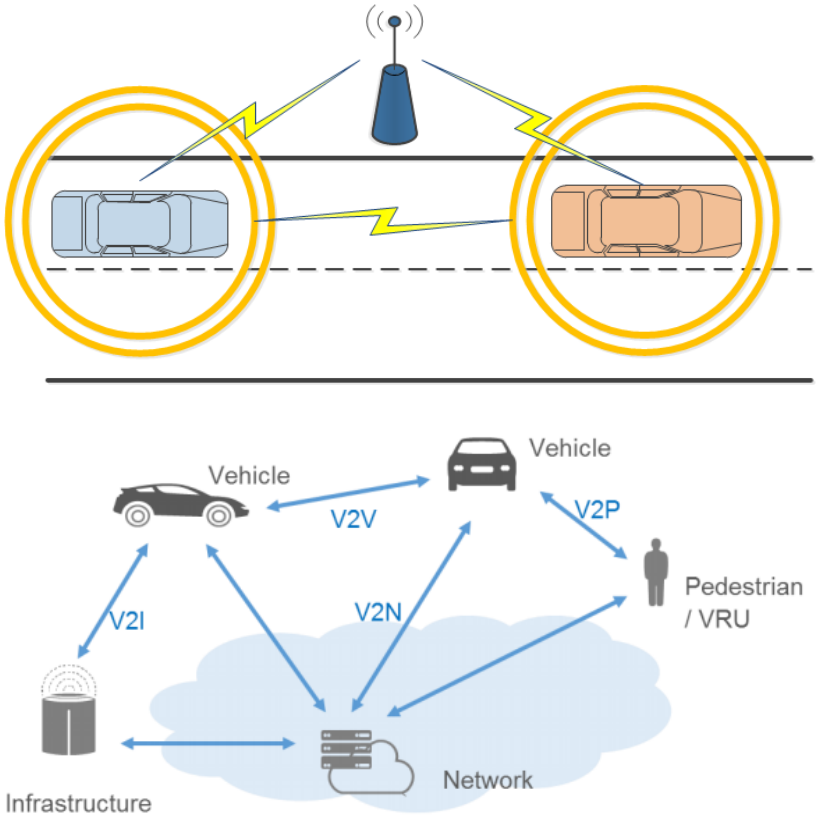
V2X Beyond the Horizon: DSCR, 5G and the Future of Connected Vehicle Technology

ITS Carolinas Annual Meeting
February 12, 2018
Session 3B

V2X-Based Safety Applications

Source:USDOT

- Address crashes that cannot be prevented by current in-vehicle camera and sensor-based technologies (“vehicle-resident” technologies)
- Not restricted by the same line-of-sight limitations as crash avoidance technologies that rely on vehicle-resident sensors.
- V2V communications (BSMs) contain additional information, such as path predictions and driver actions (braking, steering) not available from traditional sensors. This information can be used by receiving vehicles to more reliably predict potential collision events as well as reduce false warnings.



Source: 5G Americas V2X Cellular Solutions

Dedicated Short Range Communication (DSRC)

- Bi-directional wireless communications permitting secure and fast messaging needed for safety applications.
- These communications occur in a 75 MHz band of the 5.9 GHz spectrum, which was allocated by the FCC for use by ITS vehicle safety and mobility applications.
- V2X provides safety beyond the line of sight with zero latency broadcasting technology

WWAN (> 1000 m NLOS[1]) (UMTS, HSPA, LTE)

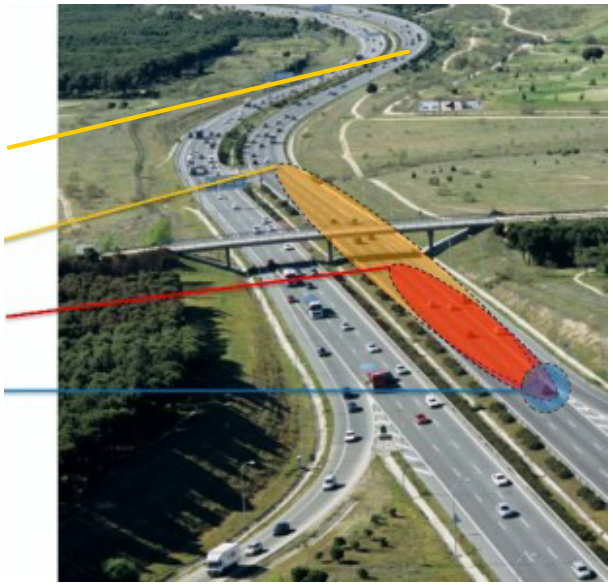
V2X (< 1000 m) NLOS[1] (IEEE 802.11p, DSRC))

