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ITE San Diego

Qualcomm

The Road to Vehicle to Everything (V2X) Communication

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Agenda

Jim Misener

C-V2X
Technology
overview

State of Deployments
and Standards:
Run-up to San Diego
Deployment

National
implications and
What's Next



Sam Amen

Problem
statement:
Caltrans
TSMO
Requirements

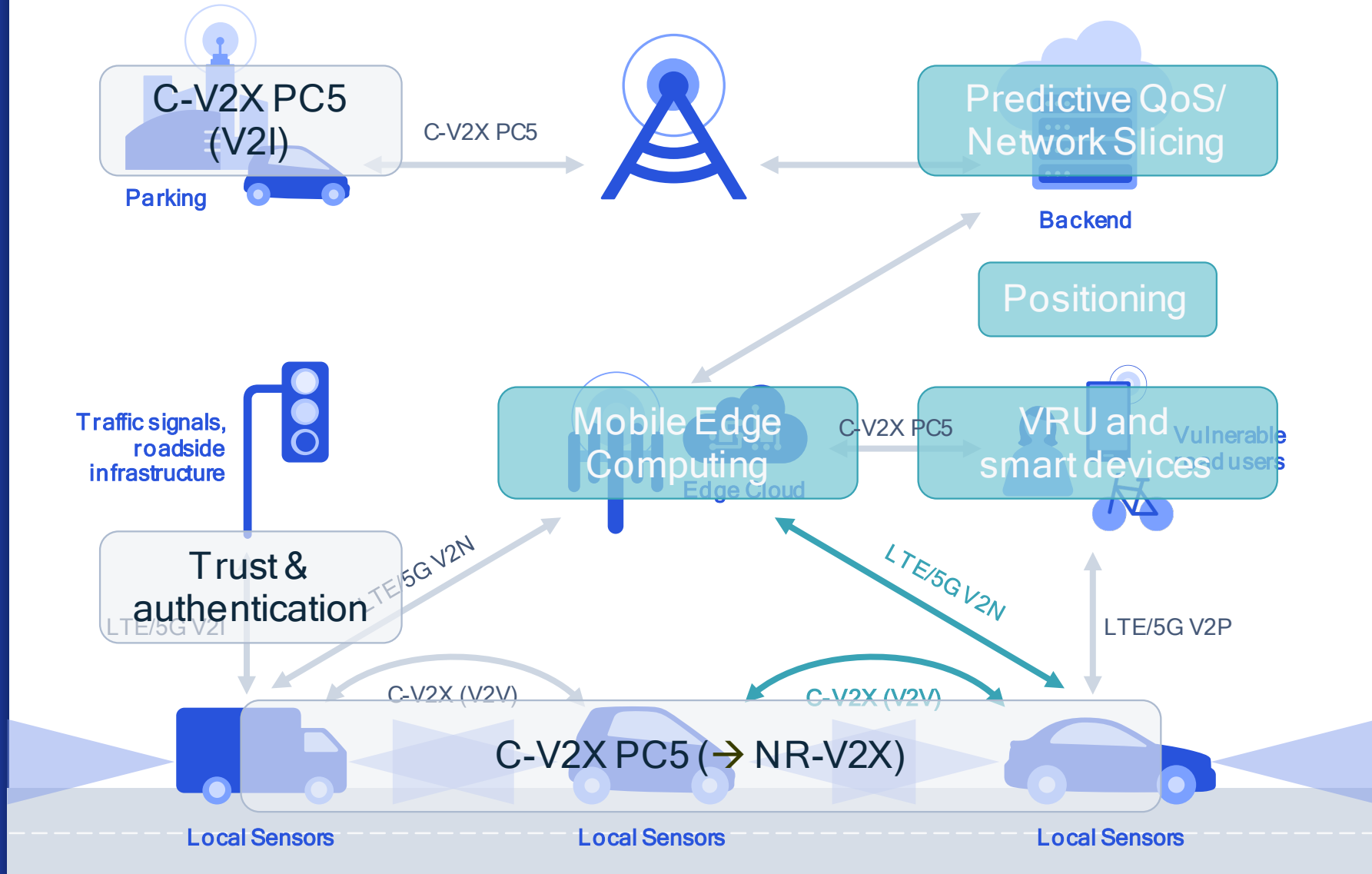
Caltrans'
plans for
C-V2X

Why this is
important to
California and
the San Diego
Region

C-V2X is a unified technology platform that optimizes:

