

Autonomous Driving Technologies for Advanced Driver Assist System

Toyota Motor Corporation

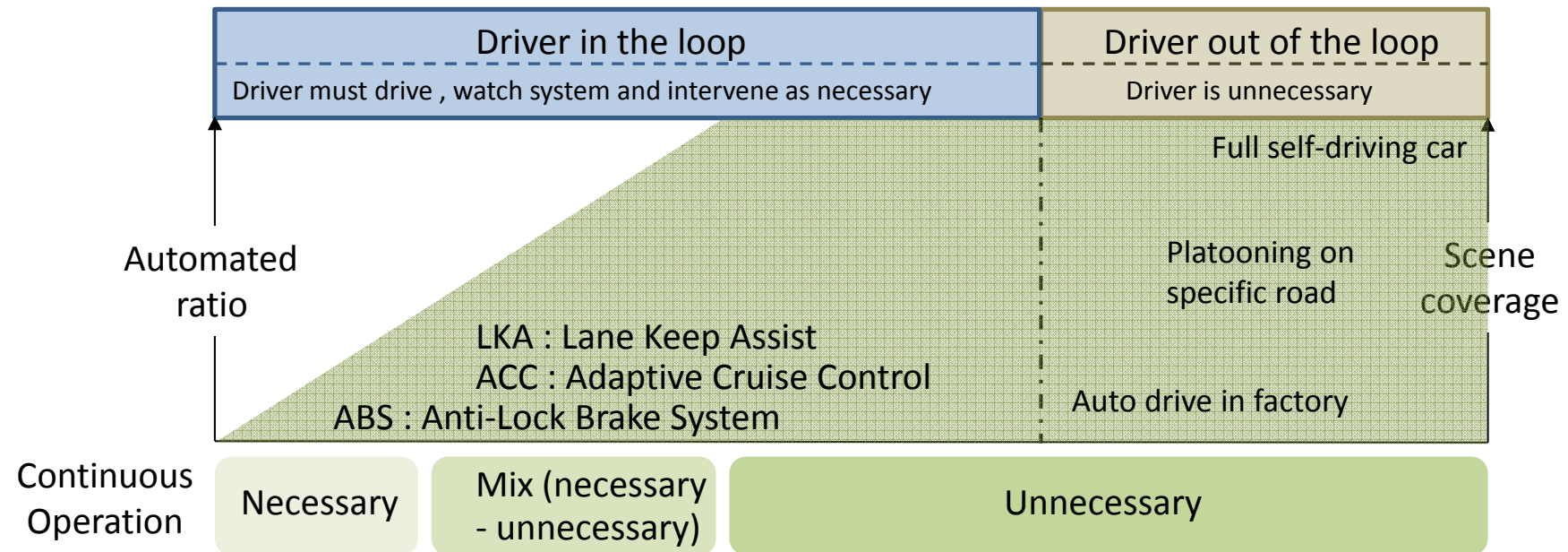
Advanced Vehicle Control System Development Div.

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Definition of automated driving

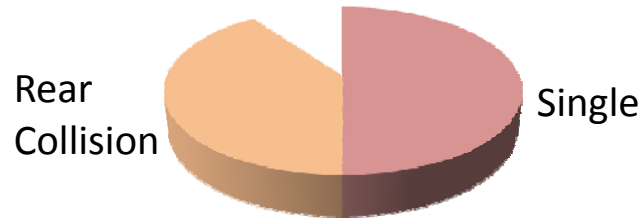


NHTSA definition Level



Safety

Traffic Accident : Highway



Decrease of recognition / judgment ability after driving for a long time.

Poor operation in unfamiliar environments or at high-speeds.



Automated Driving

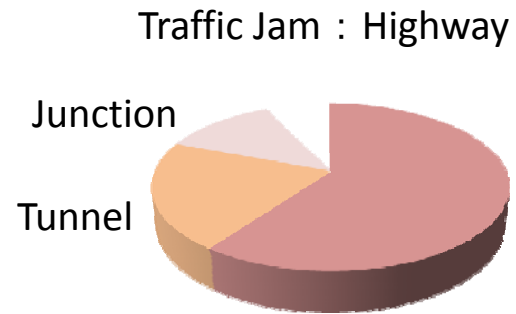
FCW
LDW

FCA PCS
LDP

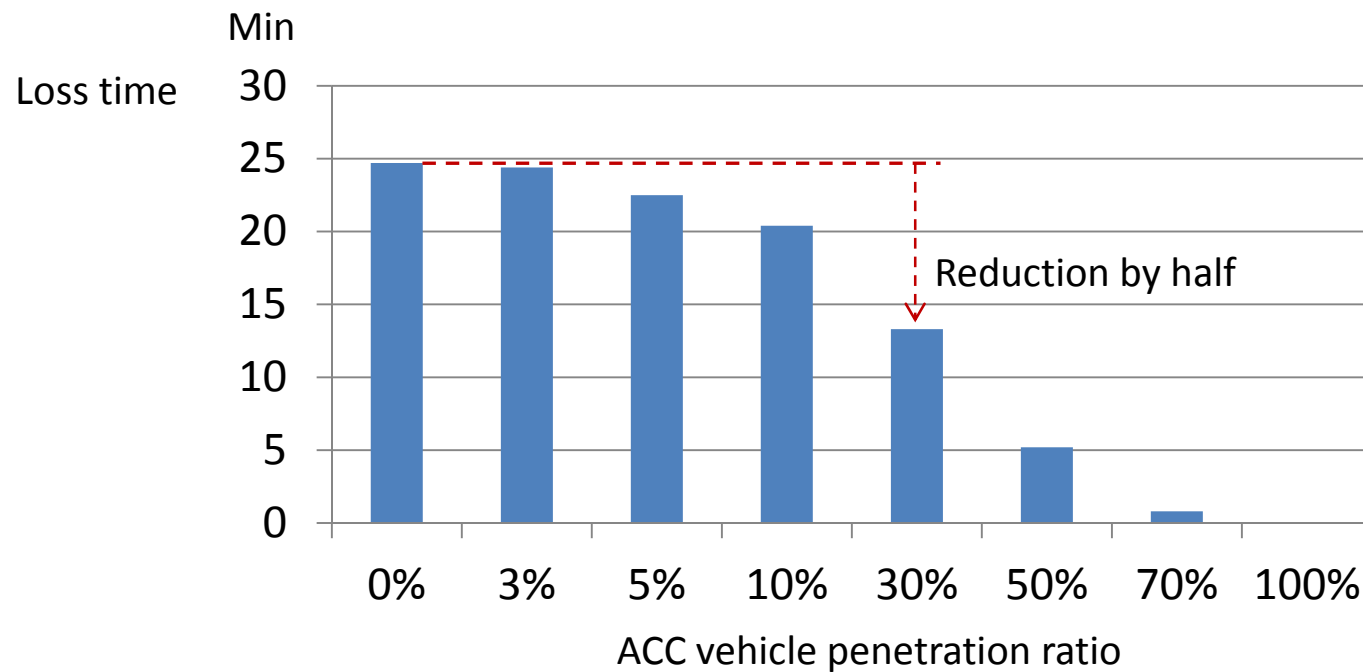
FCW : Forward Collision Warning
FCA : Forward Collision Avoidance

