FORMAL ARCHITECTURE OVERVIEW
INDUSTRIAL IOT

Software and Services Group
IoT Developer Relations, Intel

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INTRODUCTION VIDEO

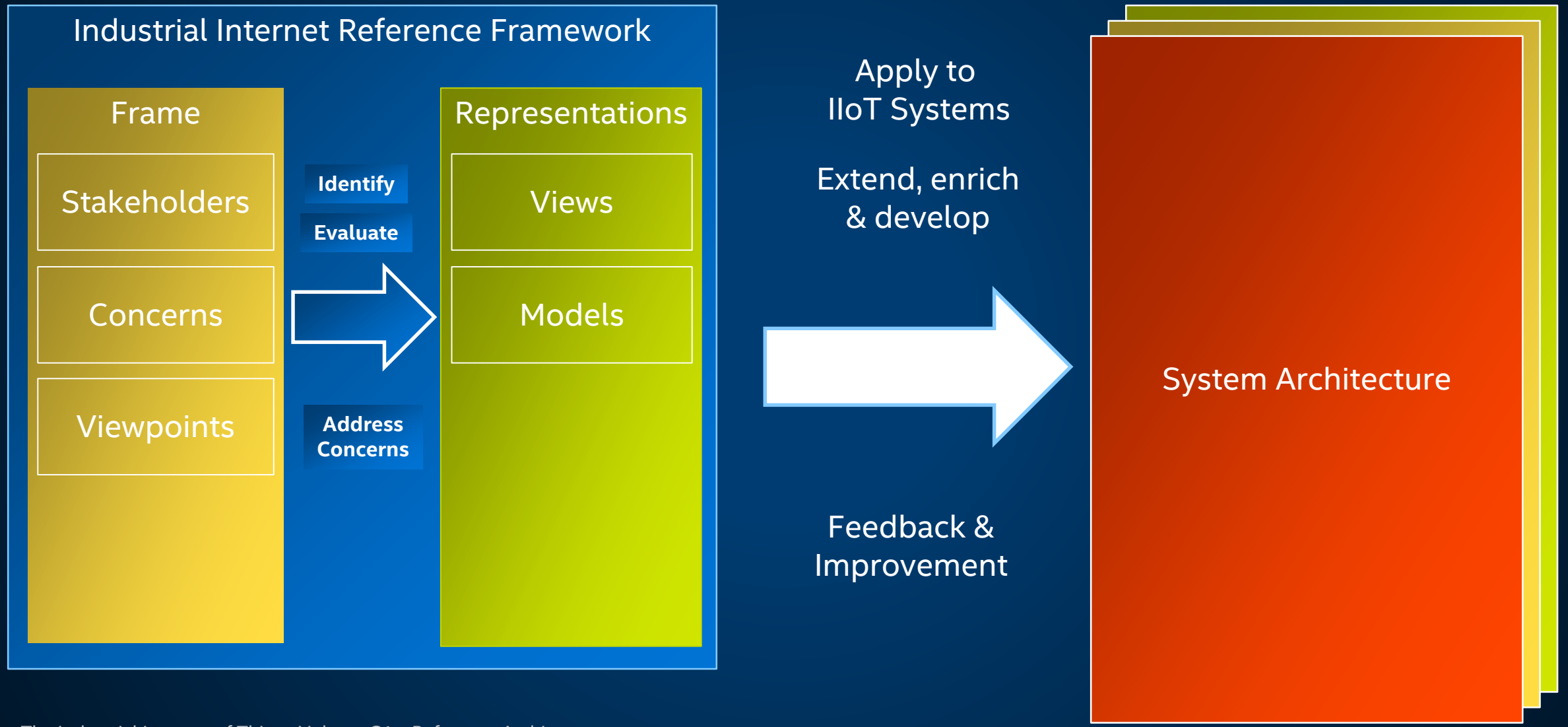
FORMALIZING THE INDUSTRIAL INTERNET OF THINGS

ADDRESSING ENVIRONMENT COMPLEXITY

“The IIoT landscape is replete with proprietary connectivity technologies and specialized connectivity standards optimized for a narrow set of domain-specific use cases in vertically integrated systems. These domain-specific connectivity technologies, though optimal in their respective domains, can be a hindrance to the sharing of data, designs, architectures, and communications essential to creating new value streams and unlocking the potential of a global IIoT marketplace. The overarching goal of IIoT connectivity is to unlock data in these isolated systems (“silos”) and enable data sharing and interoperability between previously closed components and subsystems (brownfield) and new applications (greenfield), within and across industries.”

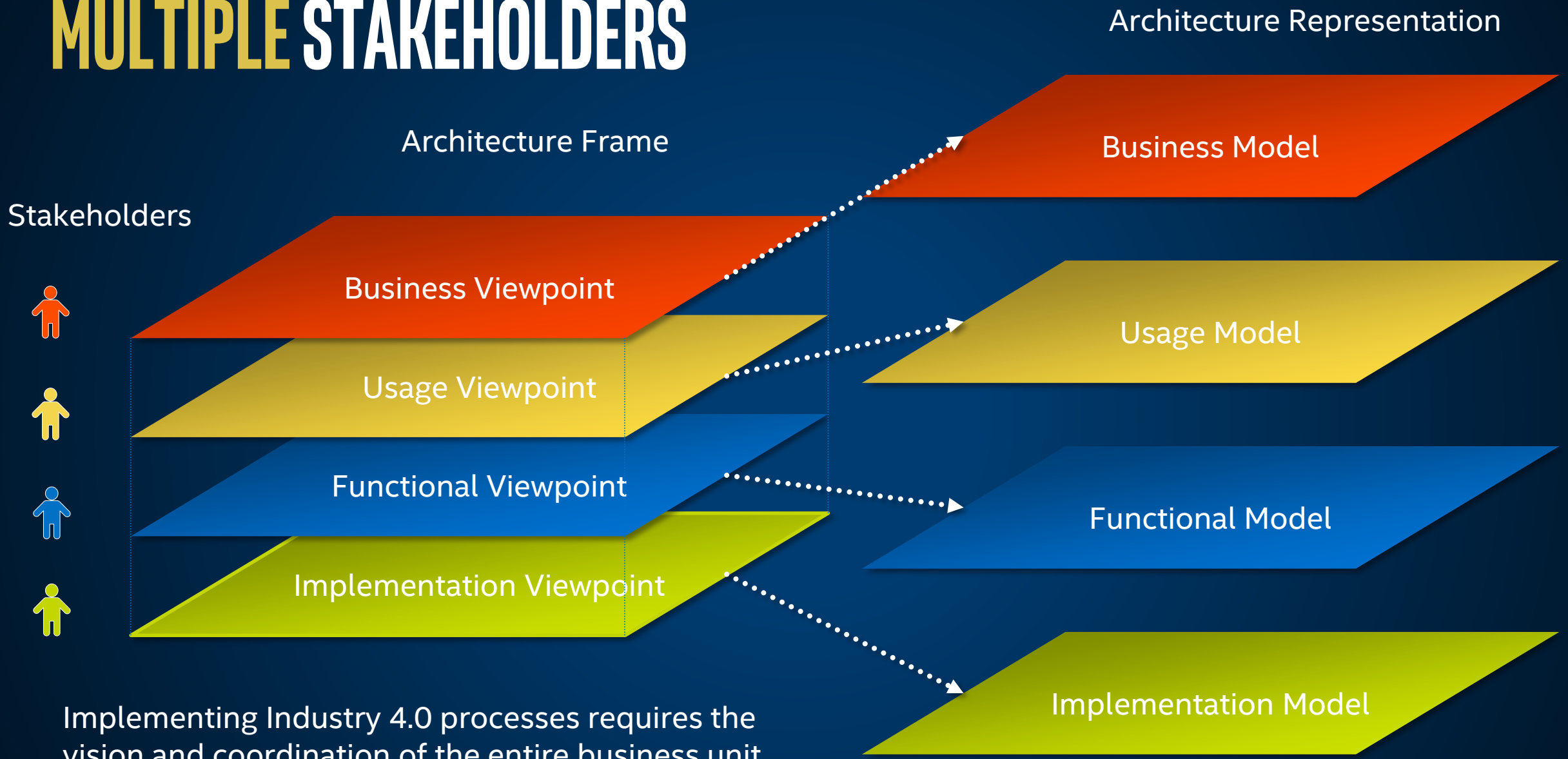
The Industrial Internet of Things Consortium
Volume G5