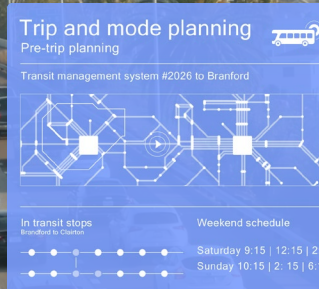
- **Short-range**, networkless, direct communications (C-V2X **PC5** today)
- **Long-range** cellular network communications (C-V2X **Uu** today)

Supporting direct communications, safety and comprehensive services



Communications support a broad range of transportation applications – and the region's 5 big moves

Ranging from pre-trip planning to en route information through safety services



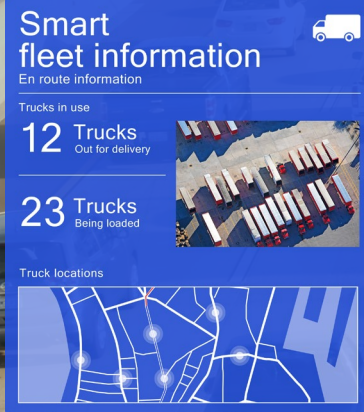
Pedestrian
safety warning



Smart parking



Roadside
units (RSUs)



Truck
platooning



Live 3D Maps



Autonomous
vehicles



Traffic management

Safety services



Gps tracking 10:08am arrival

Emergency vehicle ahead



3 Rerouting
Traffic light delays

5 Road delays
Rerouting Traffic
to side streets

Smart
lighting





Enhanced range
and reliability for direct
communication without
network assistance



V2V

Vehicle-to-vehicle
e.g., collision avoidance safety systems



V2I

Vehicle-to-infrastructure
e.g., traffic signal timing/priority



V2P

Vehicle-to-pedestrian
e.g., safety alerts to pedestrians,
bicyclists



V2N

Vehicle-to-network
e.g., real-time traffic/routing, cloud services

C-V2X

Established the foundation
of C-V2X for safety in Rel-14/15
with continued evolution in Rel-16 5G
NR for advanced use cases



Release 14/15 / 16 C-V2X standards
completed (V2V, V2I, V2P)



Broad industry support with 5GAA



Global trials started in 2017



Qualcomm® 9150 C-V2X chipset
announced in September 2017



Integration of C-V2X into the Qualcomm®
Snapdragon™ Automotive 4G (SA415M) and
5G (SA515M) Platforms announced in 2019

Realizing Enhanced Safety with C-V2X

Contingent on standards that are nearing completion

Reduced spectrum
with difficult evolution

Today: C-V2X for safety services



V2V and V2I Safety



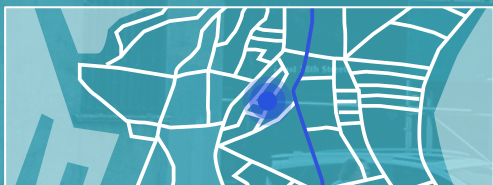
I2V messages

Future: 5G V2X?



Sensor Sharing and
Cooperative Maneuvering

Red light violation warning



Context-based
personalized information
Premium

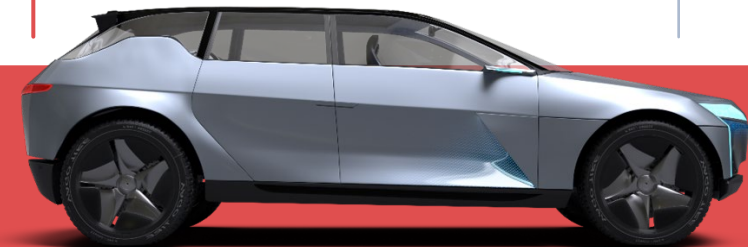


Road safety is an
important motivation

C-V2X momentum in 2020

The timeline is accelerating, particularly in Europe, US and China

	January	February		September	October	November	
EU	ETSI European specifications and standards for C-V2X completed	C-V2X devices passed European Radio Equipment Directive (RED)					
US			FCC 5.9 GHz NPRM Comments Received	Work Zone and GLOSA applications complete for C-V2X deployment with VDOT, Audi and ATC			FCC 5.9 GHz Report and Order points way for 30 MHz of C-V2X-exclusive spectrum in US
China				China national goal announced: By 2025, LTE-V2X will achieve regional deployment, and NR-V2X testing will begin	Additional China national goal announcement: New energy vehicles will have intelligent network technology, and C-V2X is recognized as a fundamental technology	Another China national goal: C-V2X terminals of 50% new vehicles in 2025 and growing to 100% in 2030	



