



TOSHIBA

Realization of Next Generation Cyber Physical Systems and Toshiba IoT Reference Architecture

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Position Cyber Physical Systems (CPS) as the core of Toshiba's technology strategy

Toshiba positions the Toshiba IoT Reference Architecture as the Group's shared framework for realizing CPS, and uses it as technological base for the rapid development and provision of B2B services.

To earn recognition as a CPS technology company, Toshiba will work to reflect Toshiba IoT Reference Architecture to global standard.

Going forward, Toshiba will provide B2B business services (enterprise services) as Toshiba Enterprise IoT suites (SPINEX suites)

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01

Cyber Physical Systems

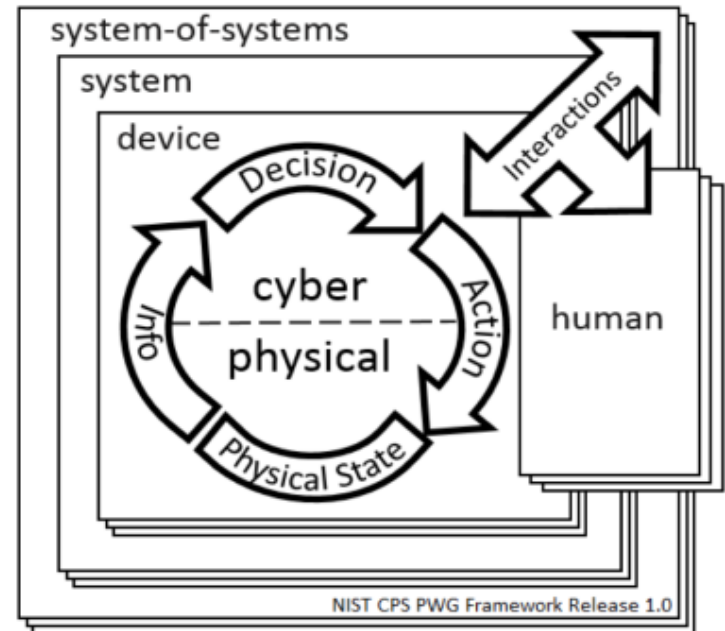


What Are Cyber Physical Systems?

- It consists of IoT, IoS and IoP
- A closed loop back between cyber and physical
- Systems, System-of-Systems and Human



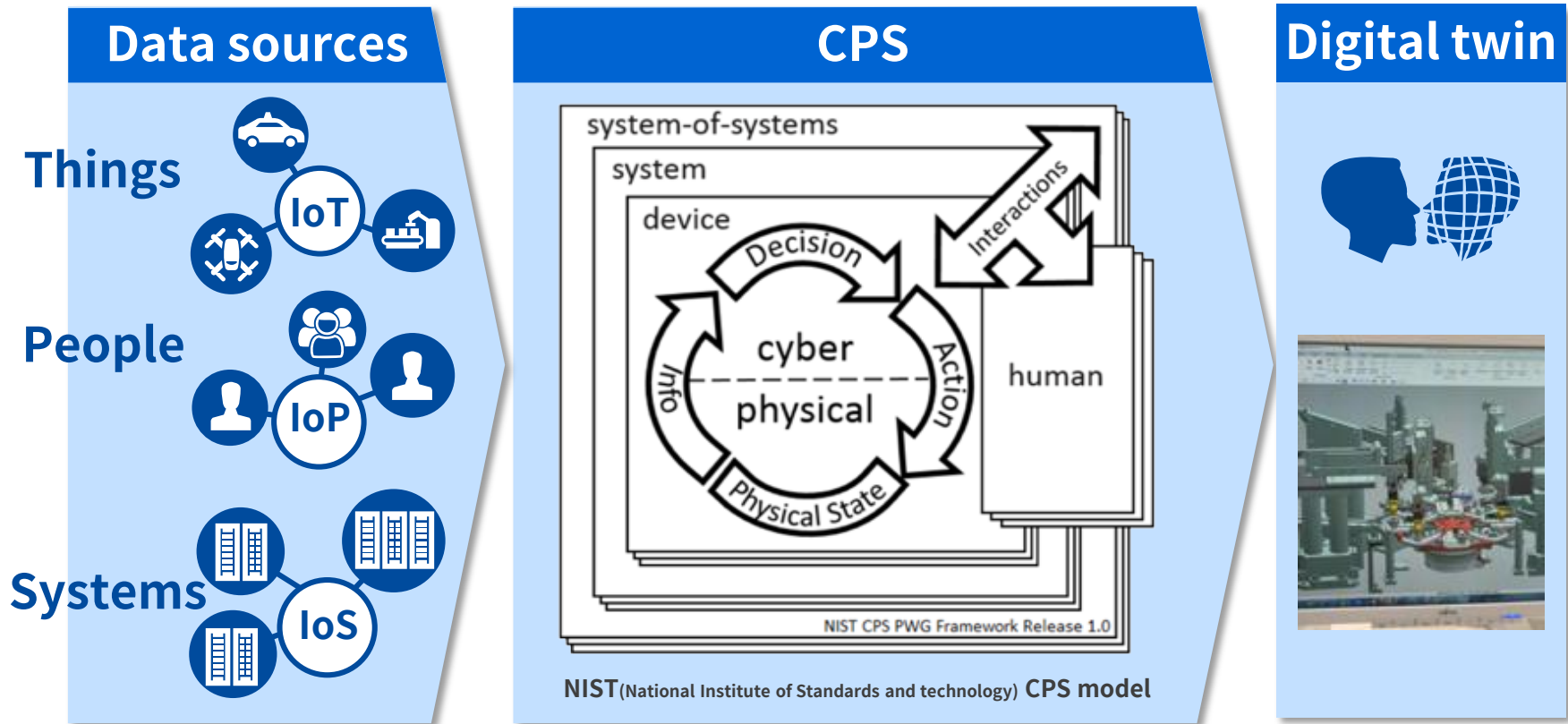
Source: "Recommendations for implementing the strategic initiative INDUSTRIE 4."