PCS : Pre-Crash System
LDW : Lane Departure Warning
LDP : Lane Departure Prevention

Environment



- ① Vehicle density becomes high.
- ② Speeds slow down at uphill of sag area.
- ③ Deceleration wave spreads and amplifies.



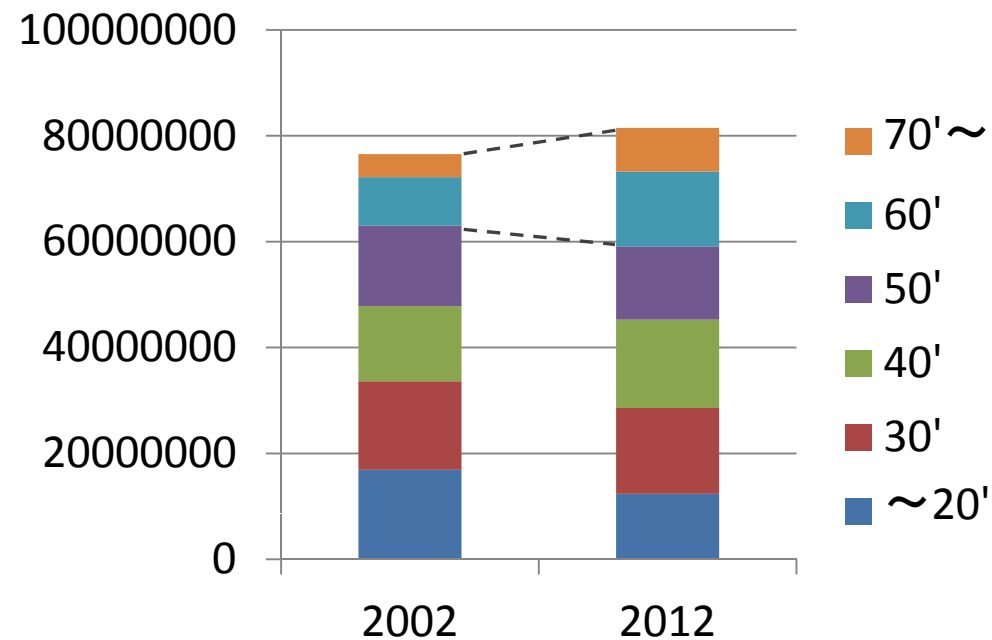
Moving Assist

Harmonized increase of road safety and decrease of driving work load

Most effective



For the elderly



Driving license numbers according to age in JAPAN

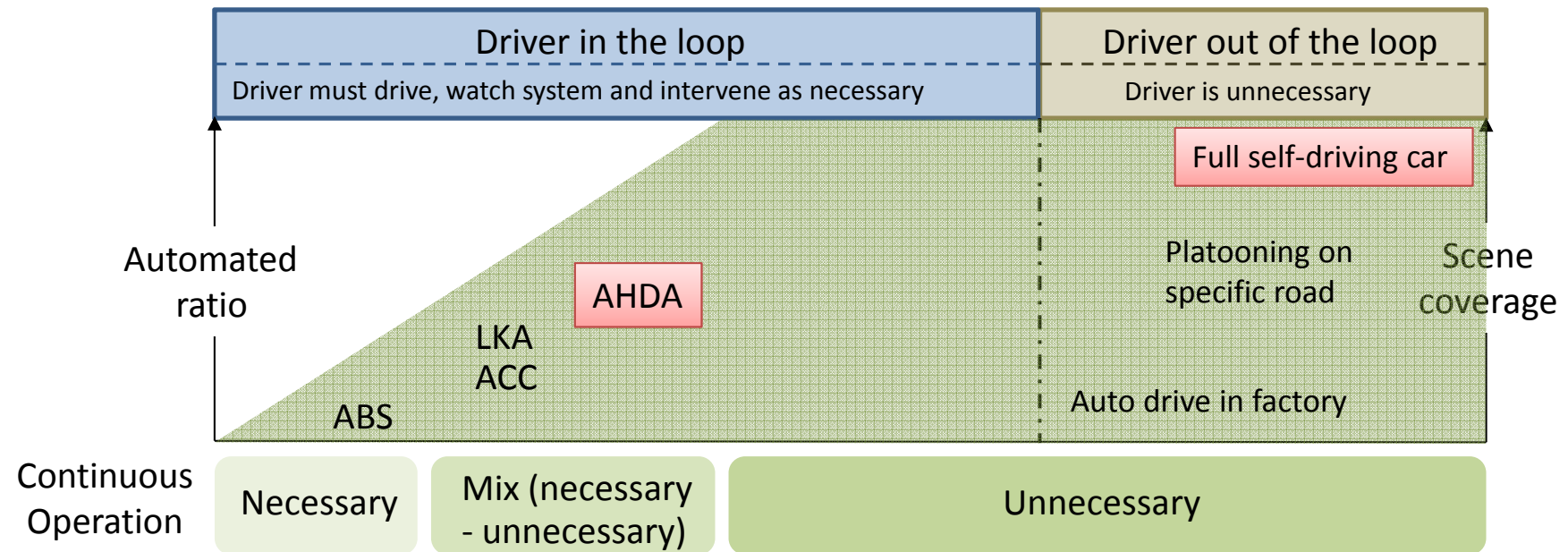
Other Effect

Automated vehicle and technologies positively affect our lives.

