



Networking People, Communities, and Daily Lives

Digital Transport System of Expressway Operation and Maintenance in Japan



November 16, 2017

Seminar on "Boot up Digital Transport 2021"

Ministry of Transport, Kingdom of Thailand



NETWORKING PEOPLE, COMMUNITIES AND DAILY LIVES

Metropolitan Expressway Co., Ltd.



Digital Transport System

Why do we need Digital Transport System ?

- ✓ Ensure Safety
- ✓ Improve Environmental Quality
- ✓ Improve Customer Service
- ✓ Mitigate Labor Shortage
- ✓ Reduce O&M Cost

How we can boot up Digital Transport ?”

- ✓ Big Data
- ✓ Network Technologies
- ✓ Artificial Intelligence



Expressway Companies in Japan -toll road networks-

National Expressway



Nippon Expressway Co., Ltd. (NEXCO)
(West, Central, East)

Urban Expressway



[Metropolitan Expressway Co., Ltd.](#)
Hanshin Expressway Co., Ltd.

Other Expressway



Honshu-Shikoku Bridge
Expressway Co., Ltd.



Tokyo Metropolitan Area



Japan International Expressway Co., Ltd.

※Jointly established by 5 companies for overseas investment project

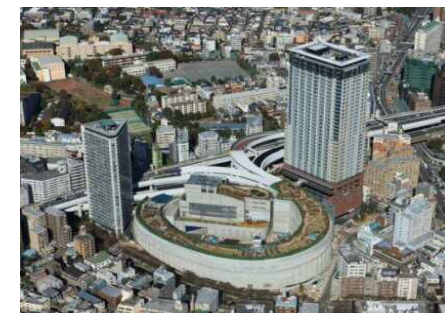
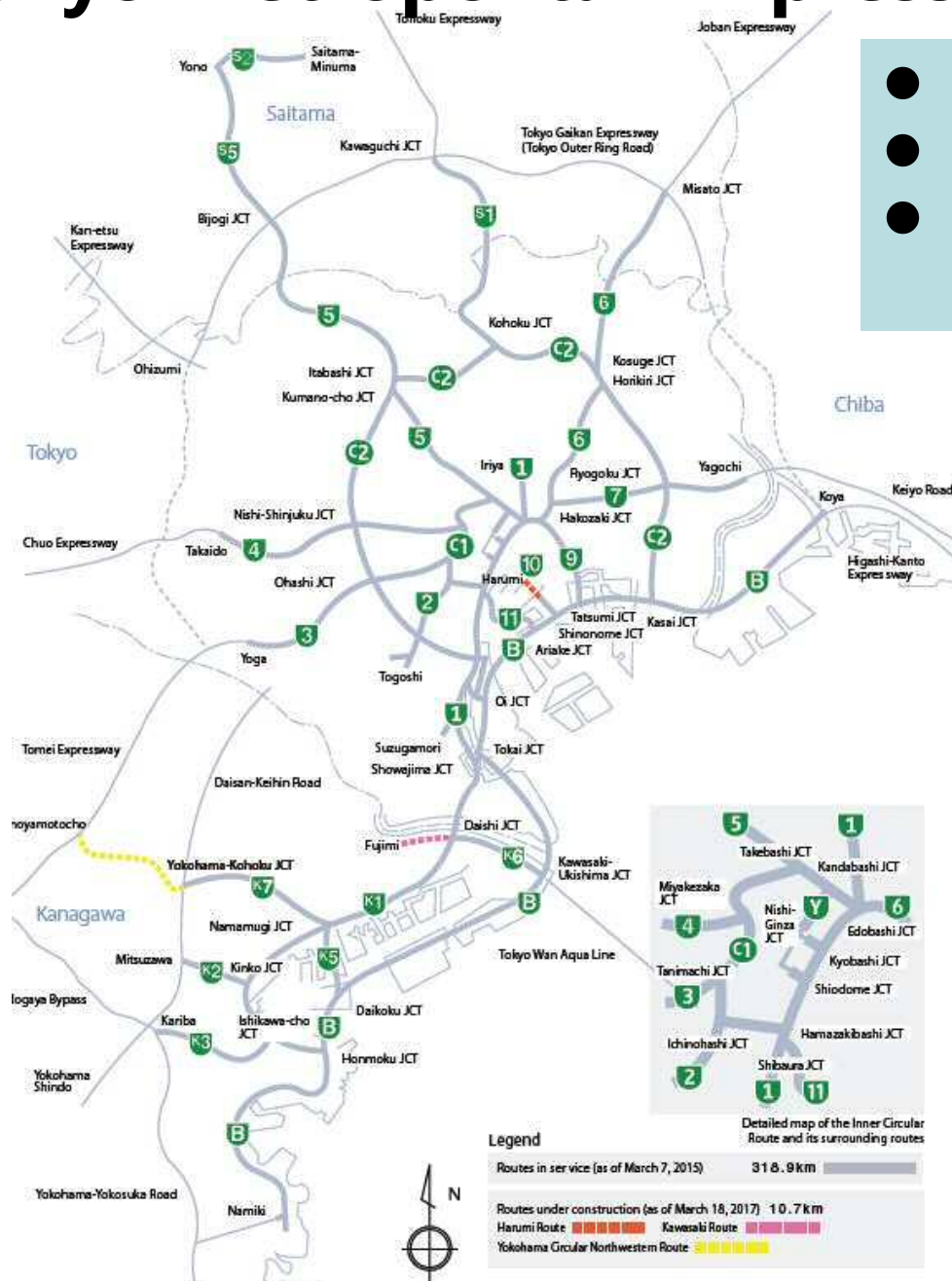




Tokyo Metropolitan Expressway

As of March 2017

- Total Length in Service: 318.9Km
- Traffic Volume: 0.97 million veh/day (ave)
- Toll Revenue: 269.4 billion JPY (\$2,449 million USD)





Our Mission

“Provide Safe, Reliable and Comfortable driving to customer”



Maintenance

Safety

Reliability

Comfort

Construction/Renewal



Operation



Digital Transport Systems for Operation and Maintenance in Shutoko

Operation

- Intelligent Transport Systems (ITS)
- Electric Toll Collection (ETC)

Maintenance

- Maintenance Information Management Systems (InfraDoctor and i-Dreams)

