Real-World Environmental Applications

Moving AERIS Forward

- The AERIS Research Program considered a 20-30 year planning horizon researching applications that support a more sustainable relationship between transportation and the environment chiefly through fuel use reductions and resulting emissions reductions
  - The program's emphasis was on modeling and analysis of applications that do not exist today
  - ConOps were developed to facilitate modeling and analysis of the applications
  - Limited emphasis on prototyping – although one application was identified as a near-term application and is being prototyped now

- Some applications defined and modeled are better candidates for near-term deployment than others (e.g., Eco-Approach and Departure versus Eco-Cooperative Adaptive Cruise Control)

Moving AERIS Forward

- Now that we've discussed the potential for connected vehicle environmental applications, the next step is to move from the theoretical to physical world (i.e., begin discussions on how to move from research to deployment)

- **Key Question for Today:** If we take a step back, what can be done in the near-term to address environmental challenges using connected vehicle technologies?

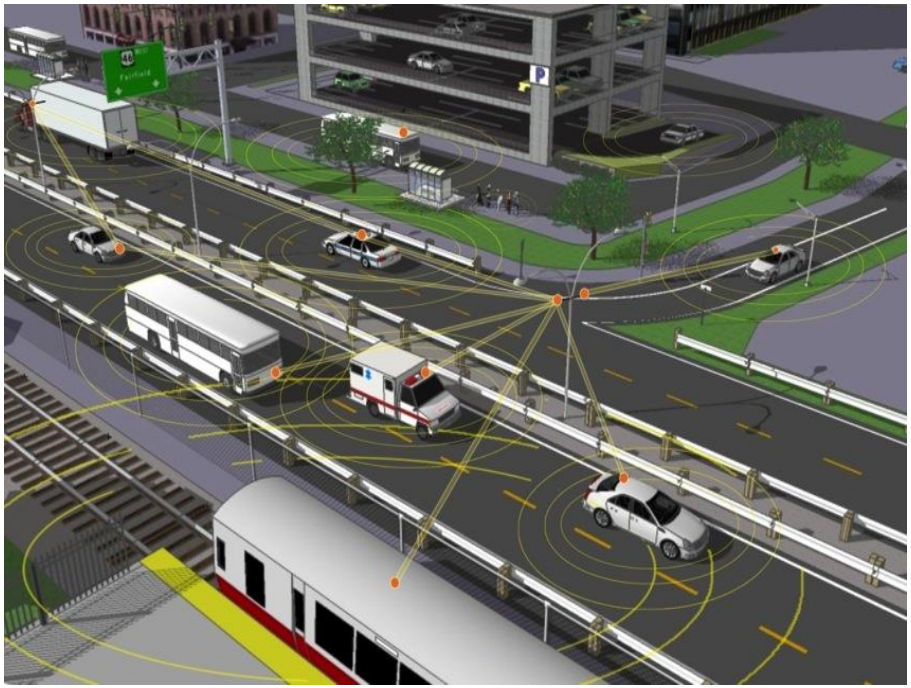
  - In thinking how we move forward with near-term deployments, we should not limit our thinking to applications defined by the AERIS program – but think about how connected vehicle applications of all types can be incorporated into our existing transportation system

  - Near term applications may or may not correspond to AERIS applications specifically; however for today's discussion they applications should leverage technology in addressing environmental challenges

Transitioning to Connected Vehicles

Today's Intelligent Transportation Systems

Next Generation of Transportation



In the near-term, how can we leverage existing ITS deployments and connected vehicle technologies to reduce congestion, improve safety, and reduce transportation's negative impact on the environment?