- Industrial development by investment in technologies such as onboard devices and infrastructure.
- Economic development by improving the movement of the people.
- Revolution of logistics.
- Change of the urban planning.

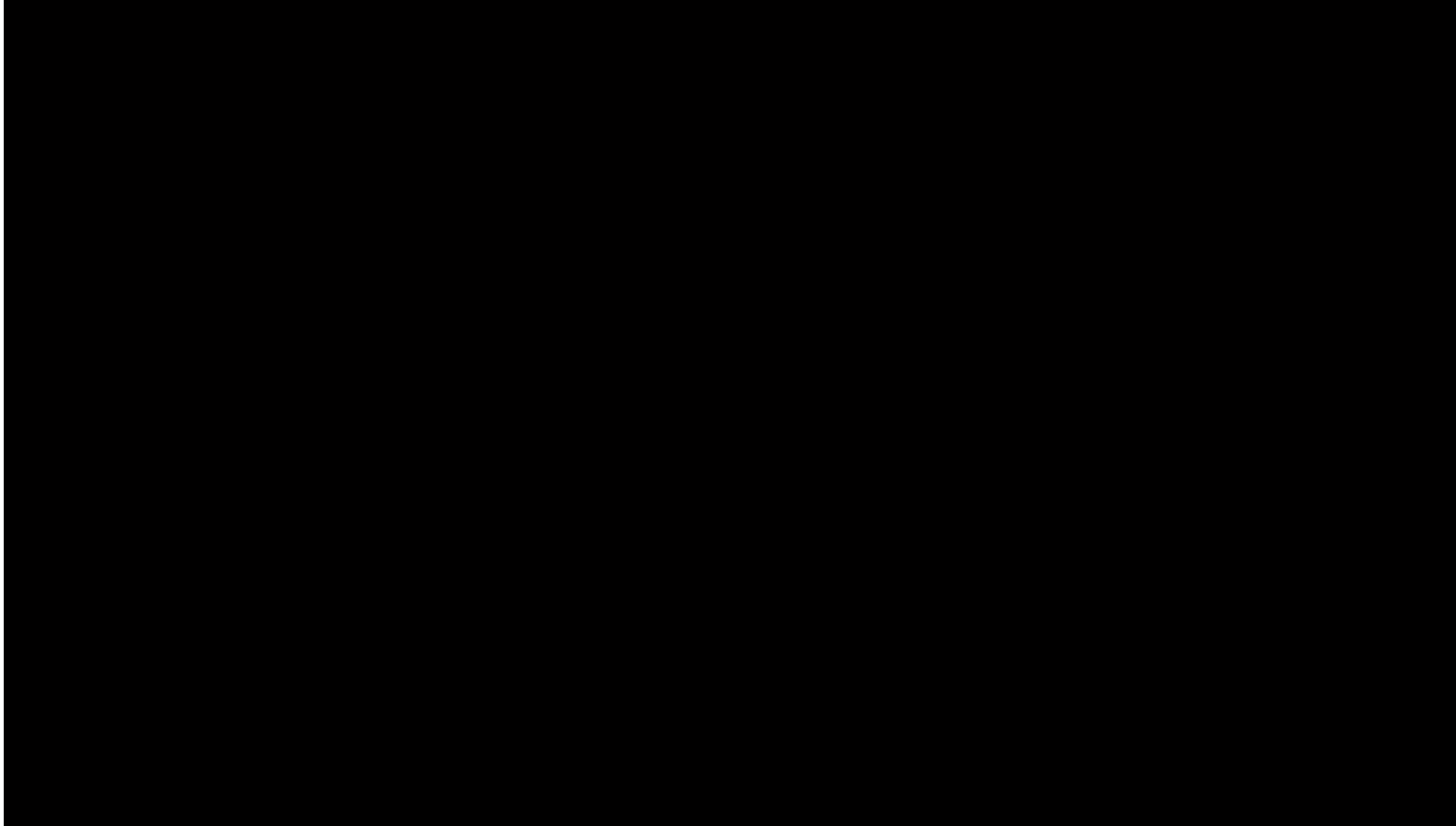
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TOYOTA's System

