V2X Truck Platooning in S. Korea

Overview

Timeframe

- Overall : 2018.4 ~ 2021.12 (4 years)
- Currently 1st year

Budget

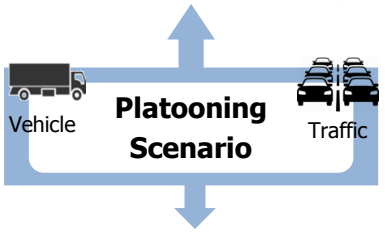
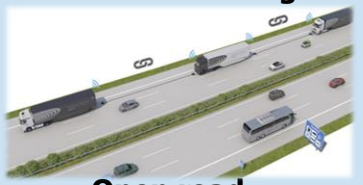
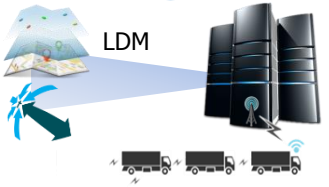
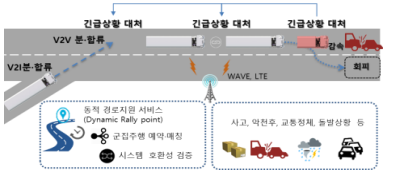
$ 12 Million (Including private and government fund)

Consortium

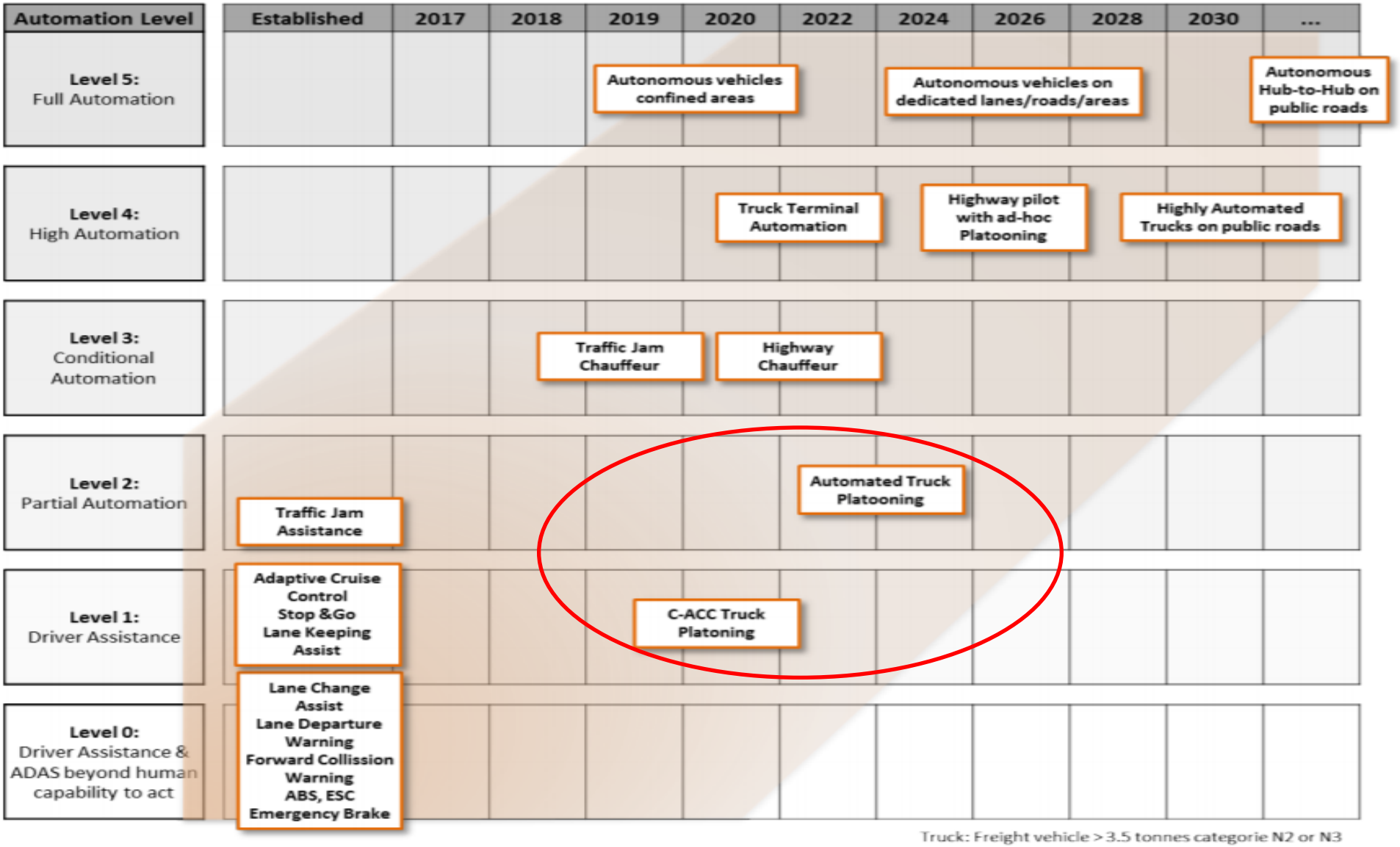
- KEC : Coordinator
- Partner : 13(OEM, suppliers, researchers)

Project schedule

Co-work & Testing@ Highway

	Y1(2018)	Y2(2019)	Y3(2020)	Y4(2021)
Platooning Vehicle	 Platooning module design	• LV : 1ea • FV : 2ea • Longitudinal	• LV : 1ea • FV : 2ea • +Lateral	• LV : 1ea • FV : 3ea • + Merging, Split
	Design	V2V Control	V2X Control	V2X. Full length
		V2X Platooning  Test road	V2X Platooning  Open road	V2X Platooning  Open road
Infra Service Tech	 Safety & Mgt services Concept design	 Safety & Mgt Services SW development & Test	 Safety & Mgt Services On open road	 Assessment of Safety & Mgt Services on open road
	Design	Algorithm. SW	Systems	V2X Validation

EU Automated Freight Vehicles Path(ERTRAC,2017)



Truck: Freight vehicle > 3.5 tonnes categorie N2 or N3

EU Automated Freight Vehicles Path(ERTRAC,2017)

2.5.1.1. **C-ACC Platooning (Level 1)** Partially automated truck platooning, in which trucks are coupled by Cooperative ACC (C-ACC), through **speed control** keeping a short but safe distance to the lead vehicle, while the **drivers remain responsible for all** other driving functions.