Source: "Cyber-Physical Systems (CPS) Framework Release 1.0"

How are CPS, IoT, Digital Twin and AI related?

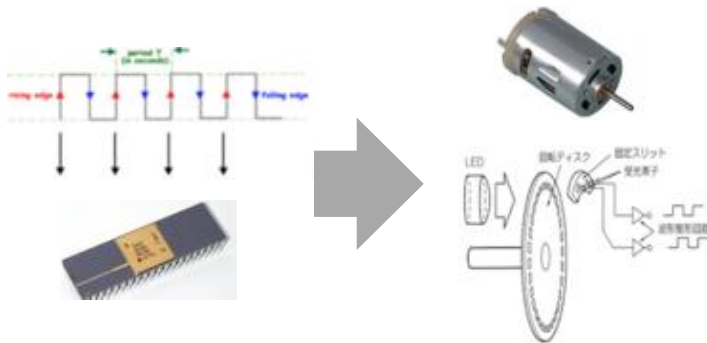
- CPS consists of physical and cyber loops
- Systems and systems-of-systems are components
- Interaction with people is achieved by AI



System vs. System-of-Systems

CPS falls into two broad categories—control and service
There is a need for architecture to unify control (Japanese DNA) and service

Closed Innovation



Traditional CPS (System)



Time constrained **Control**
(best efforts not possible)

Interruption, I/O triggers state transition

- Servo motor controls
- Interrupt processing with encoder pulse

Open innovation



Recent CPS (System-of-Systems)

Service with a feedback loop
(As-a-Service)

Data/API triggers state transition
Data sources: DB (IoS), people (IoP), things (IoT)

- Public loops
- Enterprise loops

Public Loop & Enterprise Loop

- CPS service loops are classified into two
- System of Systems is the differentiating key

PLATFORM
INDUSTRIE 4.0

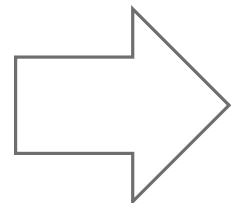
Public loop

- Remote monitoring
- Asset management
- Prevention and maintenance

Enterprise loop

Engineering

Production



**System-of-Systems
(as a Service)**



- API
- Data

Action



02

Toshiba IoT Reference Architecture

Toshiba IoT Reference Architecture Positioning

Follows IoT and CPS reference models



Integrated into logical architecture



Toshiba IoT Reference Architecture

International standardization



Toshiba's DX technology
Open to the world, all people

As a Service

Toshiba Enterprise Service



Digital Energy



Digital Infrastructure



Digital Logistics



Digital Manufacturing

Power and Water

Building facilities

Knowledge of control technology and IoT solutions that are actually used in numerous domains