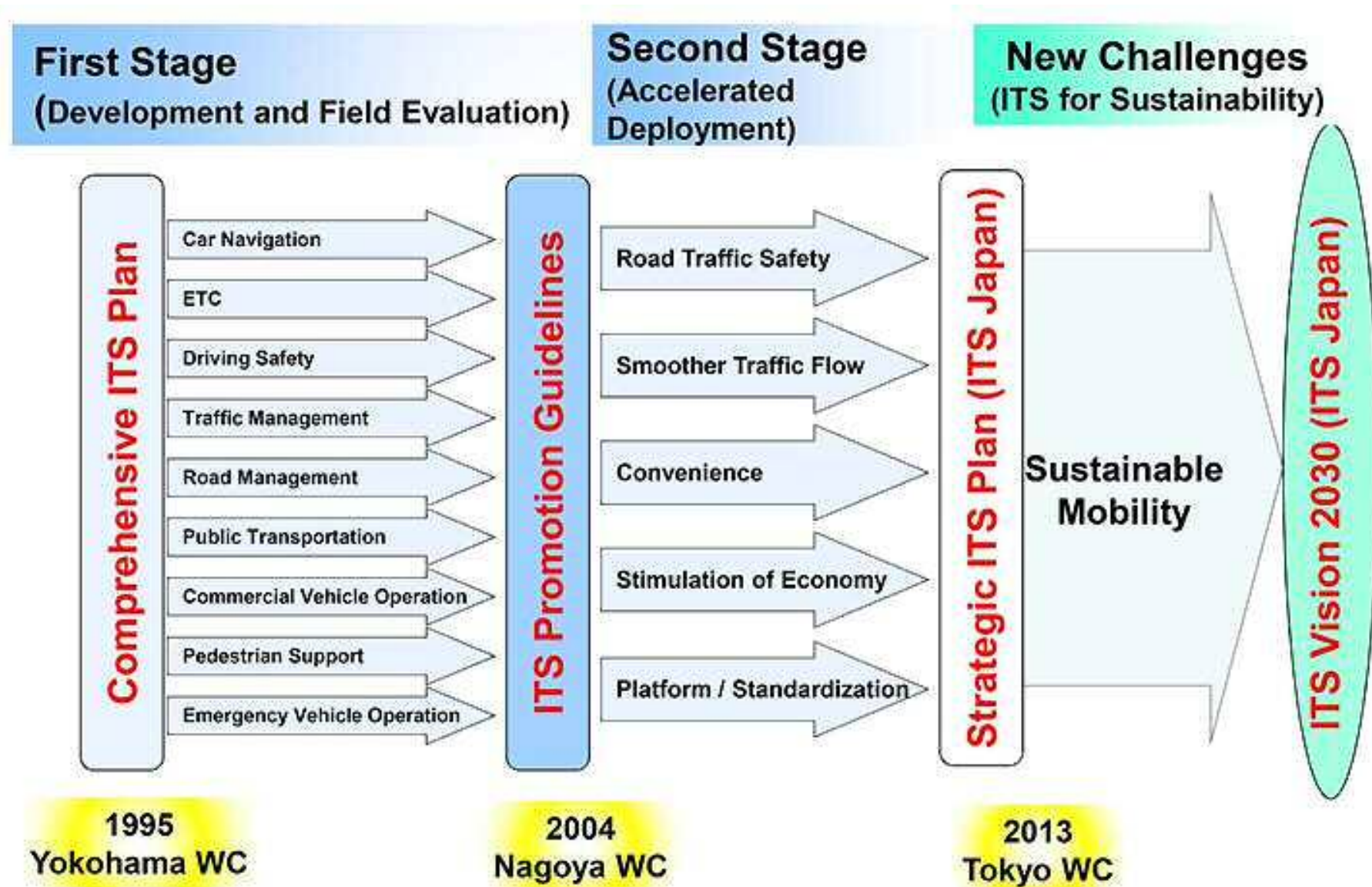
Intelligent Transport System (ITS)

- System to integrate people, roads and vehicles
- Solve road traffic issues
 - ✓ Congestion
 - ✓ Accidents
 - ✓ Environmental impacts



Source: ITS Technology Enhancement Association (ITS-TEA) <https://www.its-tea.or.jp/english/>

ITS Progress in Japan



Source: ITS Technology Enhancement Association (ITS-TEA) <https://www.its-tea.or.jp/english/>



Traffic Management of Shutoko -A Million Daily Traffic-

As of April 2015

Incidents

Fallen Objects

Year

25,522

Day

70

Accident

10,342

28

Vehicle Breakdown

11,209

31

129

Every 11 min. 1 incident!



Lane regulation



Patrol



Facilities control system



Traffic control system



Rescue



Crackdown (Overloaded Truck)

ITS Solution for Traffic Management

Provide drivers with real-time traffic information (update **every minute**)

Data Collection



Vehicle Detector



Anemometer



CCTV Camera



Emergency Phone



Patrol Car



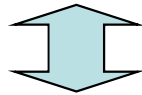
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Data Processing



System (Main functions)

1. Preparation of Traffic Data
2. Judgment of Congestion
3. Calculation of Travel Time
4. Production of Data to be Provided



Traffic Control Center

Data Provision



Graphic Information Board



Variable Message Sign



Graphic Information Board on street



Travel Time Information



Congestion Information



Wind Speed Information



MEX Navi

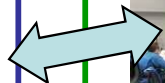
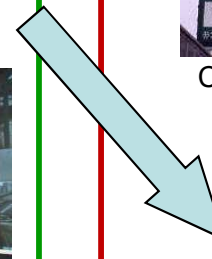


Information Center

Japan Road Traffic Information Center

Related Organizations

Auto/Manual



Traffic Information for Drivers

Japan Road Traffic Information Center



Personal Media



Car Navigation



Smart Phone

Advanced Operation Systems

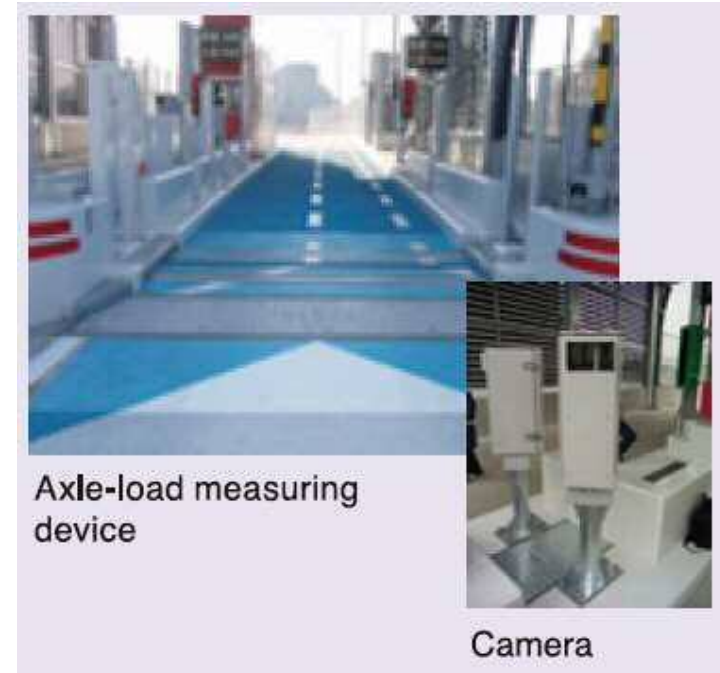
Incident Detection System

- Traffic incidents are automatically detected by processing images from CCTV camera.
- Employed for long-distance tunnel.



Automatic Axle-load Detection System

- Overloaded vehicles are automatically detected
- Installed at the toll gates





Electric Toll Collection

- Accurate, Fast and Secure Transaction
- Various Tolling
time, zone, Traffic Demand Management
- Reduce Workforce/Workload in Tolling
- Reduce Congestion and Accident in Toll Plaza
- Reduce Carbon Dioxide and Noise

