TOYOTA INFOTECH
Envisioning Mobility

Envisioning Smart Mobility Society in the Connected Future

January 23rd, 2019

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TOYOTA INFOTECHNOLOGY CENTER CO., LTD.

What Customers and Society Want from Automobiles

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Ever-better cars (cherished cars)

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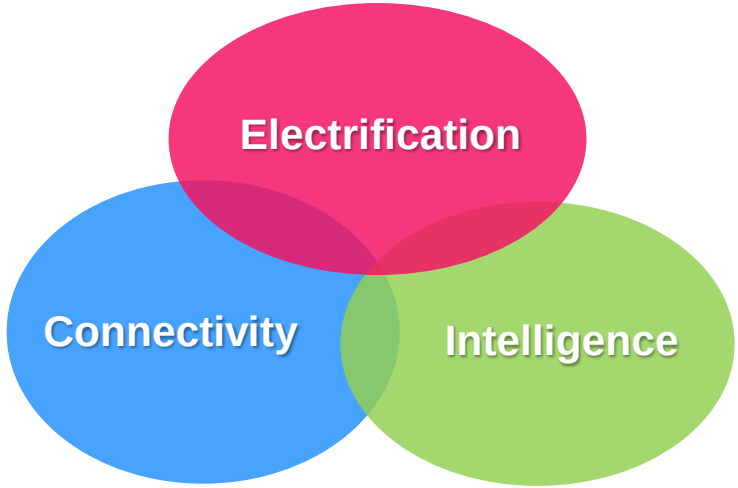

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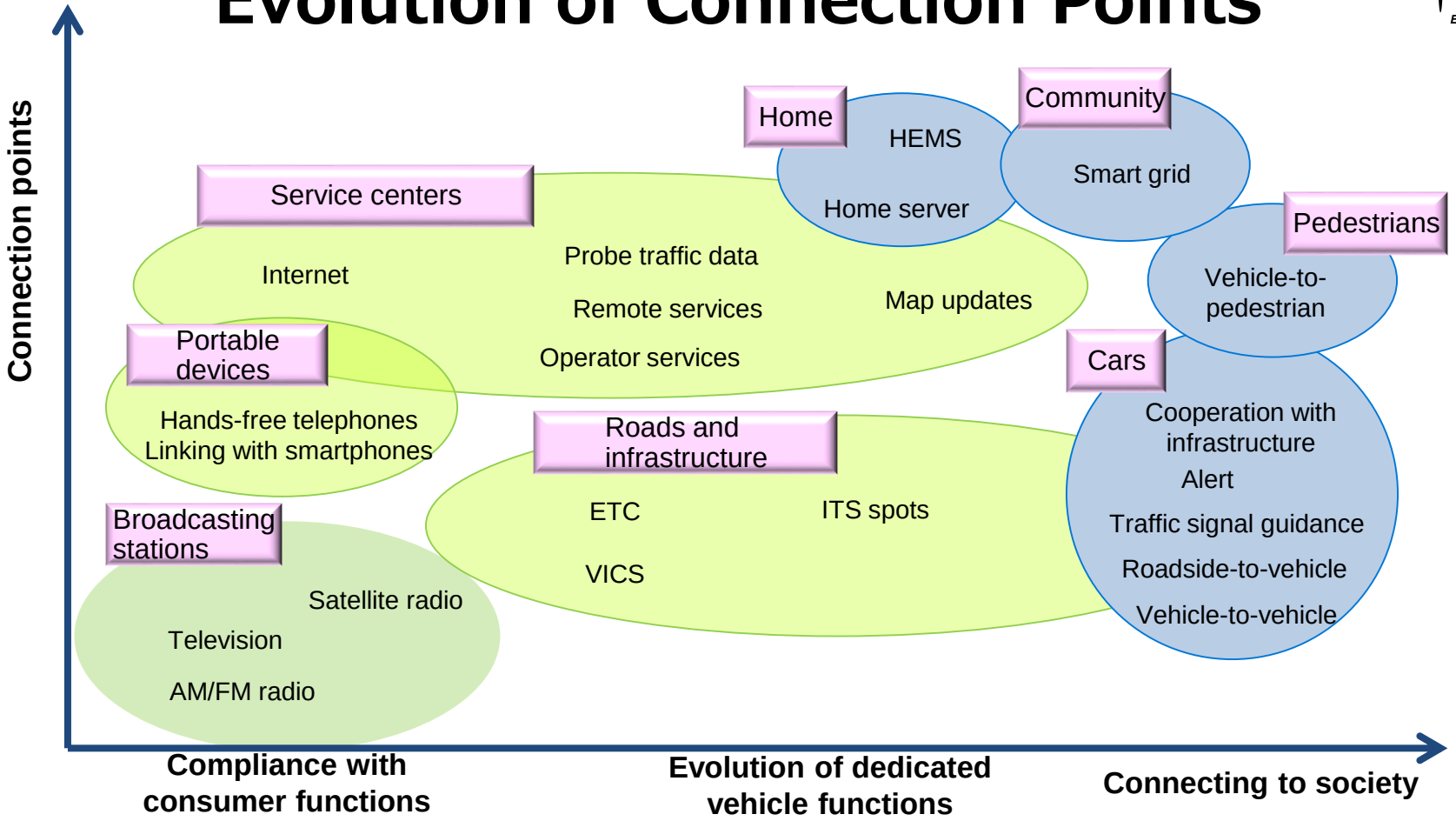
Envisioned new mobility society

Contents

Contents

Evolution of Connection Points



Driving Support Systems with Infrastructure Cooperation

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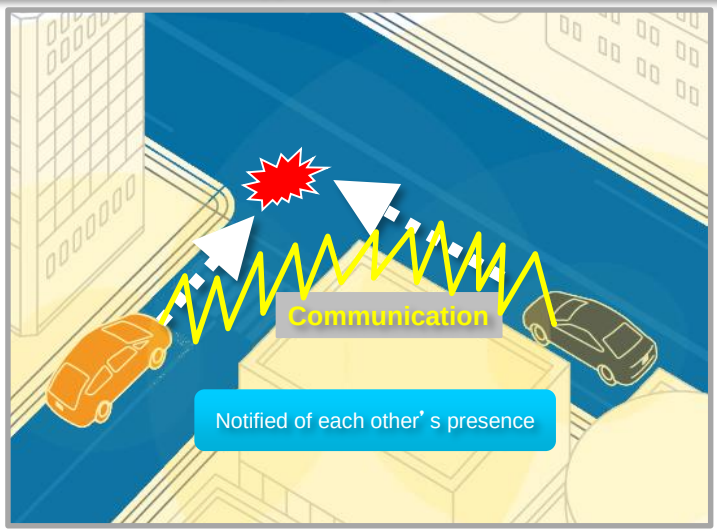
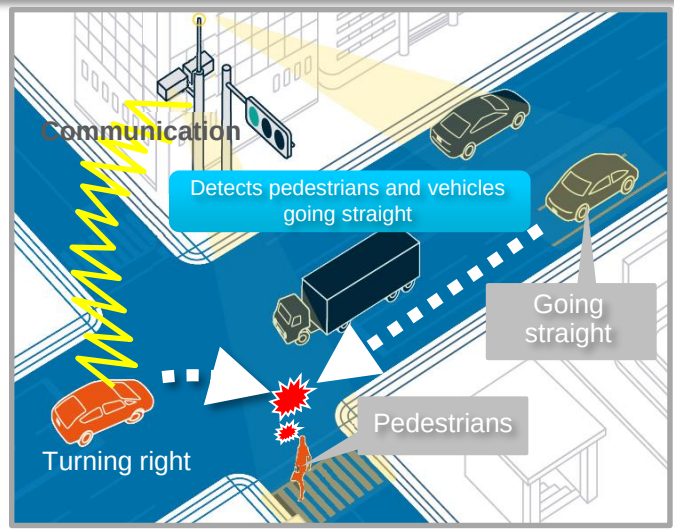
- **Vehicle-to-vehicle and roadside-to-vehicle communication prevent accidents with cars or pedestrians at intersections with poor visibility.**