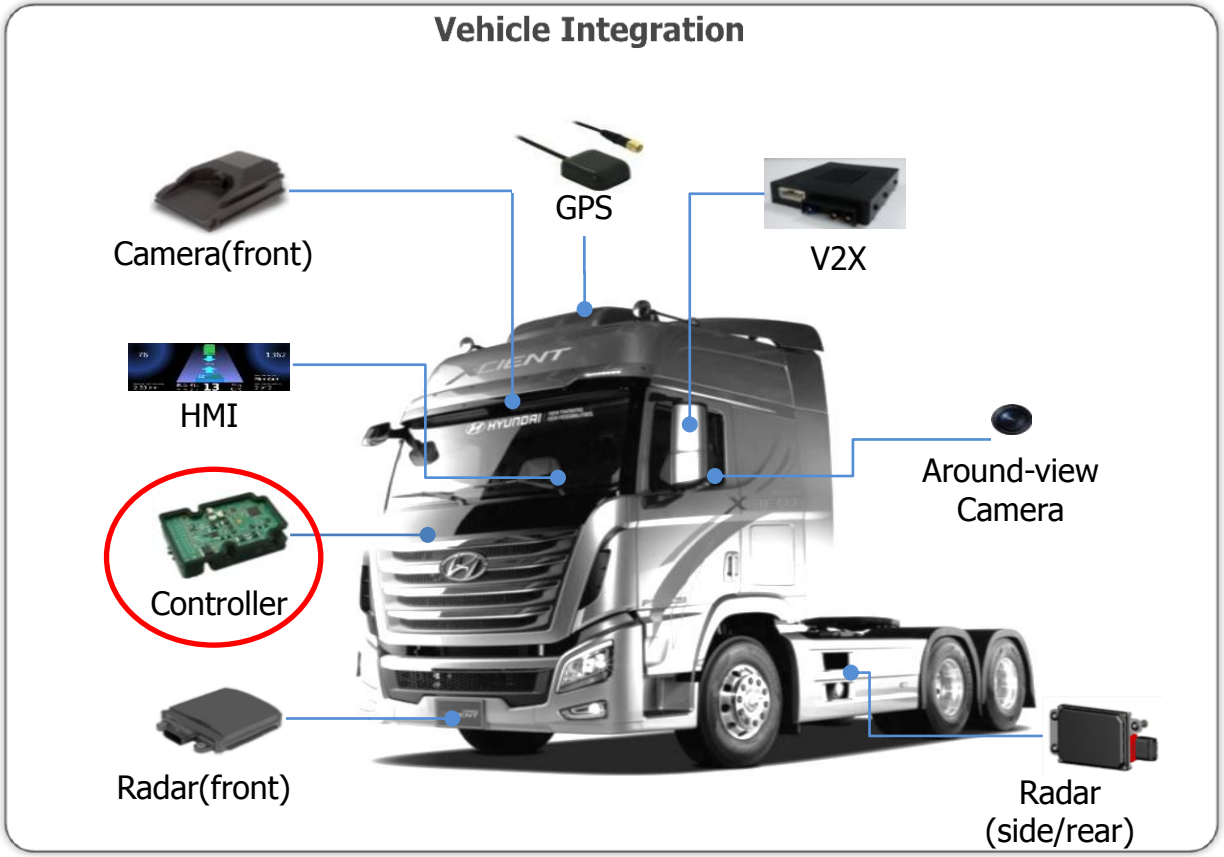
2.5.1.2. **Automated Truck Platooning (Level 2)** This function enables platooning **in both dedicated lane/road and on open roads in mixed traffic**. The vehicle should be able to **keep its position in the platoon** with a safe distance between the vehicles. The **driving behaviour of the leading vehicle is transmitted by V2V** communication to the following vehicle taking vehicle characteristics into consideration, such as braking capacity, load. The function will also handle **platooning management of forming, merging and dissolving platoons** together with **interaction with other road users and road infrastructure requirements.**

2.5.1.3. Highway Pilot platooning (Level 4) Automated Driving on motorways or highways from entrance to exit, on all lanes, incl. overtaking and lane change. The driver must deliberately activate the system, but does not have to monitor the system constantly. The driver can at all-time override or switch off the system. There is no request from the system to the driver to take over when the system is in normal operation area (i.e. on the motorway).

Project Objective#1

Truck Automation

> **Enables Platooning in open highway and keeping FVs position in the platoon with a safe distances and lane keeping. The driving behavior of the LV is transmitted by V2V to FV(s) and synchronize(cooperate) the behavior**



Perception

- Sensor fusion + V2V + V2I(safety service)

Synchronized Control

- **Lateral** : Lane keeping(Refer to LV's Steering)
- **Longitudinal** : Refer to LV's breaking, transmission

