DRAFT (2022-11-18)

Florida Automated Vehicle Summit
(December 14-16, 2022)

Bringing the THEA CV Pilot to an End

DECEMBER 16, 2022

HIDEKI HADA, ADVANCED PRODUCT PLANNING OFFICE

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Toyota V2X Products

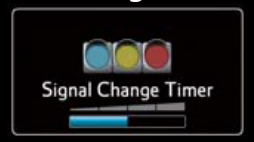
First introduced in 2015, ITS Connect products are adopted in approximately 263,000 vehicles (Japan).

- **V2V and V2I applications**

Emergency Vehicle Notification

Crossing Collision Prevention

Signal Change Advisory



Communicating Radar Cruise Control

Right Turn Collision Caution

Right Turn Collision Caution

- **Available on popular mass-production models.**

https://toyota.jp/technology/safety/itsconnect/
https://global.toyota/en/detail/9676551#:~:text=ITS%20Connect%20uses%20vehicle%2Dto,picked%20up%20by%20onboard%20sensors.

Tampa V2X Project Applications

In Service

Default Screen

System Error

V2V Warnings between V2V Vehicles

FCW

Forward Collision Warning

EEBL

Emergency Electronic Brake Light

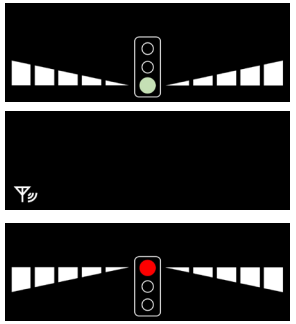
IMA

Intersection Movement Assist

V2I Warning & Information at Signalized Intersection

RLVW

Red Light Violation Warning



Signal Countdown

V2I Warning at Pedestrian Crossing

PCW

Pedestrian in Crosswalk Warning

V2I Warning at the End of Toll Expressway

ERDW

End of Roadway Warning

V2I Warning at Toll Expressway Entry

Wrong Way Entry

No Travel

Wrong Way Vehicle

WWE

Wrong Way Entry

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Toyota Participation

<u>Connected Vehicle Pilot Deployment Phase 4 (Tampa)</u>

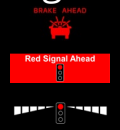
Additional deployment of DSRC vehicles and V2X applications.

- 600 vehicles
  - 400 Brandmotion
  - 200 Honda, Hyundai and Toyota vehicles

Additional application

- V2I Red Light Violation Warning





Deployment started in September 2021

- Joint tests at ACM in May 2021, in Tampa in June & July 2021.

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Tampa V2X Project Applications

2020	2021	2022

Project Agreement

Specification Development

OBU & App Development

OBU Deployment

V2X Operation

Joint Tests ★ ★ ★

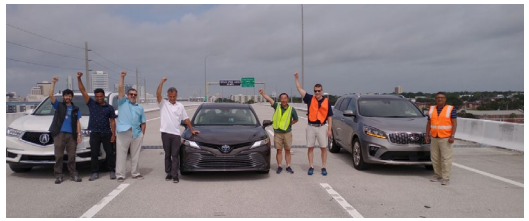
ACM Tampa #1 Tampa #2

Application Development
(Weekly Project Meetings)

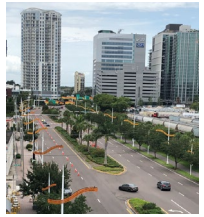
Preliminary Function Checks
(Ann Arbor)

Michigan Joint Test at ACM (May)
(Closed Test Course)

Tampa Joint Tests #1 (June)
(Closed Toll Road Test)

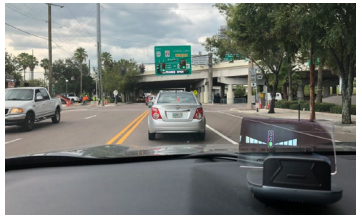


(Closed Public Road)



(Public Road Confirmation)

Tampa Joint Tests #2 (July)
(Public Road Confirmation)



(Closed Toll/Public Roads)

