National Evaluation of the SafeTrip-21 Initiative

Overview of Findings

May 26, 2011
9:30 am – 11:30 am

Agenda

9:30 Introductions, followed by description of the tests

10:00 Findings for each test

10:30 Synthesis of SafeTrip-21 findings

11:00 Q&A

Introductions

- Keith Jasper, Delcan
  - CACT Evaluation Leader
  - Real Time Intersection Delay
  - Mobile Millennium
- Gary Golembiewski, SAIC
  - Networked Traveler–Foresighted Driving
- Chris Armstrong, SAIC
  - Networked Traveler–Transit/Smart Parking
  - Portable Traffic Monitoring Devices
- Greg Krueger, SAIC
  - Former Michigan DOT

Part 1:
Description of the tests

Applicability to Day-to-Day Operations

- Requires Minimal Infrastructure Development
  - Can achieve safety and mobility benefits in the short-term
- Provides a Bridge to Connected Vehicle Development
  - Some benefits available 10 years before implementation
- Technologies now available
  - Mobile devices and wifi widely available and widely used
- Applications must be compliant
  - Work Zone Mobility Rule, Section 1201 Rule

SafeTrip-21 Initiative

SafeTrip-21
Field Operational Test Beds

- Safe and Efficient Travel through Innovation and Partnerships for the 21st Century
- Emphasis on applications that:
  - do not entail extensive public sector infrastructure
  - can achieve immediate benefits
  - demonstrate the potential for sustainable deployment
  - leverage existing technology to address current transportation needs
- Launched in Spring 2008
  - California Connected Traveler Test Bed (5 applications)
  - I-95 Test Bed (4 applications)
- Evaluation Report finalized

California Connected Traveler (CACT) Test Bed

- CACT Partners' Applications
  - Networked Traveler–Foresighted Driving
  - Networked Traveler–Transit/ Smart Parking
  - Mobile Millennium
- Independent Applications
  - Real Time Intersection Delay
  - Portable Traffic Monitoring Devices

Networked Traveler-Foresighted Driving

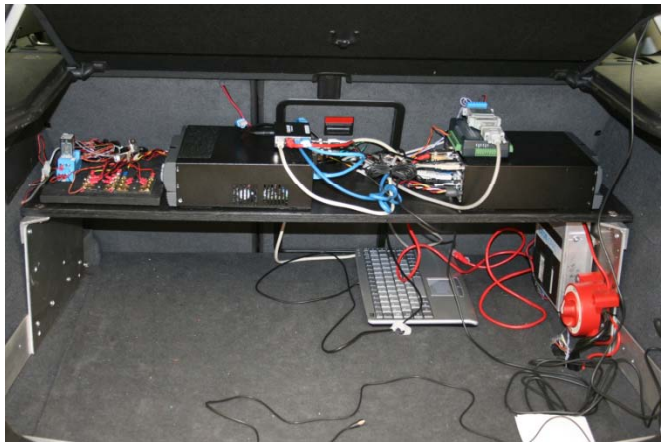
- Provides in-vehicle audible alert ("Slow Traffic Ahead") of imminent slow-moving traffic
- Conducted from mid-July to mid-November, 2010
- Concentrated on major highways in the Bay Area
- Integrated:
  - Real time speed information from existing sensors
  - Location, speed, and direction information from 4 specially equipped vehicles
  - Calculated potential impact situations +/- 60 secs ahead of time
- 24 recruited drivers, regular driving habits

Networked Traveler-Foresighted Driving

- Technologies
  - Four Instrumented Vehicles (2 Nissan, 2 Audi)
    - *Advanced driver assistance system (ADAS)*
    - *Safety alerts integrated into each vehicle's sound system*
  - Above Ground Highway Sensors

Networked Traveler-Foresighted Driving

- Deployment challenges and solutions
  - Agency stance on distracted driving impacted
    - *Experimental design*
    - *Schedule*
    - *OBE design/procurement*
    - *Participant feedback procedures*