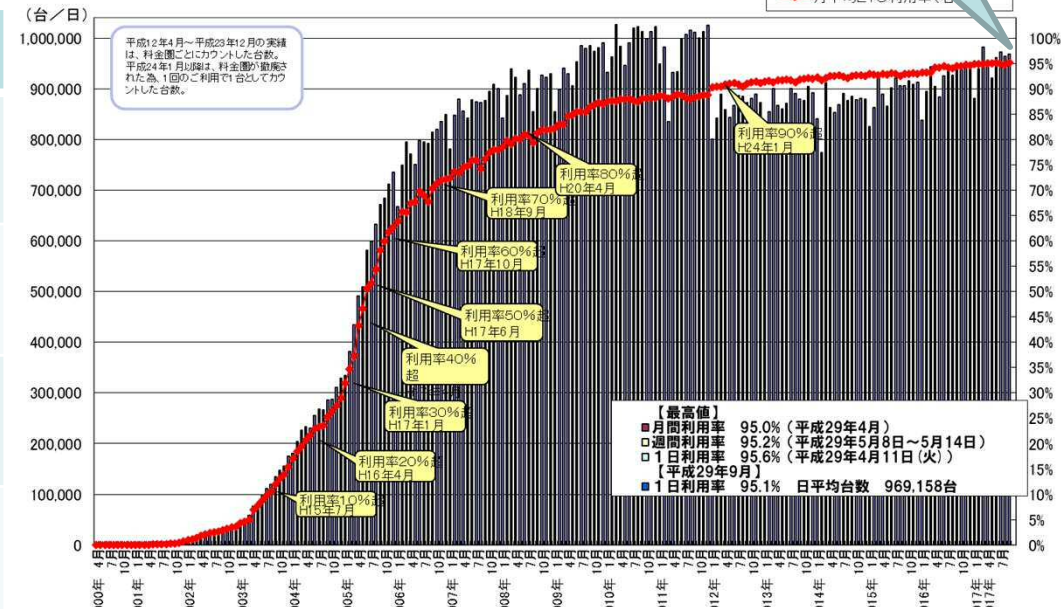
Tolling in Shutoko

Toll Rate: 5 class, distance based

Type of Vehicle	ETC (JPY)	Cash (JPY)
Compact	270~ 1,070	1,070
Standard	300~ 1,300	1,300
Middle	310~ 1,380	1,380
Large	390~ 2,040	2,040
Extra-large	460~ 2,600	2,600

- Toll rate increases JPY10 per 0.1 km
- Payment with credit card exclusively used for Electronic Toll Collection System

High ETC Usage Ratio



ETC Cleared Toll Gate Congestion



2002 (ETC Usage 1%)



2008 (ETC Usage 80%)



Electronic Toll Collection (ETC)

Error Ratio 0.03%



Surveillance Camera



ETC Lane Display



Wireless Device
(Antenna)



