

# Software Defined Business Transformation with Scale-free Network

December 8, 2023

## Toshiba Corporation

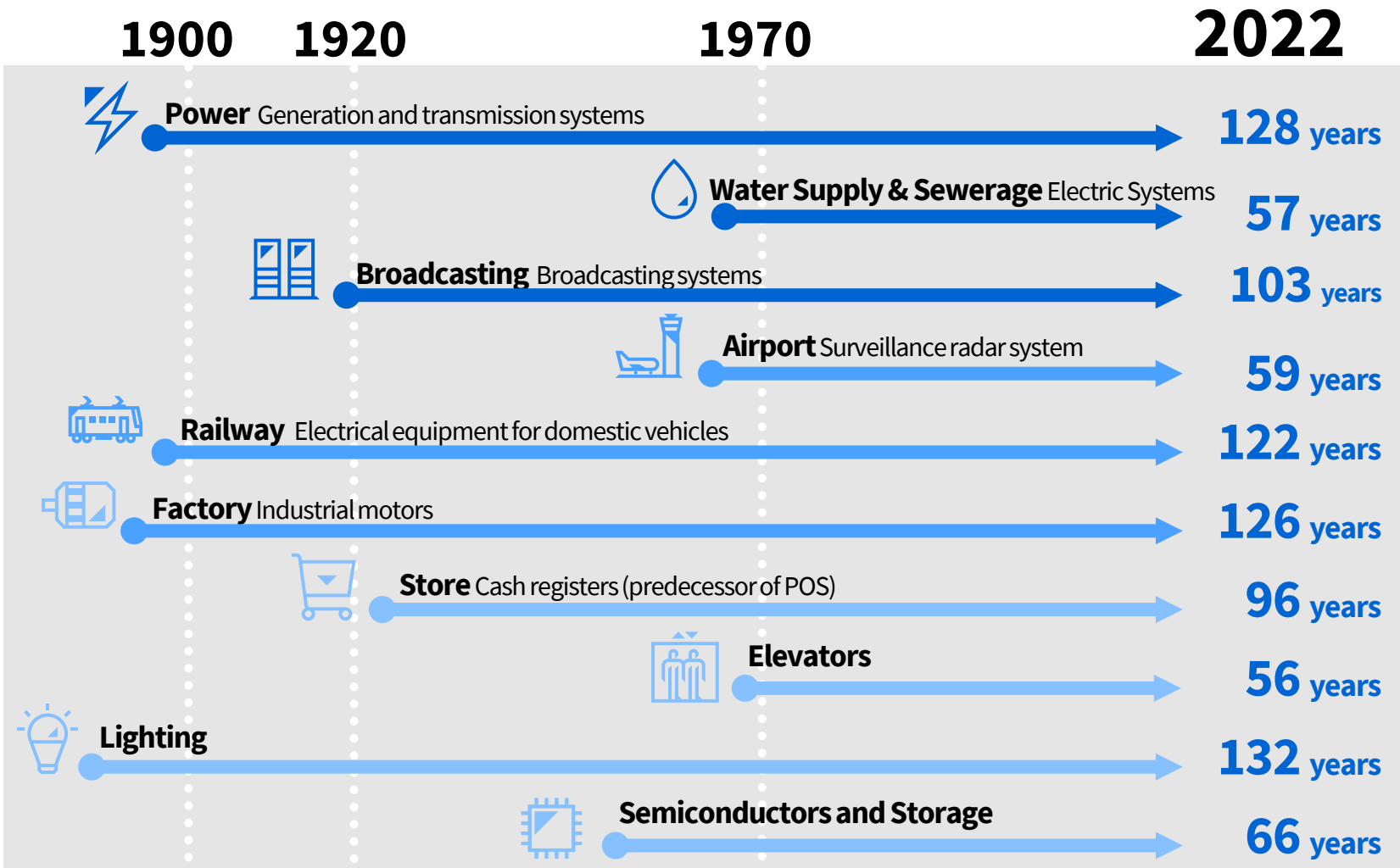
Toshiba Senior Vice President, Chief Digital Officer  
(Director, President and CEO, Toshiba Digital Solutions Corporation)

**Shunsuke Okada**

**TOKYO**  
SYSTEMS  
ENGINEERING  
SUMMIT  
**2023**

# Businesses that Support Daily Lives and Social infrastructures

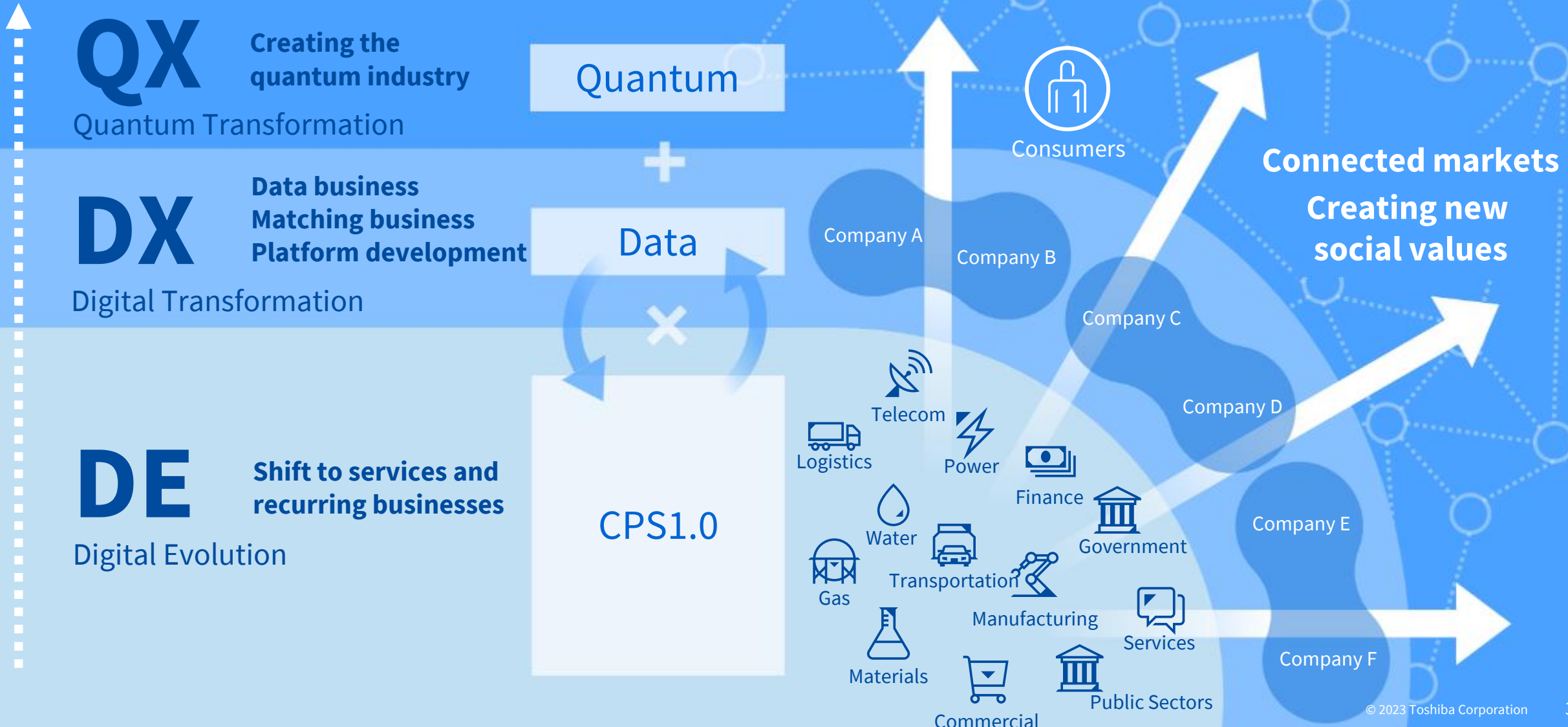
Many businesses contribute to economic security by supplying core infrastructure and key products that support industries



