

5G Support for Washington State Transportation Policy

Innovation to Enable Safety Today

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Selected WSTC Goals & Policies

Safety:

- Integrate into system operations
- Ensure safety of those who operate & maintain roadways
- Harness emerging tech to reduce crash hazards

Mobility

- Reliable multimodal across state
- People and freight throughput
- Respond to demographics and lifestyle preferences
- Access, regardless of ability or income

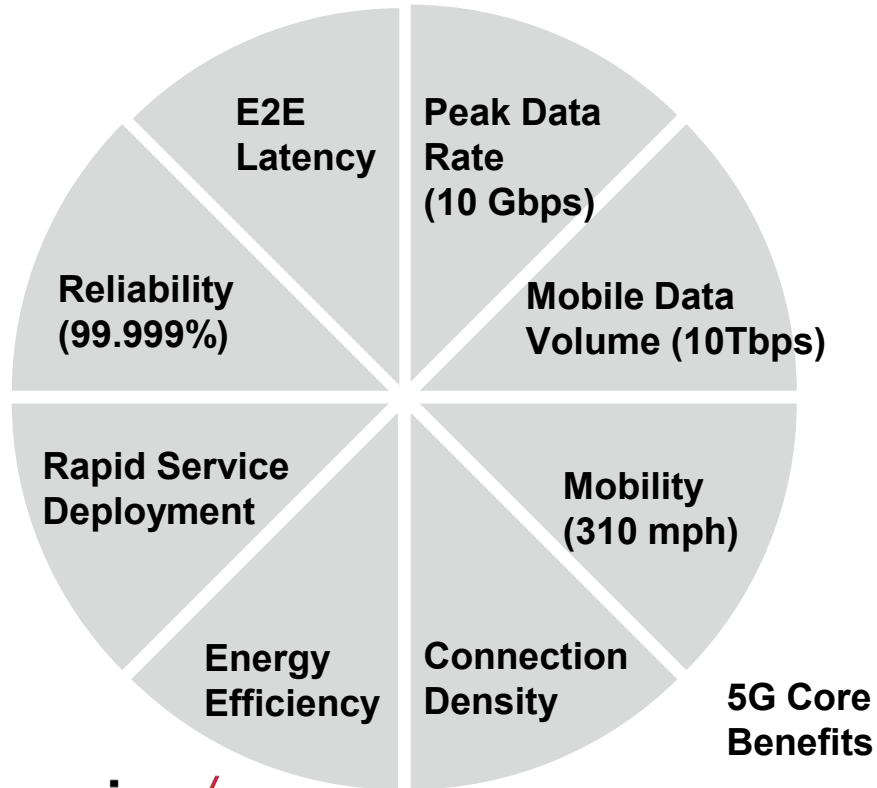
Revenue

- Road Use Charging (RUC)

**Improving
Safety,
Mobility, &
Revenue**

**Using Digital
Infrastructure
to Connect,
Analyze, &
Automate**

5G: Digital Infrastructure Pillar



- Latency: ~200x improvement over 4G
- Peak data rate: Up to 10 Gbps
- Throughput: Up to 10 Terabits/km²
- Connection density: Up to 1million/km²

Edge Computing Built on 5G – AWS Wavelength

Why it matters...

