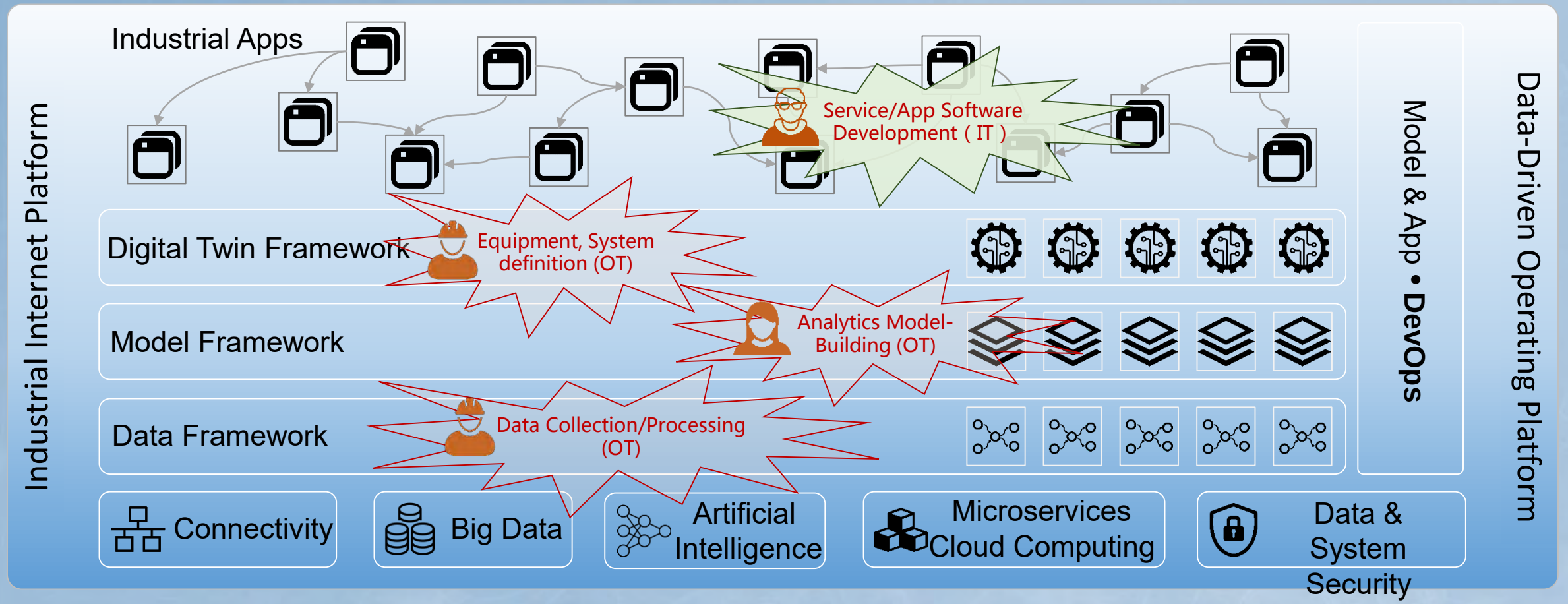
Need a new breed of data-driven industrial OS
for unified & lightweight data, analytics & application agile DevOp



Application Islands
Data Silos

Thingswise Industrial Internet Platform

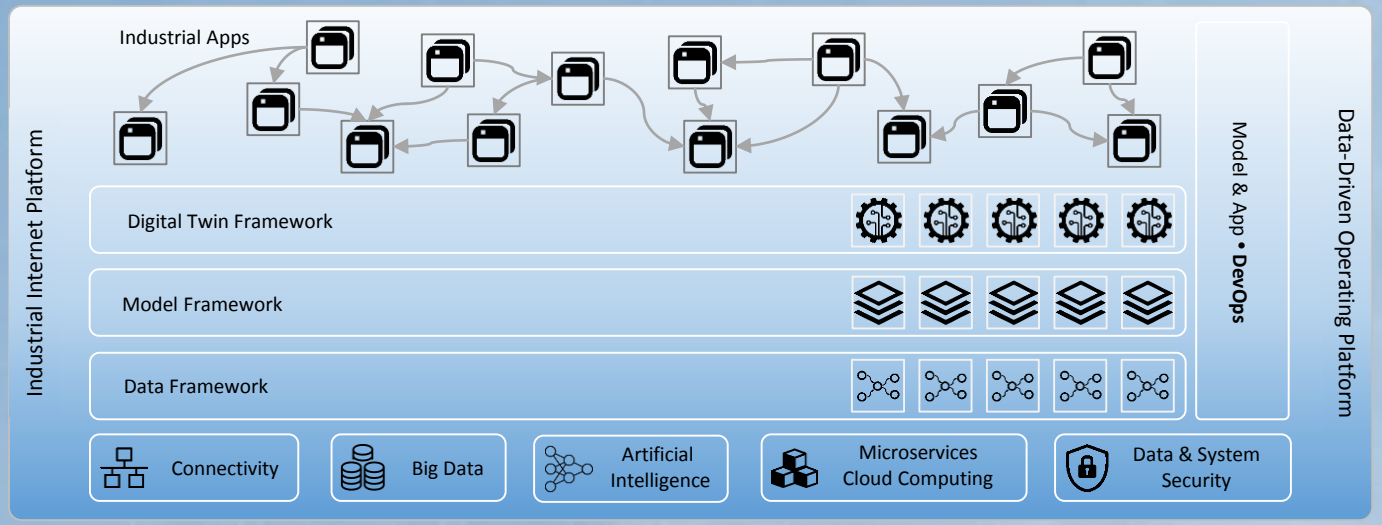
Simple, Lightweight &
Easy to Use, Fliexible to Deploy



www.thingswise.com www.yo-i.com.cn

Thingswise Industrial Internet Platform

as Data-Driven Industrial OS



Simple & Lightweight
Scalable & Reliable
Extendable & Portable

Easy to use：

- ✓ Full function Industrial Internet platform purposely-built with requisite technologies
- ✓ GUI-based codeless development & configuration
- ✓ Logical division of expertise, loosely coupled independent delivery

Flexible to deploy：

- ✓ Support low-latency edge computing and large-scale cloud computing
- ✓ Safeguarding system and data security and control

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