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System of Systems and Total Optimization

- Symbiotic Autonomous Decentralized Systems(ADS) -

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Services & Platforms Business Unit
Hitachi, Ltd.

http://www.hitachi.com/rev/archive/2016/r2016_05.html

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1-1. History of Hitachi

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Hitachi founded in **1910**

History of a century
Social Infrastructure

5hp Motor

Nuclear Plant

Railway System

Now

History of a half century
Information Technologies (IT)

Mainframe

Internet

IoT

1965

1-2. Segment constitution (FY2015)

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■Financial Services *3

■Others
(Logistics and Other services) *2

■Smart Life &
Ecofriendly Systems

■Automotive Systems

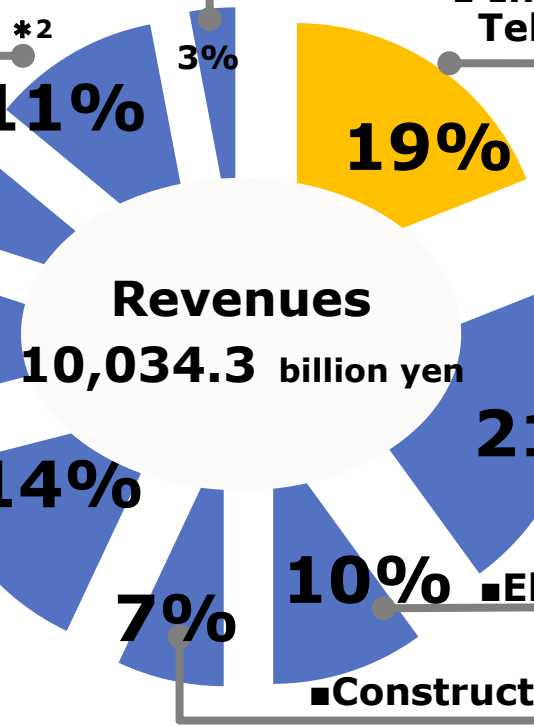
■High Functional Materials &
Components

■ Information &
Telecommunication Systems

■ Social Infrastructure &
Industrial Systems*1

■Electronic Systems & Equipment

■Construction Machinery



*1: Effective on April 1, 2015, the "Power Systems" became part of the "Social Infrastructure & Industrial Systems. "
*2: Hitachi Transport System, Ltd. which is included in "Others" became equity-methods affiliate of Hitachi, Ltd. on May 19, 2016.
*3: Hitachi Capital Corporation which constitute of "Financial Services" is planned to become equity-methods affiliate of Hitachi, Ltd. in October, 2016 or after.

1-3. Social Innovation

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Hitachi meets global needs through our Social Innovation business.

"IT" x "Social Infrastructure"

1-4. Global Activities

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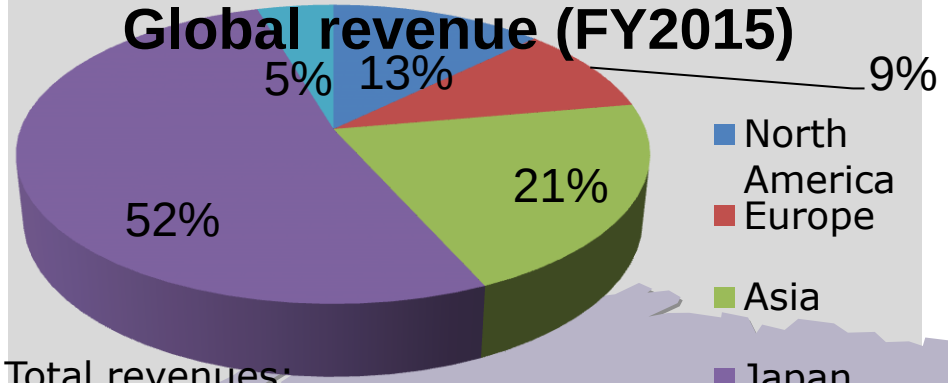
Global revenue (FY2015)



Total revenues:
10,034.3 billion yen

IIC Testbed: FA PaaS

http://www.iiconsortium.org/test-beds.htm

Traffic Management Solutions

Maui Energy Management System

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2-1. Three Waves in IT

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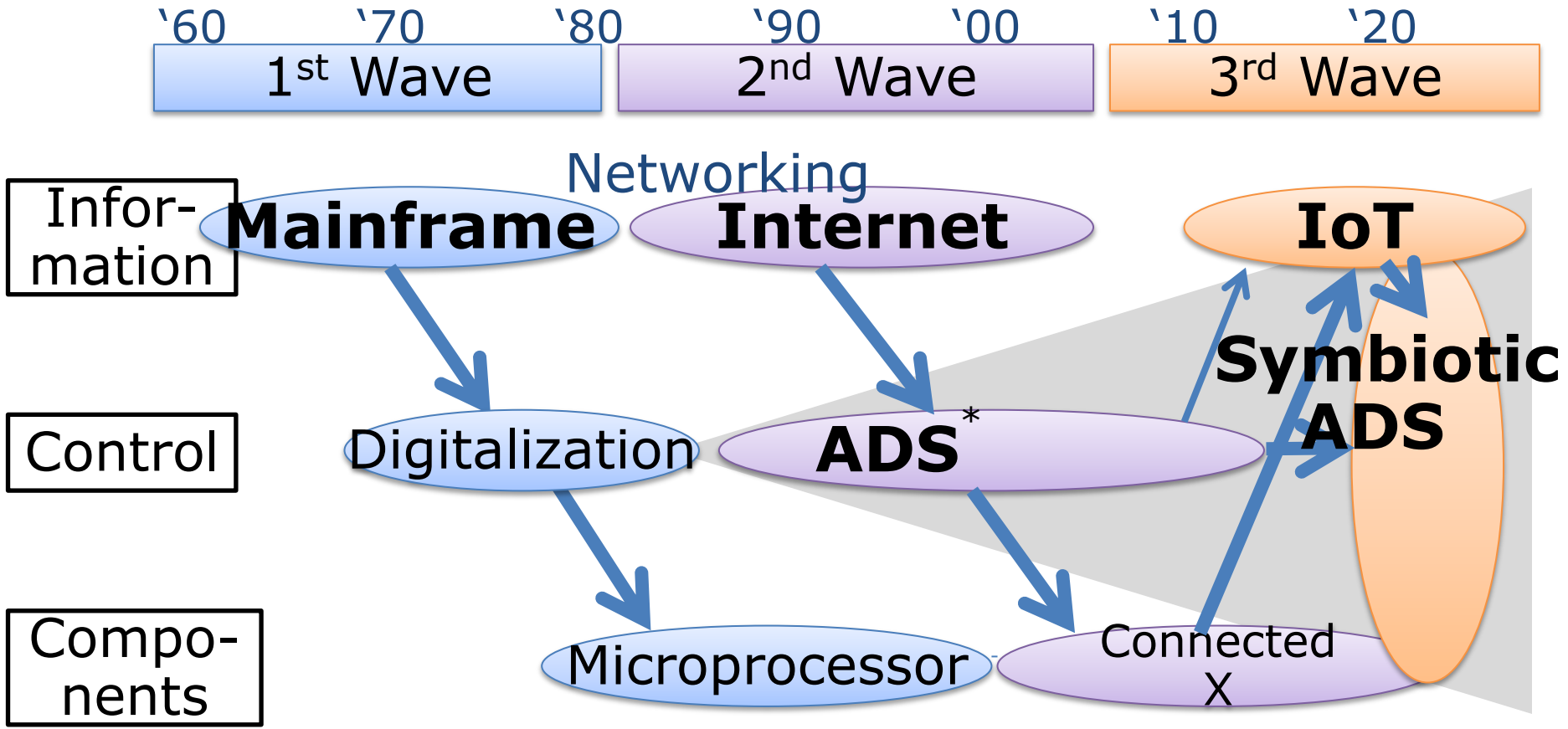