Prevent a crossing collision through communication with the approaching vehicle

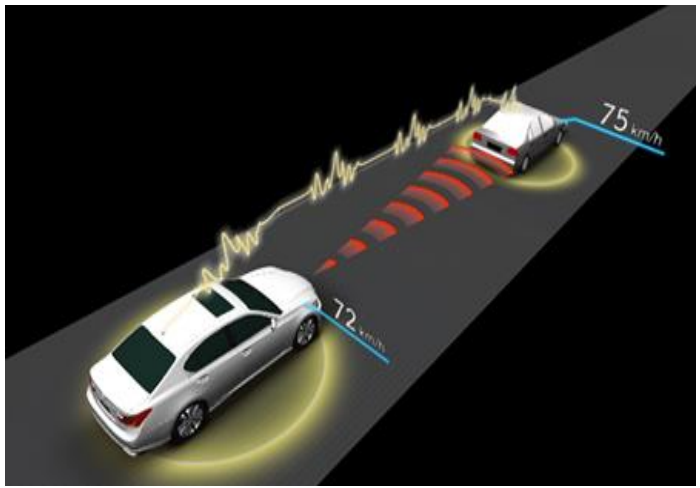


Detected by sensors, preventing a right-turn collision



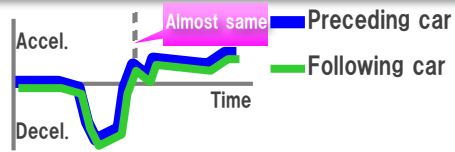
Cooperative – ACC

- Realize stable follow-up running, based on acceleration information of vehicles ahead
- No unnecessary acceleration and reduction of traffic congestion

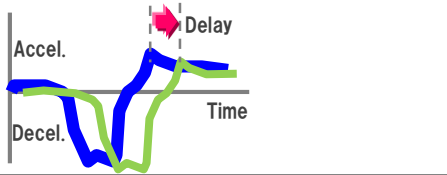


Acceleration/deceleration in platooning

C-ACC



Ref.: Cruise control with radar only



Social loss by traffic congestion (yearly)

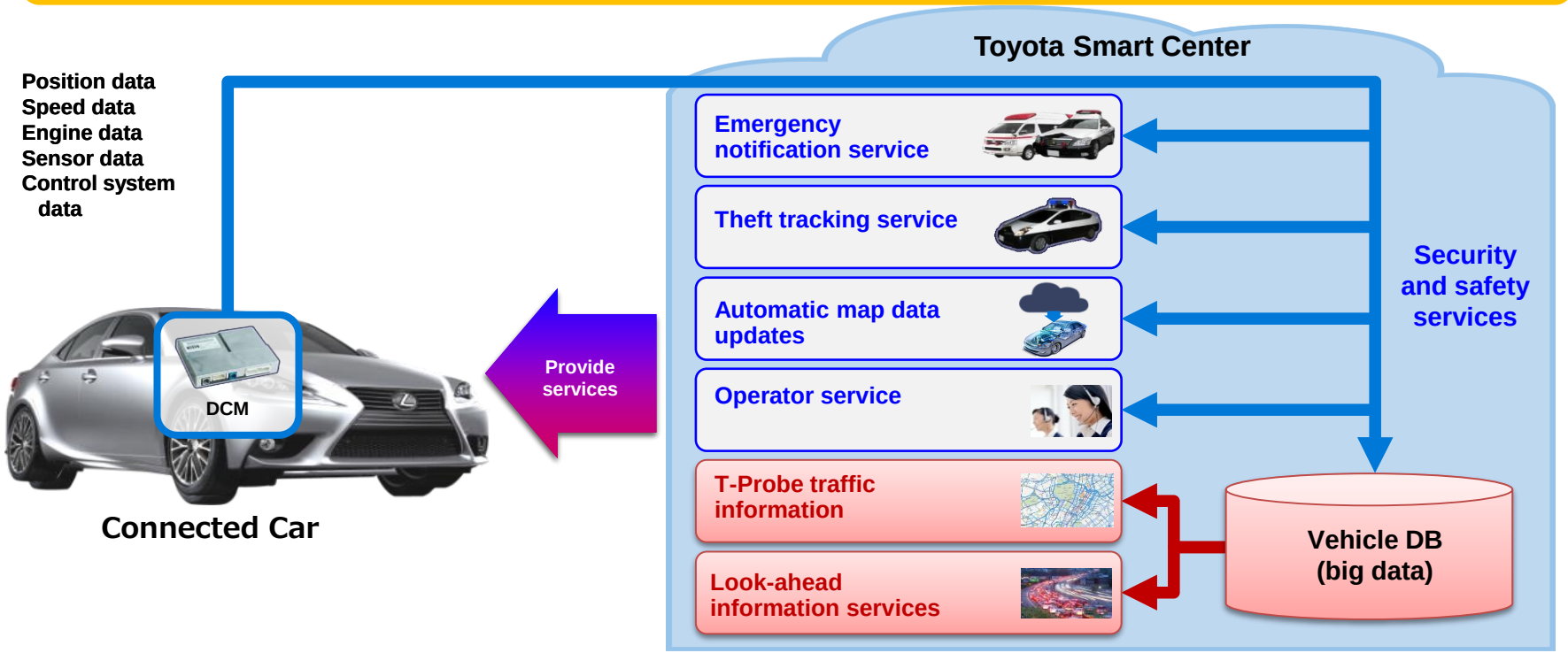
3.81billion hours

Approx. 10 trillion JPY

Source: The white paper 2007 by the Ministry of Land, Infrastructure, Transport and Tourism

Current Connected Services

- On-board communication device (DCM) mounted to expand points of contact with customers.
- Offer various services to support a secure, comfortable and safe car life by being connected
- Realize a more fulfilling mobility society through the use of big data collected from vehicles.