Vehicle Detector



Departure Point Control Unit



Roadside Display Unit

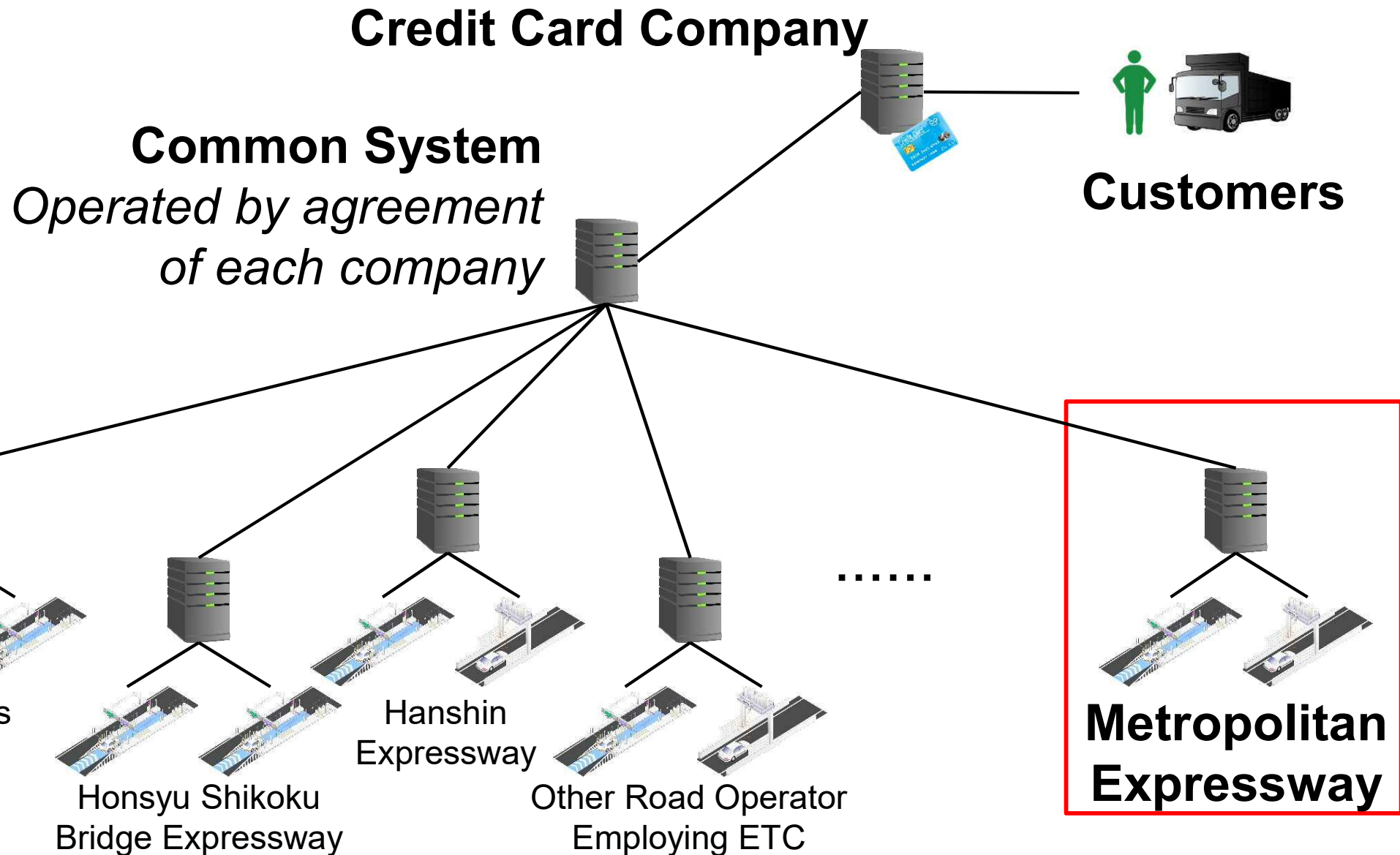


Entrance

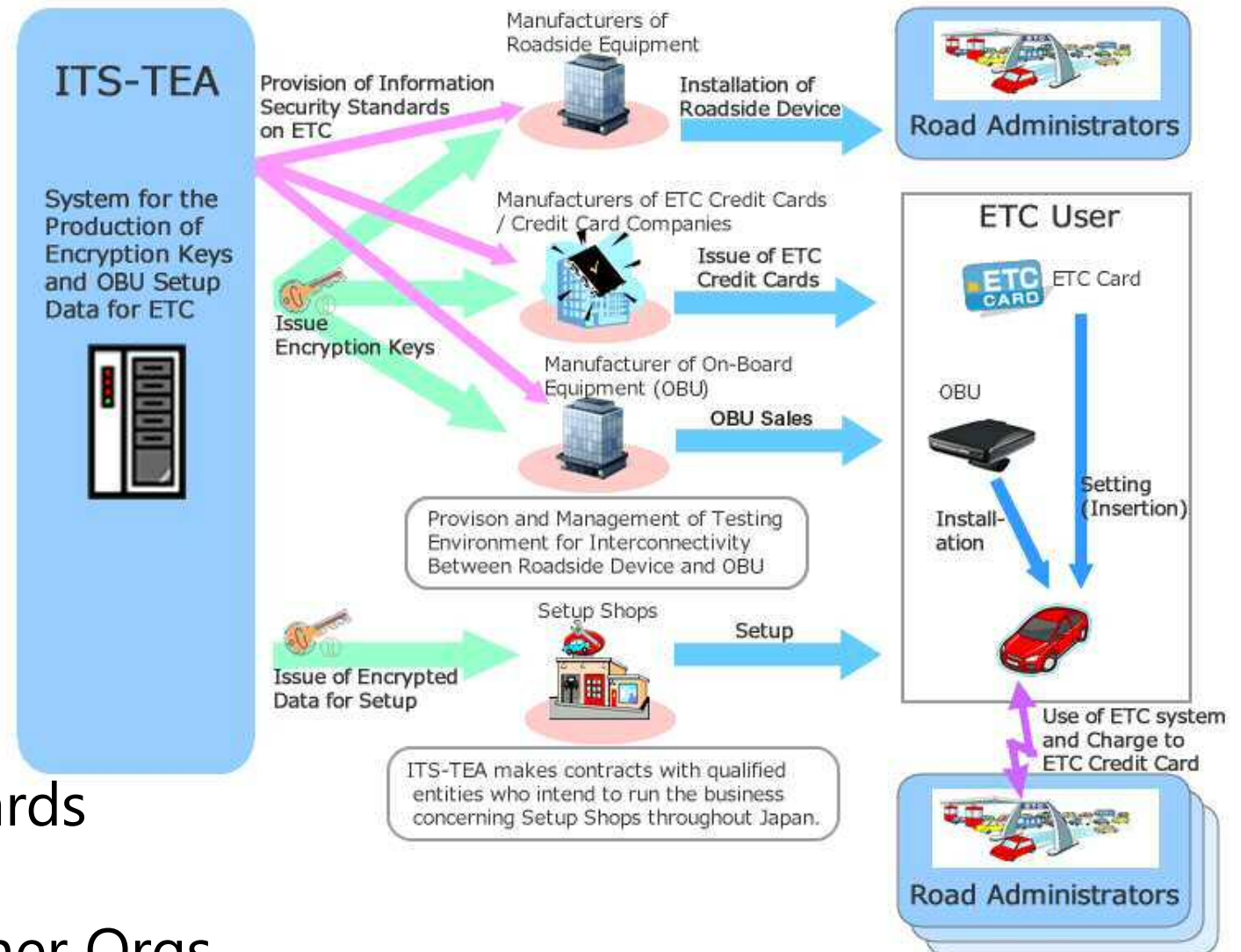


Exit (Free Flow Type)

Nationwide ETC System



ITS Technology Enhancement Association (ITS-TEA)



Mission of ITS-TEA

- Promotion
- Tech/Security Standards
- R&D incl. Expansion
- Tech Exchange w/other Orgs.

ETC 2.0

- Driving Support Services Using ETC System
- Communication between Roadside Antennas and Vehicles
- High-Throughput Bidirectional Communication System



- Information includes:
 - ✓ Safe Driving
Hazard ahead
 - ✓ Congestion Bypassing
Real time traffic condition
 - ✓ Disaster Management
Earthquake



Maintenance System

Objective:

- Ensure Safety for Customer and Society
- Appropriate Asset Management
- Reduce Maintenance Cost regarding Life Cycle Cost

Means:

- Strategic Maintenance Approach
- Maintenance Cycle
- Information Management System



Various Asset to be Maintained in Shutoko

As of March 2017

◆ Approx. 95% Structures out of 318.9 km

Type of structures	Length (km)	Percentage of length (%)	
Steel Girder	202.6	63.5%	95%
Concrete Girder	38.6	12.1%	
Tunnel	43.2	13.5%	
Semi-Underground	18.9	5.9%	
Surface Earthwork	15.9	5.0%	5%
Total	318.9	100.0%	100%



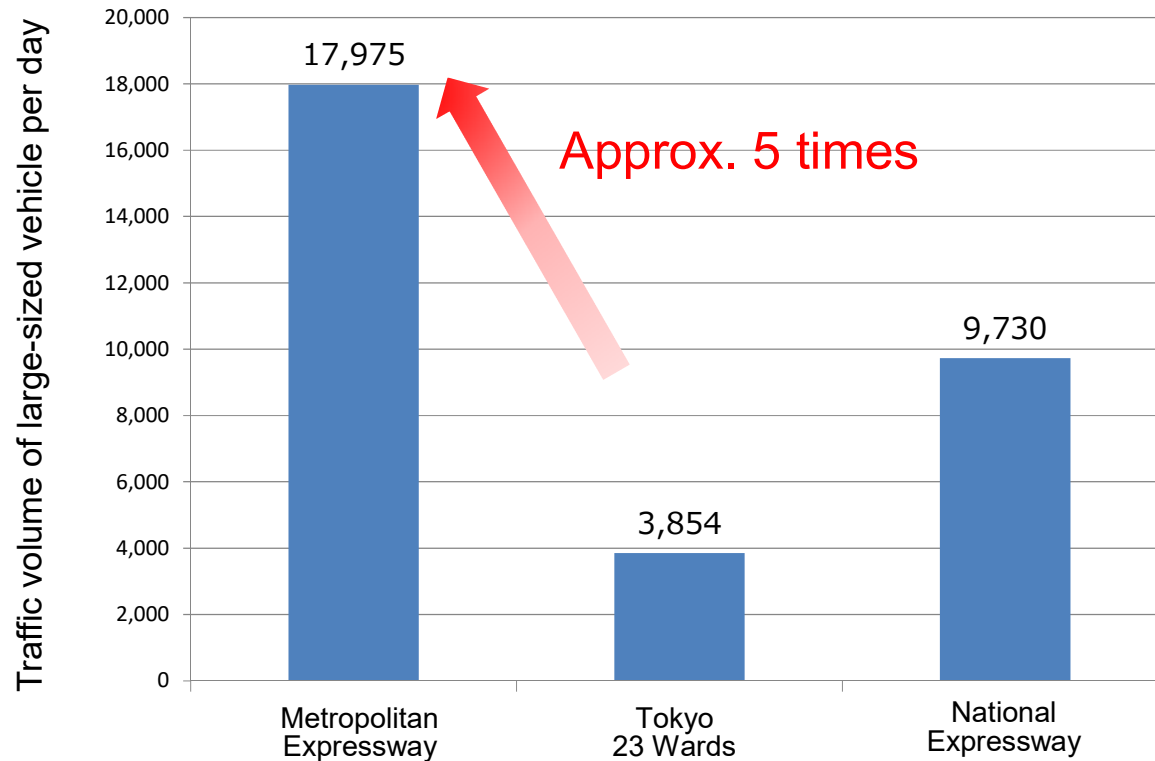
◆ Approx. 920 items/km Facilities

i.e. light, signage, traffic detector

Total 350 types, 290,000 items (Approx.)