\*Based on internal research

# Evolution of the Digital Economy and Changes in the Business Environment

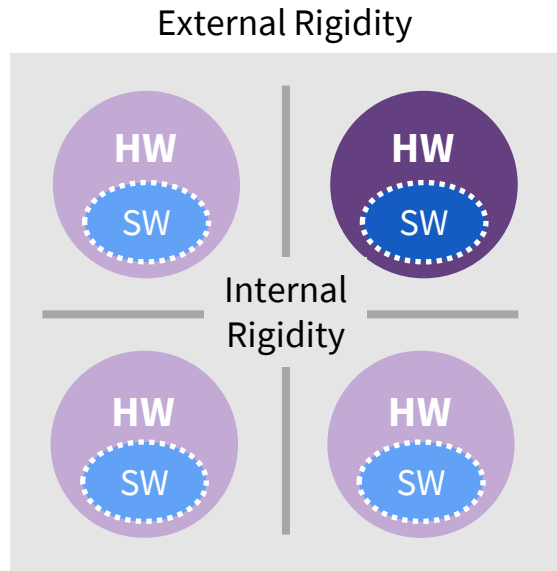
## Evolution of the digital economy



# Software Defined Transformation

Create a platform after separating apps, software and hardware

## Current status

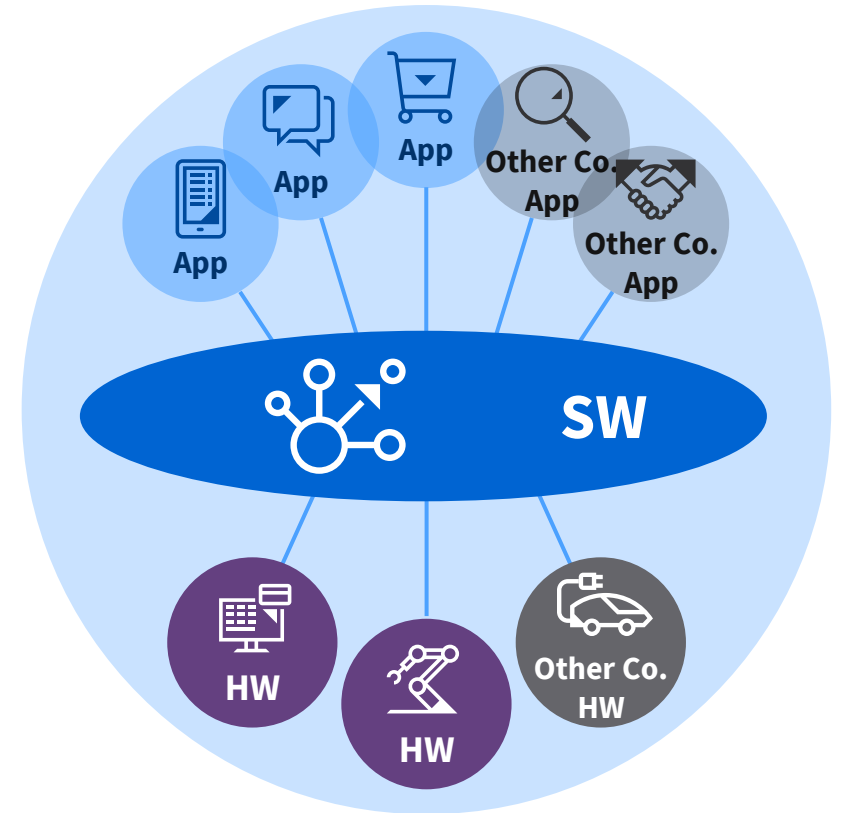


## DE: Digital Evolution



The key to change is  
“Software Defined”

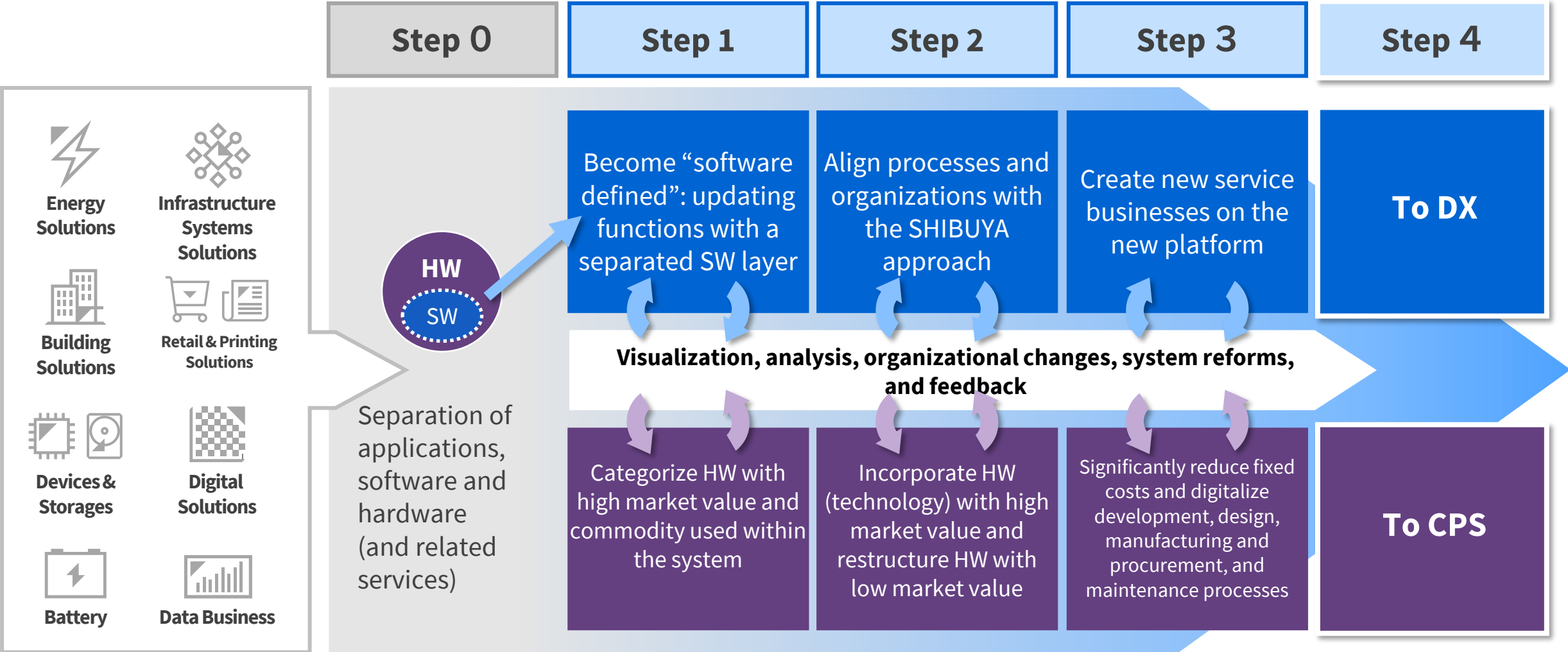
## DX: Digital Transformation



Create a platform

# SHIBUYA Approach: Evolving Process from DE to DX

Reviving the company (city) without stopping the business (train)



