



# **Connected Cities Research Program**

**Intelligent Transportation Systems Joint Program Office (ITS JPO)  
U.S. Department of Transportation**

Road Weather Management Virtual Stakeholder Meeting

Marcia Pincus  
Connected Cities Program Manager

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# *Smart City*

**“A city that uses information and communications technology (ICT) to enhance its livability, workability, and sustainability.”**

*The Smart Cities Council*

# Digging a Bit Deeper – The Evolution from “Smart” to “Connected” (a Suggestion)

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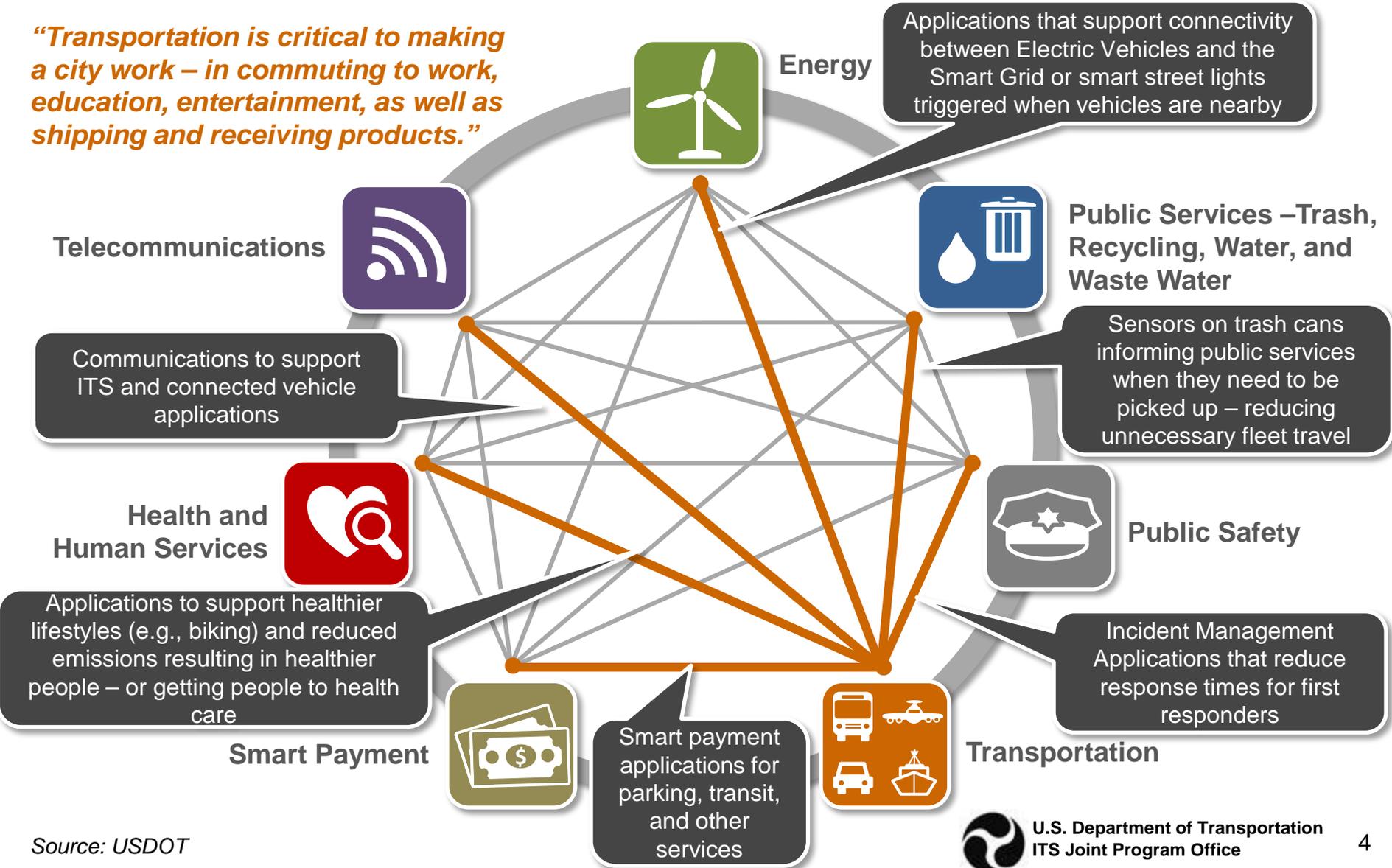
- All critical city systems—transportation, energy, public services, public safety, health care, public safety, telecommunications and others—are capable of communicating with each other to allow coordination and improve efficiency, and capable of generating, transmitting and processing data about all sorts of activities within the city.
- **If** a “connected city” is a system of connected systems that use ICT to communicate with and leverage themselves/each other to improve vital city operations,
- **Then** the ITS JPO’s Connected Cities Research Program is designed to examine the opportunities created where these systems have points of interface with transport and mobility.
  - In other words, where the **connected city, the connected citizen and the connected vehicle meet** and interact.