*ADS: Autonomous Decentralized Systems

HITAC* 7250 (1967) ; Control Computer

* HITAC: Hitachi Automatic Computer

2-1. Three Waves in IT

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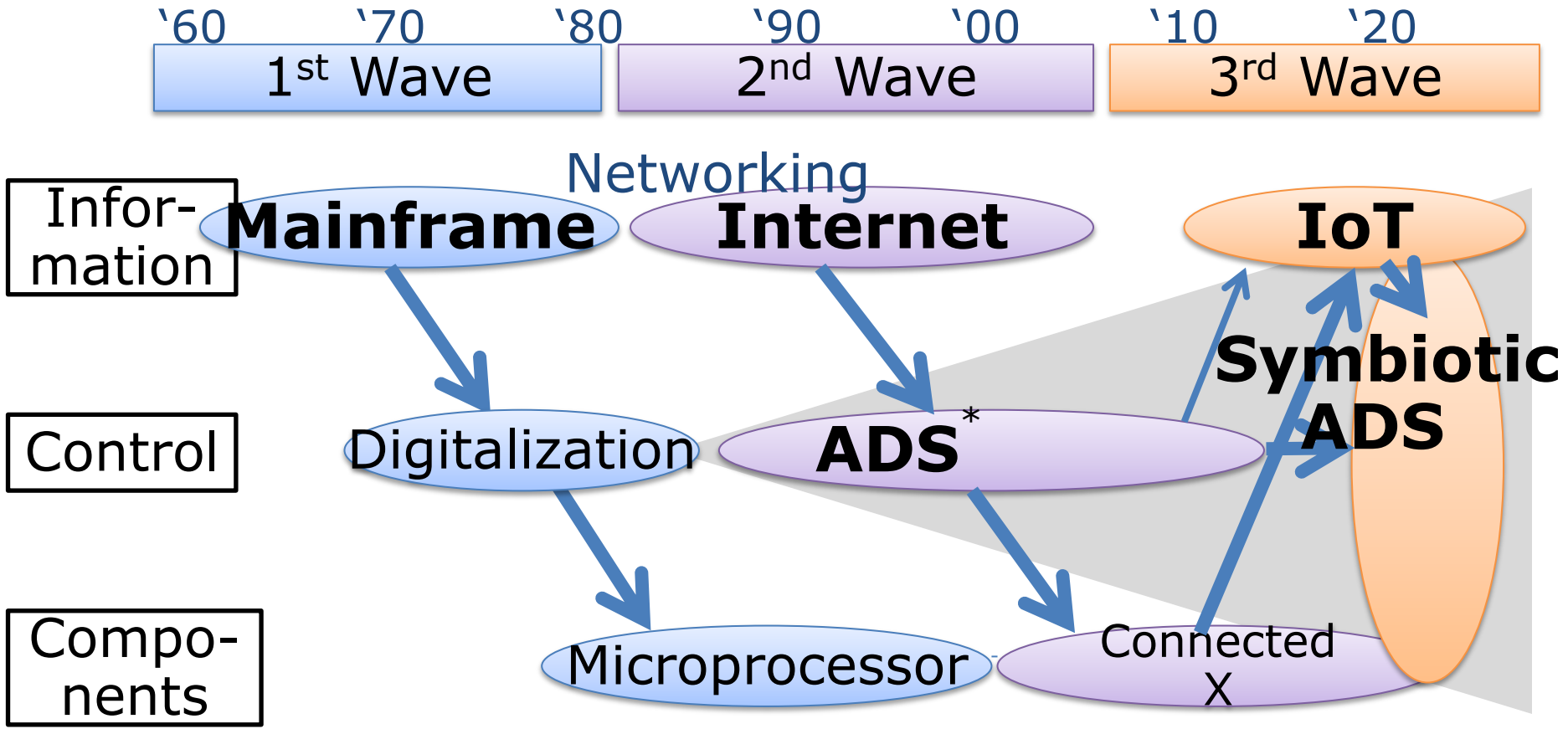
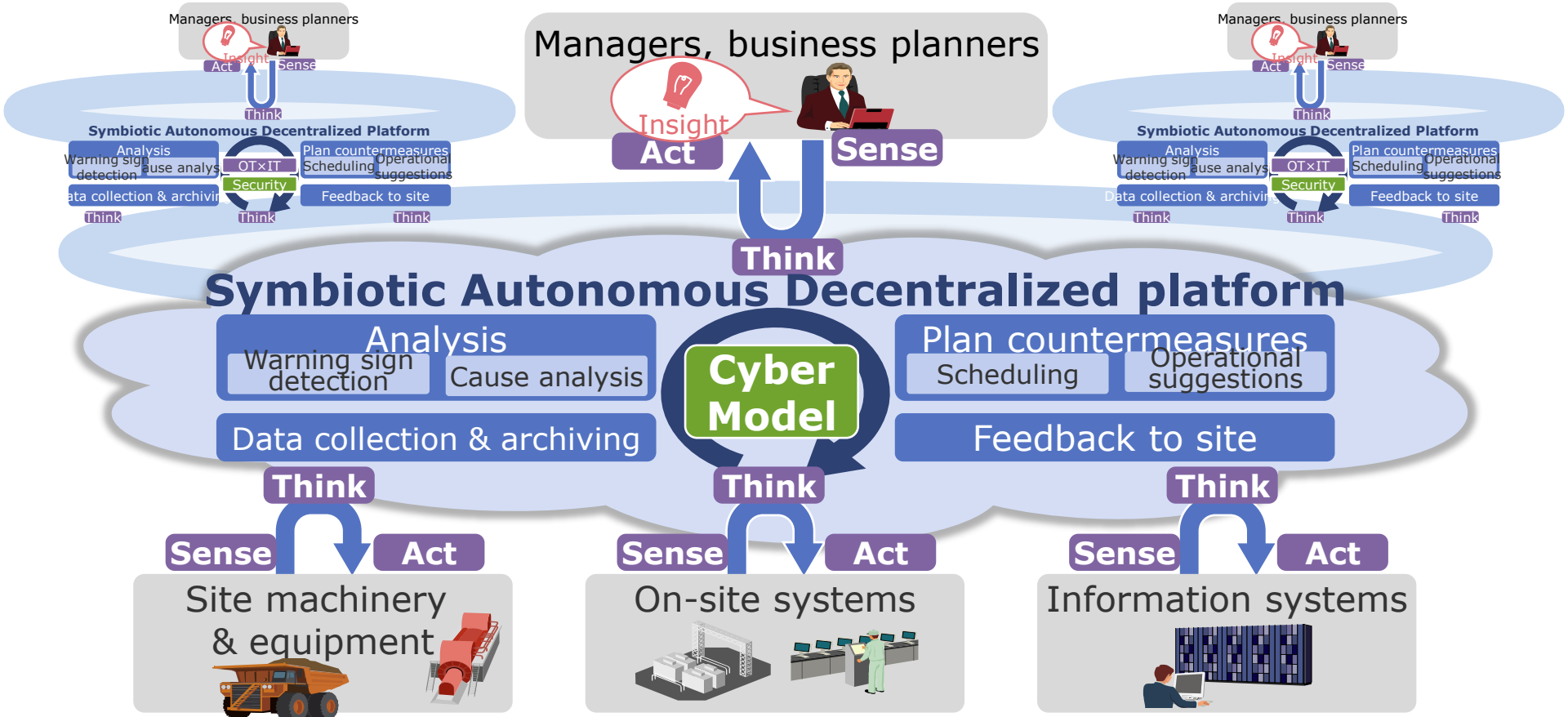


