V2X

Cooperative Systems

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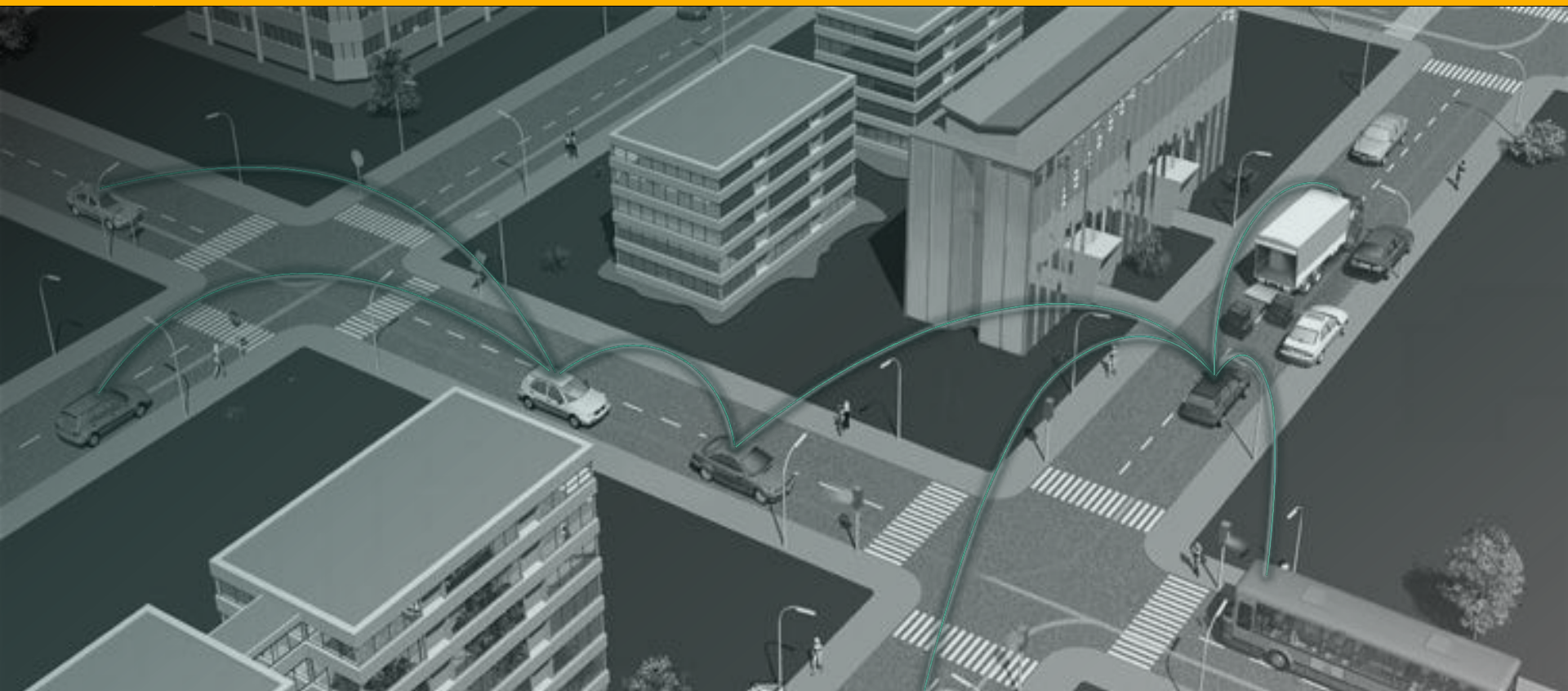

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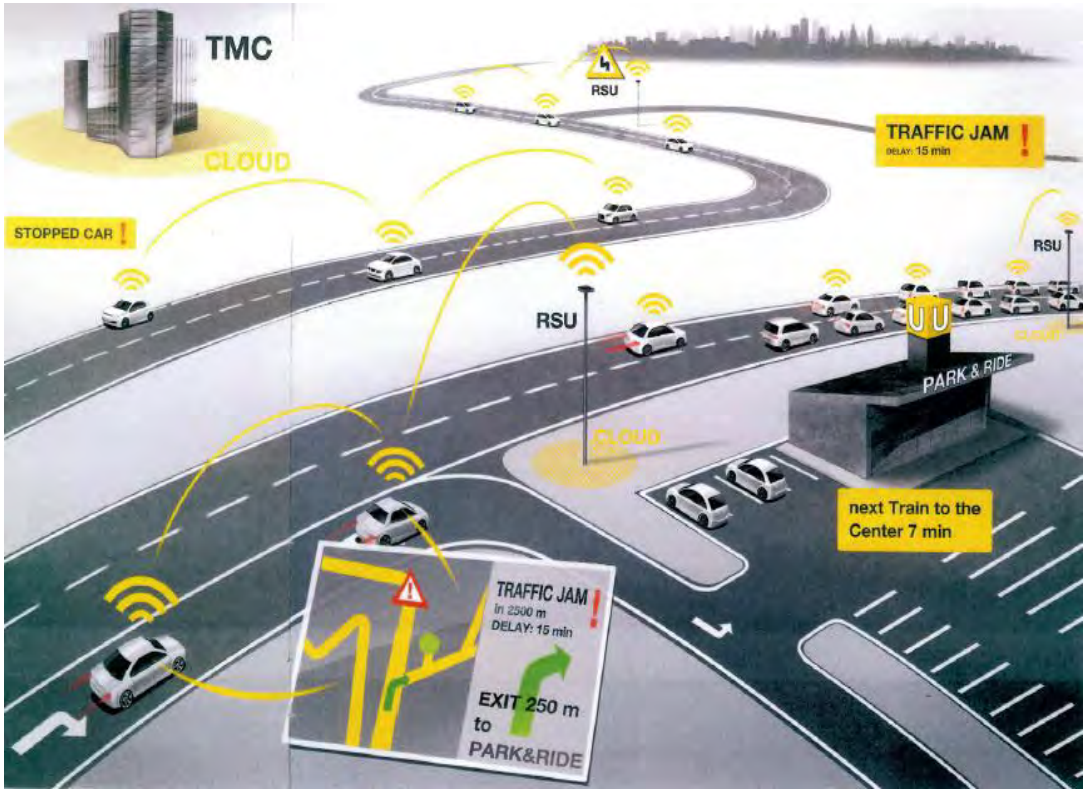
- Infrastructure Architecture
- V2X end-to-end System
- Basic Elements of a V2X System
- Field Operational Tests - Demonstrations
- Conclusion – V2X System Deployment
- V2X Next steps

