
cisco Live!
ALL IN

The bridge to possible

Vehicle Safety?

How Cisco is doing its part to connect roadways to drivers

Mark Knellinger – Tranportation Solutions Architect
@markknellinger

PSOIND-1001

Cisco Webex App

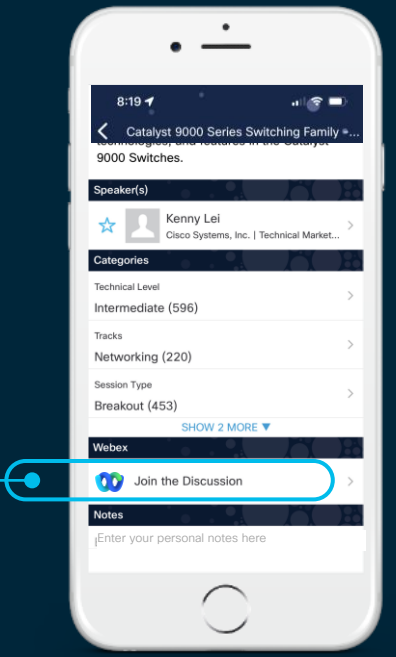
Questions?

Use Cisco Webex App to chat
with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion”
3. Install the Webex App or go directly to the Webex space
4. Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until June 17, 2022.



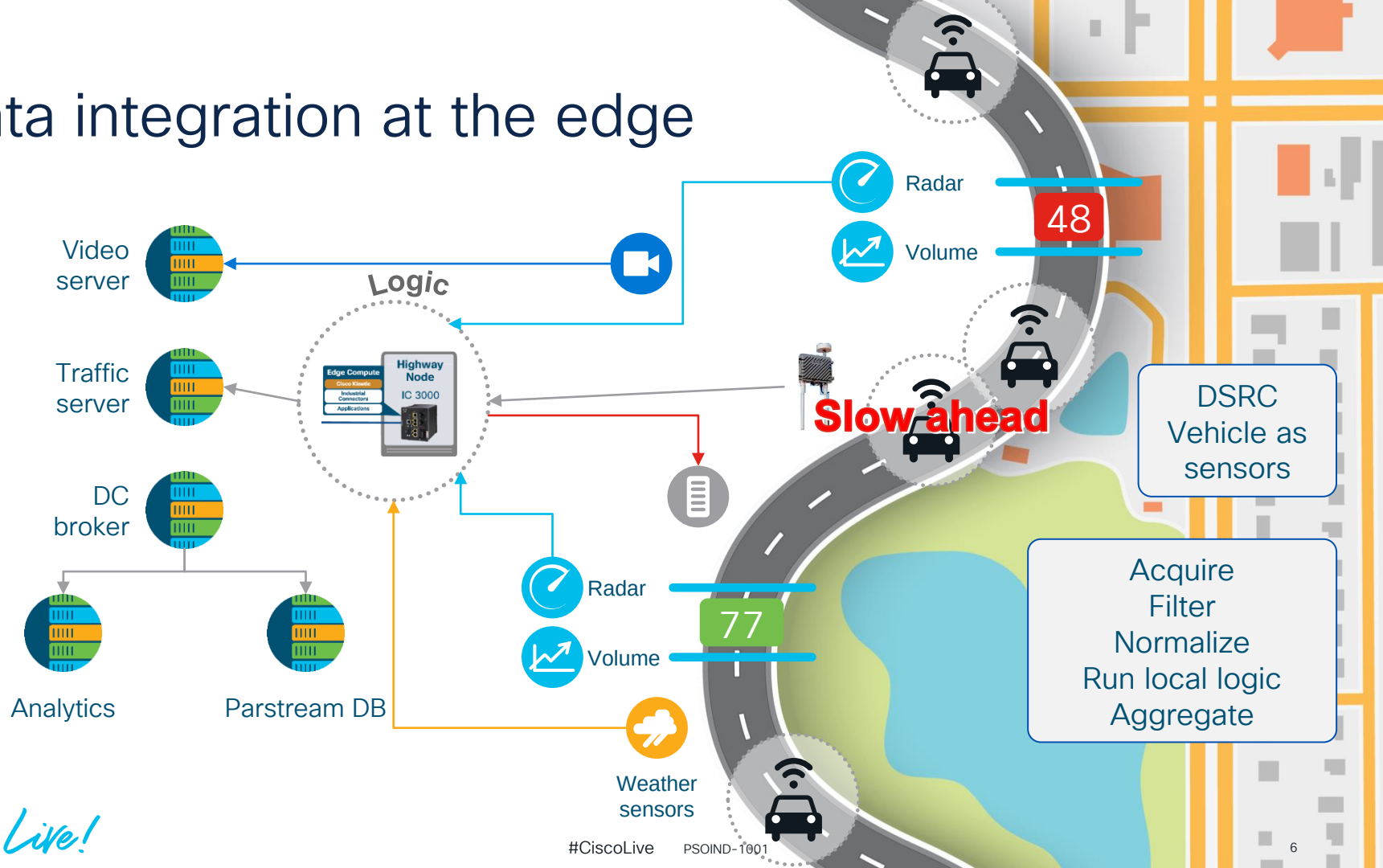
https://ciscolive.ciscoevents.com/ciscolivebot/# PSOIND-1001

Agenda

- Introduction
- Data and Automation
- The power of the edge
- V2X Innovation
- Conclusion

Data

Data integration at the edge



Edge Intelligence data processing

Acquisition

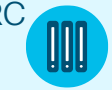
- Acquire millions of messages per second