*ADS: Autonomous Decentralized Systems

2-2. Symbiotic ADS



* OT: Operation Technology

2-3. Example of Symbiotic ADS

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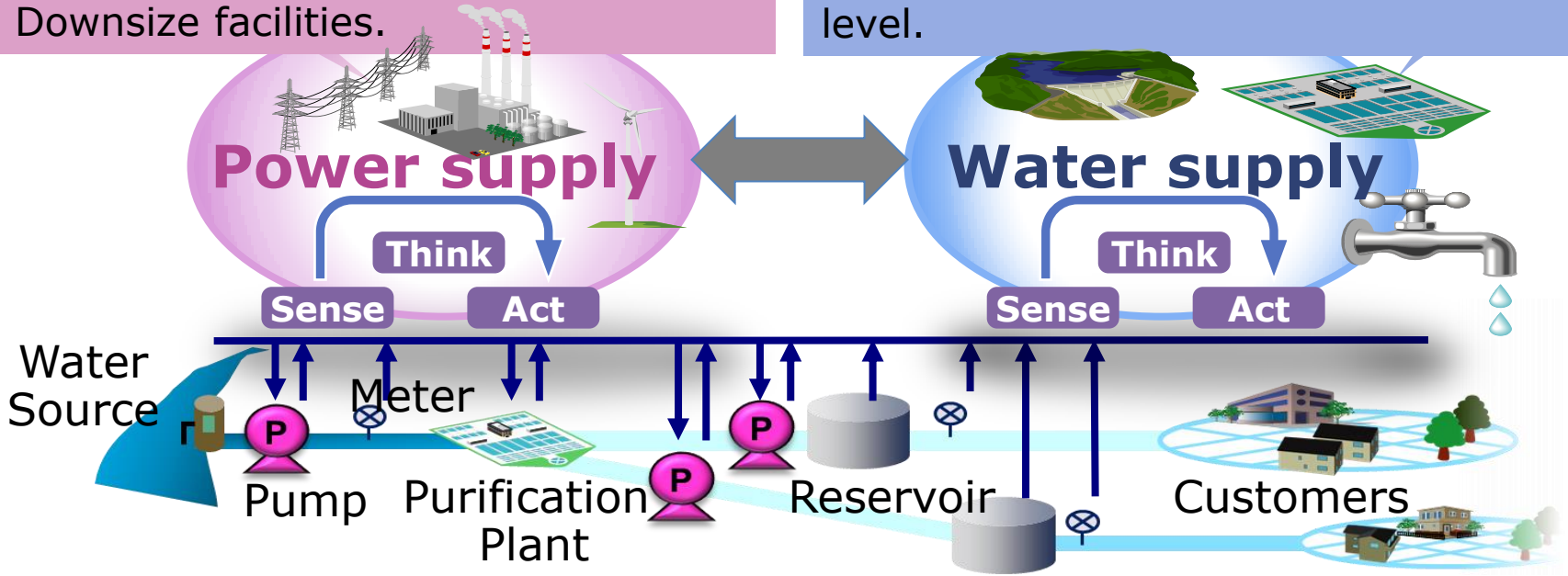
Coordination between Power and Water supply operation systems cuts/shifts energy consumption.

- Loosen tight balance between demand and supply of electricity.
- Downsize facilities.

Save energy cost by utilizing off-peak price, incentives and contract of lower level.



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3-1. Artificial Intelligence(AI) related Techs

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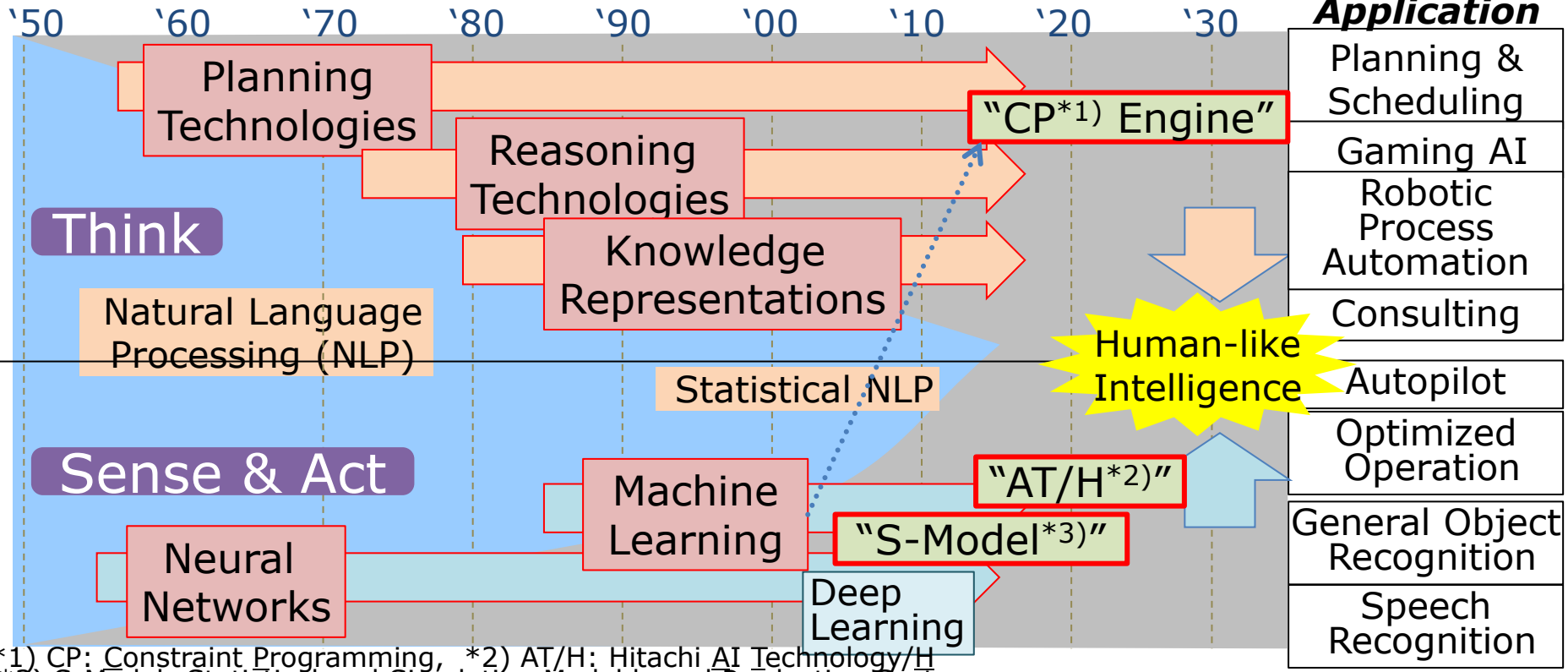
AI technologies can be categorized into some groups led by requesting applications.