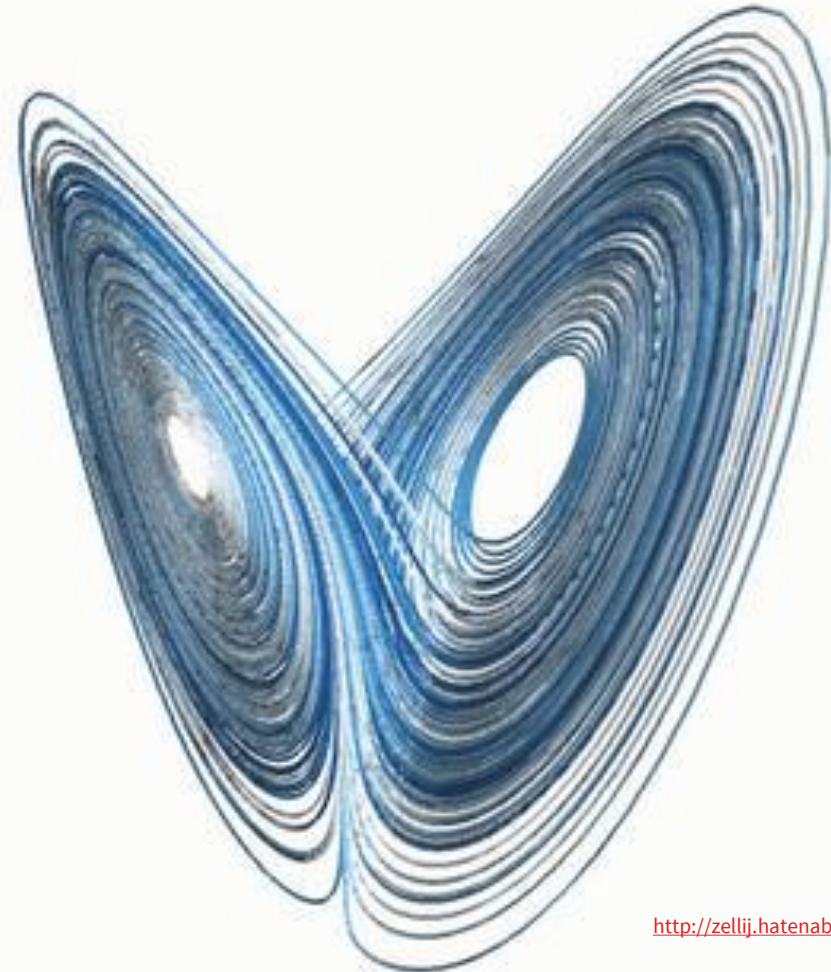
# Lorenz Attractor

Impossible to predict

$$\frac{dx}{dt} = -px + py$$

$$\frac{dy}{dt} = -xz + rx - y$$

$$\frac{dz}{dt} = xy - bz$$

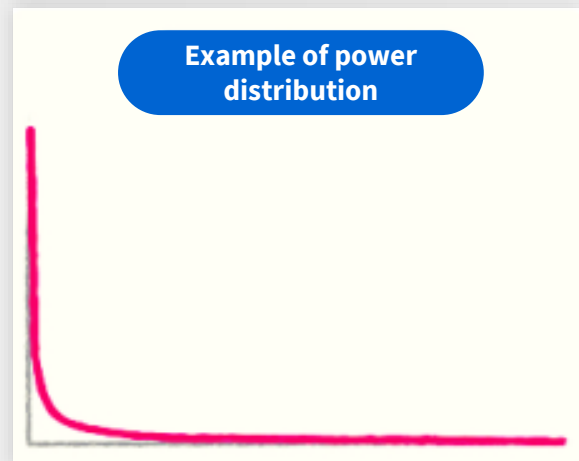
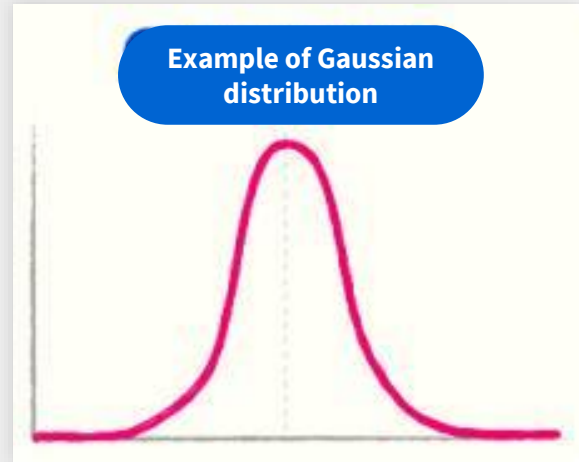


Source: HatenaBlog  
<http://zellij.hatenablog.com/entry/20130207/p1>



# The World of Normal Distribution and Chaos

## Real chaos is inequality



Source: DIAMONDonline (<https://diamond.jp/articles/-/49684?page=3>)



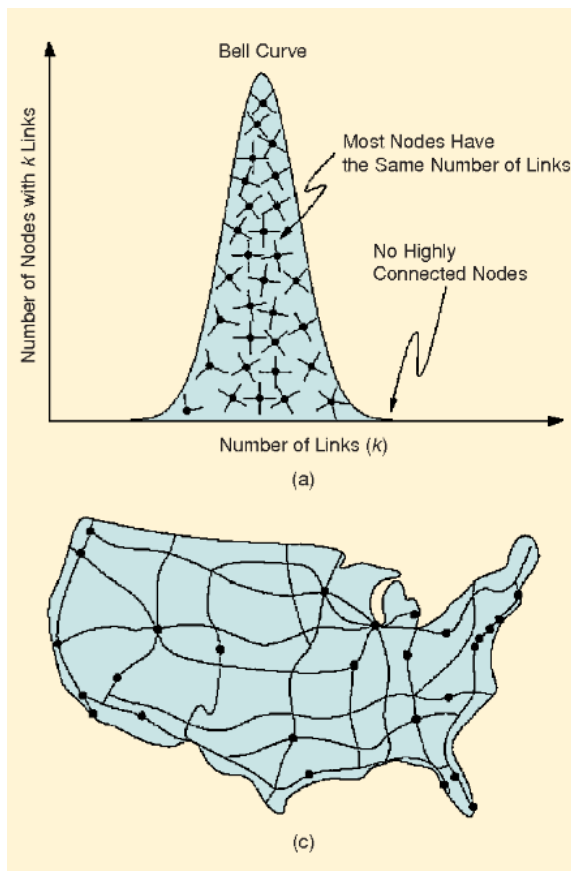
Source: The physics of the Web (<https://physicsworld.com/a/the-physics-of-the-web/>)



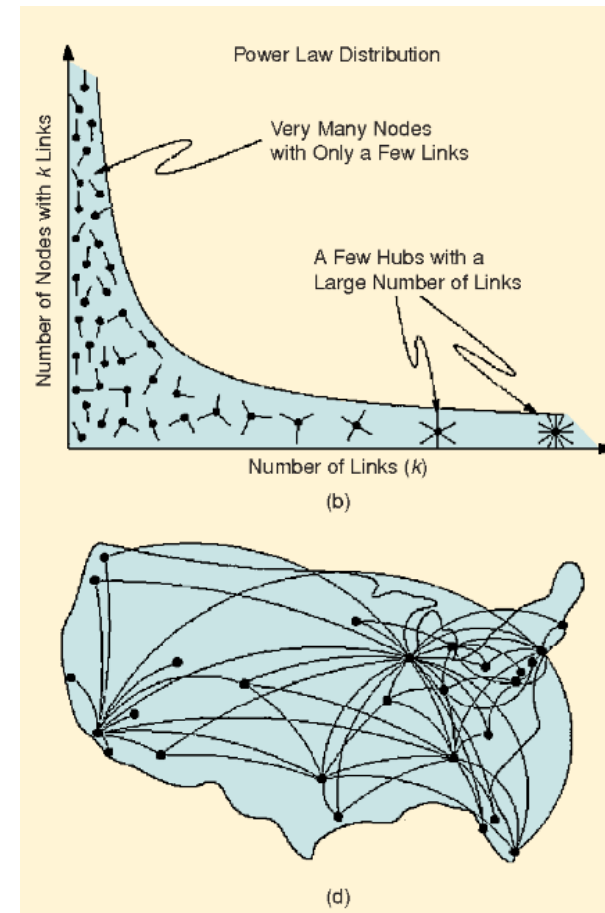
# Albert-László Barabási Scale-Free Network

## Scale-free networks that produce innovation

### Random network



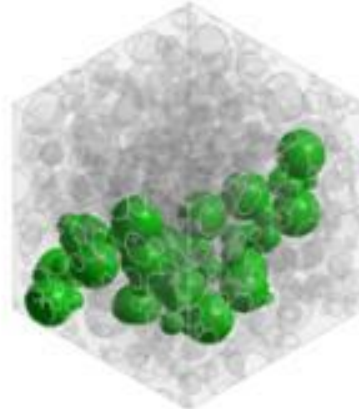
### Scale-free network



# Percolation: The Phenomenon of Immediate Change Once a Critical Point is Passed

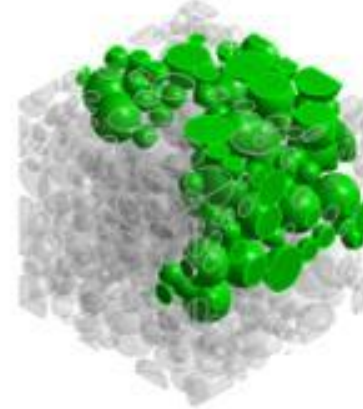
## Innovation occurs above the critical point

Fill rate 45%



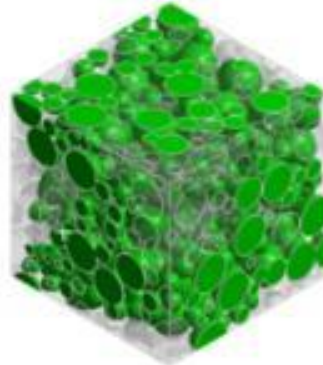
充填率45%

Fill rate 50%



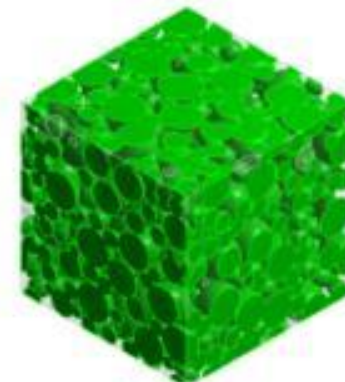
充填率50%

Fill rate 55%



充填率55%

Fill rate 65%



充填率65%

クラスターの成長過程

## Cluster growth process

Source: CYBERNET (<https://www.cybernet.co.jp/ansys/case/analysis/399.html>)

# A Scale-free Network Example

From “things” to “events ” is wrong  
⇒ the “platforms” where things happen are important



引用元 : <https://apps.apple.com/jp/app/facebook/id284882215>



引用元 : <https://www.instagram.com/?hl=ja>



引用元 : <https://apps.apple.com/jp/app/clubhouse-drop-in-audio-chat/id1503133294>

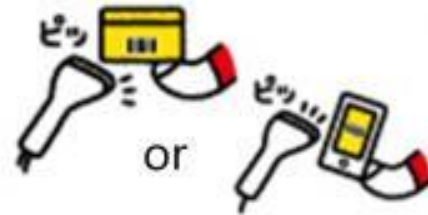
# Receipts to your Smartphone



Download the app  
and register



Show your membership  
barcode at the cashier



Pay just as always



The shopping  
receipt is in your  
smartphone!



