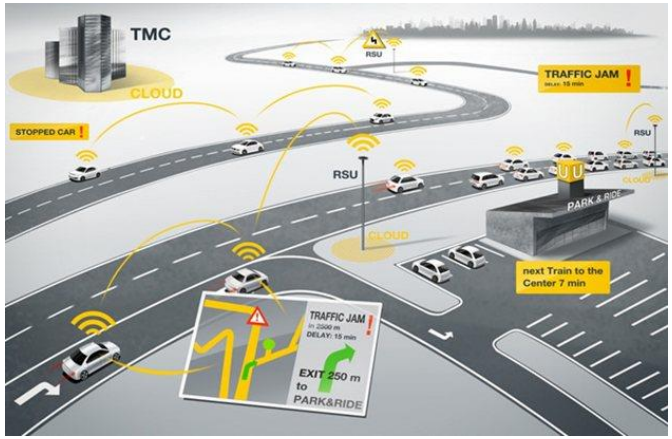
“Connected Vehicles”

October 27, 2015

Tokyo International Exchange Center

Cooperative ITS

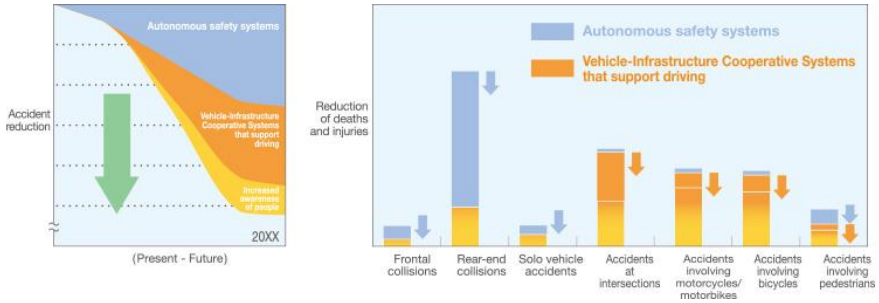
Connecting vehicles, roads and people for safer and better mobility



http://www.kapsch.net/ktc/Portfolio/Intelligent-Mobility-Solutions/Connected-Cars

http://360.here.com/2014/12/10/continental-map-road-future-ces/

http://www.its.dot.gov/landing/cv.htm



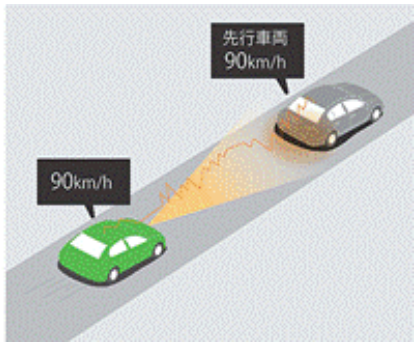
http://www.toyota-global.com/innovation/intelligent_transport_systems/infrastructure/

Connected Vehicles

DSRC V2X vehicle products are now in/near deployment phase

Japan V2X Vehicle Products

http://newsroom.toyota.co.jp/en/detail/9676551/



http://www.toyota-global.com/innovation/intelligent_transport_systems/infrastructure/

Example of display screen

Example of display screen

US V2X Vehicle Products

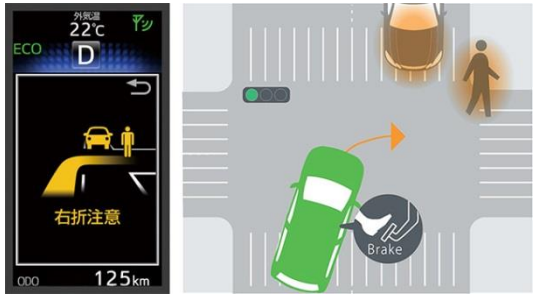
http://media.gm.com/media/us/en/gm/news.detail.print.html/content/Pages/news/us/en/2014/Sep/0907-its-overview.html

US DOT NHTSA issued an Advanced Notice of Proposed Rulemaking (ANPM) in August 2014 proposing mandatory installation of 5.9GHz V2V DSRC on light vehicles. They are aiming to issue NPRM (draft regulation) by mid 2016.