Lower latency for real-time responses

- Enabling V2I, V2V

Consistent connectivity

- Less variability, dropped packets

Elasticity

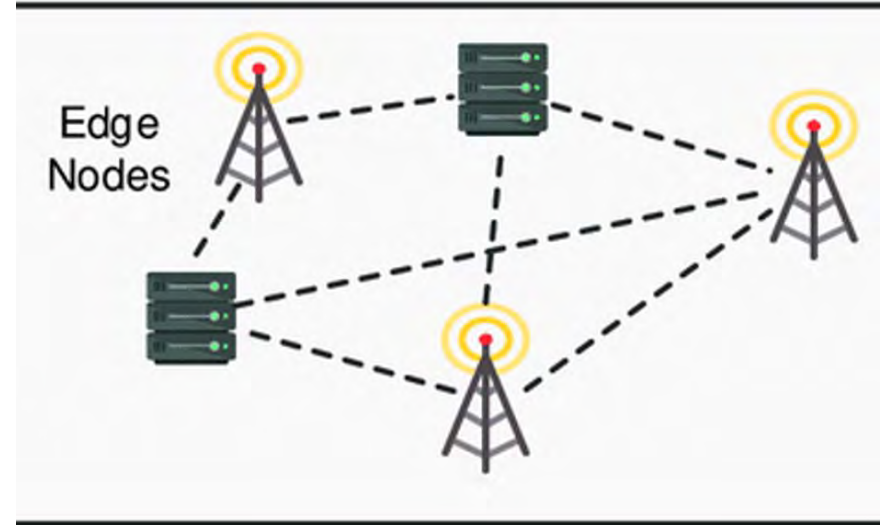
- Scale to meet demand

Reduce on-board resources

- AI/ML, GPU acceleration

Consistent developer experience

- Familiar tools and services



Edge Compute: 5G/Data/Application traffic does not traverse the internet

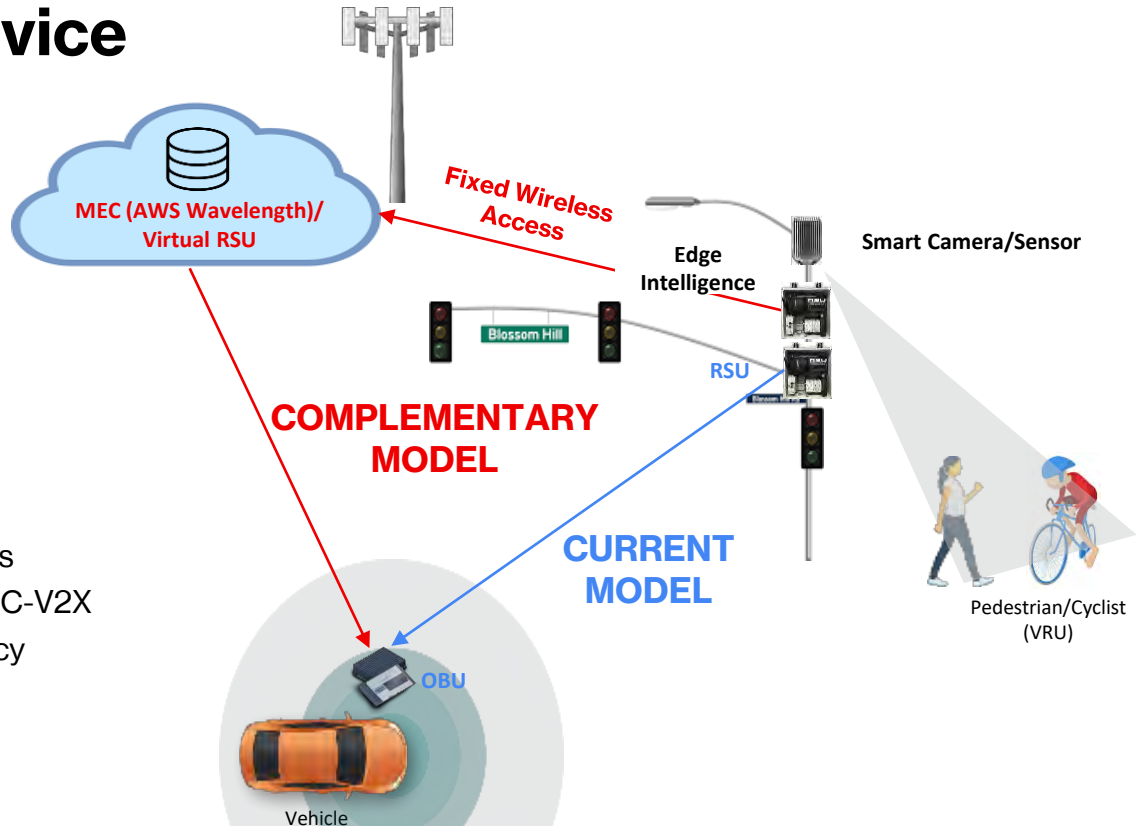
Virtual RSU as a Service

Use Cases

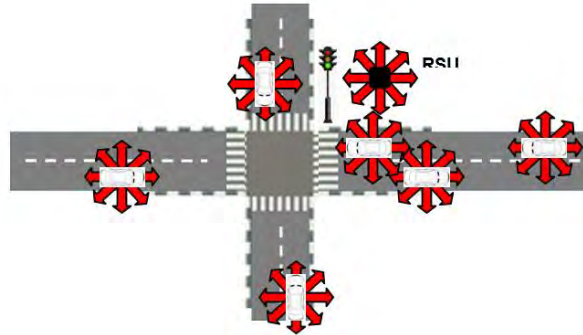