Factories and logistics

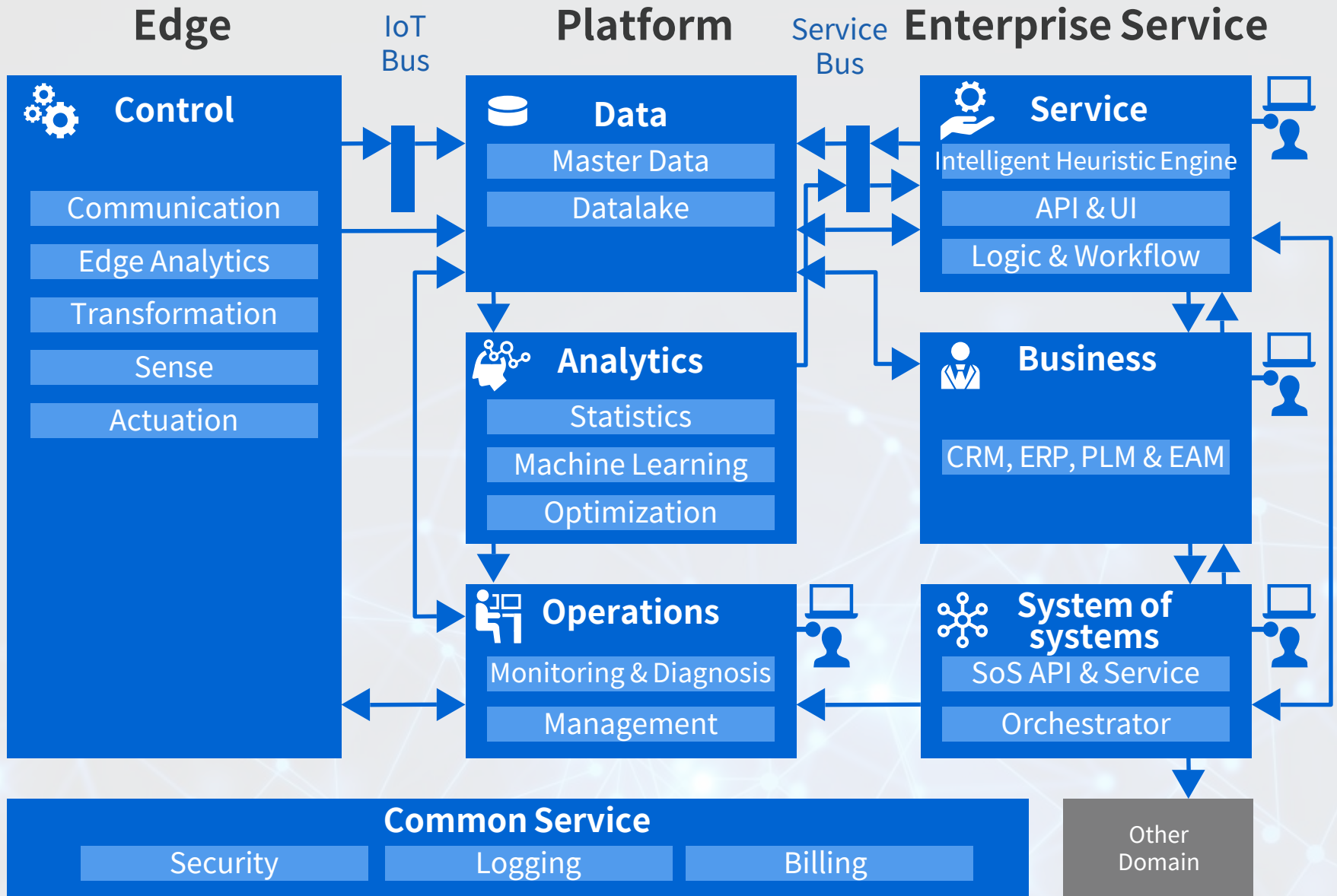
Transportation and roads

R&D technology components

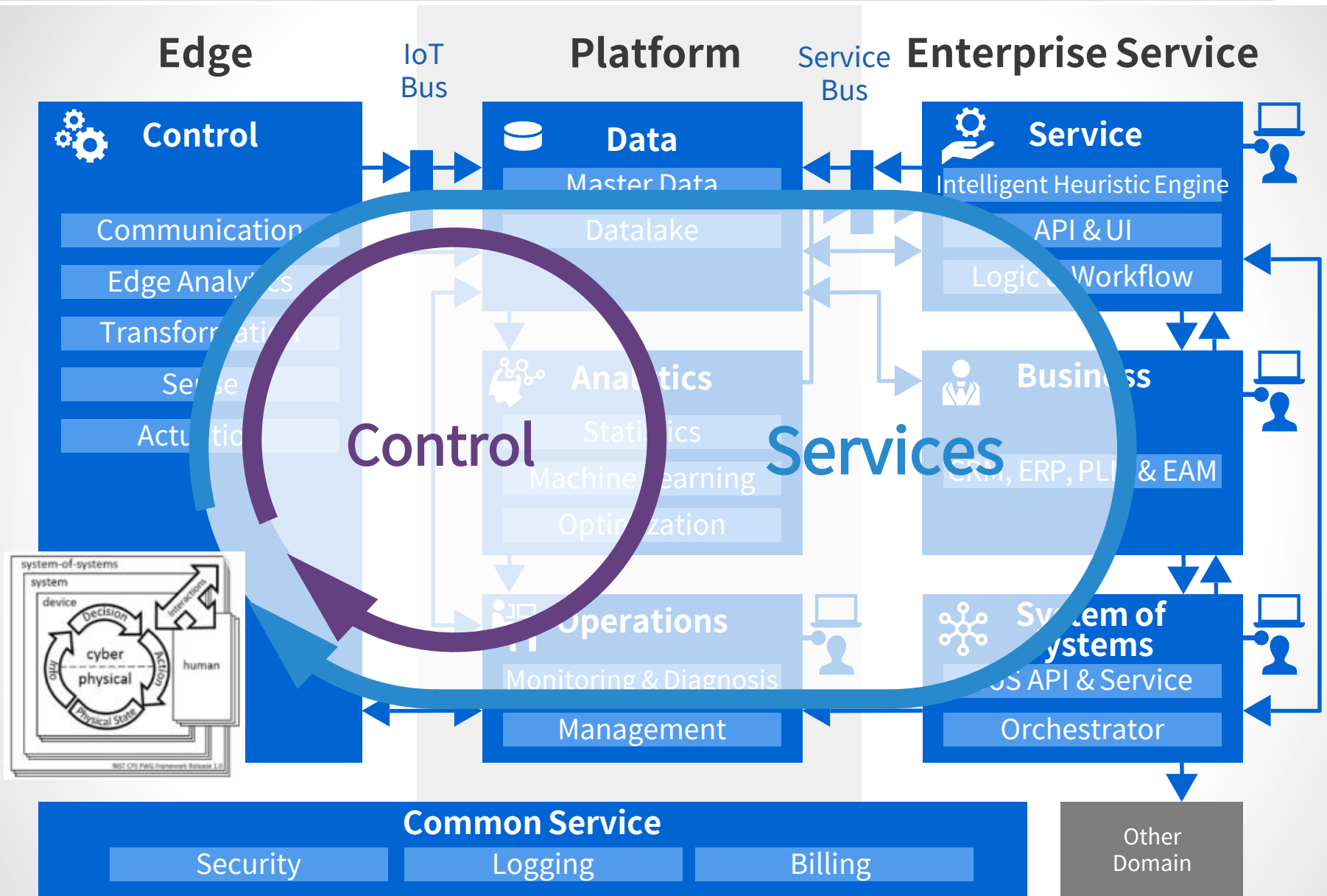
Since its founding, a DNA ready to support AI