2020



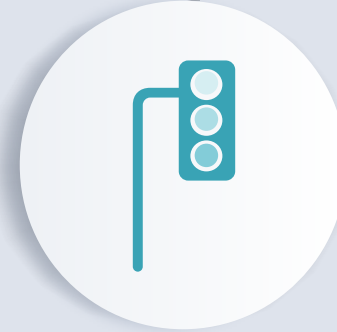
Vehicle

**Radio: SAE International
C-V2X Technical Committee**

- V2V “profile”
- Test standard
- V2V/V2I/I2V in one 20 MHz channel

Applications

- Same applications with other radio
- New “5G” short range applications:
sensor sharing and maneuver
coordination



Roadside

NEMA TS10 (RSU)

ITE RSU (in process)

Connected Infrastructure Committee

- Multi-org (ITE, NEMA, SAE International, IEEE) to fill gaps for red-light collision warning “Day 1” applications

Vehicular and Roadside V2X standards are maturing

Traffic Families

Defined in SAE J3161 WIP
C-V2X Deployment profiles

Allows V2V and
V2I services to be
delivered by one
20 MHz Radio*

Critical V2V
(example:
Event BSM)

Critical I2V
(example: RSM,
MAP)

Essential V2V
(example: BSM)

Essential I2V
(example: SPaT)

Transactional
(example: tolling
transactions)

Low Priority
(example: TIM)

Background
(example: TCP/IP)

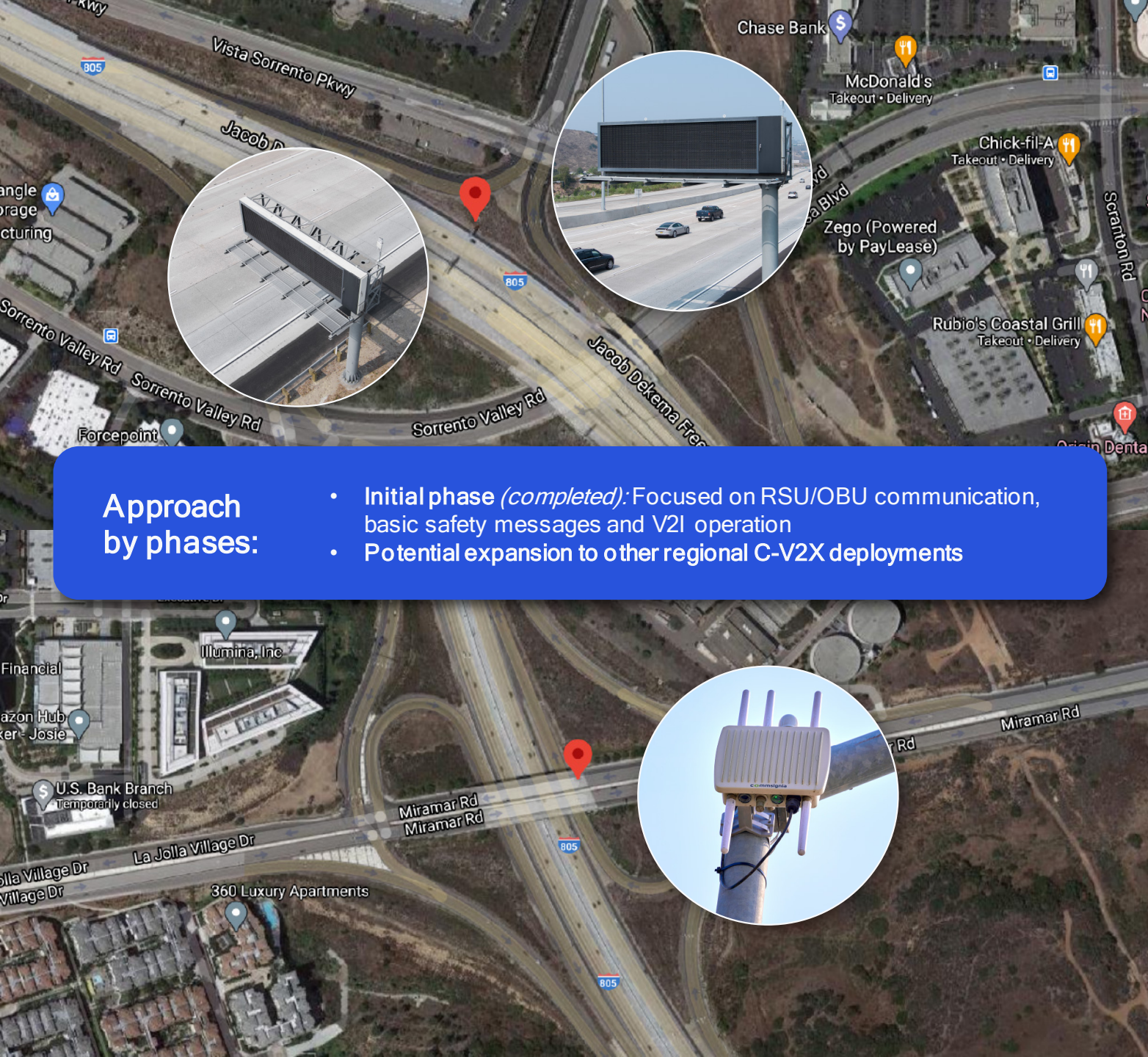
Priorities are
assigned to
each of these
families.