Advanced Automatic Crash Notification System (AACN)

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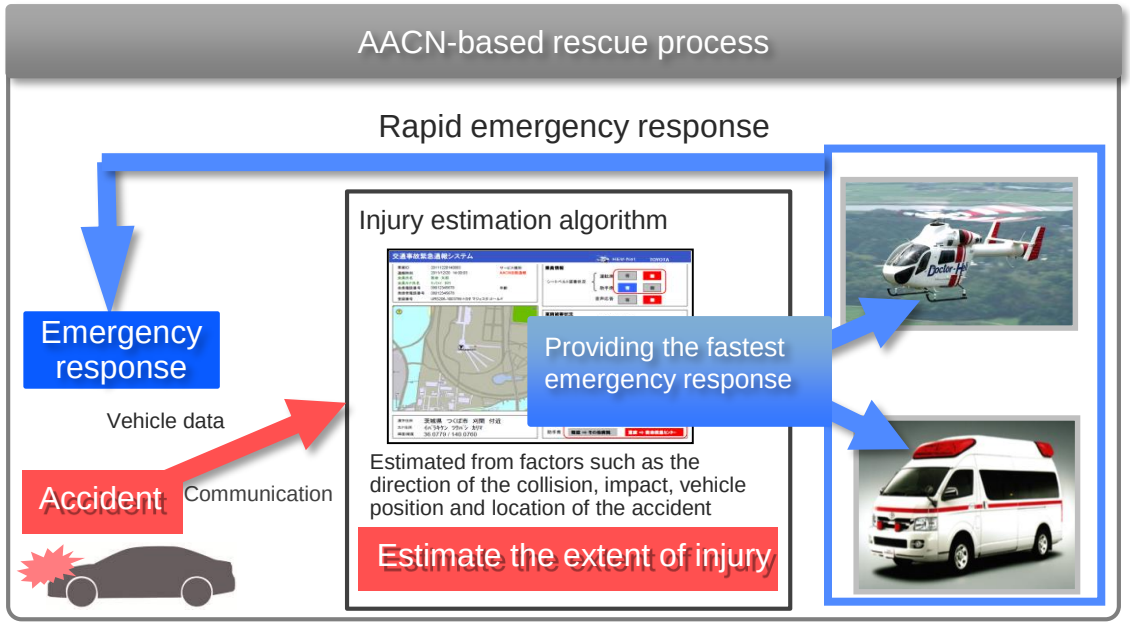
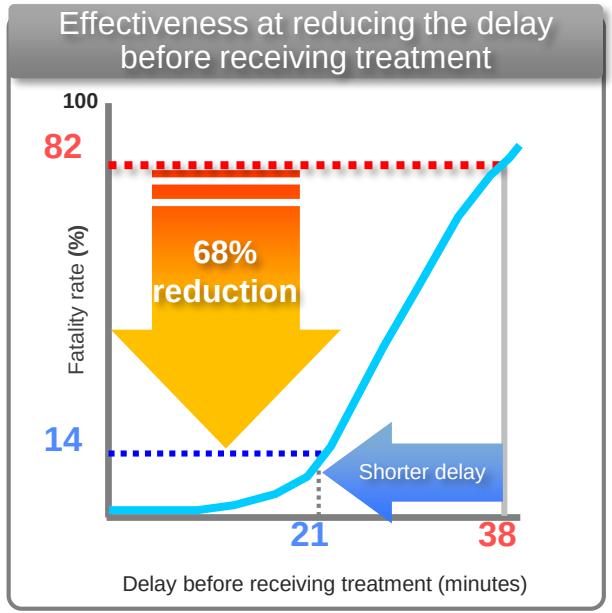
- **Estimate accident conditions and injury severity from vehicle data, request the dispatch of a medical helicopter depending on the extent of obstructions, and shorten the delay before the emergency response.**





http://www.mlit.go.jp/jidosha/anzen/02assessment/data/h28_3_4_2.pdf

Deepening of Human Connected Services

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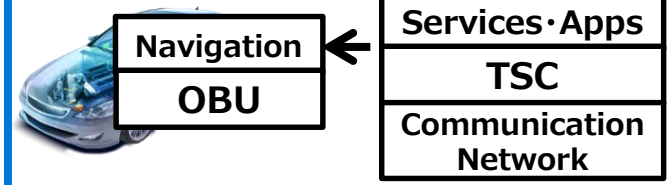
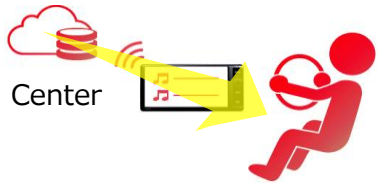
Former Telematics Services