***The Connected Cities Research Program seeks to maximize and leverage the benefits of connected transportation by integrating those transport services/vehicles and related technologies and data with other data enabled innovations in a city***



# Example Components of a Connected City

*“Transportation is critical to making a city work – in commuting to work, education, entertainment, as well as shipping and receiving products.”*



# What Makes a Connected City: Some Thoughts

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## 1. Connected Vehicles

- Connected vehicles and connected travelers send and receive information about their movements in the network – offering cities unprecedented opportunities to provide more responsive and efficient mobility solutions in real-time and long term.

## 2. Sensor-Based Cities (IoT)

- Connected cities contain and use a collective “intelligent infrastructure” that can sense what’s around and/or sense their own status. These data allow city operators to know how the city is operating and how its performance can be enhanced using real-time information to monitor performance and trends of the city – transportation is part of that. A connected vehicle is another sensor.

## 3. Connected, Involved Citizens

- Connected cities use new analytical processes and applications that are facilitated by ICT advances and that engage the connected citizen, allowing and encouraging fully informed choices – particularly with respect to personal mobility – and both generating and sharing information in new and useful ways.

## 4. Urban Analytics

- In a data-rich environment, cities are increasingly able to deploy (previously unavailable, and now open) datasets to address complex urban problems – connected vehicles and connected travelers are one source of data.

# What Makes a Connected City: Some Thoughts

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## 5. User-Focused Mobility/Service Choice

- Connected cities support sustainable mobility including traveler-oriented strategies that deliver innovative solutions across all transportation modes including transit, bicycling, electric vehicles, and shared mobility services. Connected vehicle technologies are likely to foster further innovation in these areas, particularly with respect to automation. Also includes freight and related services.

## 6. New Business Models and Partnering Opportunities Exist

- The private sector – especially app developers – is pushing innovation, especially by creating new opportunities to partner with government. The public sector is also pushing innovation, creating new opportunities/models for governance and interagency partnerships.

## 7. Smart Grid

- A connected city supports programmable and efficient energy transmission and distribution system (with supporting telecommunication and computing sub-networks) that responds to dynamic demands and is resilient and closely integrated with electric vehicles. ITS is also grid-dependent.



# What Makes a Connected City: Some Thoughts

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## 8. Resilience

- The ICT in a connected city, including telecommunications and computing, need to be resilient, secure and respect privacy; it would also support standards harmonization, common technology architectures and integrative policies so that if one part of the system fails or is compromised, the entire system does not collapse, and the gap in service is bridged effectively and restored quickly.

## 9. Low-Cost ICT/Efficient ICT

- ICT infrastructure, technologies and services are a critical part of a connected city; success depends upon affordable ICT, from both a public and personal perspective, and data efficiency (data use/reuse, open data, big data).

