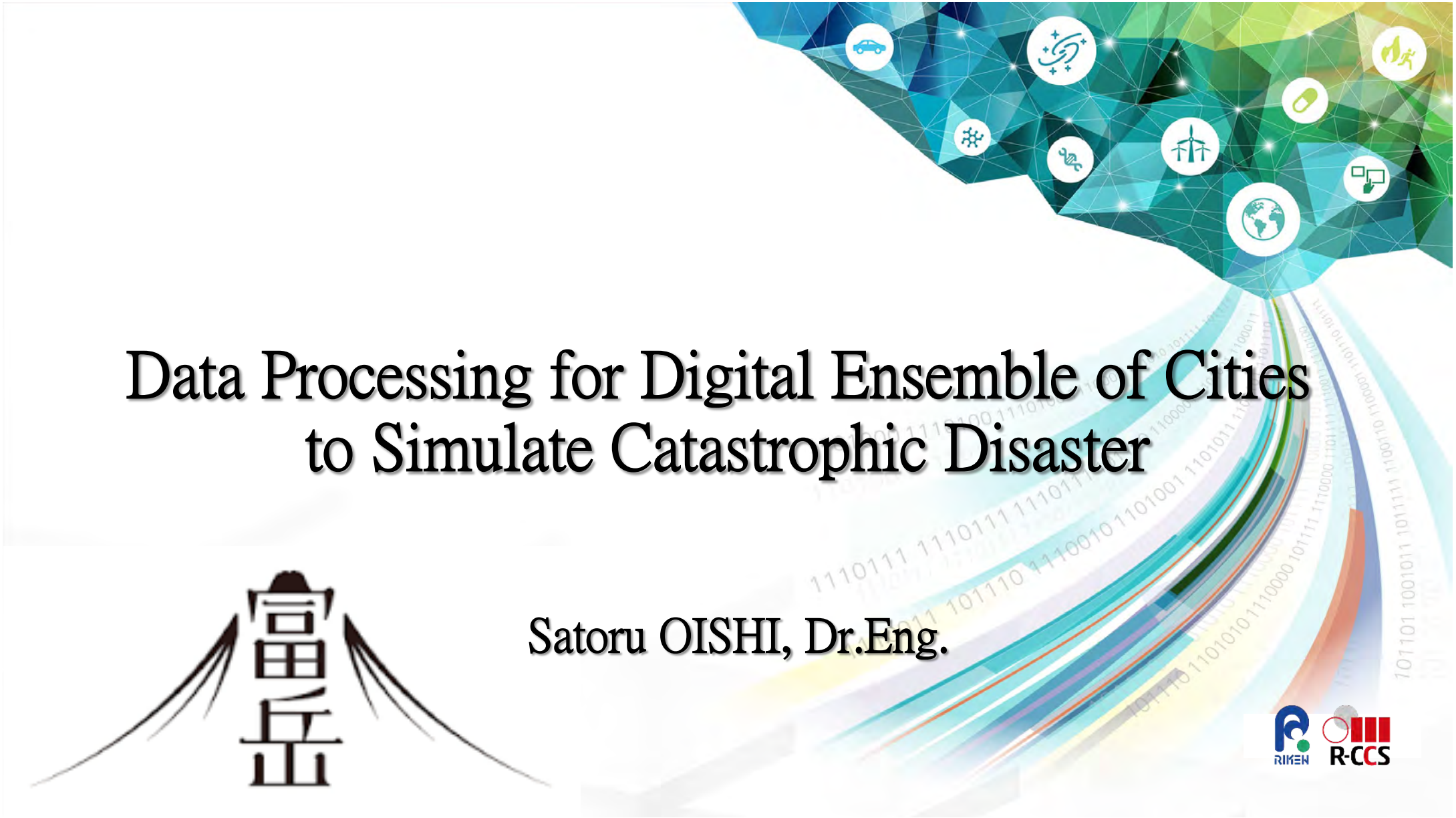
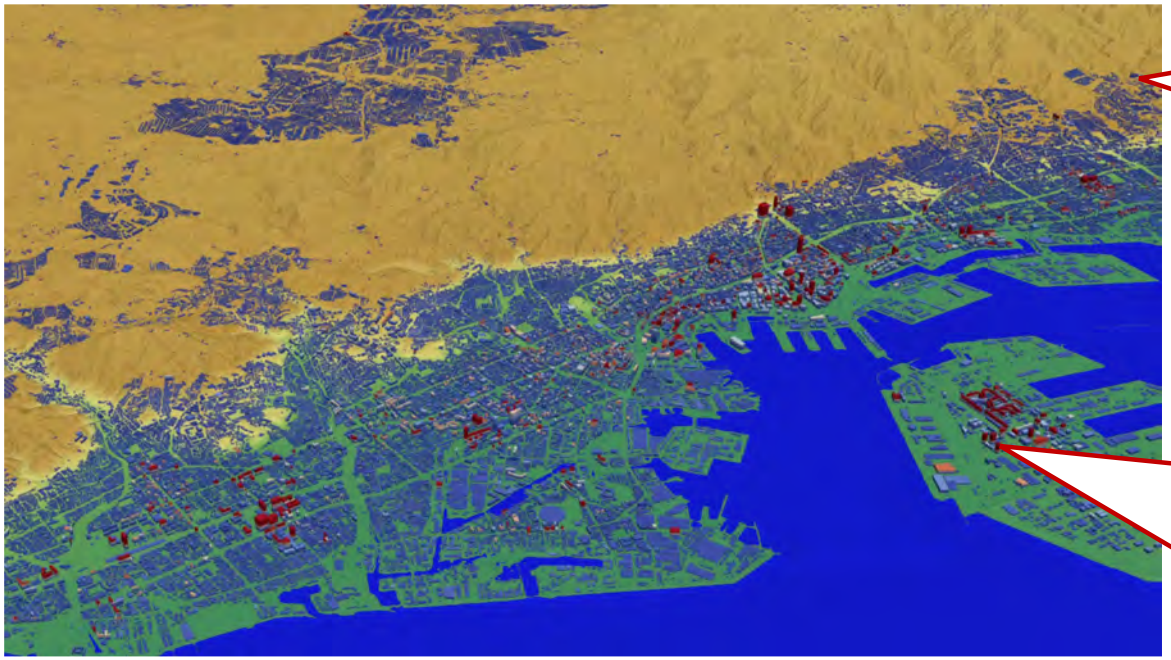