Heavily Used Road Network

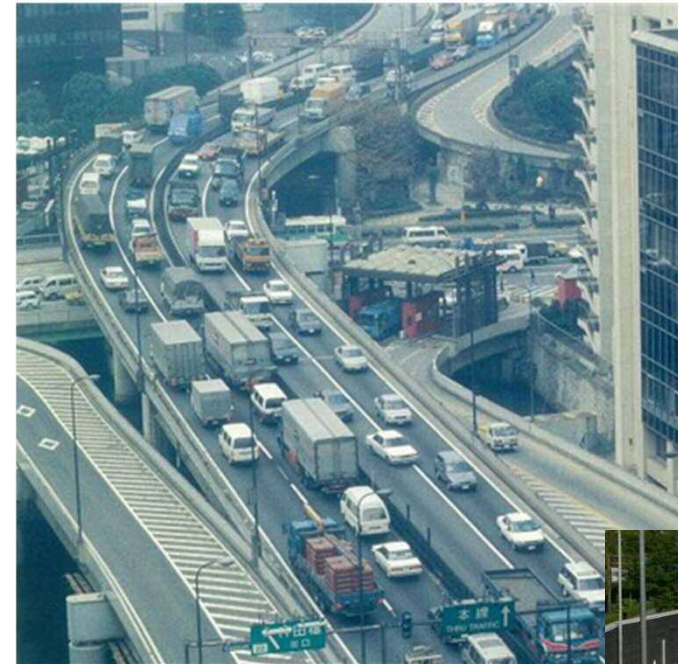
- The average traffic volume **970,000 vehicle per day**
- High Large-sized vehicle volume **5 times of local roads in Tokyo**



Source : Road Traffic Census, 2010

All data : Spot traffic volume of large sized vehicle on weekdays;

Total of traveller km of 24h (weekday) of vehicles mentioned / Total length of routes

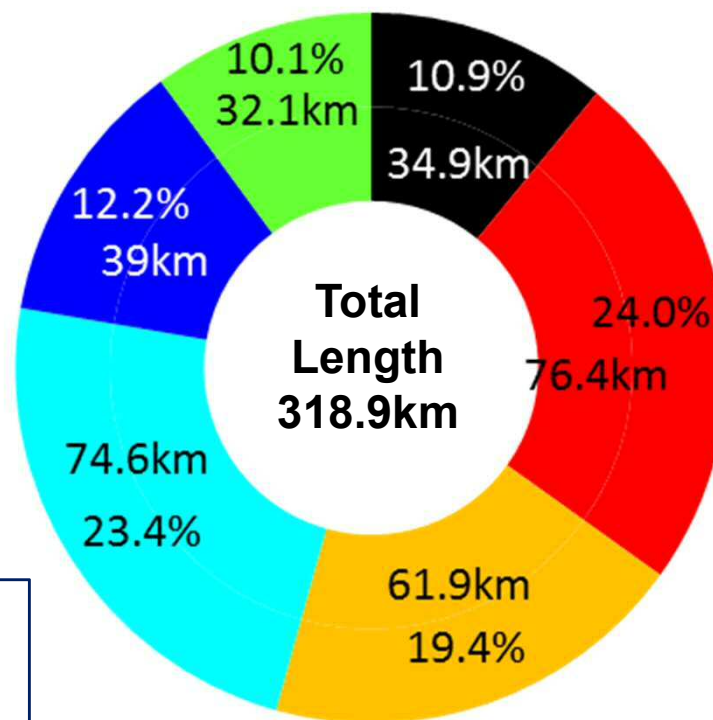
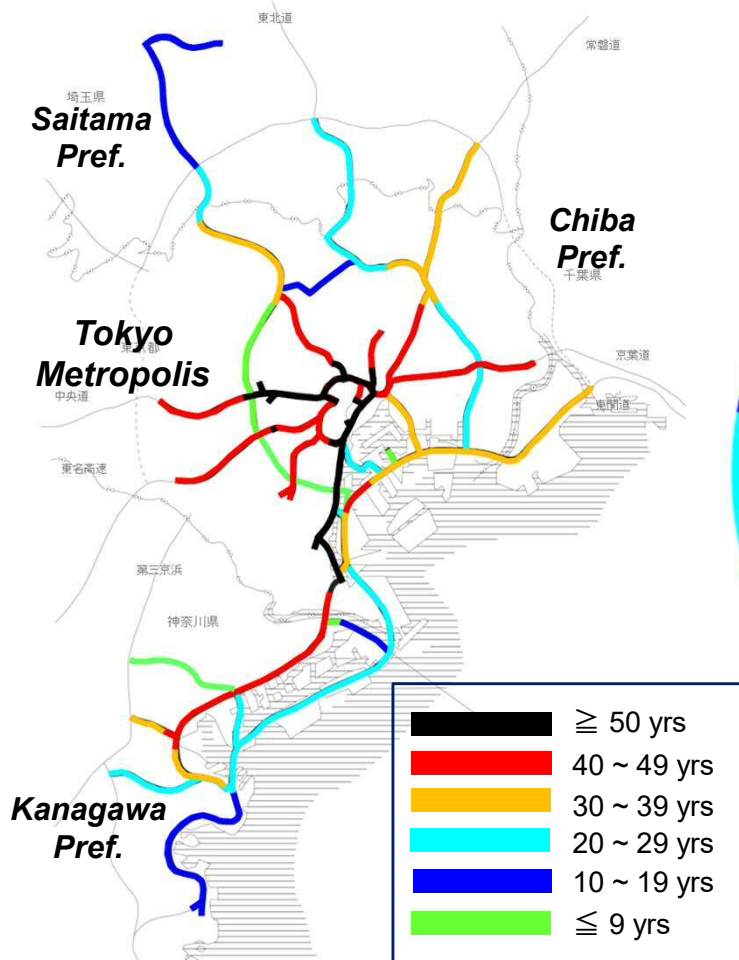


Number of violation vehicle with more than 12tf axle weight: 150,000 times
⇒ **Approx. 410 time/day**

Aging Structures Over 50 years

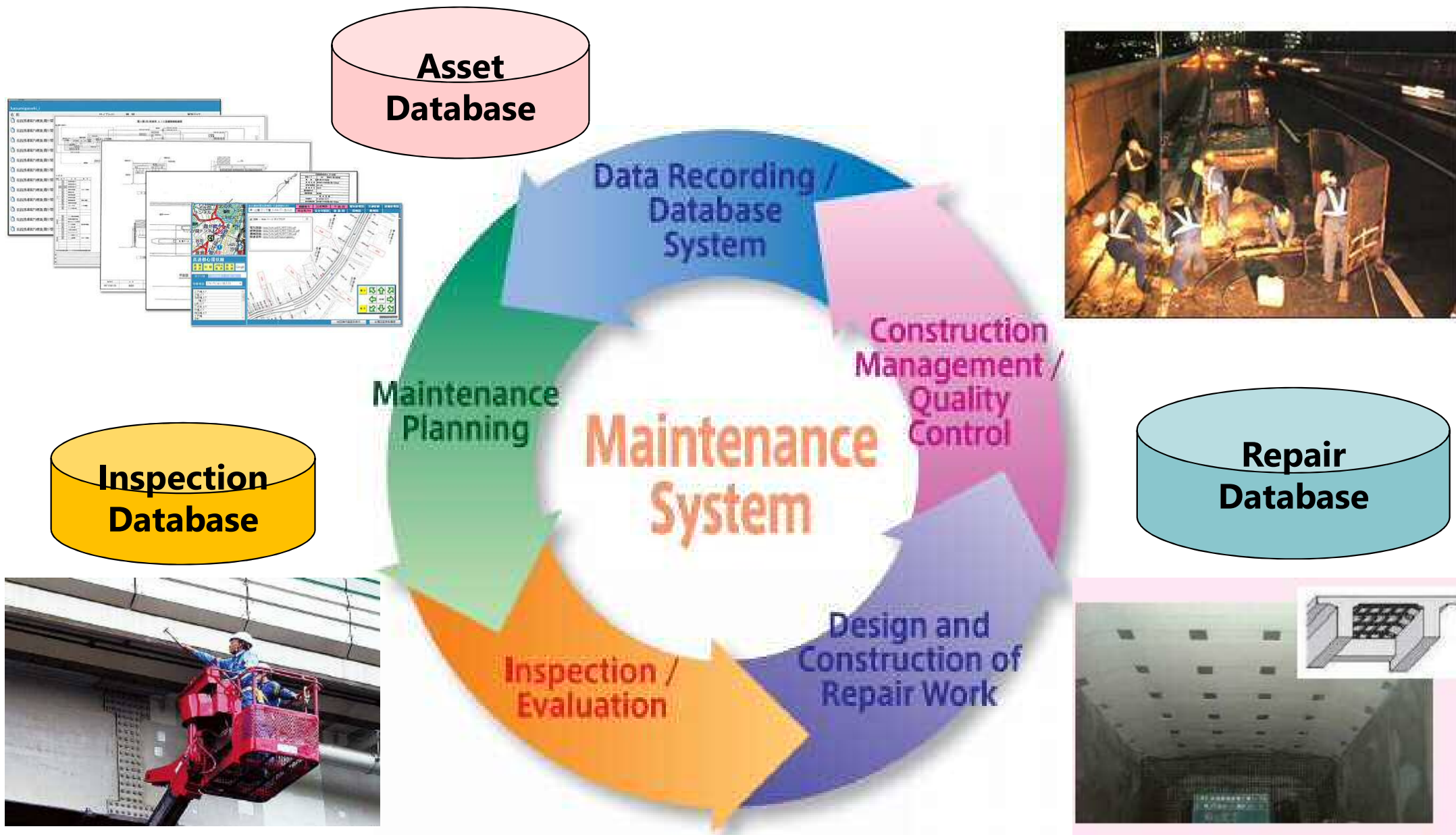
- 11%(35km) in service 50+ yrs
 - 35% (111km) in service 40+ yrs
- In 2027 1/3 structures are 50+ yrs**