# High Utilization of Smart Receipt Introduction Coupons

## From the demonstration project in Okinawa



### Sales campaign coupon

200 yen

Primary

High utilization

56.7%

(3,876 issued / 2,196 used)

Secondary

High utilization

49.0%

(4,450 issued / 2,181 used)

### Reciprocal Customer Transfer

Okinawa Co-op ↔ PETBOX

Big spenders

(6 → 75)

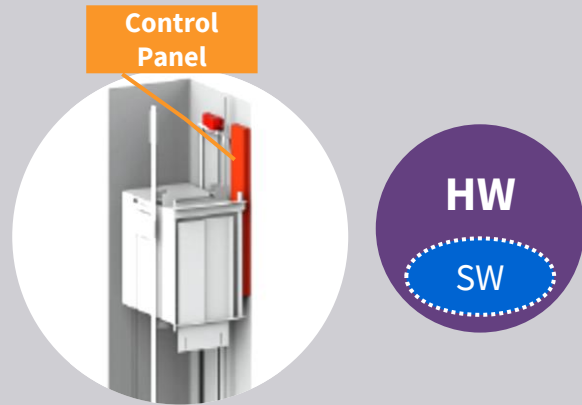
9.5x

# DE Case Study : Software Defined Transformation of Elevators

Develop elevator system as a service (SaaS)  
that can continually update elevator and building operations

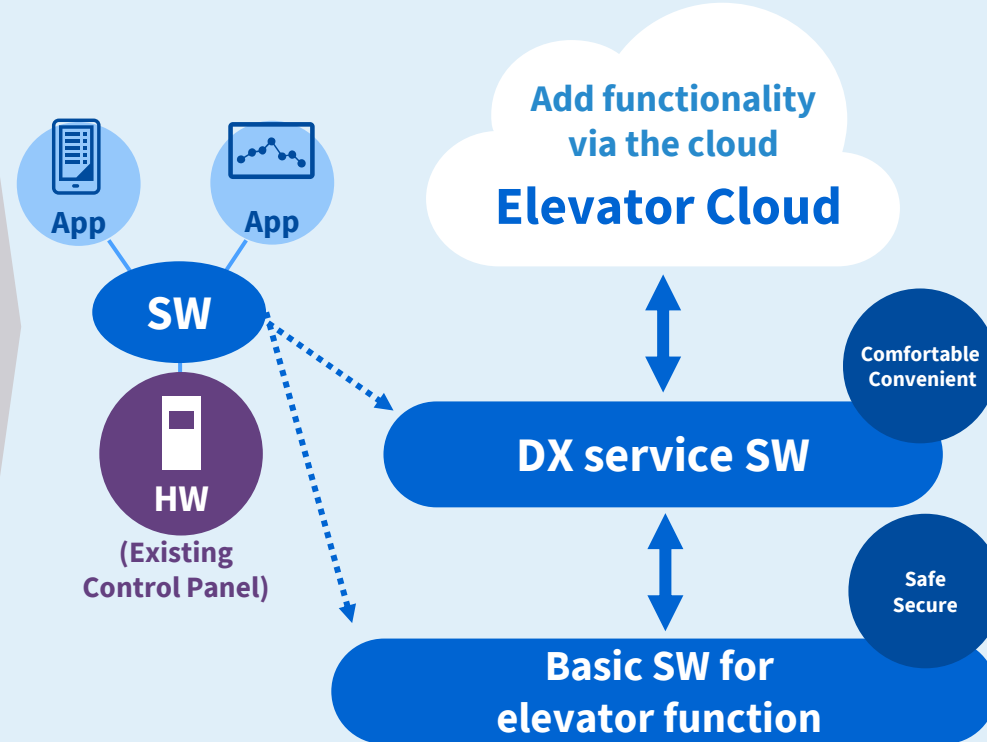
Before

Inseparable  
HW and SW



After

Separated HW and SW



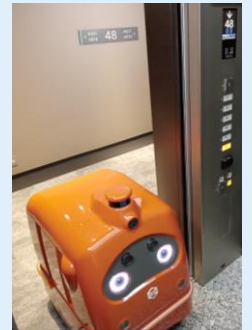
Toshiba Elevator Cloud Service

## ELCLOUD

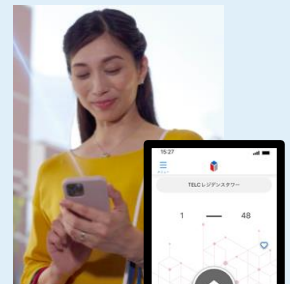
Connected Elevators that evolve and create new value

Elevators and robots work together

Robots move about freely on each floor and provide a variety of services



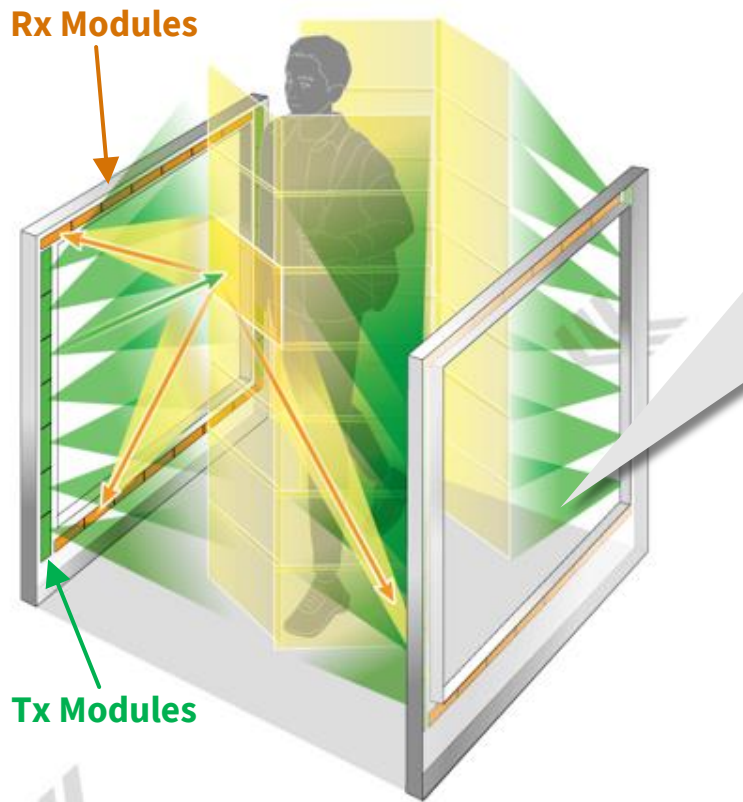
From smartphone app  
Able to call elevators



In market from Nov.2023

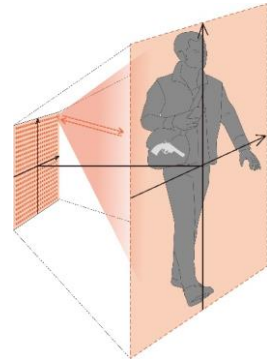
# Walk-through Body Scanner using Millimeter-Wave Radar

## High-Definition Radar Imaging in less than 1 second

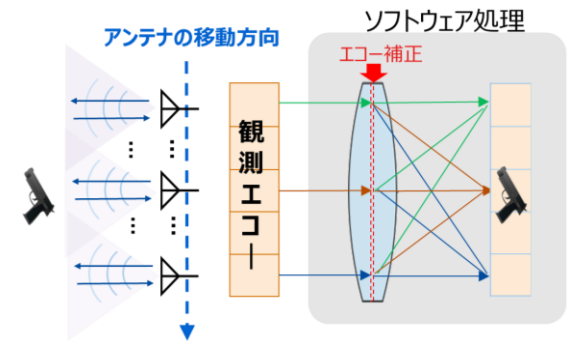
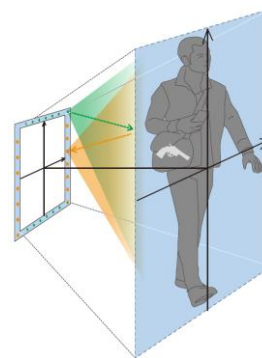


### High-Definition Imaging with Fewer Scanning Points

Conv. : Massive sensors

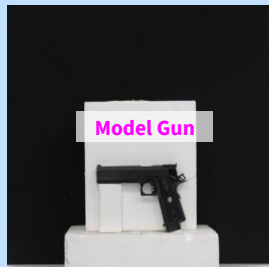


Toshiba : less than 10%

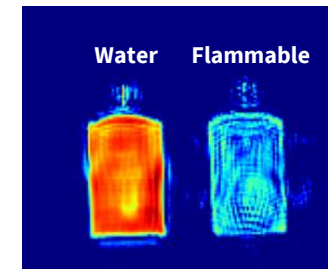
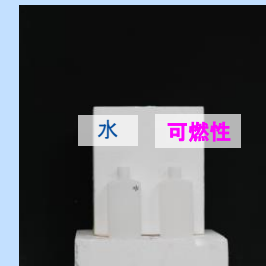


Lens Focusing Processing on SW

### Gun



### Liquid



## Commercial Radar IC



## Modularization



## Systematization



Original designed module achieves system scalability and operational flexibility



## Building safe and secure space with diverse operators through a platform

### Challenges for Operators

- Difficult to adjust to various scenes and sites
- Need for professional knowledge of radar technology