Data Processing for Digital Ensemble of Cities to Simulate Catastrophic Disaster

Satoru OISHI, Dr.Eng.

1. Disaster Simulation needs programs and data

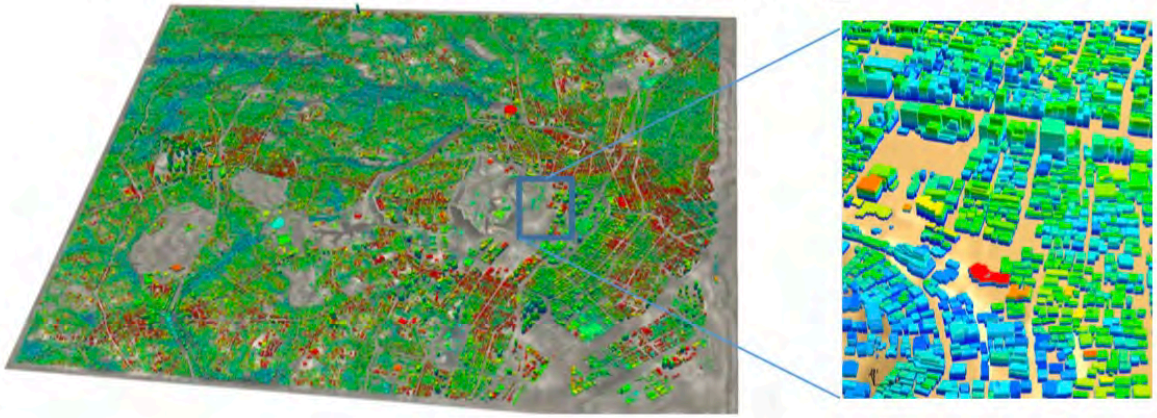
Developing advanced large-scale numerical simulation of natural disasters of earthquake, tsunami, flood and inundation for Kobe City and other urban areas in Hyogo Prefecture bridge between Advanced Science and Local Government



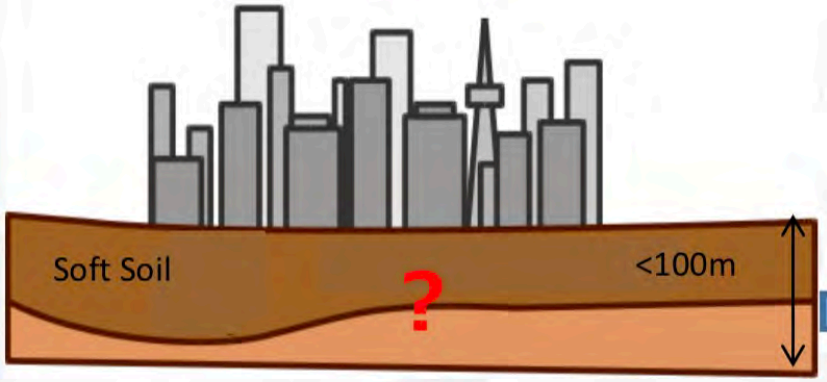
Solvers have been awarded in SCs

Automatic builder of Urban structure model “Data Processing Platform” is applied for a patent

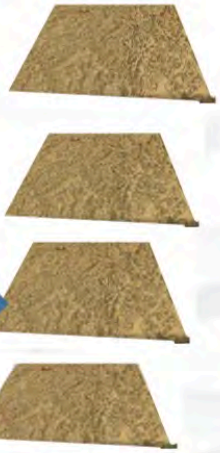
Large Scale simulation and AI coming together
[Ichimura et. al. Univ. of Tokyo, IEEE/ACM SC17 Best Poster 2018 Gordon Bell Finalist]



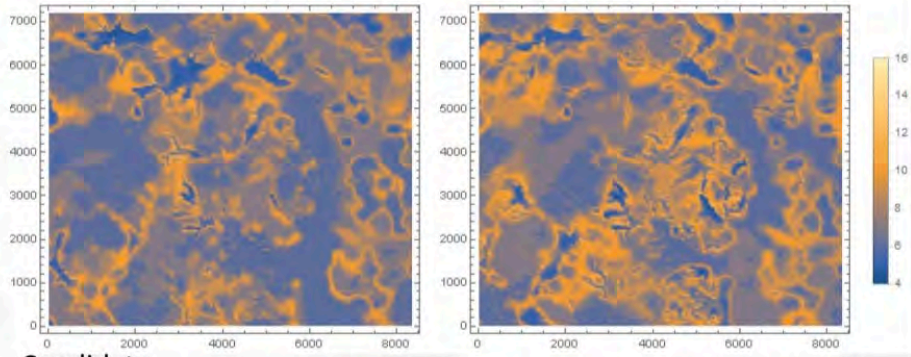
130 billion freedom earthquake of entire Tokyo (2018 ACM Gordon Bell Prize Finalist, SC16,17 Best Poster)