Radar **(< 200 m)**

Camera **(< 80 m)**

Ultrasonic **(< 4m)**

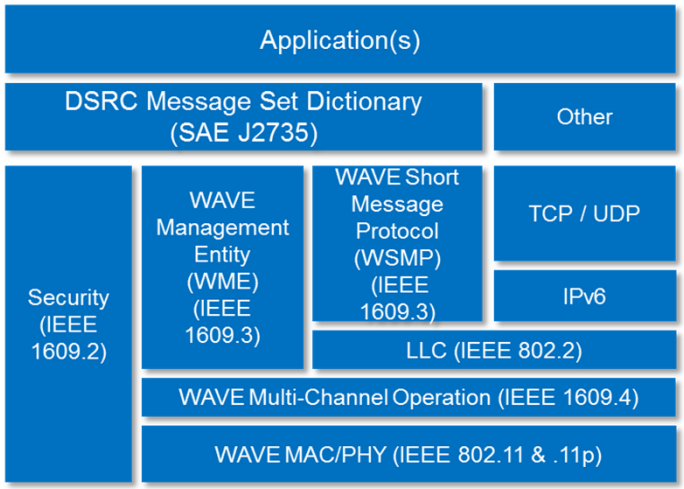
NLOS = Non Line of Sight



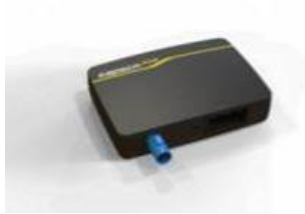
5.850 GHz							5.925 GHz
		CH175			CH181		
5850-5855 reserve 5 MHz	CH172 service 10 MHz	CH174 service 10 MHz	CH176 service 10 MHz	CH178 control 10 MHz	CH180 service 10 MHz	CH182 service 10 MHz	CH184 service 10 MHz

Dedicated Short Range Communication (DSRC)

- Vehicles communicate with each other by passing and interpreting messages
  - Vehicles disseminate Basic Safety Messages (BSM) 10x a second based on the SAE J2735 Standard
  - A vehicle that receives the message processes the data and assesses collision threat that in turn and triggers either an automatic response or driver warning
- WAVE (Wireless Access in Vehicular Environments) is the core design aspect of DSRC – it is a suite of IEEE P1609.x standards

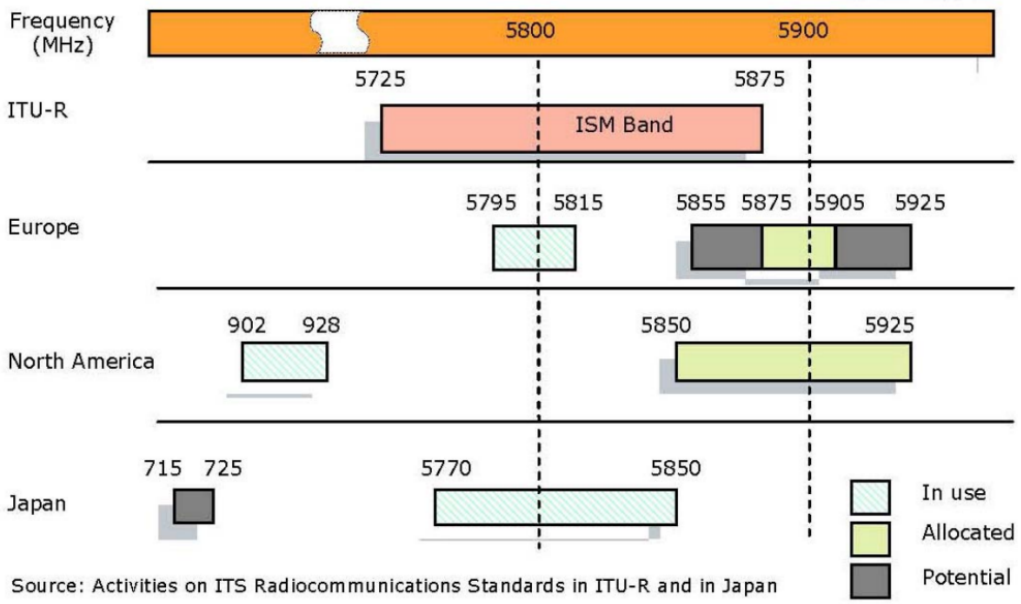


Roadside Units (RSU)



On-Board Unit (OBU)