## 10. Safety

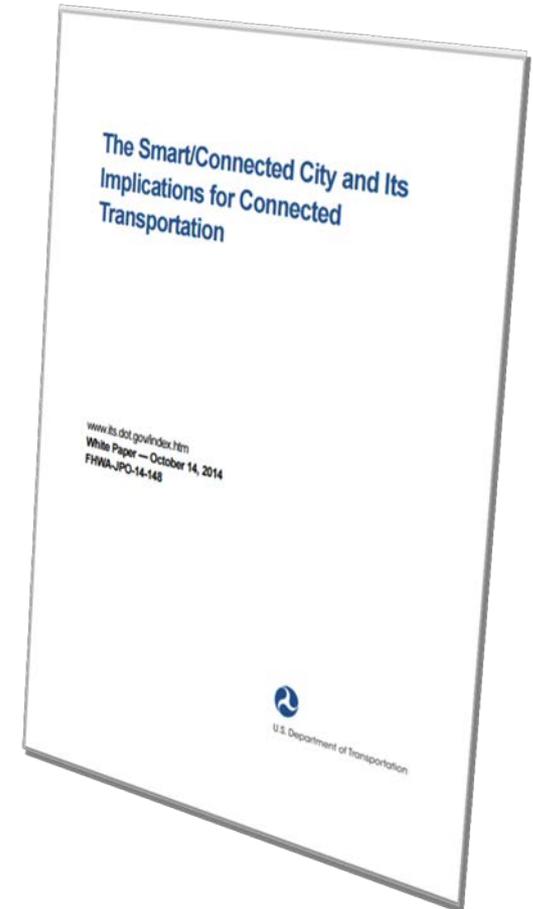
- Safety benefits of many kinds can accrue to a connected city that didn't exist before, including vastly improved safety for drivers, pedestrians, bicyclists, motorcyclists, and ordinary citizens as they move through the city daily.



# Recent Publications and Webinars

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- **White Paper:** *The Smart/Connected City and Its Implications for Connected Transportation*
  - Published to National Transportation Library in November 2014:  
[http://ntl.bts.gov/lib/54000/54200/54204/smart\\_connected\\_city\\_FINAL\\_111314.pdf](http://ntl.bts.gov/lib/54000/54200/54204/smart_connected_city_FINAL_111314.pdf)
- **Stakeholder Webinar:** *Creating Smart Paths for Connected Cities: Introducing a New Connected Cities Research Program* – February 26, 2015
  - Solicit stakeholder input on the Connected Cities Research Program and begin a discussion on the initial vision for the program, initial research questions, and strategies to address these research questions.



# Key Takeaways

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***“Cities are Changing, Citizens are Changing, Vehicles are Changing, Business Models are Changing, Interactions with Cities are Changing”***

- Certain trends are taking hold that deeply impact our lives and the communities in which we live.
  - Widespread adoption of smartphones and wireless devices
  - Crowdsourcing, social media, gamification, and incentivization
  - Urban analytics
  - An economy where access is more important than ownership
  - The potential of connected vehicles and automated vehicles
  - Opportunities for electric vehicles to be integrated into the transportation system
  - Differing views of transportation from millennials and future generations
  - New business models and partnering
  
- These trends are enabling people, the transportation industry, and our cities to change the economics of mobility decisions. Leveraging these capabilities allows system users and operators to get information and act on it—creating a positive impact on how we live, work, and move.

# The ITS JPO Connected Cities Program

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An aerial, isometric view of a city street scene. The scene includes a multi-lane road with a white truck, a white car, a blue and white taxi, and a white car. A green highway sign for route 46 is visible. A multi-story building with a parking garage is in the background. A network of yellow lines and circles is overlaid on the scene, representing a connected transportation system. The lines connect various points on the road, including vehicles and infrastructure, suggesting data flow and communication between them.

## Connected Cities: “Working” Vision

Incorporate and expand connected transportation to ensure that connected transportation data, technologies and applications – as well as connected travelers – are fully integrated with other systems across a city, and fulfill their potential to improve safety, mobility and environmental outcomes in a complexly interdependent and multimodal world that supports a more sustainable relationship between transport and the city.