*1) CP: Constraint Programming, *2) AT/H: Hitachi AI Technology/H
*3) S-Model: Statistical and Simulation Model based Production System

3-2. CP*1) Engine with Machine Learning

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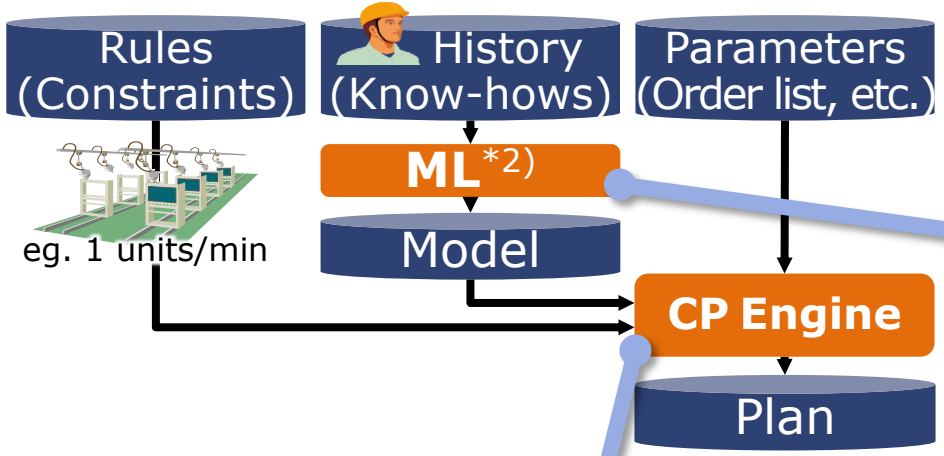
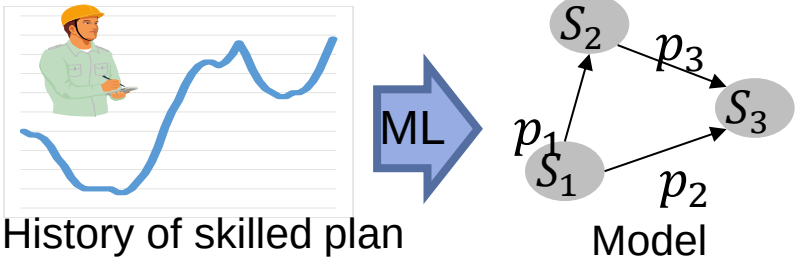
Automatically plans as if expert operators do.



Technology ML

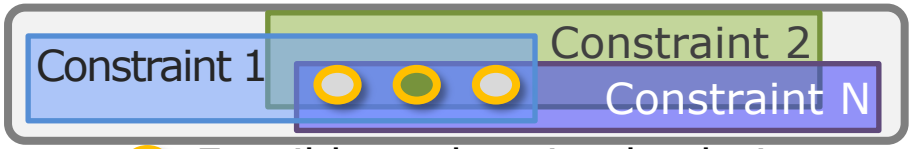


History of skilled plan

Model

Generates stochastic model from history of past plan which made by experts.

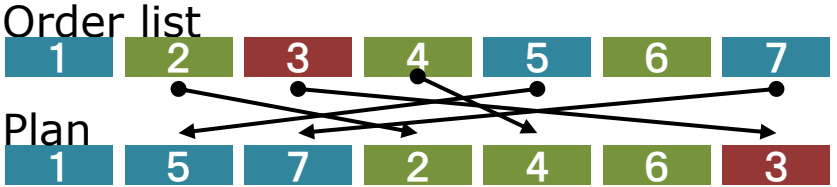
Technology CP Engine



: Feasible and optimal solution

Exploits solutions, which satisfy all the constraints and conform to the model.

Case Production process plan



Satisfies all the rules with conforming to expert's know-how.

*1) CP: Constraint Programming, *2) ML: Machine Learning

3-3. AT/H

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Helps manager to discover the most sensitive features to the outcome.

Input Data

Outcome as KPI
- Profit
- Sales-cost

Demand
- Visit
- SNS
- Weather

Operation
- Order
- Assist
- Logistics

Infrastructure
- Store
- IT/Signage

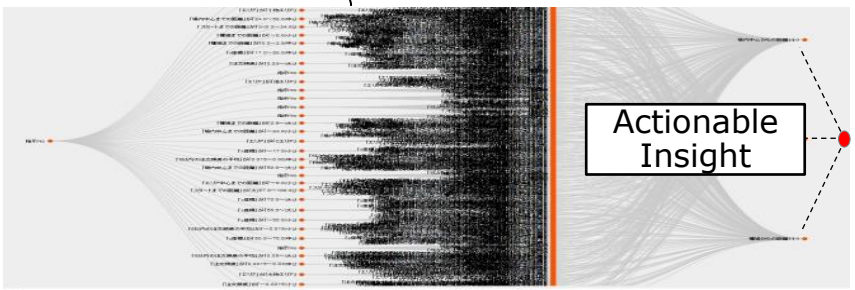
Objectives (**Macro**)

Sur-rounding data (**Micro**)

Autonomous Analysis

Interprets input data and generates combinatorial relations between features.

Narrows down a large number of features into the most sensitive to the outcome.



Optimized Operation

Distribution
- Clerk Positioning

Logistics
- Warehouse Operation

Plant Operation
- OPEXreduction

Call Center
- Work Planning

features; Combination of some **Micro** data with specific range

3-4. 14 Practical Applications of AT/H

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1. ***Distribution***
2. *Insurance*
3. *Securities*
4. *Bank*
5. ***Logistics***
6. ***Employee activation***
7. *Water* ***plant operation***
8. *Railway*
9. *Pharmacy*
10. *Manufacturing*
11. *Construction*
12. *Machinery*
13. *Material*
14. *Motor vehicle*

Distribution	Logistics	Plant Operation	Call Center
			
Discovery of a hotspot where a clerk stands increasing revenue per customer by 15%	Discovery of optimized picking order with the efficiency improvement of 10%	Discovery of efficient operation pattern to improve OPEX by 3.6%	Discovery of members pattern to take a break to increase order success rate by 13%

3-5. IoT Platform “Lumada”

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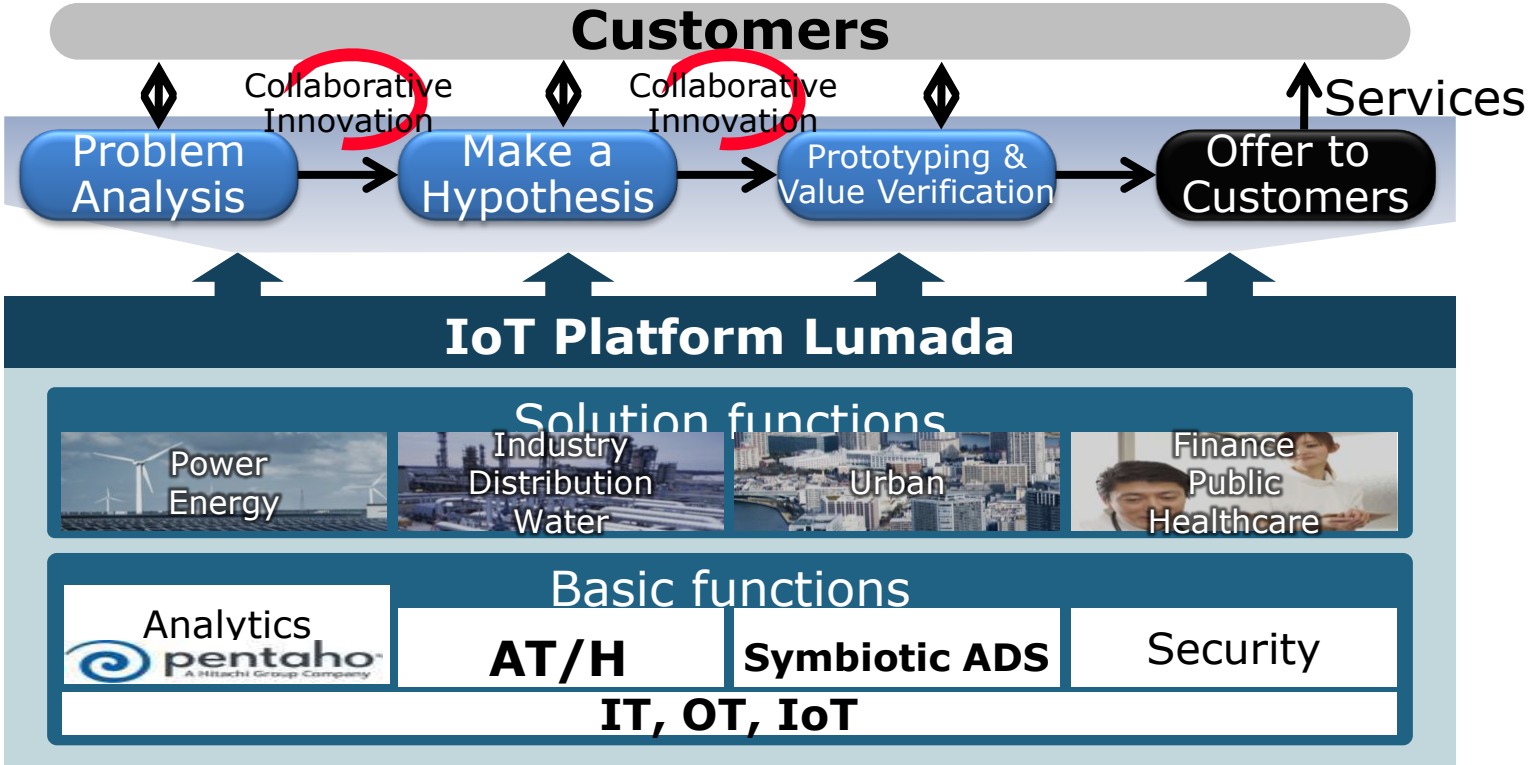
Lumada = il**lum**in**a**te **da**ta
Means for Customers to enjoy Digitalized Innovation quickly and easily



