Traffic Signals and the Cloud

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A **Smart City** utilizes **innovative and emerging technologies and concepts** to collect, analyze, and utilize data from many sources to enhance the city’s livability.

**Smart City** concepts are easily extrapolated to **Smart Region** concepts.
Traditional ITS

- Highway Cameras
- Radar Detectors
- Intersection Detectors
- Adaptive Traffic Signals
- Variable Message Signs
- Fiber Optics
- Modern Control Centers
Innovative and Emerging Technologies

- Crowdsourced Vehicle Monitoring (WAZE/Google)
- Connected Vehicles (CV) and People
- Real-time Big Data Processing
- Real-time Traffic Signals
- In Vehicle/Personal Messaging
- Real-time Mobile Apps
- Internet of Things (IoT)
Connected/Automated Vehicle Projects

- NJDOT Statewide CV Connectivity & Transit Signal Priority
- PennDOT CV/AV Oncall
- PANYNJ XBL CAV System Engineering
- Tampa CV Pilot & HART Automated Shuttle
- Jacksonville Ultimate Urban Connector (U2C)
- City of Columbus Smart City Challenge
- Florida Turnpike Enterprise Automated Vehicle Proving Ground
- Michigan DOT Connected Vehicle Support Program
- Florida DOT Connected Vehicle Program Support Services
- Tennessee DOT CAV Plan
- U.S. DOT Vehicle-to-Infrastructure (V2I) Reference Implementation
- U.S. DOT DSRC Standards Support
- Florida DOT Transportation Systems Management & Operations Program Support

- Florida DOT Automated Vehicle General Engineering Contract
- U.S. DOT ITS Strategic Plan
- Michigan DOT Truck Parking Information and Management System
- Miami-Dade Expressway Authority Connected Vehicle Program Support
- Central Florida Expressway Authority CAV Plan
- U.S. DOT Connected Vehicle Test Bed Operations Management Support
- Safety Pilot Connected Vehicle Model Deployment
Tampa Connected Vehicle Pilot

- Multi-modal suite of applications collocated at intersections
- Bus, streetcar, vehicle, pedestrians and bikes
- Expressway and arterial streets
SPaT Challenge

32 States Committed
Number of states committed to respond to SPaT Challenge.

216 Signals Operating
Current number of operating signals. Number of signals planned for 2018, 2019, and 2020+.

2,036 Signals Planned

HNTB
FLORIDA CONNECTED VEHICLE PROJECTS AND INITIATIVES

PROJECTS/INITIATIVES

PLANNING

Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies (I-STREET) Gainesville Signal Phase and Timing (SPaT) Trapezium Central Florida Autonomous Vehicle (AV) Proving Ground Driver Assistive Trucking Platooning (DAFP) Pilot

DESIGN/IMPLEMENTATION

I-75 Florida's Regional Advanced Mobility Elements (FRAME) Gainesville I-75 Florida's Regional Advanced Mobility Elements (FRAME) Ocala Florida's Turnpike Enterprise (FTE) SunTrax Gainesville Autobus Tampa Hillsborough Expressway Authority (THEA) Connected Vehicle Pilot City of Orlando Greenway/Pedestrian Safety SR 434 Connected Vehicle Deployment Downtown Tampa Autonomous Transit Orlando Smart Community 2017 ATCMTD

OPERATIONAL

US 90 SPaT Tallahassee Osceola County Connected Vehicle Signals Voyage at The Villages
CV SAFETY BENEFITS

- 94% of the crashes are due to human errors
  - Potential to address majority of these crashes

- Red light violation warning and pedestrian in crosswalk warning
  - Potential to reduce 250,000 crashes and 2,000 fatalities each year

- Curve speed warning
  - Potential to address 169,000 crashes and 5,000 fatalities each year

- Traffic management applications on freeways
  - Can reduce 25% of the incident related crashes

Source: USDOT

Source: Savari
CV MOBILITY BENEFITS

- Combination of signal control applications (TSP, FSP, CV signals)
  - Reduce travel time by 24%

- Incident scene pre-arrival staging guidance
  - Reduce travel time by 23% for emergency responders
  - Reduce number of stops by 15% for emergency responders