# Some Questions That Focused Our Thinking

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## ▪ Overarching Issues

- What are some **critical issues and challenges facing today's cities**? How can connected vehicle technologies, data and/or applications help address these issues?
- How will the integrated and connected nature of today's cities be of critical importance to the **likelihood of success of the eventual deployment of connected vehicles**?
- How do **transportation services and connected vehicle technologies, data and applications intersect with other sectors of the city** and how can these be **leveraged** to the overall benefit of a jurisdiction?
- What are the **proper performance measures** when speaking of connected vehicles operating in a connected city?
- Who are the **core stakeholders** at the nexus of the connected traveler and the smart city, both inside and outside of transportation? How can necessary partnerships and other relationships among them be developed?



# Some Questions That Focused Our Thinking

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## ▪ Data and Analysis

- What **data gaps** exist – are there data a city wishes it had that connected vehicles can provide? From what variety of sources can transportation data be collected? What technologies and methodologies are most useful for doing so? How can all these **data be efficiently managed, used and re-used, in a connected city?** What other sectors might benefit from connected vehicle data? How might the transport sector benefit from data from other sectors?
- What is the role of **urban analytics**? How can connected vehicle data – along with transportation data and other data available in a smart city – be used to create **innovative and informative techniques to support decision making** by public agencies and connected travelers?
- How are **planning agencies harnessing the potential of connected vehicle data**, and supporting smart transportation applications in the traditional transportation planning process?
- With limited resources available, how can transportation agencies find **efficient ways to leverage and implement smart solutions** that utilize connected vehicle data? Are there examples of **public-private partnerships** where connected vehicle data is being used?



# Some Questions That Focused Our Thinking

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## ▪ Specific Strategies and Applications

- What are the implications for connected vehicles with respect to **shared-use mobility**?
- What types of **crowdsourcing, social media, gamification and incentivization** strategies can be used to effectively address/solve different kinds of transportation issues in a connected city? **Are some techniques more effective than others** when desiring a certain outcome or certain objective or result?
- What is the role of connected vehicle technologies and applications in traffic operations to enable successful **bicycle-specific mobility strategies**, and **better manage and integrate bicycle traffic** into a city's overall transportation network?
- How might connected vehicle technologies **accelerate or foster electric vehicle adoption**, and vice versa, in a connected city environment? How might electric vehicles **align with vehicle automation** and how might this affinity affect transportation operations in a city?
- How can the relationship between the **smart grid and the transportation system** support more **environmentally sustainable transportation** and continue innovations addressing the operational limitations and **opportunities for electric vehicles** and a reliable grid to serve them?
- Other questions that **YOU** think are critical?



# Where Do We Go From Here?

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- Identify how cities and city agencies can harness the power and potential of connected vehicle data, technologies and applications – and leverage these effectively and efficiently to help achieve overall economic, social, and other goals.
- Explore how cities and agencies might leverage the opportunities presented by location-aware internet-connected mobile communications technologies and apps – and the data they collect and generate – to connect to citizens, influence traveler behavior in the short and long term, and affect public policy and decision-making.
- **There are many interesting topics to explore** – here are just a few:
  - Mobility As A Service / Shared Use Mobility
  - Connected Cycling
  - Service-Focused Urban Automation
  - Smart, Connected Asset Management, Operations, and Decisionmaking
  - Smart Grid, Roadway Electrification and Evs
  - Innovative Business Models and Partnering
  - City-Wide Data Flows and User Needs
  - Interagency Data Exchange
  - Reducing Barriers, Unifying Communities

# Just a Few Real-World Examples

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# Copenhagen, Denmark

## Greener, More Efficient City

- The city has an ambitious goal of becoming the world's first carbon-neutral capital by 2025
- A string of green lights embedded in the bike path — the “Green Wave” — flashes on, helping cyclists avoid red traffic lights
- Truck drivers can see on smartphones when the next traffic light will change
- New LED streetlights brighten only as vehicles approach, dimming once they pass
- Technologies that inform bikers of the quietest or fastest route to their destinations
- Testing systems to prioritize buses or bikes over cars at intersections during certain hours, and installing traffic systems that flash a warning to truck drivers in a right-turn lane when cyclists are present