Tour of the World: Environmental Applications

J.D. Schneeberger, Noblis

Tour of the World: Environmental Applications

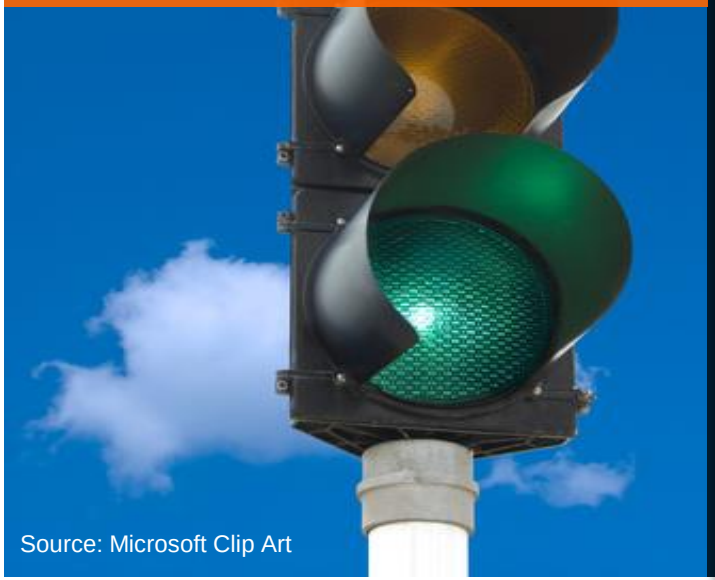
Before Take-Off

- There are several examples of applications deployed to reduce vehicular emissions and fuel consumption
- This presentation summarizes a handful of applications the AERIS research team learned about through discussions with the stakeholder community, research papers, and articles published on the web or in magazines
- There may be applications or research discussed in this presentation that workshop participants may have been involved in or have been deployed in the jurisdictions they represent
- If there are any inconsistencies in the application descriptions or if you have updated benefits data, please let us know

Traffic Signal Operations

Opportunities with Connected Vehicle Technologies

- Leverage connected vehicle technologies to enhance traffic signal priority applications and adaptive signal control systems
- Obtain additional environmental benefits by supporting Eco-Approach and Departure applications



Source: Microsoft Clip Art

Traffic Signal Operations

- **The Metropolitan Transportation Commission's Program for Arterial System Synchronization[1]**
  - 2011 outcomes of the first funding cycle (13 projects involving 339 traffic signal locations)
  - Fuel consumption savings of 14 percent or more than 9.87 million gallons
  - CO emissions reductions of 519.42 tons
  - Oxides of nitrogen (NO_x) emissions reductions of 94.19 tons
- **"Green Light for Clean Air"[2]**
  - Germany deployed an environmental-oriented traffic control system in Potsdam. The system takes in traffic volumes and also factors in the current nitrogen dioxide (NO_2) levels.
  - Whenever the NO_2 is too high in the city, selected traffic signals respond with extended red phases, slowing down vehicle access to critical areas.
  - DMS inform drivers of increased pollution levels.

1. Metropolitan Transportation Commission (MTC): http://www.mtc.ca.gov/services/arterial_operations/downloads/PASS/Summary_with_all_Project_ Fact_Sheets.pdf
2. Siemens: www.siemens.com/mobility

Speed Reductions and Speed Harmonization

Opportunities with Connected Vehicle Technologies

- Enhance traffic data collection using connected vehicle probe data
- Provide speed limit information to drivers improving compliance (connected automation opportunities)
- Introduce variable eco-speed limits on "Code Red Air Quality Days"

Source: Carolina Burnier, Noblis

Speed Harmonization

- Research from the University of Texas at Austin found that reducing speed limits on a freeway from 65 mph to 55 mph on a "Code Red Air Quality Day" resulted in a 17 percent reduction in NO_x over a 24 hour period[1]
- In The Netherlands, local traffic emission reductions of NO_x were in the 20 to 30 percent range and PM_{10} were reduced by approximately 10 percent[2]
- In the UK, speed harmonization reduced vehicle emissions between 4 and 10 percent depending on the pollutant, and fuel consumption was also reduced by 4 percent[2]

1. Wang, Z., & Walton, C. M. (2006). An Investigation on the Environmental Benefits of a Variable Speed Control Strategy. Springfield: National Technical Information Service.
2. Synthesis of Active Traffic Management Experiences in Europe and the United States: http://ops.fhwa.dot.gov/publications/fhwahop10031/sec3.htm

