Smart Communities – How 5G, Mobility, Vision Zero and Multi-Modal Approaches are Converging

Sean Harrington
Vice President of City Solutions, Verizon
Addressing Most Pressing City Priorities

- Mobility
- Public safety and security
- Sustainability and Efficiency
- Digital equity/Inclusion
First Generation
Second Generation

Camera | Audio | Motion | Radar | Sonar | Accelerometer

Magnetometer | LIDAR | Photocell | Air Quality

2,500,000,000,000,000,000,000 bytes / day

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More Than Sensors

Distributed Computing
Machine Learning
Interconnected Systems
Light Pole as a Sensor Hub
Computer Vision in Street Lights
Integrated Smart Communities Solutions

Network densification | Connectivity | One Fiber

- Intelligent Lighting
- Intelligent Video
- Intelligent Traffic Management
- Traffic Data Services
- Intersection Safety Analytics
- Parking Optimization
- Digital Kiosk

City control nodes/sensors

- Fiber
- Small cell
- 4G/5G/Wi-Fi

Improving sustainability and efficiency | Reducing crime and increasing security | Enhancing citizen experience
Traffic Data Services

- Live traffic using cellular location data
- Congestion mitigation and root cause analysis
- Origin-destination and traffic impact studies
- Accurate location, travel direction and speed
Intersection Safety Analytics

The online management portal offers:

- A customizable interface
  - Speed of vehicles and bicycles at an intersection
  - Count and turning movement of vehicles correlated with traffic signal phases
  - Cyclist movement through an intersection correlated with traffic signal phases
  - Count of pedestrian crossing an intersection correlated with walk/stop phases.
  - Pedestrian movement outside of designated cross walk.
- The ability to pull reports for each intersection by time and date, as well as global reports
- Policy creation tools
- 24x7x365 access to historical data
- Near real-time data

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How It Works

Solution components:
• Video sensors observe intersection
• Data is integrated with traffic signal phase data
• System performs edge-distributed video analytics.

Data flow:
• Video sensors detect conditions at an intersection and record metadata in cloud platform.
• Data analytics services process the data and transform it into meaningful traffic safety metrics.
Sacramento

Verizon solutions implemented:

- Wi-Fi
- Intelligent Traffic and Data Services
- Public Safety solutions
- 5G connectivity

“This partnership serves as a critical step in upgrading our city's infrastructure to support the newest and best technology, and the economic growth that comes with that technology.”

—Mayor Darrell Steinberg, City of Sacramento
There are eight performance attributes, or currencies, to be considered when evaluating whether a 5G network can deliver on its full potential:
5G networks will one day offer peak data rates of 10 Gbps.

- Verizon 5G Home has demonstrated speeds of 600 to 800 Mbps downlink and 250 Mbps uplink in third-party testing³

5G has the potential to deliver speeds many times faster than today’s 4G networks, powering uses such as:

- Intelligent video
- Remote diagnostics
- Mobile command centers for live video and audio

Verizon has taken its award-winning 4G network to new heights.

- 953 Mbps in a real-world environment, using 4G LTE Licensed Assisted Access (LAA)¹
- 1.45 Gbps in 4G LTE Advanced in six-channel carrier aggregation²

Latency

All kinds of new applications become possible once you reach very low levels of latency, including:

- Immersive extended reality (XR), combining artificial reality (AR), virtual reality (VR) and mixed reality (MR)
- Autonomous driving
- Computer vision
- Haptics-enabled tactile internet
- Robotics

4G LTE networks currently offer end-to-end latency in the realm of 40 to 50 ms.

Verizon 5G Ultra Wideband should eventually offer less than 10 ms end-to-end response times.¹ ²

¹ Latency improvements are due to lower latency in the 5G radio access network and the extension of the core network closer to end users.
The 8 currencies can only be fully realized on a 5G network built the right way.