DSRC Standards Harmonization



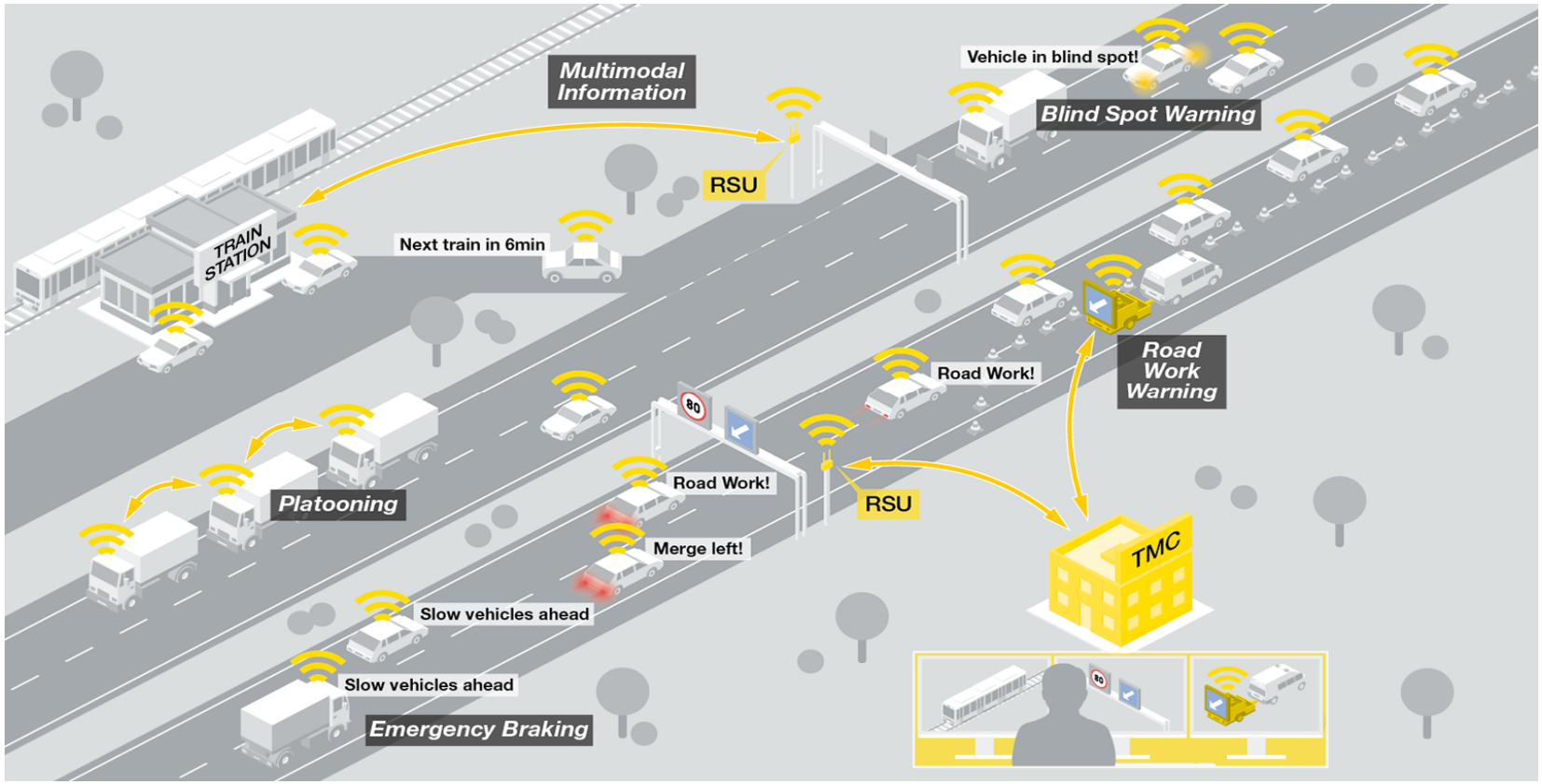
Source: Activities on ITS Radiocommunications Standards in ITU-R and in Japan

	Japan	USA	Europe
Standard / Committee	ITS-Forum	IEEE802.11p/1609.x	CEN/ETSI EN302 663
Frequency range	755 – 765 MHz	5850 – 5925 MHz	5855 – 5925 MHz
No. of Channels	One 10 MHz channel	Seven 10 MHz channels (Two 20 MHz channels formed by combining 10 MHz channels)	Seven 10 MHz channels
Modulation	OFDM		
Data rate per channel	3 -18Mbit/s	3 -27Mbit/s	3 - 27Mbit/s
Output power	20 dBm (Antenna input)	23 - 33 dBm (EIRP)	23-33 dBm (EIRP)
Communication	One direction multicasting service (broadcast without ACK)	One direction multicasting service, One to Multi communication, Simplex communication (broadcast without ACK, multicast, unicast with ACK)	
Upper protocol	ARIB STD-T109	WAVE (IEEE 1609) / TCP/IP	ETSI EN 302 665 (incl. e.g. GeoNetworking) TCP/UDP/IP

Table 2-1: High level global overview of ITS.