Cooperative Adaptive Cruise Control (CACC)

Cooperative Adaptive Cruise Control (CACC)

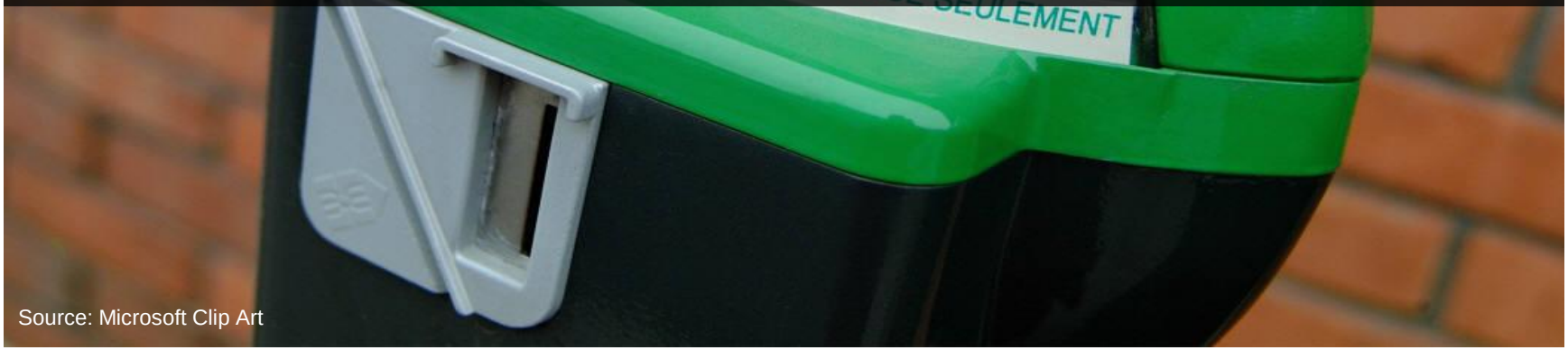
- Safe Road Trains for the Environment (SARTRE)[1]
  - The concept includes a group of vehicles driving together with a lead vehicle, driven normally by a trained professional driver, and several following vehicles driven automatically by the system with small longitudinal gaps between them
  - CACC minimizes unnecessary accelerations and decelerations saving fuel and reducing CO_2 and other emissions
  - Following vehicles fuel savings ranged from 15 percent at a 7 meter gap to just over 4 percent at a 15 meter gap

1. SARTRE Final Report: http://www.sartre-project.eu/en/publications/Documents/SARTRE_Final-Report.pdf

Smart Parking

Smart Parking

- **30% of automobile traffic in business districts is attributable to drivers driving around, waiting for street-side parking**
  - 950,000 excess vehicle miles per 15 block area per year
  - 47,000 gallons of wasted fuel
  - 730 tons of carbon dioxide (CO_2)
- **Madrid, Spain Smart Parking Meters[1]**
  - After pulling into a parking space, drivers are prompted to enter their license plate number on a keypad on the meter, which is networked into a vehicle-registration database
  - Hybrids and other newer, fuel-efficient cars get a discount of up to 20 percent, while older vehicles and diesel-powered models pay a surcharge of as much as 20 percent



Source: Microsoft Clip Art

1. Bloomberg Businessweek: http://www.businessweek.com/articles/2014-06-30/these-parking-meters-know-if-youre-driving-a-gas-guzzler

Tesla and its Smartphone App

Tesla's Smartphone App

- The cars have a persistent internet connection – through AT&T in the US, and other carriers abroad. This allows for built in internet radio, software updates, remote diagnostics, and support for their smartphone app