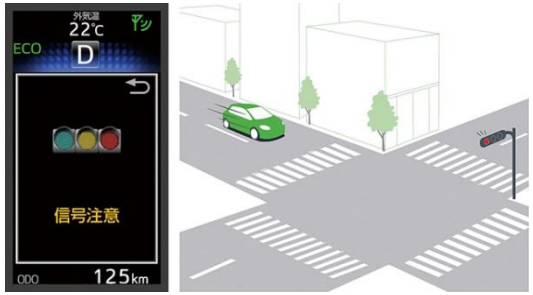
Connected Vehicles

DSRC V2X enables various cooperative applications

Right-Turn Collision Caution

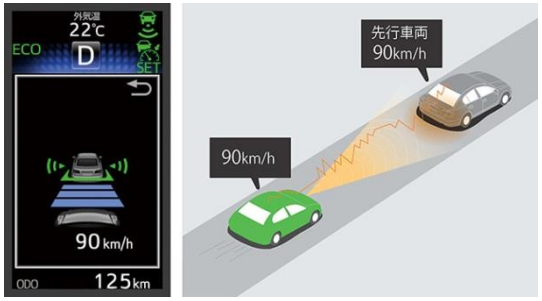


Red Light Caution

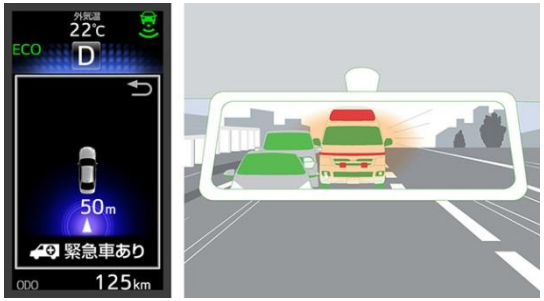


Signal Change Advisory

Communicating Radar Cruise Control



Emergency Vehicle Notification



Roadside Unit

http://newsroom.toyota.co.jp/en/detail/9676551/

Connected Infrastructure

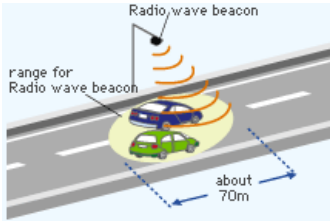
DSRC V2X infrastructure is now in/near deployment phase

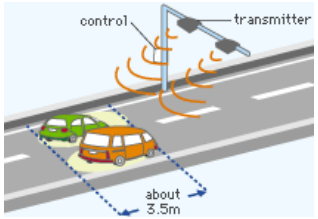
Japan - ITS Spot (2011-)

http://www.mlit.go.jp/road/ITS/j-html/spot_dsrc/tenkai.html

Japan – VICS (1996-)

http://www.vics.or.jp/en/vics/beacon.html





European C-ITS Corridor

https://www.bmvi.de/SharedDocs/EN/Anlagen/VerkehrUndMobilitaet/Strasse/cooperative-its-corridor.pdf?__blob=publicationFile

http://www.eco-at.info/project-description.html

DAIMLER

BOSCH
Technik fürs Leben

Continental

Connected Infrastructure

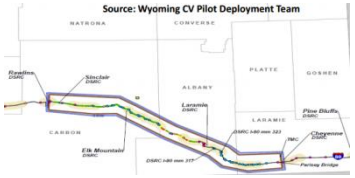
Several V2X infrastructure deployment projects are planned/underway in USA.

Southeast Michigan Connected Corridor

Operational in 2016

http://www.michigan.gov/documents/mdot/I-696_96_Corridor_Map_467821_7.pdf

FHWA Connected Vehicle Pilot Deployment



Wyoming

New York City

Tampa, FL

http://www.its.dot.gov/press/2015/ngv_tech_announcement.htm#sthash.InjpYhP7.dpuf

Virginia Connected Corridor

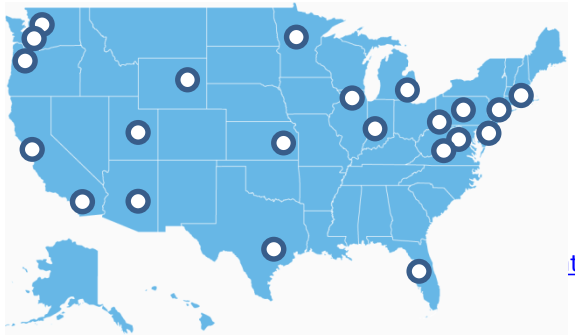
Northern Virginia I-66 Freeway

ttp://www.dmv.virginia.gov/vatransportationconference/presentations/thursday/session5a/kilpatrick.pdf