Filtering

- Determine what messages are meaningful
- Generate baseline sampling

Normalization

- Work across standards, CV2X, DSRC J2735-2016, DSRC J2735-2009, VZMode, NTCIP



Apply logic and analytics

- Logic based on rules
- Analytics through microservices

Aggregation

- Apply aggregation policy for data, sampled, alerts, and so on

Benefits

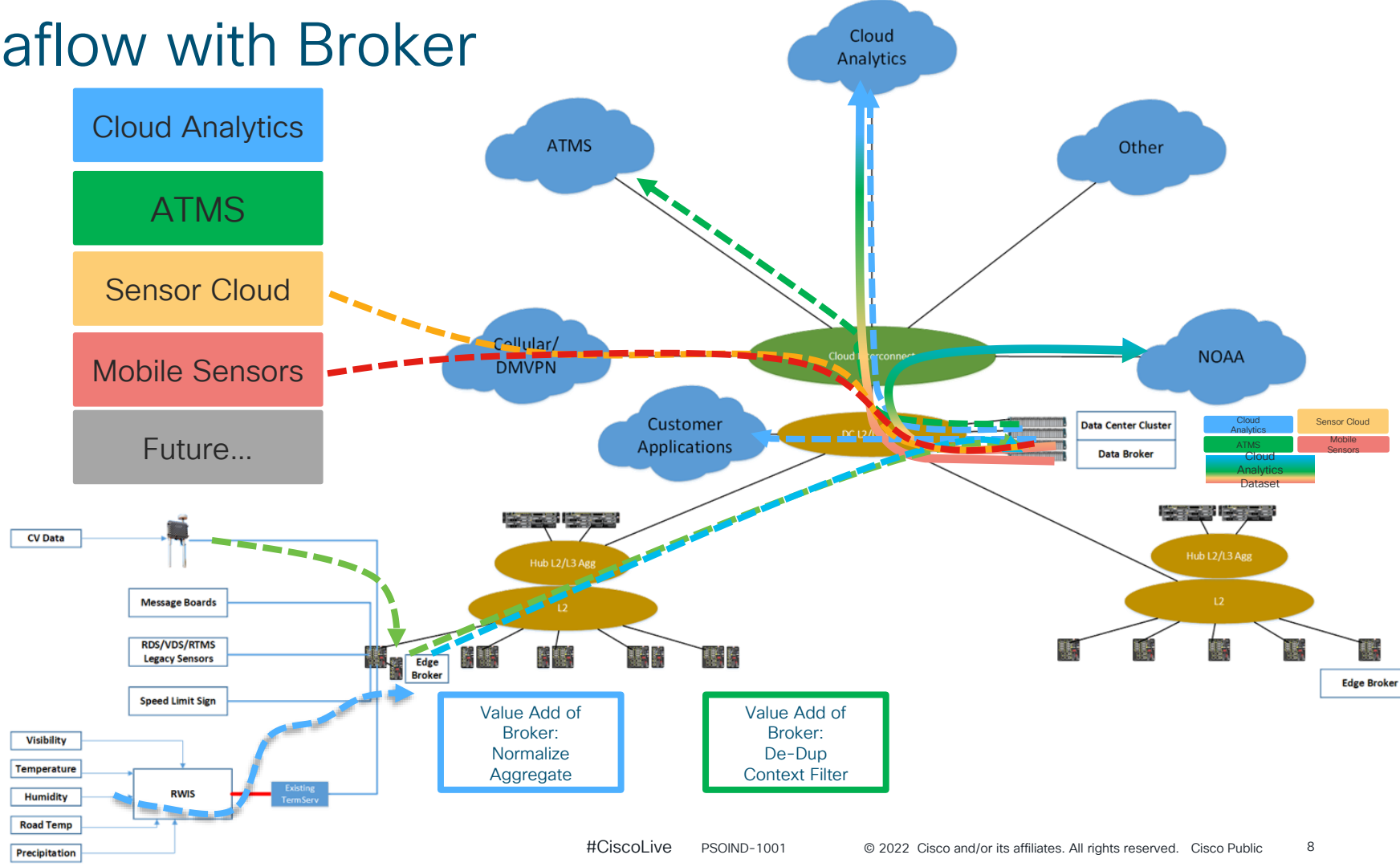
- Quicker
- Allows for automation*
- More reliable

"We found that Cisco was a partner for us, providing a solution based on Cisco Kinetic, and thus we got a more layered architecture."

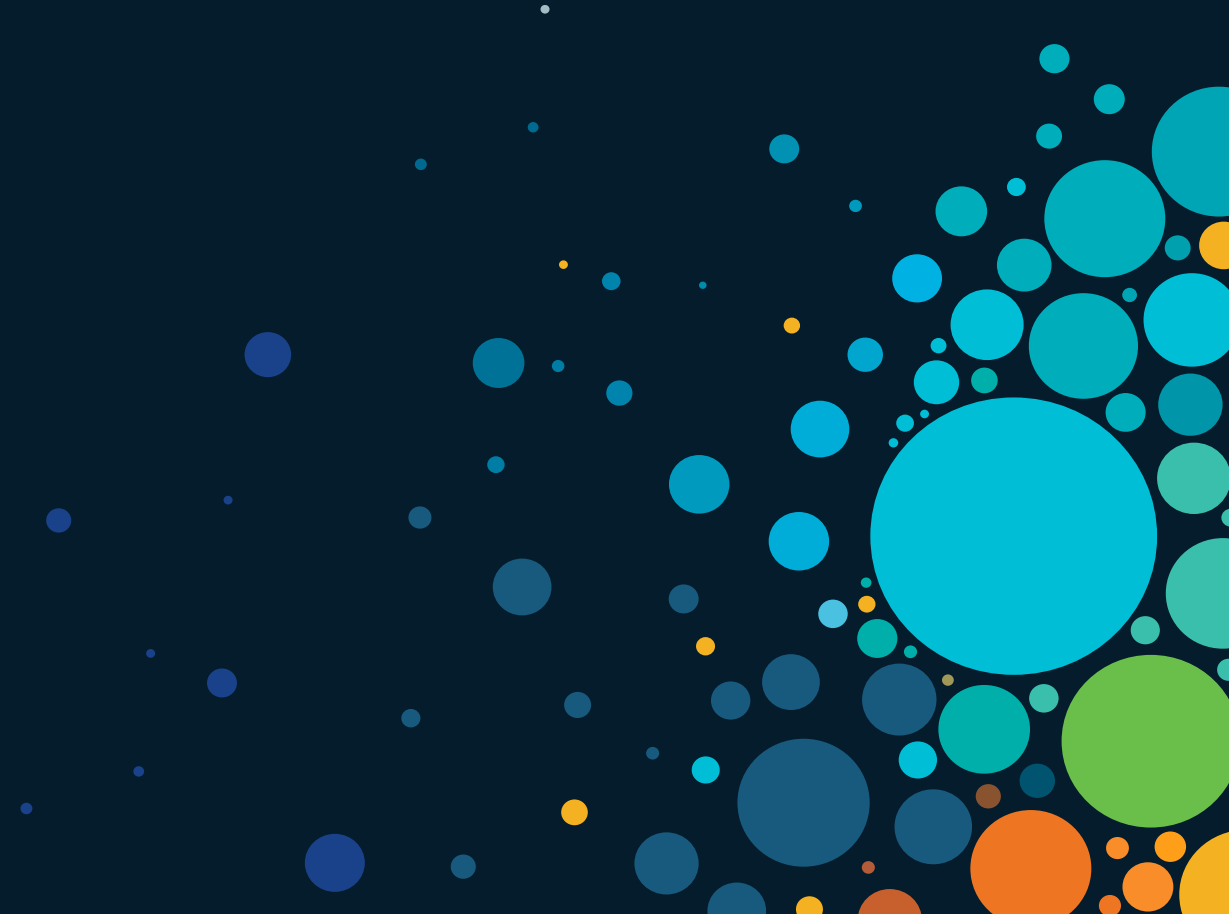
— Gerard Avontuur, Program Manager, Rijkswaterstaat (RWS)