- Real time traveler information
- VRU alerts
- Workzone alerts
- Traffic queue detection
- Wrong way driving
- Transit signal priority/pre-emption

Outcomes

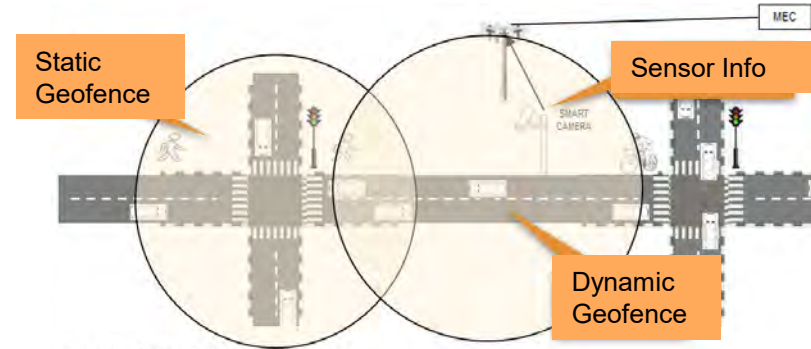
- Vision Zero support – situational awareness
- Safety and throughput - Real time scalable C-V2X
- Lower total cost of ownership for the agency



vRSU: Future-proof V2X at Scale



Physical RSU: UDP Broadcast



Virtual RSU: Point to Point w/ Geofencing

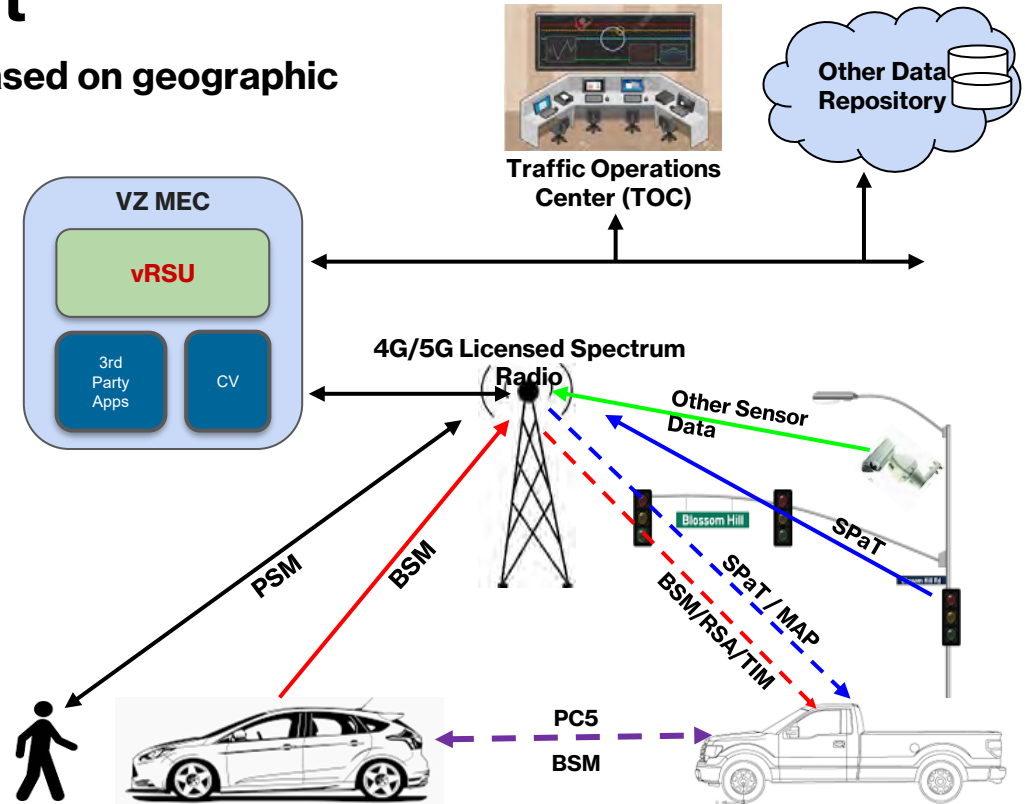
Why it matters...