- Sensor data process technology
- Voice recognition technology
- Image process technology
- Statics process technology

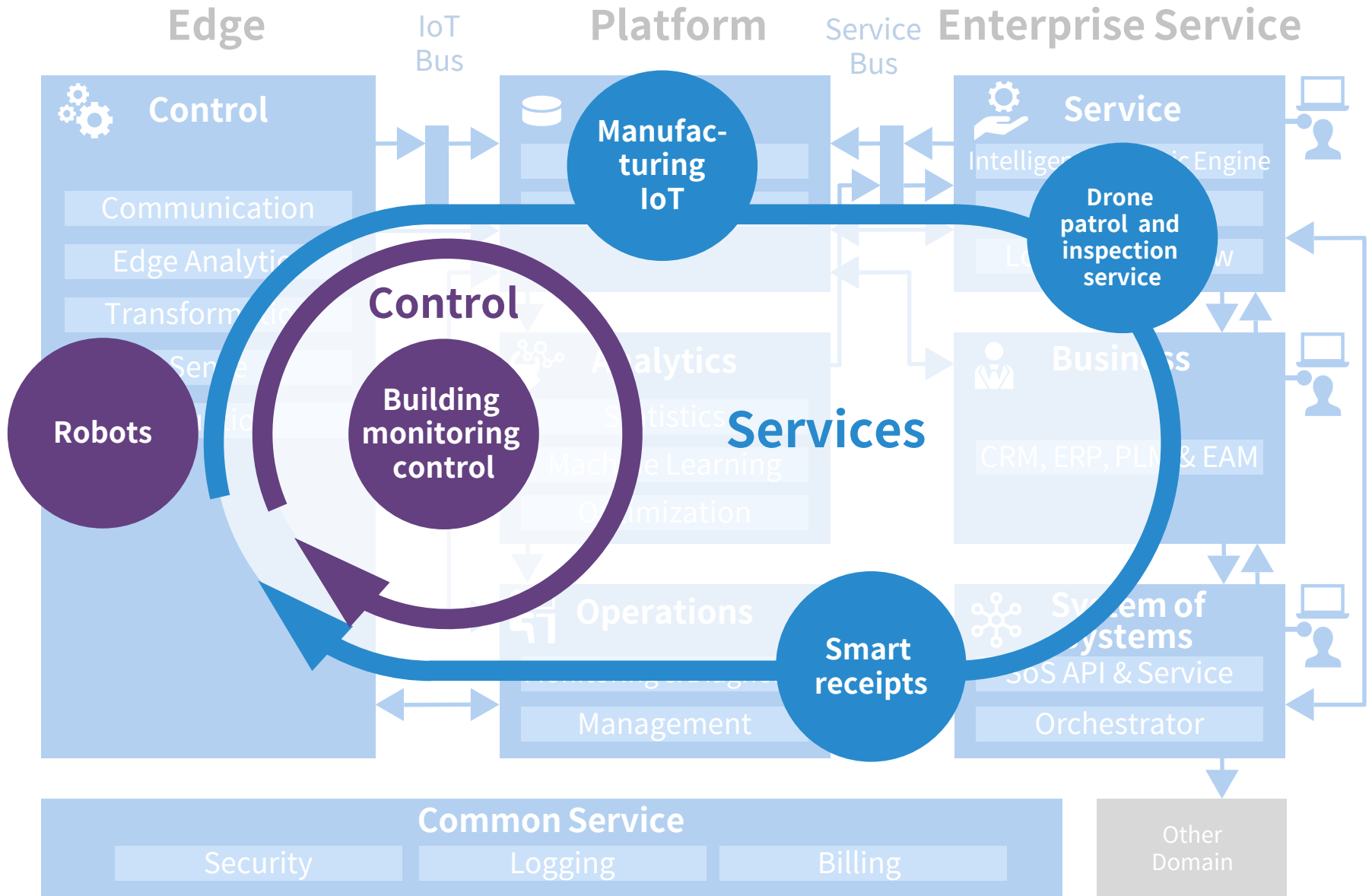
Toshiba IoT Reference Architecture Ver2.0 (3 Tier Architecture)