**CEATEC<sup>®</sup>**  
AWARD

Minister for Internal Affairs and  
Communications Award 2023

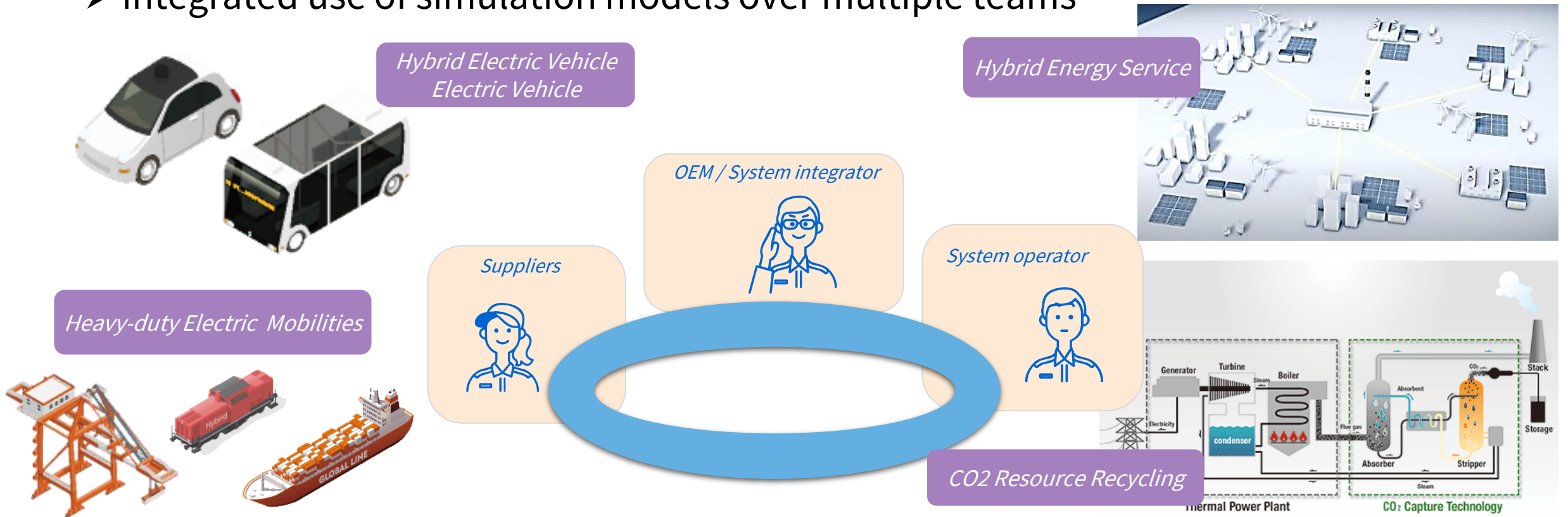
### <Toshiba's Platform Concepts>

- 1 : **Software Defined Architecture**
- 2 : **Service Provisioning** (Automated Calibration, DB update, etc)
- 3 : **Open environment for customization**

# DX Case Study : Cross-company Collaborative Model-based Development

Modern system development, system optimization, verification requires

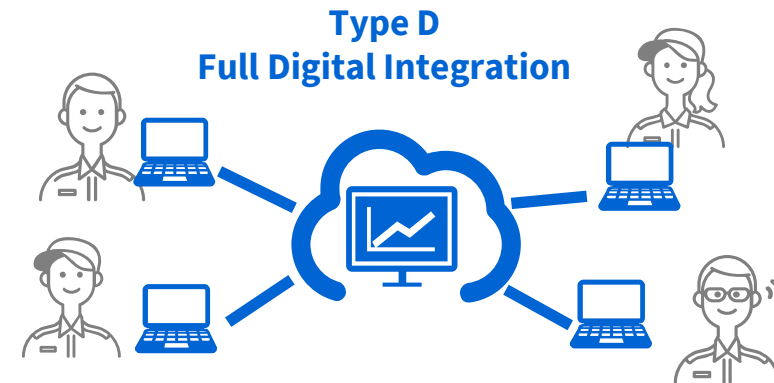
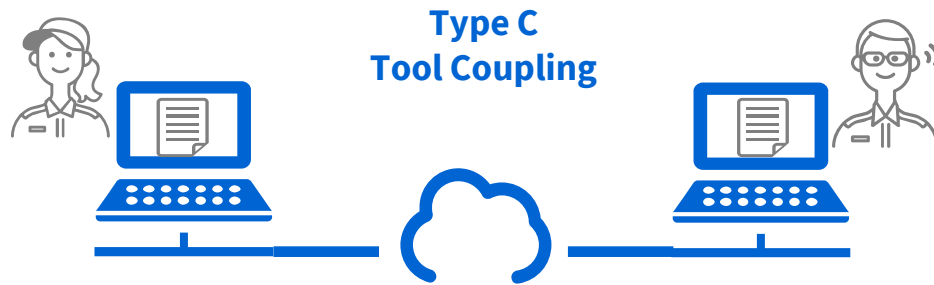
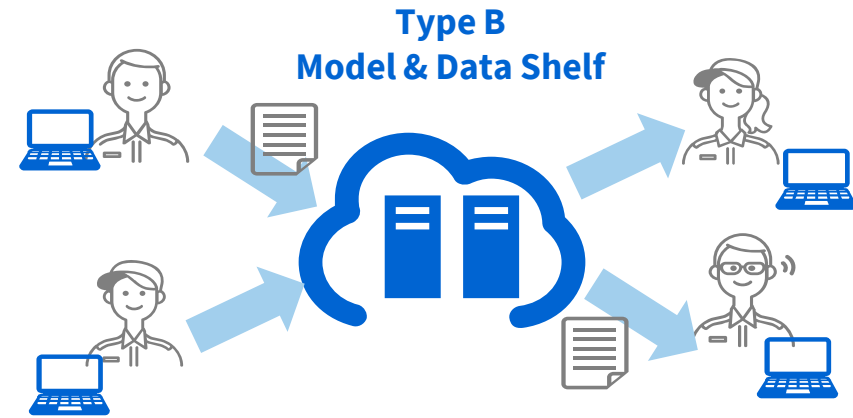
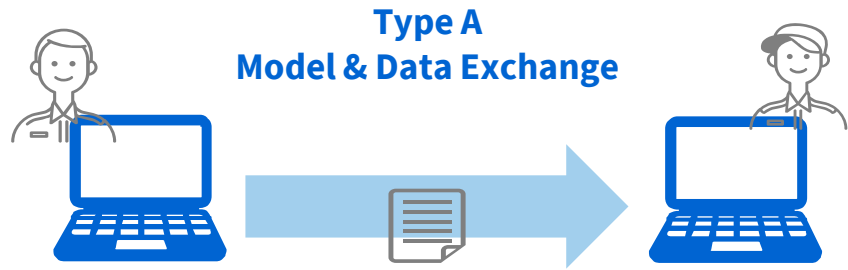
- large scale simulation of a coupled multi-domain system
- integrated use of simulation models over multiple teams



Industry 4.0 and 5.0, Gaia-X, Catena-X accelerate Collaborative MBD

# DX Case Study : Cross-company Collaborative Model-based Development

## Four Ways to Achieve Collaboration



**International organizations and groups are working toward interoperability on model exchange at any time and anywhere. Toshiba supports these activity!**

# DX Case Study : Cross-company Collaborative Model-based Development Distributed Co-simulation Platform - VenetDCP



## High Inter Connectivity

Coupling multiple tools and models running at different locations  
Supporting SSP & FMI standards  
Easy-to-use administrative user interface for tool-coupling