Infrastructure Architecture




V2X Cooperative Systems

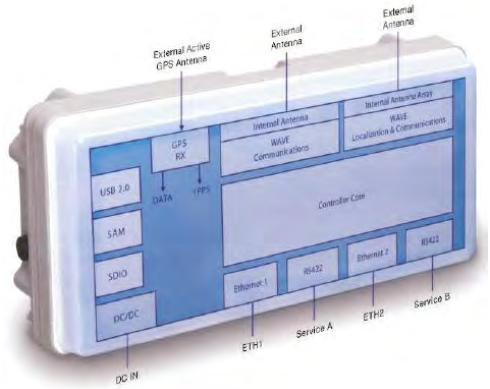


Concept of cooperative mobility:

V2V + V2I = V2X

- V2X is based on DSRC a two-way wireless radio communication
- Applications related to environmental driving, safety and mobility
- New services for V2X leading to smarter and safer transportation

V2X Cooperative Systems



Car connectivity - infomation servis for:

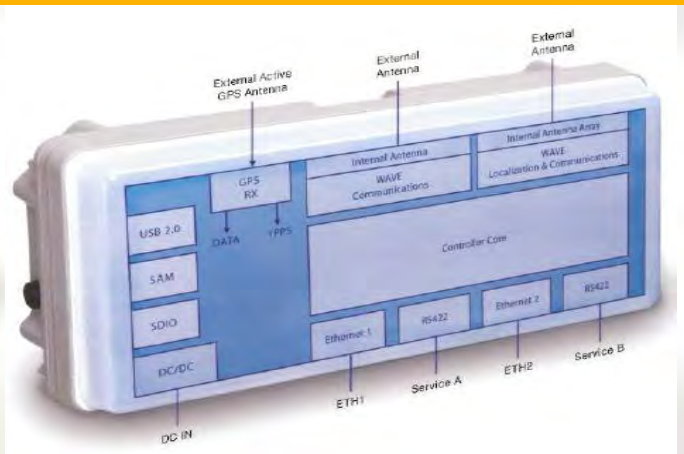
Drivers

Road operators

Car manufactorers

Public authorities

V2X end-to-end System



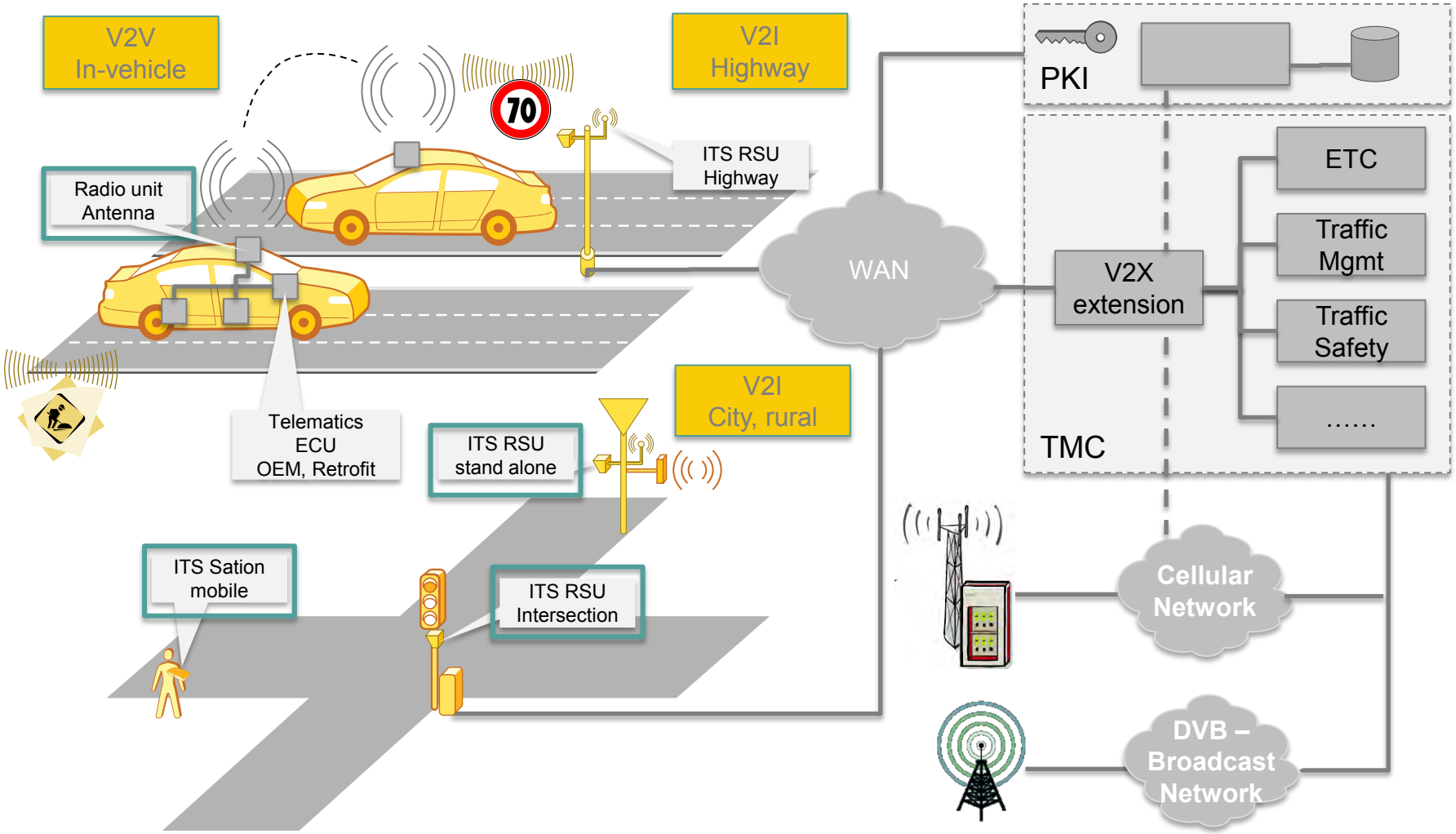
V2X end-to-end System

- V2X end-to-end system is much more than a V2V system and a real major step to co-operative ITS
- V2X end-to-end system leverages all available information, communication and processing capabilities of the vehicle and infrastructure for co-operative ITS
- V2X end-to-end system design and integration is a complex task that requires integration and operation capabilities of Dedicated Short Range Communication, Security and Telecommunication!

V2X Dynamic real-time information to:

- Increase driver safety
- Avoiding crashes or predicting dangerous situations
- Traffic efficiency
- Reccomending alternate roates
- Eco-friendly driving
- Offering parking
- The time until the next traffic signal change
- Optimum spead
- Secure
- Comfortable journay
- Provide Payment services (fueling, e-charging ETC)
- Commercial infotainment
- Collection of vauable data for environmental purposes
- Traffic data for low emmision zones and a number of business related and technical challenges