Toshiba IoT Reference Architecture Ver2.0 (3 Tier Architecture)

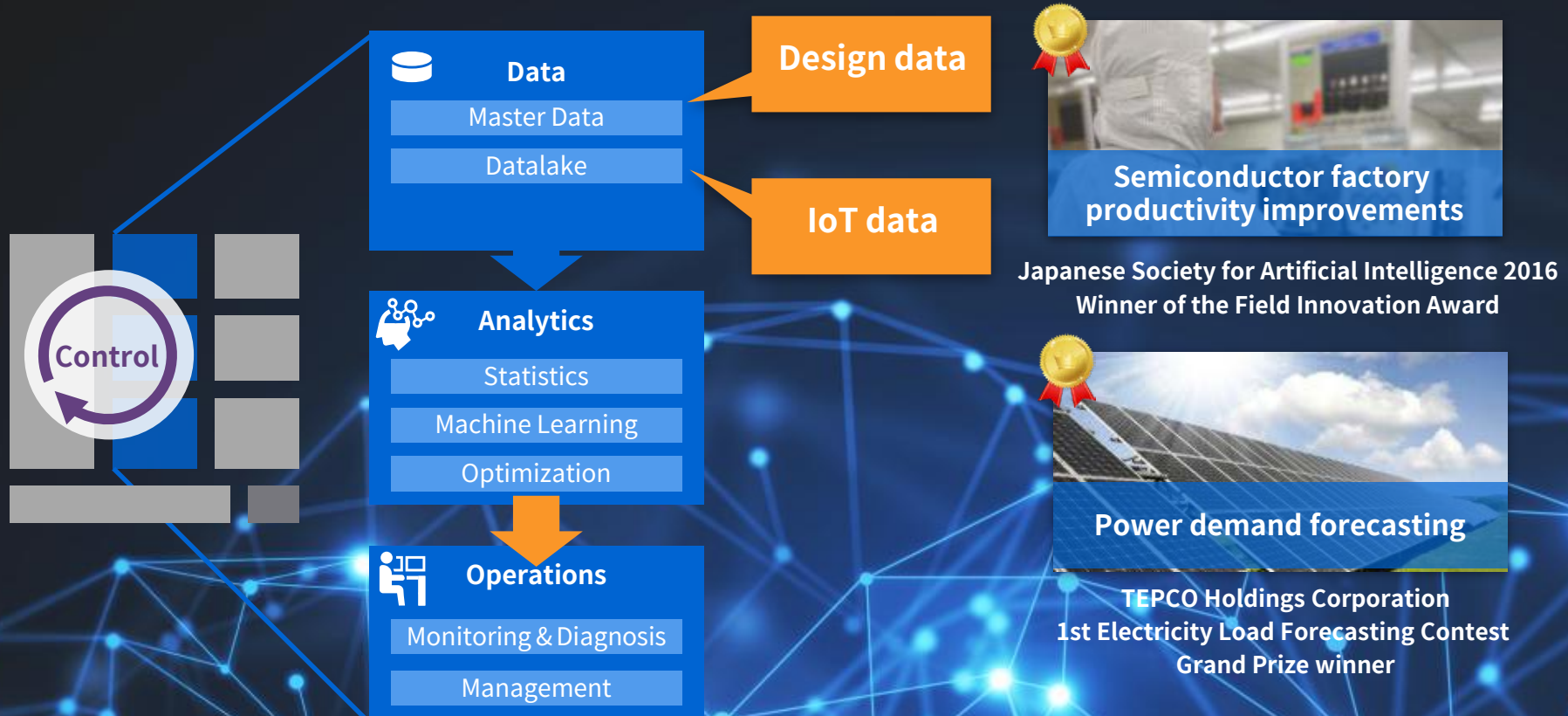


Toshiba IoT Solution (Example)