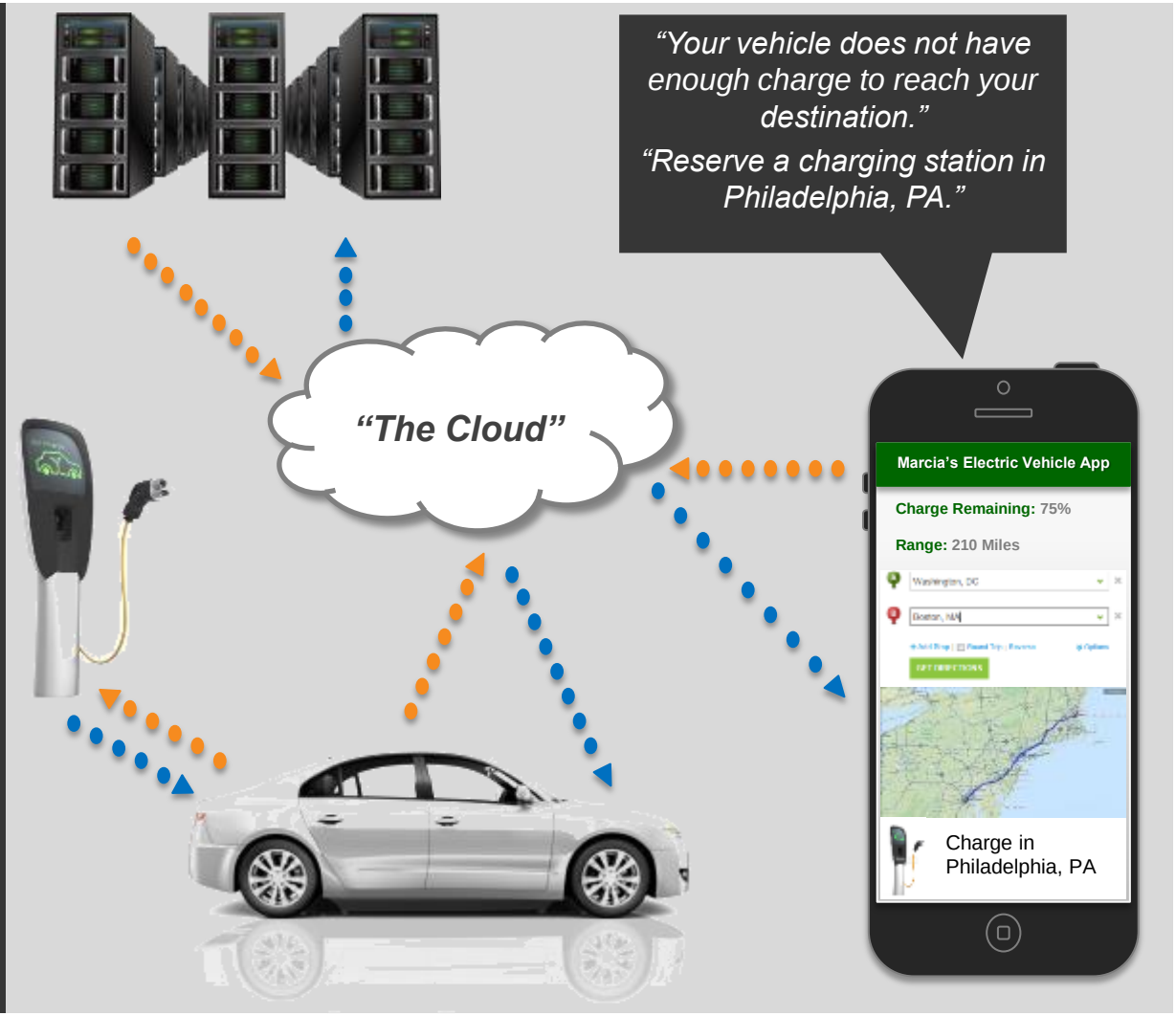
- The apps allows for drivers to control their cars in 4 major ways over the internet:
  - View and control the charge
  - Geo-track it in real time with speed and direction
  - Remotely control locks, sunroof, horn and lights
  - Adjust the interior temperature