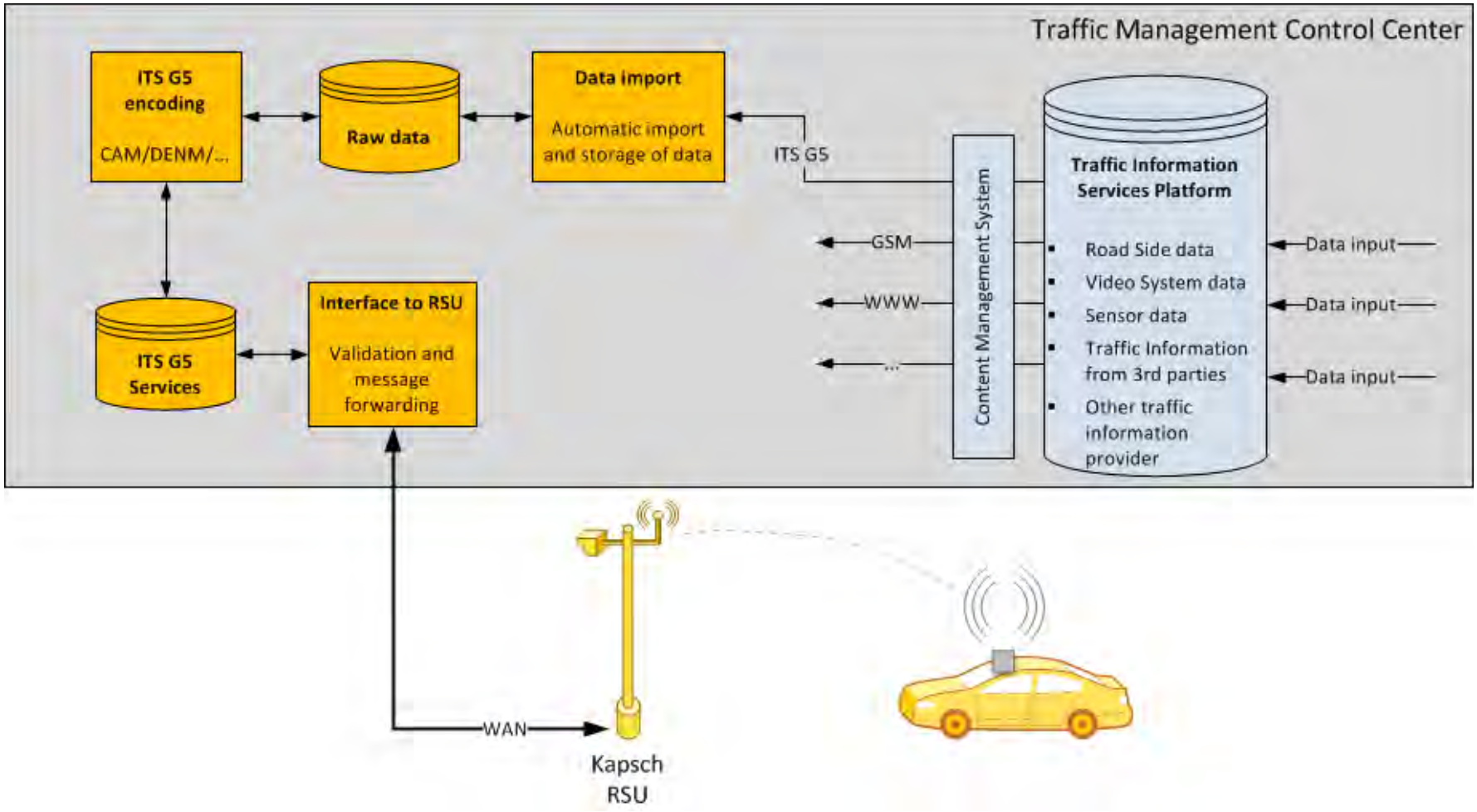
V2X Cooperative Systems



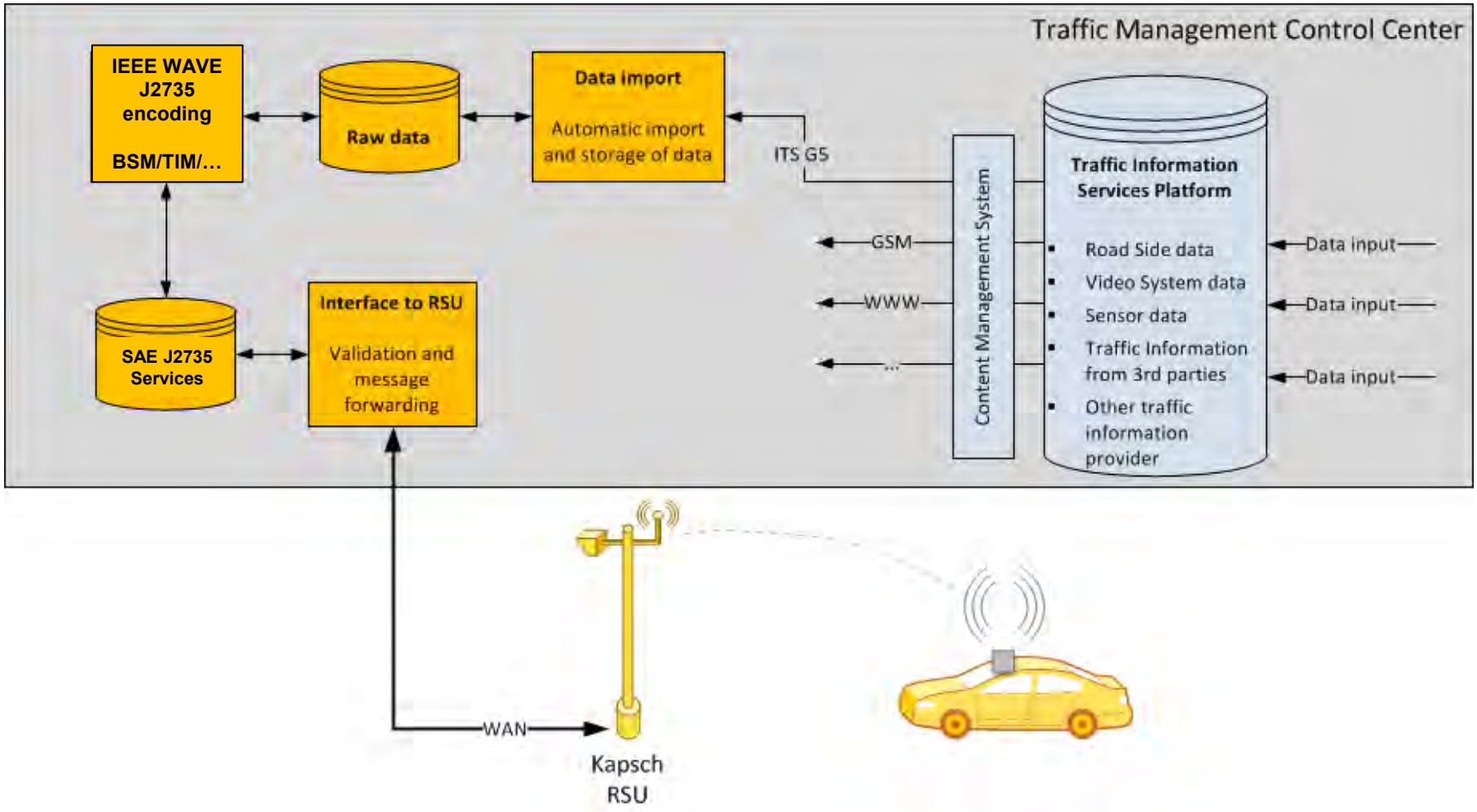
V2X end-to-end System Elements

- Traffic Management Control Centre
- Traffic Signal Controller(s)
- Road Side Sensor and 3rd party data interfaces
- Public Key Infrastructure
- Certificate Authority (root, intermediate)
- Road Side Equipment
- Road Side ITS G5 Station
- In-Vehicle ITS G5 Station
- Other communication media e.g. cellular, DVB etc.