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4-1. Industrial Solutions

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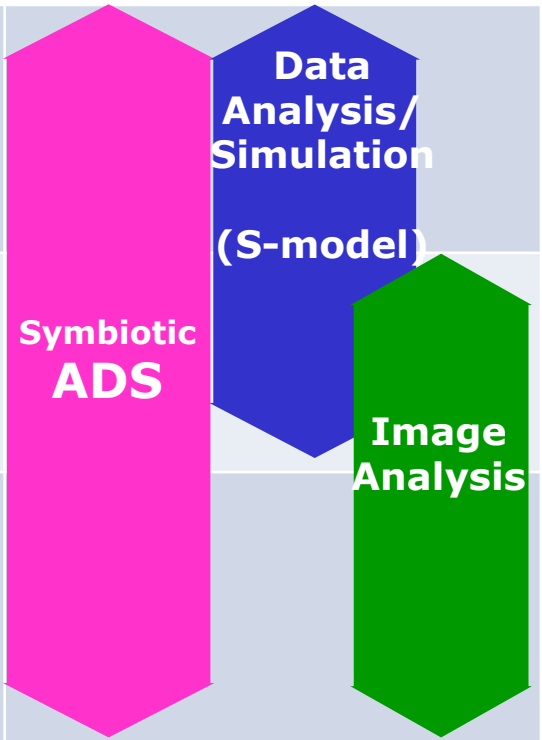
No	Issues	Solutions	Slide#	Technologies
1	Frequent change of constraint conditions to manufacturing shop floor	• Dynamic Scheduling of Production	4-2 4-3 4-4 4-5	
2	Lower efficiency in work process improvement	• KAIZEN through Work Process Analysis	4-6 4-7	
3	Mega recall caused by lower quality of production in global sites	• Quality Control using Image Sensing Data	4-6 4-8	

4-2. Problems in Manufacturing shop floor

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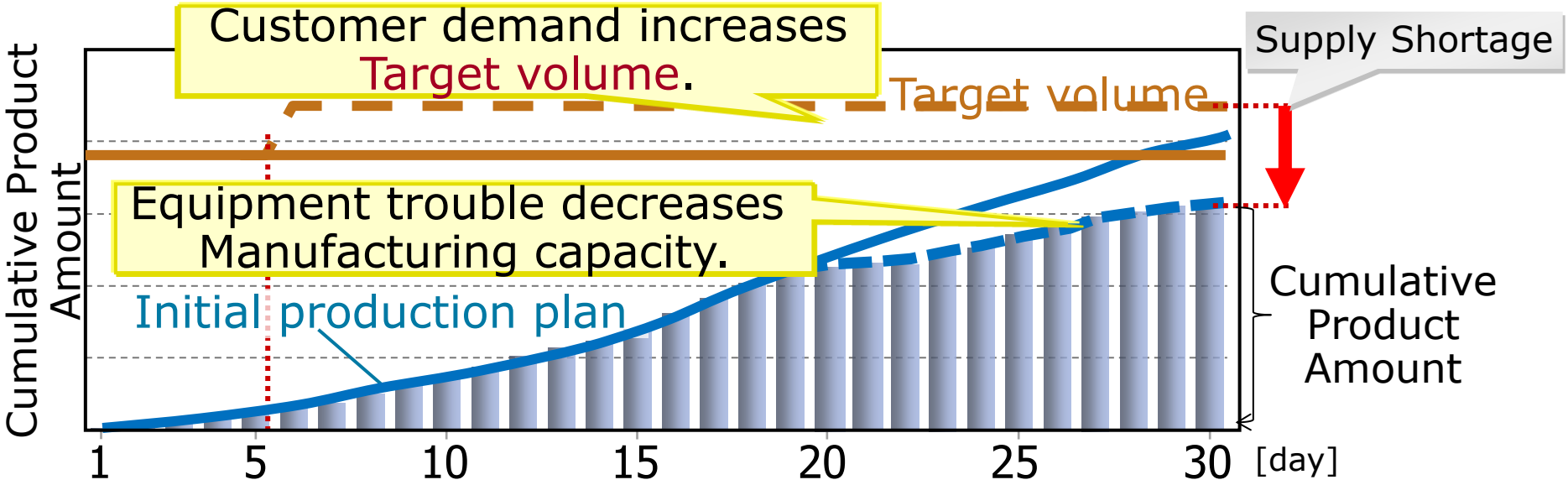
Conditions of manufacturing shop floor changes frequently.



Dynamic Scheduling Solution is highly required to achieve target.

Step 1: Detects difference between initial plan and daily result.
Step 2: Re-schedules production plan for recovery.