| Why it matters... | | | |
|---|---|---|---|
| Point to Point Comms <ul style="list-style-type: none">SecureVehicle Specific MsgSimplifies OBU processing | Geofencing <ul style="list-style-type: none">ContextualGeodynamicAware of traffic intelligence | Cellular Network <ul style="list-style-type: none">Scale out – unconstrainedBandwidth to upload sensor data | As a Service <ul style="list-style-type: none">Continuous UpgradesNo ownership issues |

Virtual RSU Arrangement

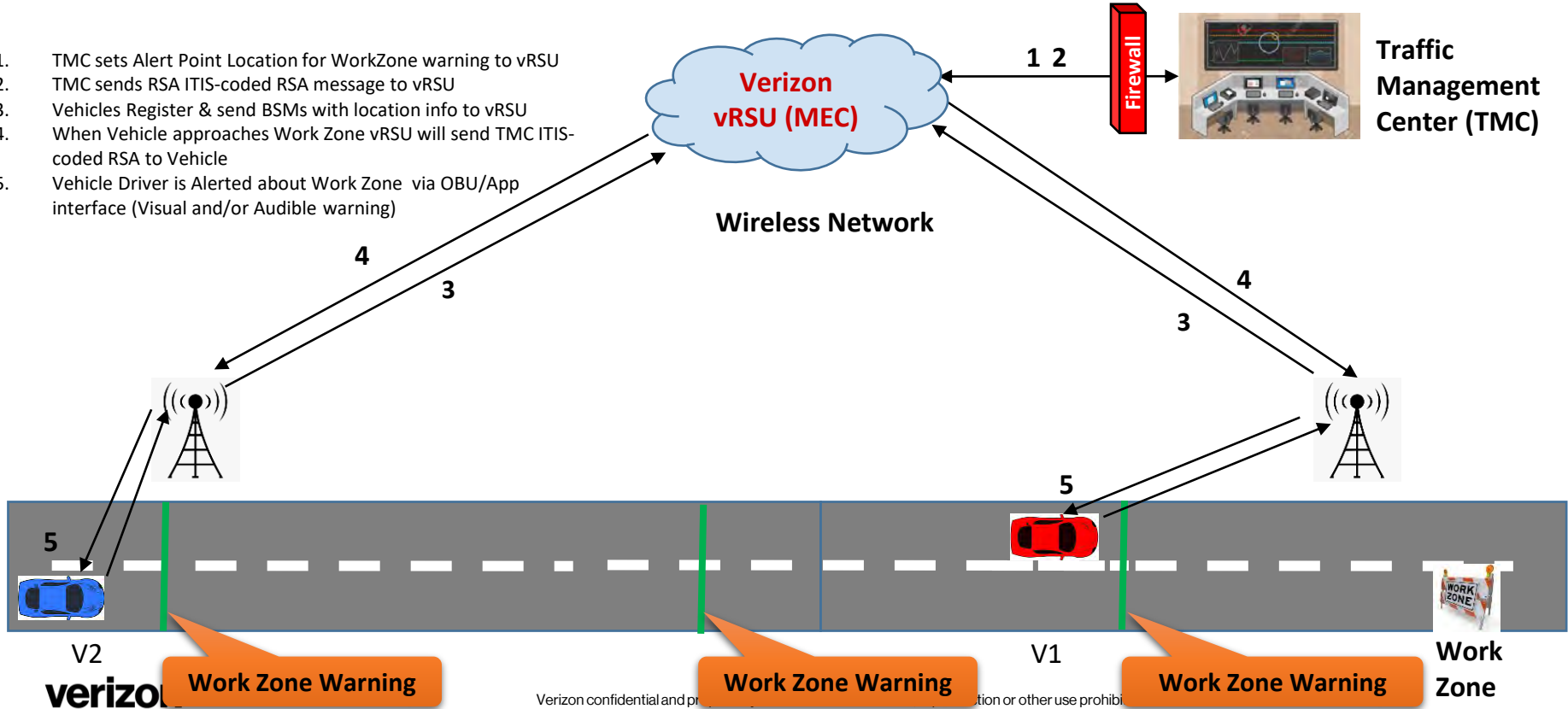
Standards-based messaging delivered based on geographic relevance