V2X End-to-End System Solution



V2X End-to-End System Solution



Basic Elements of a V2X System

V2X Roadside Unit

- TCC interconnected fully system integrated unit e.g. WAN
- TCC interconnected temporary system integrated unit
  e.g. mobile RSU with cellular backhaul
- Standalone unit

TRX/MTX-9450 - 5.9 GHz ITS Roadside Unit

Key Features	• Compatible with IEEE 802.11p, IEEE 1609.x and SAE J2735 • Compatible to current specifications of ITS G5 • Supports IEEE 1609.2 based security for signing and verification • Internal or external antennas configurable • Built-in GPS • UL and FCC Certified
Characteristics	• Flexible I/O ports: 2 x Ethernet, 2 x Serial RS422, USB 2.0 • Antenna: Built-in directional and 2 x ext. N-conn. fem. Ant. • Operational temperature range: -35°C to +75°C • Protection classification: IP67 • Radiated power: +33 dBm EIRP maximum, adjustable • Supply voltage: 24/48VDC nominal
Target Applications	• Commercial Vehicle Inspection • V2I Day 1 Use Cases (CAM, DENM, SPaT, BSM, TIM,...) • Tolling US e.g. HOT, ORT/MLFF
References	• Port of Hood River • Lee County • FTE, Sun Pass • Schodak NYSERDA • Roadsafe • USDOT RSE Safety Pilot • Testfeld Telematik • ITS WC 2012 VIE

V2X Onboard Unit

- Fully vehicle integrated embedded unit
- Partly vehicle integrated retrofit unit
- Standalone aftermarket unit

TS3306 5.9 GHz ITS On Board Unit

Key Features	• Compatible with IEEE 802.11p, IEEE 1609.x and SAE J2735 • Compatible to current specifications of ITS G5 • Supports IEEE 1609.2 based security for signing and verification • Optional external antenna connector for WAVE/ITS G5 • Bluetooth interface to smart phone , tablet or laptop. • Built-in GPS receiver
Characteristics	• Single PCB design with integrated 5.9 WAVE/ITS G5, GNSS and Bluetooth solutions. No internal connectors. • Operational temperature range: -40°C to +85°C • Internal re-chargeable battery tested up to +105°C. • Output power: +14 dBm • Receiver Sensitivity: -90 dBm (6 Mbps)
Target Applications	• Commercial Vehicle Inspection • Electronic Payment and Access Control • Transit Signal Priority • Traveler Information • Signal Phase and Timing • USDOT Safety Pilot applications • CAM/DENM
References	• US DOT Schodack • FTE / Sun Pass • US DOT Safety Pilot • ACS Help • Testfeld Telematik / ITS WC 2012

Customized ITS Roadside Cabinet

Key Features	• Power Supply AC/DC. DC/DC • Protection Units • Application Controller • Network Interconnection • Supervision
References	• Port of Hood River • Lee County • FTE, Sun Pass • Schodak NYSERDA • Roadsafe • Testfeld Telematik • ITS WC 2012 VIE

Field Operational Tests - Demonstrations

ITS WC 2012 Vienna Demonstrations and Testfeld Telematik FOT

- V2X Demo Tour Kapsch

On A4 (4 vehicles, 30km)

Use Cases
In-vehicle signage
Hazardous location notification
Traffic jam ahead warning
Road works warning
Weather warning
Travel times, status and on route update
Park & ride
Information on flight delays
CAM Monitoring

- Demo Tour Testfeld Telematik / C2C-CC

On A23, Handelskai, Prater (30 vehicles, 16km)

Use Cases
Some of V2X Kapsch use cases +
Traffic Monitoring at ITS2012
SPAT message – traffic lights
Green light optimum speed advisory
Emergency priorisation
Red Light Violation
Intersection Collision Warning
Emergency electronic brake lights