HMI, Test

- **HMI** : Driver acceptance of V2X services
- **TEST** : HILS & Test track

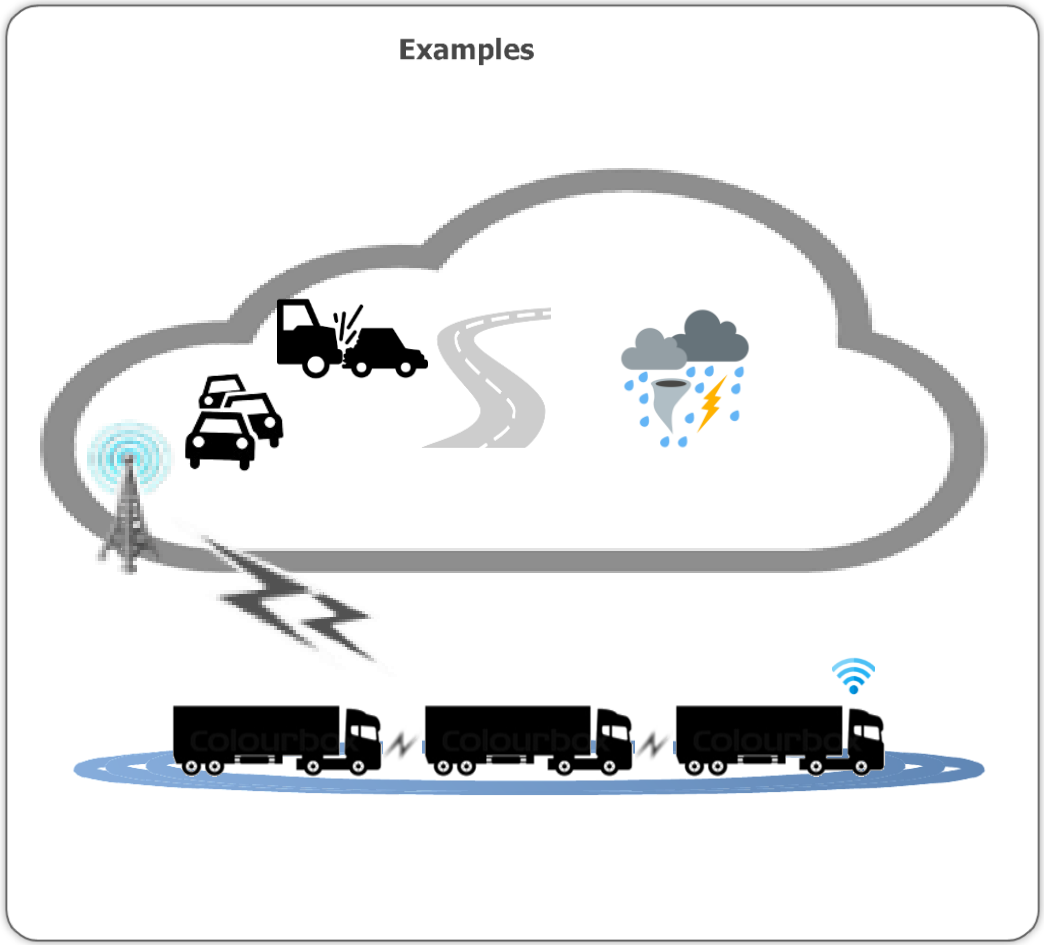
Freight Vehicle Automation Roadmap

		Now	Advanced	Automated Truck (This Pjt)	Highway Pilot (Future)
System		ACC	CACC	CACC+LKAS	CACC+LKAS+Cooperative Control
		Sensors	Sensors+V2V	Sensors+V2X	Sensors+V2X+Logistics Mgt
SAE (LV)	LV	Lv. 0	Lv. 0 ~ 1	Lv. 0 ~ 2	Lv.4
	FV	Lv. 1	Lv. 1	Lv. 2 ~ 3	Lv.4
Control	Longi.	O	O	O	O
	Lateral	X	X	O (Lane Keeping)	O (Lane change, overtaking)
Comm.	V2V	X	O	O	O
	V2I	X	X	O (Safety, Rally point)	◎ (Logistics Mgt)
Dist. Btw @90kph (Time Gap)		50m (2s)	12.5m (0.5s)	12.5m (0.5s)	12.5m↓ (0.5s↓)

Project Objective#2

C-ITS Services for Truck Platooning

> **Enables providing Customized C-ITS services(e.g. incidents ahead, traffic, weather) to platooning under consideration of platoon's behaviour and trailer-truck specification**



Scenario

- **Weather**
- **Traffic** : congestion, accidents, incidents
- **Road stucture** : Reduced lane, IC, Jct

※ Development of scenario based on vehicle specification in platooning

Message sets

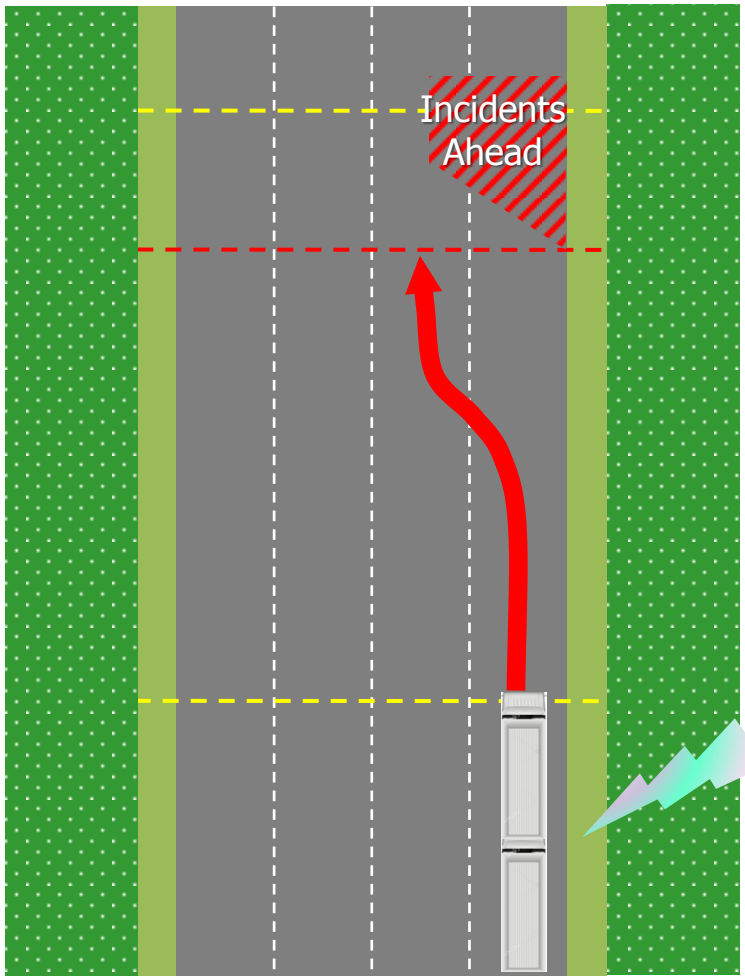
- **Dedicated to Platoon**
- **Protocol**