V2I Deployment Coalition

U.S. Department of Transportation Federal Highway Administration | AASHTO | ITS America | ite

http://www.nationalruralitsconference.org/wp-content/uploads/2015/08/Legg_D2.pdf

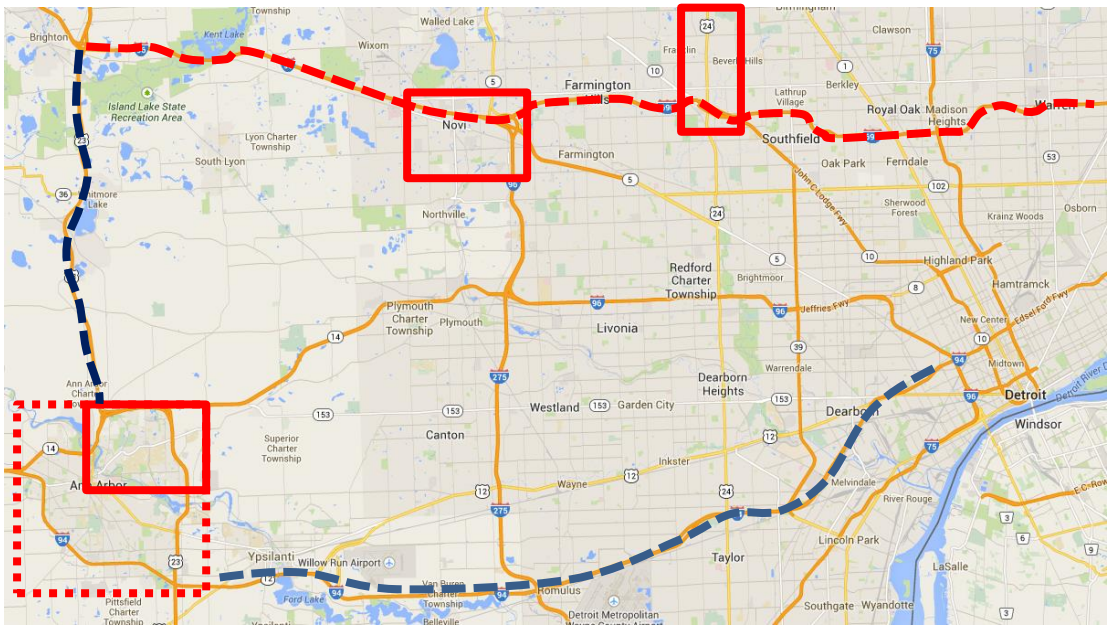


Connected Infrastructure

Michigan is a leading state for DSRC V2X deployment.

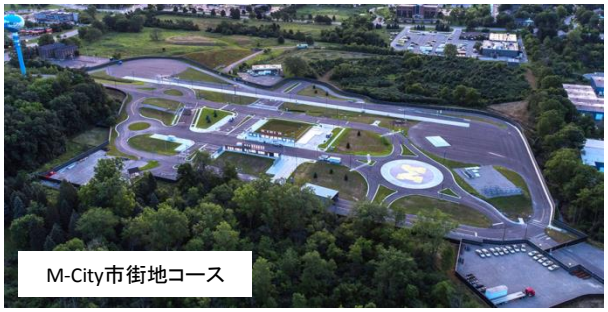
Michigan Mobility Transformation Center (MTC) Initiative

- Deployment of DSRC V2V vehicles & V2I infrastructure
- Creation of connected & automated test fields



Connected Ann Arbor (9000 DSRC vehicles)

Connected Southeast Michigan (20,000 DSRC vehicles)