As of March 2017



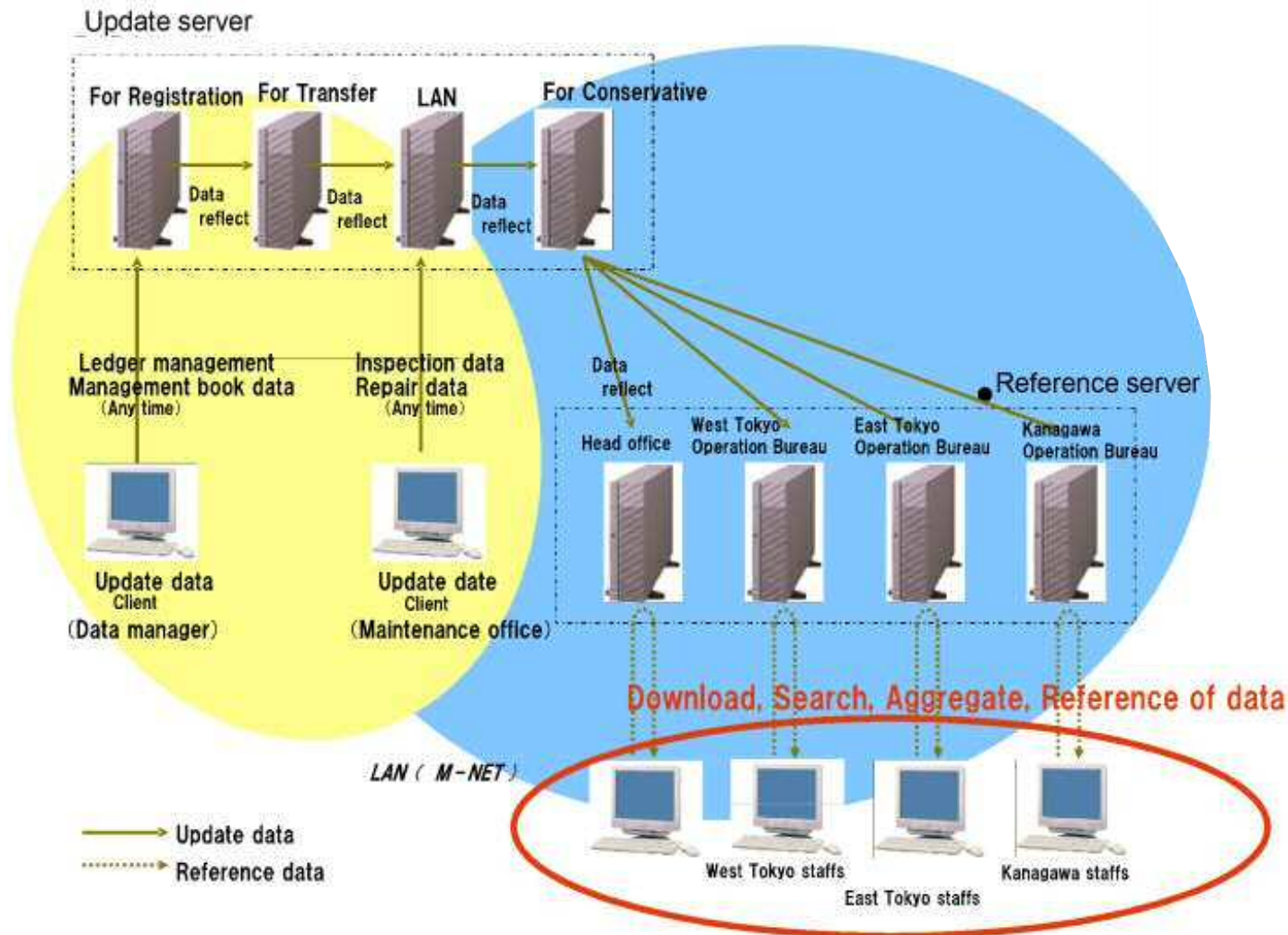


Maintenance System with Integrated Database



Team up for Maintenance with Integrated Data Base

All engineers can share information in data base by individual PC through internal LAN



Shutoko Operation Bureau

Maintenance Management Div.

Planning and Environment Div.

Civil Engineering Maintenance Design Div.

Maintenance Work Office

Shutoko Group

Shutoko Engineering (Inspection)

Shutoko Maintenance (Maintenance of Work)

Highway Technology Research Center (Database)



Maintenance System with Virtual Road Model

InfraDoctor[®]