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Lessons Learned

#1: Collaboration - Success

Leadership

Clear Goals

#2: Deployment Focus

Focus on “D” of R&D

#3: Cooperative Challenges

Test Environment

Multiple Stakeholders

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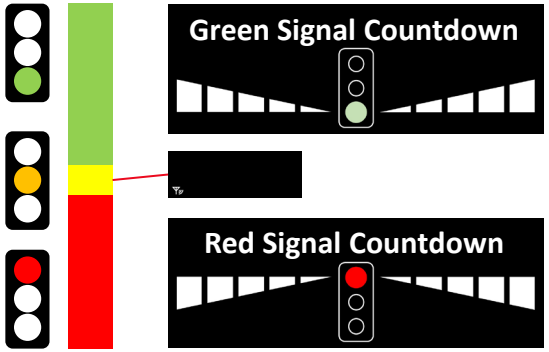
V2X Signal Countdown Evaluation

Field Evaluation

Evaluation using Tampa V2X environment



Evaluation Summary

Do you want this application?

Red Countdown
Yes = 92%

Green Countdown
Yes = 86%

Both Red & Green
Yes = 76%

Speed Advisory for Green
Yes = 84%

Are you satisfied with this application?

Satisfied (≥7pts in a 10pt scale)
Red = 80%
Green = 60%

Does the information change driving?

Safer = 56%
No Change = 40%

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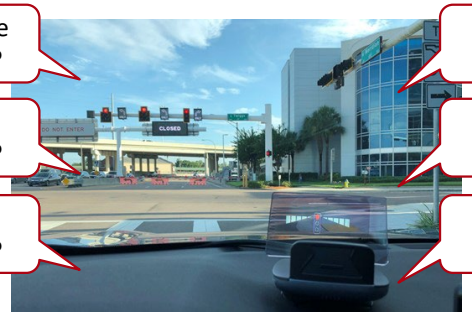
Cooperative System Challenges

Challenges in Root Cause Analysis



Vehicle Issue?

App Issue?

OBU Issue?

RSU Issue?

Signal Issue?

Road Issue?

Consistent Problem?

Only at This Intersection?

Only at Specific Situations?

Common Issue in the Area?

Doe s a Fix Work for All?

Nationwide Issue?

Both technical and organizational efforts are necessary for issue resolutions for each case.

V2X Enabled Vehicle

Vehicle OEM

OBU Supplier

System Supplier

V2X Standard

V2X Signals

RSU Supplier

Traffic Signal

Traffic Signal Supplier

V2X Roadside Unit

Infrastructure Installer

Traffic Signal Controller

Controller Supplier

Road Sensors, Detectors, etc.

Infrastructure Supplier

Road Authority

Trans. Engineering Div.

Trans. Mgmt. Firms

Traffic Mgmt. Center

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Thank You!

- Great Project & People
- Great Outcomes
- Open the Door for the Future

Toyota Motor North America
Research & Development
Advanced Product Planning Office

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Ref.: Toward Ultimate Goals

What is the best solution for the society for the problem we want to solve with V2X?

- Problem: Crashes at signalized intersections
- Solution: V2X is "a" promising solution. We should explore many others, too.

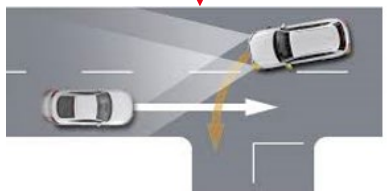
Improve City Design

Traditional Signalized Intersection

Improve Driver Behaviors

V2X Enabled Intersection

Infrastructure Solutions



Vehicle Solutions

Road Design Change

Ref.: Cooperative System Challenges

NTSB
Strong support for V2X for safety

Standards
Already exit

Other Regions
(Deployment Underway: gov't-ind. partnerships)

Japan (2015-)

Europe (2019-)

China (2021?-)

Cloud Alert
(Ex. HAAS Alert)

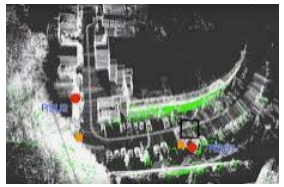
USDOT
Research on cooperative automation
Support V2X under SMART/ATTAIN grants

USA
Still unable to break the wall. Champion nor roadmap unclear.

Cloud Alert
(Ex. Waze)

State DOT
Defend V2X spectrum
Lead & coordinate V2X deployment

Infrastructure & Sensing
Rapid advancement of sensing technologies and data analytics



ADAS / ADS / Data
Rapid advancement of vehicle technologies and data accumulation

Cloud SPaT
(Ex. Traffic Technology Services)