Communication profiles (# subchannel, data rate, retransmission)
set for V2V, V2I and I2V

*Opportunity for lower 10 MHz can be used
for platooning or other apps

Priority of different Traffic Families

Traffic Type	Safety Services				Mobility Services		
Traffic Direction	V2V		I2V		V2I - I2V		
Traffic Families	Critical V2V	Essential V2V	Critical I2V	Essential I2V	Transactional	Low Priority	Background
Minimum Priority (PPPP)	2	5	3	5	6	7	8
Minimum packet delay budget	20 ms	100 ms	100 ms	100 ms	100 ms	100 ms	100 ms
Example Messages	Critical BSM, EVA	BSM	RSM, MAP	SPaT	EFC/TolI	TIM	TCP, UDP



Approach by phases:

- Initial phase (*completed*): Focused on RSU/Obu communication, basic safety messages and V2I operation
- Potential expansion to other regional C-V2X deployments

Initial C-V2X deployment on I-805

Caltrans, City of Chula Vista,
SANDAG and Qualcomm
Technologies, Inc.

How can CV help?

- Caltrans Goals

1. SAFETY FIRST
2. CULTIVATE EXCELLENCE
3. ENHANCE AND CONNECT THE MULTIMODAL TRANSPORTATION NETWORK
4. STRENGTHEN STEWARDSHIP AND DRIVE EFFICIENCY
5. LEAD CLIMATE ACTION
6. ADVANCE EQUITY AND LIVABILITY IN ALL COMMUNITIES



CV Benefits:

- Improving Safety
- Modality (first/last mile solutions) / OS
- Reducing VMT (Level 5 shared vehicles)
- Partnership for faster deployment
- Futurizing infrastructure needs (Mix Fleet)
- Improving incident investigations