INDUSTRIAL INTERNET REFERENCE ARCHITECTURE



The Industrial Internet of Things Volume G1 – Reference Architecture

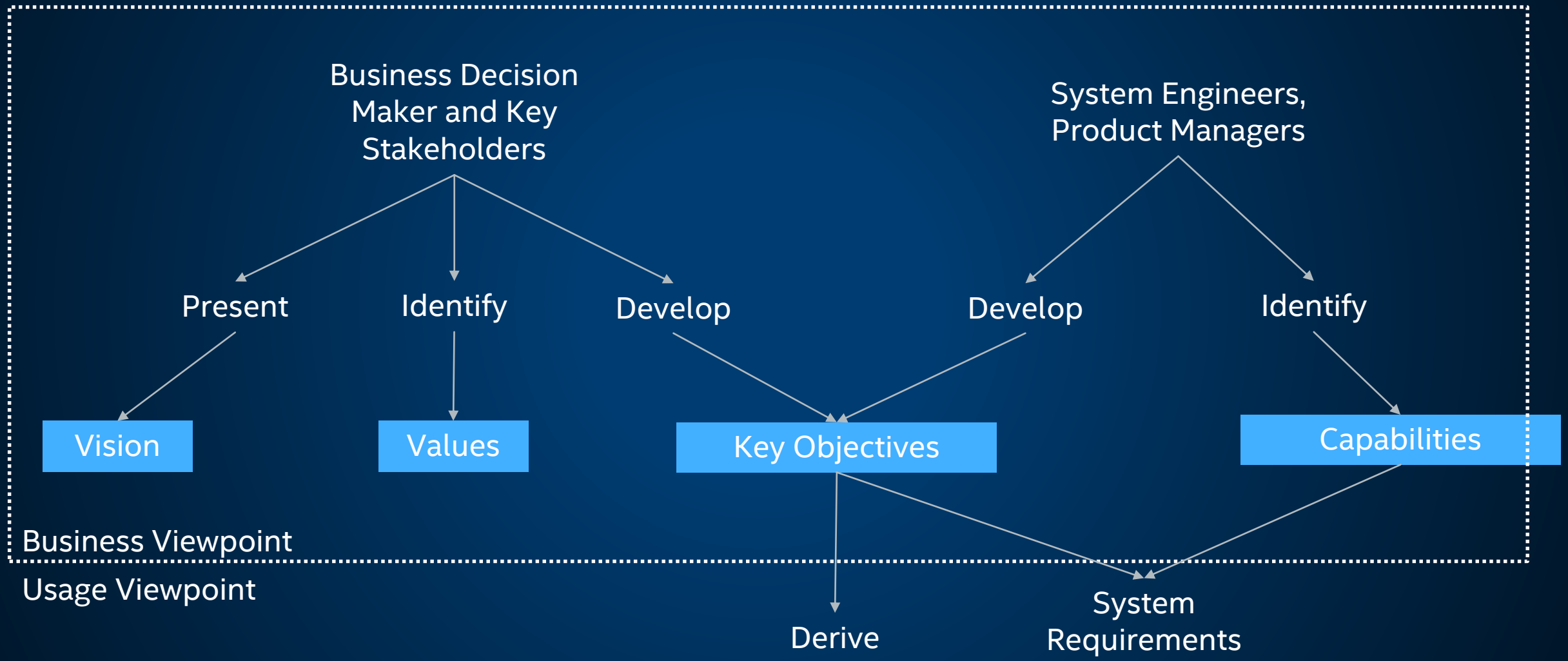
MULTIPLE STAKEHOLDERS



Implementing Industry 4.0 processes requires the vision and coordination of the entire business unit.

The Industrial Internet of Things Volume G1 – Reference Architecture

BUSINESS AND USAGE VIEWPOINTS



FUNCTIONAL VIEWPOINT

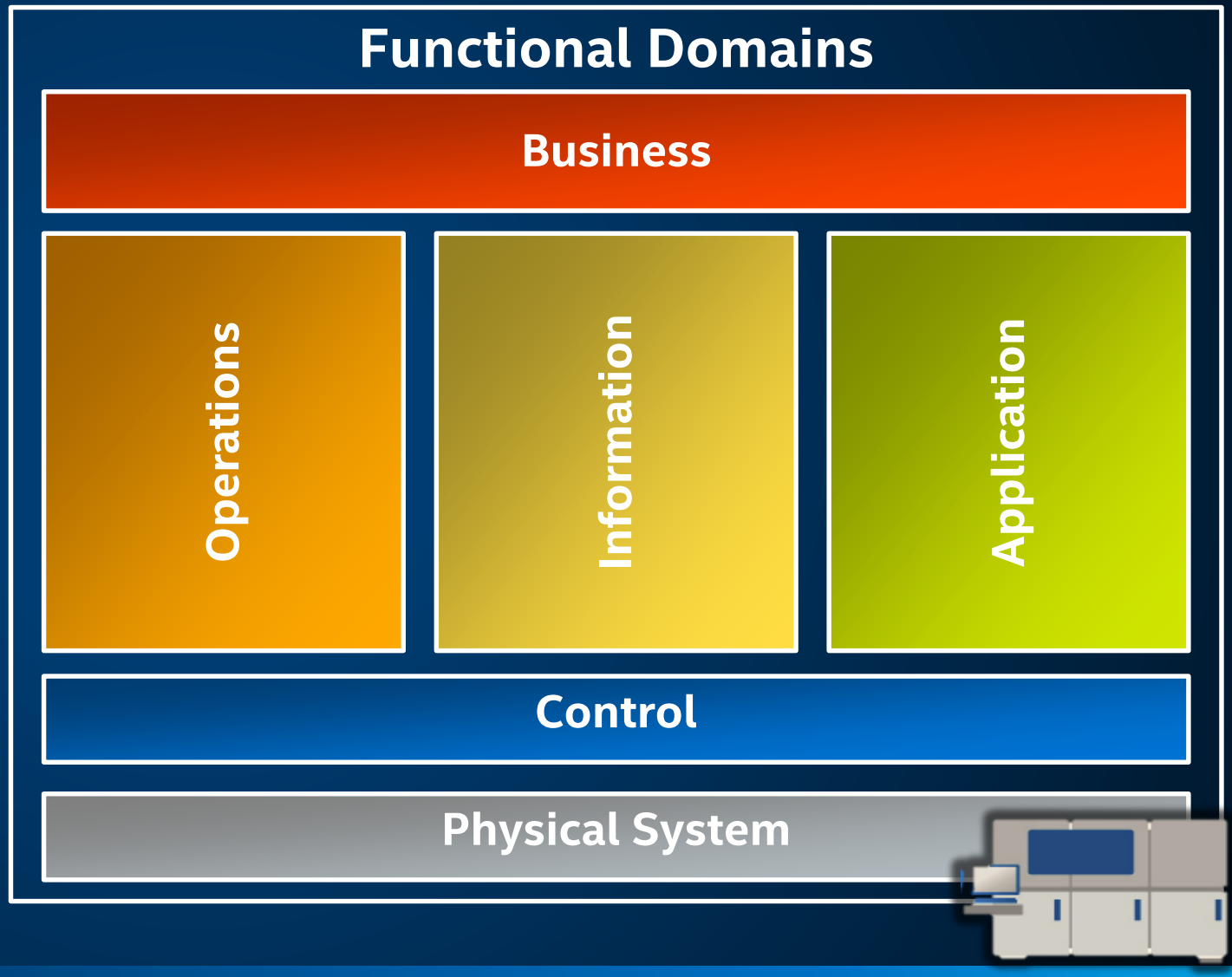
THE CONTROL DOMAIN
the collection of functions that are performed by industrial control systems.