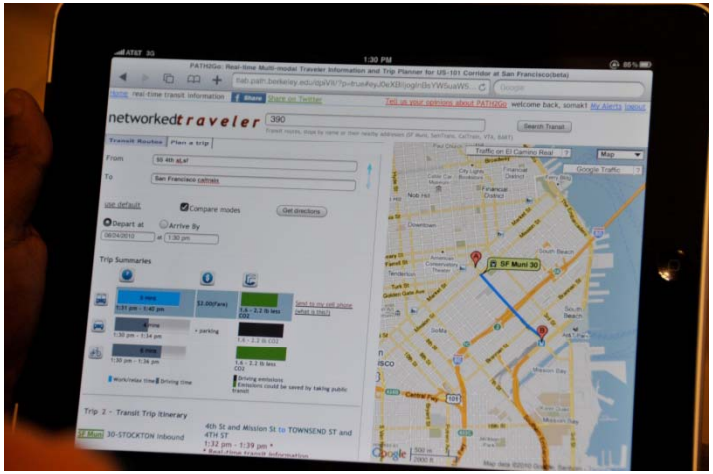


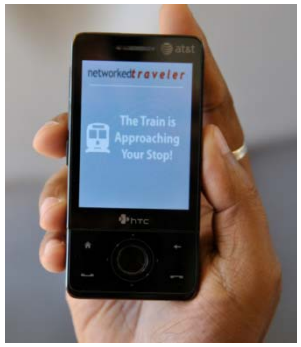
Networked Traveler-Transit/Smart Parking

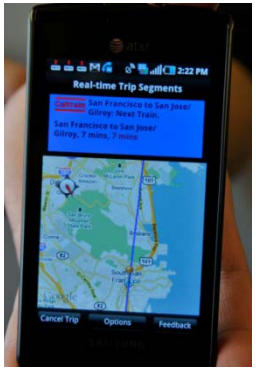
- Provides real-time transit and parking information to the San Francisco Bay Area with a focus on the US-101 corridor
- Integrates:
  - Bus and rail service information across most agencies serving the Bay Area.
  - Real-time parking availability at selected rail stations.
- Delivers information via website and Smart Phone app (iPhone, Android, Windows Mobile)
- Conducted from mid-July to mid-November, 2010
- 905 registered users from general public

Networked Traveler-Transit/Smart Parking

- Technologies:
  - One of the first real-time, cross-agency trip planners (website and smart phone).
  - Real-time parking availability.
  - Website provides multi-modal travel cost/benefit comparisons considering trip cost, time, and carbon emissions.
  - Integrated mode sensitive “geo-fencing” functionality to prevent distracted driving.

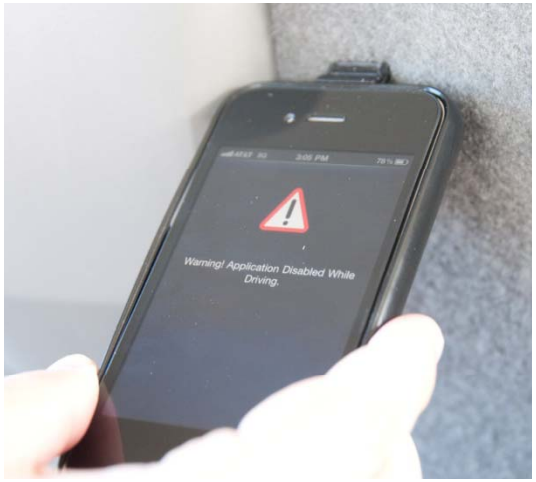






Networked Traveler-Transit/Smart Parking

- Deployment challenges and solutions
  - Installing GPS trackers on trains and buses to collect real-time data. Installing parking lot sensors.
  - "Geo-fencing" technique
    - *Prevent use of application if user is moving in vehicle; allow use of the application if a user was on moving bus or train.*
    - *Allows use of the application while walking or waiting at a bus stop or train station*
    - *Display a warning message when the application is blocked.*
    - *Ensure applications worked consistently across three smart phone platforms – Android, iPhone, and Windows Mobile*