ssp fmi



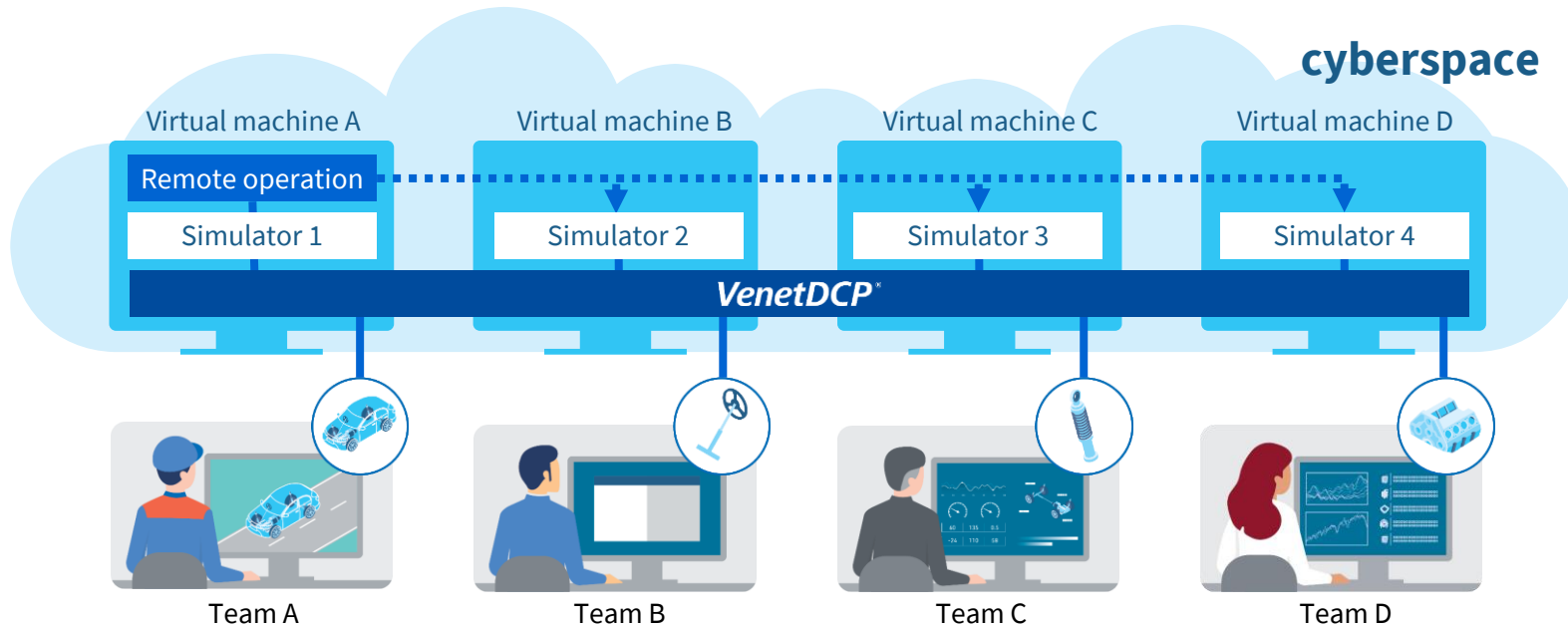
## Protection of Model Confidentiality

Distributed co-simulation without disclosing model to other teams



## Remote Operation and Automation

Remote simulation start & stop, parameter change from other location  
Automating distributed co-simulation without operator



## Simulators with verified interoperability

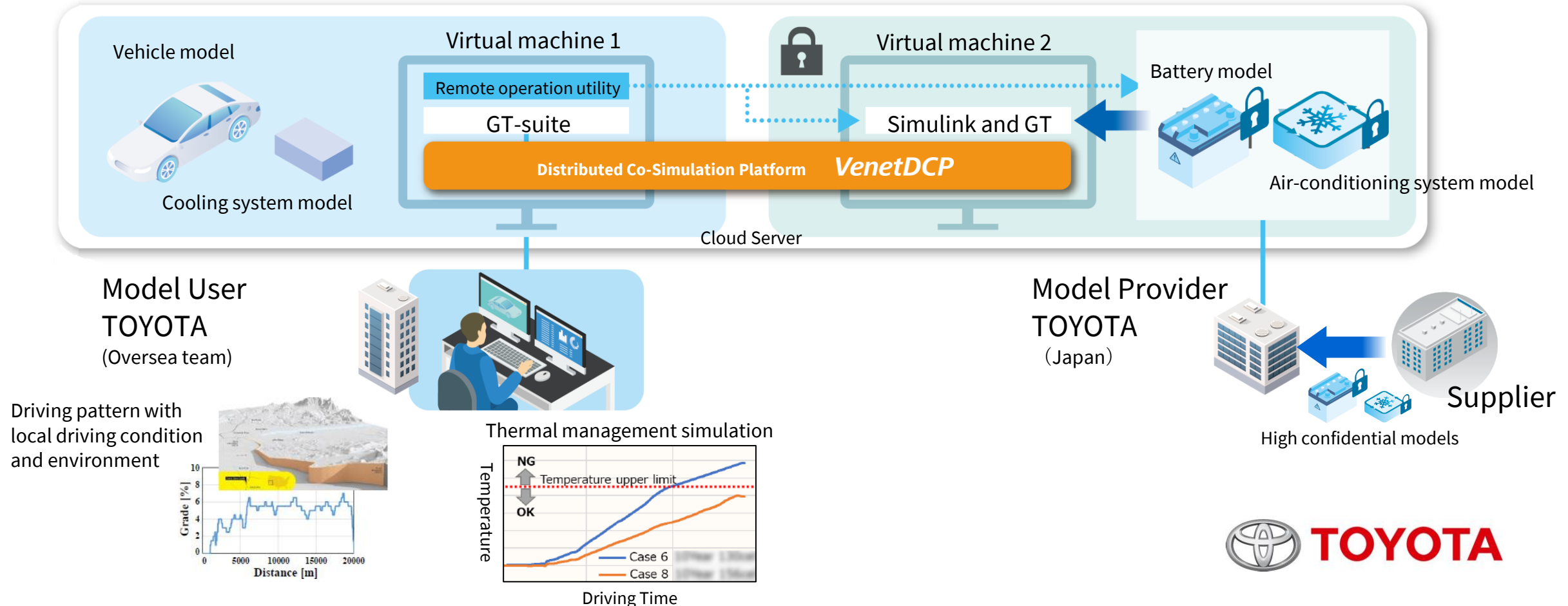
Altair Twin Activate  
ANSYS Twin Builder  
AVSimulation SCANer  
AVL CRUISE M  
Dassault Systèmes Dymola  
dSPACE VEOS  
dSPACE SCALEXIO  
dSPACE MicroAutoBox  
ESI SimulationX  
ETAS COSYM  
Gamma Technologies GT-SUITE  
IPG CarMaker  
MathWorks Simulink  
Modelon Impact  
National Instruments LabVIEW  
OpenModelica  
Python  
Siemens Simcenter Amesim  
Siemens Simcenter STAR-CCM+  
Unreal Engine  
Vector CANoe

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# DX Case Study : Cross-company Collaborative Model-based Development

## Thermal management co-simulation interconnecting overseas sites

- Thermal management co-simulation of electric vehicle using high confidential supplier models
- Confidential models are stored on the provider's machine and can be simulated without disclosing the contents
- Co-simulation can be remotely operated from Toyota overseas team
- Oversea team can develop thermal management which is highly adapted to local driving condition and environment

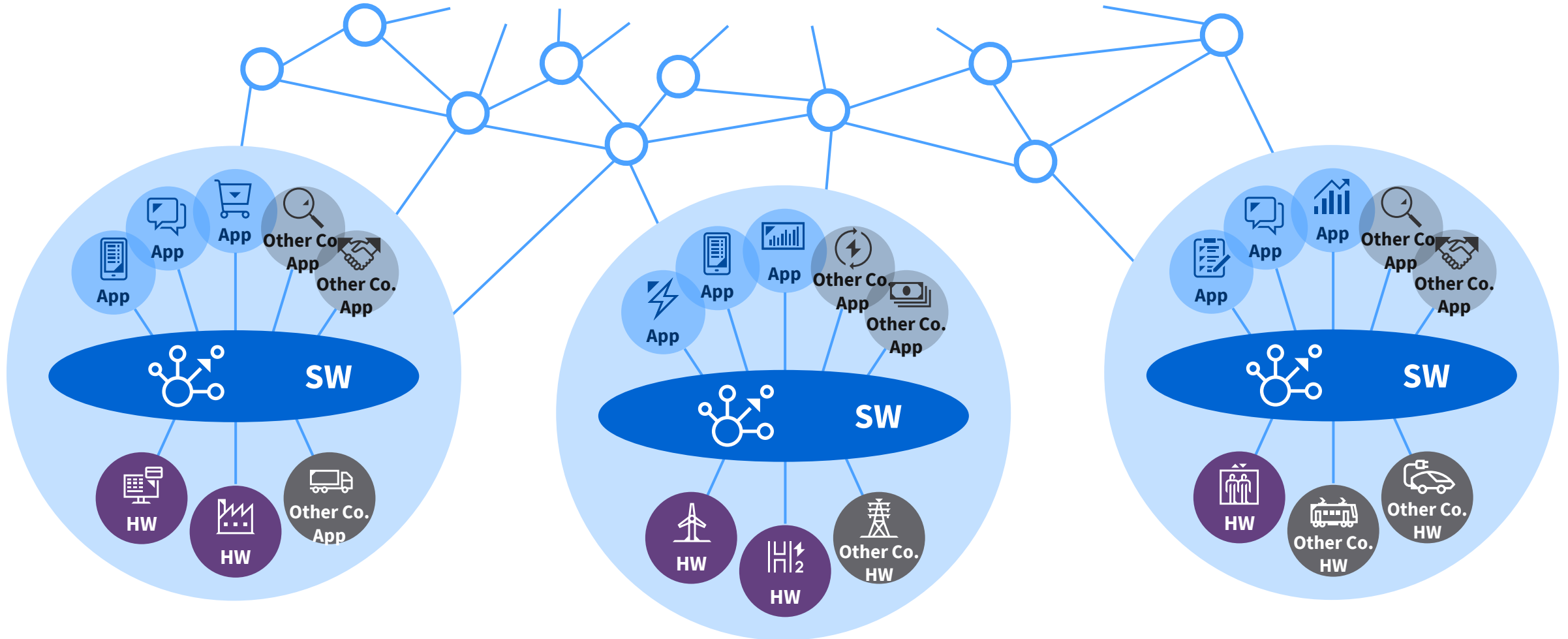


# The Future Created by Quantum Technologies (2030-)

**QX**

Quantum Transformation

## A world optimized by quantum technologies



# QX Case Study : Advantages of Quantum Computing

## Static Problem Solving



## Dynamic Problem Solving



Communications

Huge Data

# Q-STAR Progress and Use Case Studies

## 2021 Establishment

2021.5  
Founder's Association  
Established

**11 Members**

2021.9  
Establishment of Q-STAR

**24 Members**

6 Working Groups  
4 Subcommittees

## 2022 Discussion and use case creation

2022.5  
Became General Incorporated Association

**65 Members**

8 Working Groups  
5 Subcommittees

## 2023 Demonstration Stage

2023.1  
MOU signed to establish International Council  
of Quantum Industry Associations

**87 Members**(as of Nov. 2023)

8 Working Groups  
6 Subcommittees

- Participated in the review working group to create "Vision of Quantum Future Society"