Toshiba's Strengths from a Control Perspective

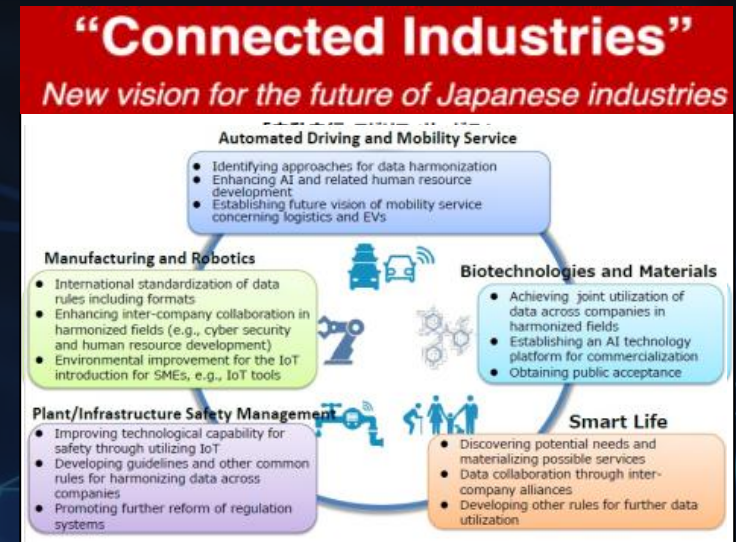
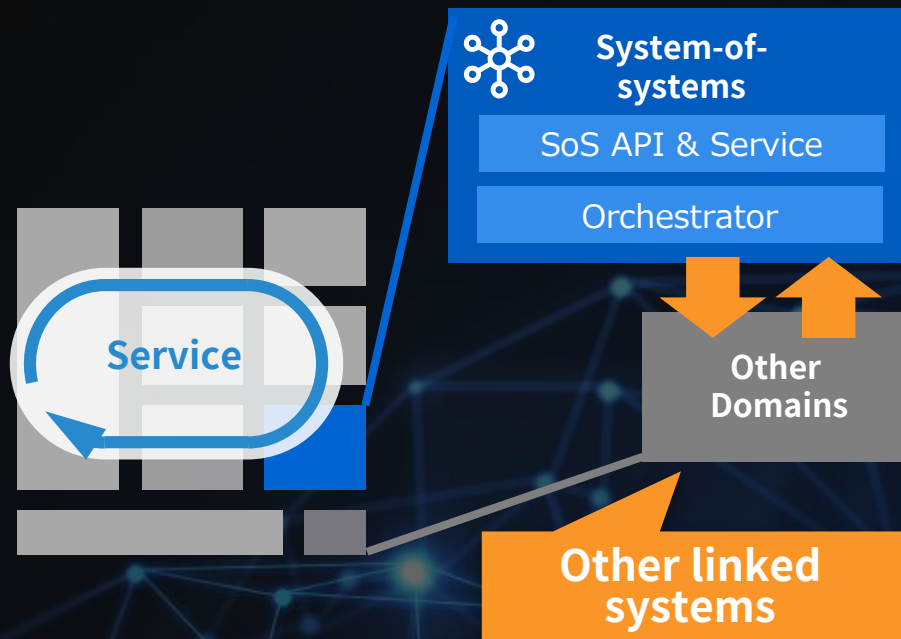
Results of analytics can be connected to operations



Many vendors in cyberspace, such as Microsoft and IBM, are entering the field of IoT. However, nearly all of their involvement is limited to data collection and analysis. Toshiba's strength lies in its ability to analyze results based on cutting-edge AI & mathematical optimization, and reflect them in to specific operations and controls (actions). Apart from Toshiba, there are not many companies in the world that are capable of doing this. This is because we have retained data and knowledge from our involvement in the design of plant and equipment over a long period of time.

Toshiba's Strengths from the Service Perspective

Demonstrate interaction with existing Toshiba businesses, and expand services from areas where new value can be provided through cooperation (O&M)



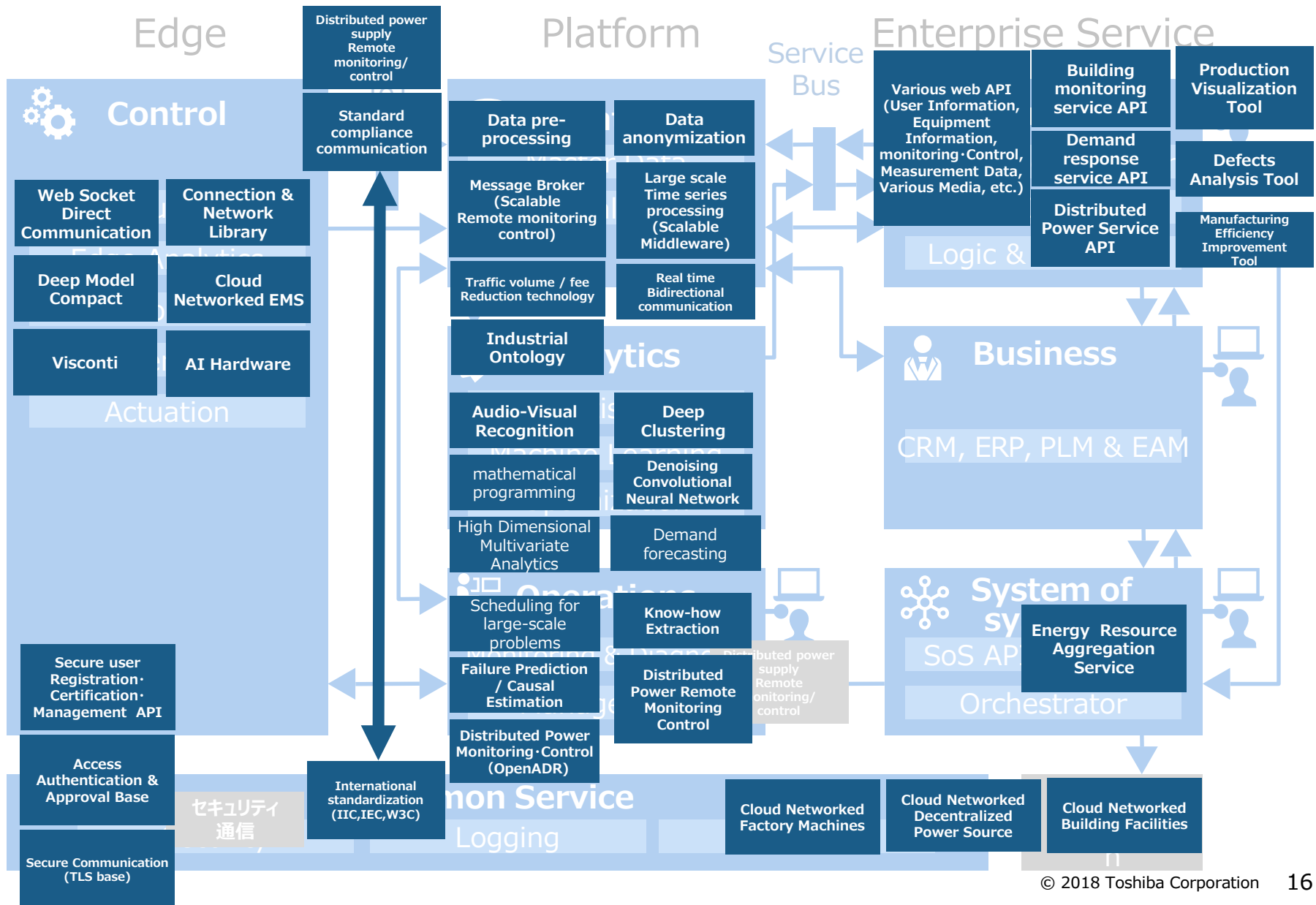
Japanese government announced Connected Industries in 2017, covering five business domains. All are very closely linked to Toshiba's business domains. Systems-of-Systems creates value by connecting multiple systems or different businesses. In this area, Toshiba's long accumulated industry know-how is an important differentiating factor