** Decisions can be automated based on agency preferences*

Dataflow with Broker

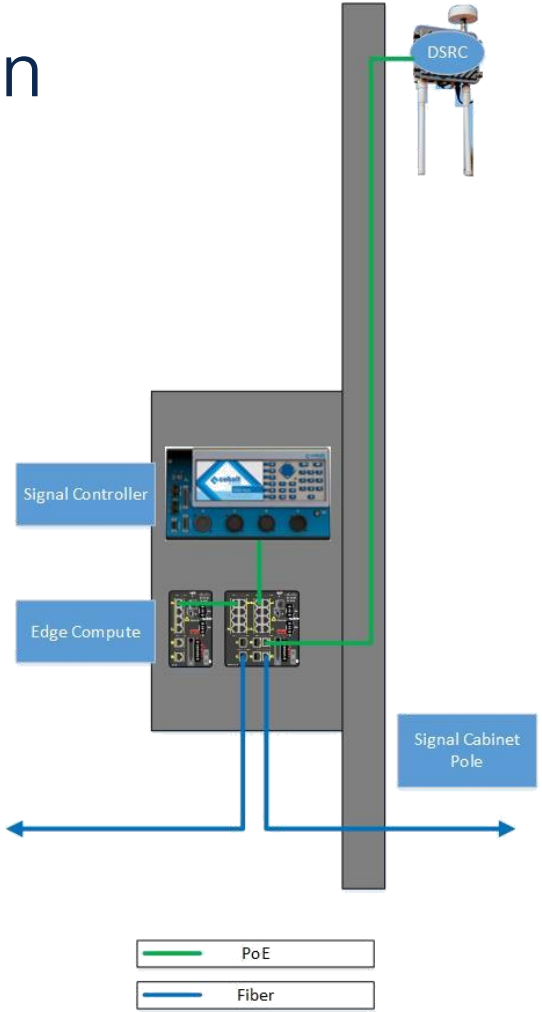


Automation

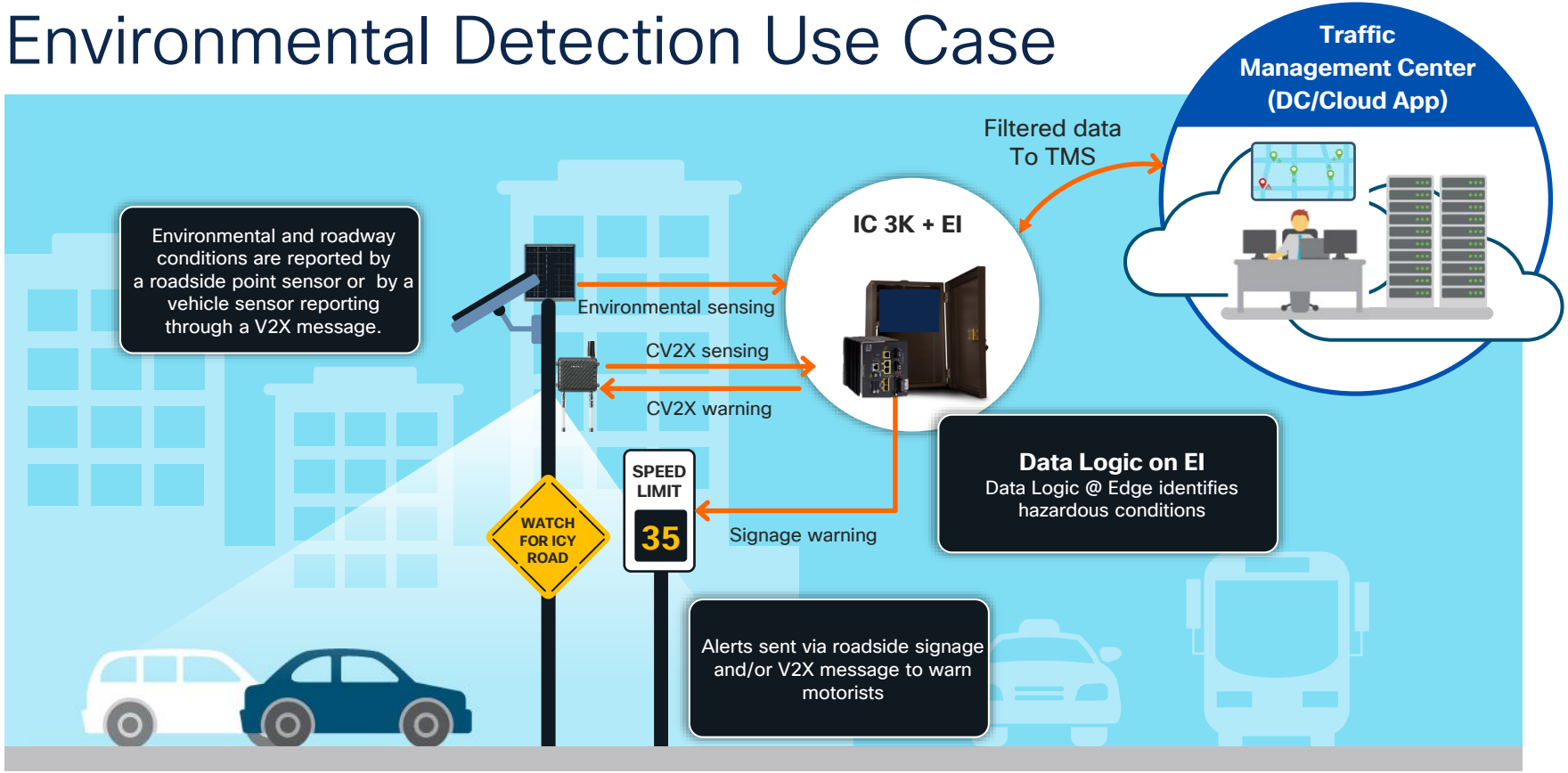


Connected Vehicle Capable Intersection Layout – Typical base configuration

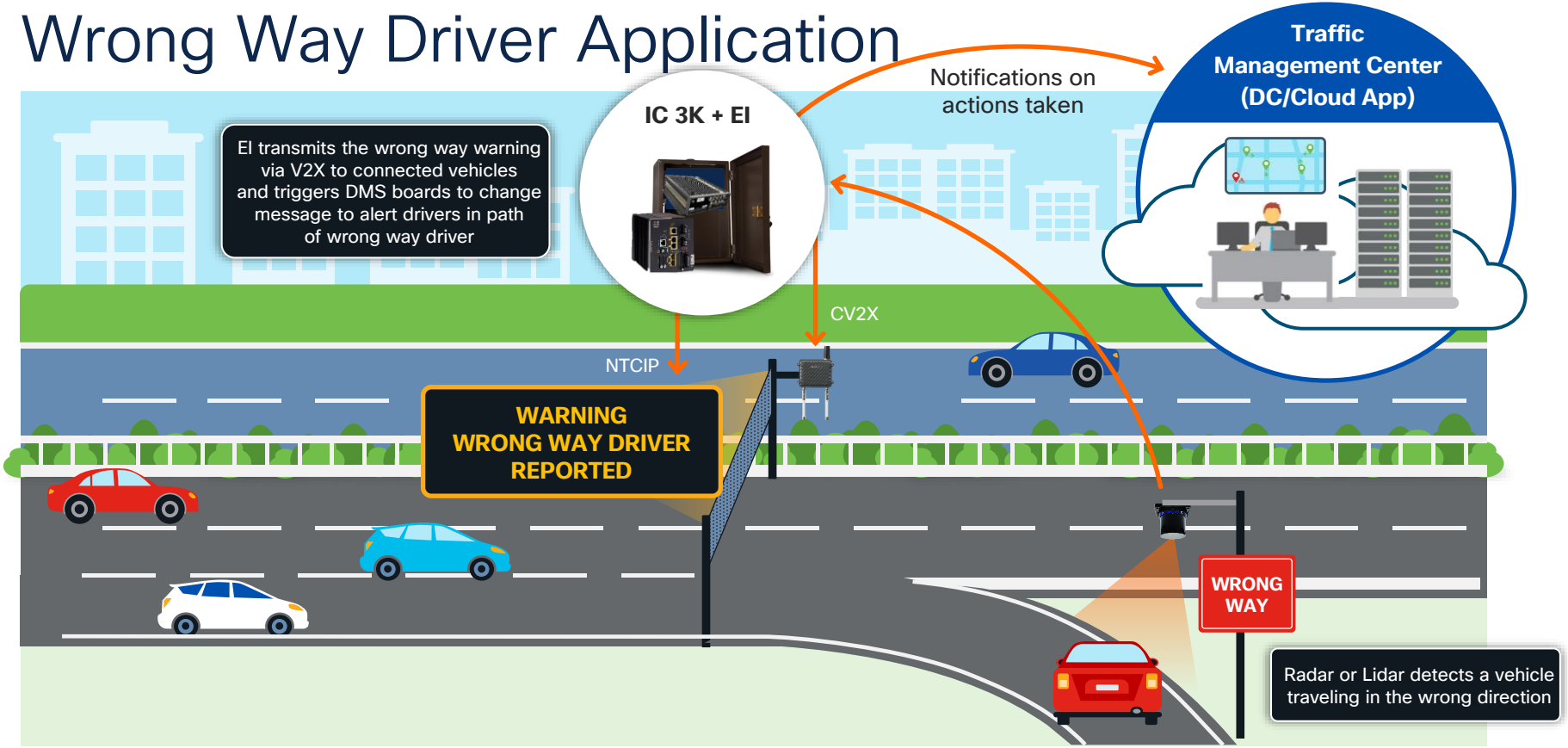
- Signal Controller
- CV2X Roadside Unit (RSU)
- Industrial Networking
  - IE-3x00 Series switch
  - IR-1101 Router
  - IC-3000 Edge compute
- Edge Intelligence