TSMO - Transportation System Management and Operation (Mobility) - Case studies

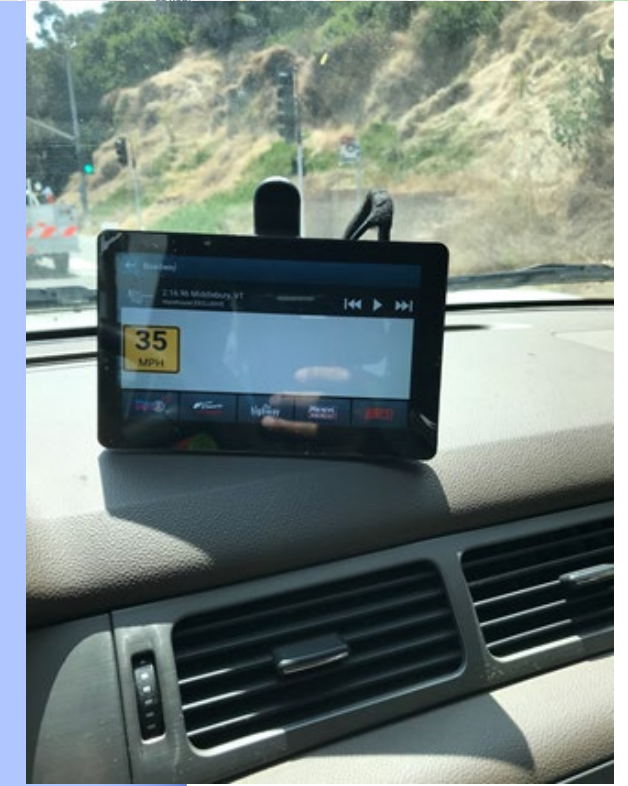
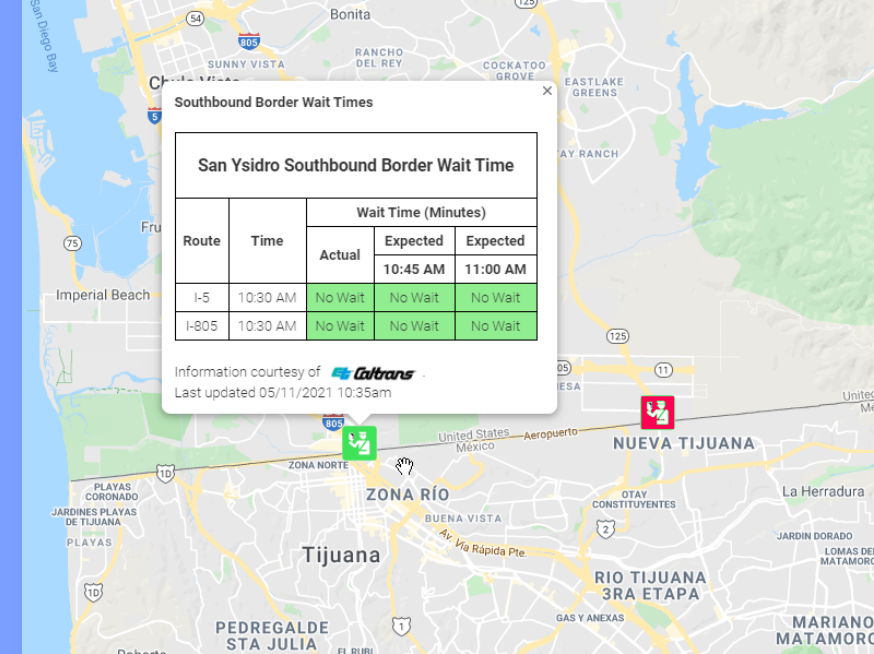
- Construction zone warning
- TIM - Traveler Information Messages
- Speed harmonization (No Regulation Support)
- Advance CMS (TIM and Speed)
- Vulnerable users warning