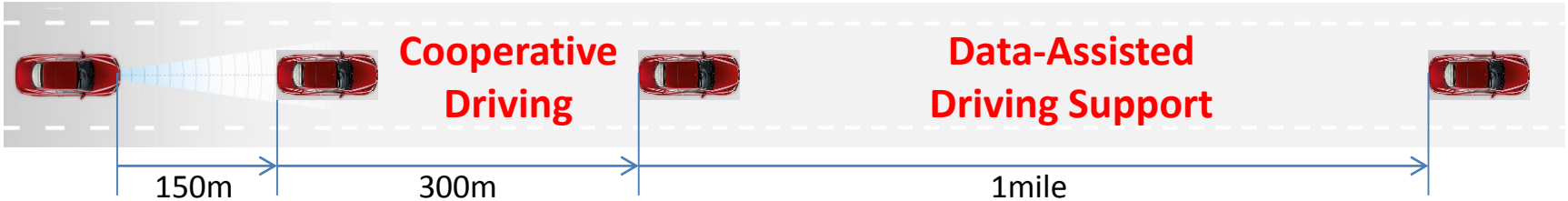


http://www.michigan.gov/documents/msp/Connected_Vehicles__Autonomous_trucks_-Castle_485666_7.pdf

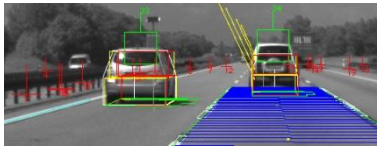
http://www.its.dot.gov/testbed/PDF/March_AffiliatedTestBeds_Newsletter.pdf

Next Opportunities

V2X opens up opportunities for cooperative and data-assisted driving.



PCS, FCW, LDA, ACC, LTC
Collision Avoidance/Mitigation
Automated Driving Assist

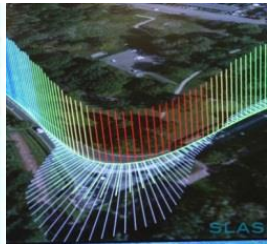


Competition Phase

V2V & V2I
Early Alert
Cooperative Driving

Product Development Phase

Data Accumulation & Sharing
Incident Reporting & Sharing (Cellular)
Hazard Notification, Data-Assisted & Automated Driving



Technology Development Phase

Michigan MTC

Mobility Transformation Center

The University of Michigan initiative to promote research and deployment of “automated,” “connected” and “connected & automated” technologies.

Corporate Partners

Government Partners

Michigan Department of Transportation

ECONOMIC DEVELOPMENT CORPORATION

University Divisions

Engineering, Transportation Research, Business, Urban Planning, Law, Information, Public Policy, Medical, Energy Institute, etc.

http://www.mtc.umich.edu/

University of Michigan, M-City

City test course for connected and automated R&D projects

<u>Operated by the University of Michigan MTC</u>

Designed to simulate various road scenes:

- Pavement, Intersections, roundabout, number of lanes, lane markings, tunnel, trees, buildings, roadside objects, signs, traffic signals, etc.

http://www.mtc.umich.edu/test-facility

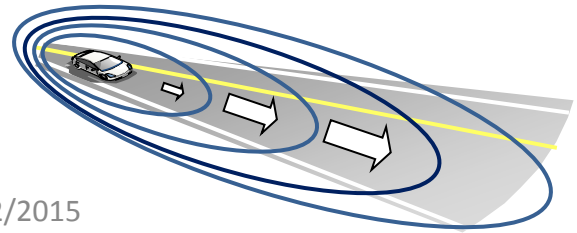
Next – V2V Safety

DSRC has two advantages: longer range and wide angle

Extended Forward Collision Alert

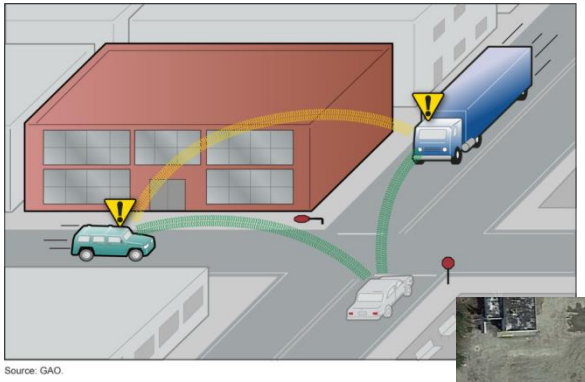
Prevent/mitigate end-of-traffic-jam rear end crashes
“150 Car Pile-Up on Michigan Highway I-94”
https://www.youtube.com/watch?v=W9fI5M6_XVk

Drivers could not see stopped vehicles until last seconds because of heavy snow.