These functions can be done from almost anywhere

Electric Vehicle Charging Information

Charging Information

- Electric vehicle charging information applications can inform travelers of the vehicle's range
- Applications can inform travelers of **locations and the availability of charging stations**
- Applications may allow drivers to **make reservations** to use charging stations before they start their trip or while en-route
- Electronic payment cards—or applications on smart phones—may also be used to support the **payment at charging and fueling stations**



Catenary Systems

eHighway

- The South Coast Air Quality Management District (SCAQMD) is planning to install an eHighway system in the proximity of the Ports of Los Angeles and Long Beach, the two largest ports in the U.S.
- eHighway is the electrification of select highway lanes via a catenary system which supplies trucks with electric power, similar to how modern day trolleys or streetcars are powered on many city streets, while still offering the same flexibility as diesel trucks
- The expected result is lower fossil fuel consumption, substantially reduced smog-forming, toxic and CO_2 emissions, and lower operating costs

Opportunities with Connected Vehicle Technologies

- Dedicated freeway lanes – similar to other kinds of managed lanes – optimized for the environment by encouraging use from vehicles operating in eco-friendly ways
- Support Eco-Speed Harmonization, Eco-Cooperative Adaptive Cruise Control, and in-motion Wireless Power Transfer (WPT)

1. Siemens eHighway: http://www.mobility.siemens.com/mobility/global/en/interurban-mobility/road-solutions/electric-powered-hgv-traffic-ehighway/pages/electric-powered-hgv-traffic-ehighway.aspx

Wireless Power Transfer

Wireless Power Transfer

- **Qualcomm Halo' London Trial**
  - The trial includes a combination of passenger cars and light good vehicles and will be based partially in Tech City in the East of London
  - The objective of the trial is to allow partners to better understand how wireless power transfer can be deployed in a mega city environment like London and to gain feedback from drivers on their experience of wireless charging
  - Car share services and taxis are good candidates for testing

EUROPEAN COMMISSION

FABRIC[1]

- Four year, €9 million ($11.3M) project to address the technological feasibility, economic viability and socio-environmental sustainability of dynamic on-road charging of electric vehicles

- **Utah State University (USU)[2]**
  - Recently began construction on a state-of-the-art facility that will include an electrified track, a quarter mile long oval, that will be used to demonstrate the effectiveness of wireless power charging – including in-motion wireless charging

1. FABRIC: http://www.egvi.eu/projectslist/102/37/FABRIC
2. Utah State University Breaks Ground on Electric Vehicle Test Facility: http://www.govtech.com/transportation/Utah-University-Breaks-Ground-on-Electric-Vehicle-Test-Facility.html

Eco-Driving

Eco-Driving

- **Eco-Driver: European Commission**
  - Targets a 20% reduction of CO_2 emissions and fuel consumption in road transport by encouraging the adoption of green driving behavior
  - Drivers receive eco-driving recommendations and feedback adapted to them and to their vehicle characteristics
- **Eco-Routing**
  - University at Buffalo researchers found that green routing could reduce overall emissions of carbon monoxide by 27 percent for drivers, while increasing the length of trips by an average of just 11 percent
  - Rerouting just one fifth of drivers—those who would benefit most from a new path—reduced regional emissions by about 20 percent

1. EcoDriver: http://www.ecodriver-project.eu/
2. Edmunds Auto Observer: http://www.edmunds.com/autoobserver-archive/2011/10/eco-driving-may-boost-truck-fuel-economy-by-22.html