03

Technology Seeds and Solutions

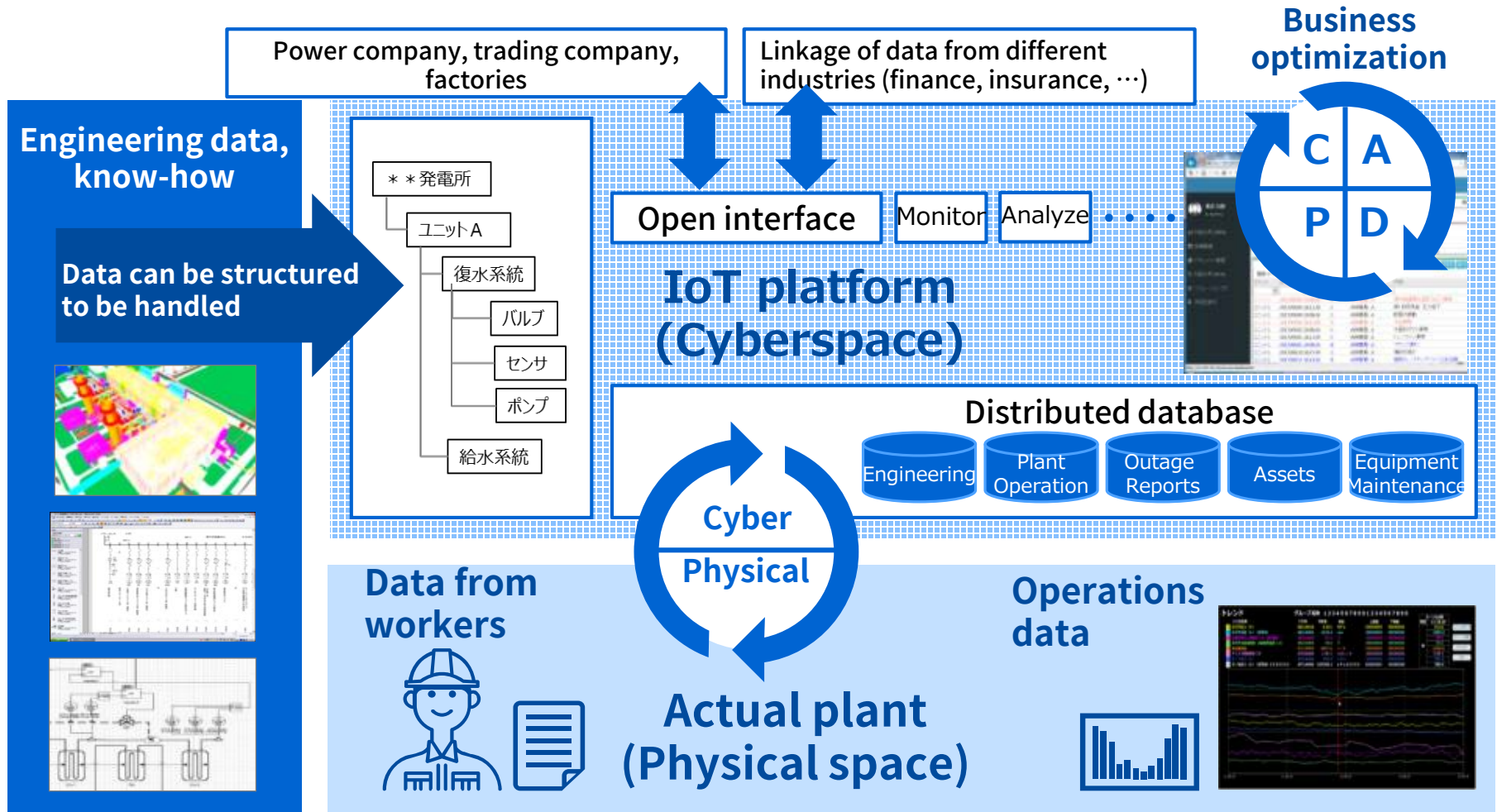


Technologies Supporting Toshiba IoT Solutions (Example)