THE OPERATIONS DOMAIN
the collection of functions responsible for the provisioning, management, monitoring and optimization.

THE INFORMATION DOMAIN
the collection of functions for gathering data and transforming, persisting, modeling or analyzing that data to acquire high-level intelligence about the overall system.

THE APPLICATION DOMAIN
the collection of functions implementing application logic that realizes business functionalities.

THE BUSINESS DOMAIN
enable end-to-end operations of the industrial internet of things systems



CONTROL DOMAIN

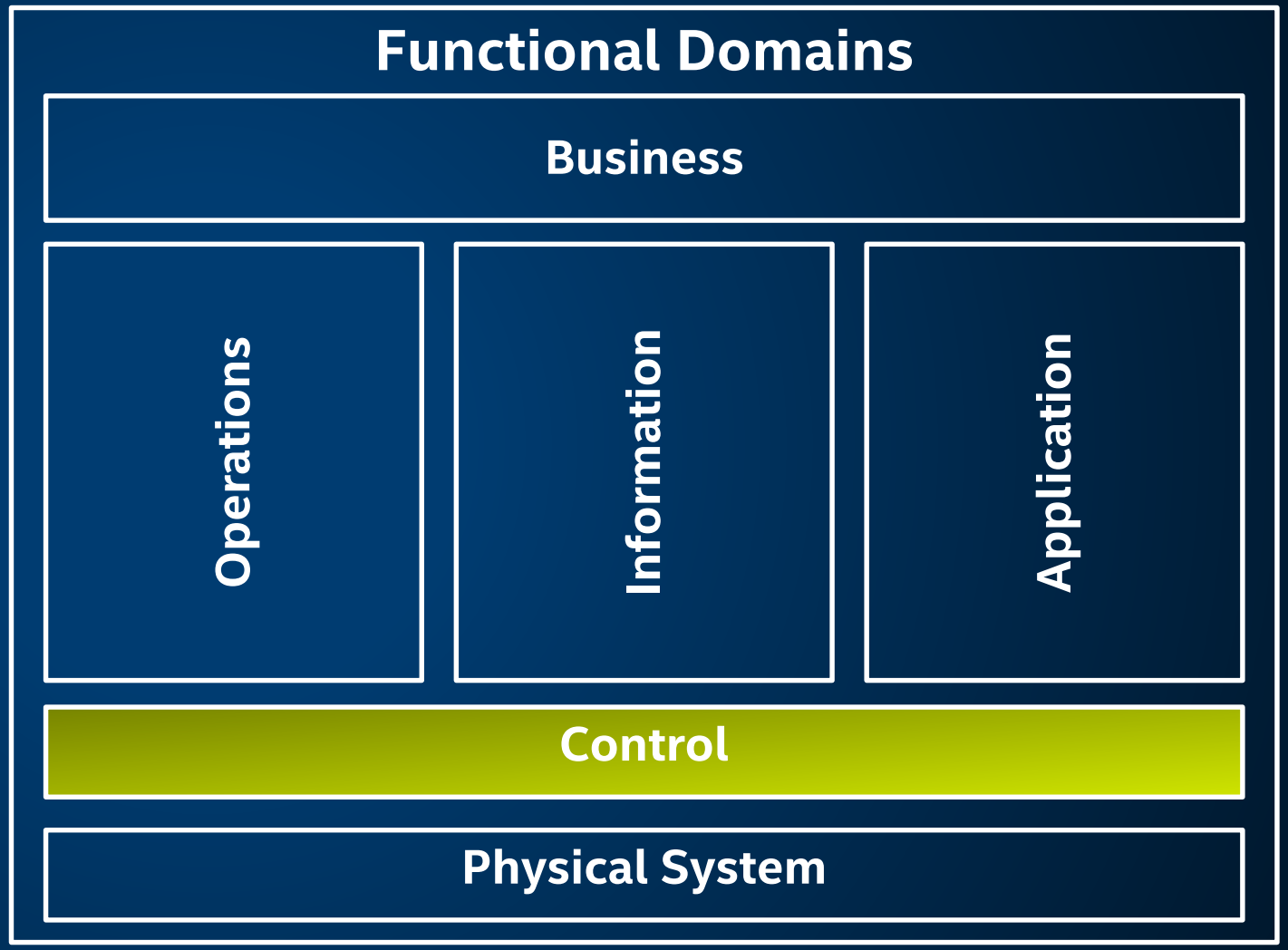
FUNCTIONAL VIEWPOINT

The collection of functions that are performed by Control Domain

- Sensing
- Actuating
- Entity Abstraction
- Modeling

IMPLEMENTATION VIEWPOINT

3. Physical Sensors and Actuators
4. Communications and Protocols



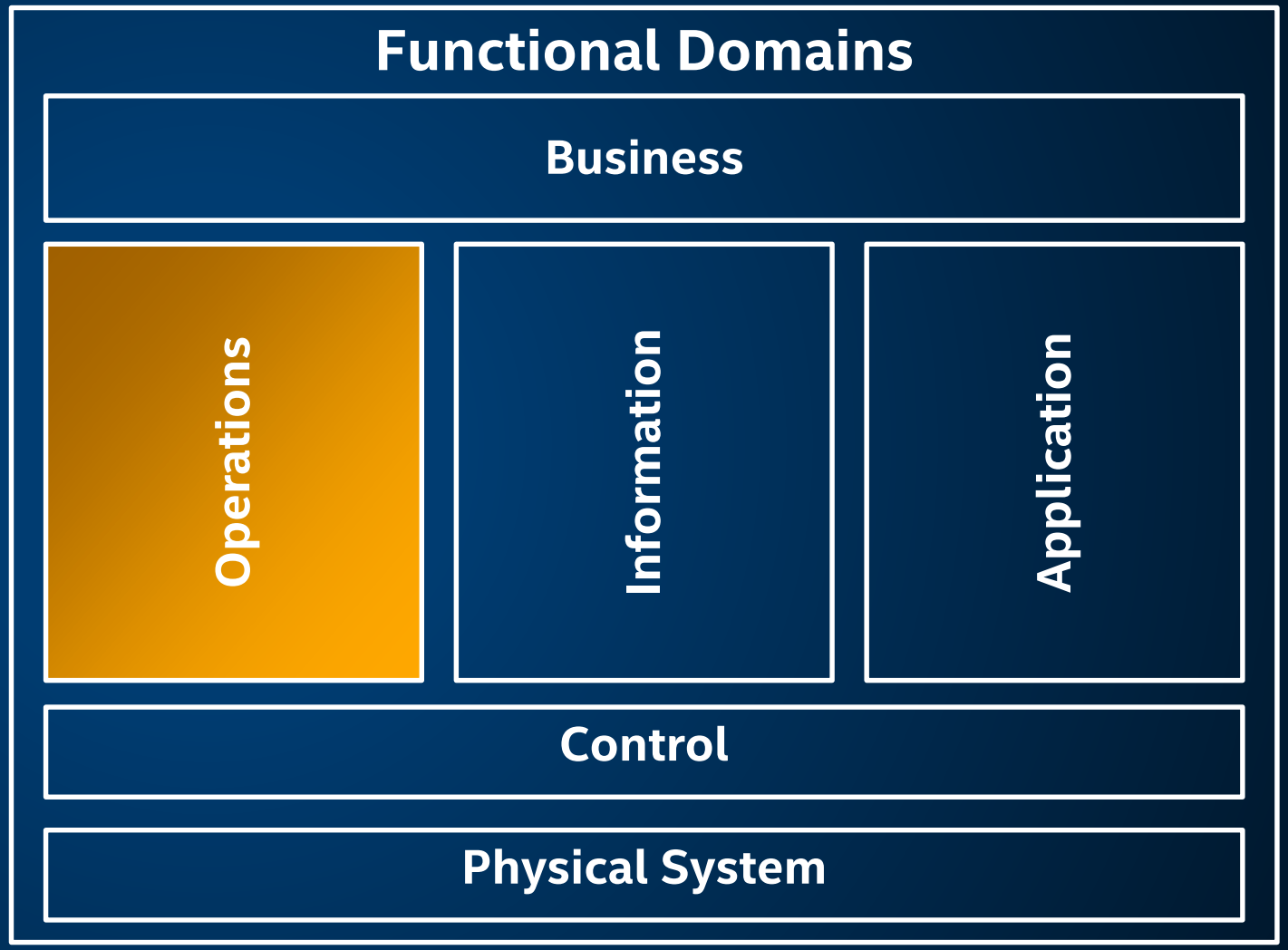
OPERATIONS DOMAIN

FUNCTIONAL VIEWPOINT

The operations domain represents the collection of functions responsible for the provisioning, management, monitoring and optimization of the systems in the control domain