Environmental Detection Use Case

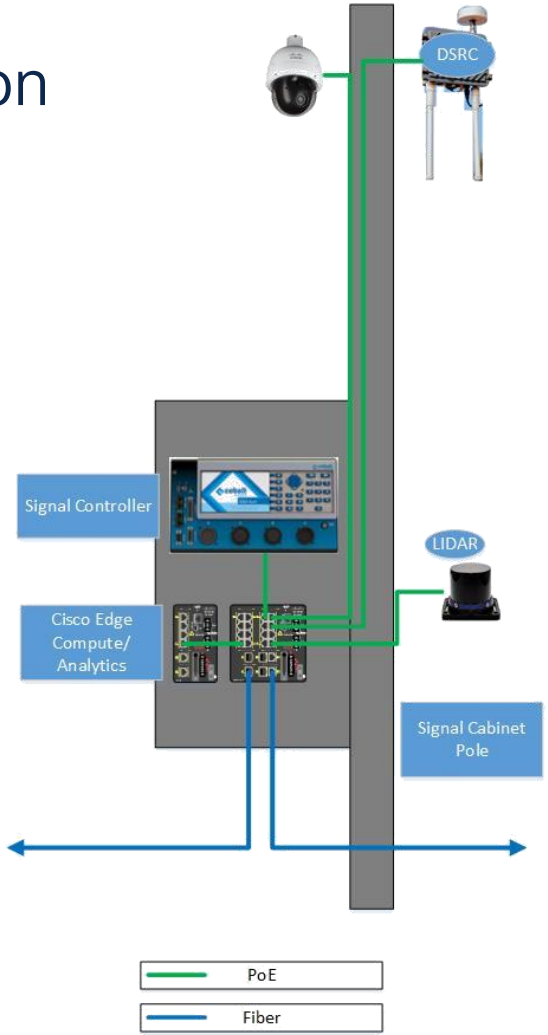


Wrong Way Driver Application

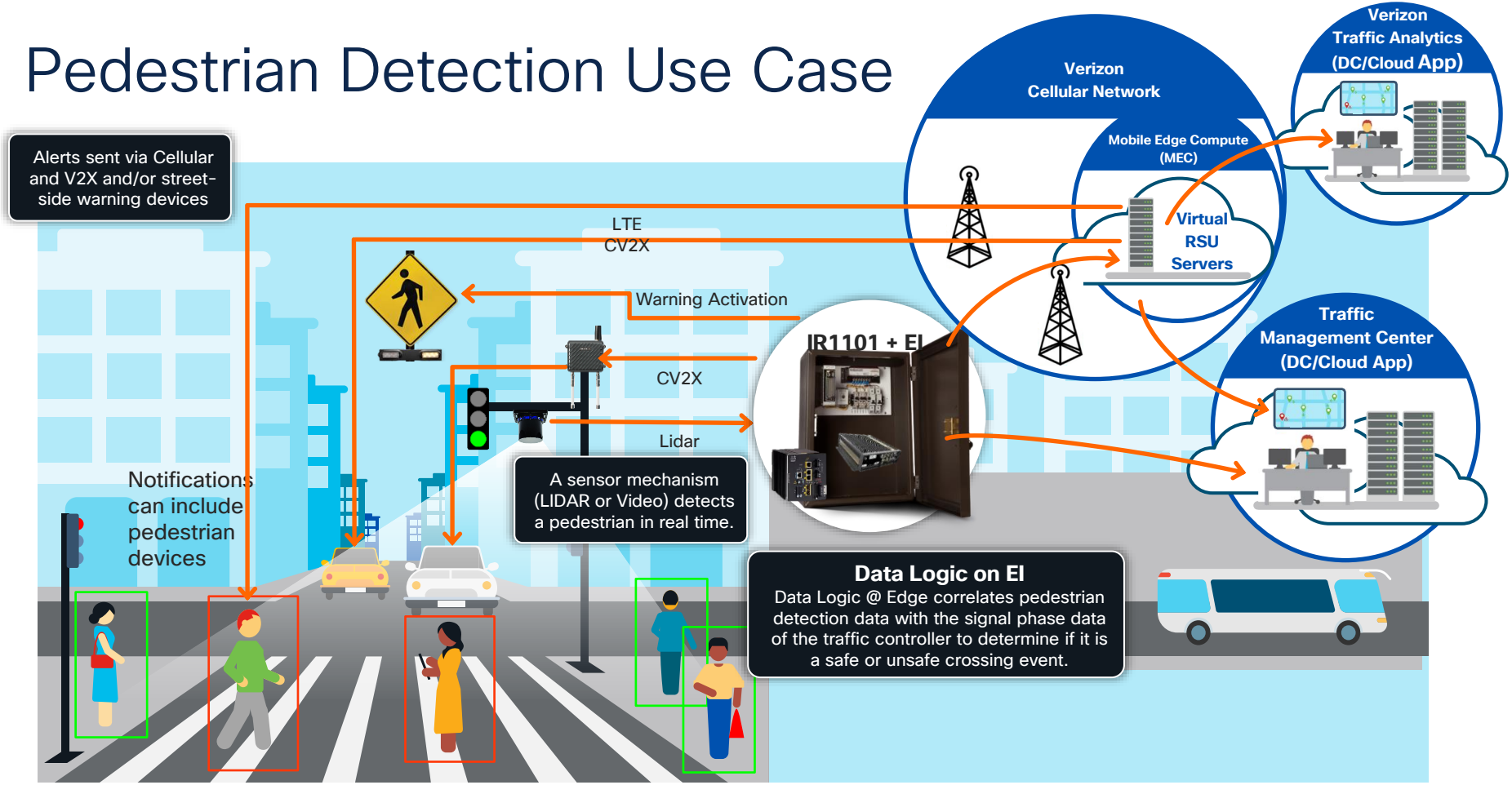


Connected Vehicle Capable Intersection Layout – Advanced configuration

- Cisco IR1101
- Cisco IE Switch
- Cisco IC-3000
- Cisco Wireless (Fluidmesh or Public Access)
- Meraki Video Camera
- Non-Cisco Devices
  - Signal Controller
  - LIDAR or Video analytics
  - Roadside Unit Radio (DSRC or CV2X)
  - Weather and Road Sensors
  - Variable Message Signs
  - Radar
  - Realtime Traffic Measurement Systems



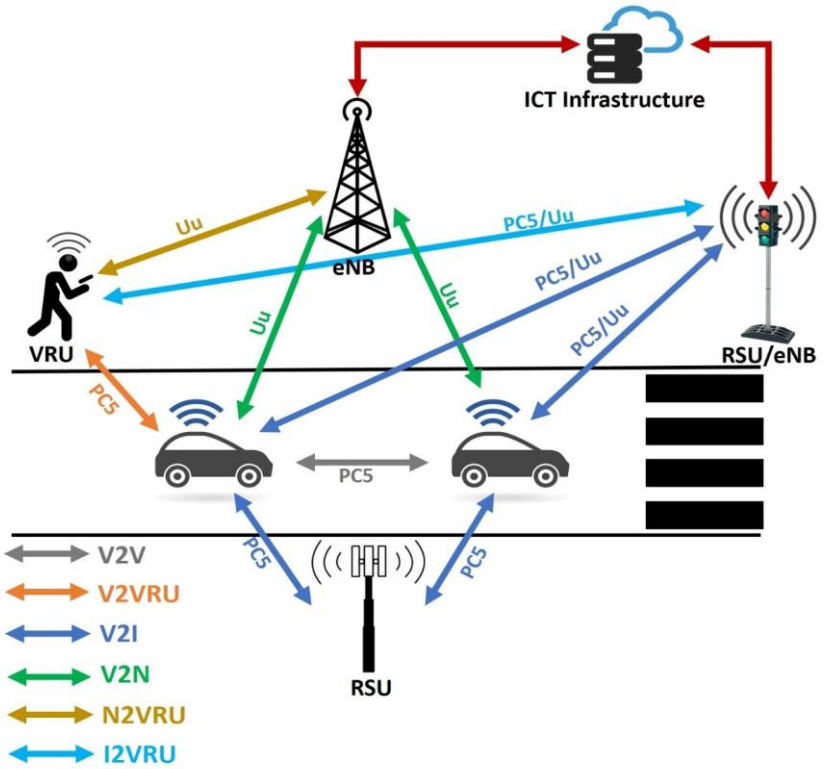
Pedestrian Detection Use Case



Vehicle to Everything
V2X and Cisco

Current CV2X - LTE-V2X PC5 Mode 4

- LTE-V2X uses the LTE band 47 using UARFCN 55140 with a 20 MHz Channel
  - Identifier
    - V2X 5800
  - Operating Frequency Band
    - 5855 - 5925
  - EARFCN
    - 54540 - 55239
  - Channel Bandwidths
    - 10, 20
  - Single-Carrier Frequency-Division Multiple Access (SC-FDMA)