Source Rohde & Schwarz Application Note 2014

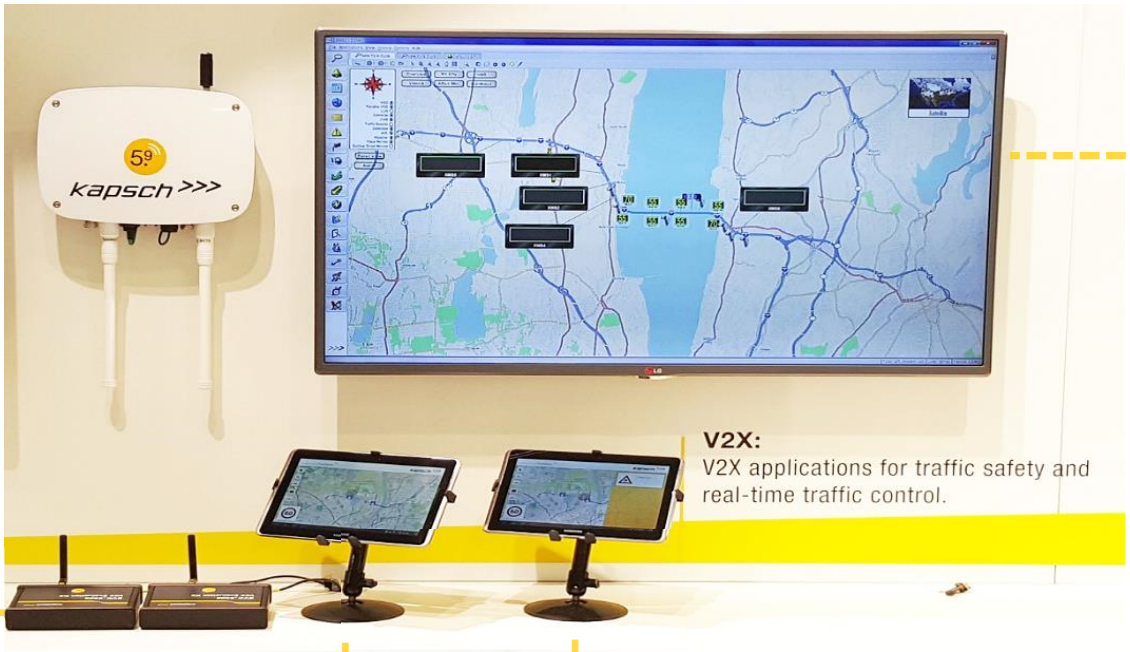
V2X Networks to Support Traffic Management



V2X Traffic Management

V2X Roadside unit (RSU)

V2X On-Board Unit (OBU)



Traffic Management System (ATMS)

V2X applications

On Board Unit (OBU)

- Includes V2X dual communication stack configurable to ETSI ITS G5 and IEEE WAVE™ protocol and related standards suite
- 5.9 GHz DSRC aftermarket device, designed for a variety of V2X applications.
- 12VDC powered (supports vehicle-based power).
- Fully IEEE 802.11p and 1609 compliant.
- Interfaces: Bluetooth , GPS, MMI (LED, buzzer, key, 3rd party carry-in devices)
- EVK includes Software Development Kit for V2X Application Development

KVE-3320

EVK-3300

V2X Roadside Station RIS-9160

- Leading 5.9 technology
- Modular design with optional WiFi / Bluetooth support
- NEMA and IP67 Standards Compliant
- API Open Platform to run customized applications