IMPLEMENTATION VIEWPOINT

5. Virtualization and Consolidation
6. Security and IIoT



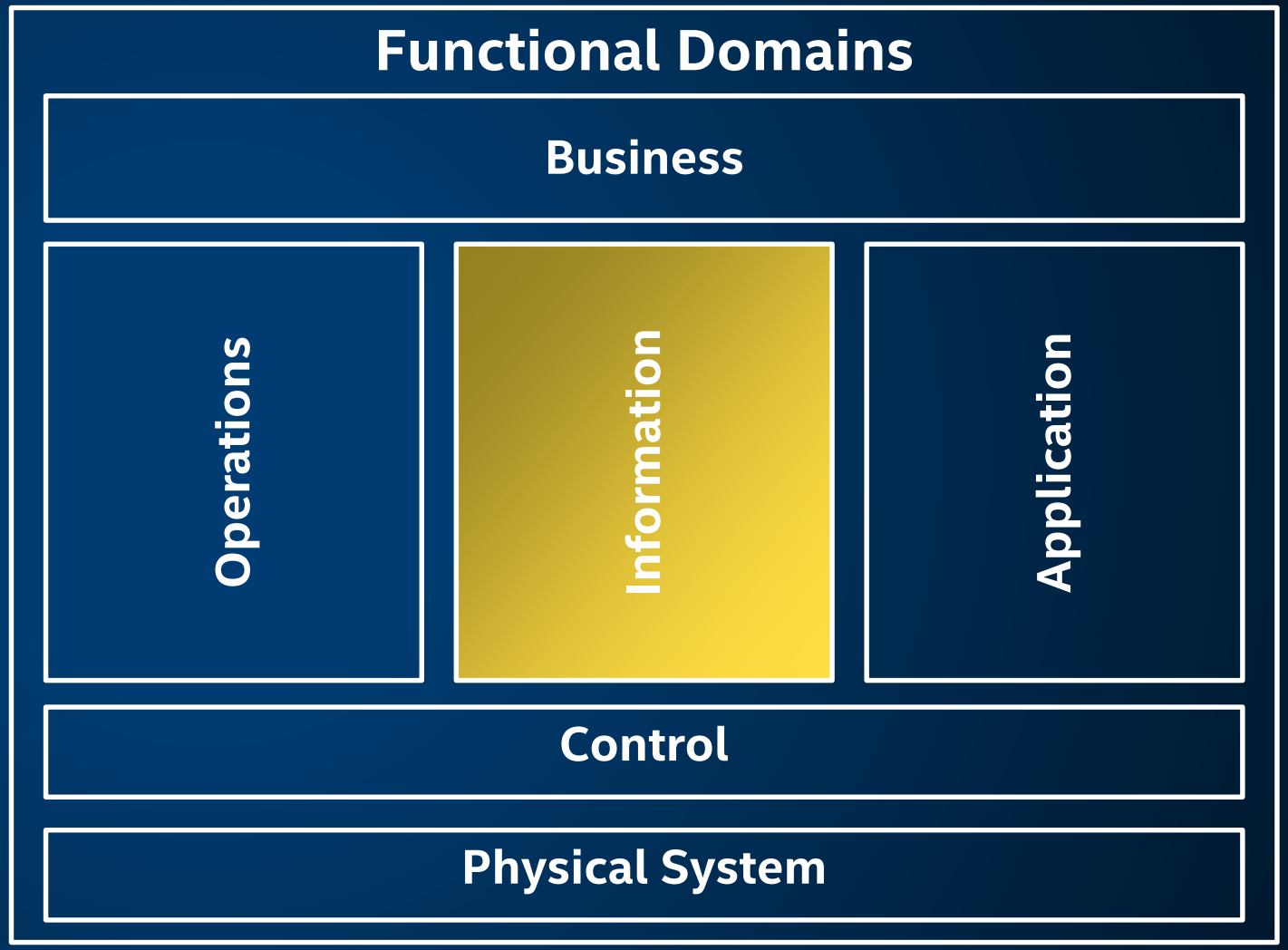
INFORMATION DOMAIN

FUNCTIONAL VIEWPOINT

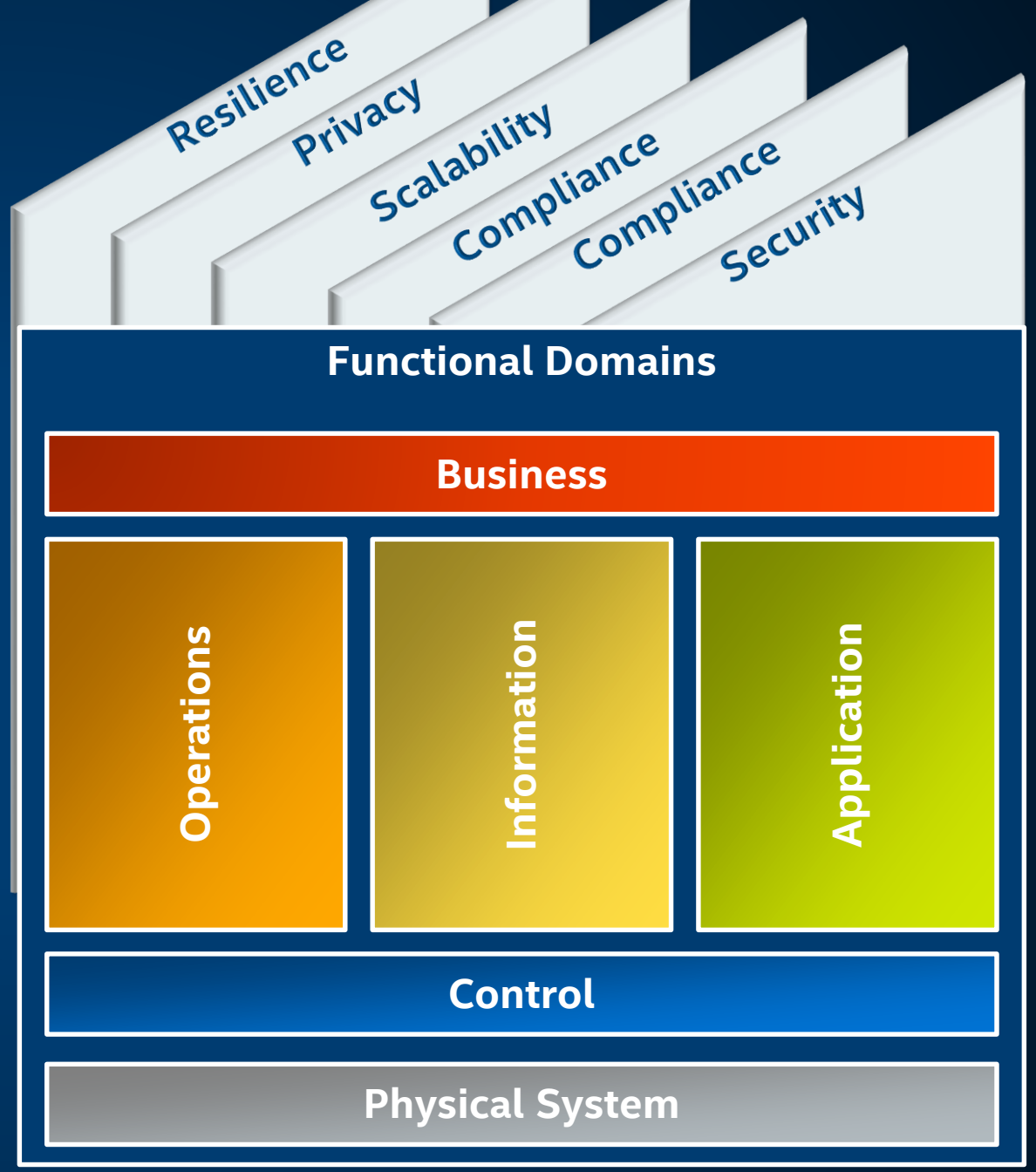
The collection of functions for gathering data and transforming, persisting, modeling or analyzing that data to acquire high-level intelligence about the overall system.