Intersection Movement Assist

Inform the driver about existence of an approaching vehicle on a crossing road
http://www.nhtsa.gov/staticfiles/rulemaking/pdf/V2V/Readiness-of-V2V-Technology-for-Application-812014.pdf



Intersection with most crashes in Southeast Michigan
--- Good visibility
http://semcog.org/Data-and-Maps

Next – V2I Safety

Communication with infrastructure systems advanced vehicle applications

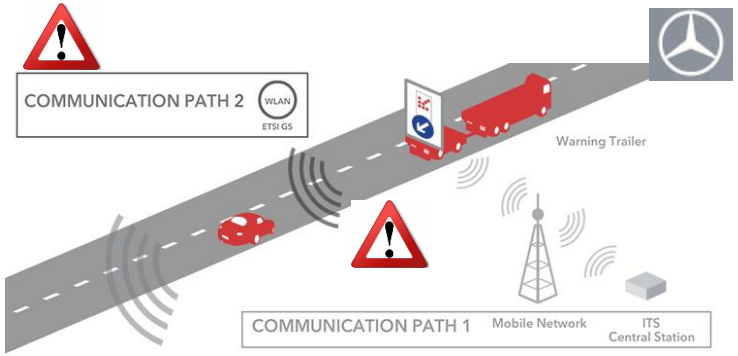
Traffic Signal Phase Display (BMW)

Traffic Signal Phase (Control Server)

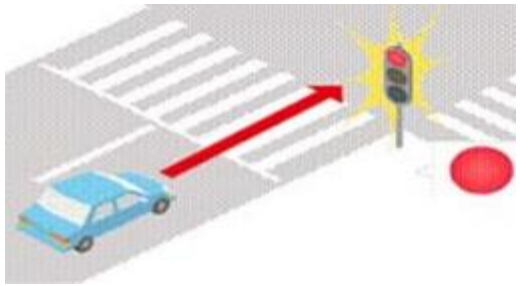
iPhone Android

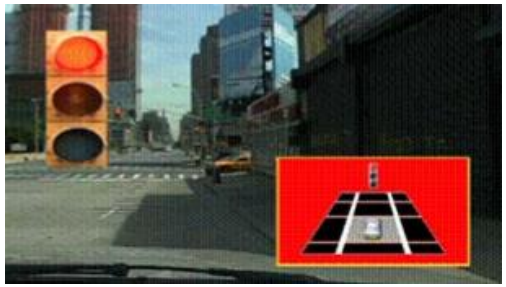
In-Vehicle Display (Signal Wait Time)

V2X Incident Notification (Mercedes)