Earthquake



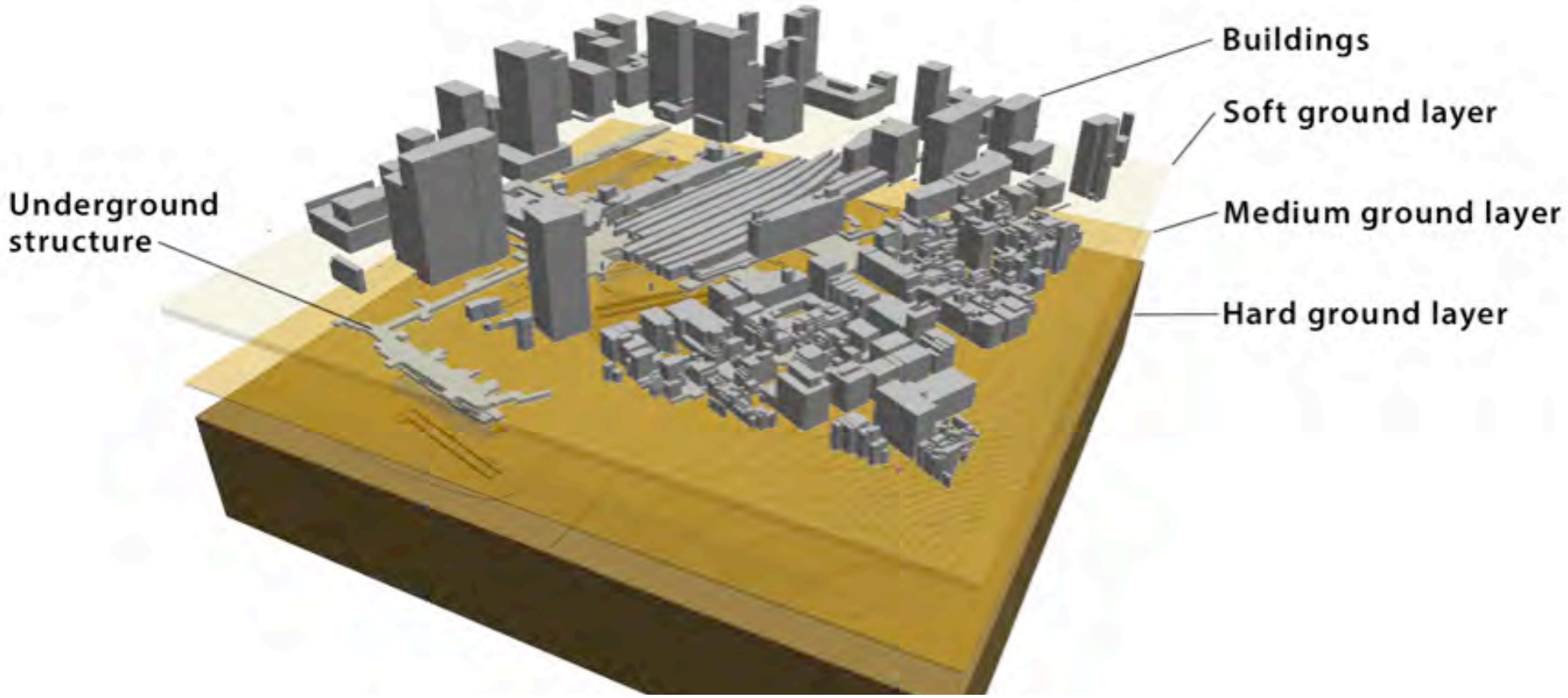
Too Many Instances



Candidate Underground Structure 1

AI Trained by Simulation to generate candidate soft soil structure

Candidate Underground Structure 2



They developed faster solver, and it is necessary to build “digital cities” for applying it in the real world

Applications of DPP

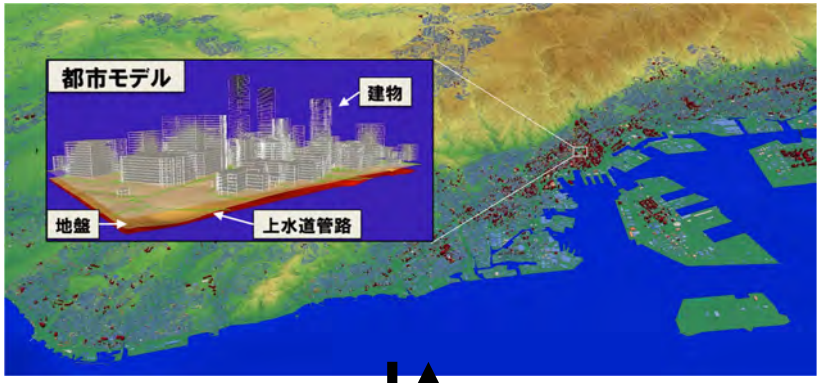
A variety of data and simulations will be connected by DPP and form a framework

Commercial Resource

Official Database

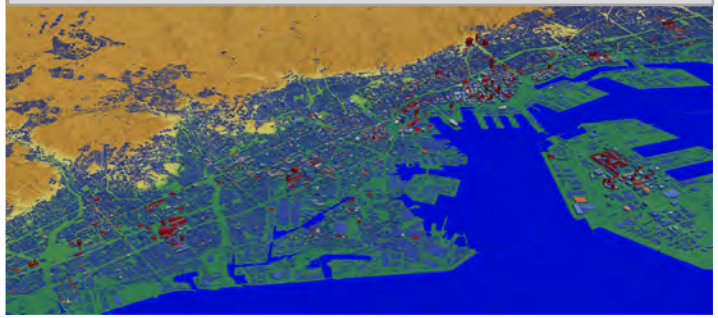
Monitoring Data

Sensor Data



Data Processing Platform (DPP)