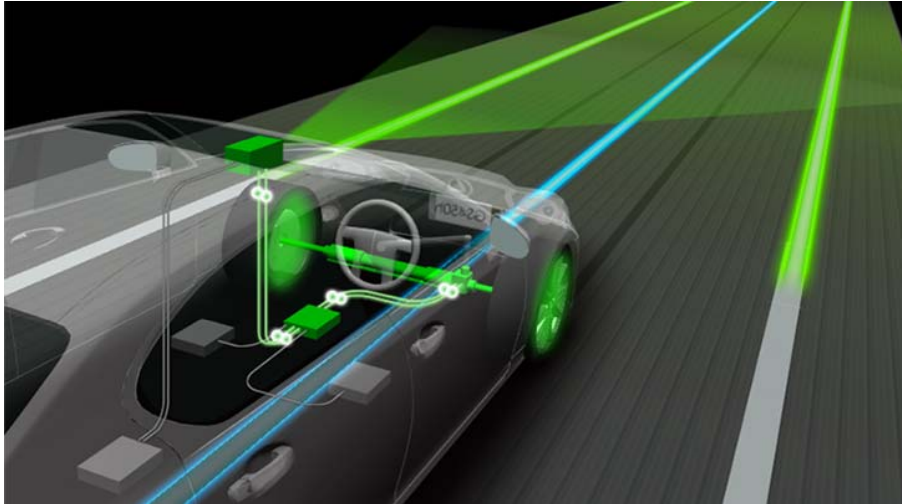


AHDA : Automated Highway Driving Assist

AHDA

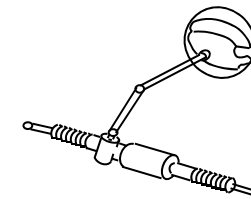
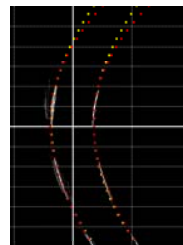
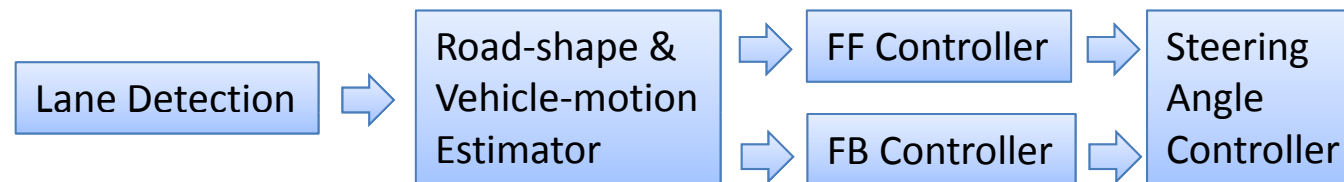


LTC : Lane Trace Control

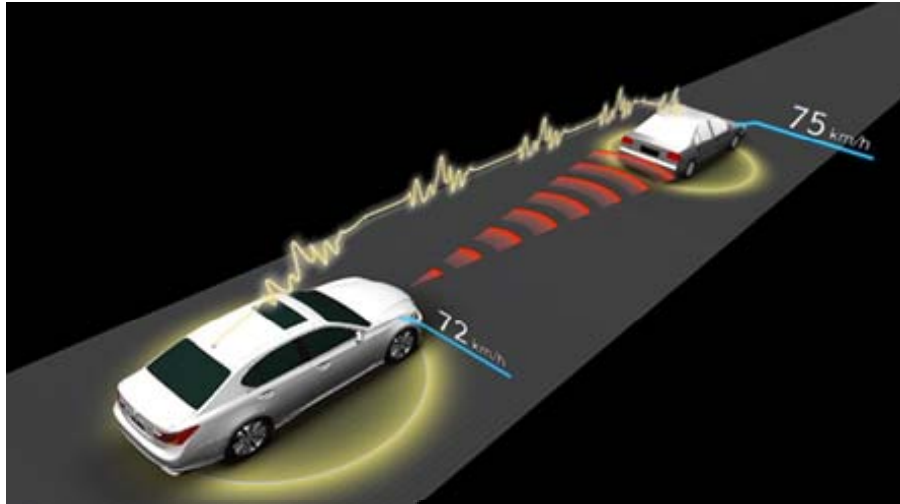


- Recognize lane markers by onboard camera and calculate estimated track

- Control steering wheel and vehicle velocity along calculated track

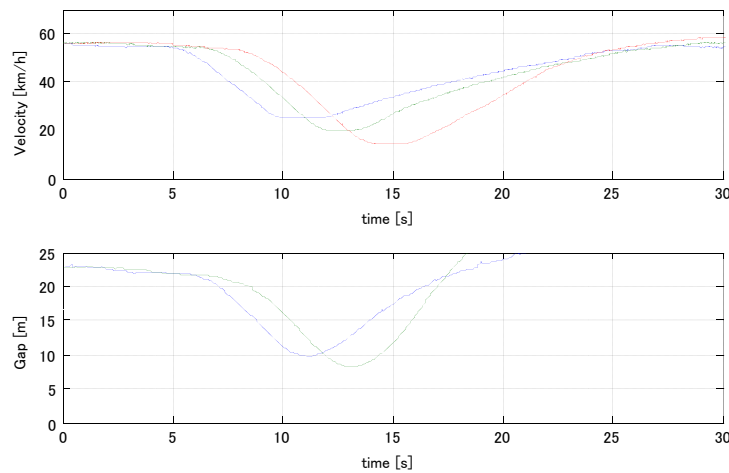


Cooperative - ACC

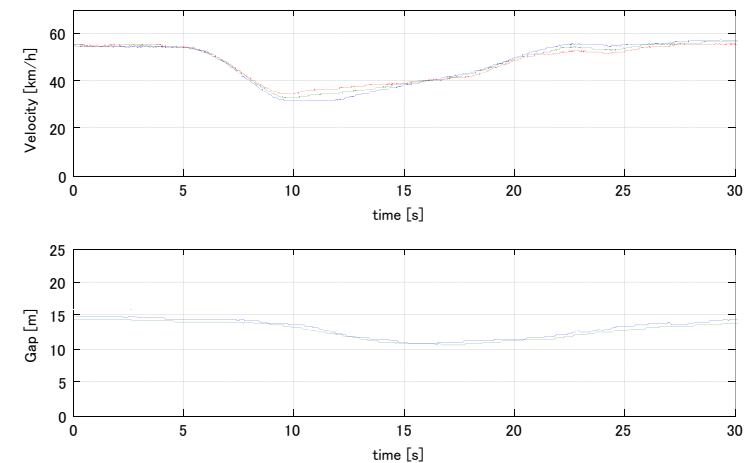


- V2V 760MHz ITS exclusive frequency

- Transmitting acceleration data to mitigate delay of onboard ranging sensor (e.g., radar)