IMPLEMENTATION VIEWPOINT

7. Automated Control Systems
8. Smart Video Systems



CROSSCUTTING FUNCTIONS AND SYSTEM CHARACTERISTICS



APPLICATION DOMAIN

MANUFACTURING ANALYTICS

PRODUCTION PERFORMANCE

PROCESS QUALITY

PREDICTIVE MAINTENANCE

DATA PROCESSING

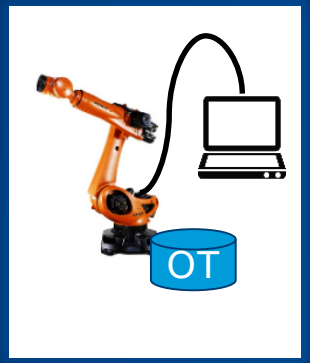
PRODUCTION RULES

REMOTE SERVICES

SENSOR CLOUD

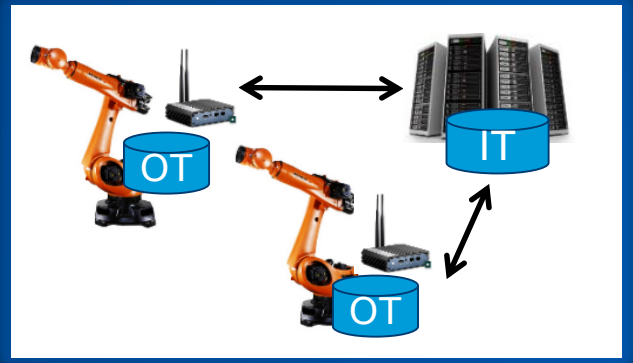
AN EVOLUTION TOWARD SMART FACTORY

NOT CONNECTED



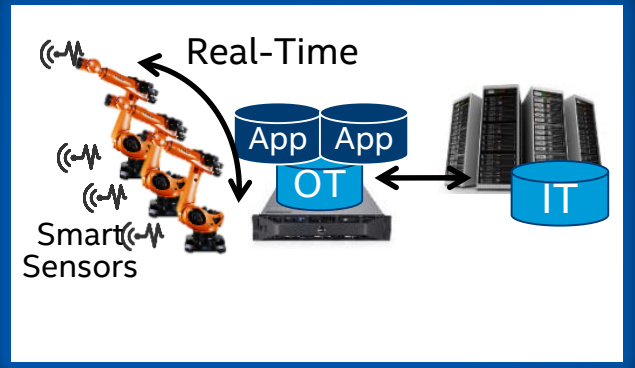
Fixed function

CONNECT THE UNCONNECTED



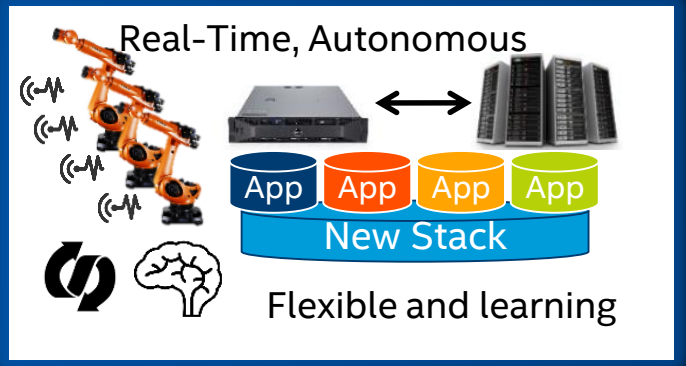
First IoT adoption

SMART AND CONNECTED THINGS



Machines & sensors built to be intelligent and interconnected

SOFTWARE-DEFINED AND AUTONOMOUS



New merged control stack is optimized for machine apps

LEARNING LOOP

- Predictive maintenance
- Machine learning
- Increased efficiencies

CONTROL LOOP

- Reduced OPEX
- Increased use of assets
- **Synchronized real-time control**

AUTONOMOUS LOOP

- Flexible function
- Down the wire updates
- Reconfigurable production