OBU: On-Board Unit

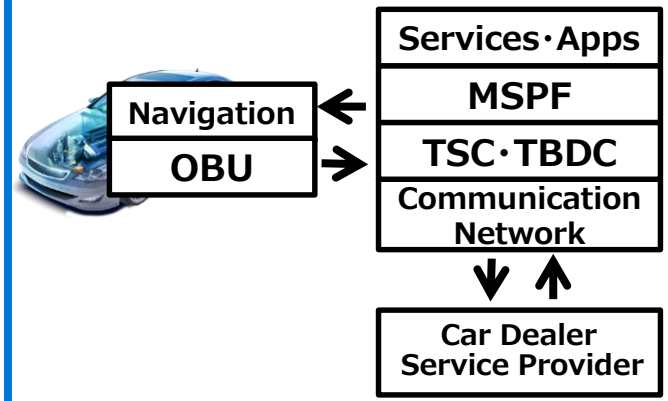
Example : Information Delivery



・Music
・Map Updates
・Apps
・Notifications

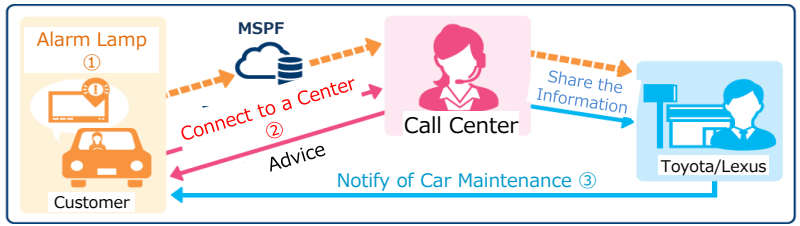
One-way Service

Connected Services



Example : e-Care（Driving Advice）

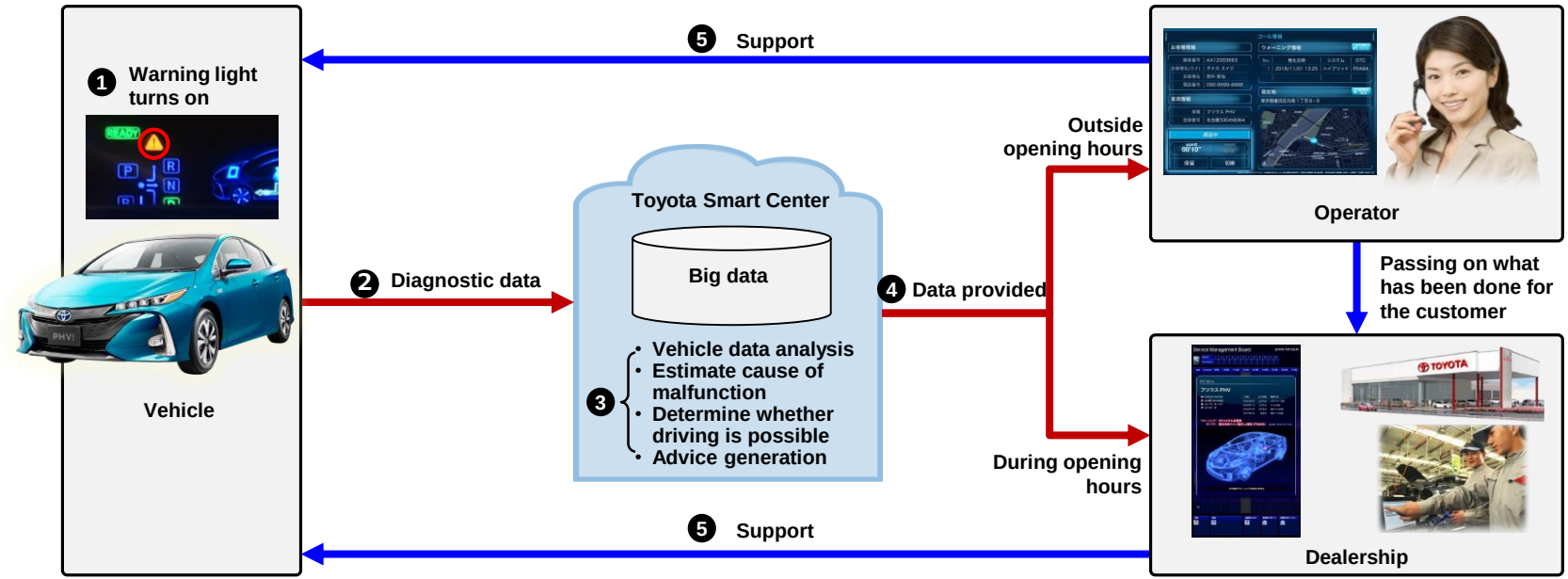
・Operator Services ・Supports through MSPF
・Notifications of Car Maintenance



Two-Way Service, close to customer's safety and security

e-Care Service

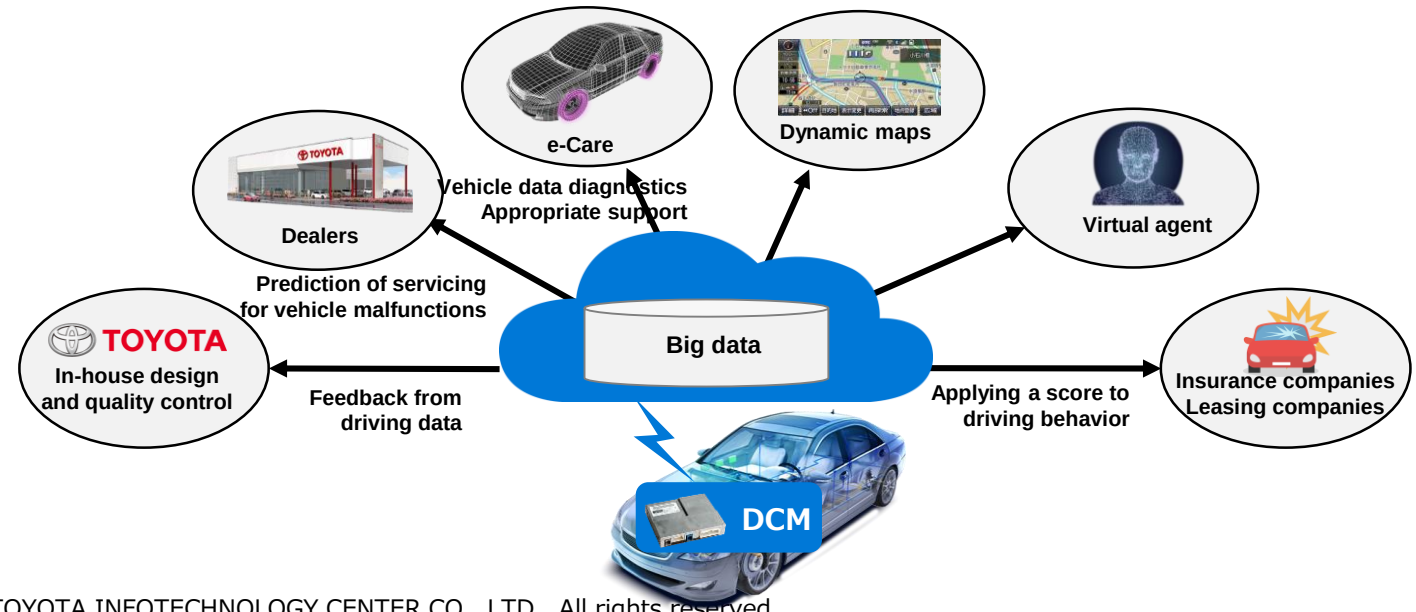
- When a warning light in the vehicle turns on, the data for that vehicle is analyzed at the Toyota Smart Center, the probably cause of the anomaly is determined, and appropriate advice on matters such as deciding whether driving is still possible is generated automatically.
- The data is also sent to the service adviser at the relevant dealership and to the operator at the Center to provide real time support to the customer.