Earthquake Simulation



Tsunami Simulation

Evacuation

Disaster Response

Social Simulation

Disaster Recovery

Digital twins of automobiles, turbines went forward

Digital twins of cities are in progress
but they have shapes... only

Applications of DPP

To build digital twins to simulate “complex disaster” as DIGITAL ENSEMBLE

FIGURE 10. EXAMPLE OF PLACING THE PLANNED BUILDING INTO THE ENVIRONMENT

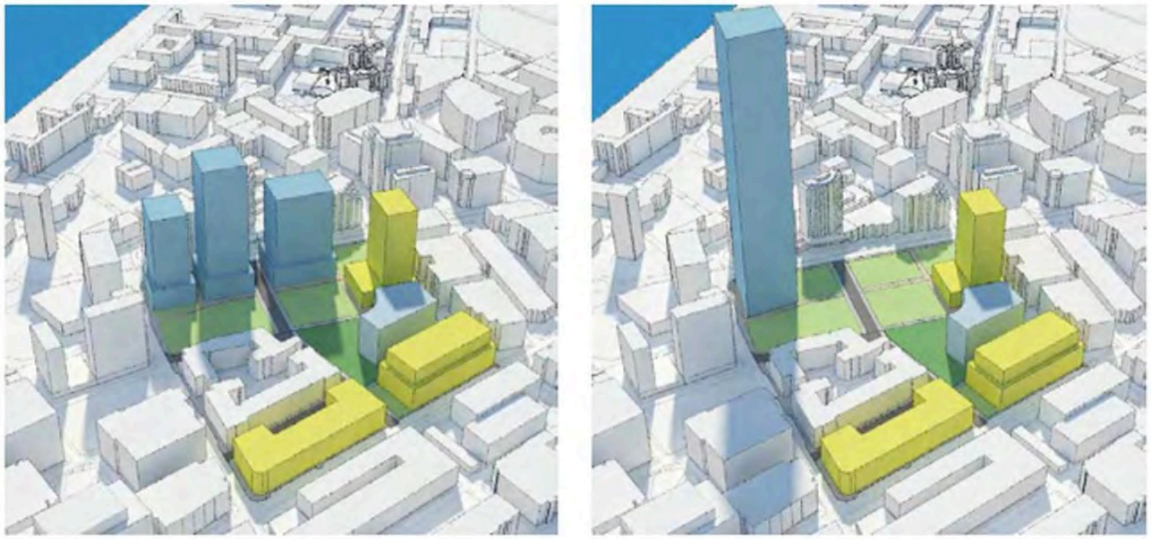


Image source: https://johnsanzone.com

Digital Twin in Estonian city
From report of CIVITTA (2018)
Vision of e-construction platform

- Earthquake
- TSUNAMI
- High Tide
- Land slide
- Severe Rain
- Inundation

5!=120

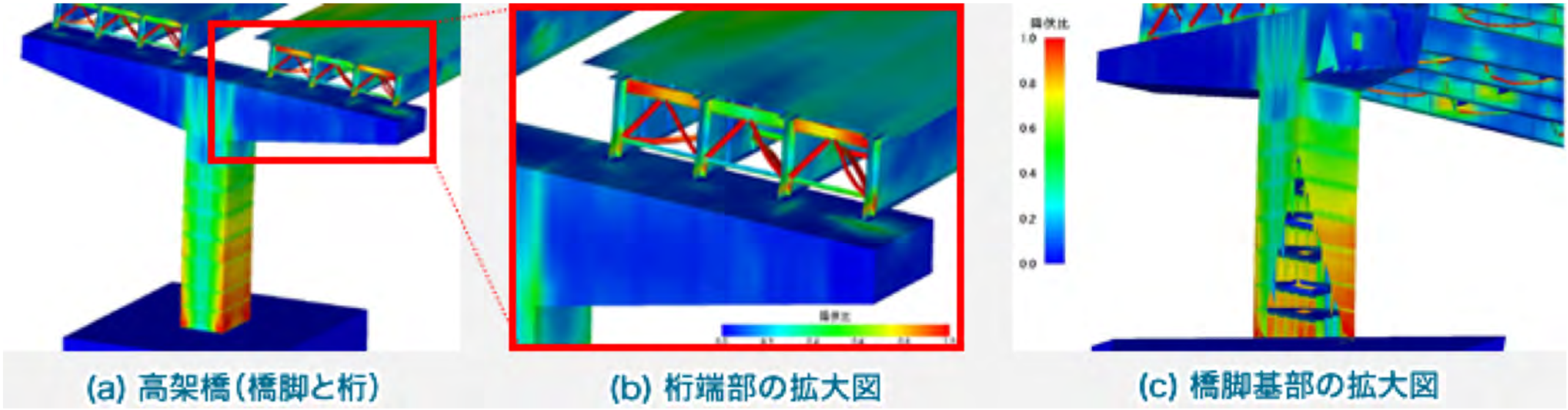
- Traffic
- Economy

Importance of simulation

Integrate all kinds of geo hazards, water hazards and related hazards

Demand for natural disaster simulations became increasing because disasters frequently take place leading more concern of risk of natural hazards