- 33 units for Colorado DOT on C470 as part of RoadX program

DSRC Assessment

kapsch challenging limits

Advantages

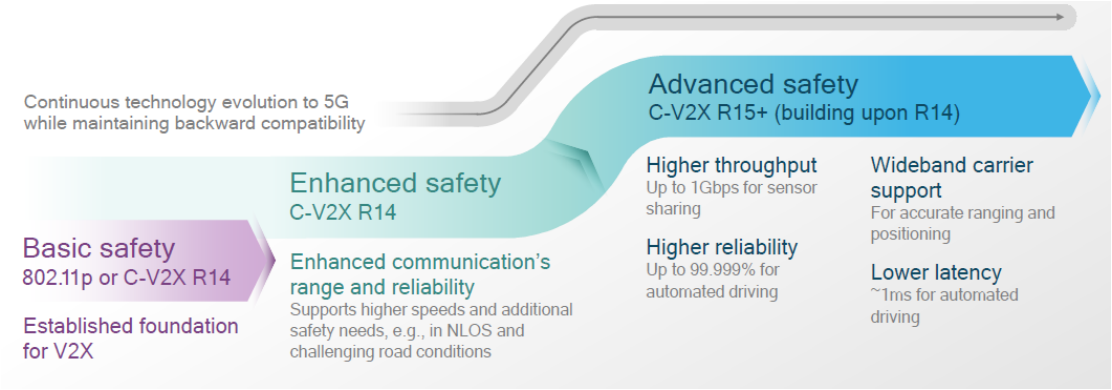
- Established technology
- Embraced across the globe
- Currently accommodates V2V and V2I solutions
- Capable of functioning at high speeds and adverse weather conditions
- Low latency

Disadvantages

- Questions about rate of adoption
  - Limited RSUs deployed today
  - Market penetration rate for OBUs
- No inherent redundancy
- Limited spectrum for V2V road safety
- Limited range (1000 meters)
- Evolution path is uncertain

Cellular V2X (C-V2X)

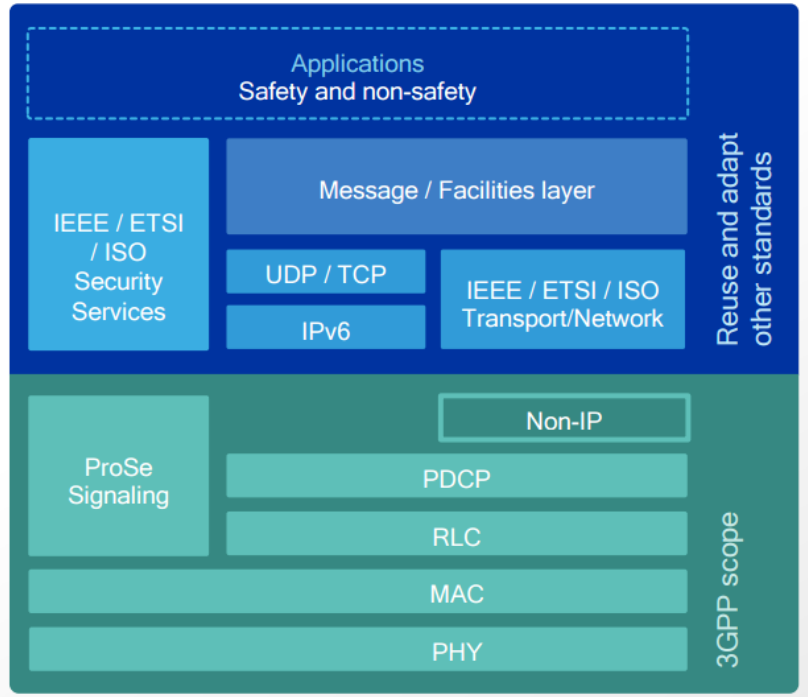
- C-V2X communications is an emerging technology that works off of LTE (Long-Term Evolution) features and cellular networks to provide V2X capabilities
- Supports Direct Communications (V2I/V2V/V2P)– independent of cellular networks based on PC5 interface using 5.9 GHz
- Also supports Vehicle to Network (V2N) applications for longer-range interactions