Caltrans case studies

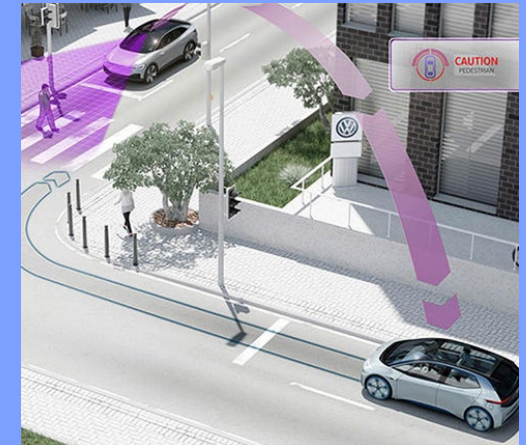
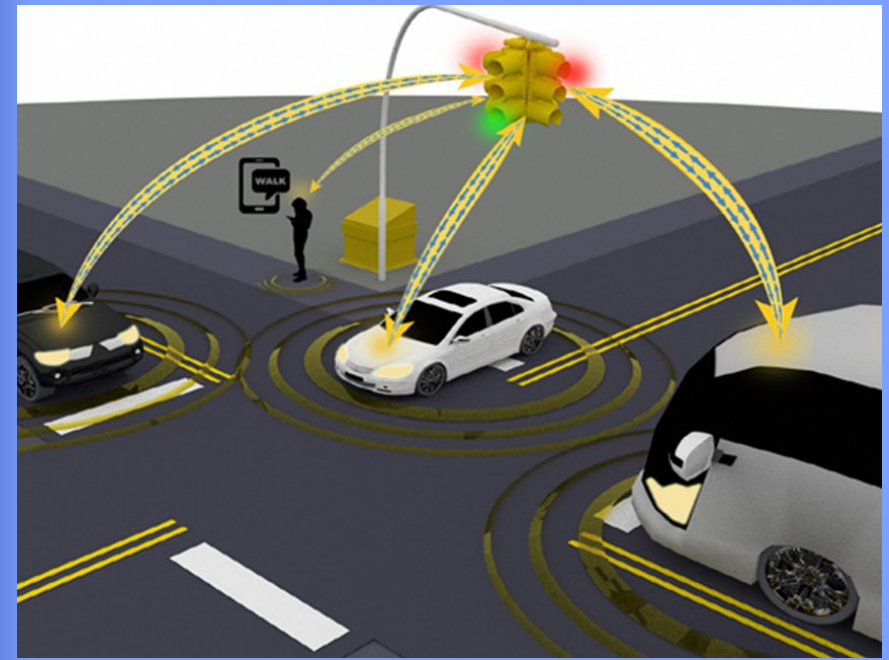
- Realtime pavement condition
- Auto-enforcement of AV, and HOV-Only lanes
- Data collection by CV to TMC

Vehicle speed/travel time
Border wait time
Origin-destination data
Vehicle classification
Vehicle occupancy
Vehicle lane position



Caltrans case studies

- Provide SPaT during SPSP after loose battery power
- Researches -
 - CAV minimum geometric requirements
 - CV policy
 - Cyber security
- Bus-on-shoulder (SANDAG)
- I-15 ICM with CV