Eco-Driving and Gamification

Eco-Driving and Gamification

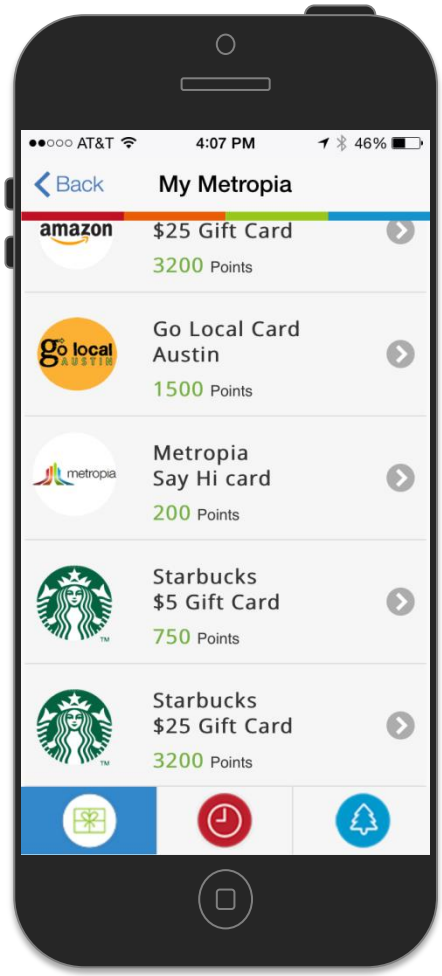
- Dash, a Manhattan-based startup, signed a deal with the NYCDOT to install its data tracking-and-analysis technology in up to 500 NYC volunteers' automobiles as part of a year-long pilot program called DriveSmart, funded by a $1 million federal grant and overseen by the city DOT
  - The app scores a driver based on his or her mobility choices and behaviors behind the wheel
  - Dash allows you to share driving information with friends and on social networks on a competitive leaderboard

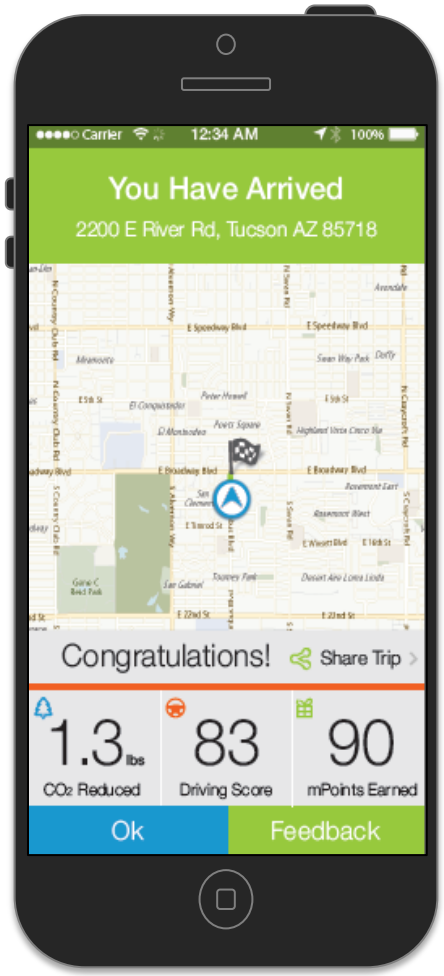
Gamification and Incentives

Source: The "Metropia" APP is unveiled in Austin - to ease congestion: http://www.newsradioklbj.com/news/austin-local-news/metropia-app-unveiled-austin-ease-congestion

Gamification and Incentives

Metropia: Earning Points can be exchanged for local rewards or to plant trees





Environmental Data Collection

Chicago Sensor Project[1]

- The city is deploying sensors attached to traffic poles that will stream a variety of environmental data to the city's open data portal
- Minute-by-minute measurements of temperature, humidity, light, sound, barometric pressure and air quality, will be shared with researchers and the general public in real time
- The sensors will also estimate pedestrian traffic on the sidewalks by counting the number of smartphones in the area

Portable Pollution Sensors[2]

- The University of California, San Diego built a portable pollution sensor that transmits air quality readings to smart phones, allowing users to monitor air quality in real time
- The user interface displays the sensor's readings on a smart phone by using a color-coded scale for air quality based on the EPA's air quality ratings, from green (good) to purple (hazardous)