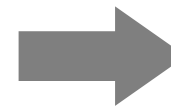
- Discussed over **50** use cases



- Participated in the working group to create 'Strategy of Quantum Future Industry Development'



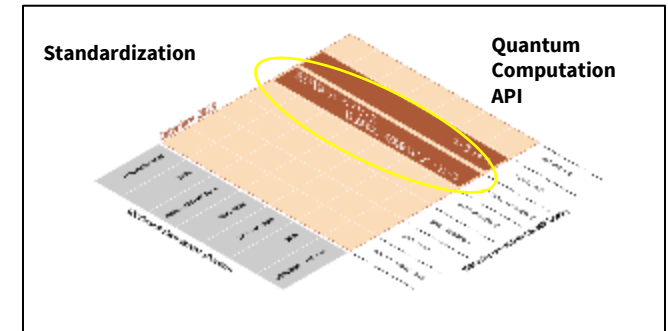
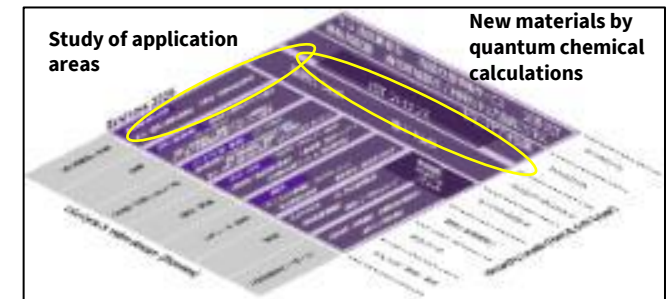
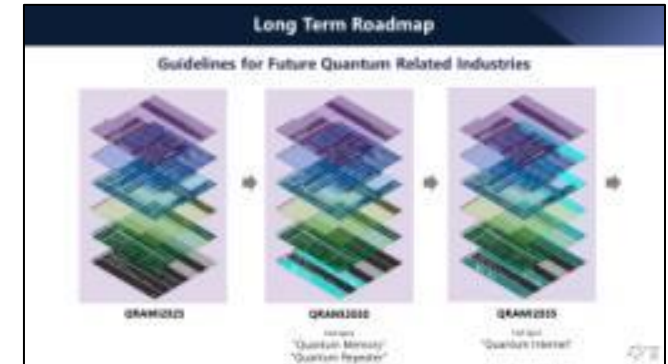
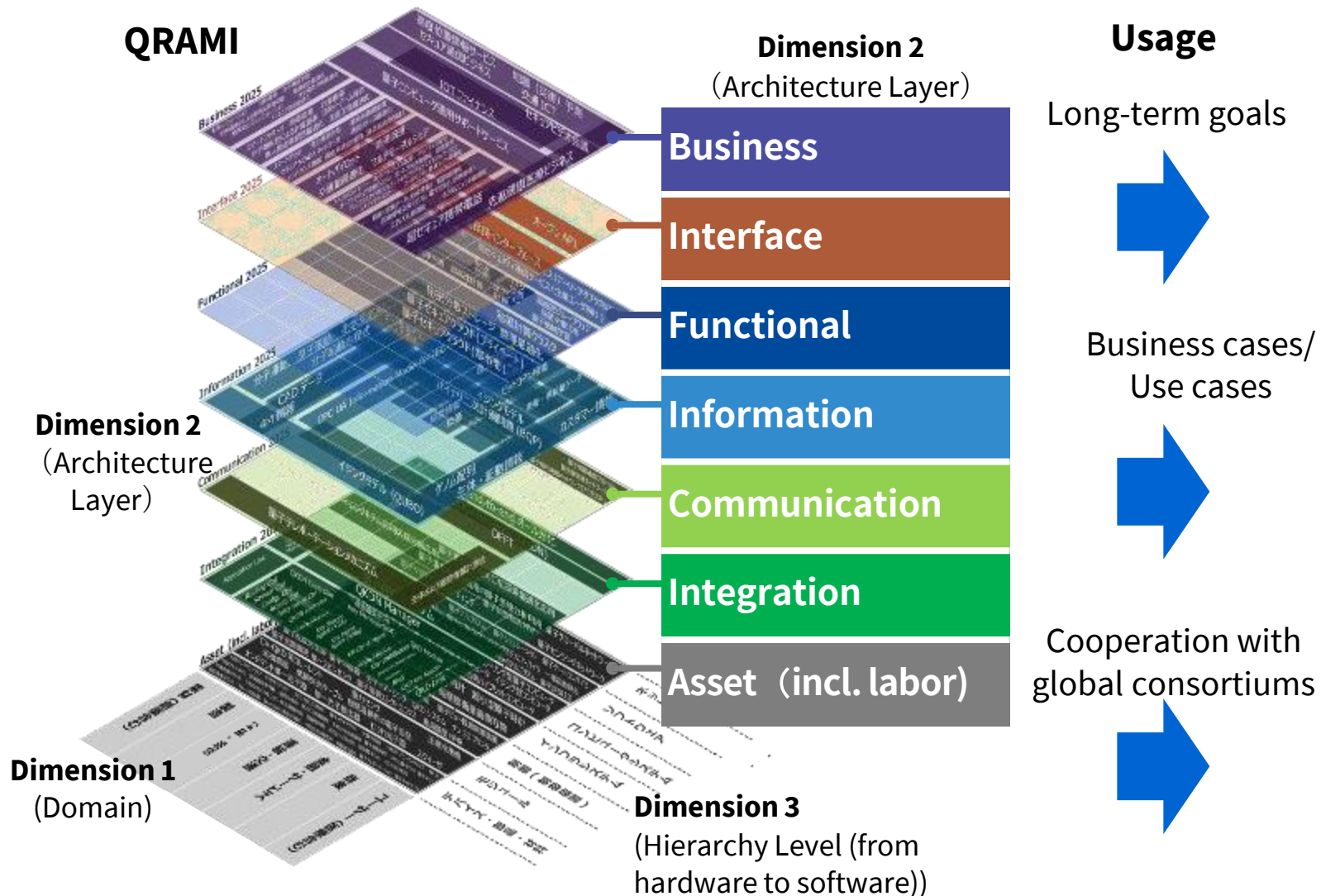
- Selected **16** of the discussed cases and made industry roadmap





# Creation of Global Communication Tool: QRAMI

Q-STAR has created QRAMI (Quantum Reference Architecture Model for Industrialization) as a reference architecture model to view future quantum business, and aim to use it as a global tool for common understanding



# Quantum Key Distribution - Recent Global Deployments

Implemented PoC for financial blockchain with US-based **J.P. Morgan Chase & Co.**  
(February 2022)

Implemented trials in industrial networks with **NCC & BT**  
(October 2020)

Supplier to multiple national Quantum secured networks for **EuroQCI** project  
(2023)

Tokyo metro QKD network (2023)



QKD multiplexing trial with **Orange**  
(2023)

Quantum-safe 5G networks with **DT** (2022)

Securing Gov networks with **PNSC** (2023)

Q-SDN with **UPM** and **Telefonica**  
(2023)

QKD on railway infrastructure **CTU**(2023)

Continuing trial with US-based **Verizon**

Validated IOWN Secure Optical Transport Network with **NTT** (Nov 2021)

Jointly constructing 124 mile quantum test bed integrating solid state quantum memory nodes (April 2022)



**CHICAGO QUANTUM EXCHANGE**

Commercial quantum-secured metro network trial in London with **BT** associated with **EY** (since April 2022) and newly joined by **HSBC** (since July 2023)



Implemented long-range hybrid quantum-secured network with Korea-based **KT**  
(March 2022)

Launched collaboration in the quantum cryptographic communications business in Southeast Asia with Singapore-based **SpeQtral**  
(August 2021)