Contents

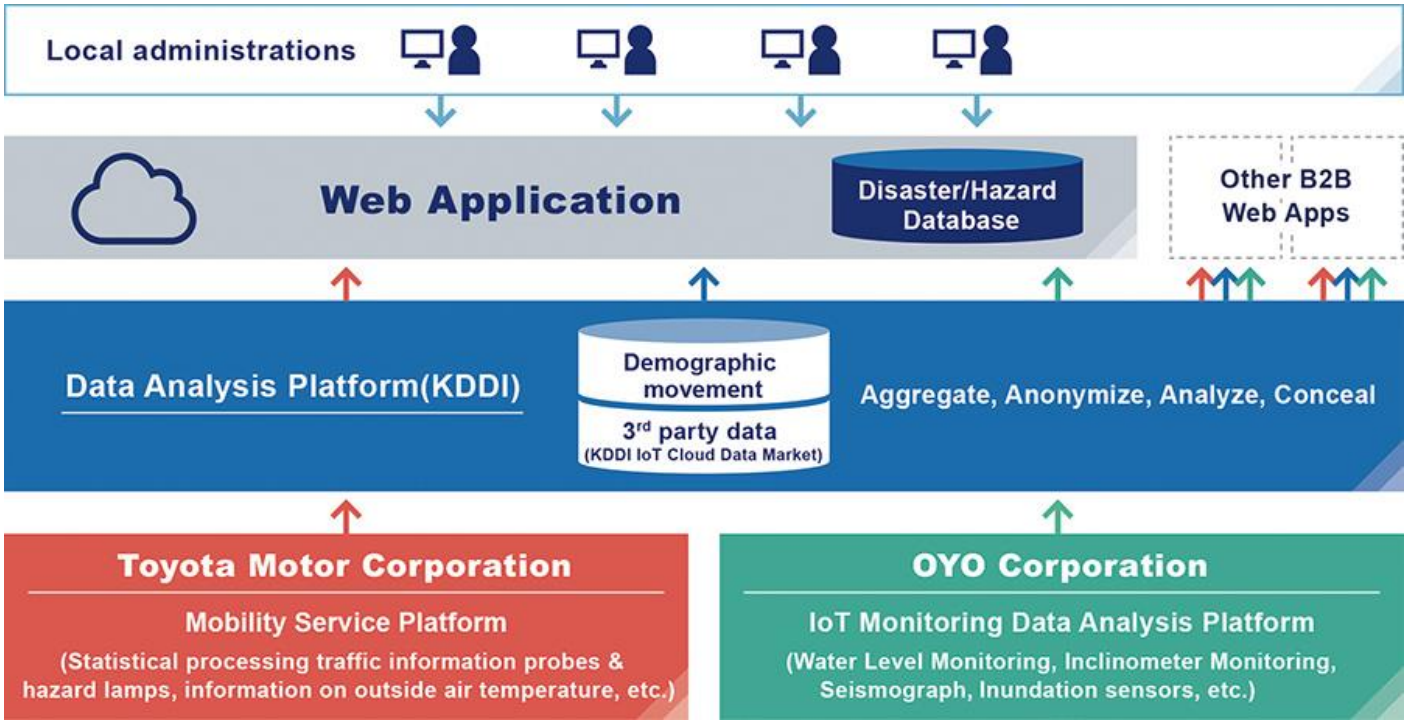
Expansion of Big Data Use

- Driving data is fed back to the in-house Design and Quality Control divisions to promote early detection and early resolution of field issues.
- Big data is used to predict individual vehicle malfunctions and the need for maintenance, and propose a visit to the dealership.
- Disseminate the e-Care Service, which remotely analyzes vehicle data when a warning light turns on and provides appropriate support.
- Collect images from on-board cameras and generate a dynamic map that encompasses the level of traffic and obstructions for each lane.
- An AI-based agent that understands the driver well provides support for safe and comfortable driving.



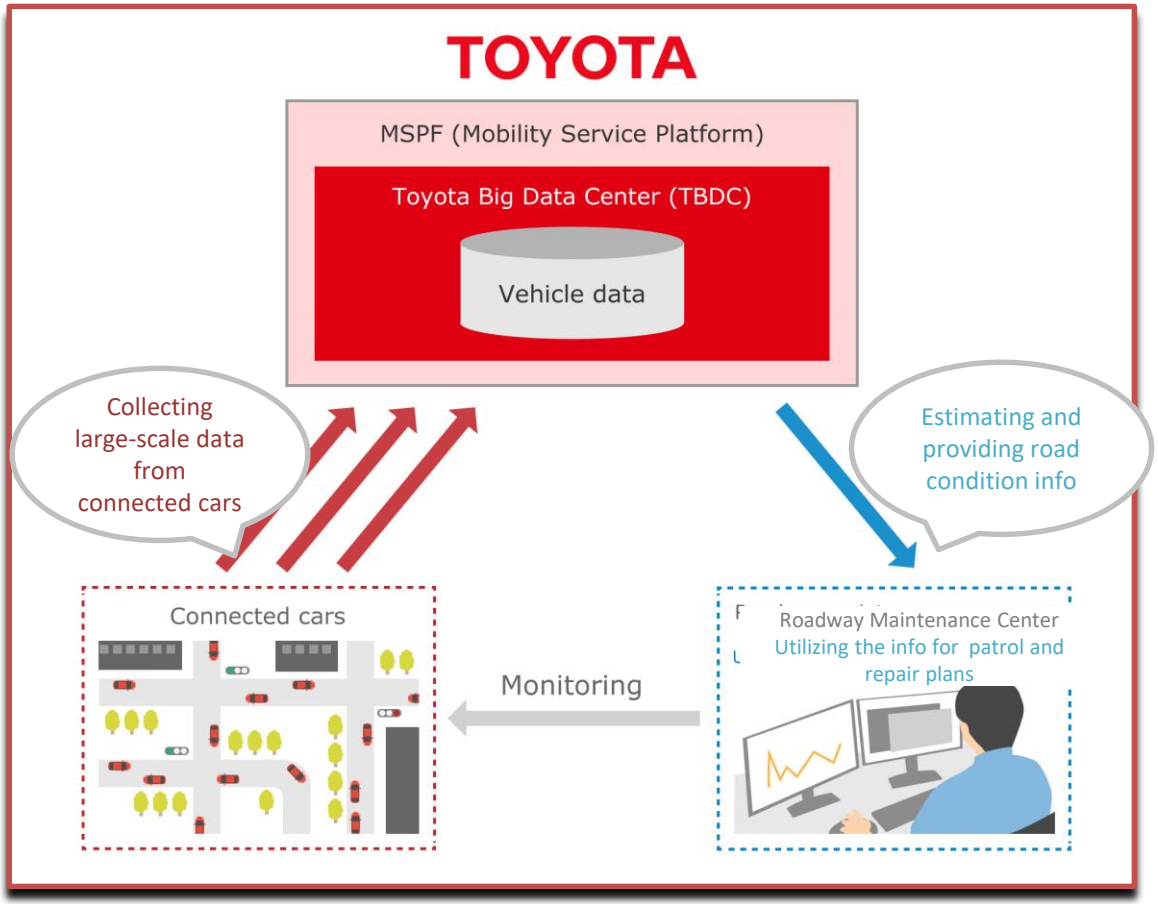
Applications for Disaster and Hazards Information Support

- **Statistically processed probe data is sent to KDDI by the Toyota Smart Center.**
- **Provide local government with informational support for disaster and disaster prevention activities. Connected vehicle's probe data would lead safer, more secure and more convenient society.**



https://newsroom.toyota.co.jp/en/corporate/22302761.html

Road Condition Monitoring Service



https://newsroom.toyota.co.jp/en/corporate/23485508.html

Automobile Insurance of Connected Car

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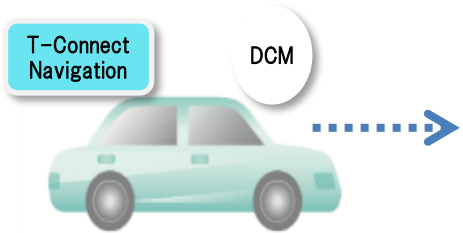
1 Fun Scored your safe driving technique



Safe driving score / Safe driving advice

Drive Report for each drive

Monthly Report

Automobile Insurance of Connected Car

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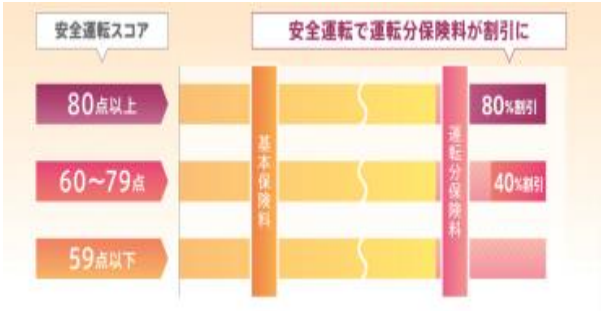
2 Benefit Receive a insurance fee discount with safe driving