4-3. S-Model based Production System

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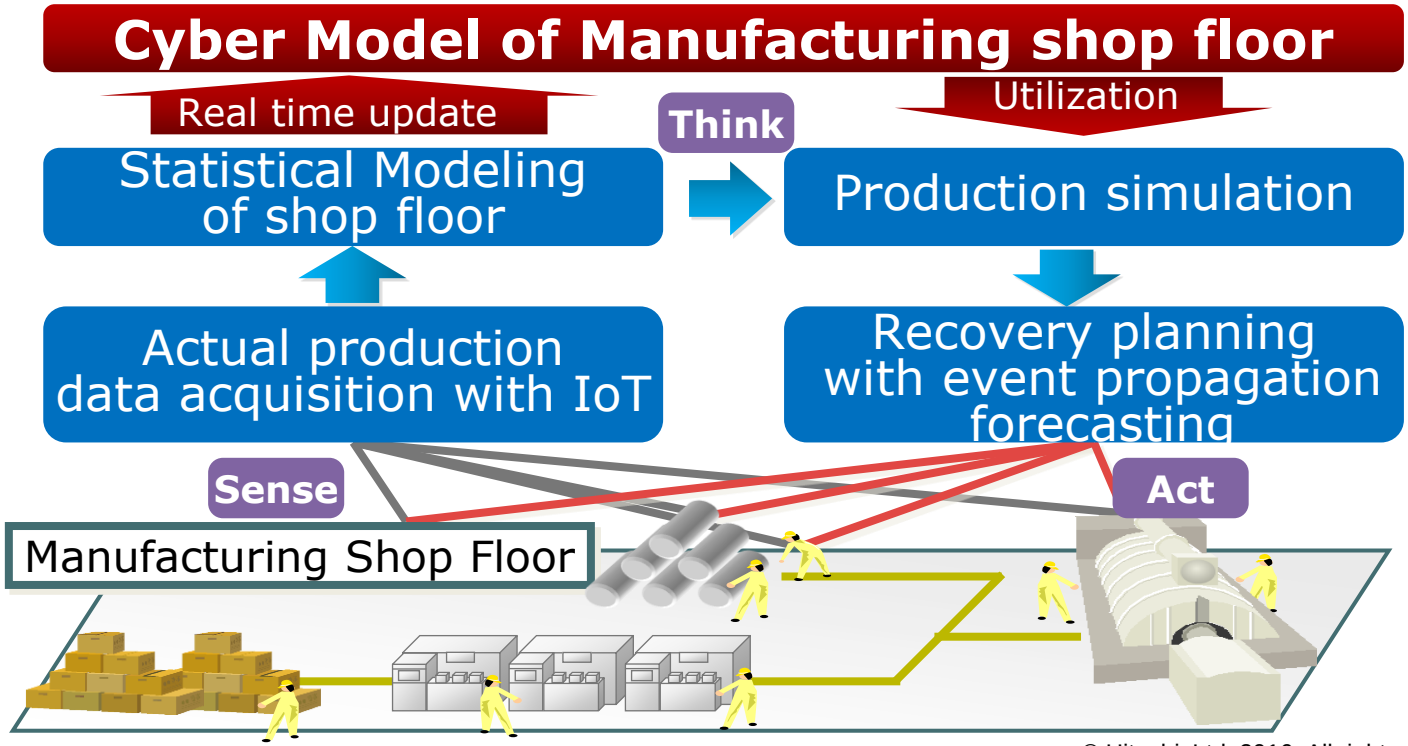
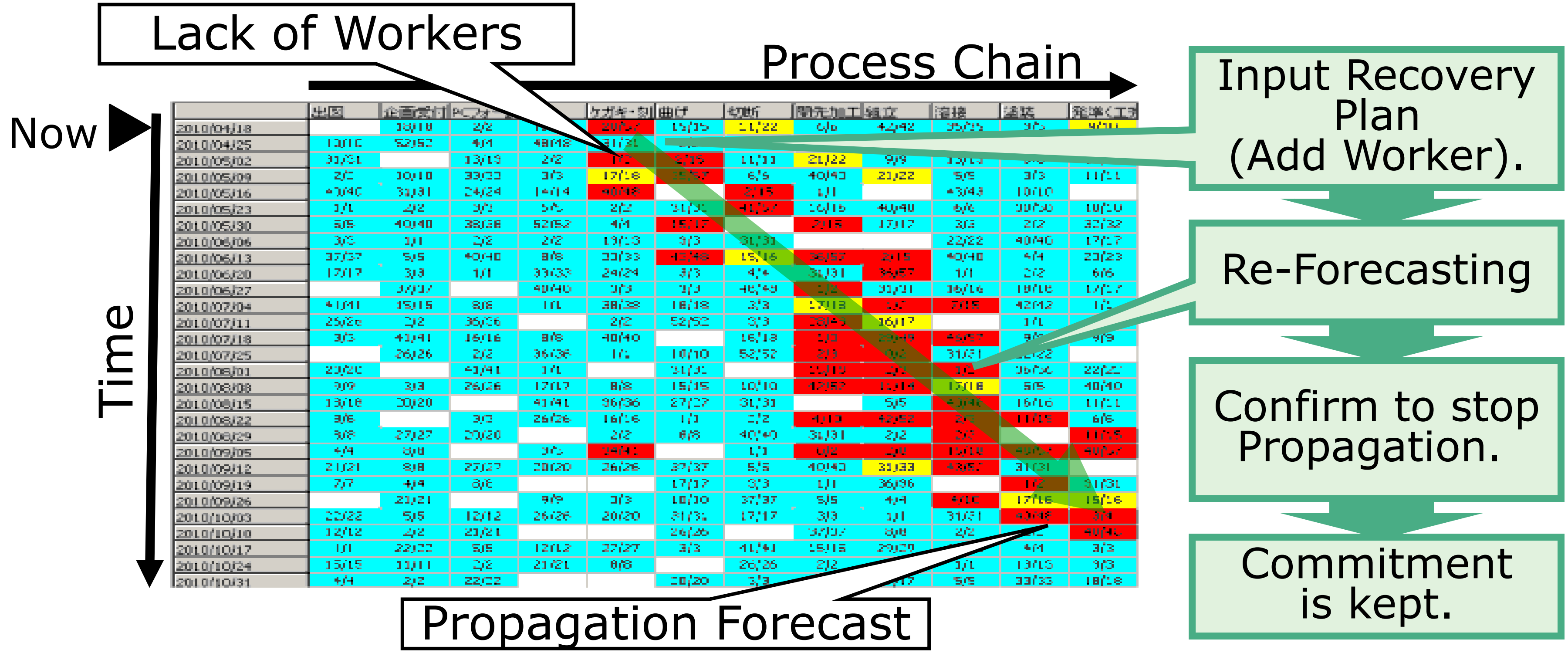
Production forecasting & re-scheduling with Statistical Modeling and Simulation technologies(**"S-model"**)



4-4. “Tsunami Analysis”

Event Propagation Forecasting like behavior of “**Tsunami**”



4-5. Recovery by S-Model Production System

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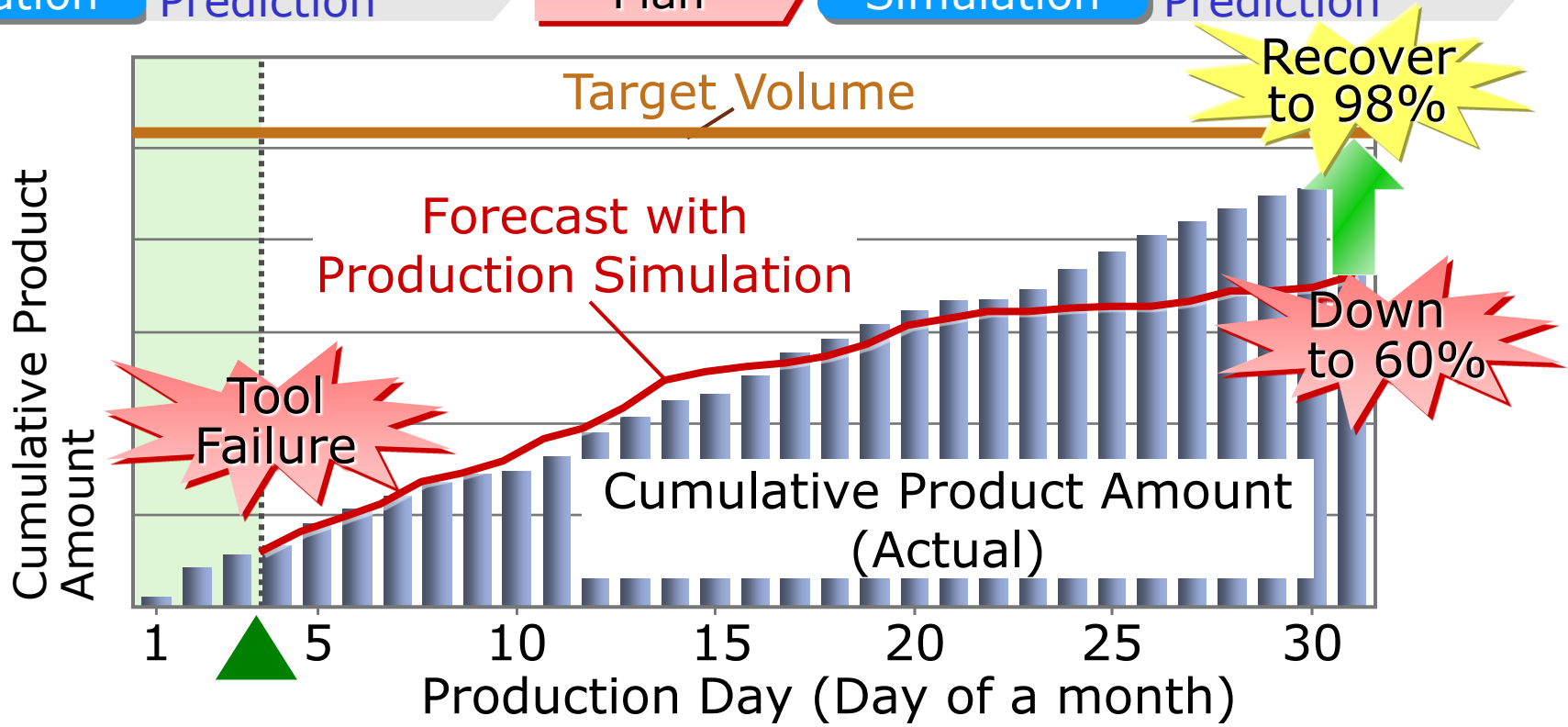
Production Simulation → Target Volume Prediction → Recovery Plan → Production Simulation → Target Volume Prediction



4-6. Image Analysis

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Work Process Analysis

To detect bottleneck process and improve it quickly using video image data and RFID.