ACC



C-ACC

TOYOTA Autonomous Vehicle

Front Camera

360° LIDAR

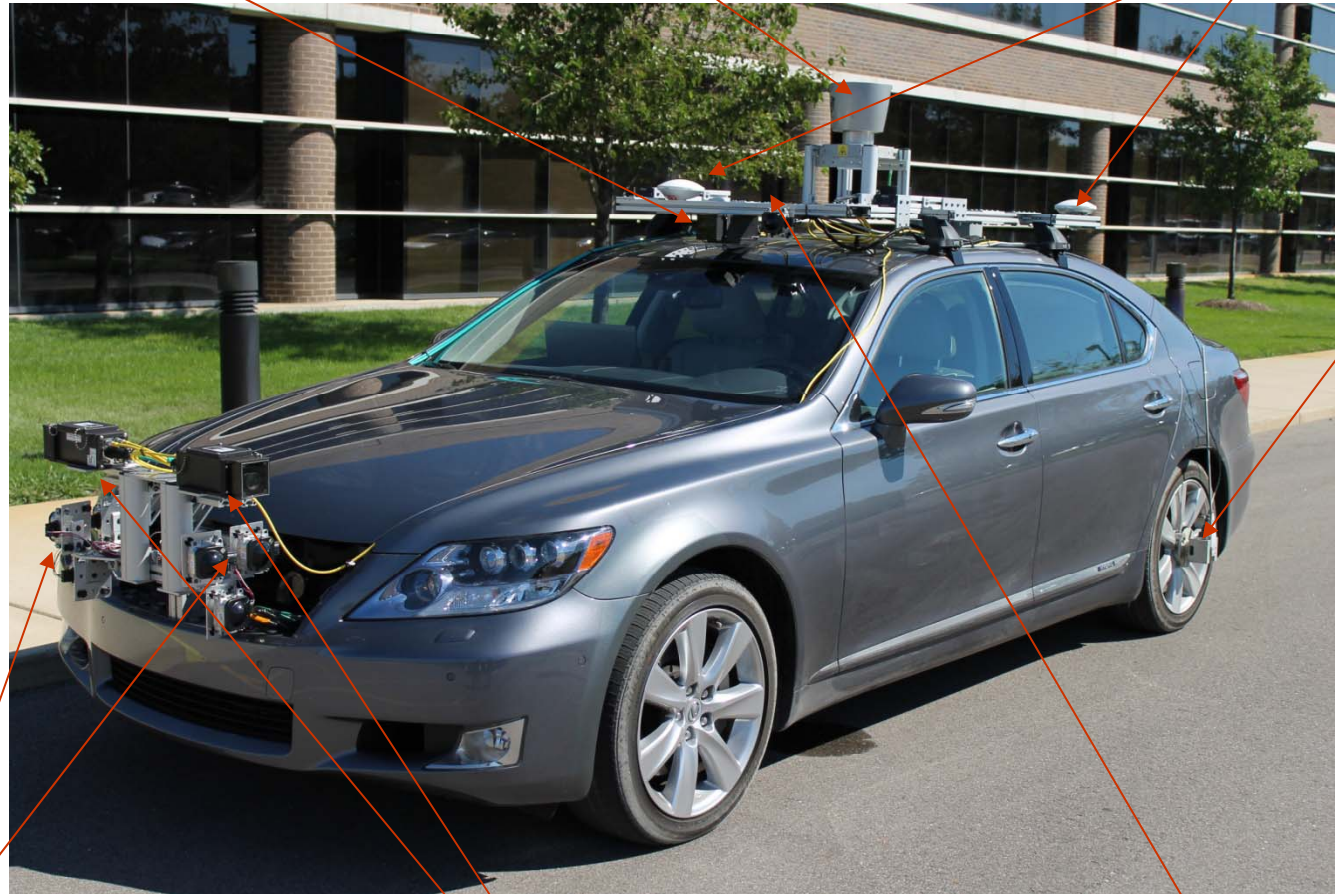
GPS System

Speed
Sensor

Side Radar

Side Camera

Front Radar

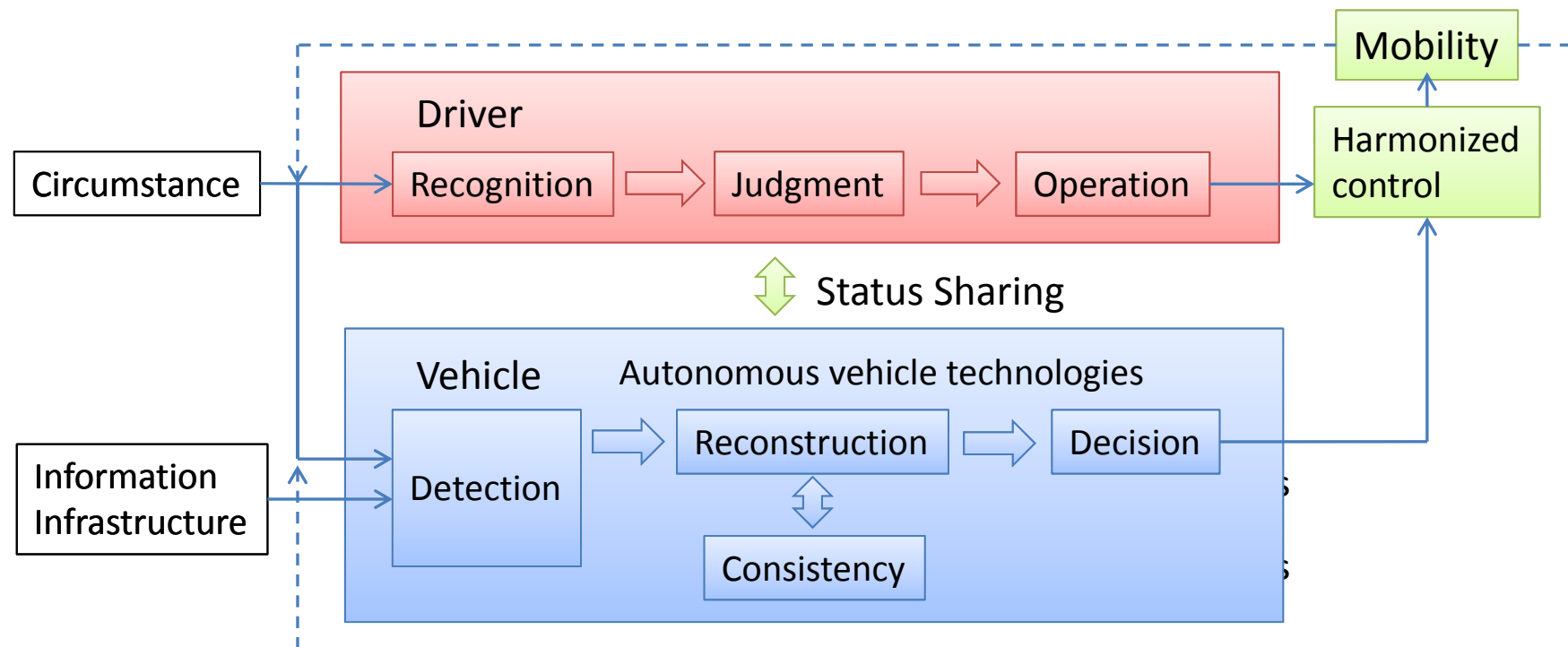


TOYOTA Autonomous Vehicle

Philosophy

Autonomous vehicle technologies enable every driver to drive like expert safety driver.