Safe Driving Score

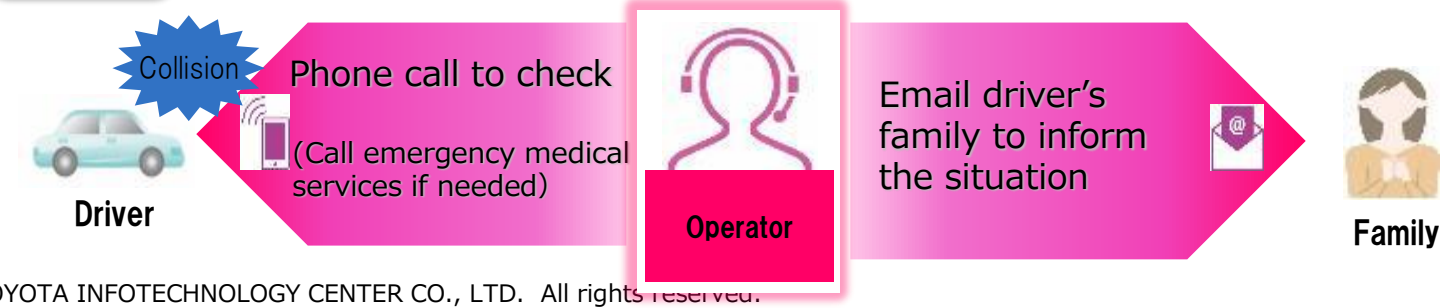


Discount sample based on safe driving score

Mileage

Determined insurance rates by actual driving mileage.

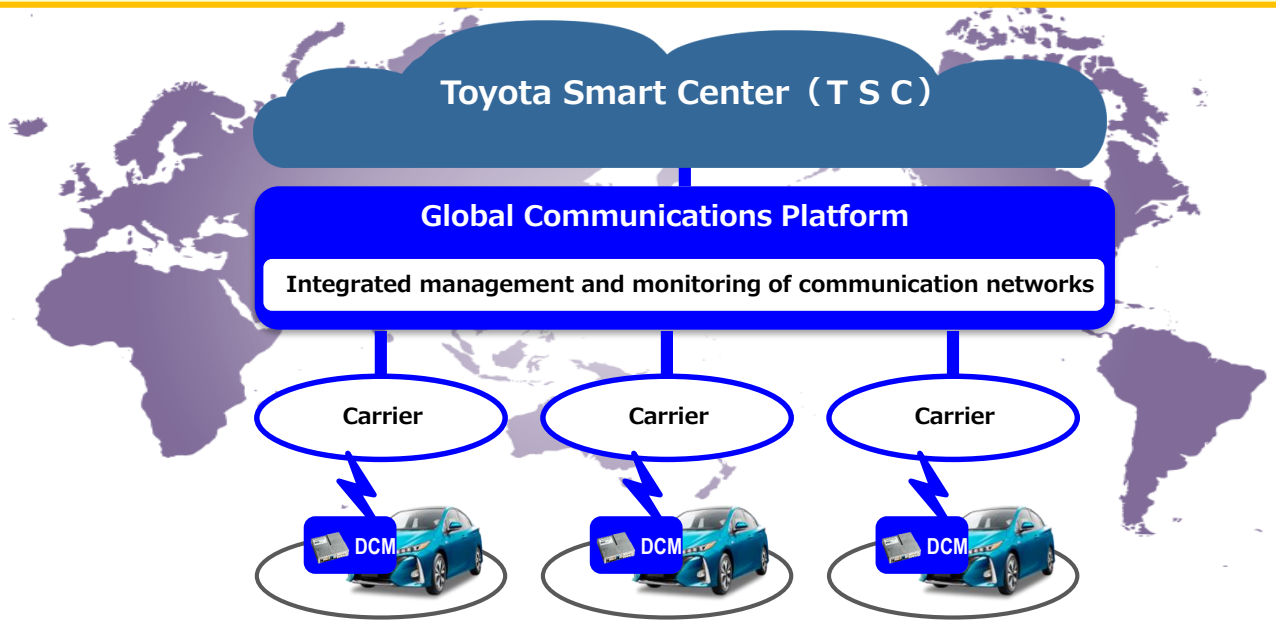
3 Support 24 hours a day/7 days a week/365 days a year



Contents

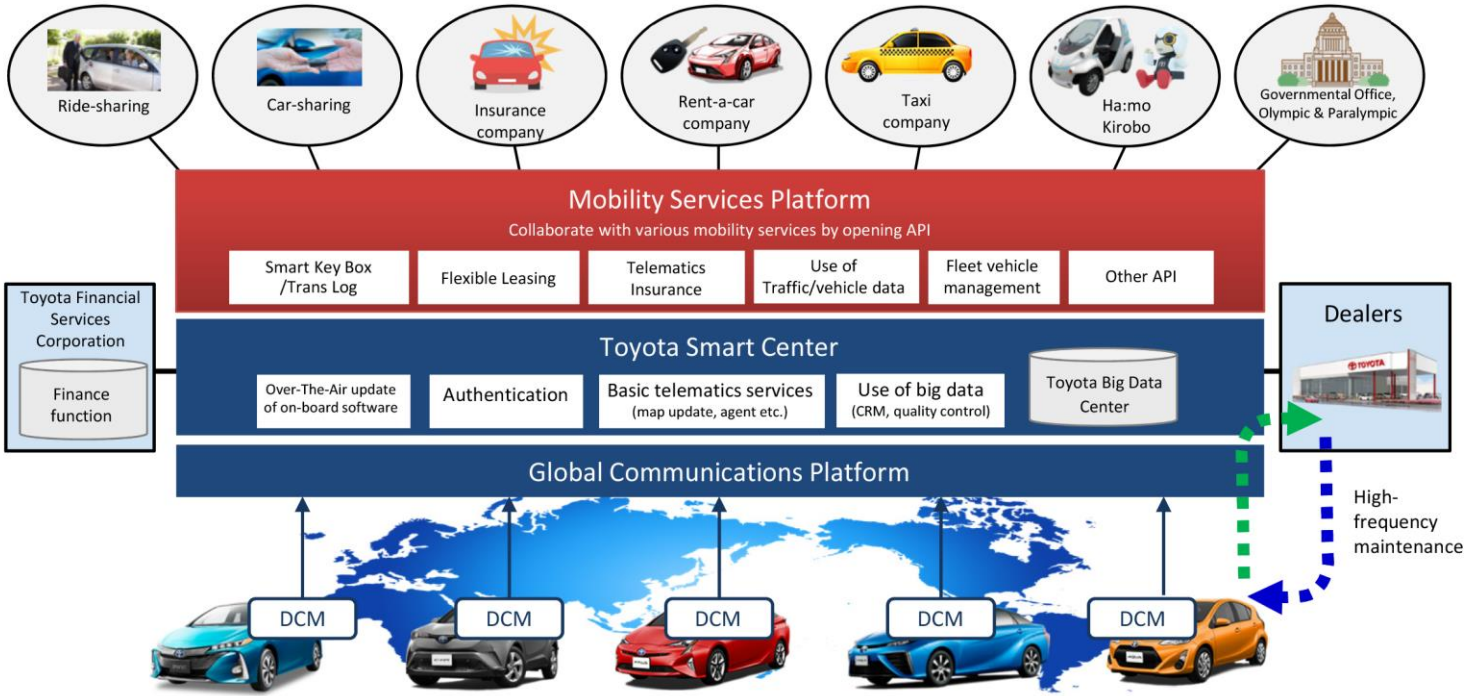
DCM - Standard Equipment

- The onboard Data Communication Module (DCM) as the Toyota global standard
- To be installed into most new passenger vehicles sold in Japan and US by 2020, gradually extended by other major areas
- Global Communications Platform established by Toyota and KDDI jointly will be automatically connected with telecommunications carriers in different countries, based on vehicle position information