New Maintenance System launched in 2017

3D point cloud data, GIS platform and Cloud Server



Metropolitan Expressway Company Limited



Shutoko Engineering



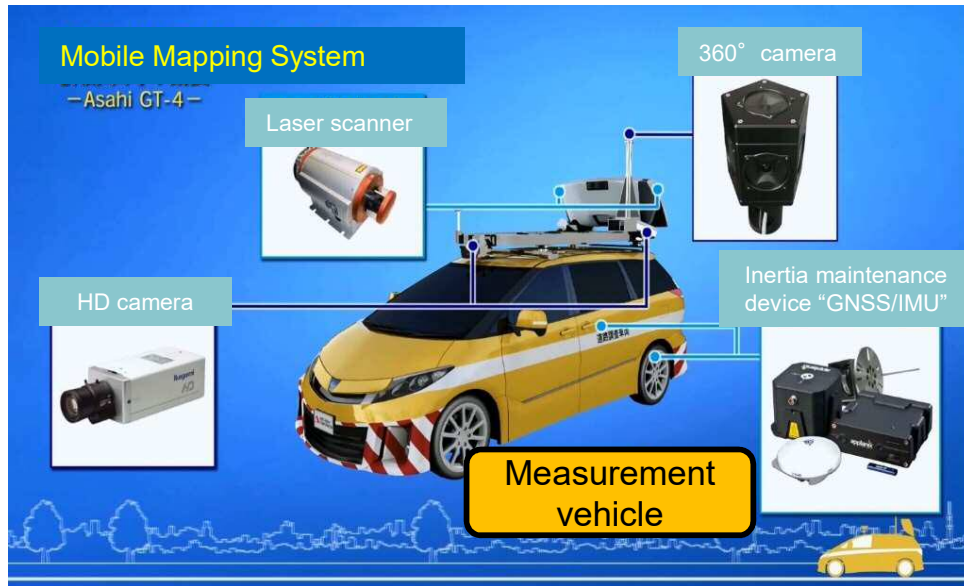
ELYSIUM



AERO ASAHI CORPORATION



InfraDoctor



3D Point Cloud Data

by Mobile Mapping System

- Laser Scanners
- 360 deg. Camera
- High Density Camera



Cloud Server

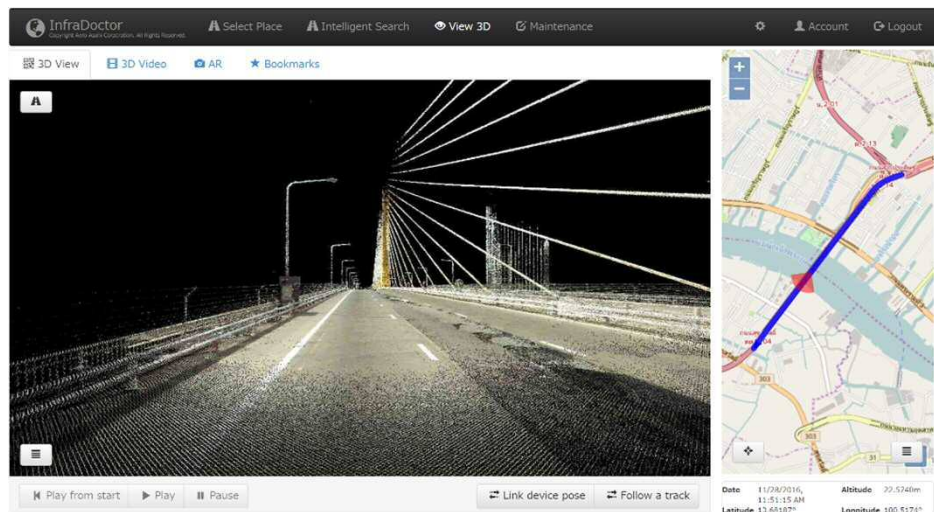
3D Point Cloud Data + GIS Map

- Asset Database
- Inspection Database
- Repair Data
- As-built drawing

Deployment of InfraDoctor in Thai



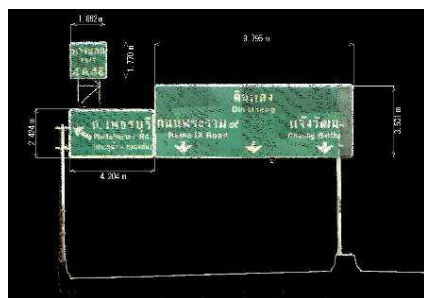
Measurement work in EXAT



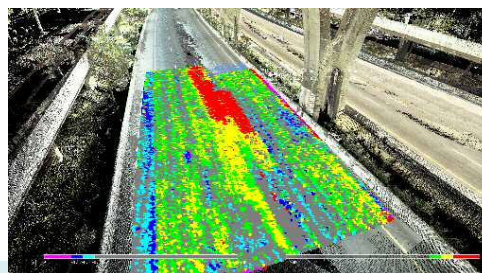
GIS Database with 3D Point Cloud Data (Rama 9 Bridge)



Example of 3D Point Cloud Data (EXAT)



Measurement of signboard dimension



Road surface monitoring (level)



i-DREAMs

Intelligence-Dynamic Revolution for Asset Management Systems

i-DREAMs provide seamless dataflow
among design, construction and maintenance



Structural
Deterioration
Analysis



InfraDoctor



Smart Inspection
Systems

Damage Analysis by Artificial Intelligence

Information Management for On-going and Future Projects

“Boot up Digital Transport” Current effort in Japan

i-Construction

- Integration of construction and ICT (Information and Communication Technologies)
- Seamless dataflow from design to maintenance
- Dramatically enhance overall productivity of construction



Autonomous Vehicle

- 3D point cloud data from InfraDocotr will be able to use for 3D digital map for the vehicle



What we have learned form Digital Transformation

- Digital Transformation is key element for operation and maintenance of the expressway.
- Expressway companies need to commit technical development of digitalization, because the road operators own needs.
- On the other hand, human factor is very important especially in decision making process (i.e. defining system specification, evaluate output from systems...)

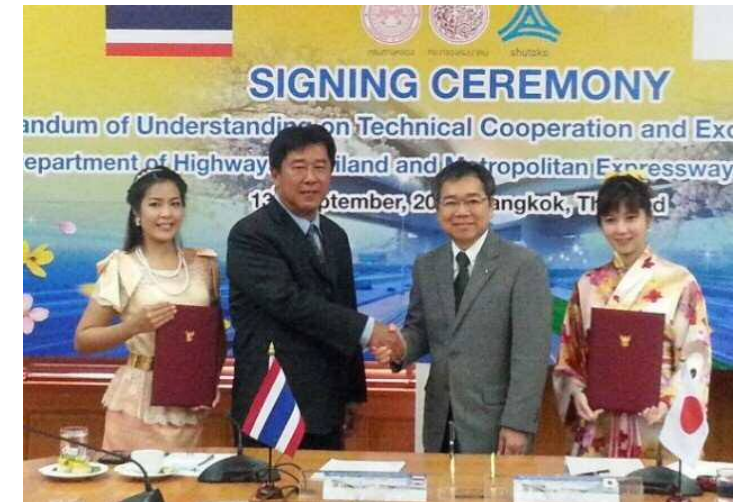
Shutoko in Thailand

- Shutoko Bangkok office (since June 2011)
- MOU with 5 road related-organizations
- Tech. exchange program (training/seminars) in Japan and Thailand (5 in Thailand)
- 9 Engineering consulting projects (ETC and ITS)
- 4 JICA/MLIT consulting projects

List of MOU (Thailand)

Organization	Date
Expressway Authority of Thailand (EXAT)	2010.4.7
Bangkok Expressway and Metro Public Co., Ltd. (BEM)	2012.7.18
Don Muang Tollway Public Co., Ltd. (DMT)	2012.8.30
Sirindhorn International Institute of Technology, Thammasat University (SIIT)	2015.7.21
Department of Highways, Ministry of Transport (DOH)	2016.9.13

※MOU: Memorandum of Understanding



MOU Signing Ceremony with DOH (Sep. 2017)



JICA Project (Technology Transfer)
(DRR Bridge Inspection Manual)



Shutoko Bangkok Office

Director: Mr. Seiji KUROKAWA

Address: Suite 1806, Level 18, Park Ventures Ecoplex,
57 Wireless Road, Lumpini, Patumwan, Bangkok, Thailand 10330