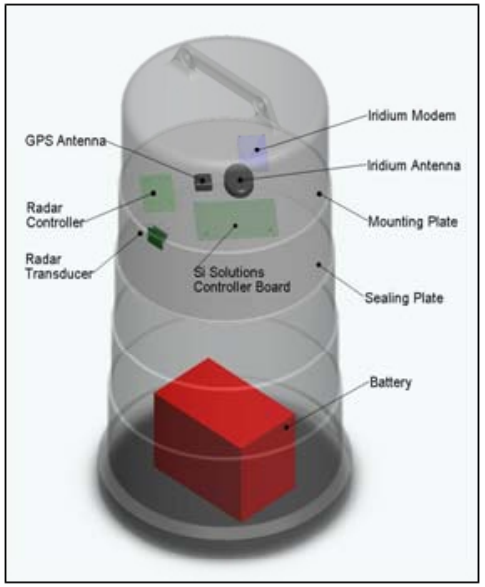


Portable Traffic Monitoring Devices

- Manage work zones cost effectively in real time through active monitoring of traffic conditions.
- 12 PTMDs available over 5 month test period beginning in September 2009
- Primarily District 4 participation:
  - Interstate 680 construction
  - Bay Bridge Closure – Labor Day Weekend
  - Highway 101 – Golden Gate Bridge
  - Bay Bridge Reverse Curve
  - Interstate 880
  - Event Management in Pasadena (i.e., Rose Bowl Parade)

Portable Traffic Monitoring Devices

- Technologies
  - Single K-band radar unit can be set to collect either vehicle speed or traffic volumes
  - Housed in a NCHRP 350-compliant traffic channelizer with built-in GPS
  - Includes web-based map interface and historical data collection
- Deployment challenges
  - Battery charge time
  - Traffic volume counts across multiple lanes



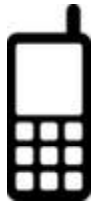
Real Time Intersection Delay

- Vendor proposed application:
  - Traffic volume/signal timing monitoring system
- Two phase test
  - Bench test at PATH RFS (August 2009)
  - Field test at El Camino Real/Dumbarton Road (Oct-Nov 2009)
- Cycle-by-cycle data transmitted to vendor:
  - Traffic volume, signal timing, cycle length
  - Delay calculated remotely and posted to internet
- TrafInfo Communications Inc., PATH, and Caltrans

Real Time Intersection Delay

- Technologies
  - TrafMate 6, interfaces with 2070 controller (RS-232 port)
  - Wireless communication antenna, connects to TrafMate 6
  - Remote server
- Deployment challenges and solutions
  - Loop detectors needed on all approach lanes
  - Loop detectors must <u>count</u> vehicles in all lanes
  - For the test, replaced the 2070 detector cards, necessitating additional calibration effort to ensure vehicle counts were accurate