Stress force is calculated in a model with structure mechanics

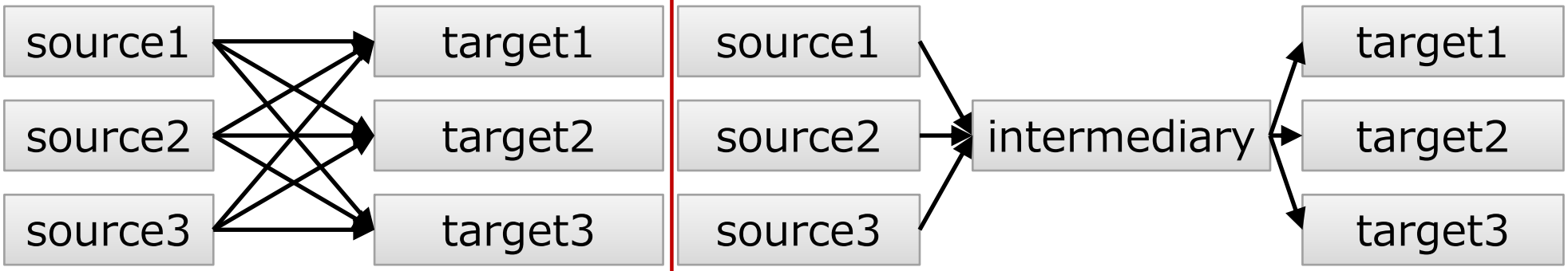


From Hanshin Expressway Co. Ltd. Homepage

2. Research Achievements

Urban Structure Objects builder as “DPP”

Research for urban hazards requires urban structure objects which represent structure and shape of cities in digital form. However, it takes very long time to develop urban structure objects. We developed Data Processing Platform (DPP) for automatic creation of urban models from maps, official database.



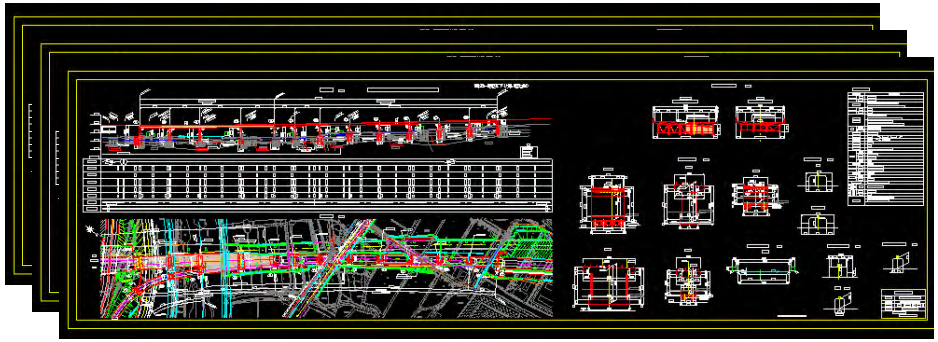
M * N patterns

M + N patterns

2. Research Achievements

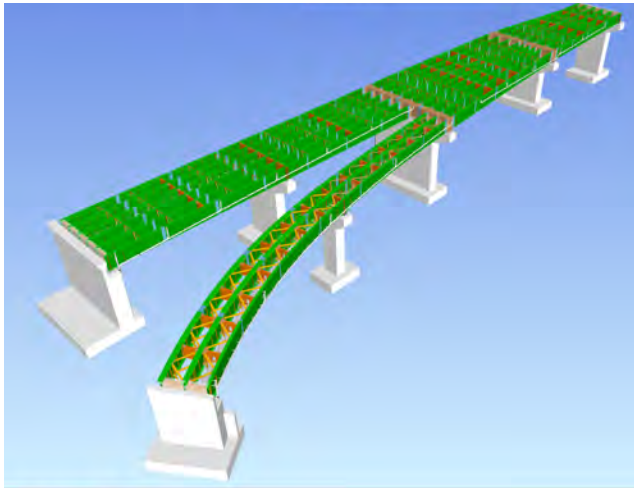
Bridge Structure Modeling from 2D CAD

In Japan, we have more than 150,000 bridges having more than 10,000km. Most of them are “plat e garter bridge” those have simpler form but not well digitized. It takes more than 40years to creat e digital form by personnel whose population is now estimated as 2000.
DPP can automatically translate the 2DCAD data into 3D shape and FEM data.

