Preparing for V2V, V2I & I2V: 5 Focus Areas to Understand
THE WHY: IMPORTANCE OF V2X AND CAV
1. Understand V2X Communication Technologies
VEHICLE TO EVERYTHING (V2X)

V2V + V2I + I2V = V2X
V2X COMMUNICATION TECHNOLOGIES

- V2V
- V2I
- I2V
- V2P / V2D
- N2V
- V2G
- V2C
- I2N
- C-V2X
- I2N2V
- V2N
- V2N2V
- V2N2I
- V2M
- V2G
SMART CITIES DEFINED

Information and communication infrastructure (ICT) that allows smart devices (like smartphones, automobiles, thermostats, water meters) to connect to smart infrastructure (problem reporting, traffic signals and information, parking systems, the electric grid, billing systems) to improve quality of life and productivity in cities.
SMART INFRASTRUCTURE – CAV

- Smart infrastructure
- Connected and automated vehicles (CAV)
- Vehicle-to-Everything (V2X)
- Infrastructure-to-Vehicle (I2V)
- Vehicle-to-Vehicle (V2V)
- Vehicle-to-Infrastructure (V2I)
- Vehicle-to-Pedestrian (V2P)
- Vehicle-to-Cloud (V2C)
CONNECTED & AUTOMATED VEHICLES (CAV) DEFINED

Vehicles capable of communicating with each (V2V), with roadside infrastructure, such as traffic control signals (I2V, V2I), or with other devices.
VEHICLE TO EVERYTHING (V2X)

Driving View  Aerial View
VEHICLE TO VEHICLE (V2V)
INFRASTRUCTURE TO VEHICLE (I2V)
VEHICLE TO INFRASTRUCTURE (V2I)
DSRC VS. 5G

Cellular and IEEE 802.11p for C-ITS

Big Data

Infrastructure

Other Road Users

4G

Cellular

802.11p

Siemens - Why 802.11p beats LTE and 5G for V2x
CELLULAR VEHICLE-TO-EVERYTHING (C-V2X)

C-V2X defines two complementary communication modes

**Network communications**
V2N on “Uu” interface operates in traditional mobile broadband licensed spectrum

**Direct communications**
V2V, V2I, and V2P on “PC5” interface, operating in ITS bands (e.g. ITS 5.9 GHz) independent of cellular network

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1. PC5 operates on 5.9GHz whereas Uu operates on commercial cellular licensed spectrum. RSU stands for roadside unit.

## USE CASE APPLICATIONS

<table>
<thead>
<tr>
<th>Application Use Cases</th>
<th>V2V</th>
<th>V2I</th>
<th>I2V</th>
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<tbody>
<tr>
<td>Red Light Violation Warning (RLVW)</td>
<td>X</td>
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<td>Curve Speed Warning (CSW)</td>
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<td>Stop Sign Gap Assist (SSGA)</td>
<td>X</td>
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<tr>
<td>Spot Weather Impact Warning (SWIW)</td>
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<td>X</td>
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<tr>
<td>Reduced Speed/Work Zone Warning (RSWZ)</td>
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## USE CASE APPLICATIONS

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<td>Pedestrian in Signalized Crosswalk Warning (Transit)</td>
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<td>Traffic Signal Timing/Priority</td>
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<tr>
<td>Blind Intersection Alerts</td>
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<tr>
<td>Collision Avoidance Safety Systems</td>
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<tr>
<td>Forward Collision Warning / Emergency Electronic Brake Light</td>
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<tr>
<td>Blind Spot Warning and Lane</td>
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<tr>
<td>Do-Not-Pass Warning</td>
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<td>X</td>
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<tr>
<td>Intersection Movement Assist</td>
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<tr>
<td>Cooperative Adaptive Cruise Control</td>
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<tr>
<td>Automatic access control/parking access</td>
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<td>X</td>
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</table>
2. Importance of Big Data and Analytics
DATA: BIG DATA IS GOLD
3. Applying V2X in Rural and Urban Areas
APPLYING TO RURAL ITS: WILDLIFE DETECTION

Courtesy of Colorado Department of Transportation.
APPLYING TO RURAL ITS: WILDLIFE DETECTION

Safety Notification – I2V Situational Awareness and Environmental to Vehicle Warning
APPLYING TO RURAL ITS: WASHES AND FLOODING IN AZ

Safety Notification – I2V Situational Awareness and Spot Weather Impact Warning (SWIW)*

Courtesy of AZ Family 3 and 5 - Firefighters rescue drivers stranded in flooded Phoenix wash
Safety Notification – I2V Situational Awareness and Spot Weather Impact Warning (SWIW)*

Body Of Man Pulled From Flooded Arizona Wash

By ASSOCIATED PRESS • OCT 5, 2018

Authorities in northwestern Arizona say a man has died after his car was swept into a flooded wash bed.

The Mohave County Sheriff's Office says a rescue helicopter located the body of 34-year-old Joshua Allen Carlisle of Golden Valley on Thursday about 2 miles (3.2 kilometers) from where his vehicle went into the wash during a storm.

Deputies say they had received reports late Wednesday of an SUV becoming submerged.

A water rescue team found the vehicle a little over half a mile (0.8 kilometers) from the road along the wash bank.