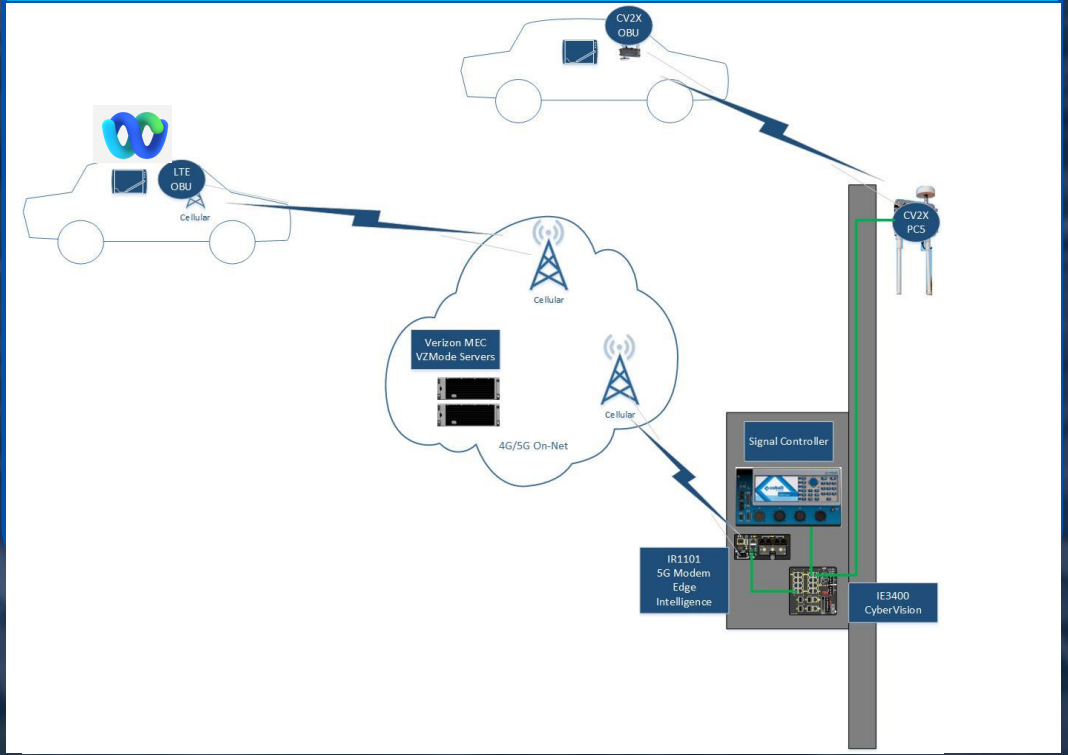


Cisco V2X implementation
CV2X RSU and Verizon Virtual RSU

Use Cases

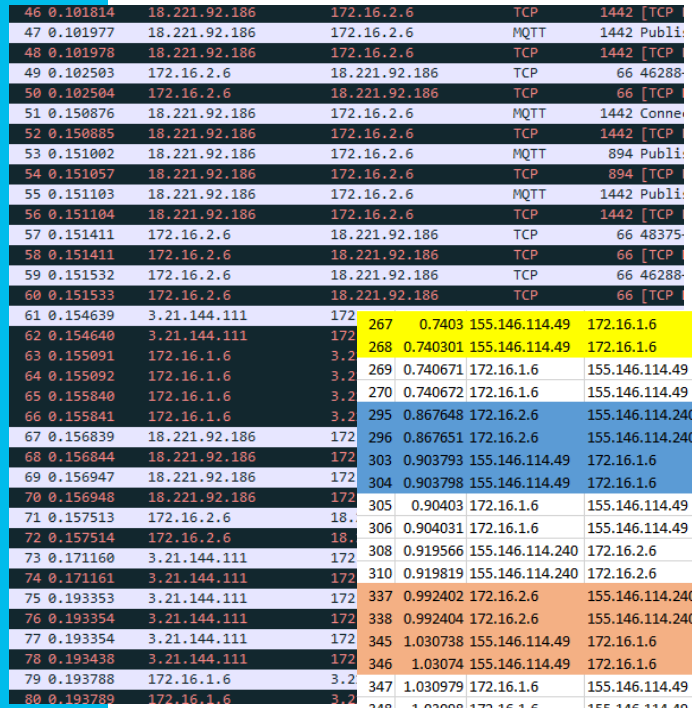
- Cellular SPAT delivery
- Pedestrian Protection
- Real-Time Telemetry Data
- Compare Virtual RSU to Roadside RSU
- Platform for Demonstration with Webex
- Cohda V2XLocate Deployment

V2X Solution



Evaluation Process

- Raw Packet Capture
  - Filter Packets
  - Decode Packet
  - Export Packets
- Align Conversations
  - Export for Measurements
- Conversation Timing
  - Graphing Results



46	0.101814	18.221.92.186	172.16.2.6	TCP	1442 [TCP
47	0.101977	18.221.92.186	172.16.2.6	MQTT	1442 Publi
48	0.101978	18.221.92.186	172.16.2.6	TCP	1442 [TCP
49	0.102503	172.16.2.6	18.221.92.186	TCP	66 46288
50	0.102504	172.16.2.6	18.221.92.186	TCP	66 [TCP
51	0.150876	18.221.92.186	172.16.2.6	MQTT	1442 Conne
52	0.150885	18.221.92.186	172.16.2.6	TCP	1442 [TCP
53	0.151002	18.221.92.186	172.16.2.6	MQTT	894 Publi
54	0.151057	18.221.92.186	172.16.2.6	TCP	894 [TCP
55	0.151103	18.221.92.186	172.16.2.6	MQTT	1442 Publi
56	0.151104	18.221.92.186	172.16.2.6	TCP	1442 [TCP
57	0.151411	172.16.2.6	18.221.92.186	TCP	66 48375
58	0.151411	172.16.2.6	18.221.92.186	TCP	66 [TCP
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61	0.154639	3.21.144.111	172		
62	0.154640	3.21.144.111	172		
63	0.155091	172.16.1.6	3.2		
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65	0.155840	172.16.1.6	3.2		
66	0.155841	172.16.1.6	3.2		
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70	0.156948	18.221.92.186	172		
71	0.157513	172.16.2.6	18.		
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73	0.171160	3.21.144.111	172		
74	0.171161	3.21.144.111	172		
75	0.193353	3.21.144.111	172		
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79	0.193788	172.16.1.6	3.2		
80	0.193789	172.16.1.6	3.2		

267	0.7403	155.146.114.49	172.16.1.6	MQTT	257 Publish Message [VZCV2X
268	0.740301	155.146.114.49	172.16.1.6	TCP	257 [TCP Retransmission] 3123
269	0.740671	172.16.1.6	155.146.114.49	TCP	66 43942 > 31234 [ACK] Seq=
270	0.740672	172.16.1.6	155.146.114.49	TCP	66 [TCP Dup ACK 269#1] 4394