Source: New York Times



Source: Microsoft Clip Art

1. [http://www.nytimes.com/2014/12/09/business/energy-environment/copenhagen-lighting-the-way-to-greener-more-efficient-cities.html?\\_r=0](http://www.nytimes.com/2014/12/09/business/energy-environment/copenhagen-lighting-the-way-to-greener-more-efficient-cities.html?_r=0)



# Mobility on Demand



Source: Thinkstock

## Helsinki, Finland

- Recently announced plans to transform its existing public transport network into a comprehensive, point-to-point “mobility on demand” system by 2025
- The plan aims to transcend conventional transport by allowing people to purchase mobility in real-time, straight from their smartphones – furnishing options so cheap and flexible and well-coordinated that it becomes competitive with private car ownership, not only on cost, but also on convenience and ease of use

## Las Vegas, Nevada

- A transportation start-up in Las Vegas is creating its own intelligent mass private transit system with a fleet of shared use bikes, shared-use cars (electric vehicles), buses, and on-call valets
- The guiding philosophy is that most city dwellers don't care much about the vehicle that gets them from point A to point B, as long as they can get to their destination cheaply and quickly

1. <http://www.theguardian.com/cities/2014/jul/10/helsinki-shared-public-transport-plan-car-ownership-pointless>  
2. <http://www.washingtonpost.com/blogs/innovations/wp/2014/11/07/armed-with-a-fleet-of-teslas-shift-takes-aim-at-uber-public-transit/>



# Sensor Based Cities

## Chicago Sensor Project

- 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

## Santander's Prototype Smart City

- 10,000 sensors were installed around downtown Santander measuring temperature, air quality, noise levels, and the movements of cars and people
- Smartphone apps allow people of Santander to choose to become human sensors themselves
- Sensors in trash cans help garbage collectors avoid unneeded trips because sensors inform them beforehand which trash cans need emptying



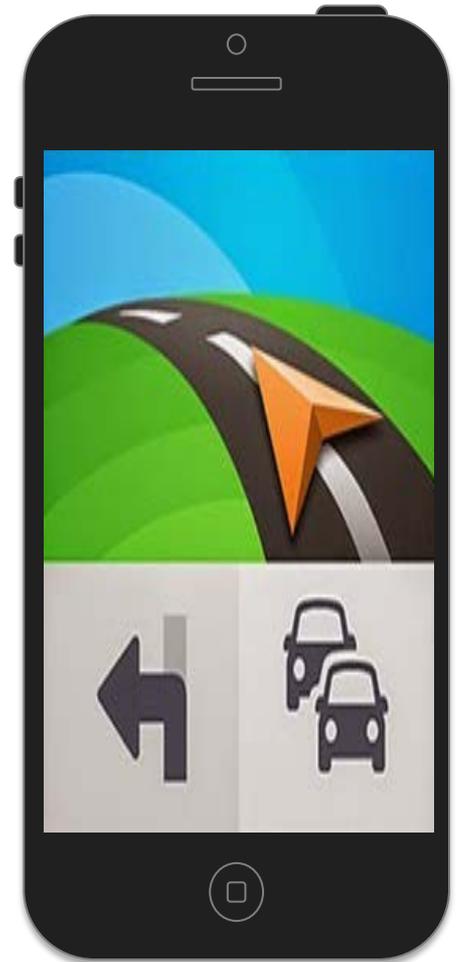
Source: Microsoft Clip Art

1. Chicago: Chicago Sensor Project: <http://www.govtech.com/data/Chicago-Sensor-Project-Will-Measure-Pedestrian-Traffic-Air-Quality-Data.html>
2. <http://www.spiegel.de/international/world/santander-a-digital-smart-city-prototype-in-spain-a-888480.html>



# Connected Citizens Program (CCP)

- A third partner app provider recently launched a Connected Citizens program bringing cities and citizens together to answer the questions “What’s happening, and where?”
- The app provider exchanges publicly available incident and road closure reports, enabling government partners to respond more immediately to accidents and congestion on their roads.
- In turn, the app provider aggregates their partners' data on their platform, resulting in one of the most succinct, thorough overviews of current road conditions today.
- With the addition of city data, users will be even safer on the roads and more knowledgeable about construction, marathons, floods or anything else that can cause delays.
- For government partners, publicly-available third party data is a powerful tool to build more efficient cities. Real-time information from drivers is essential; no one knows more about what's happening in a city than the people who live there.