■ Technologies produced by developing an autonomous vehicle are then realized in various Advanced Driver Assist Systems.



JAPAN Auto Pilot System

■ For the time being, automated driving is focus area of advanced driver support systems.

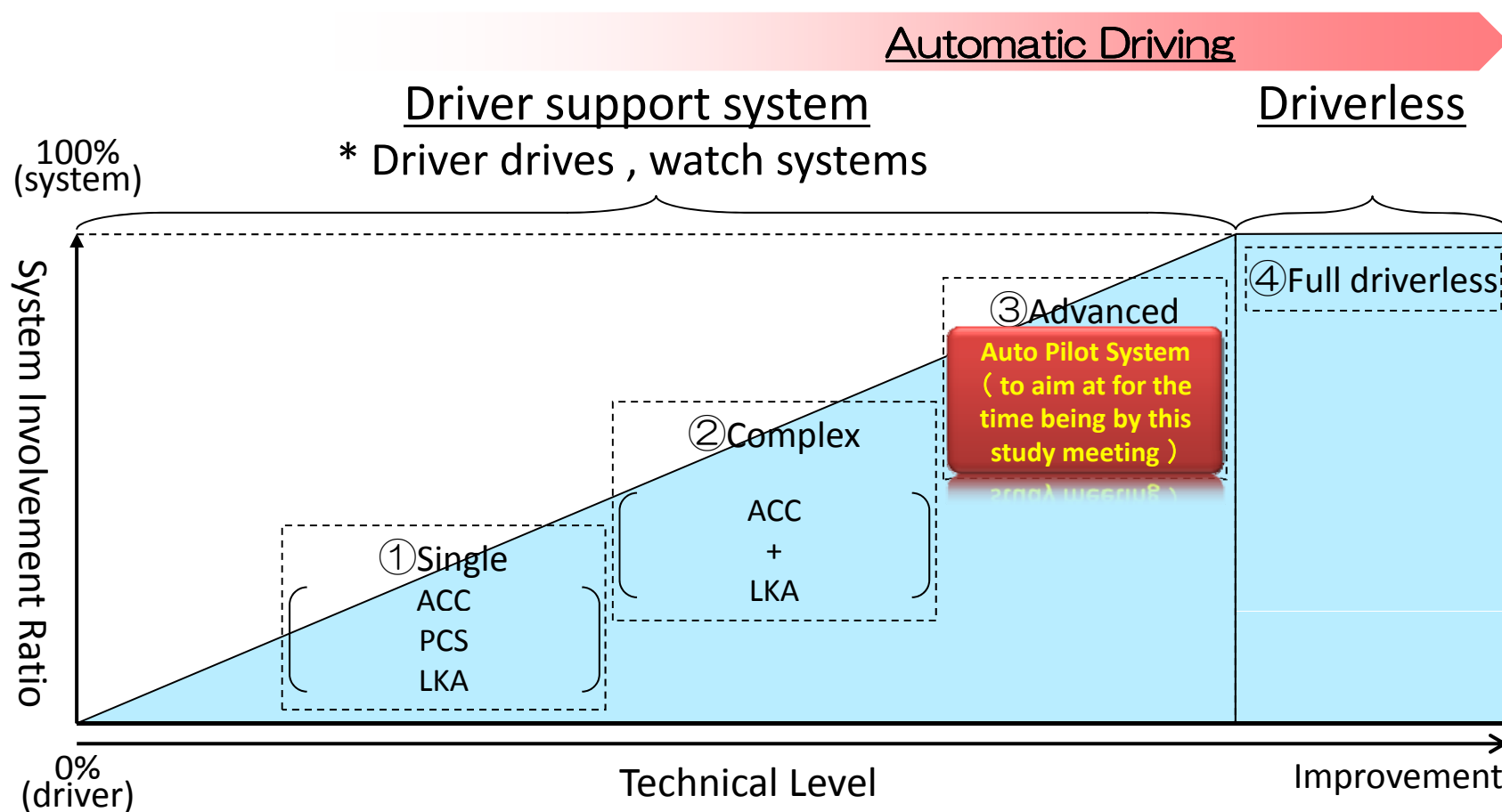
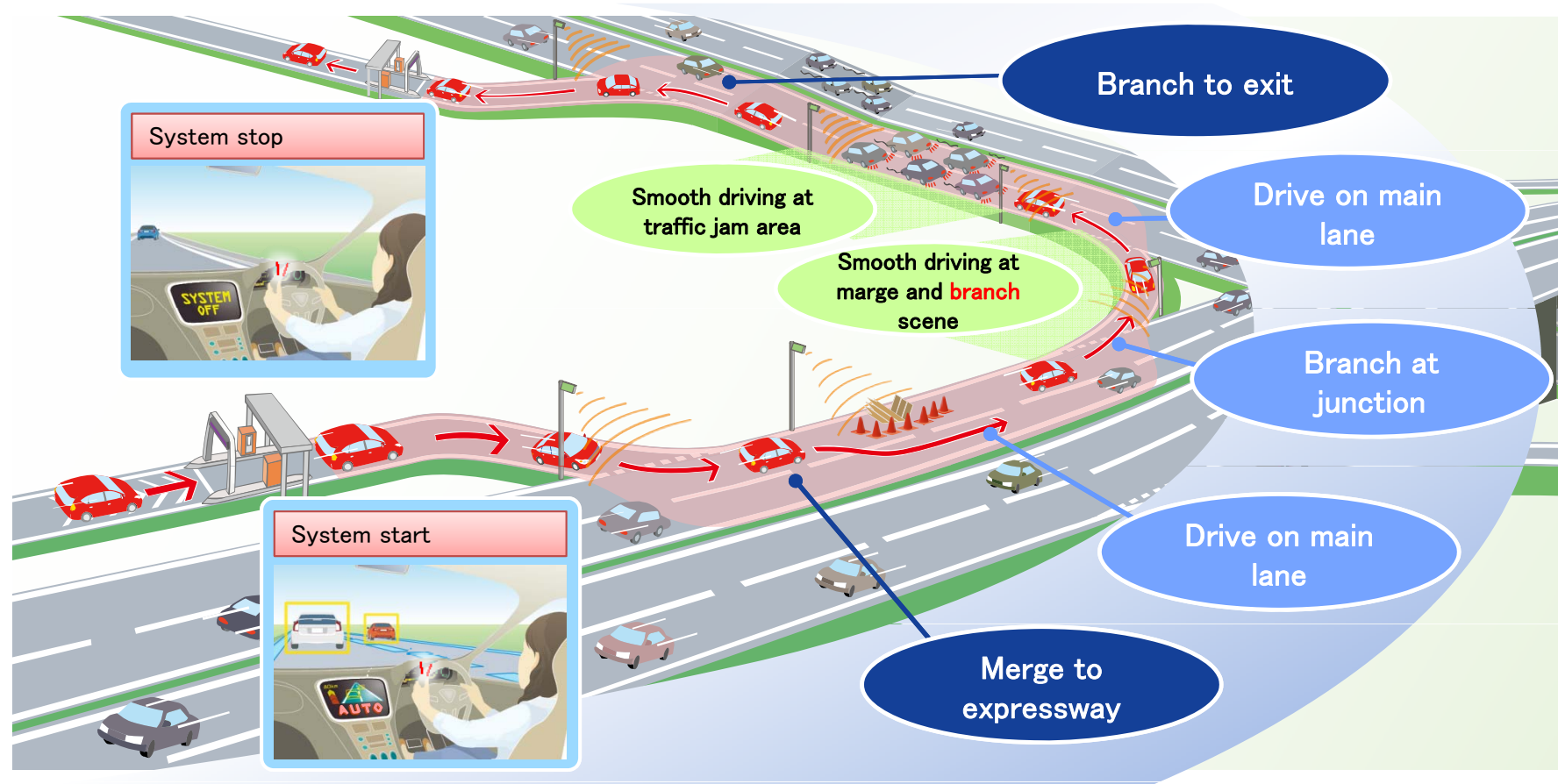