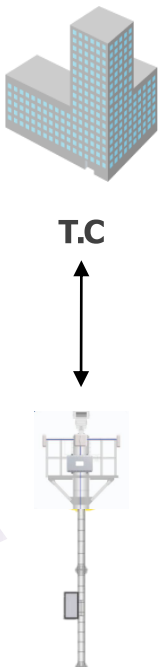
Test

- **Cooperative perception**
  - Evaluate vehicle behaviour w/wo I2V transmitted

C-ITS service example

Provide dedicated and timely services under consideration of number of trucks, Gap, Speed in platooning





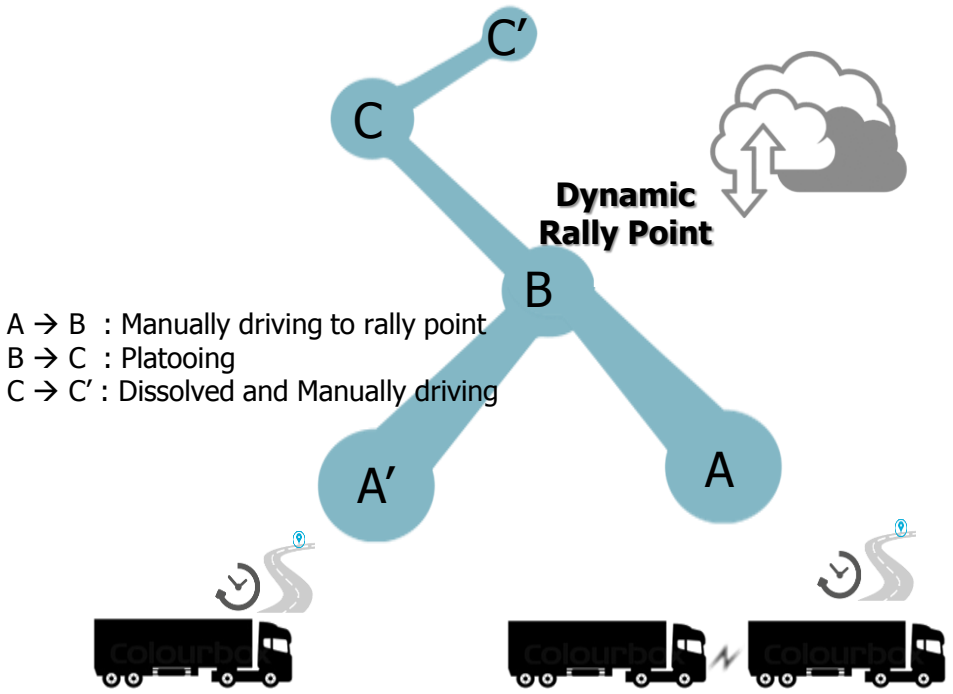
	Alone	Platooning(2FVs)
	500m Ahead	1,500m Ahead
	-	Monitoring Platoonings
	-	Generate dedicated Messages
	Received broadcasted messge(short range)	Received dedicated Information(Long range)
	-	Make decision of strategic behavior for platoon(including vehicles inside)
	Determine the control for itself	Determine the control for platoon
	React	Platoon React (e.g. Mitigate platoon breaking, dissolved and/or reforming)

Project objective#3

Platooning management service

> **Enables verifying the vehicles based on specification, loading status and providing the dynamic rally point to merge together on the open road even though vehicles are departed from different point**

- **Dynamic Rally Point**
  - Inform the merging point to LV and FVs(who wants to join) referring to traffic status and road structure



Platooning Platform

- **Privacy**
- **Matching** : Verification, Routing, Loading staus
- **Mileage point** : role dependant, benefit share