- Delivers any SAE J2735 safety alert
- Based on policy from TOC
- Used with vehicle and phone OBUs
- RT Latency today <100ms
- Services wherever 4G/5G present
- Integrates w/ IoT (video, lidar, weather)
- 3rd party MEC-hosted apps feasible
- No installation, offered as a service



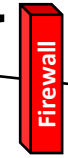
Use Case - Work Zone (Construction) Warning

1. TMC sets Alert Point Location for WorkZone warning to vRSU
2. TMC sends RSA ITIS-coded RSA message to vRSU
3. Vehicles Register & send BSMs with location info to vRSU
4. When Vehicle approaches Work Zone vRSU will send TMC ITIS-coded RSA to Vehicle
5. Vehicle Driver is Alerted about Work Zone via OBU/App interface (Visual and/or Audible warning)



Use Case - Curve Speed Warning/Alert

- Vehicle Sends BSMs with Location to vRSU
- Curve Speed Alert Locations are identified by DOT and sent to vRSU
- vRSU constantly monitors vehicles entering Curve Speed Zone
- When Vehicle approaches Curve Speed Zone vRSU will send TMC ITIS-coded RSA to Vehicle
- Vehicle Driver is Alerted about Curve Speed Zone via OBU/App interface (Visual and/or Audible warning)