5G V2X builds on C-V2X

with advanced use cases

Safety use cases

Advanced use cases

Upperlayers
Mapping use cases to transport profile

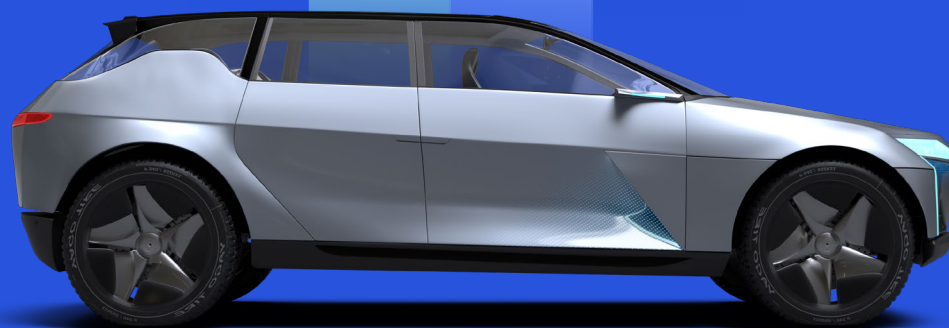
C-V2X

Rel 14/15 sidelink
Broadcast messages



5G V2X

Rel 16+ sidelink
Multicast messages



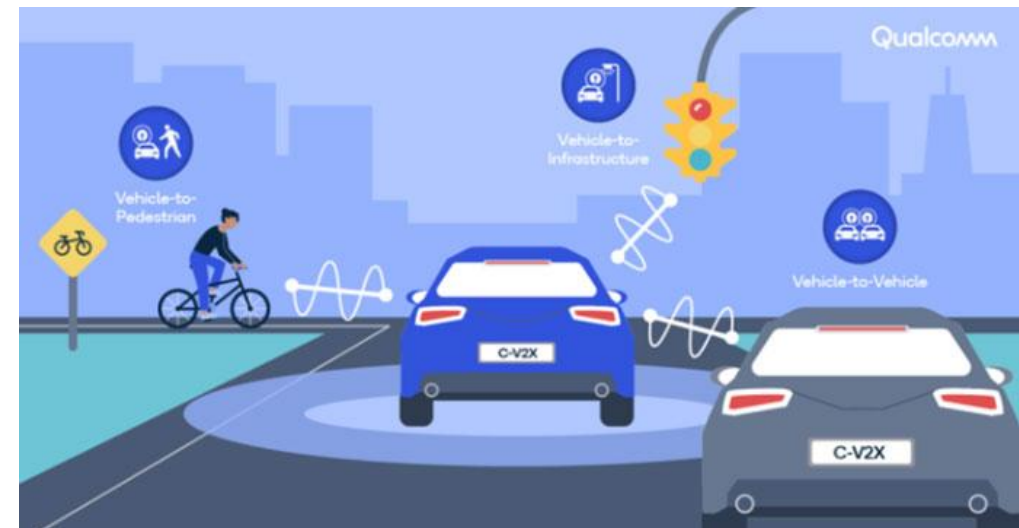
5G V2X sidelink

The Next Step: Smarter transportation infrastructure also creates new opportunities

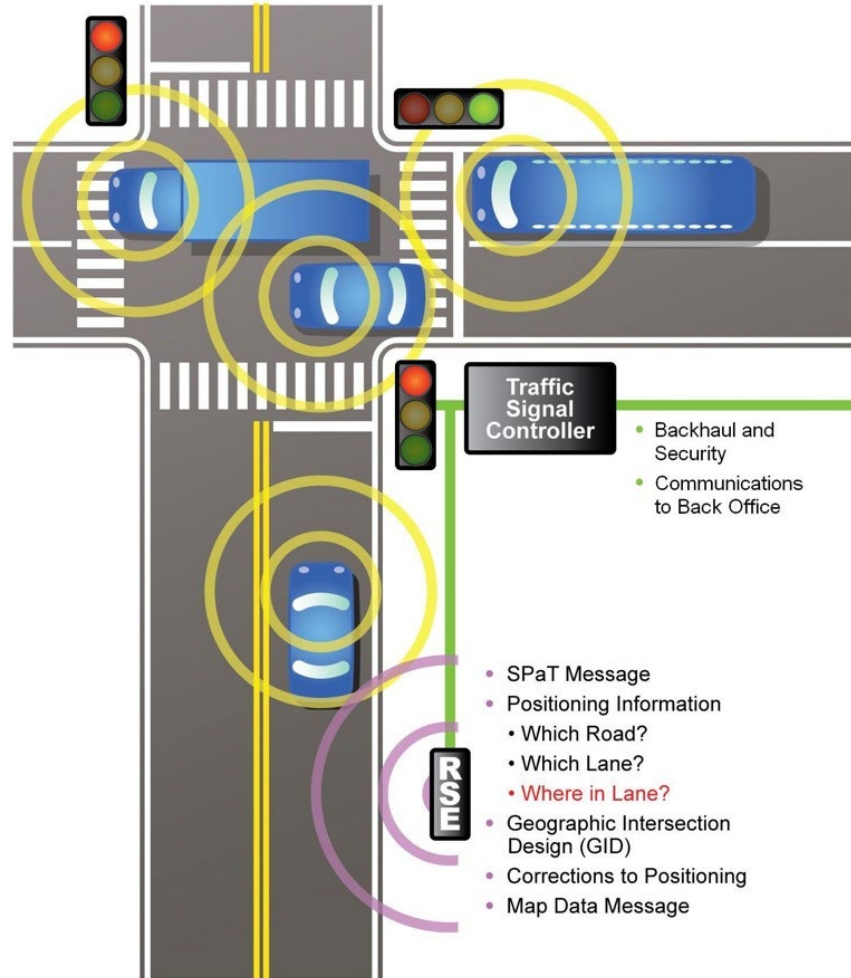


Deployment Challenges:

- Limited capacity of 30 MHz assigned to C-V2X
- Deployment funding for C-V2X (SHOPP, CIP, SB1, etc.)
- Partnership challenges
- Driving across states and country lines.
- Data sharing
- Freight, Transit, EMT, and CHP priorities
- Cyber security, and consumer acceptance
- Regulations (NHTSA vs State)



State of California CAV Strategic Plan (Draft) - 2021



Highlights

- Establish internal CAV working group
- Establish internal CAV outreach
- Investigate CAV workforce needs
- Develop CAV implementation plan
- Develop CAV design standards
- Strategically upgrade Caltrans infrastructure for CAV-ready
- Work with CalSTA to identify policy objectives



Thank you

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