The Route on A4 Highway

System Components – OBU

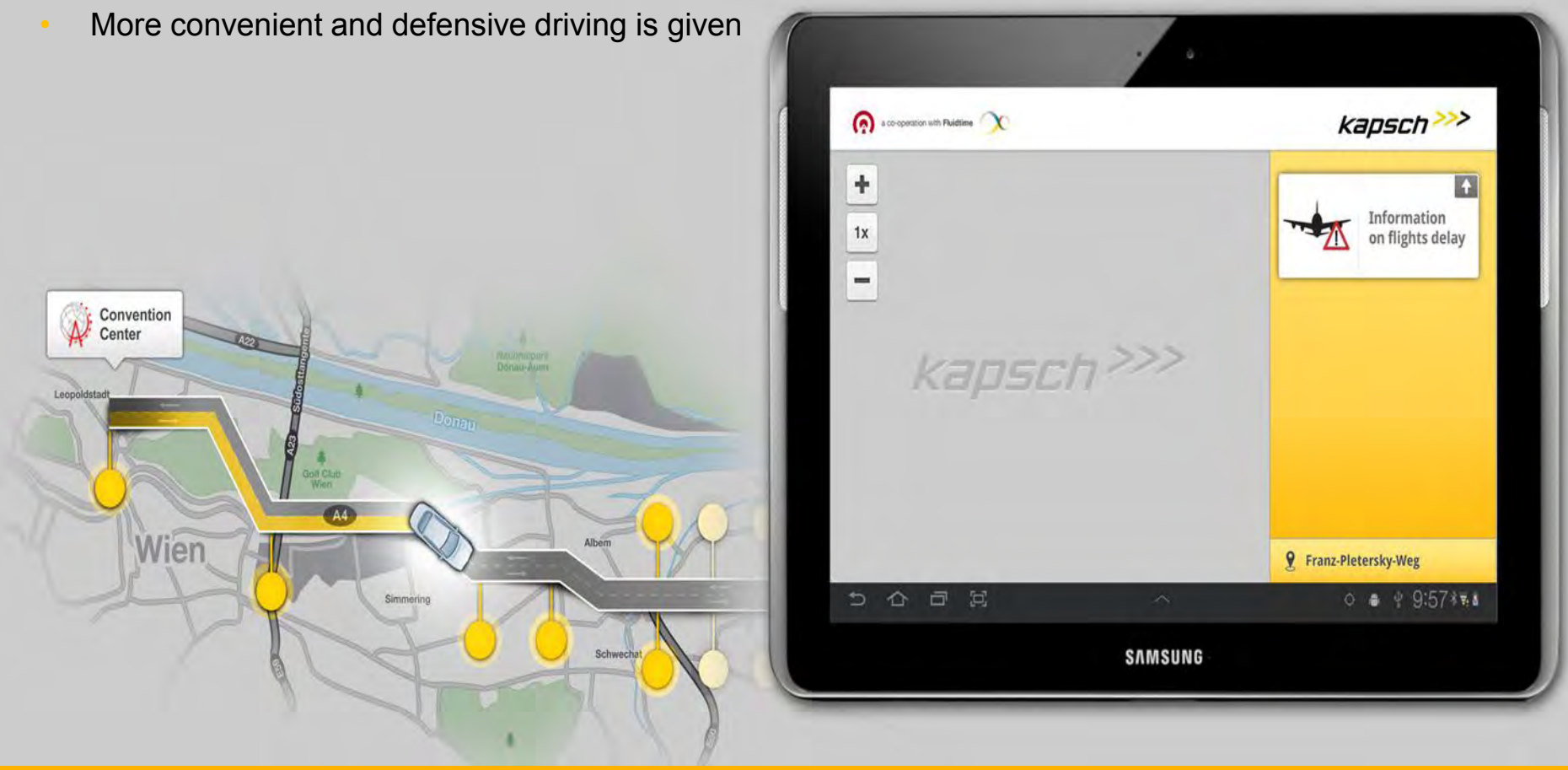
System Components – RSU

Weather Warning

- Bad weather condition detection and information distribution is highly time critical.
- Our solution informs drivers in real-time about the latest road conditions.
- Location based information is provided.

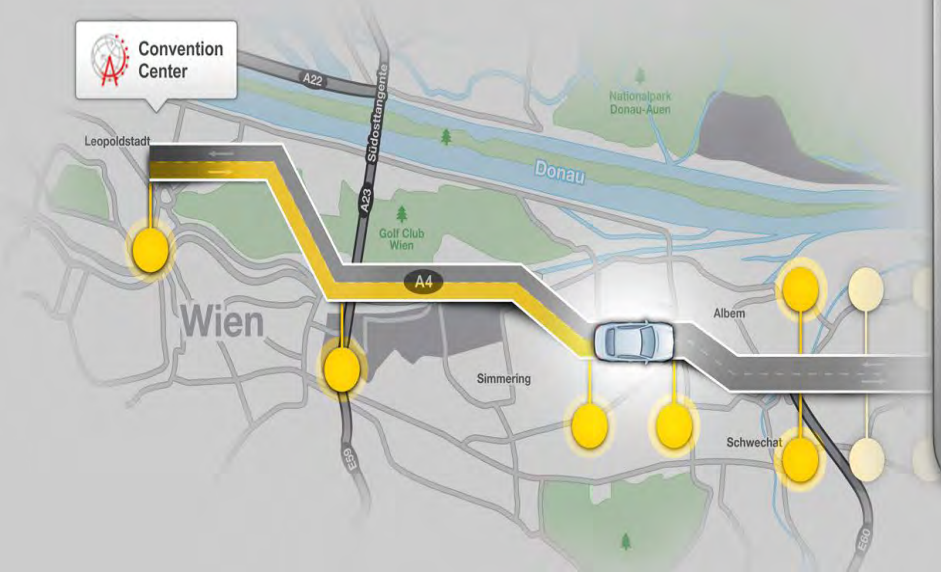
Flight Delay Information

- Main paths to airports provide the latest flight schedules
- More convenient and defensive driving is given