Source: Qualcomm

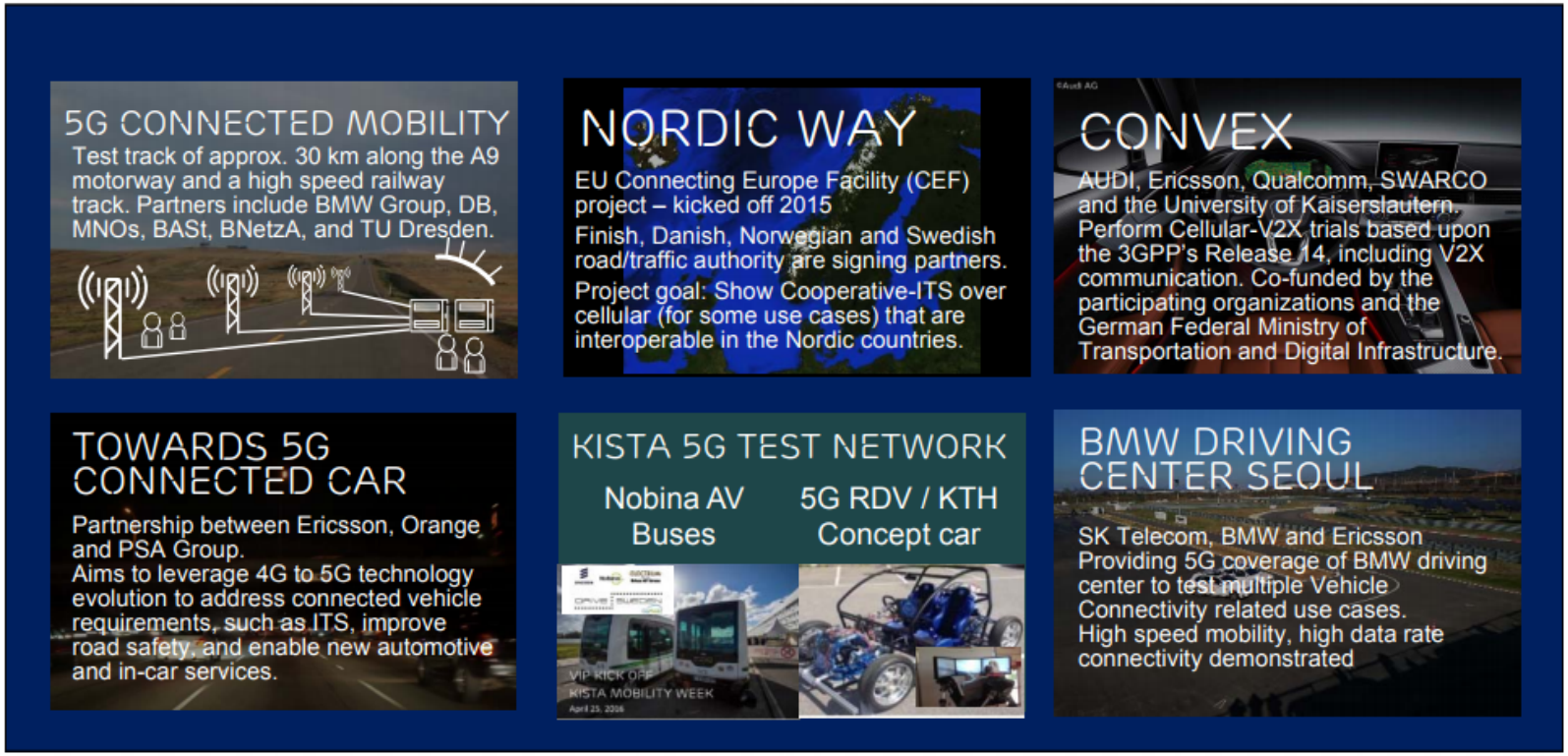
Compatible with Existing Communication Standards

- Builds upon existing standards
- Reuse existing security and transport layers defined by IEEE 1609
- Backwards compatible with current cellular based services



Source: Qualcomm – The Path to 5G C-V2X

Cellular V2X Trials



Source: Ericsson 2017 – Cellular Technology Based V2X

5G – A Work in Progress

kapsch
challenging limits

Advantages

- Does not require separate OBU
- More reliable at high speeds and long ranges
- V2X capability already contained in 5G standards from 3GPP
- Pilots with European OEMs planned for 2017
- R15+ would support autonomous driving
- Envisioned to support IoT and Smart Cities

Disadvantages

- Today 4G is the prevailing standard. There is no formal 5G specification today and unlikely to see 5G as the prevailing standard until 2020 or beyond
- Questions about connectivity / lack of coverage in rural/sparse areas
- Privacy concerns as data is passed through cloud

Battle over V2X Technology: DSRC vs 5G

5G vs DSRC

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The Battle Over Vehicle-to-Vehicle Communication Technologies ...

Autonomous Vehicle Research and Analysis from Strategy Analytics. ... The Battle Over Vehicle-to-Vehicle Communication Technologies: **DSRC** vs. **5G**. Download Report

https://www.strategyanalytics.com/access-services/automotive/autonomous-veh...

What Does Auto Industry Want from 5G? | EE Times

What Does Auto Industry Want from **5G**? Cellular Industry goes for spectrum land grab. ... **5G** vs. **DSRC** or LTE in cars ; After years of **DSRC** tests, where is it now?

eetimes.com/document.asp?doc_id=1328895

Prelude to 5G: Qualcomm, Huawei Muscle into V2X | EE Times

Prelude to **5G**: Qualcomm, Huawei Muscle into ... test — and finally implement — a Dedicated Short-Range Communications ... **5G** approach seems to me to be an ...

eetimes.com/document.asp?doc_id=1328030

Connected cars myth vs reality DSRC vs 5G | auto connected ...