**Fiber**
- Significant fiber in major cities to drive densification
- Verizon has committed to invest $1.05 billion on new fiber-optic cable from Corning from 2018 to 2020¹

**Small-cell deployment**
- Verizon has spent years densifying our 4G LTE network. Many 4G locations will be used for 5G
- We have built relationships with municipalities of all sizes so we can accelerate network deployment

**Millimeter-wave spectrum**
- Critical spectrum holdings
- Nationwide deep millimeter-wave spectrum

**Edge computing**
- We have network locations nationwide that are ideally suited to house edge computing resources
- Edge computing will enable low-latency applications

Enabling V2X with 5G/MEC

Vehicle to MEC through 5G
Video-based sensor fusion delivers location of non-AV vehicles, pedestrian data, “see around corners”, obstructions

Enables Real-Time HD Mapping
# Use Case Description

<table>
<thead>
<tr>
<th>#</th>
<th>Use Case</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Signal Phase for Driver</td>
<td>As a driver receive signal phase info.</td>
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<tr>
<td>2</td>
<td>Signal Phase for VRU</td>
<td>A pedestrian’s/cyclist’s phone would receive signal phase of nearby intersection.</td>
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<td>3</td>
<td>VRU Collision Detection</td>
<td>As a driver, vehicle would receive notification of pedestrians and cyclists in the corridor as detected by Smart City cameras OR provided by a pedestrian / cyclist VRU app.</td>
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<tr>
<td>4</td>
<td>Vehicle Collision Detection</td>
<td>A pedestrian’s/cyclist’s phone would warn of vehicles approaching.</td>
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<tr>
<td>5</td>
<td>Green Light Optimal Speed Advisory</td>
<td>As a driver receive safe and optimal signal approach speed to make green light based on signal phase info and traffic queue info as detected by Smart City cameras.</td>
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<td>6</td>
<td>Localized Road Issues</td>
<td>As a driver or cyclist, receive localized road issues (potholes, icy patches, accidents, work zones) as detected by Smart City cameras.</td>
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<td>7</td>
<td>Traffic Congestion and Reliability Prediction</td>
<td>As a delivery company, route planners receive predicted best travel time windows when corridors / routes are less congested as detected and analyzed by Smart City cameras with historical data OR from TDS data coupled with weather &amp; other road related events.</td>
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<td>8</td>
<td>Lane / Road Departure bad weather</td>
<td>As a driver, receive Lane / Road departure warning in bad weather as detected by Smart City cameras.</td>
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<tr>
<td>9</td>
<td>Nearby Emergency Vehicle Notification</td>
<td>As a driver, cyclist or pedestrian, receive notification of an approaching emergency vehicle as detected by Smart City cameras.</td>
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<tr>
<td>10</td>
<td>Overheight Collision Warning</td>
<td>As a truck driver, receive warning that height of truck is too high for an upcoming overpass or bridge</td>
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<tr>
<td>11</td>
<td>Corridor Metrics</td>
<td>C-V2X app receives data on vehicles, pedestrians, and cyclists from Smart City cameras OR C-V2X / VRU apps to collect / calculate corridor performance measurements (vehicle type, travel time, travel time reliability, average speed on freeways, volume/capacity, congestion level, emission quantities, collision data) and send to DOT, toll-operators, city planners.</td>
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Integrated Corridor Management – Use Case Diagrams

Use Case 1: Green Light Optimal Speed Advisory

Use Case 2: Traffic Congestion and Reliability Prediction

Use Case 3: Driver & VRU Collision Detection

Use Case 4: Lane / Road Departure Bad Weather

Use Case 5: Traffic Congestion and Reliability Prediction

Use Case 6: Nearby Emergency Vehicle Notification

Use Case 7: Use Case 7

Use Case 8: Use Case 8

Use Case 9: Nearby Emergency Vehicle Notification

Use Case 10: Nearby Emergency Vehicle Notification

Use Case 11: - collect metrics such as vehicle type, travel time, travel time reliability, average speed on freeways, volume/capacity, congestion level, emission quantities, collision data, etc.
Situational Awareness

6,227 pedestrians were killed in automobile-related accidents in 2018.

Multimodal
Thank you.