295	0.867648	172.16.2.6	155.146.114.240	MQTT	301 Publish Message [VZCV2X
296	0.867651	172.16.2.6	155.146.114.240	TCP	301 [TCP Retransmission] 3847
303	0.903793	155.146.114.49	172.16.1.6	MQTT	257 Publish Message [VZCV2X
304	0.903798	155.146.114.49	172.16.1.6	TCP	257 [TCP Retransmission] 3123
305	0.90403	172.16.1.6	155.146.114.49	TCP	66 43942 > 31234 [ACK] Seq=
306	0.904031	172.16.1.6	155.146.114.49	TCP	66 [TCP Dup ACK 305#1] 4394
308	0.919566	155.146.114.240	172.16.2.6	TCP	66 31234 > 38479 [ACK] Seq=
310	0.919819	155.146.114.240	172.16.2.6	TCP	66 [TCP Dup ACK 308#1] 3123
337	0.992402	172.16.2.6	155.146.114.240	MQTT	302 Publish Message [VZCV2X
338	0.992404	172.16.2.6	155.146.114.240	TCP	302 [TCP Retransmission] 3847
345	1.030738	155.146.114.49	172.16.1.6	MQTT	257 Publish Message [VZCV2X
346	1.03074	155.146.114.49	172.16.1.6	TCP	257 [TCP Retransmission] 3123
347	1.030979	172.16.1.6	155.146.114.49	TCP	66 43942 > 31234 [ACK] Seq=
348	1.03098	172.16.1.6	155.146.114.49	TCP	66 [TCP Dup ACK 347#1] 4394
362	1.045322	155.146.114.240	172.16.2.6	TCP	66 31234 > 38479 [ACK] Seq=
364	1.045569	155.146.114.240	172.16.2.6	TCP	66 [TCP Dup ACK 362#1] 3123
393	1.171022	172.16.2.6	155.146.114.240	MQTT	302 Publish Message [VZCV2X
394	1.171023	172.16.2.6	155.146.114.240	TCP	302 [TCP Retransmission] 3847
403	1.212623	155.146.114.240	172.16.2.6	TCP	66 31234 > 38479 [ACK] Seq=
404	1.212623	155.146.114.240	172.16.2.6	TCP	66 [TCP Dup ACK 403#1] 3123
411	1.213207	172.16.2.6	155.146.114.240	MQTT	302 Publish Message [VZCV2X
412	1.213207	172.16.2.6	155.146.114.240	TCP	302 [TCP Retransmission] 3847
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420	1.218817	172.16.1.6	155.146.114.49	TCP	66 [TCP Dup ACK 419#1] 4394

Verizon and Cisco Test Results

Standard LTE Public Internet Network – No Optimizations

Maximum – 62.272 ms
Minimum – 33.442 ms
Average – 42.833 ms

	Test1a	Test1b
	milliseconds	milliseconds
	50.064	48.795
	47.052	36.403
	36.145	41.859
	38.336	35.983
	47.441	46.487
	48.176	34.773
	43.695	47.435
	38.63	43.129
	33.442	54.991
	35.579	62.272
		42.094
		40.743
		35.76
		38.717
	41.856	43.5315