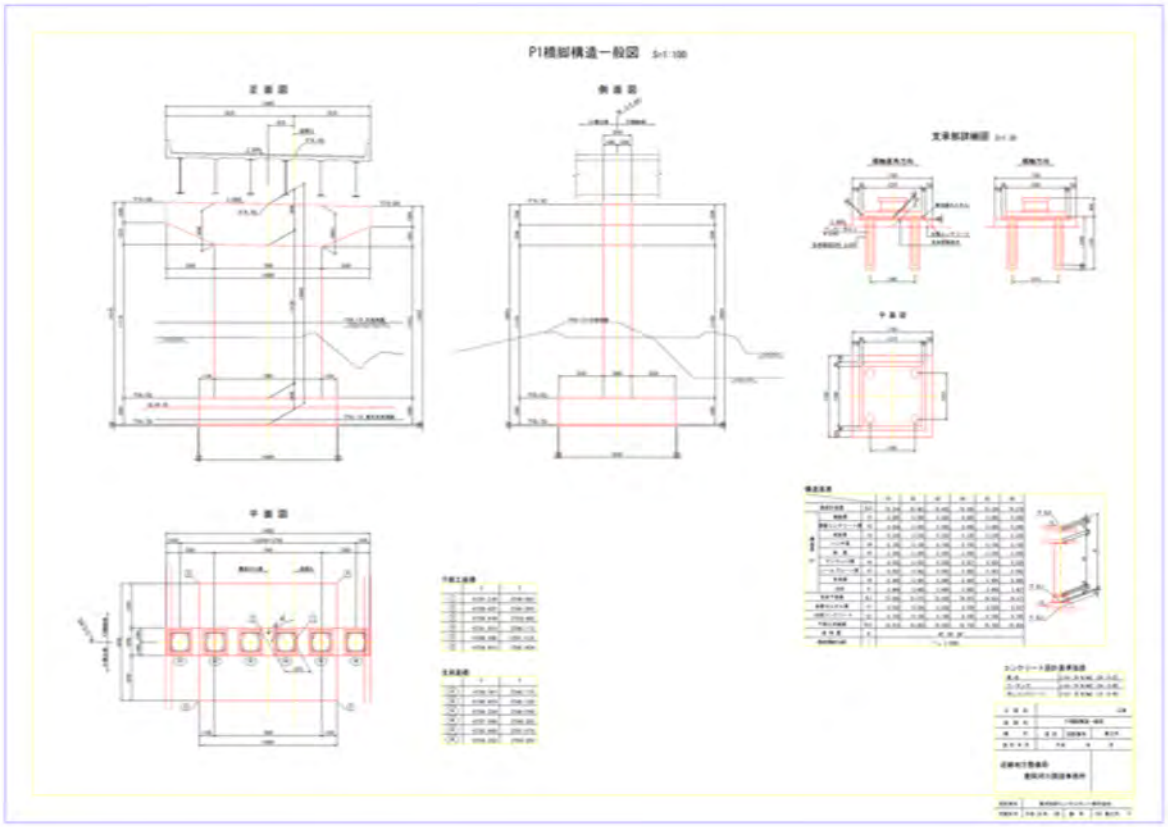


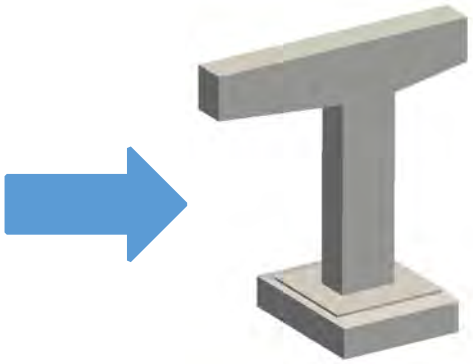
2D CAD data(SXF) files

Transforming
by
DPP

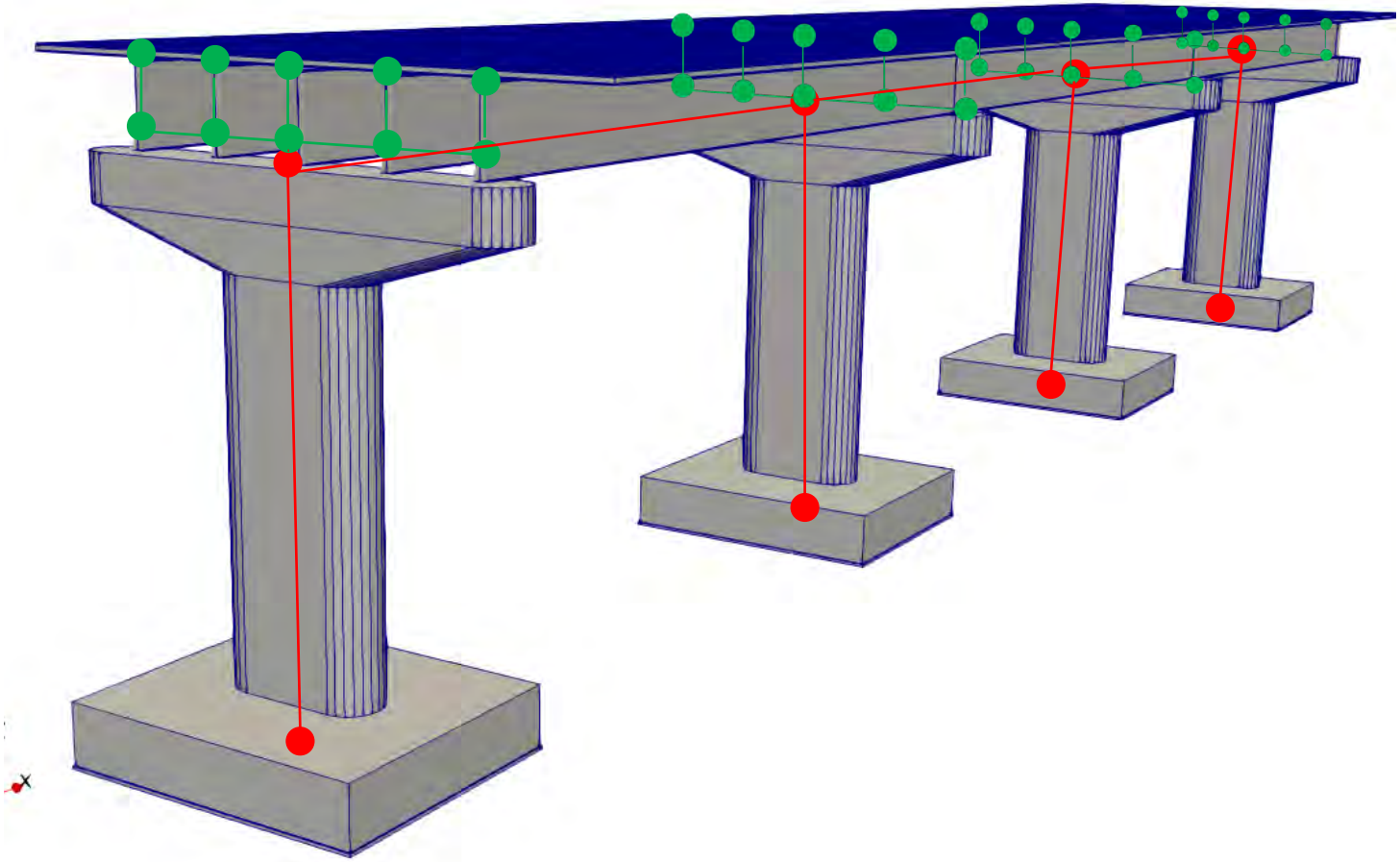


3D digital bridge
showing the outlook
use for FEM


P1橋脚構造一般図

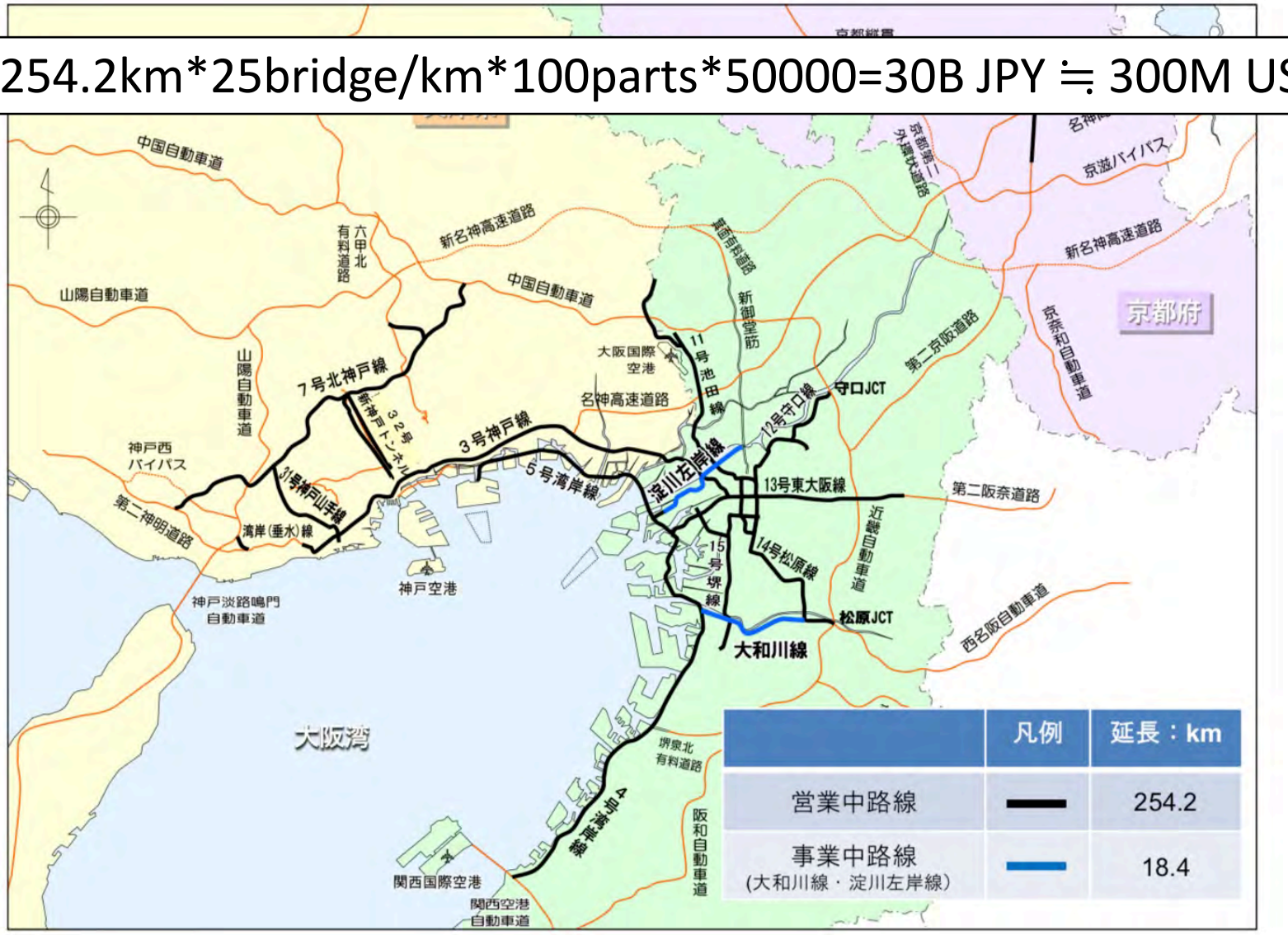