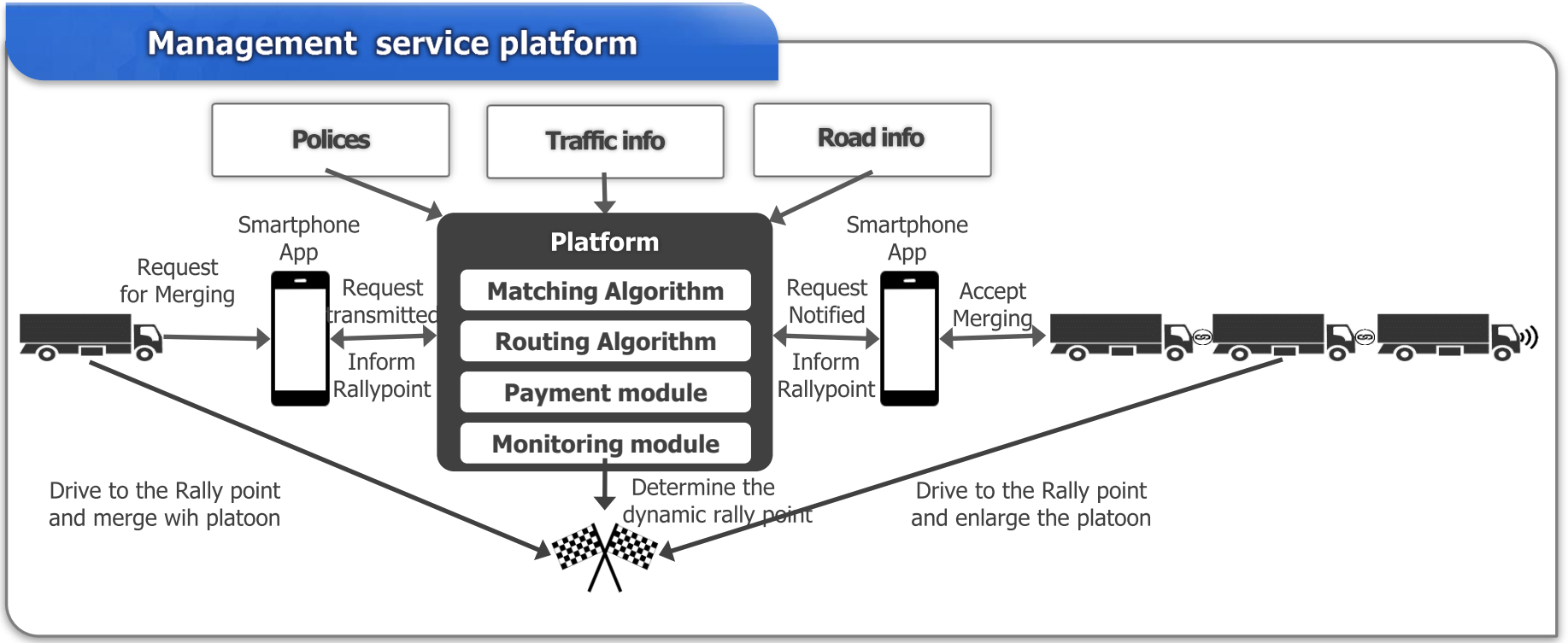
Mobile App.

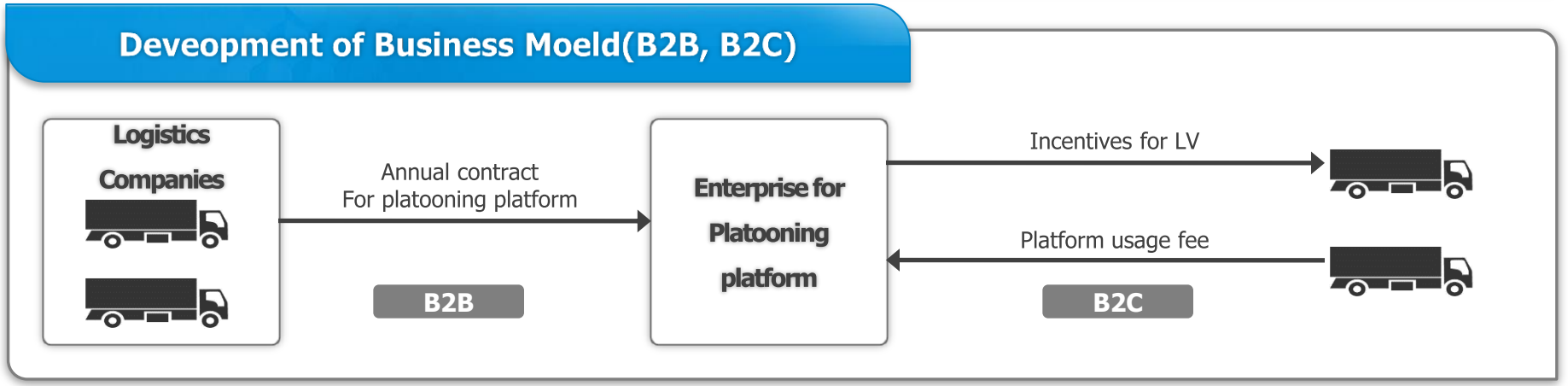
- **Booking, Navigation to the rally point**