# SQBM+ : Addressing Large-scale Combinatorial Optimization Challenges

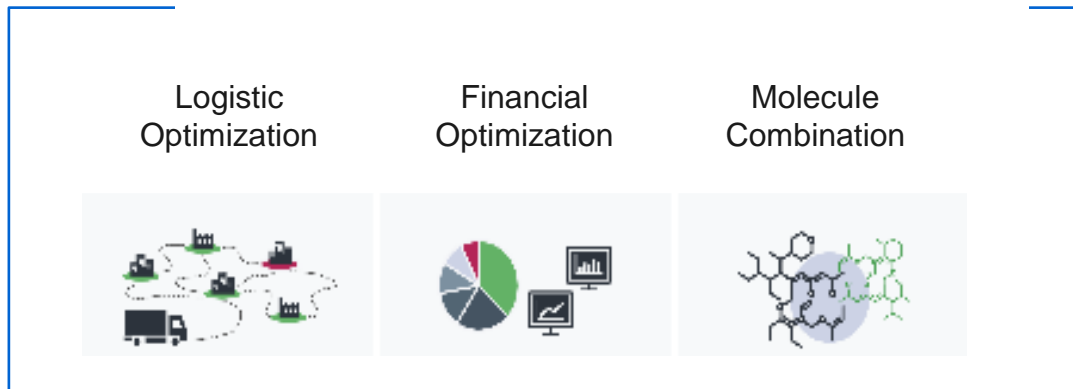
## The Challenge

### Optimization

#### *Large-scale, combinatorial*

Large-scale combinatorial optimization is a challenging computing process to find the best combination among an exponential number of candidates

#### *Real world problems:*



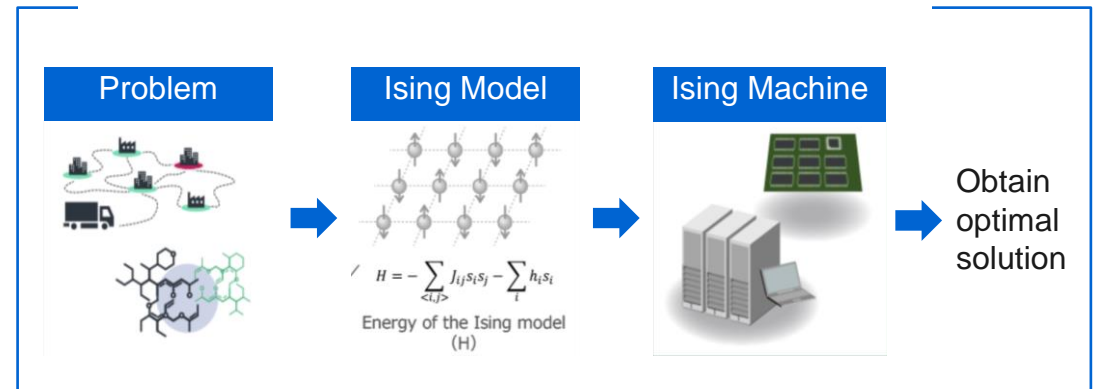
## Toshiba Solution

### *SQBM+*

#### *Quantum-inspired solution*

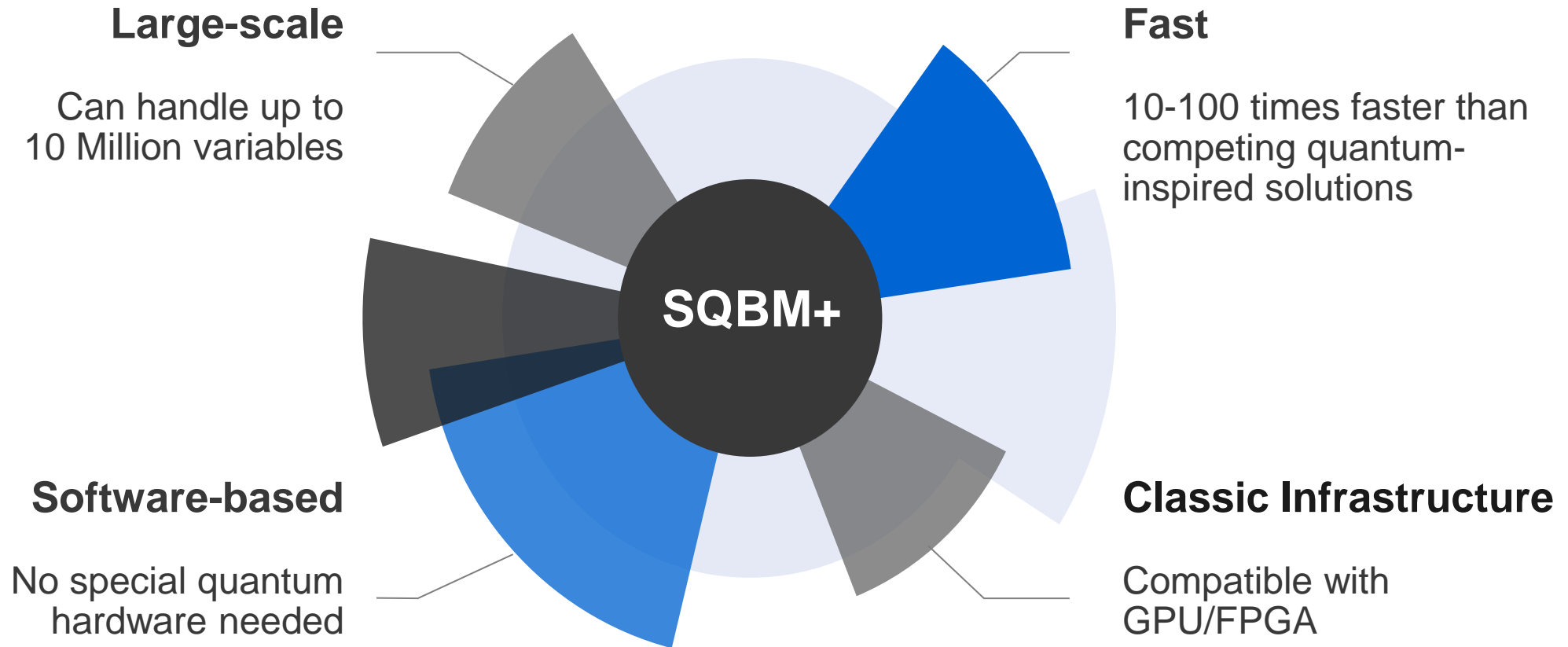
Solves large-scale combinatorial optimization problems through an Ising machine that emulates quantum bifurcation mechanics

#### *SQBM+ process:*



# SQBM+ : Key Features

Achieve quantum-level performance on classical infrastructure



# SQBM+ Use case : Capability Enhancement for IT systems

## 1 Real-time



2D graph maximal matching

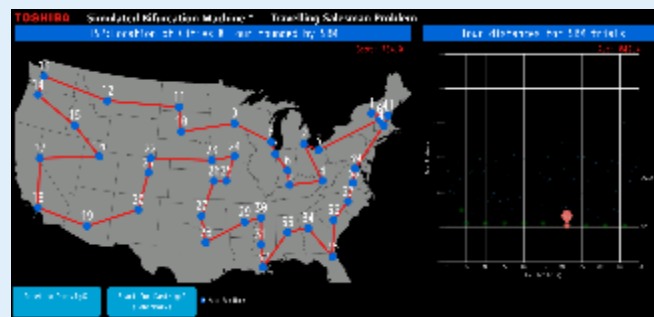
### Multi-object Tracking

Real-time tracking of multiple objects in videos

> 30FPS

<https://www.youtube.com/watch?v=bWMZjwHtm5g>

## 2 Interactivity



Traveling salesman problem

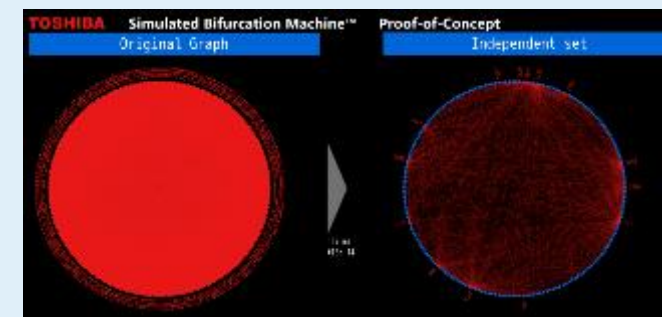
### Interactivity improvement for optimal route search

Instantly presents patrol routes to visit points specified by user

7 ms/search

<https://www.youtube.com/watch?v=NSh3nQTpOW8>

## 3 Stream Data Process



Maximum independent set problem

### Maximum Independent Set Detection

Fast extraction of independent components from large stream data

Faster and more accurate than existing solutions

<https://www.youtube.com/watch?v=WIDoO-DJClo>

Demo videos are available through the YouTube links

# Today's Key Messages

## What remains unchanged

“Committed to People, Committed to the Future”

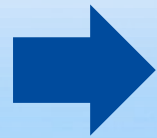
Continue to support daily lives of people and the society, and to contribute for the economic security assurance

## What we aim to achieve with the evolving digital economy

Our business: Transformation through “DE→DX→QX” to develop data service as a primary source of revenue

Our challenges: Break through both the internal and the external rigidity

Our action: SHIBUYA Approach → Being “software defined” is key



**Contribute to the achievement of carbon neutrality and a circular economy through digitization**

A hand is shown from the bottom, reaching upwards towards a bright sun. A rainbow is visible in the background, arching across the sky. The scene is bathed in warm, golden light. On the left side, there is a decorative graphic consisting of a blue vertical bar with a textured, wood-like appearance, and a red triangle pointing downwards from the bottom left corner.

The Essence of Toshiba

Committed to People,  
Committed to the Future.