In this Tuesday, Oct. 2, 2018 photo provided by the Tohono O`odham Nation Dept. of Public Safety, is flooding near the Maricopa Dam community in Arizona. The southern Arizona dam that had been at risk of breaking and flooding a small village held steadily Wednesday, Oct. 3, as the lake behind it receded after being swollen with runoff from the remnants of Tropical Storm Rosa.

CREDIT TOHON O`ODHAM NATION DEPT. OF PUBLIC SAFETY VIA AP

Workers gather at the edges of a washed out stretch of U.S. 89 near Cameron, Ariz., on Thursday, Oct. 4, 2018. The Arizona Department of Public Safety says a vehicle collision occurred there late Wednesday that killed at least one person. (Coconino County via AP)
APPLYING TO RURAL ITS: HIGH COUNTRY AND SNOW

Safety Notification – I2V Situational Awareness and Spot Weather Impact Warning (SWIW)*
4. Existing Technologies
CURRENT TECHNOLOGIES
DEPLOYMENTS IN THE US

New York City

Tampa Bay

Wyoming

Michigan

Arizona

Denver

Executive Order creating the Institute for Automated Mobility
DEPLOYMENTS IN THE US
5. Prepare with a Plan for Development and Deployment
ESTABLISH A VISION AND PLAN AS A CITY AND REGION

GREATER PHOENIX: A SMART REGION

The Smart Region plan is about intentionally collaborating with regional partners to adopt and scale solutions that transform Greater Phoenix. This transformation brings together diverse stakeholders to enhance quality of life and well-being for all residents.

Meeting of the Minds webinar, "The A to Zs of Arizona’s Quest to Become a Smart City Tech Hub." http://meetingoftheminds.org/cal/the-a-to-zs-of-arizonas-quest-to-become-a-smart-city-tech-hub
IDENTIFY CORRIDOR(S) TO LAUNCH AND DEPLOY TECHNOLOGY

- High volume of driving, traffic, and congestion
- Increase mobility
- Improve public safety
- High arterial corridor with crashes/collisions
- High travel time
- High pedestrian involved crashes/collisions
- High volume of freight trucks
Jennifer Toothaker, City of Tucson - Smart Cities Council City Networks Task Force, “Transportation Networks: Building Intelligent Roadways/ Connected Vehicles”, July 26, 2018
VISUAL EXAMPLE OF DEPLOYED DSRC

Tucson Living Transportation Laboratory, 300 meter (min) DSRC Deployment (approx. 3 miles)

Dr. Larry Head, University of Arizona - Smart Cities Council City Networks Task Force, "Transportation Networks: Building Intelligent Roadways/Connected Vehicles", July 26, 2018
AZ Urban iLabs

A connected network of Innovation Sandbox Districts throughout the Region to design cities of the future and accelerate the development of next generation technology products processes, and services.
WHO’S INVOLVED? INTERGRATE WITH EVERYONE

• Local, Regional, and County Government Partners
• Regional Council Governments Partners
• Community and Industry Partners
• Education and Workforce Development Partners
RESOURCES
COMPLETE YOUR READINESS AND GET INVOLVED!!!

- Be Involved in your local Smart City and Region Plan
- Connected and Automated Vehicles
- Autonomous Vehicles, Self Driving Buses, and Vehicle Fleets
- Education and Workforce Development
- Arrange a Site Visit or Tour of the Test Bed
- Prepare for New Federal Regulations and Standards

- Establish Open Data Policy
- Security and Privacy is IMPORTANT
- Validate and Test
- Knowledge Sharing and Best Practices
- Funding – Grants and Innovation Funds
- Community Involvement
- Community and Industry Partners
- Education and Workforce Development Partners
The Communication Platform

Connected IoT Sensors
- Performs object identification of vehicles, pedestrians, and cyclists
- Integrates with Smart Infrastructure
- Data is collected at intersections using a set of stationary LiDAR (light detection and ranging) sensors

Critical Data and AI
- Lightweight sensor data allows for immediate interpolation of important data points
- Real time, non-sensitive data
- Analyze traffic flow patterns easily with lightweight, critical data

Safer and Smarter Roadways
- Ease traffic congestion
- Improve transportation and public safety
- Communicate advance warnings for alerts and threats in the roadway to vehicles
- Prepare for smart city, connected and automatous vehicle (CAV), and vehicle-to-everything (V2X) readiness
Why LiDAR

- Range
- Data collection rate
- Details
- Field of View
- Width and Height
- 3D Shape
- Object Detection at Long Range
- Pedestrian Identification
- Accuracy
- Read signs and see color
- Night Time
- Fog
- Rain, snow, dust

LiDAR
Radar
Video/Camera
Contact us to establish a testbed program: 303-880-7577 and dkeeton@sensagrate.com

A smart city infrastructure to vehicle (I2V) communication platform

Sensor Technology
- Object detection
- Integrates with Smart Traffic Lights

Critical Data
- Real-time data interpretation
- Non-sensitive data

Safer and Smarter Roadways
- Safer, smarter traffic analytics
- Range up to 200 meters in 360°

Benefits
- Improve roadway safety
- Cloud based communication platform
- Prepare for smart city and automotus vehicle readiness

Testbed Program Opportunity
- Deploy Sensagrate Temporary Ecosystem (STE) Units at strategic intersections
- Mounted or mobile deployment installation
- Testing performed in 30-day increments
- Multiple intersection deployment
- Reporting and metrics on traffic flow health and analysis
Presentation Link

🌐 http://www.sensagrate.com/itsaz2018