Image of Auto Pilot System

- Auto Pilot System works on expressways from enter to exit.



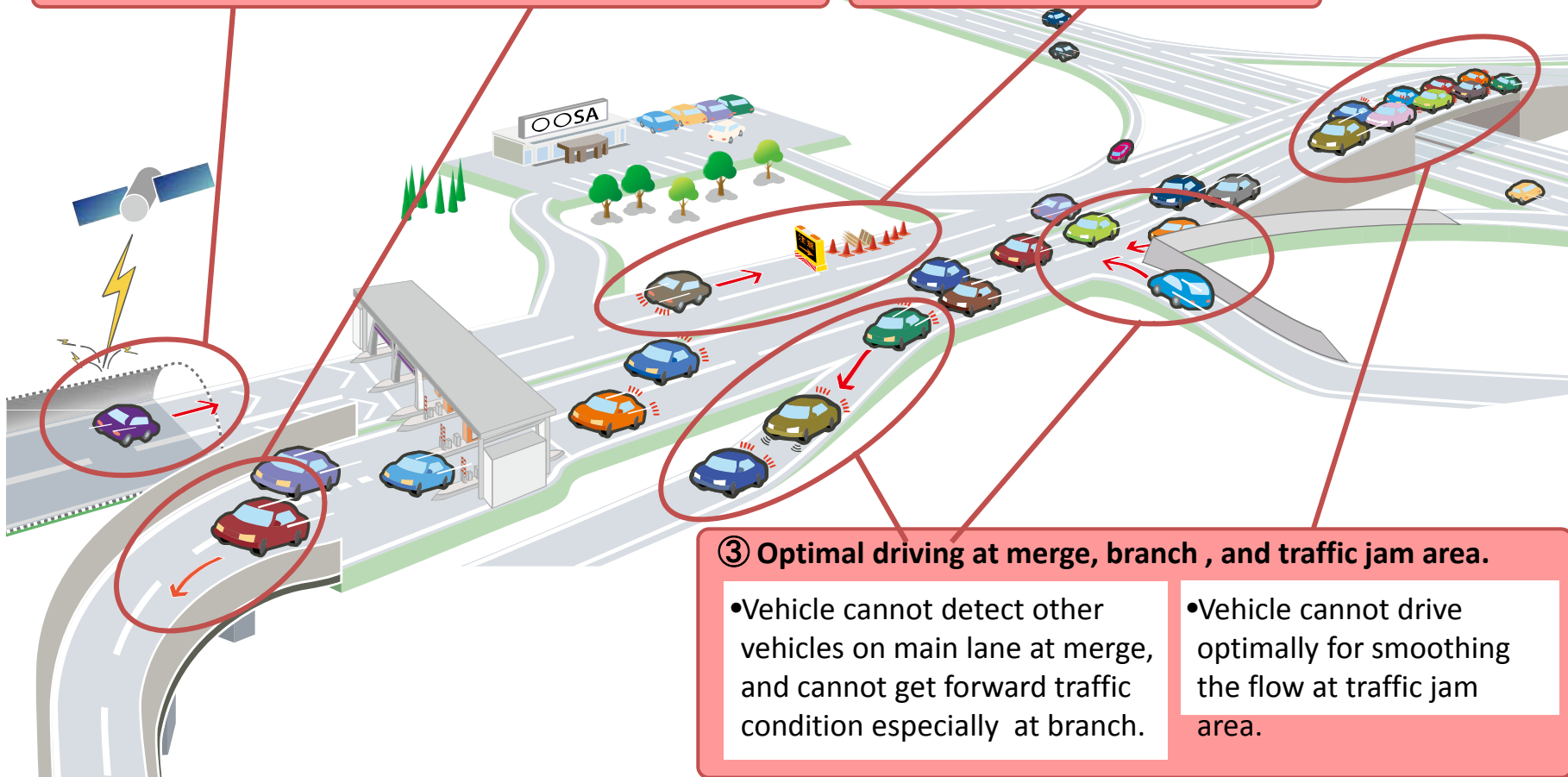
Vehicle Issues

① Continuous driving on a lane

- Vehicle cannot define own position at areas with no GPS signal (e.g., tunnel)
- Vehicle cannot drive smoothly at sharp curve or steep slope , etc.

② Lane change

- Vehicle cannot have enough margin at lane-changing without forward regulation.



③ Optimal driving at merge, branch , and traffic jam area.

- Vehicle cannot detect other vehicles on main lane at merge, and cannot get forward traffic condition especially at branch.
- Vehicle cannot drive optimally for smoothing the flow at traffic jam area.

Infrastructure Support

① Continuous driving on a lane

- Provide position information at tunnel.

- Provide road structure data as curvature, slope, etc.