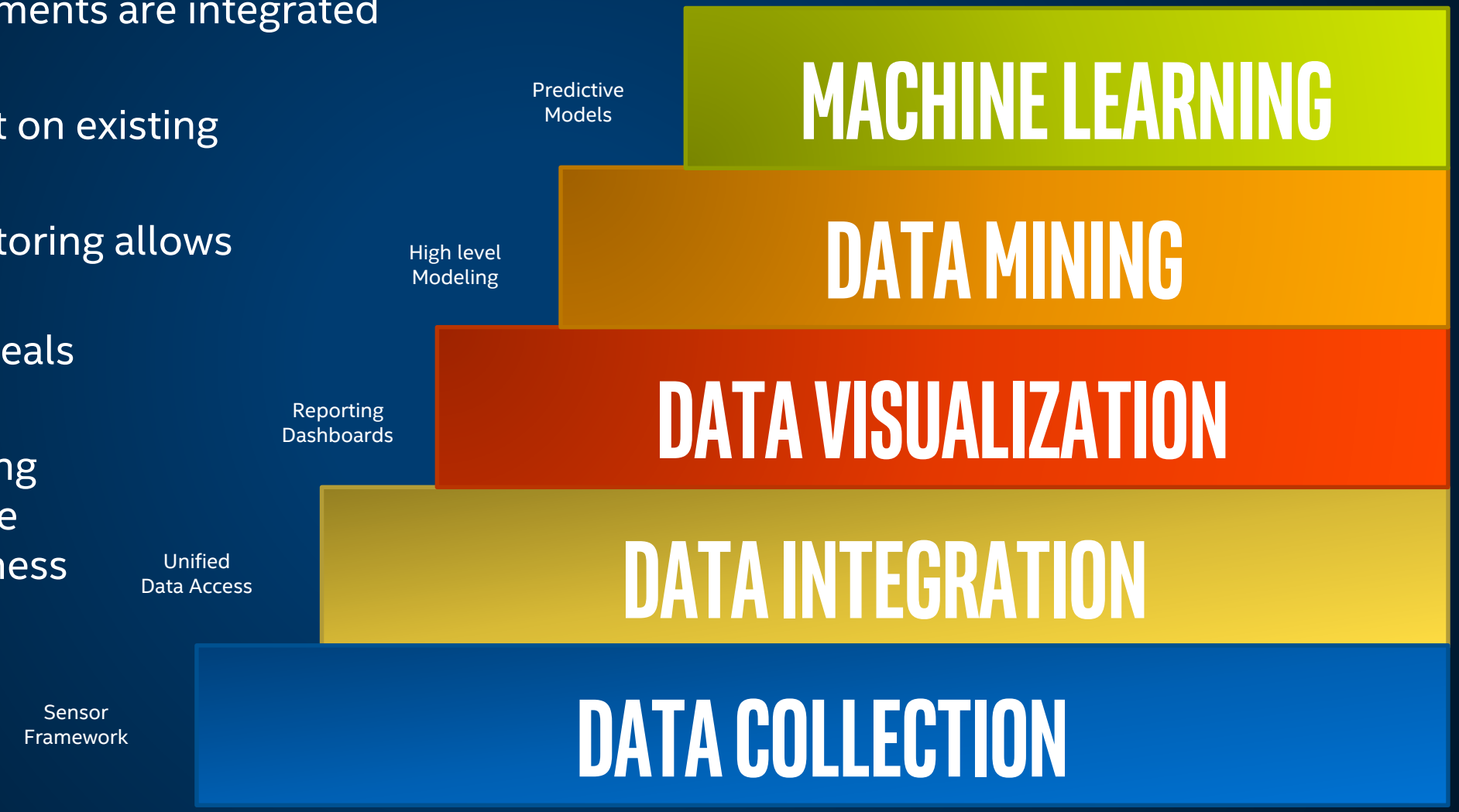
INCREASING AUTONOMY

COMPUTE POWER

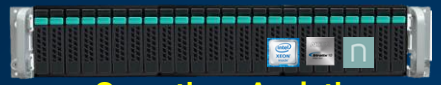
AI

INTELLIGENTLY USE EXISTING PRODUCTION DATA

- Existing deployments are integrated with sensors
- Data sheds light on existing processes
- Real-time monitoring allows optimization
- Data mining reveals new patterns
- Machine Learning builds predictive models of business processes



FUNCTIONAL DOMAINS & COMPUTATIONAL DEPLOYMENT PATTERNS EDGE



Operations Analytics
(HPC) Server

Business Operations Server

Control Domain

Actuators

Gateway

Controller

Sensors

Data Flows

Information Domain

Data & Analytics Services

Ingestion & Transformation

Streaming and Batching

Higher Level Info. Flows

$ Monetization

IT

Business Domain

Bi Analytics
CRM
EMR
ECS
MYA

Business Apps.

Orchestration Flows

Data Flows

Operational Flows

Operations Domain

Provisioning & Deployment

Asset & Metadata

Predictive Analytics &

Optimization

Application Domain

Control Automation

API and Operator Portal

Process Flows

Manufacturing Flows

Customer Apps.