Connected cars myth **vs** reality **DSRC vs 5G** Posted on November 30, 2016 by Bryan ... New business models for insurance and **5G** technology prospects are explored in detail.

autoconnectedcar.com/2016/11/connected-cars-myth-vs-reality-ds...

Legal Battle over V2X

- FCC ET Docket No. 13-49 (reconcile use of 5.9GHz between DSRC & Wi-Fi)
  - "Detect and Vacate" - DSRC and Wi-Fi would share the spectrum, unlicensed devices would detect DSRC operations and vacate the spectrum (Proposed by CISCO, Supported by the ITS and Auto industry)
  - "Rechannelization" – Split the DSRC into 2 contiguous blocks (Proposed by Qualcomm, Supported by other blocs)
- NHTSA NPRM: 49 CFR Part 571 / Docket No. NHTSA-2016-0126
  - Mandate DSRC vehicle-to-vehicle (V2V) communications for new light vehicles and to standardize the message and format of V2V transmissions

Negative Response to NPRM

- 5GAA - Rather than moving forward with the proposed regulation, NHTSA should instead undertake an updated, comprehensive technology neutral analysis of V2V solutions, including DSRC and Cellular-V2X, against the performance requirements in the NPRM.
- BMW- The NPRM should be amended to be technology neutral by giving adequate consideration to all communication technologies when prescribing specific requirements and not solely focusing on DSRC.
- AT&T – Supports the intent of the NPRM but takes no position at this time on the specific wireless technology to be used for the communication between vehicles—i.e. the transmission of the [BSM] in the context of the proposed mandate.
- Verizon - As NHTSA moves forward with requirements for V2V, it should craft open performance requirements for V2V solutions, rather than limit the types of communications systems that might be used to meet those requirements.

We are in a Holding Pattern

- NHTSA is reviewing the submitted comments and will adjust its proposal before issuing a final rule

- FCC and NTIA are conducting an evaluation of the two proposed spectrum sharing proposals

USDOT Formal Statement on V2V - 11/1/2017

- "The Department of Transportation and NHTSA have not made any final decision on the proposed rulemaking concerning a V2V mandate. Any reports to the contrary are mistaken. In all events, DOT hopes to use the dedicated spectrum for transportation lifesaving technologies. Safety is the Department's number one priority."

- On background – In response to the proposal, NHTSA is still reviewing and considering over 460 comments submitted and other relevant new information to inform its next steps. An update on these actions will be provided when a decision is made at the appropriate time taking into consideration the rich comments received in response to the proposed action published in December 2016. While DOT withdrew, or revised 13 rules this year, V2V is not one of them, as it remains on the DOT's significant rulemaking report.

