Data Needs for Cities

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Vice President, City Solutions
Major city initiatives

- Sustainability and efficiency
- Public safety and security
- Citizen experiences
Increasing sustainability and efficiency

• Replace costly and inefficient lighting.
• Cut emissions and energy costs.
• Reduce traffic congestion.
Addressing public safety and security needs

- Enhance situational awareness with advanced video monitoring.
- Improve traffic patterns.
- Maintain well-lit public places.
Enhancing citizen experiences

- Bridge the digital inclusion.
- Deliver public and municipal Wi-Fi.
- Provide access to hyper-local information.
Data is the lifeblood for solutions that address these challenges

- Intelligent Lighting
- Intelligent Video
- Intelligent Traffic
- Parking Optimization
- Citizen Engagement
Light Pole as a Sensor Hub

Smart Lighting

Smart Parking

Traffic (vision zero)

Public Safety (some use cases)

One Network
No Trenching

Additional Sensors & Smart Apps

Foundation for Public Wi-Fi

Smart Lighting

Traffic (vision zero)

Public Safety (some use cases)
Computer Vision as a Multipurpose Sensor
Computer Vision as a Multipurpose Sensor

- Washington, DC use cases: Parking, Traffic, and Public Safety
- 3 Class Support: Vehicles, Pedestrians, and Bicyclists
Computer Vision as Multipurpose Sensor

### Parking

<table>
<thead>
<tr>
<th>Feature</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway Parking</td>
<td>• Applicable to avenues, streets, and ways</td>
</tr>
<tr>
<td></td>
<td>• Used for parallel or front to street side parking areas</td>
</tr>
<tr>
<td></td>
<td>• Support for marked and unmarked parking</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
<tr>
<td>Poor Parking</td>
<td>• Impaired visibility offset from the curb</td>
</tr>
<tr>
<td></td>
<td>• Applicable to parallel side parking areas</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
<tr>
<td>Lot Parking</td>
<td>• Parking in outdoor lots, malls, airports, and wide area parking places</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
</tbody>
</table>

### Traffic

<table>
<thead>
<tr>
<th>Feature</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Count and Speed</td>
<td>• Tracking, counting, and estimating speed for moving vehicles</td>
</tr>
<tr>
<td></td>
<td>• Applicable to city streets, avenues, and highways</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
<tr>
<td>Vehicle Classification</td>
<td>• Precisely identify passenger vehicles in stopped traffic</td>
</tr>
<tr>
<td></td>
<td>• Detect vehicles and concerned by count cars, trucks, and motorcycles</td>
</tr>
<tr>
<td></td>
<td>• Use to estimate roadway usage and maintenance needs</td>
</tr>
<tr>
<td>Wrong Way Detection</td>
<td>• Identify vehicles missing against traffic flow</td>
</tr>
<tr>
<td></td>
<td>• Use to detect and respond to dangerous driving behavior</td>
</tr>
<tr>
<td>Pedestrian Tracking</td>
<td>• Identify track and count pedestrians</td>
</tr>
<tr>
<td></td>
<td>• Meets for jaywalking detection near bus stops and parking garages</td>
</tr>
<tr>
<td></td>
<td>• Apply to sidewalks, crosswalks</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
<tr>
<td>Bicyclist Tracking</td>
<td>• Identify, track, and count bicycles</td>
</tr>
<tr>
<td></td>
<td>• Meets for assessing bicycle lane utility</td>
</tr>
<tr>
<td></td>
<td>• Use in determining new bicycle lane needs</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
</tbody>
</table>

### Intersections & Vision Zero

<table>
<thead>
<tr>
<th>Feature</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume and Speed</td>
<td>• Sparse Scenes, accuracy reduction with density</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
<tr>
<td>Outside of Intended Location</td>
<td>• Jaywalking is well supported</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
<tr>
<td>Against Signage</td>
<td>• Applicable to red light and greenlight violations</td>
</tr>
<tr>
<td></td>
<td>• Typical installation: Lighting poles of 6m (2011) or higher</td>
</tr>
<tr>
<td>Object Line Crossing with Count</td>
<td>• Identify, track, and count objects crossing boundary</td>
</tr>
<tr>
<td></td>
<td>• Apply to entry and exit ways</td>
</tr>
<tr>
<td>Object Enters with Count</td>
<td>• Identify, track, and count objects entering an area</td>
</tr>
<tr>
<td></td>
<td>• Apply to protected areas and keep out zones</td>
</tr>
<tr>
<td>Object Leaves with Count</td>
<td>• Identify, track, and count objects leaving areas</td>
</tr>
<tr>
<td></td>
<td>• Apply to determine exit direction following entry</td>
</tr>
<tr>
<td>Object Dwell with Count</td>
<td>• Identify, track, and count objects dwelling in an area</td>
</tr>
<tr>
<td></td>
<td>• Apply to object entering and staying within a specified area</td>
</tr>
<tr>
<td>Perimeter Protection</td>
<td>• Apply security events to detect and protect areas around buildings</td>
</tr>
<tr>
<td></td>
<td>• Use for border control/land boundary treaty</td>
</tr>
</tbody>
</table>
Intelligent Parking Solutions