Note: TSP = Transit Signal Priority; FSP = Freight Signal Priority
Source: USDOT
CV PROJECT SERVICE PACKAGES

- ARC-IT has more than 100 packages in 12 categories

- **Base Packages**
  - CV Traffic Signal System - TM04
  - Pedestrian and Cyclist Safety - VS12
  - V2V Basic Safety - VS02
  - Drawbridge Management - TM18
  - Transit Signal Priority - PT09
  - Emergency Vehicle Preemption - PS03
  - Freight Signal Priority - CVO06
  - Smart Roadside and Virtual Weigh in Motion (WIM) - CVO08

Source: https://local.iteris.com/arc-it/html/servicepackages/servicepackages-areaspsort.html

Source: Applied Information

Source: Savari
OPPORTUNITIES FOR CONNECTIVITY

- Signal Phase and Timing
  - Eco-Driving
  - Transit Signal Priority
- Safety Applications
  - Intersection Collision Avoidance
  - Queue Warnings
  - Pavement Condition Warnings
  - Work Zone Applications
  - Incident Warnings
- Congestion Reduction
  - Traveler Information
  - Routing and Navigation
  - Location Services
Connected Vehicles and Smart Traffic Lights

Connected Vehicle (V2I)

Traffic Signal Equipped DSRC Radio

Bus with Connected Vehicle Device

Connected Vehicle Applications
- Pedestrian in Signalized Crosswalk Warning (Transit)
- Intersection Movement Assist (IMA)
- Left Turn Assist (LTA)
- Vehicle Turning Right in Front of Bus Warning (Transit)
- Eco-Approach and Departure at Signalized Intersections
- Eco-Traffic Signal Timing
- Eco-Traffic Signal Priority
- Operations Communications

- Dozens of new applications being developed with technology
- Opens doors for BRT funding for Transit Signal Priority Implementation
Connectivity Approaches

• Big Data
  – Uses existing data application to provide large amounts of probe vehicle data
  – Extensive traffic management analysis opportunities

• ATMS Cloud Connectivity
  – Uses existing ATMS to provide data to the cloud
  – Limited effectiveness one way data

• Direct Signal Cloud Connectivity
  – Streams traffic signal data to the cloud for use by the public and other traffic signals
  – Low cost quick deployments with good analytic tools

• DSRC & Cloud
  – Provides direct CV applications to fleet vehicles and offers public access over cellular
  – Provides advantages for fleet and larger data sources
Big Data Device Penetration

Histogram of Device Sample Share of Residents for Tracts in Florida

Device Penetration Rate

# of Tracts with This Device Sample Share
ATMS CENTRALIZED TRAFFIC SIGNAL CLOUD

- Existing infrastructure
- Higher latency
- Secure applications
- TMC Control

LEGEND
- Wireless
- Wired
- Optional
DIRECT TRAFFIC SIGNAL CLOUD CONNECTION

- Direct connect from edge switch or cellular connection
- Mid to low latency
- Non-secure applications

LEGEND

- Ped-Bike
- Controller
- Drawbridge
- Device with Wireless Connection
- Cloud Hosted Environment
- Subscribers
- Application Program Interface (API)
  SPaT/MAP/BSM (SAE J2735)

Wireless

Wired

Optional
DSRC & CLOUD TRAFFIC SIGNAL COMMUNICATION

- Modified infrastructure
- Secure applications
- Very low latency
- TMC Control

Traffic Management Center

ATMS Central Network

Local Intersection

Ped-Bike

Controller

Drawbridge

Cloud Hosted Environment

Subscribers

Device with Wireless Connection

Real-time Operational Data Exchange

OBU Equipped Vehicle

SPaT/MAP/BSM (SAE J2735)

SPaT/MAP/BSM (SAE J2735)

Real-time Operational Data Exchange

Wireless

Wired

Optional

LEGEND

OBU Equipped Vehicle

Freight

Emergency Vehicle

Transit

Dual Band (DSRC and Cellular)
Trade-off Discussion

- Infrastructure/Costs
- TMC Control
- Low latency applications
- Secure applications
- Data quantity

In any case require standard data formats!