Opportunities with Connected Vehicle Technologies

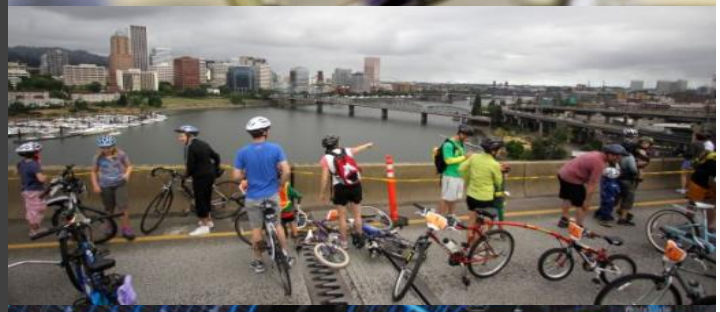
- Real-time fuel consumption and emissions data is collected to monitor vehicular emissions

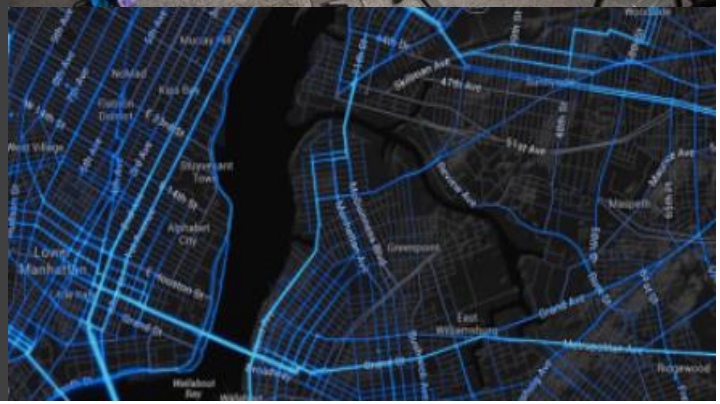
1. Chicago: Chicago Sensor Project: http://www.govtech.com/data/Chicago-Sensor-Project-Will-Measure-Pedestrian-Traffic-Air-Quality-Data.html
2. Portable sensors enable monitoring of pollution on smart phones; inferring pollution maps with greater granularity: http://www.greencarcongress.com/2012/12/citisense-20121219.html

B2I and P2I Applications

Leveraging Fitness Apps[1]

- Strava, a popular fitness-tracking app for runners and cyclists, is now selling its data to local governments allowing city planners to put the data to use
  - Oregon's Department of Transportation is using the data in hopes that it might help figure out how to handle the steadily increasing bike traffic in cities like Portland
  - London, Glasgow, and Orlando have all signed agreements with Strava
- The aggregate data these sensors pick up can be used by governments to learn about the citizens' behavior and, from that, governments can plan better
- These types of apps may also be used by bike share service providers to manage their operations (e.g., identify patterns and track bikes)





1. Why a Fitness-Tracking App Is Selling Its Data to City Planners: http://gizmodo.com/why-a-fitness-tracking-app-is-selling-its-data-to-city-1572964149

Low Emissions Zones

Low Emissions Zones

- London has the largest Low Emissions Zones in the world covering almost all of greater London, targeting emissions from older diesel-engine lorries, buses, coaches, vans, minibuses and other heavy vehicles
- The cities objectives are to:
  - Reduce air pollutants (NO_2) and CO_2 emissions
  - Promote sustainable travel
  - Stimulate the low emission vehicle market
- The Mayor of London recently announced the intention to create an ultra low emissions zone where almost all the vehicles running during working hours are either zero or low emissions vehicles
- Low emissions zones are also currently in operation or being planned in Germany, Sweden, the Netherlands, Denmark, Italy, and Japan