Automation Flows

DM Analytics Platform or
Gateway Platform

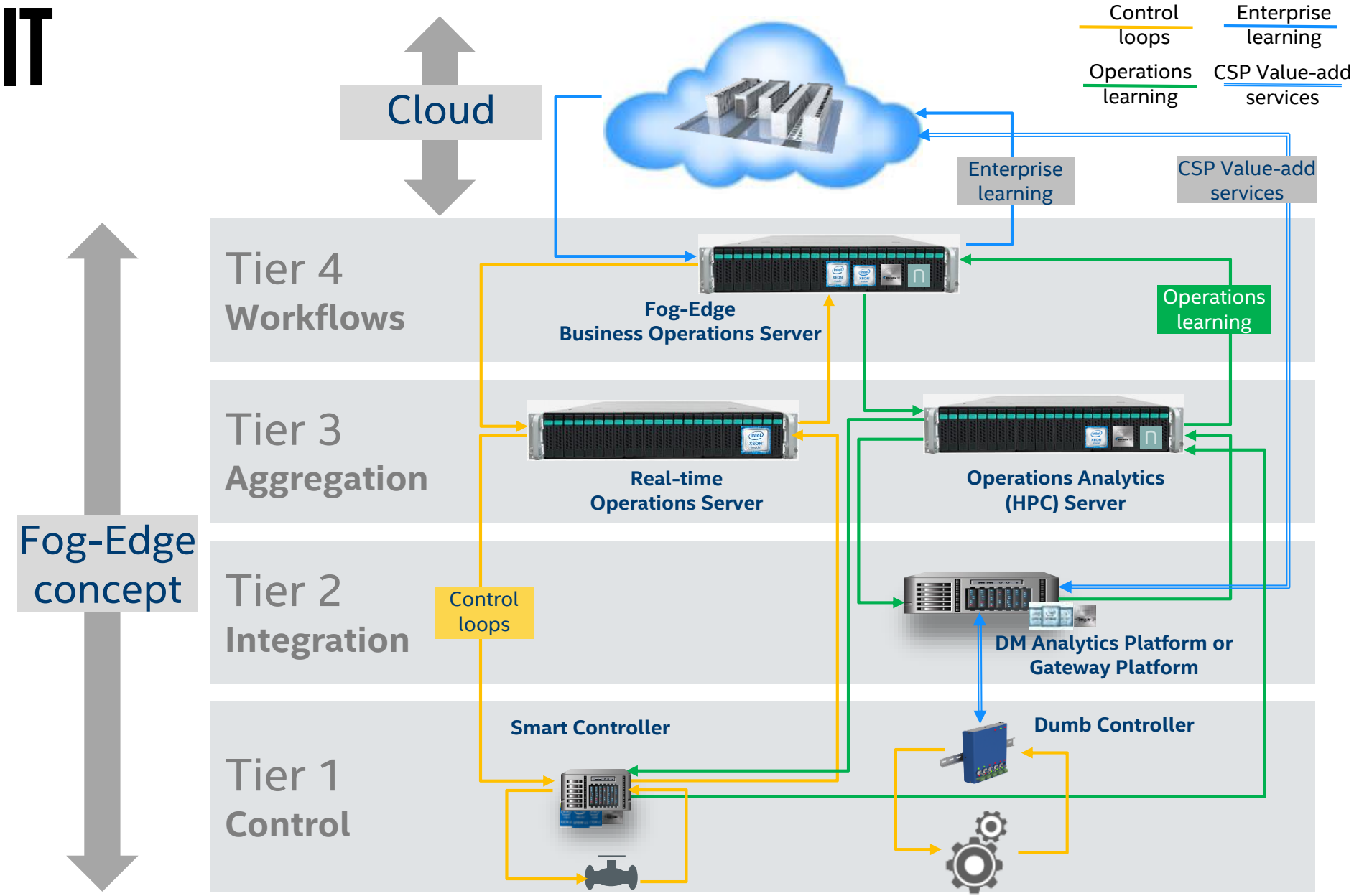
Dumb Controller

Real-time
Operations Server

OT
Operator App

MULTI-TIER OT-IT STRUCTURE

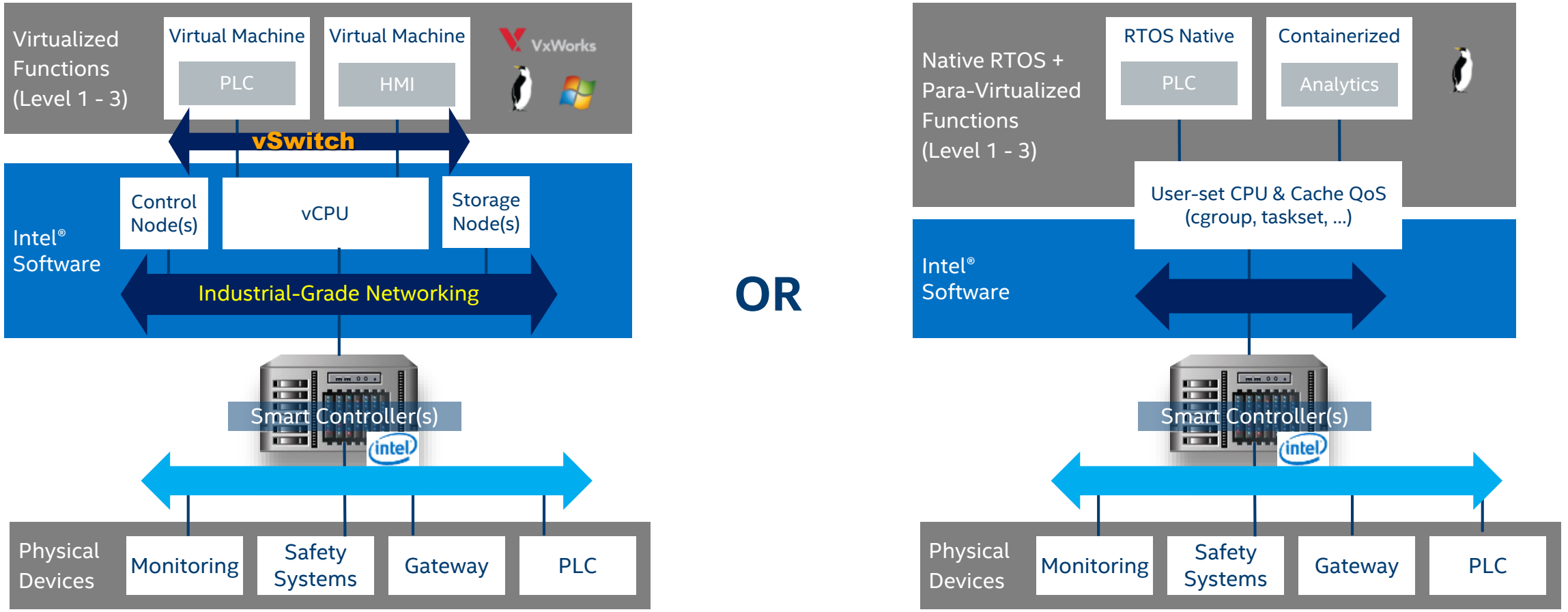
- Multi-tier OT-IT structure: converges ISA-95 model with traditional IT computing & networking distribution model
- Enables modularity and portability of services to support current & emerging use cases