• Enables drivers to find parking faster and easier
• Optimizes parking revenue
• Enhances parking enforcement by identifying parking violations
• Reduce traffic & carbon emissions
Video Node 4K & Parking

Power & Cellular backhaul

Dual HD video sensor

Integrated 180 degree coverage

Stitched field of view
Verizon Parking Solution

VZPark: Parking Wayfinding App

• Help citizens find parking faster – reduce circling time
• Improve trip planning capabilities by communicating parking congestion before people leave the house

VZPlan: Parking Optimization

• Simple reports to help planners optimize parking performance and help reduce congestion
• Integrated view of parking hot spots by time of day and day of week
• Configurable reporting tools to address city-by-city specific “pain points”
Parking Optimization Solution
Intelligent Traffic Management

• Signal Optimization
• Near Real-Time Data
• Increase Traffic Safety
Intelligent Traffic Management

Performance measures

Basic features:
• Travel times
• Intersection delay
• Origin/destination data

Advanced features:
• Volume/Occupancy/Speed data
• Congestion Emissions data
• Vehicle miles/hours traveled
• Timing plan analysis
• Temperature sensing and alerts

Advanced Plus features:
• 24/7 Turn movement counts
• Export to Syncro
• Volume/capacity ratios w/LOS
• Wait Times
• Arrivals on green
• Red-light violations
• Coordination diagrams

Sensor zones key
- Advanced detect
- Stop bar
- Departure

Controller cabinet
APCC
Bluetooth/Wi-Fi radio

Verizon Managed Service
Intelligent Traffic Management

Depicted:
Purdue Coordination Diagram and volume-to-capacity ratio by Time of Day and Signal phase
Traffic Data Services

- Live road traffic information
- Congestion mitigation & root cause analysis
- Origin-destination studies
- Traffic impact studies
Traffic Data Services – Real-time Traffic
Traffic Data Services – Origin-Destination

- Identify where people come from & where they go
- Analyze mobility patterns of the people caught in the congestion
- Determine main contributors for congestion through specific areas
- Leverage data to evaluate effectiveness of changes