V2I Signal Violation Warning



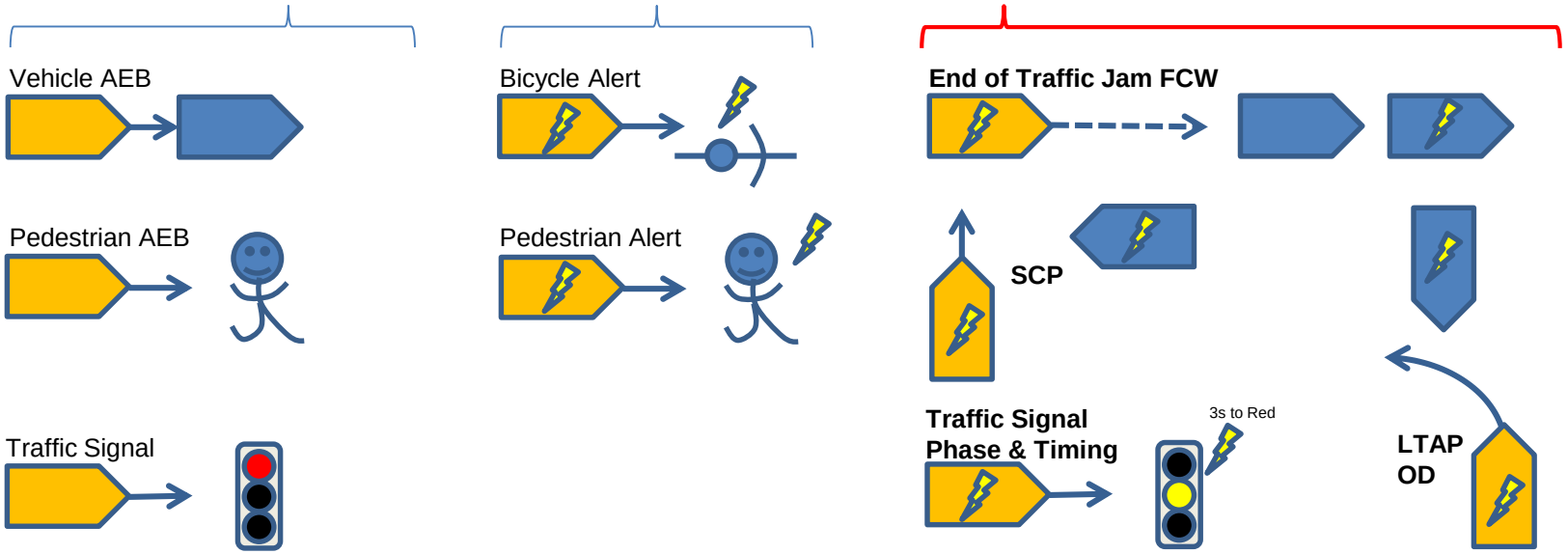


http://www.toyota.com/csrc/printable/9Hada.pdf

Next – Safety & Media

Other wireless media may complements DSRC V2X

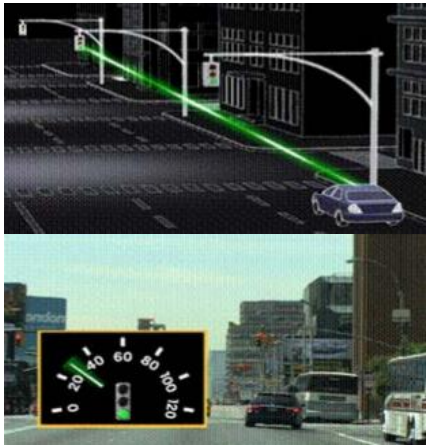
	On-Board (Ex. Radar/Camera)	**Mobile V2X** (Ex. TD LTE Direct)	**DSRC** (5.9GHz V2X)	**Cellular V2X** (Ex. 3G/4G)
Technology	Detection	Device-to-Device	V2V and V2I	Vehicle-to-Server
Target	Vehicle, Pedestrian, Bicyclist, Sign/Signal	Pedestrian, Bicyclist, POI	Vehicle, Infrastructure (Signal Phase)	Location, Map, Traffic, POI, etc.