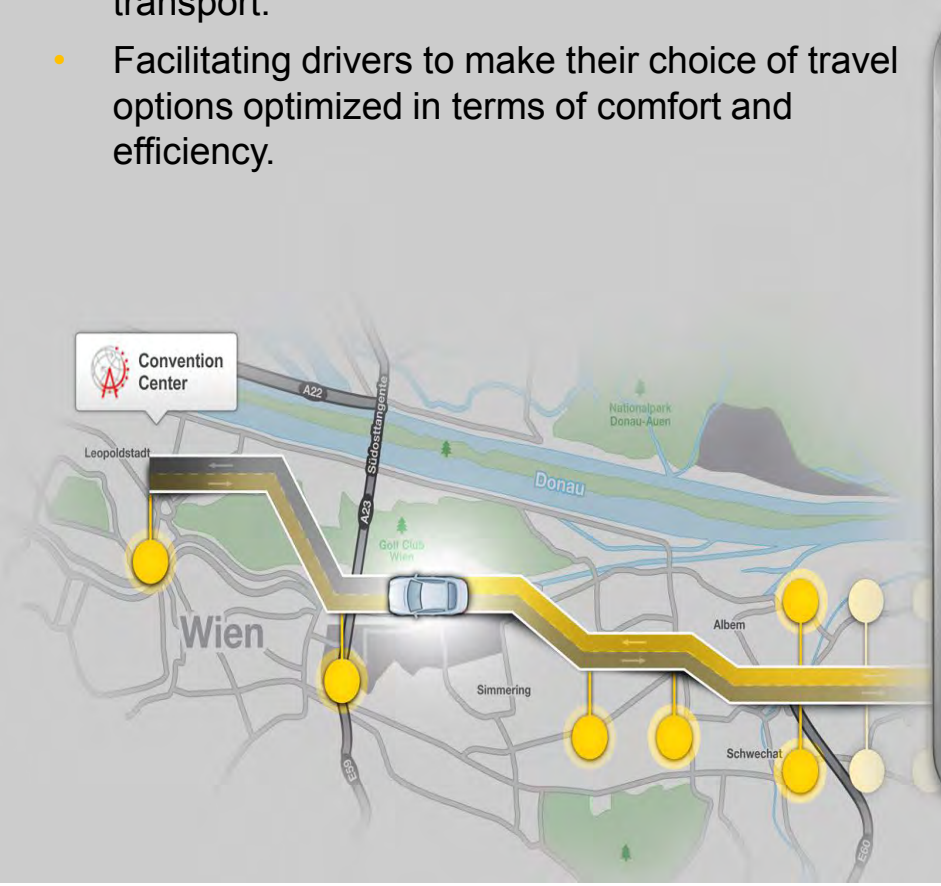
Hazardous Location Notification

- Obstacles unexpectedly appearing on the roads put road users at risk.
- Informing and warning the driver helps avoiding dangers and potential severe accidents.
- Broken down cars for example communicate their position to other vehicles in the vicinity.
- In other cases hazardous events are detected by a traffic management center and spread to all vehicles
  in the proximity.



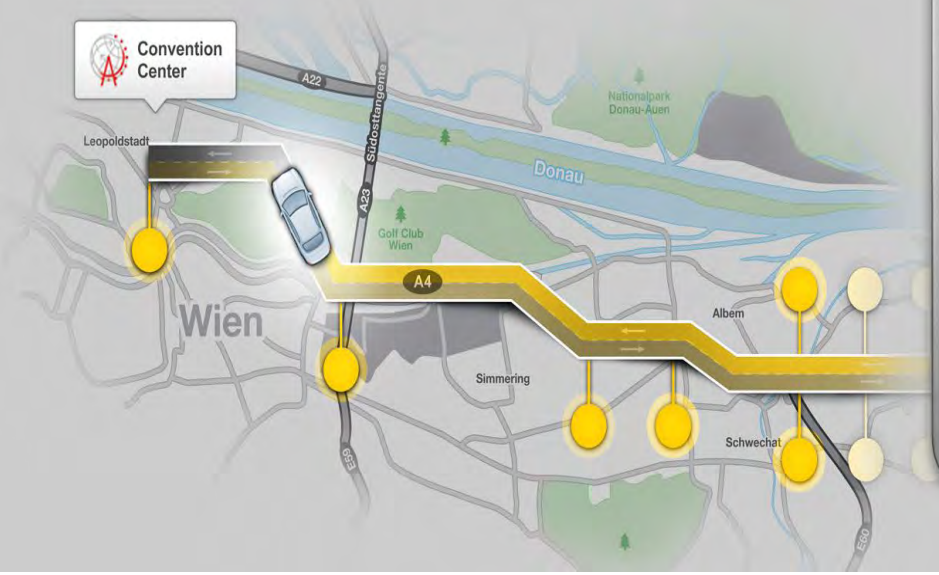
Park & Ride

- Transmission of information about park & ride facilities and frequencies of public means of transport.
- Facilitating drivers to make their choice of travel options optimized in terms of comfort and efficiency.



Road Works Warning

- Road works may cause dangerous situations due to changed traffic routing, temporary speed limits, etc.
- Road side units attached to traffic infrastructure, like temporary traffic lights or variable traffic signs, send data to the in-car system
- Drivers are informed about temporary speed limits, length of changed routing, blocked lanes or diversions.