Display

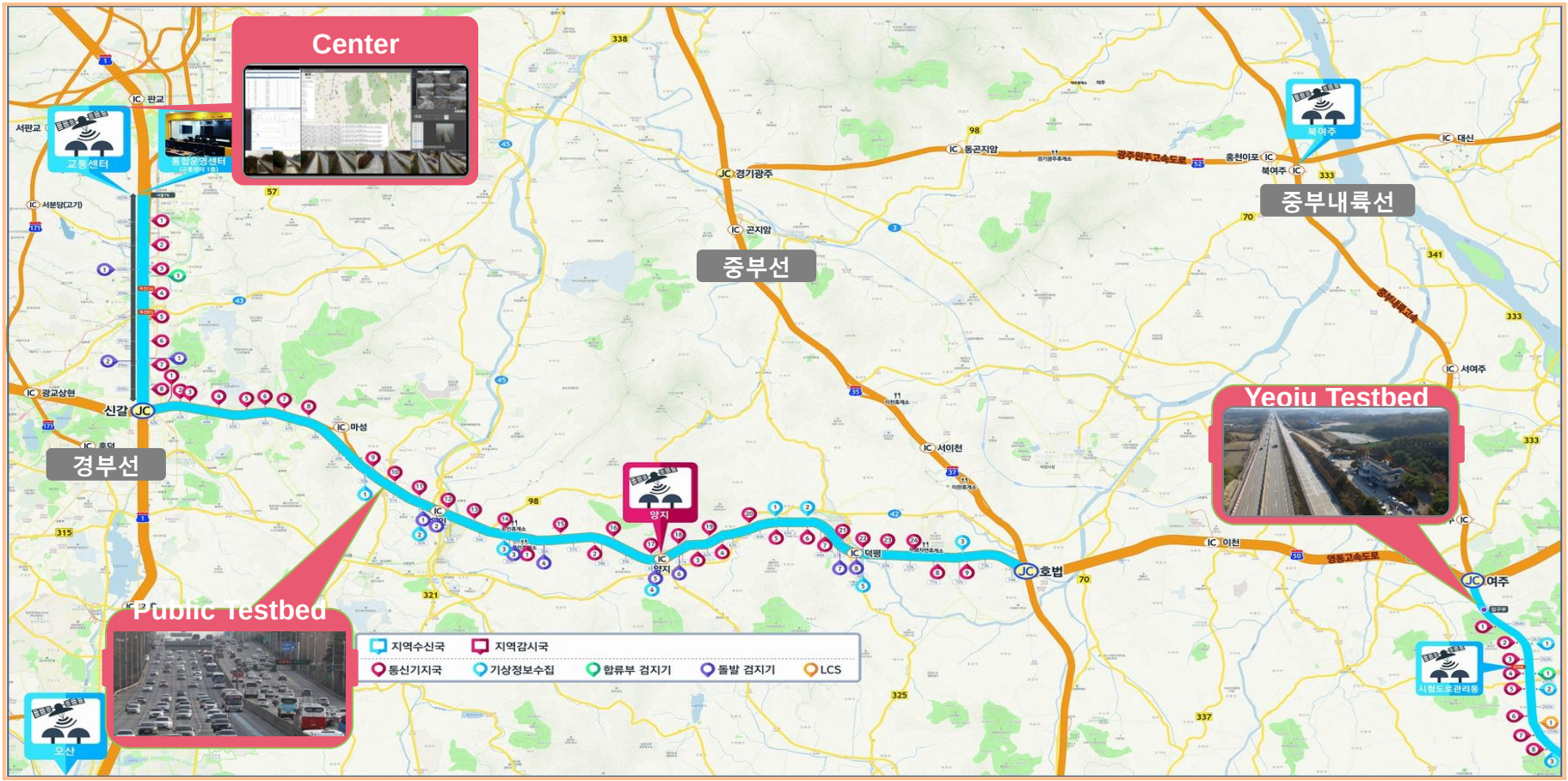
- **Integrated Visualization**
  - Navigation, Platooning(each vehicle) status, See through