Next – V2I Eco

FHWA Glide Path project demonstrates V2I eco opportunity

Toyota V2I Green Wave 2008



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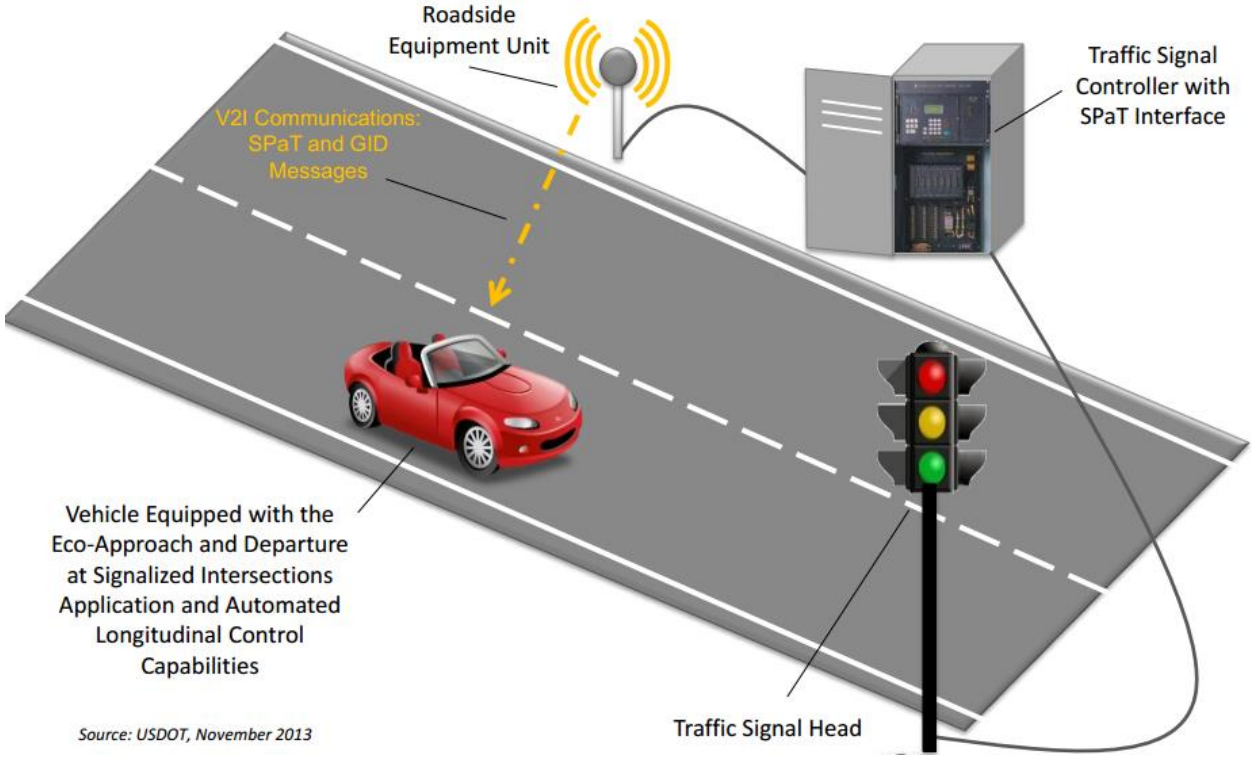
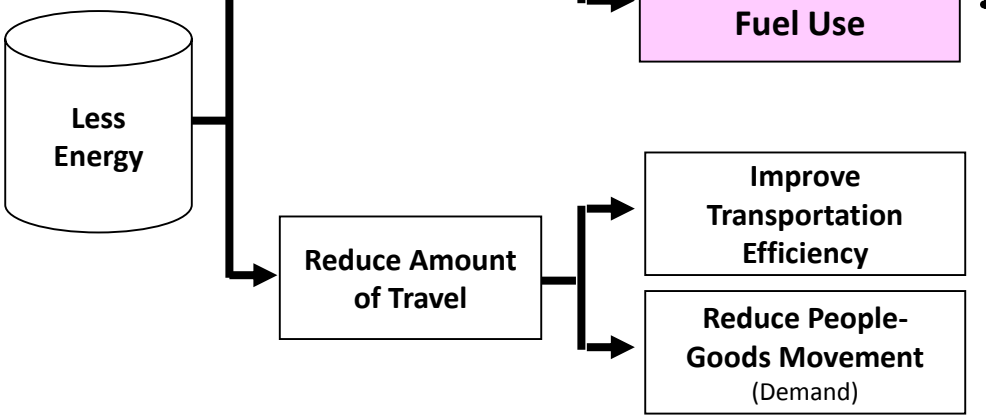


http://its.dot.gov/aeris/pdf/07_FHWAsGlidePathProject.pdf

Next – V2X Eco

V2X can be used to improve energy efficiency



Improve Way of Driving

Eco Drive & Idle Stop (15%)

Drive Control Support

- **V-I Cooperative (18%)**
- **V-V Cooperative (23%)**
- **Platooning (15%)**

Remove Bottlenecks

Improve Signal Management

- Probe Data for Signals (0.4%)
- Coordinated Signals (2%)