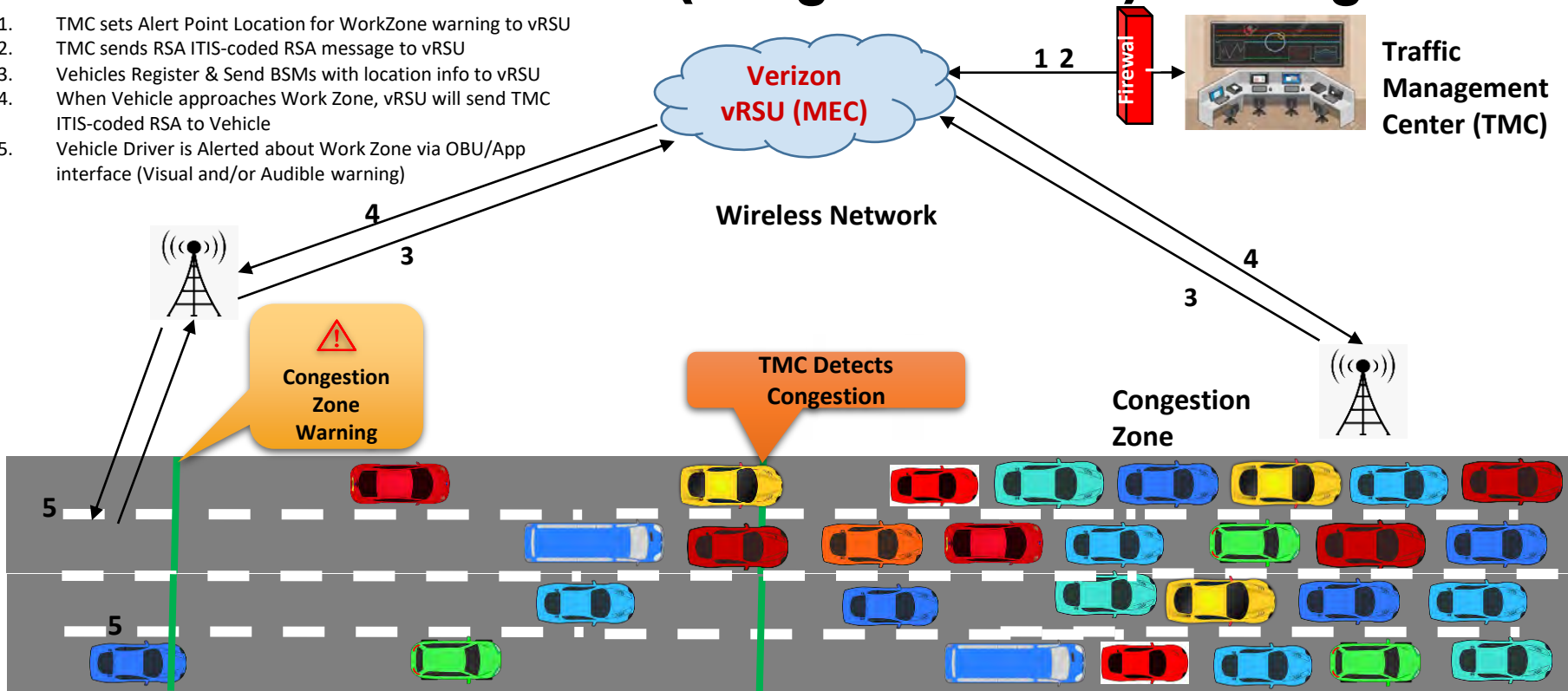
Traffic Management Center (TMC)

Wireless Network



Use Case- Back of Queue (Congestion Zone) Warning

1. TMC sets Alert Point Location for WorkZone warning to vRSU
2. TMC sends RSA ITIS-coded RSA message to vRSU
3. Vehicles Register & Send BSMs with location info to vRSU
4. When Vehicle approaches Work Zone, vRSU will send TMC ITIS-coded RSA to Vehicle
5. Vehicle Driver is Alerted about Work Zone via OBU/App interface (Visual and/or Audible warning)