Management service Concept



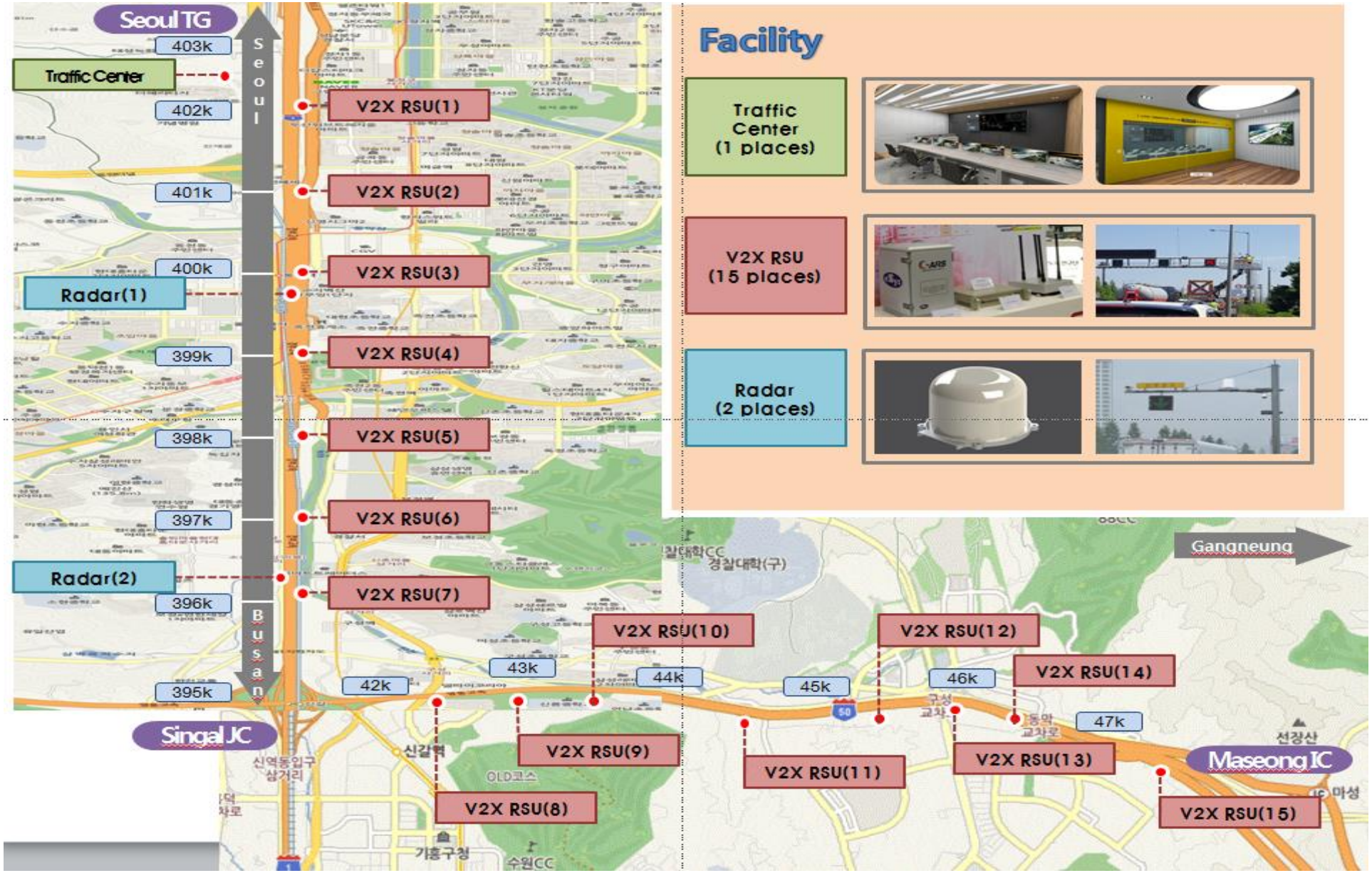


Test Road

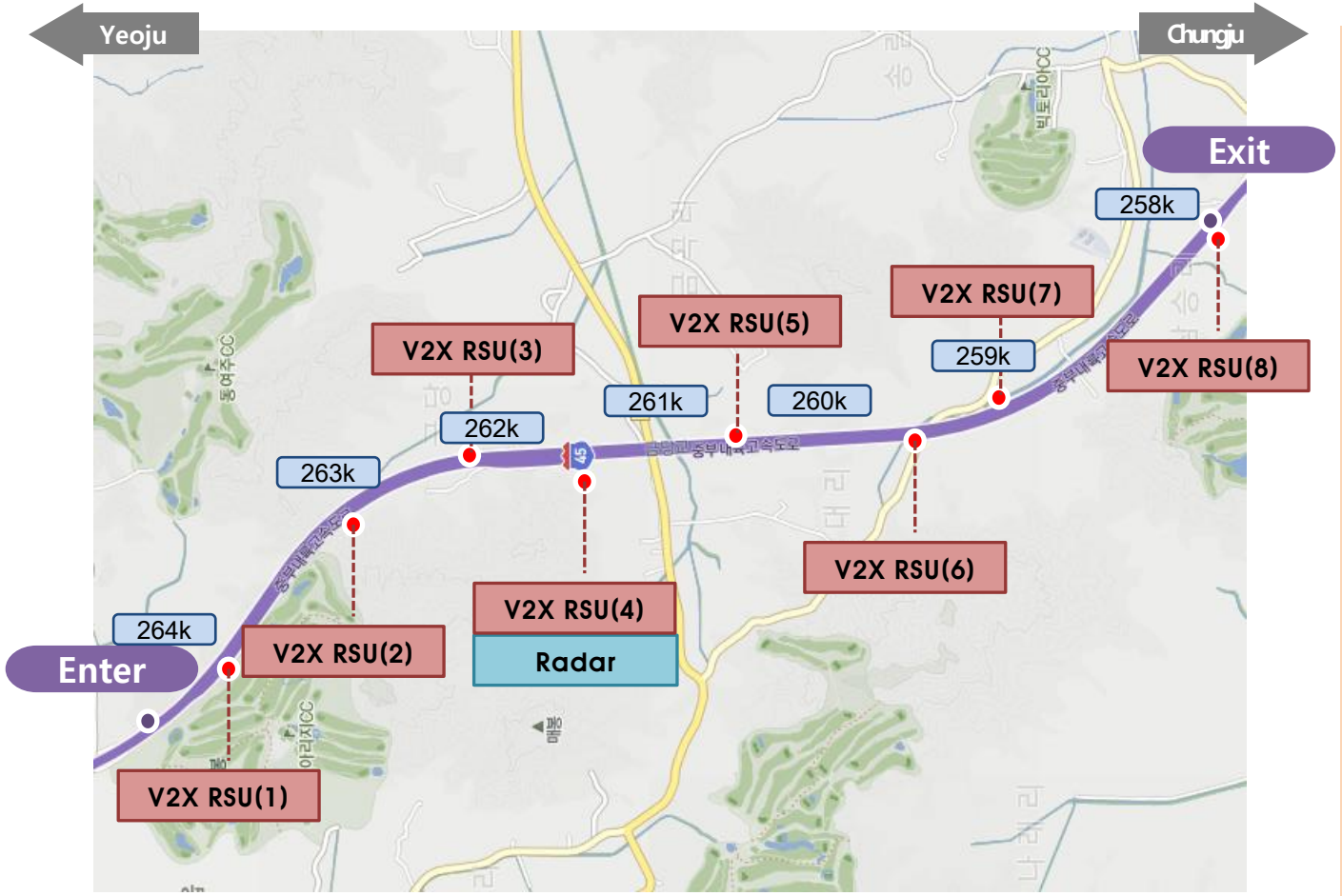


Public Road (Seoul TG –Shingal JCT-Hoebup JCT)	**Test only Road** (Yeoju Test Road)
· Length : 41km · Cooperative Automated driving Roadway SystemTestbed(after 2018) · Certified Public Road for Automated Driving (by MOLIT on Oct. 2015)	· Length : 7.7km · Prototype Installation and Test Verification Process before Public Road Test

Test Road(Public)



Test Road(Test only, Yeoju)