TEL: +66(0)2-309-3670, FAX: +66(0)2-309-3535, E-mail: **bangkok@shutoko.jp**



Kurokawa



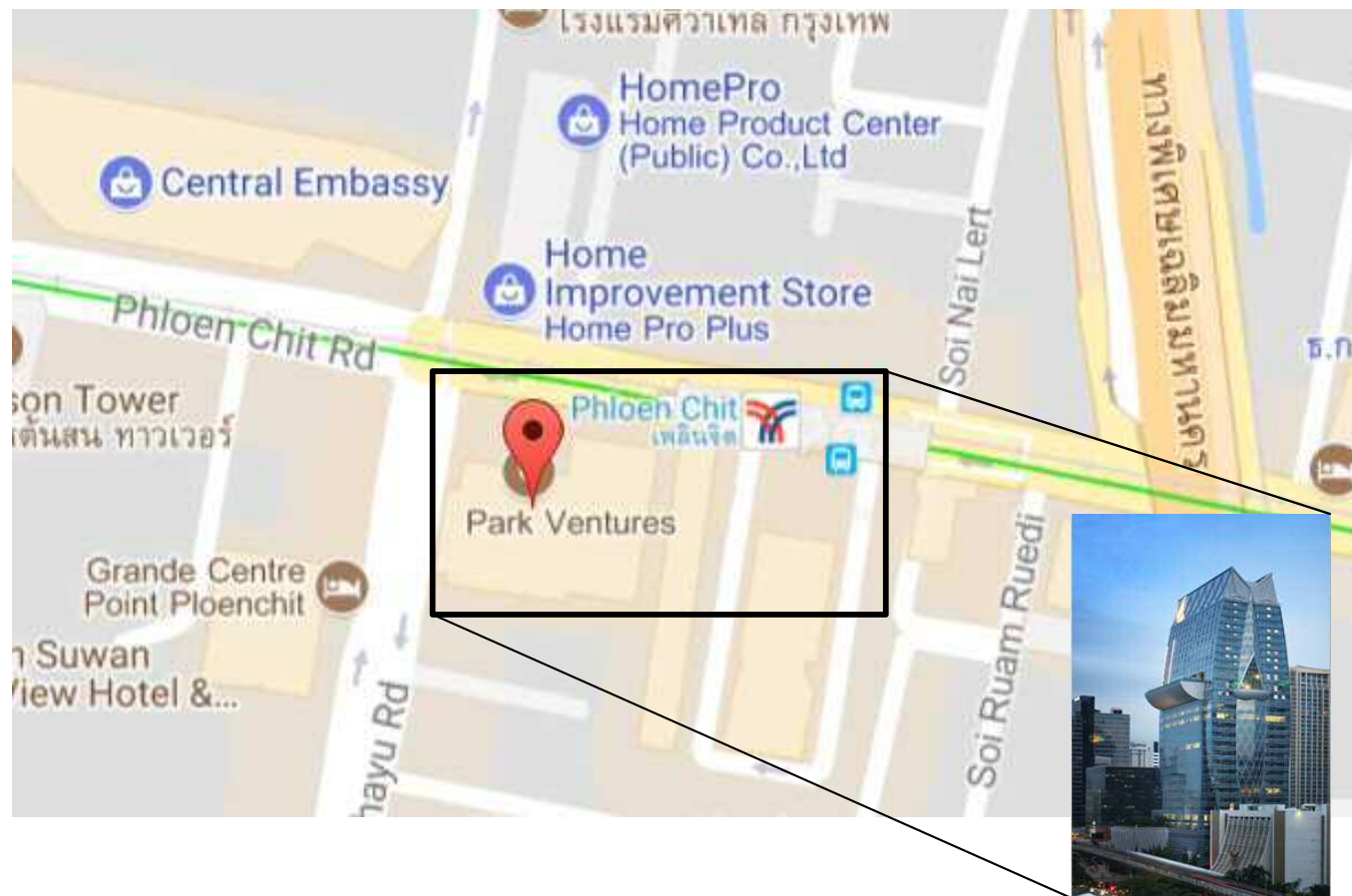
Chiba

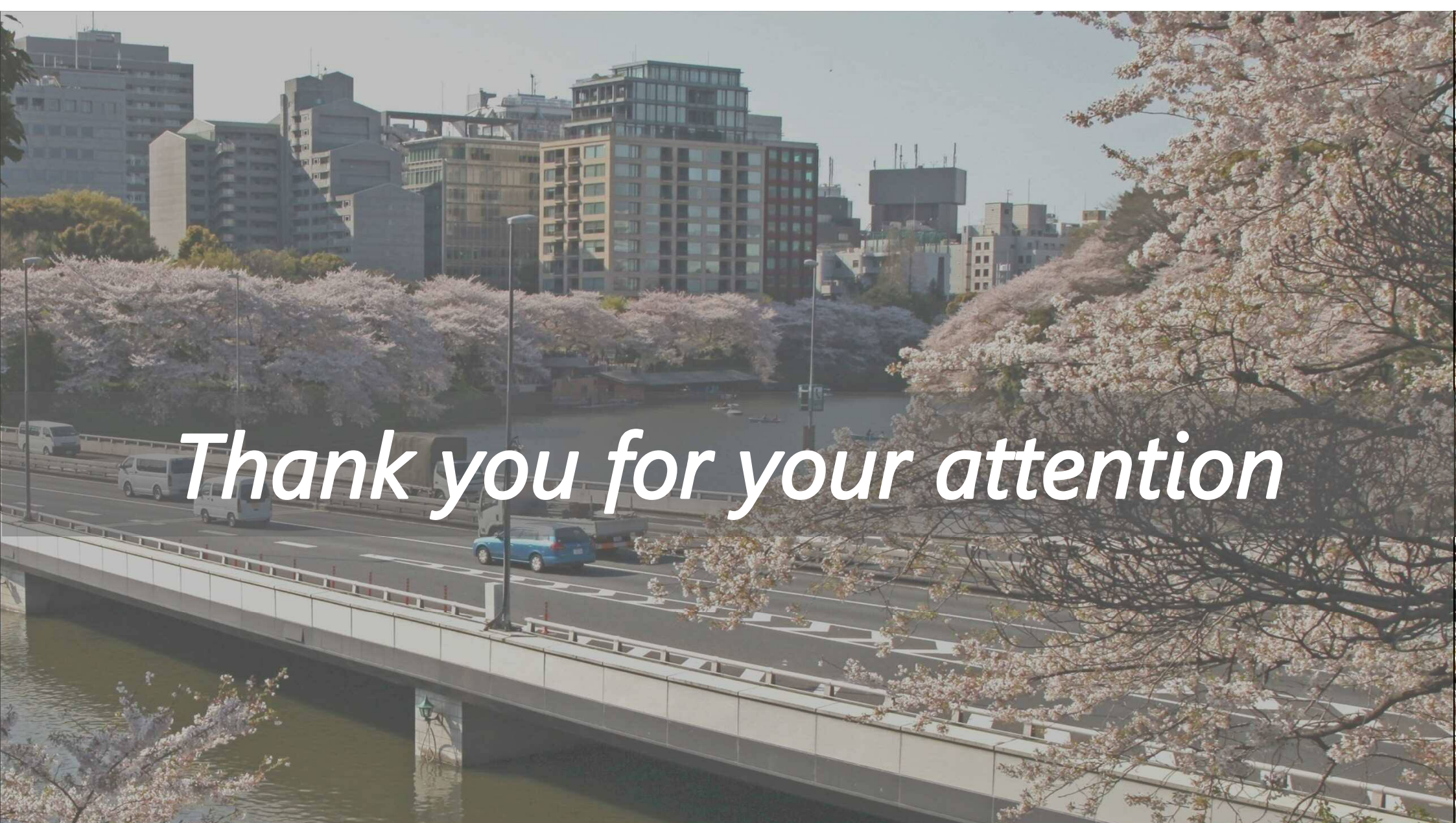


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Thank you for your attention



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<http://www.shutoko.co.jp/english>