Worker Motion Monitoring

To detect abnormal motion patterns.

4-7. KAIZEN through Work Process Analysis

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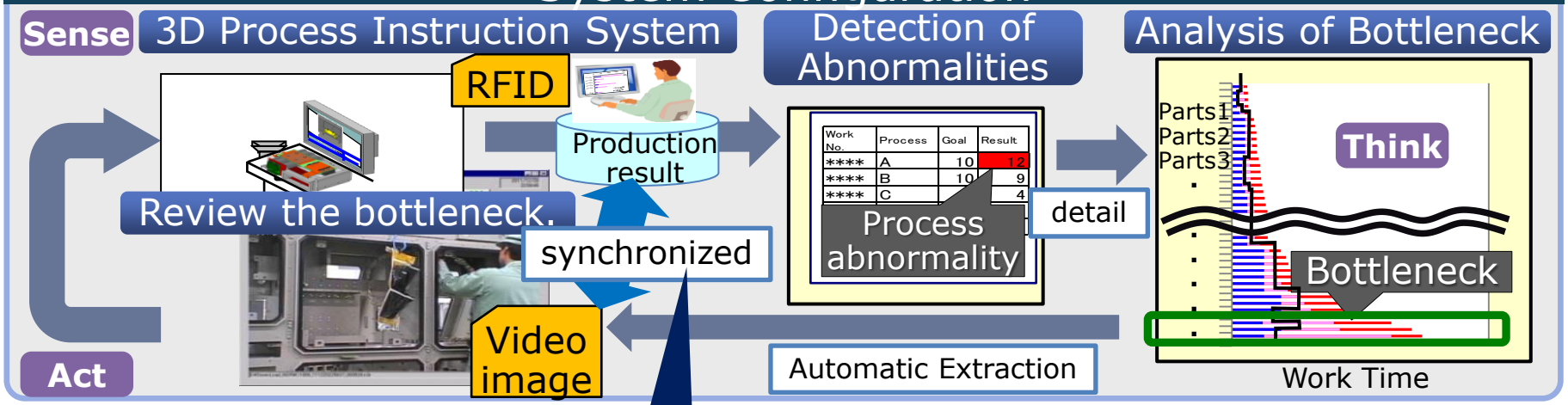
Challenges

To detect bottleneck process and improve it quickly.

Effect

Reduction of work analyzing hours: approx. -80%

System Configuration



The Video Analyzing system is synchronized with Work Process Data linked by RFID.

4-8. Quality Control using Image Analysis

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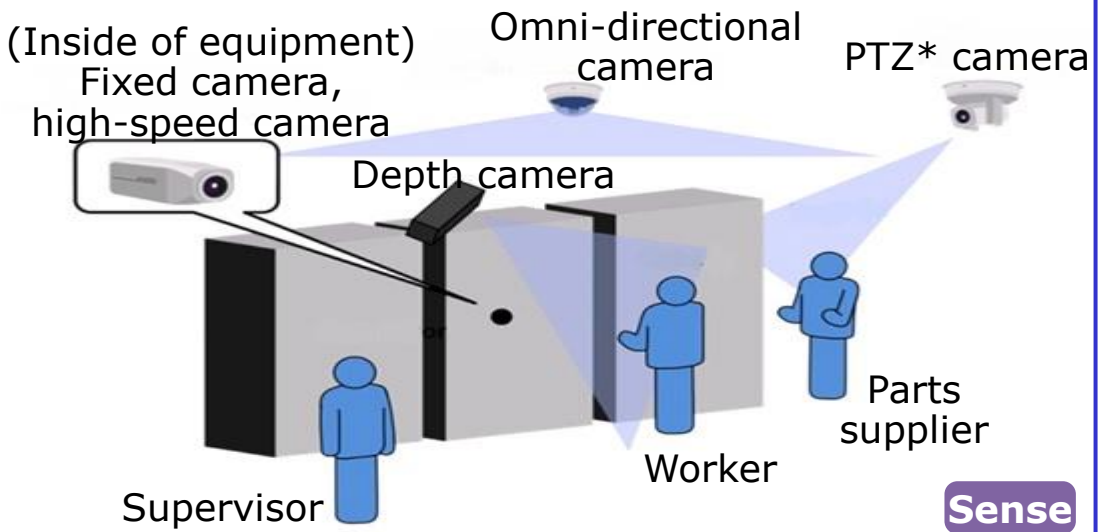
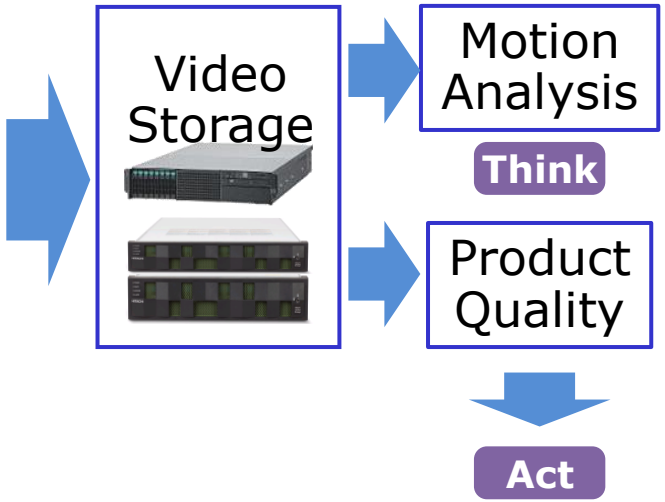
Improvement of manufacturing quality by Image Analysis

- To avoid mega product recall
- To ensure product traceability

Various cameras installed in each site





* PTZ: Pan, Tilt, Zoom

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2. **Three Waves in IT and their Impacts on the ICS**
3. **AI Technologies and “Lumada”**
4. **Examples of Industrial Solutions**
5. **Activities in Europe**

5-1. Centre for Social Innovation - Europe

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Mission: Contribution to business expansion/creation through providing solutions for matured society

European Big Data Lab. (EBDL)
Experience Design Lab. (XDL)

Platform Tech Enabler

- Big data analytics
- Ethnography
- Vision Design
- Service design

Transportation, Energy & Environment Lab. (TEEL)

Focus applications
- Rail
- Energy

Number of Researchers: 70

Copenhagen
Manchester
Cambridge
London
Kaiserslautern
Munich
Sofia Antipolis

Hitachi Cambridge Lab.(HCL)

- Quantum Computing
- Spintronics
- Electron wave optics

DFKI

Research on AI
- Deep Learning
- Industry

Automotive & Industry Lab. (A&IL)

Focus applications
- Automotive
- Industry

5-2. Hitachi's Activities on Smart Manufacturing

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acatech
DEUTSCHE AKADEMIE DER TECHNIKWISSENSCHAFTEN

The role of think tank on European policy (Industrie4.0)

Only a regular member from Asia

Industrie4.0 Platform WG1 regular member

industrial internet

The open forum of IoT application (such as GE maintenance business)

IoT Testbed for Manufacturing cosponsored by Hitachi, Mitsubishi Electric Co. and Intel was approved.