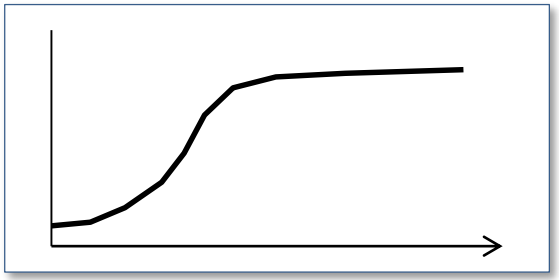
Building a Connection Platform

- **Expand the installation of on-board communication devices (DCM) and build a global communication platform.**
- **Build a mobility service platform (MSPF) that makes various services a reality.**
- **Coordinate openly with other corporations and services and contribute the creating a new mobility society.**



* API (application programming interface) provides subroutines that can be used in programming. Functions can be used simply by calling those subroutines.
* OTA (over the air) refers to updating software via wireless communications.

Data Volume Predictions for Connected Cars



Shifts in the total number of connected cars

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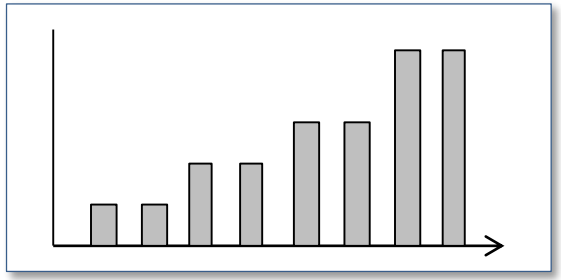
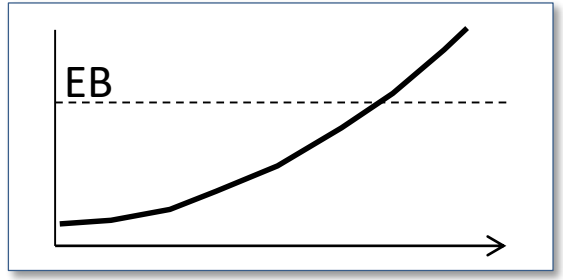
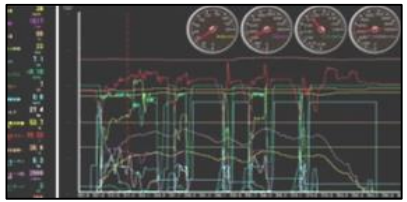


Shifts in the volume of data transfer per-vehicle

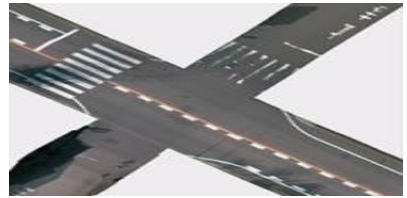


Overall volume of connected car data transfer

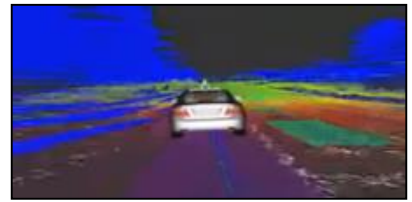
GPS probe (LBS) data
up to several hundred MB per month [constant]



ECU state data
up to several hundred GB per month [as needed]



Dynamic map generation
up to several hundred GB per month [as needed]



Peripheral sensing data
up to several dozen GB per month [as needed]

Time and scale of data on a per-vehicle basis

Requirements for the Next Generation's Smart Center

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The spread of Connected cars and needs to prepare for a rapid increase of data volume

① **Performance**

	Current	2025
Volume	● Tens of MB per vehicle･month ● Hundreds of thousands of vehicles	● Over hundreds of MB per vehicle･month ● Tens of millions of vehicles
Source	● CAN ● Tens of kinds of sensor data ● Control, diagnosis	● Hundreds of kinds of sensor data ● Image, LIDAR ● Individual trip trace
Processing time	● Minutes	● Milliseconds

② **Capacity of a big data center (adapting current DC architecture to its demands)**

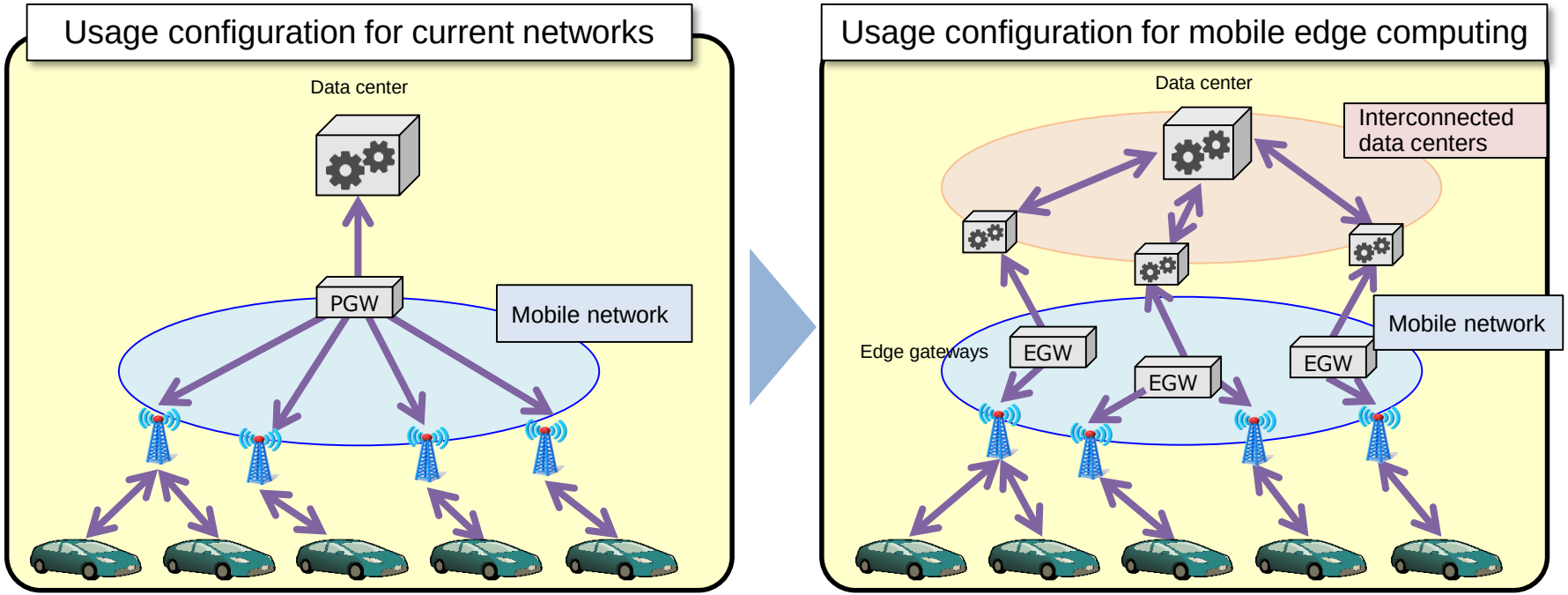
Need a large-scale building for vehicle data storage for years