Sag Support (*1)

Merge Support (*1)

Full Utilization of Road Capacity

Improved Rouge Guidance (1.6-14%)

Travel Time Shift based on Probe (0.1-15.2%)

Parking Availability

Incident Detection & Response

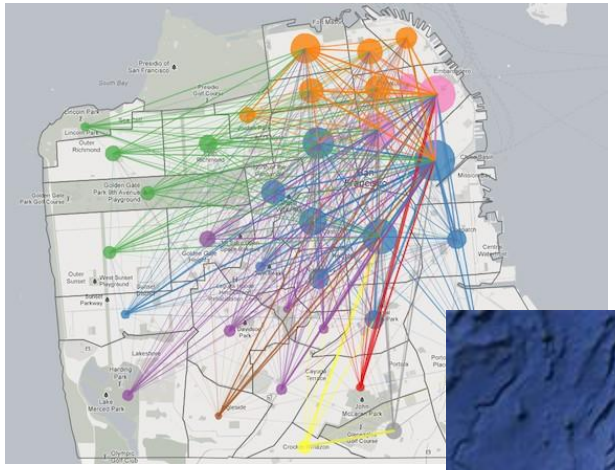
http://www.jari.or.jp/resource/pdf/O13_its/energyITS.pdf

Next – Big Data

V2X creates a new path for data and information

Travel Patterns

http://newsroom.uber.com/sf/2012/01/uberdata-san-franciscomics/

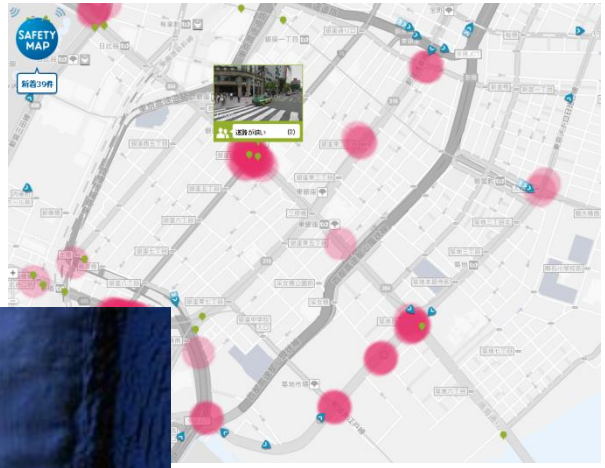


Post-Disaster Drive-able Roads

http://www.honda.co.jp/internavi/awards/

Safety Map

http://safetymap.jp/

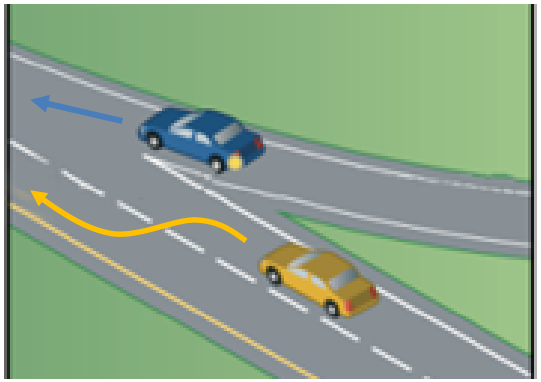


Next – Connected & Automated

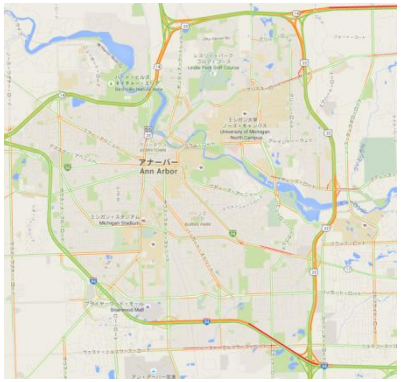
Connected + Automated = Connected & Automated Vehicles (CAV)

CAV driving to maximize safety and comfort of a groups of cars

(Eco-Safety, instead of Ego-Safety)



CAV driving to improve traffic flow by reducing speed fluctuations caused by human drivers



CAV + Ride Share?