** Not actual physical deployment scenarios*

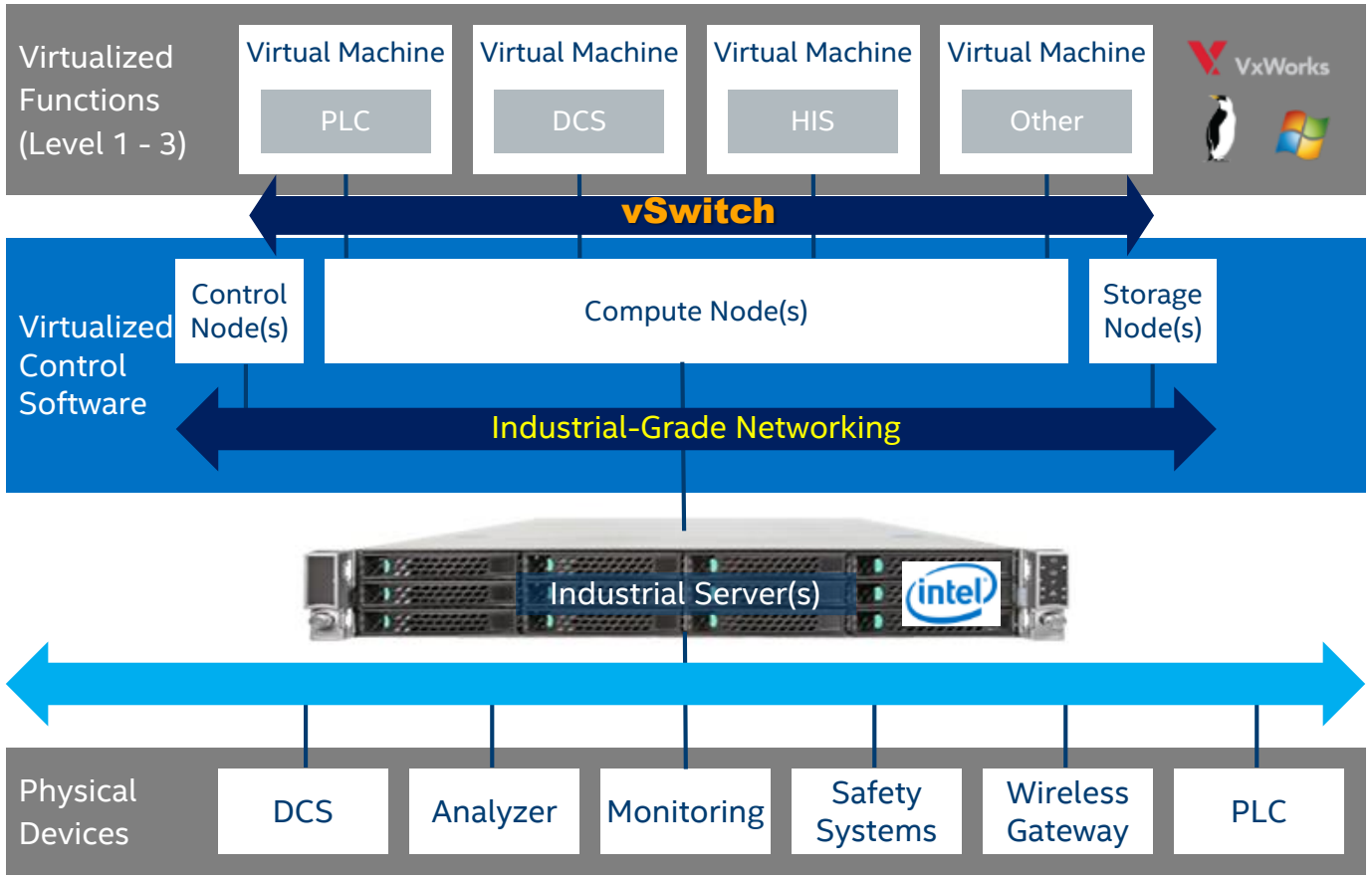
GENERALIZE PLATFORM FOR INDUSTRIAL CONTROL APPLICATIONS

SDIS for Industrial Control using *Smart-Controller* nodes



GENERALIZE PLATFORM FOR INDUSTRIAL CONTROL APPLICATIONS

SDIS for Industrial Control using *Real-time Operation Server* node



- **Secure infrastructure** that runs virtualized control functions with maximum reliability
  - Dynamic scalability from one server to hundreds
  - Integrated compute, control and storage functions
  - Six nines (99.9999%) uptime
  - Fault-tolerant to multiple hardware and software faults with no single point of failure
  - Simplified installation, commissioning and maintenance
  - Remote monitoring, diagnostics and updates
  - Supports time critical industrial applications
  - Supports standard guest operating systems
  - Runs on standard IT-class servers
  - Professional Services to accelerate deployment

PROBLEMATIC OF INDUSTRY 4.0 MULTI-TIER TRANSFORMATION

- Global Industrial player are converging OT structure to traditional IT computing & networking distribution model.

- OT/IT boundaries are not clear, as ownership and Roles & Responsibility heavily dependents on OT products legacy

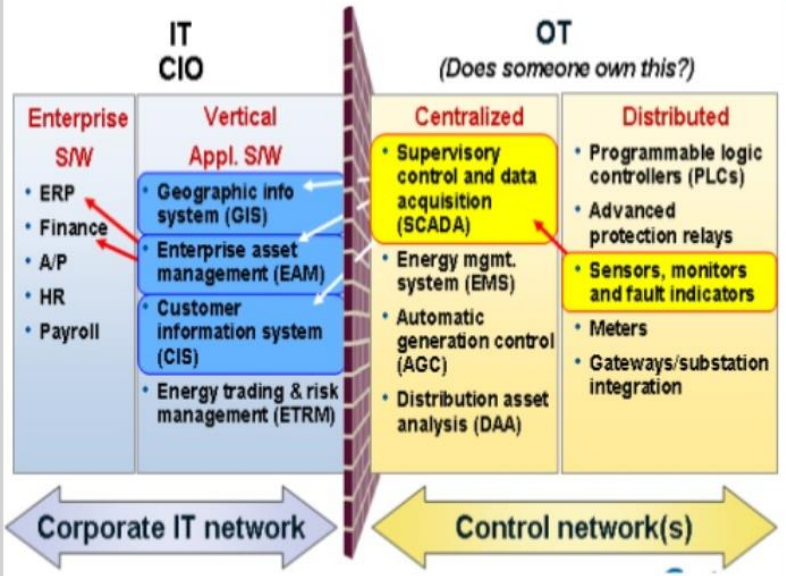
- IEEE 802.3 Ethernet networks interoperability with existing OT Systems is a strong vector for Growth.

- Lack of an open network stack allowing OT/IT convergence as well as interoperability between devices of various vendors.

- SDIS (e.g. OT SaaS) concept provides a very attractive vision for OT scability.

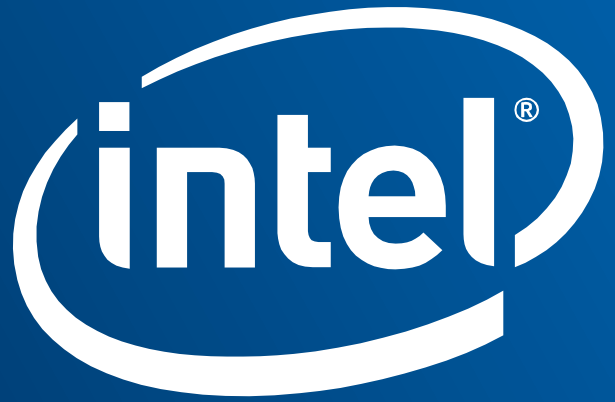
- OT product migration from Native SW micro-service (Hypervized/VMs or Container) require investment in software engineering

OT & IT ISSUES



Issues	Literature
IT versus Engineering	Steenstrup 2008; Barber, 2012; Schneider, 2006; Kern, 2009
Drivers forcing convergence	Steenstrup, 2008-2012; Romero, 2011; Wiese 2004; fyschwick, 1996
Many frameworks, standards, principles	Steenstrup 2012, IBM, Parekh 2007, Hillard, 2010, Thomas, 2009)
Successful EAM requires integration	Too, 2010; Sklar, 2004; Mays Business School, 2011; Humffray, 2003
When converge, integrate, align	Lack of academic literature

Ref. *Cooperative Research Center for Infrastructure and Engineering Asset Management*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