Environment

Multi-Pole

Control Box

Network SW

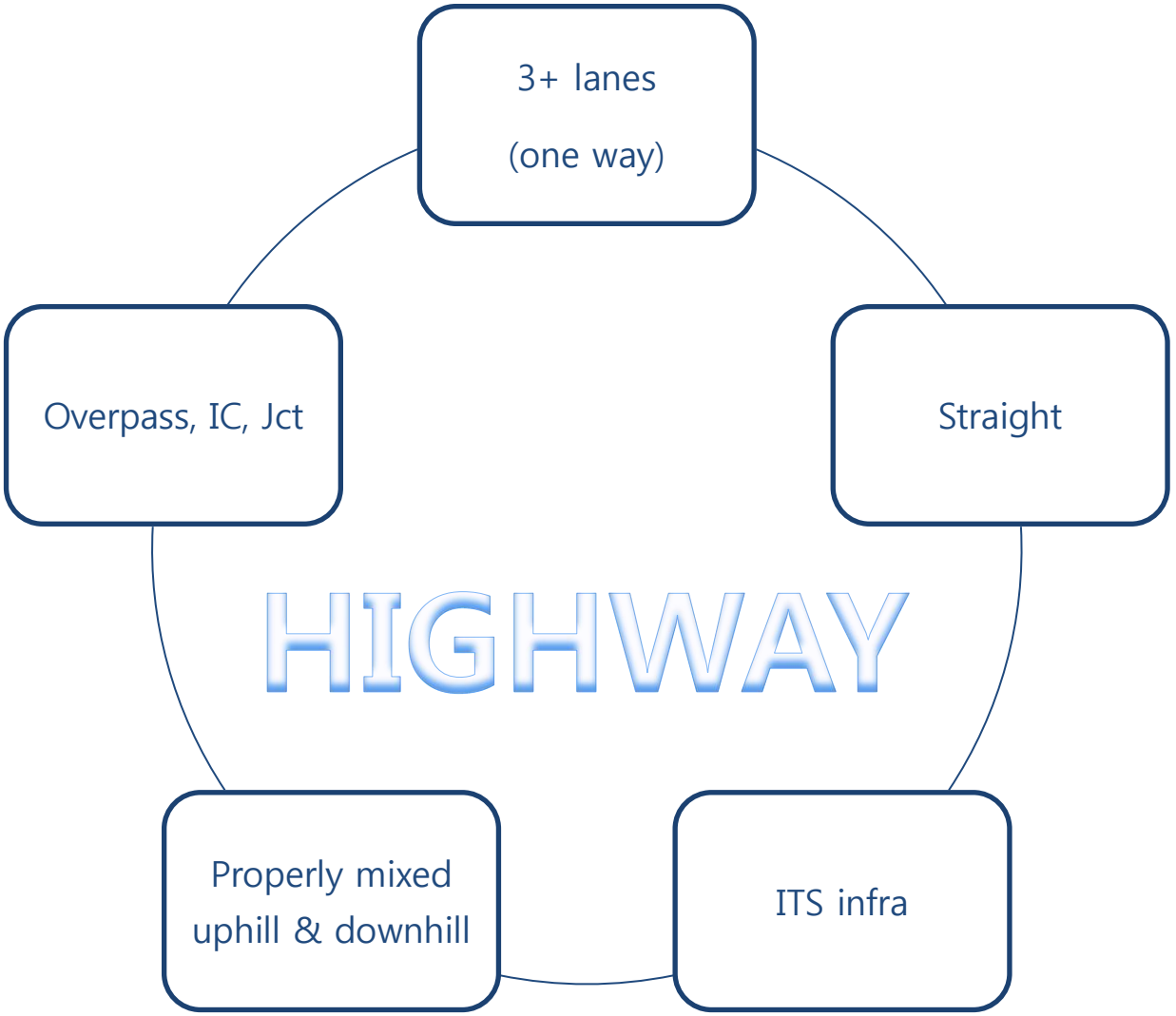
Internal Survey

Q1. In your opinion, how important are the following potential benefits of platoons

Vehicle	• Improved fuel economy	**4.54**
	• Reduced vehicle maintenance costs	**2.29**
Infrastructure	• More efficient use of available infrastructure(space)	**3.96**
Driver and/or other road users	• Reduced accident rate	**4.17**
	• Reduced accident severity	**3.42**
	• Reduced driver workload	**4.46**
	• Increased comfort	**4.25**
	• Possibility of increased driving range due to extending the allowable daily driving time	**3.46**
	• Reduced road congetion	**3.13**

Internal Survey

Q2. Which parts of the motorway network would be most suitable for open road trial and what are the important factors to consider?



Internal Survey

Q3. In your opinion, how important is it to mitigate the following potential issues for road trial in S.Korea?

Vehicle	• Technical malfunction(general vehicle components, platooning related hardware components or SW)	**4.17**
	• System reliability in adverse weather or lighting	**4.00**
	• Additional system fitted to the vehicle to enable platooning	**3.58**
Infra structure	• Causing damage to infrastructure(e.g. exceeding bridge loads)	**2.75**
	• I2V safety Service(Message) reliability	**4.08**
	• I2V management service(message) reliability	**4.21**
Driver	• Training required to use a new system	**3.88**
	• Additional responsibility of leading a platoon	**3.75**
	• No or inappropriate driver reaction to a system failure	**4.29**
	• No or inappropriate driver reaction to the request to regain control	**3.96**
Other road users	• Distraction of other road users	**3.67**
	• Obscuration of information for other road users(signs, markings, etc.)	**3.42**
	• Difficult to overtake	**3.08**
	• Prevents other road users from exiting the highway at desired junction	**3.50**
	• Motivation of dangerous driving manoeuvres(e.g. pulling ahead of platoon/in the middle of platoon)	**3.83**
	• Increased road congestion	**3.04**

Internal Survey

Q4. Can you think of longer-term barriers to the implementation of platooning?

Business model(Money?)

Job occupation

Liability and insurance

Not many adequate road for platooning

Internal Survey

Q5. What do you think is the single most important question that a open road trial should answer?

SAFETY FIRST

Fuel economy

Questionaire

Q1. With regard to twinning research action with U.S. Could you explain the specific topics and if any standard related actions ongoing?

Q2. With regard to roadmap for truck platooing. Can you share your current progress including ERTRAC?

Q3. What items should be prohibited to be loaded in a platooing trucks?

Q4. Fuel saving of truck platooning seems to be obvious, but how can leading and following vehicles share the economic benefits with regard to business model.

Q5. How do you expect to change the design criteria for the road bridge in terms of platooing?

Questionaire

Q6. What do you think is the issue of safety regulations that should be urgently reviewed for automated driving in trucks platooning, in particular, including V2V and V2I technologies?

Q7. What are the key roles of automotive OEMs, infrastructure, and related government departments to maximize synergies through the integration of transportation logistics, transportation systems and platooning technologies?

Q8. What are the ways in which Hyundai Motor Company can participate in the platooning standardization of E.U, or how could our company know the progress?

(Technical questions)

Q9. What kind of sensor is used in the lateral control with small distance gap between Platooning Vehicles?

1) if front camera is only used in order to keep the lane,
   it would be difficult to detect the lane information
2) if Radar and camera are used in order to make the front vehicle's trajectory
   by detecting the center of front vehicle's back side, it would be also difficult.
   so, I wonder how to control the lateral direction.

THANK YOU!