Science and Technology Policy
Council for Science, Technology and Innovation

Planning of science and technology policy under the initiative of Cabinet office

Committee member (Toyota, Hitachi)

Robot Revolution Initiative, SIP, IVI, etc.

IEC ISO

International standardization of IoT itself, industrial innovation by IoT

Steering committee and TC member

5-3. H-ARC concept

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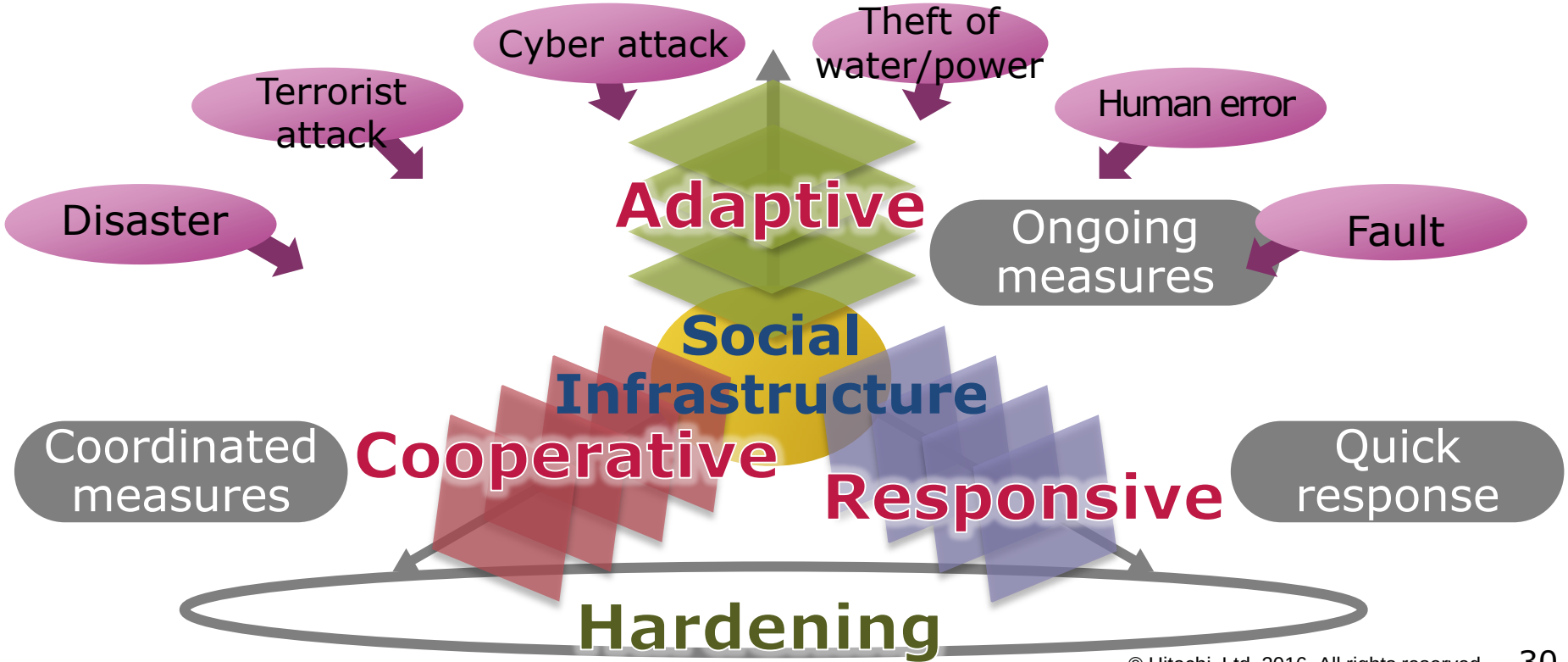
In addition to Hardening of the security, Adaptive/Responsive/ Cooperative improve security of the whole system life cycle.



5-4. Contribution to Standardization

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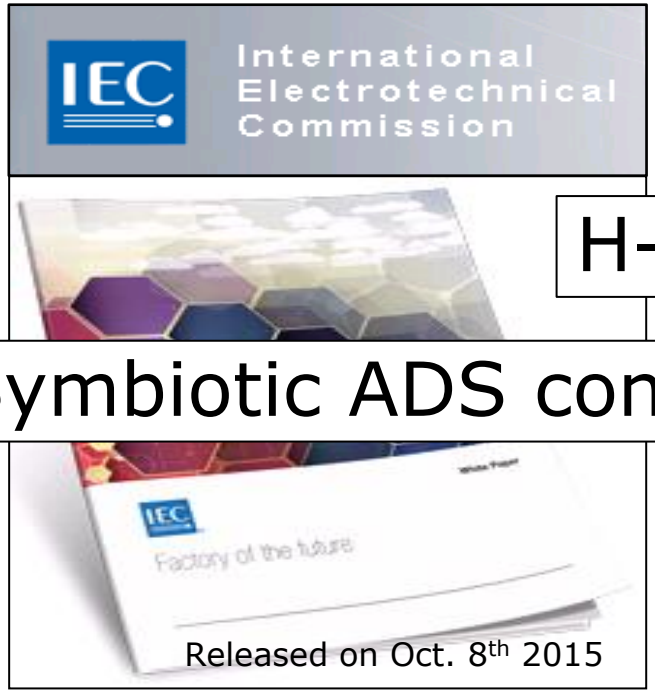
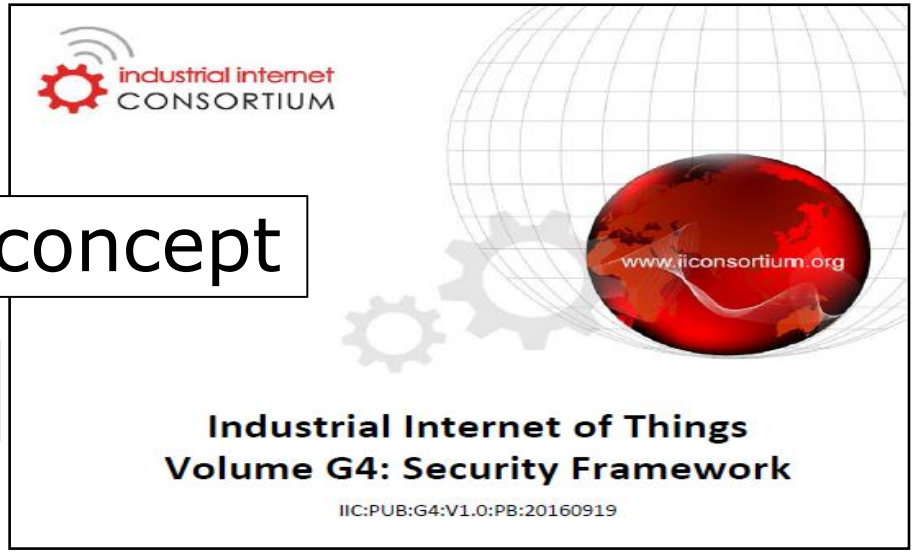


Released on Oct. 8th 2015

H-ARC concept

Symbiotic ADS concept



H-ARC concept proposal for IIC Security Framework

http://www.iiconsortium.org/pdf/IIC_PUB_G4_V1.00_PB.pdf

IEC Market Strategy Board defined the Next Generation Factory.

http://www.iec.ch/whitepaper/futurefactory/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