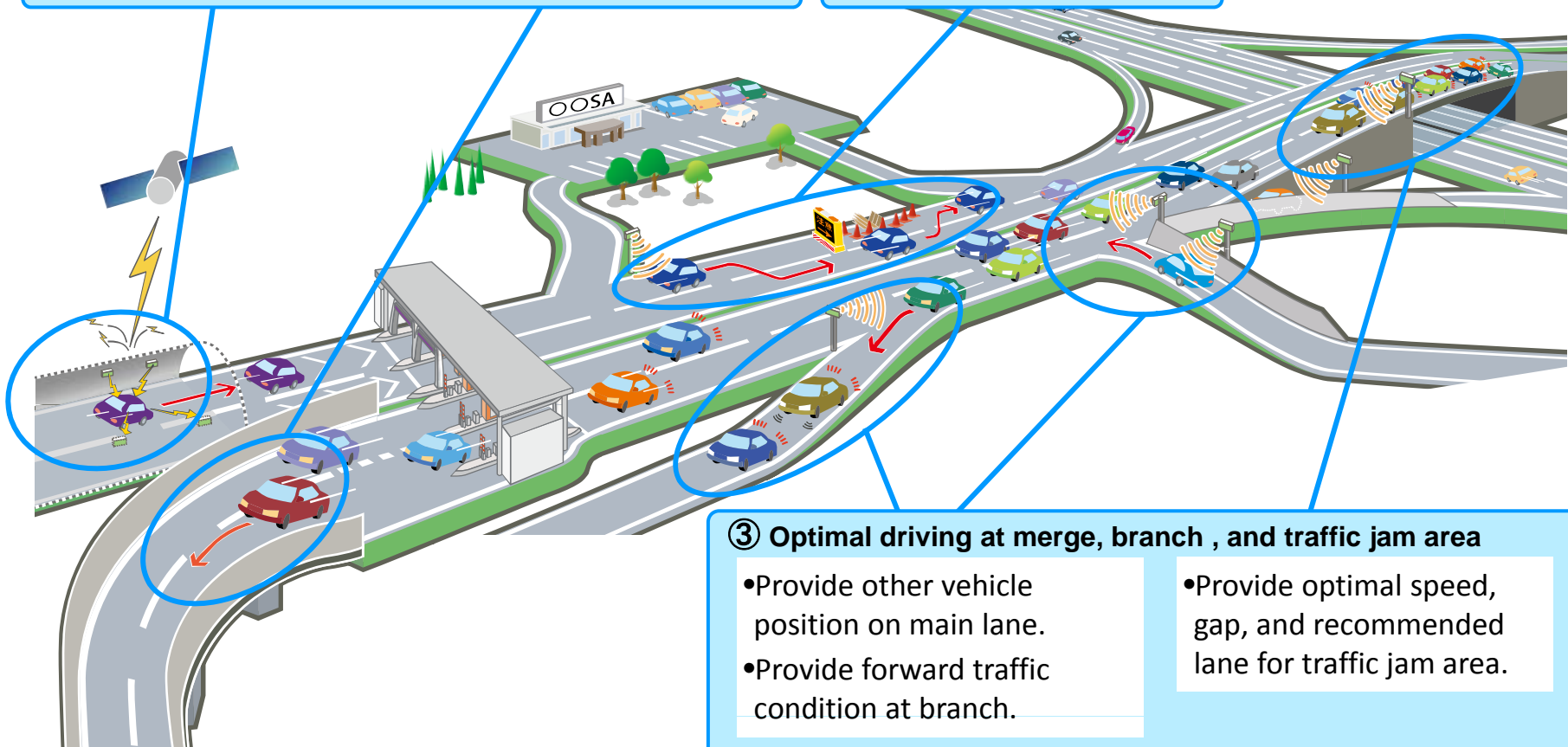
② Lane change

- Provide forward traffic regulations data.

③ Optimal driving at merge, branch, and traffic jam area

- Provide other vehicle position on main lane.
- Provide forward traffic condition at branch.

- Provide optimal speed, gap, and recommended lane for traffic jam area.



In future & Conclusion

- TOYOTA announced to launch in mid-2010s Advanced Driving Assist System Using Autonomous Driving Technologies.

- TOYOTA's Advanced Driving Assist System is for safer highway driving, reduced environmental effects and driver workload.

- TOYOTA is thinking Autonomous driving technologies are to realize Advanced Driver Assist System.

- TOYOTA is developing various Advanced Driver Assist System using not only Autonomous Driving Technologies but Cooperative systems with various governments.