Real-World Use Cases We've Tackled

FIRST RESPONDER SAFETY



✓ Emergency Preemption

INTERSECTION SAFETY



✓ Red Light Runner Warning

DANGEROUS QUEUES



✓ Back of Queue Warning

WORK ZONE SAFETY



✓ Work Zone Warning

DANGEROUS CURVES



✓ Curve Speed Warning

CAVs



✓ Left Turn Assist

TRANSIT EFFICIENCY



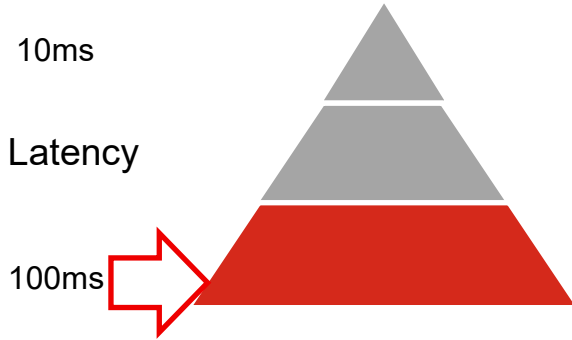
✓ Transit Signal Priority

VULNERABLE ROAD USERS

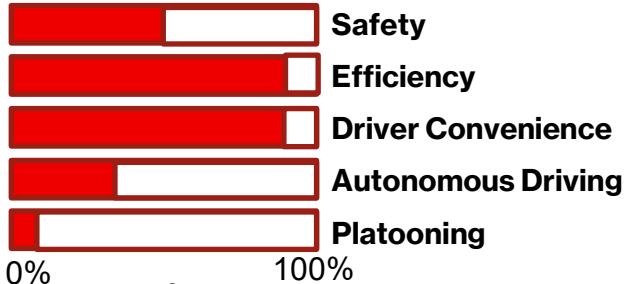


✓ Pedestrian in Crosswalk

System Speed That Satisfies Many Safety Use Cases



Est % cases enabled w/ 100ms latency, by group



Source:
Taxonomy: 5GAA WG1
% Estimates: By the author as example

Use Case Latency Requirements (in ms)

| | | |
|-------------|----------|---|
| Safety | 100 | Cross-Traffic Left-Turn Assist |
| | 100 | Intersection Movement Assist |
| | 100 | Interactive VRU (Ped, Bike) crossing |
| | 100 | R/T Situational Awareness: Hazardous Location Warning |
| | 2000 | Traffic Jam Warning and Route Information |
| Efficiency | 100 | Green Light Coordination |
| | 200 | Bus Lane Sharing Request/Revocation |
| | 1400+ | Speed Harmonization |
| Convenience | 100-5000 | Cooperative Curbside Management |
| | 50 | Obstructed View Assist |
| Assist | 10 | Hi Def Sensor Sharing |
| | 10 | Automated Intersection Crossing |
| | 20 | Cooperative Lane Merge |
| | 50 | See-Through Passing |
| | 50 | Tele Operated Driving |
| | 100 | Infrastructure Assisted Environment Perception |
| | 400 | Cooperative Lane Change of AV: Lane Change Warning |
| Platooning | 50-100 | Platooning in Steady State |

Source: C-V2X Use Cases Volume II: Examples and Service Level Requirements 5GAA 2020

Digitizing Our Roadways - A Phased Evolution

Road Infrastructure



Verizon Network/ Services

Network

NAAS

- SDWAN
- Cloud
- MPLS/ Private Network
- Cyber Security

4G/5G/ FWA

Platform

MEC

vRSU

ThingSpace

Prof. Services

API

Support

Training

Information Recipients



Rail/Transit



Traffic Mgmt/Data Center



Auto/Fleet



3rd Party Apps



Passengers/ Motorists



Bikes/Peds/ Micro-mobility



1. Connect



2. Inform



3. Automate



Perspectives on VRU Safety w/ 5G MEC vRSU

An OEM Perspective

- **VRU very important**
- **Working VRU safety since 2012**
- **Direct-communication challenged in US**
- **Now focusing on mobile network based solution**
- **5G MEC to address VRU safety: great potential**
- **Time to pursue national network-based solution**
 - OEMs, smartphone device, micromobility devices, infrastructure providers and road operators.

Network Operator Perspective

- **Safety requires detection and notification**
- **Phone provides ubiquitous VRU detection**
 - Low cost, Upcoming RTK capability
- **Phone is best to notify VRUs about safety**
- **Vehicles must receive notification**
- **Vehicles built-in systems to provide notification**
- **5G MEC vRSU best: pull detection & push notification**
- **Superior ROI than physical RSU**



Connect Now for Safety

Deliver value with what exists today

Embrace what's feasible

- **Bounded projects (corridor, geography, transit line)**
- **Use cellular network/cloud connectivity**
- **Evaluate the impact, including equity**



Pick 2 or 3 pragmatic use cases

- **VRU Presence**
- **Work Zone Warning**
- **Safety messages: Queue, Curve**
- **Transit Signal Priority, Freight Priority**



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