# Roadway Electrification

## ▪ FABRIC

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

## ▪ London's Wireless Power Transfer (WPT) 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; car share services and taxis are good candidates for testing
- The objective of the trial is to allow partners to better understand how wireless power transfer can be deployed in a mega city environment
- The Transport for London recently announced they will also test the technology on a live bus route

## ▪ FTA TIGGER Grants

- TIGGER grants are supporting WPT testing at bus stops in Salt Lake City, UT; Howard County, MD; McAllen, TX; and Chattanooga, TN

## ▪ WAVE and Utah State University (USU)

- 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



•Source: Qualcomm



# Eco-Driving and Gamification

- 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 application scores a driver based on his or her driving style (e.g., speed, accelerations) and behaviors behind the wheel
  - The application allows you to share driving information with friends and on social networks on a competitive leaderboard



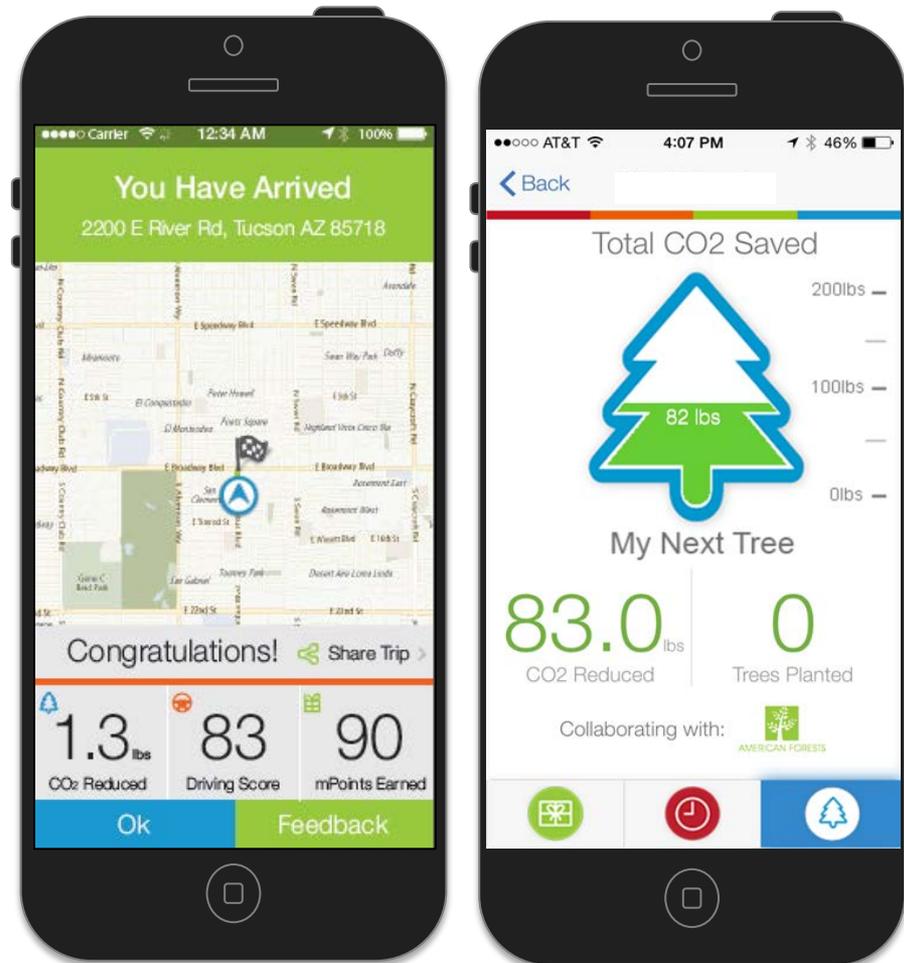
•Source: <http://techcrunch.com/2014/01/25/dashs-smart-driving-app-a-fitbit-for-cars-arrives-on-android/>