Approaches to be Developed

- With upcoming technologies, gradually expand the data center
- Minimize processing load by optimizing of software processing
- Store only necessary data by effective analytics technologies
- Minimize cost by distributed processing

Initiatives Targeted at Realizing the Next-Generation Smart Center

- **Centralized processing of large volumes of data in a (cloud) data center will eventually become impossible.**
- **Mobile edge computing will have to be introduced.**
  (Example) Tasks such as processing data in edge servers and returning it to the car
- **Initiated the establishment of the Automotive Edge Computing Consortium.**



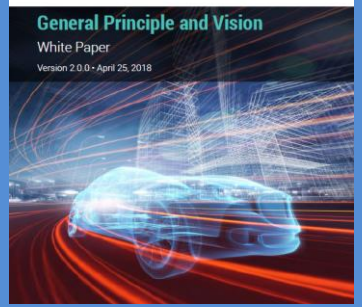
AECC :
Automotive Edge Computing Consortium

- **An infrastructure enabling the use of the enormous volume of data from cars must be built.**
- **A consortium to discuss usage requirements for edge computing in an automotive context has been established.**

Founding members

- Intel
- Denso
- Ericsson
- NTT
- NTT DoCoMo
- Toyota, Toyota InfoTechnology Center

Currently reaching out to a wide variety of related businesses



https://aecc.org/resources/

Contents

START YOUR IMPOSSIBLE

We want transportation to be not an obstacle to facing challenges, but a potential for making dreams a reality.

Reinvent ourselves as a mobility company that transcends automaking to become a company that assists people with various forms of transportation.

MOBILITY FOR ALL

Toyota will cross any obstacle and evolve to achieve this, and ensure that cars remain a product that inspires emotional attachment, no matter what the future holds.

http://www.toyota.co.jp/jpn/events/motorshow/2017-tokyo/

e-Palette Concept

A dedicated MaaS next-generation EV that leverages electrification, connectivity, and automated driving technologies.

e-Palette Concept

Movie

Source:　Narration is English only.
https://newsroom.toyota.co.jp/jp/corporate/20508200.html (With Japanese script)
https://newsroom.toyota.co.jp/en/corporate/20546438.html (No script)

Challenges of e-Palette

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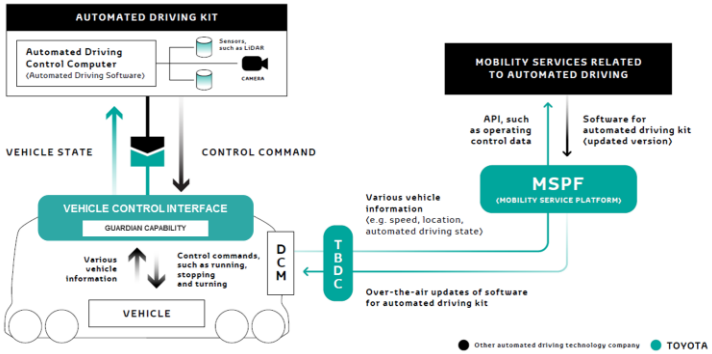
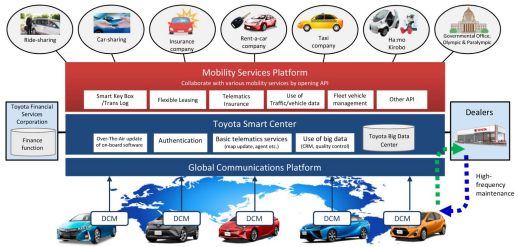
✓ **Low-floor box-shaped vehicles, tailored to various uses**

✓ **Disclose I/F for vehicle control**

✓ **Equipped with any OEM's AD kits**



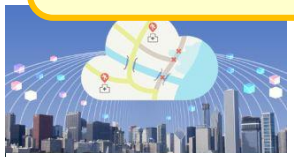


✓ **Disclose API to service providers on MSPF**

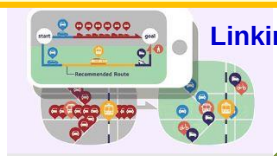
Next generation's EV ecosystem for MaaS with a convergence of Electrification, Connected, and Automated Driving

Mobility as a Service（MaaS）

Mobility services that provide the joy and freedom of travel to all people.
Support seamless, comfortable transportation, and the resolution of local public transport issues through the application of all forms of mobility.



Making use of big data

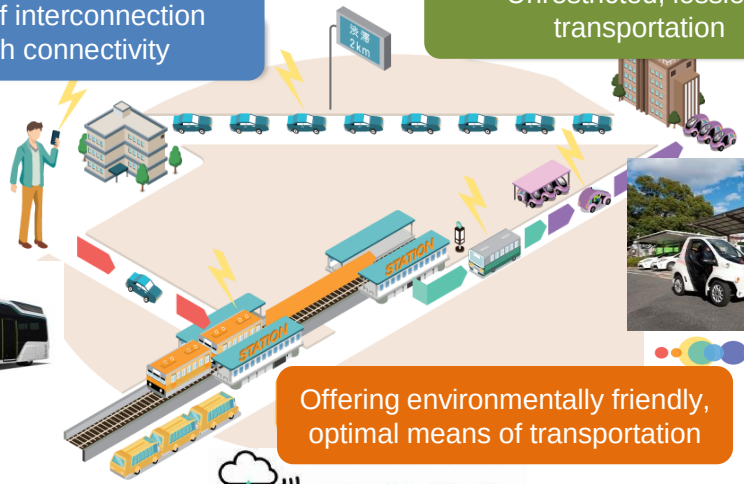


Linking with smartphones

Creating new value through novel mobility

The joy of interconnection through connectivity

Unrestricted, lossless transportation



e-Palette Concept

COMOVE

Ha:mo

FC bus

Offering environmentally friendly, optimal means of transportation

Concept-i

Concept-i Walk

Toward Making the Smart Mobility Society a Reality

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Offer freer and more comfortable transportation through MaaS and novel mobility.
Reinvent the form of communities and the design of cities → Realize the smart mobility society

Safety, security, and comfort

The joy of interconnection through connectivity

People flow, logistics, and efficiency

Unrestricted, lossless transportation

Offering environmentally friendly, optimal means of transportation

Creating new value through novel mobility

Environment and smoothness

Emotion and laughter