<table>
<thead>
<tr>
<th>road</th>
<th>direction</th>
<th>20:30</th>
<th>21:00</th>
<th>21:30</th>
<th>22:00</th>
<th>22:30</th>
<th>23:00</th>
<th>23:30</th>
<th>00:00</th>
<th>00:30</th>
<th>1:00</th>
<th>1:30</th>
<th>2:00</th>
<th>2:30</th>
<th>3:00</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route_50_West</td>
<td>Out</td>
<td>10.1%</td>
<td>11.3%</td>
<td>7.6%</td>
<td>8.0%</td>
<td>5.9%</td>
<td>10.5%</td>
<td>10.1%</td>
<td>18.5%</td>
<td>8.4%</td>
<td>6.3%</td>
<td>1.7%</td>
<td>1.3%</td>
<td>0.0%</td>
<td>0.4%</td>
<td>100%</td>
</tr>
<tr>
<td>Route_202_East</td>
<td>Out</td>
<td>15.2%</td>
<td>10.9%</td>
<td>2.2%</td>
<td>6.5%</td>
<td>10.9%</td>
<td>6.5%</td>
<td>17.4%</td>
<td>15.2%</td>
<td>4.3%</td>
<td>8.7%</td>
<td>2.2%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Route_202_West</td>
<td>Out</td>
<td>12.5%</td>
<td>10.4%</td>
<td>12.5%</td>
<td>4.2%</td>
<td>6.3%</td>
<td>4.2%</td>
<td>12.5%</td>
<td>25.0%</td>
<td>2.1%</td>
<td>4.2%</td>
<td>2.1%</td>
<td>0.0%</td>
<td>2.1%</td>
<td>2.1%</td>
<td>100%</td>
</tr>
<tr>
<td>Route_214_East</td>
<td>Out</td>
<td>11.9%</td>
<td>9.2%</td>
<td>11.0%</td>
<td>6.4%</td>
<td>8.3%</td>
<td>2.8%</td>
<td>10.1%</td>
<td>22.0%</td>
<td>10.1%</td>
<td>2.8%</td>
<td>2.8%</td>
<td>0.0%</td>
<td>2.8%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Route_214_West</td>
<td>Out</td>
<td>5.1%</td>
<td>6.7%</td>
<td>4.5%</td>
<td>6.2%</td>
<td>5.1%</td>
<td>6.7%</td>
<td>21.3%</td>
<td>19.7%</td>
<td>16.3%</td>
<td>2.8%</td>
<td>2.2%</td>
<td>1.7%</td>
<td>0.6%</td>
<td>1.1%</td>
<td>100%</td>
</tr>
<tr>
<td>Route_495_North</td>
<td>Out</td>
<td>10.9%</td>
<td>7.7%</td>
<td>6.3%</td>
<td>6.7%</td>
<td>6.4%</td>
<td>8.6%</td>
<td>14.8%</td>
<td>16.2%</td>
<td>13.7%</td>
<td>3.2%</td>
<td>1.7%</td>
<td>1.7%</td>
<td>1.2%</td>
<td>1.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Route_495_South</td>
<td>Out</td>
<td>7.6%</td>
<td>5.9%</td>
<td>4.4%</td>
<td>5.8%</td>
<td>6.4%</td>
<td>8.5%</td>
<td>15.7%</td>
<td>21.6%</td>
<td>16.2%</td>
<td>4.3%</td>
<td>1.6%</td>
<td>0.8%</td>
<td>0.7%</td>
<td>0.7%</td>
<td>100%</td>
</tr>
</tbody>
</table>

All outgoing roads Out 9.3% 7.2% 5.6% 6.3% 6.4% 8.3% 15.1% 19.1% 14.1% 3.9% 1.7% 1.2% 0.9% 0.8% 100%
• **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.

• **Movement of pedestrian** outside of designated cross walk.

Intersection Safety Analytics
Success Story

Kansas City

- 195 sensor nodes along 2.2 miles
- 90% coverage of KC’s streetcar tracks

- Public Safety
- Lighting Control
- Traffic Analytics
- Smart Parking
Core Nodes & Video Nodes on Decorative Fixtures
Parking Wayfinding
Smart City Operations

- Real-time traffic
- Street car tracking
- Parking enforcement
- Pothole prediction
- Open data integration
Traffic Automation

- 24/7 turning movements
- Ped and bike counts
- Hadoop data warehouse
- BI Visualization
Poorly Parked Vehicle Detection

- Automated blockage detection
- Machine vision based
- Edge video retrieval
- Real-time alerting
# Transforming Data Into Actions & Benefits

<table>
<thead>
<tr>
<th><strong>Lighting</strong></th>
<th><strong>Traffic</strong></th>
<th><strong>Parking</strong></th>
<th><strong>Safety</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Auto dimming  &lt;br&gt; - Fault detection  &lt;br&gt; <strong>Benefits:</strong>  &lt;br&gt; - Energy savings  &lt;br&gt; - Safer streets  &lt;br&gt; - Decreased maintenance  &lt;br&gt; - CO2 reduction</td>
<td>- Traffic planning  &lt;br&gt; - Signal timing  &lt;br&gt; <strong>Benefits:</strong>  &lt;br&gt; - Reduced congestion  &lt;br&gt; - Time savings  &lt;br&gt; - Reduced pollution</td>
<td>- Parking wayfinding  &lt;br&gt; - Optimized enforcement  &lt;br&gt; <strong>Benefits:</strong>  &lt;br&gt; - Less time-to-park  &lt;br&gt; - Increased labor-to-revenue efficiency</td>
<td>- Detection PPV  &lt;br&gt; - Video streaming to agencies  &lt;br&gt; <strong>Benefits:</strong>  &lt;br&gt; - Street car safety  &lt;br&gt; - Vision Zero  &lt;br&gt; - Forensic investigation</td>
</tr>
</tbody>
</table>