# Gamified and Incentivizes-Based Multi-Modal Traveler Information

## Gamified Smartphone App

- Using a mobile smartphone apps, users earn more rewards when they are willing to travel outside of peak traffic congestion hours, and fewer rewards when you travel during rush hour.
- Using the mobile app users reserve trips they are planning to take later in the day.
- The mobile apps predicts future travel times and assigns reward points to the departure times and routes that cause less impact to the roadway system.
- Using the mobile app not only helps to reduce congestion across the city's roadway system, but it also provides commuters with the ideal time to leave and best route to take to avoid sitting in traffic.
- Users can track their environmental footprint.
- Points can be exchanged for local rewards.



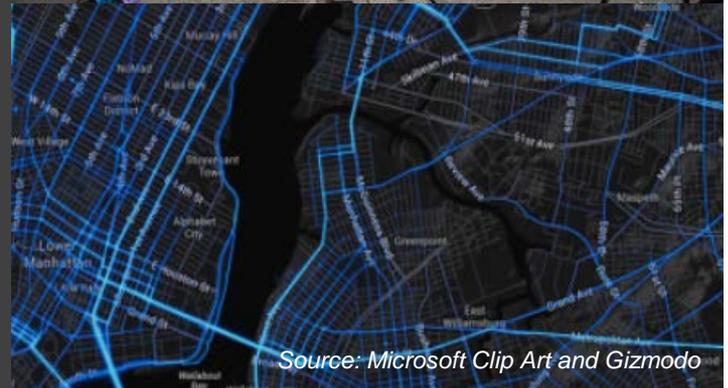
Source: Metropia



# Bicycle-to-Infrastructure (B2I) and Pedestrian-to-Infrastructure (P2I) Applications

## Leveraging Fitness Apps

- A popular fitness-tracking app for runners and cyclists is now selling its anonymized data to public agencies allowing city planners to put the data to use
  - Oregon's Department of Transportation is using the anonymized 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 fitness tracking app providers
- The aggregate data these sensors pick up can be used to learn about citizens' biking behavior and, from that, agencies can plan better infrastructure
- These types of apps may also be used by bike share service providers to manage their operations (e.g., identify usage patterns)



Source: Microsoft Clip Art and Gizmodo



# Traffic Signal Operations

## Opportunities with Connected Vehicle Technologies

Leverage connected vehicle technologies to enhance traffic signal priority applications and adaptive signal control systems



Source: Microsoft Clip Art

## The Metropolitan Transportation Commission's Program for Arterial System Synchronization

- 2011 outcomes of the first funding cycle (13 projects involving 339 traffic signal locations)
- Travel Time Savings – 18%, or over 3.8M hours
- Speed Increase – 26%
- Fuel consumption savings of 14 percent or more than 9.87 million gallons

## Potsdam's "Green Light for Clean Air"

- 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<sub>2</sub>) levels.
- Whenever the NO<sub>2</sub> 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](http://www.mtc.ca.gov/services/arterial_operations/downloads/PASS/Summary_with_all_Project_Fact_Sheets.pdf)
2. Siemens: [www.siemens.com/mobility](http://www.siemens.com/mobility)



# Smart Parking

## Smarter 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<sub>2</sub>)

## Madrid, Spain Smart Parking Meters

- 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>



# For More Information

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## **Marcia Pincus**

Email: [marcia.pincus@dot.gov](mailto:marcia.pincus@dot.gov)

The Smart/Connected City and Its Implications for Connected Transportation:

[http://www.its.dot.gov/itspac/Dec2014/Smart\\_Connected\\_City\\_FINAL\\_111314.pdf](http://www.its.dot.gov/itspac/Dec2014/Smart_Connected_City_FINAL_111314.pdf)