Use of Engineering Data

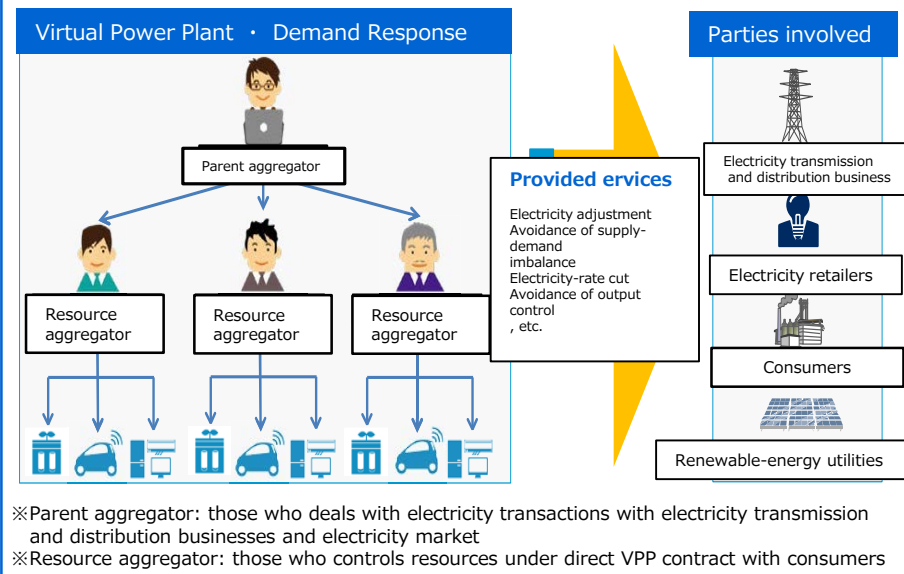
Linking IoT data from equipment and engineering data (master data) improves the quality of equipment operation and maintenance



Realization of System-of-Systems

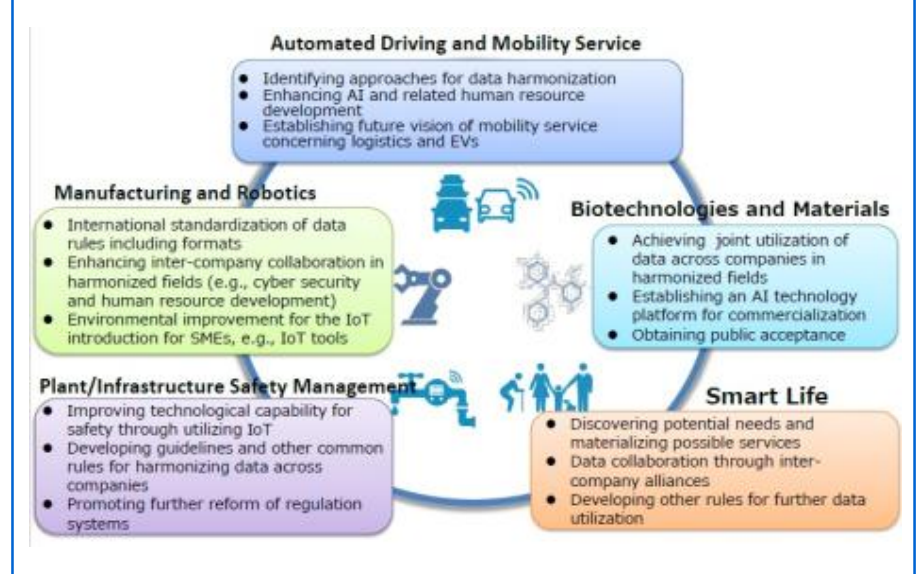
- Two use cases of System of Systems: 1) Same industry: vertical cooperation; 2) Different industry: horizontal integration
- Examples of vertical integration are resource aggregation in the power industry, and smart factory (single horizontal factory)
- Connected Industries is a typical use case of vertical cooperation

Vertical Integration



Source: Image of ERAB
Guidelines for Energy Resource Aggregation Business by Agency for Natural Resources and Energy

Horizontal Integration



Source: Ministry of Economy, Trade and Industry
“Tokyo initiative 2017”

Toshiba's IoT business strategy

Toshiba IoT Services



For Social Infrastructure



For Manufacturing



For Energy



For Logistics

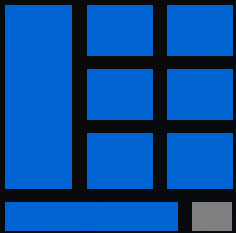


Toshiba Enterprise IoT Suite

Summary



Toshiba IoT Reference Architecture incorporate control with services



Toshiba will work to reflect IoT global reference architecture with Toshiba IoT Reference Architecture

SPINEX™

Toshiba will provide B2B IoT business services (enterprise service) as part of Toshiba IoT suite.

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