It is applied to steel garter bridge with their skeleton



17

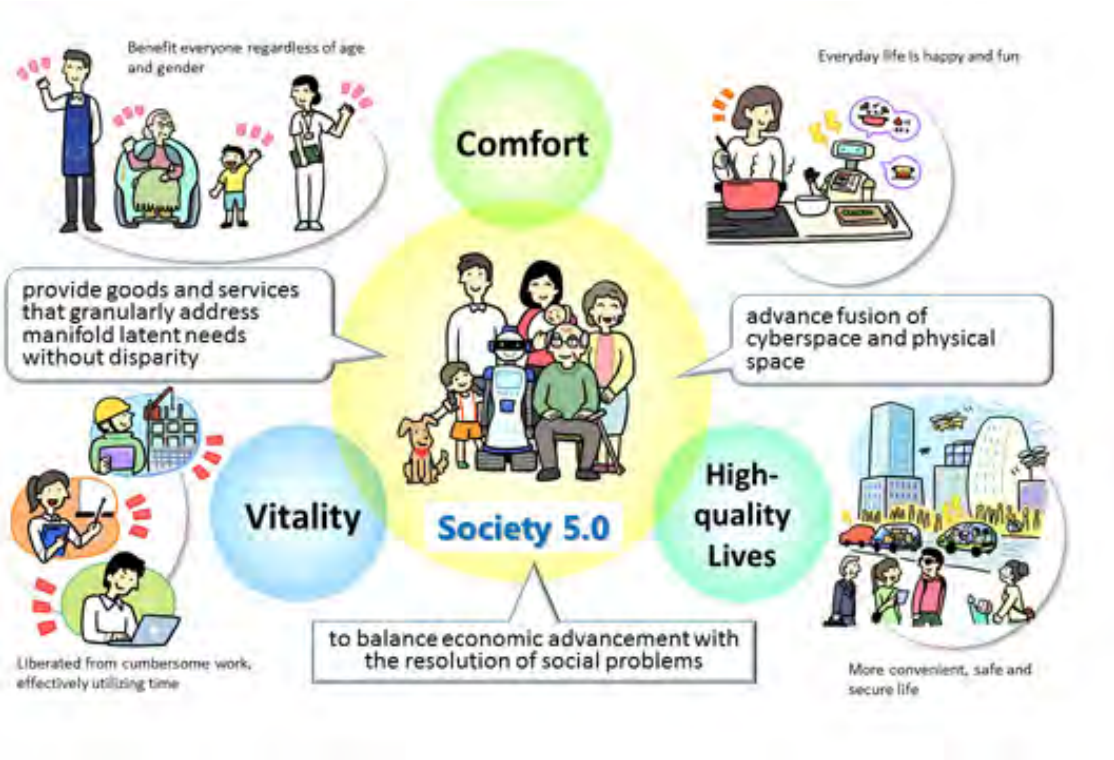
254.2km*25bridge/km*100parts*50000=30B JPY ≒ 300M USD



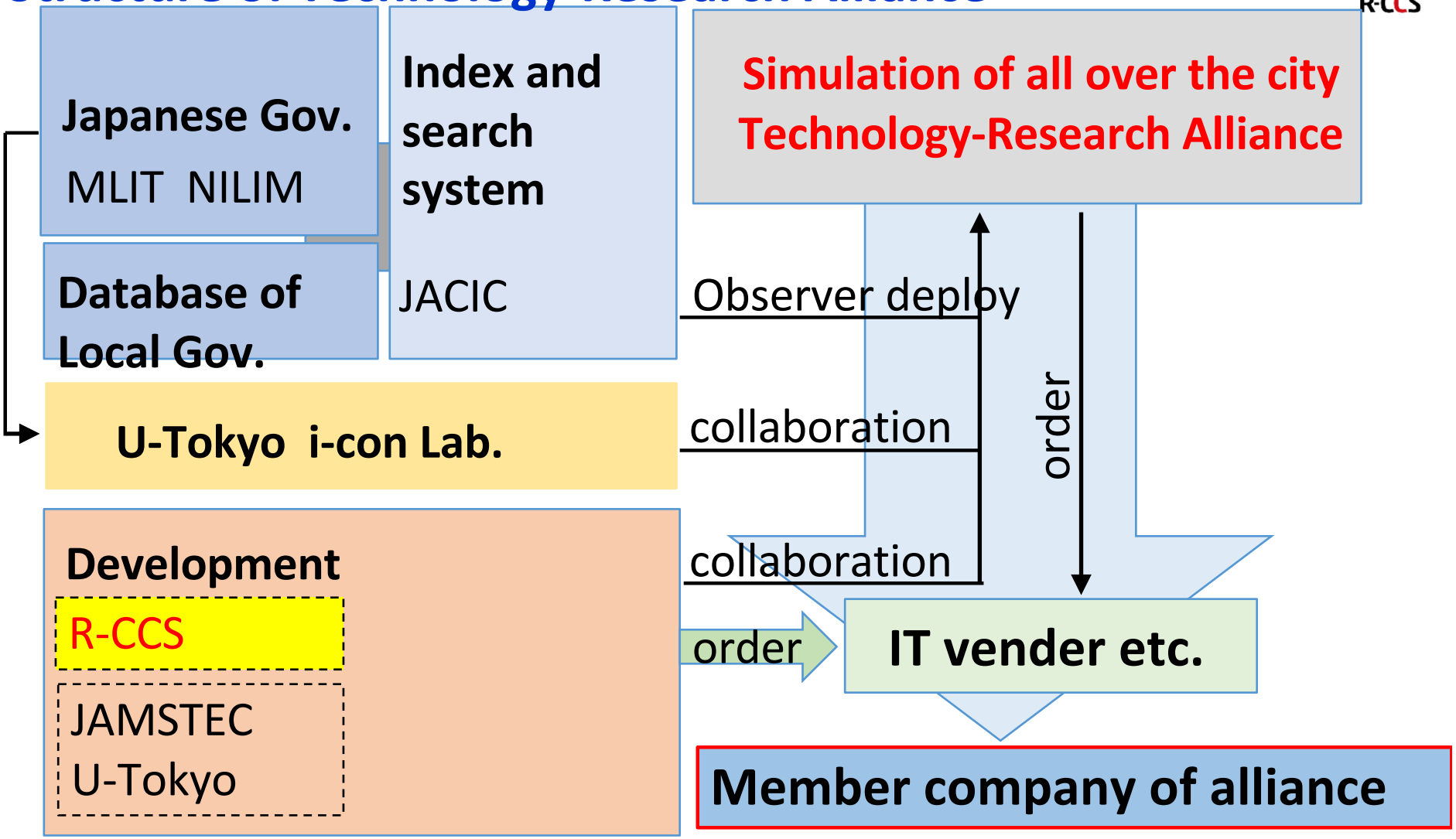
This will be a core system of Infra-data platform which is designed by MLIT, Japanese government

Society 5.0

- i-construction
- Infra-data platform



Structure of Technology-Research Alliance



We build Japanese “Digital Ensemble” in automatic way by using Data Processing Platform (DPP) for achieving Society 5.0