Expanding C-V2X Trials

5GAA Actively Promoting C-V2X

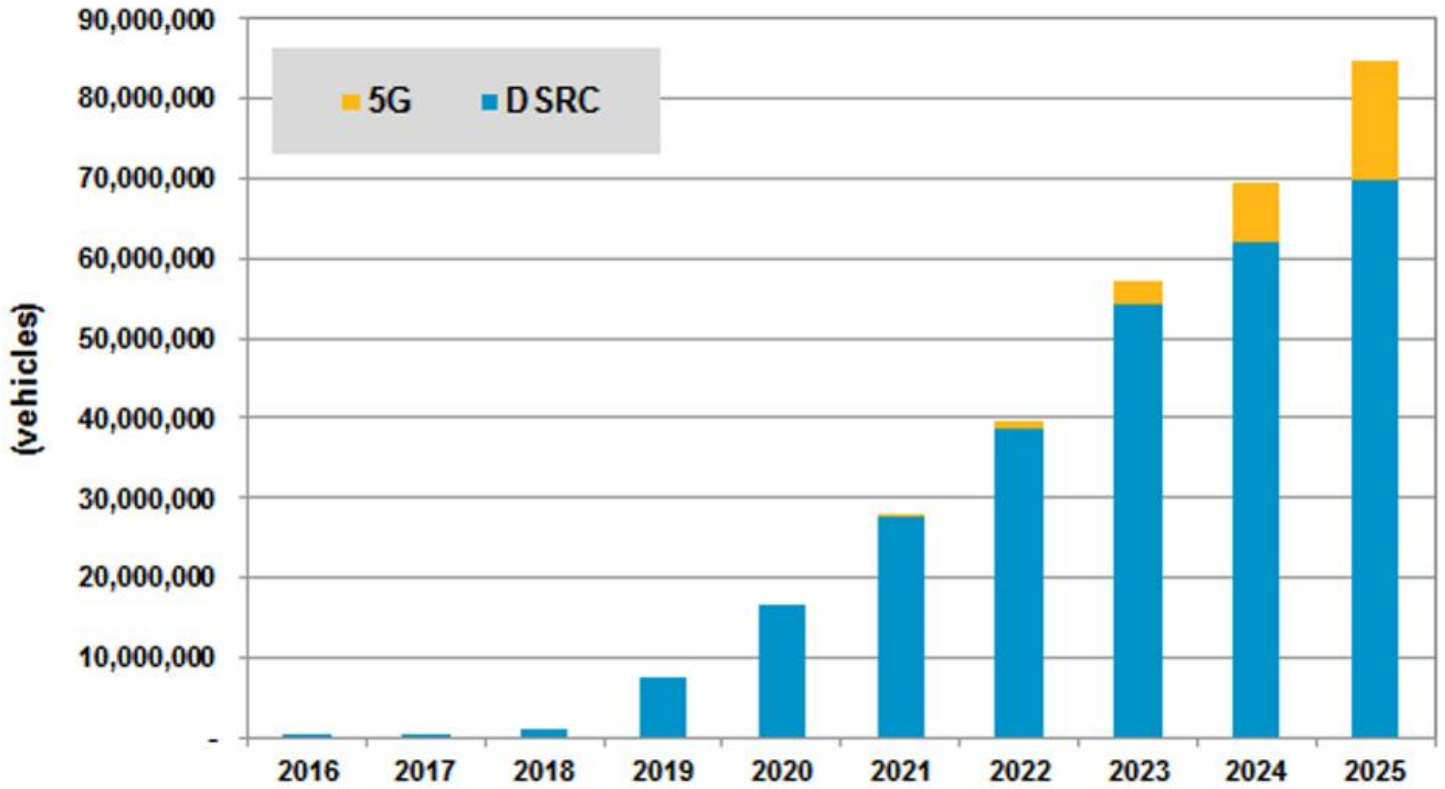
- 11/3/2017: AT&T, Ford, Nokia, and Qualcomm announced C-V2X testing at the San Diego Regional Proving Ground

Future of DSRC in the US

- Dependent on NHTSA and FCC
- DSRC operational Issues to be addressed
  - Data Safety – keeping valid certificates onboard
  - Redundancy – Road safety applications need redundancy, not inherent in DSRC
  - V2I deployment and transition period
- Data Security vs Monetization
  - BSM is about keeping data private but companies want to gain value from data

Cadillac CTS with DSCR:
V2V & V2I to Traffic Signals

Market Penetration of V2X in New Cars



Source: Light vehicle Sales with V2X Built in – Navigant research

How do we evolve our Infrastructure to support CAV

- DSRC requires increased market penetration of RSUs and OBUs, rollout has been slow
  - Cannot wait only for OEM solutions
  - Consider acceleration through aftermarket deployments
- Right of way is owned and managed by many jurisdictions
  - Think about new funding and business models to build and maintain the network infrastructure
  - Public-Private partnerships
- Privacy and safety considerations

Bridging the gap between Government vs Industry

- Government
  - Supporting innovation through testbeds and deployments
  - Must be focused on public safety
  - Trying to maintain control over technology deployments and Right of Way
  - Concerns over funding and operations
- Industry
  - Seeking to accelerate technology and consumer-based products
  - Focused on access to bandwidth, public right of way, and data
  - Hard to trust that industry will focus on safety

How do we fund the necessary V2X Infrastructure

- Oakland County Michigan RFP for DSRC Pilot CAV Network
  - The primary goal is to create a foundation of DSRC based CAV connected network communications that combines both a scalable equipment based deployment strategy and a business model to monetize network capacity for revenue generation from the network.
  - In short, the pilot seeks to monetize a network solution such that costs of expansion and operation are derived from the network or system.
  - The scope of this RFP and the response may include, but is not limited to, the purchase of new equipment, mechanisms for data backhaul and storage, solutions for power, potential upgrading of existing assets, configuration, and professional services for implementation, testing and validation.

Conclusions

- Embrace and support DSCR now
- Wait and see how 5G evolves
- Determine how to accelerate V2X implementations
- Develop V2X Infrastructures
- Think about new business models and partnerships between government and industry

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