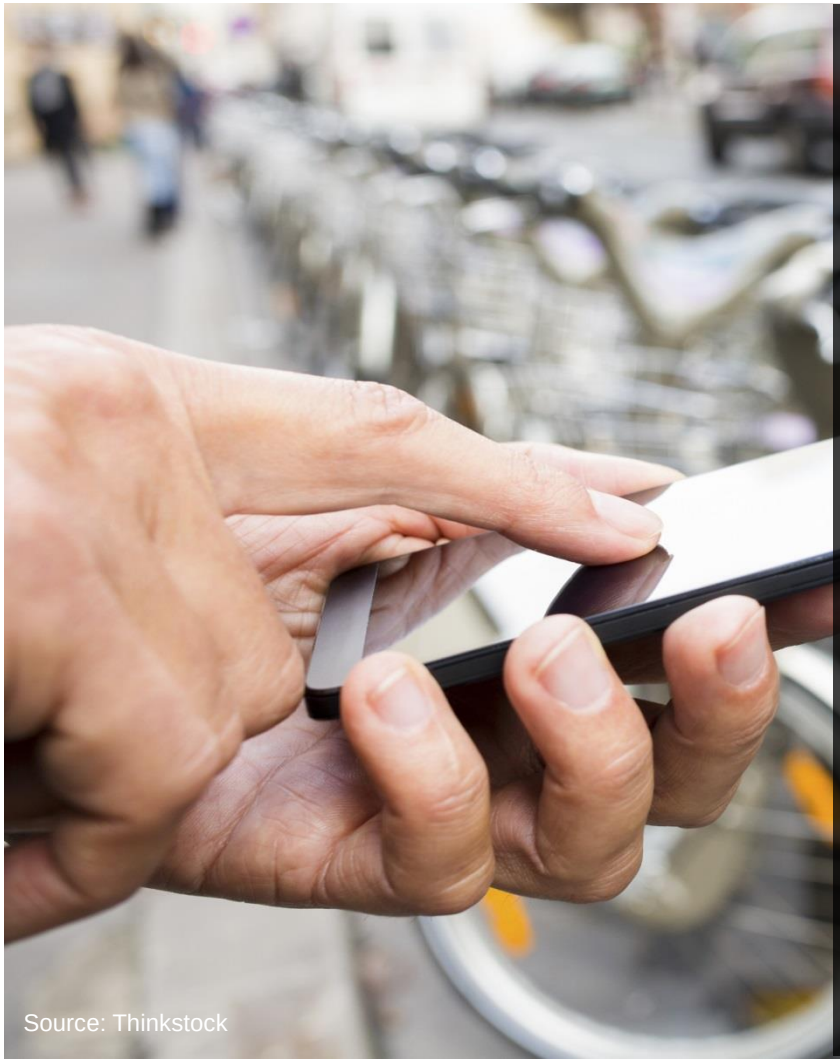
Opportunities with Connected Vehicle Technologies

- Support Low Emissions Zones operations
- Allow for real-time data collection
- Allow for traffic responsive operations during Code Red Air Quality Days and special events

Source: Microsoft Clip Art

1. Ultra Low Emission Zone (ULEZ), Michele Dix: http://cleanairinlondon.org/wp-content/uploads/CAL-264-TfL-FINAL-ULEZ-Stakeholder-event-MD-slides-STATIC-141113.pdf

Shared Use Mobility


Source: Thinkstock

Shared Use Mobility

- Mobility services that are shared among users including:
  - Traditional public transportation services, such as buses and trains
  - Taxis and limos
  - Ridesharing (e.g., car pooling, vanpooling, and real time ridesharing services)
  - Car sharing (e.g., round-trip, one-way, and personal vehicle sharing)
  - Transportation Network Companies or a company that uses an online-enabled platform to connect passengers with drivers
  - Bike sharing
  - Scooter sharing
  - Shuttle services

Evolving technology have made sharing assets easier and more efficient

On-Demand Public Transportation

Source: www.wired.com

Source: The New York Times

Kutsuplus (Helsinki, Finland)

- Designed for maximum flexibility
  - Scheduling is computer automated — riders choose their own route and summon a trip with a smartphone
  - Riders decide on a start and end point, and may choose whether to share a journey or take a private trip
- More expensive than the bus fare, but less than an expensive Helsinki taxi

Bridj (Boston, MA)

- "Pop up" bus service, with routes dictated by millions of bits of data that show where people are and where they need to go
- Collects data about people's commutes from Google Earth, Facebook, Foursquare, Twitter, LinkedIn, the census, municipal records and other sources to determine routes
- A complement to existing transit and subway service

Thank You!