Traffic Type	Safety Services				Mobility Services		
Traffic Families	Critical V2V	essential V2V	Critical V2I - I2V	Essential V2I - I2V	Transactional	Low Priority	Background
Traffic Direction	V2V		V2I - I2V		V2I - I2V		
Maximum Latency	20 ms	100 ms	100 ms	100 ms	100 ms	100 ms	100 ms
Example Messages	Critical BSM, EVA	BSM	RSM, MAP	SPaT/PSM	EFC/Toll	TIM	TCP, UDP
Example Applications	Manuever Sharing, Collision Avoidance, Blind Spot, Lane Change Warning, Perception Sharing		Required Intersection Messages, Pedestrian Protection, Vulnerable Road User Communication, Wrong Way Warning, Queue Backup, Curve Speed Warning, Work Zone Safety		Queue Warning, Cooperative Adaptive Cruise Control, Emergency Vehicle Preemption, Freight-Specific Dynamic Travel Planning and Performance, Advanced Traveler Information System, Signal Priority, Intelligent Traffic Signal System, Dynamic Speed Harmonization, Emergency Routing and Evacuations, Dynamic Transit Operations, Dynamic Ridesharing		

Impact of latency on braking distance

	Transmission Latency in (ms)	Application Latency (ms)	Human Latency (s)	Total Latency (ms)	Speed (mph)	Speed (kph)	Stopping Distance (m)	Avoidance Distance (m)	Stopping Distance (ft)	Avoidance Distance (ft)	Difference 4G and PC5 (ft)
PC5 - 40 mph	4.000	20.000	0.600	24.600	40.000	64.374	34.044	34.484	111.700	113.143	
4G Avg - 40 mph	42.833	20.000	0.600	63.433	40.000	64.374	34.044	35.179	111.700	115.421	2.278
4G Max - 40 mph	62.272	20.000	0.600	82.872	40.000	64.374	34.044	35.526	111.700	116.561	3.418
Internet - 40 mph	600.000	20.000	0.600	620.600	40.000	64.374	34.044	45.141	111.700	148.107	32.686
PC5 - 55 mph	4.000	20.000	0.600	24.600	55.000	88.514	58.829	59.433	193.017	195.001	
4G Avg - 55 mph	42.833	20.000	0.600	63.433	55.000	88.514	58.829	60.388	193.017	198.133	3.132
4G Max - 55 mph	62.272	20.000	0.600	82.872	55.000	88.514	58.829	60.866	193.017	199.701	4.700
Internet - 55 mph	600.000	20.000	0.600	620.600	55.000	88.514	58.829	74.086	193.017	243.076	44.943
PC5 - 55 mph	4.000	20.000	0.600	24.600	70.000	112.654	90.168	90.938	295.841	298.366	
4G Avg - 70 mph	42.833	20.000	0.600	63.433	70.000	112.654	90.168	92.153	295.841	302.353	3.987
4G Max - 70 mph	62.272	20.000	0.600	82.872	70.000	112.654	90.168	92.761	295.841	304.349	5.982
Internet - 70 mph	600.000	20.000	0.600	620.600	70.000	112.654	90.168	109.586	295.841	359.553	57.200

MIT researchers have found an answer in a new study that shows humans need about 390 to 600 milliseconds to detect and react to road hazards, given only a single glance at the road
https://news.mit.edu/2019/how-fast-humans-react-car-hazards-0807#:~:text=MIT%20researchers%20have%20found%20an,as%20fast%20as%20older%20drivers.

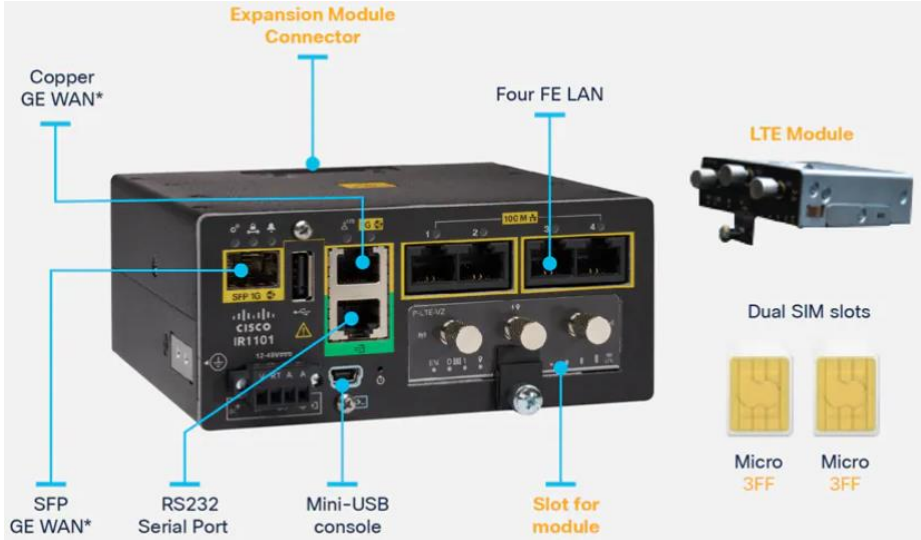
The AASHTO stopping distance formula is as follows:

$$s = (0.278 * t * v) + v^2 / (254 * (f + G))$$

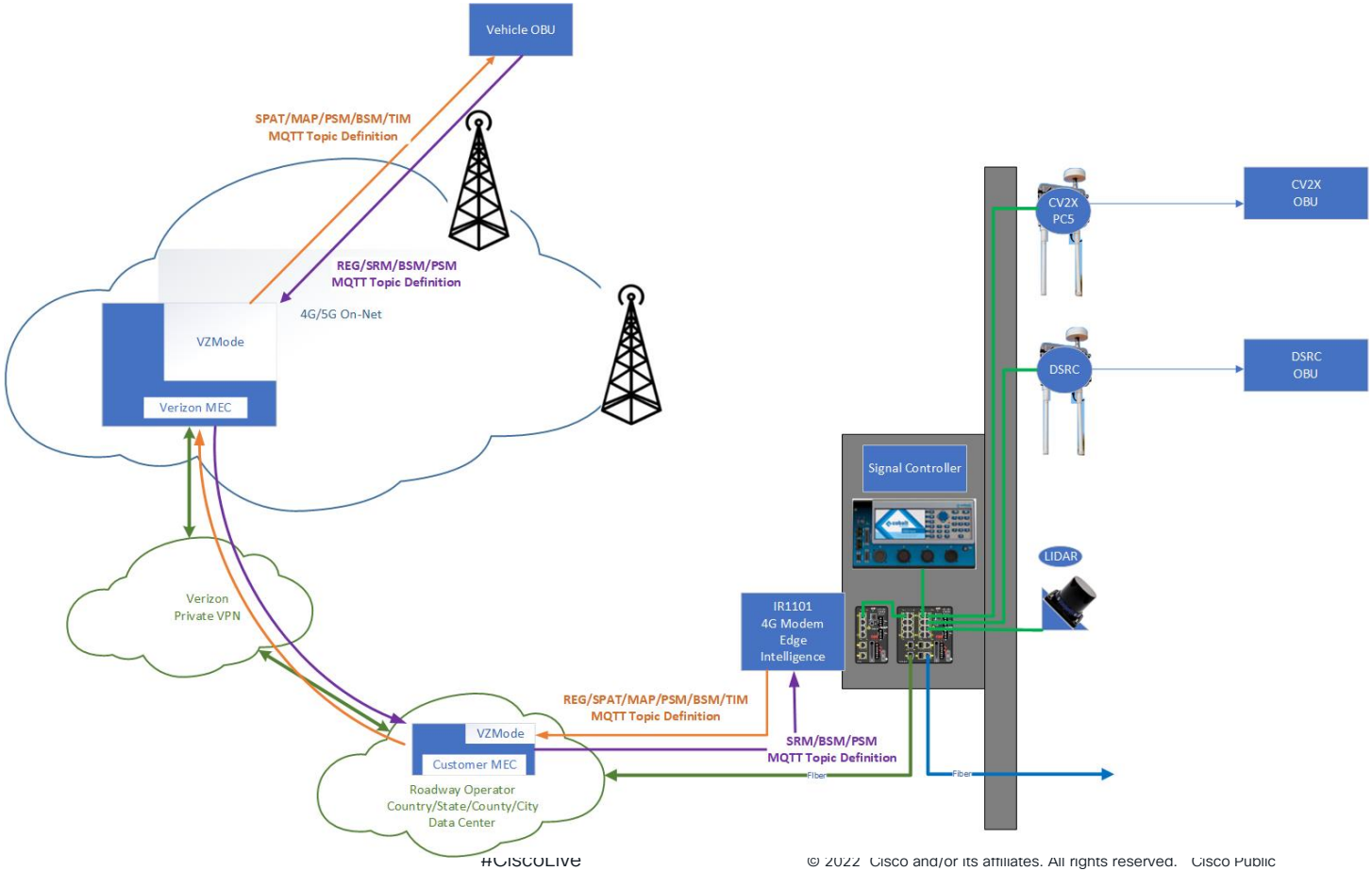
s is the stopping distance, measured in meters;
t is the perception-reaction time in seconds;
v is the speed of the car in km/h;
G is the grade (slope) of the road, expressed as a decimal. It is positive for an uphill grade and negative for a road going downhill;
f is the coefficient of friction between the tires and the road. It is typically assumed to be equal to 0.7 on a dry road and in the range from 0.3 to 0.4 on a wet road.

Cisco Cellular Enabled Intersections

- Equipment
  - IR1101 Cellular router
- Software
  - IOT Operations Dashboard
  - Edge Intelligence Software
- Features
  - Cloud based Zero Touch Deployment
  - Cloud based Software Lifecycle Management
  - Cloud based CV Application Management

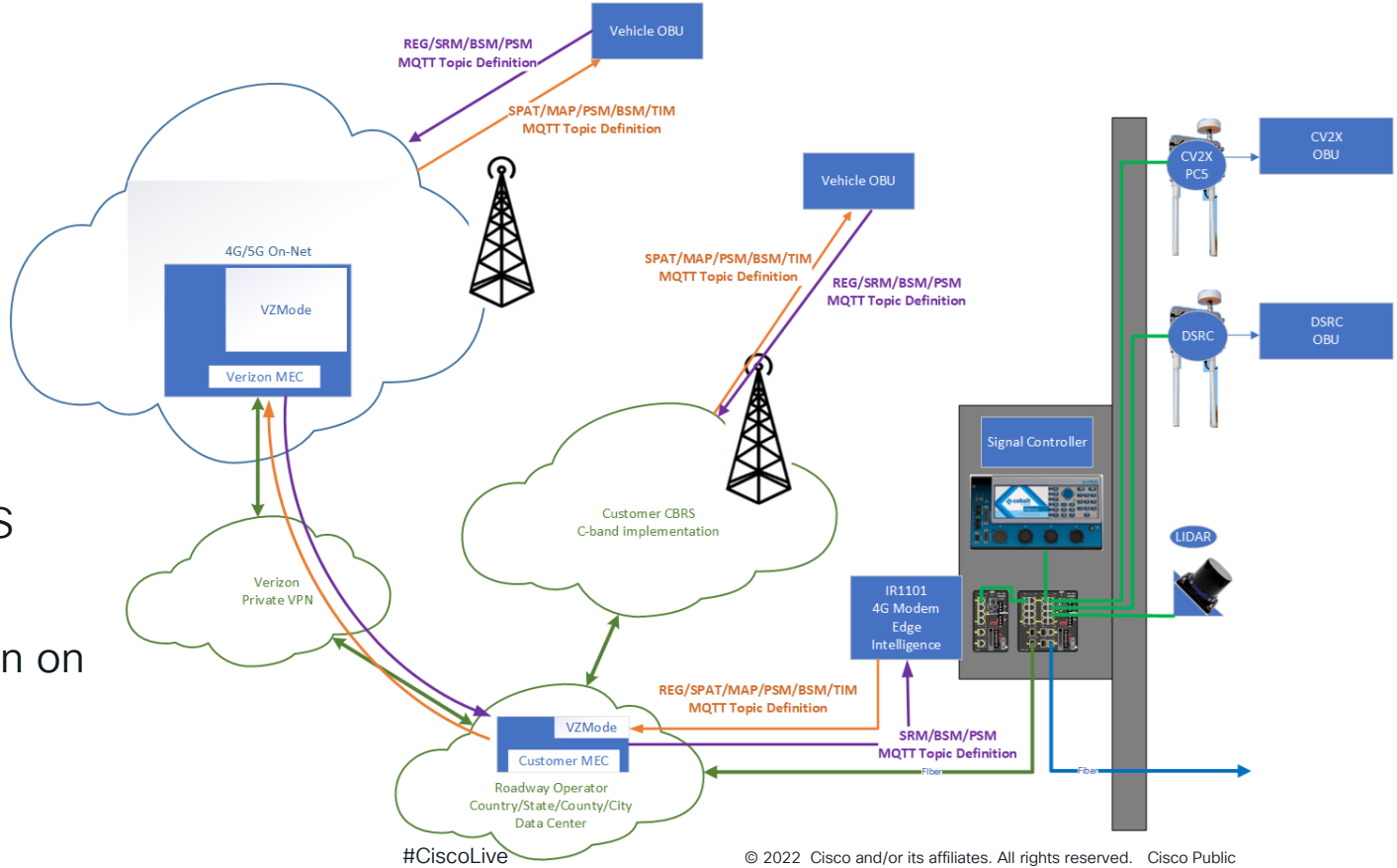


Fiber connected deployment



Private 5G Implementation

- Customer P5G CBRS
  - C-band
- VirtualRSU installation on local customer MEC



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- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
- These points help you get on the leaderboard and increase your chances of winning daily and grand prizes.

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