Messages for your safety - Summarized

Hazardous location notification

Traffic jam

Broken down vehicle

Wild animal crossing

Slippery road

Road services

Road works

Weather warning

Strong wind

In-vehicle signage

Speed limit

General traffic information

Emergency Corridor

Park & Ride

Flight information

V2X - Application

- Road safety: Road warning
- Traffic efficiency: Traffic Light Optimal Speed Advisory (Signal Phase and Timing)
- In-vehicle signage
- Weather information and warnings
- Status messages and routing updates
- Information on flight delays
- Information P+R
- Curve Speed Warning
- Cooperative intersection Colision Warning (CICAS-V)
- Basic Safety Messages
- Basic Safety Message vehicle-to-vehicle and here-I-am
- Safety advisories
- ……

Conclusion
V2X System Deployment



V2X RSU – Infrastructure Deployment

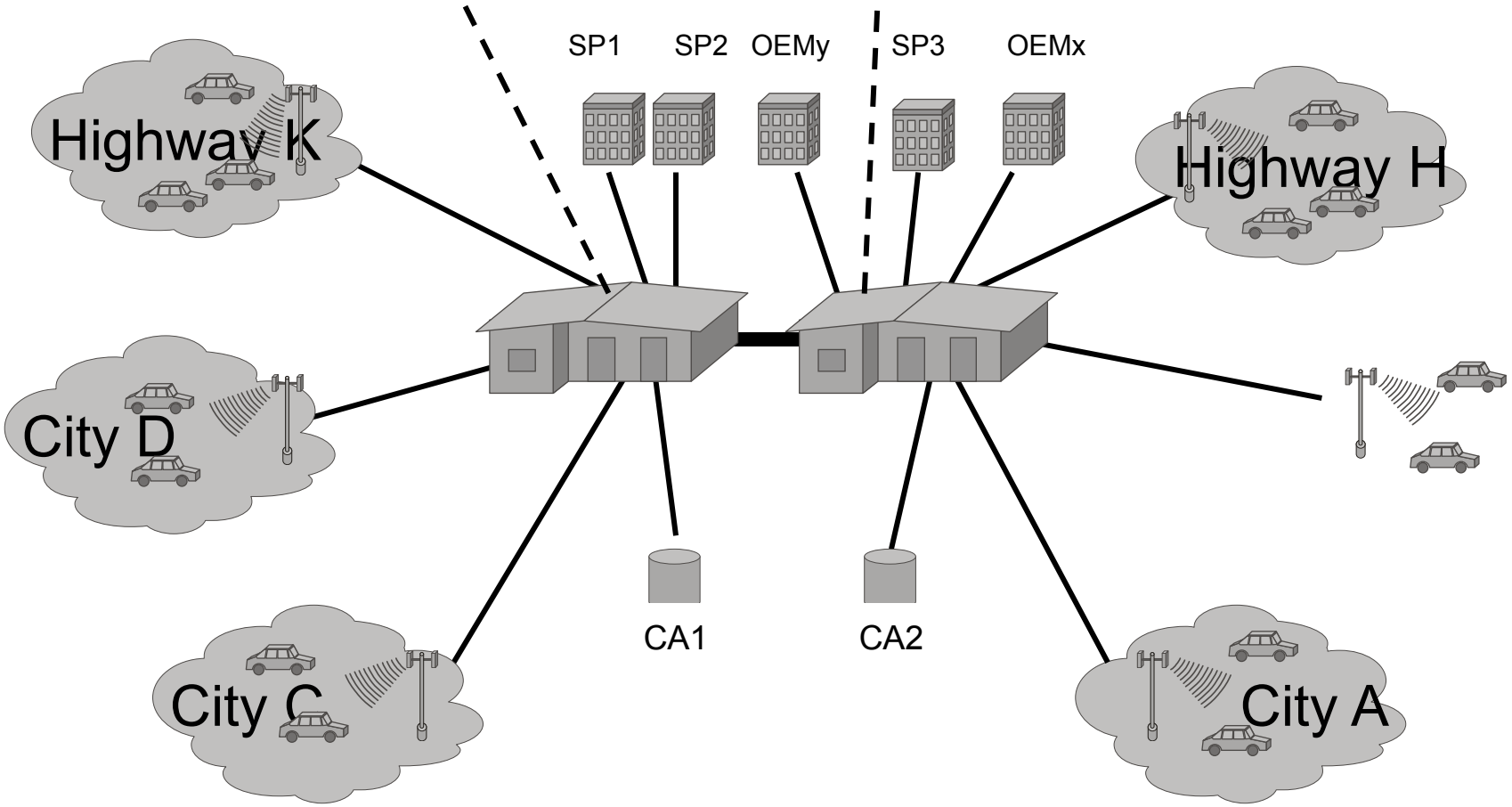
- I2V is major part of the V2X System, (refer to the use cases above)
- I2V is capable to increase user benefit and experience immediately
- I2V is highly efficient compared to V2V with respect to deployed V2X nodes
  - **V2V and I2V deployment must happen simultaneously.**

V2X Big Picture for Deployment and Operation

Following scenario needs to be considered

- Multiple Operators
- Multiple Service Providers
- Interconnection and co-ordination between those
- Covering rural and urban area
- Border areas of operation and responsibilities
- Ensure efficient use of spectrum and resources
- Maintain / ensure quality of service (availability, minimize interference, ….)
- …. require system design, radio planning, co-ordination and management

V2X Picture for Deployment and Operation



V2X Next steps




V2X Putting the Puzzle together

- Extend the focus of Pilots to live end-to-end approach
- Incl. existing Traffic Management Control Systems and Sensor Networks
- Interconnection of different V2X operators even over the country borders
- Integration and management of Public Key Infrastructure and security framework
- Deploy significant number of ITS stations (in-vehicle and on the road)
- Validate also update strategies
- Prove co-existence in live environment
- Specify conformance and interoperability standards and define the certification scheme

Thank you for your attention !

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