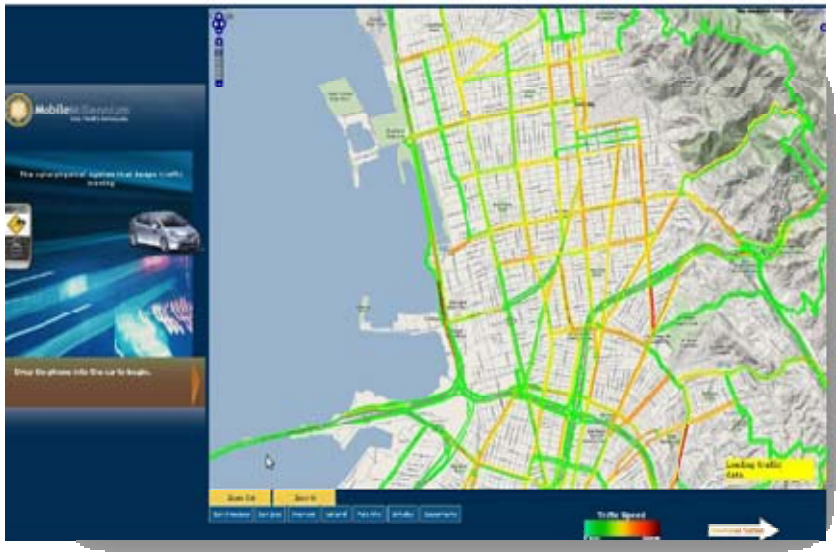
Mobile Millennium



- Provided real time highway and arterial traffic information
- ITS World Congress demo, New York City
- November 2008 – November 2009
- Nationwide, but focused on the Bay Area
- Delivered information via selected Smart Phone models
  - 2,200+ users
  - Major launch campaign
- Nokia, NavTeq, CCIT, UC-Berkeley, Caltrans

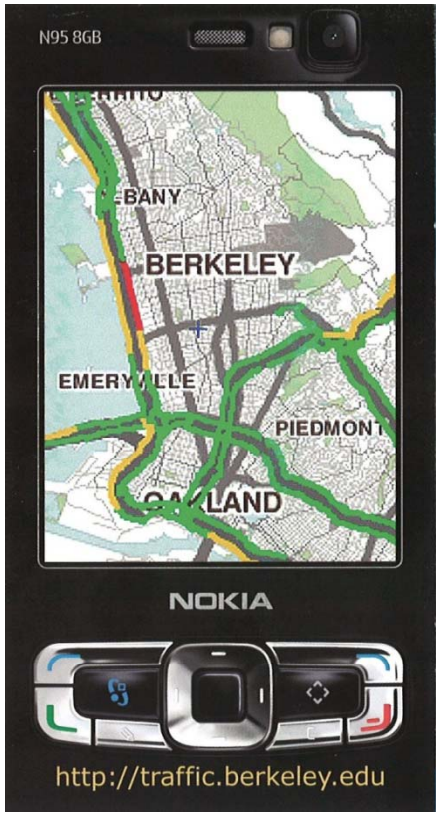
Mobile Millennium

- Technologies
  - Traffic probes
    - *GPS enabled smart phones*
    - *Taxicabs*
  - Fixed sensors
    - *PeMS*
  - Region-wide traffic application for smart phone users
  - Highway and arterial traffic models



Mobile Millennium

- Deployment challenges and solutions
  - Arterial traffic model development
  - Multiple iterations of development/refinement
  - Future procurement issues, i.e. data/information versus products/services
  - Privacy
  - ‘Virtual Trip Lines’



Questions?

Part 2:
Findings for each test

Networked Traveler-Foresighted Driving

Evaluation Findings

- Objective 1 – Understand the technical, human-machine interface, and institutional issues
- *Evaluation Activity – interviews with deployment partners*
  - System performance depended on reliability of the speed sensors
  - Interface understood by participants
  - Administrative issues impacted PATH's ability to purchase equipment in a timely manner
  - Privacy concerns were taken seriously, though was a very minor issue for participants

Networked Traveler-Foresighted Driving

Evaluation Findings

- Objective 2 – Analyze alert's perceived timeliness, accuracy, and usefulness
- *Evaluation Activity – participant interviews*
  - Majority thought the alerts were timely, though some preferred earlier warning at decision points (e.g., highway interchanges)
  - Accuracy was rated in the 60% to 70% range
  - Usefulness was rated highly, though many participants thought alerts may have been more useful if other information were available (e.g., duration, length of congestion)

Networked Traveler-Foresighted Driving

Evaluation Findings

- Objective 3 – User-perceived benefits of the alerts
- *Evaluation Activity – participant interviews*
  - Participants, in general, saw the benefits of the alerts on their daily commutes
  - However, they offered suggestions on how their benefits could be enhanced
    - *Combine with a navigation system*
    - *Expand use to non-commuting routes (where recurring congestion is not as predictable)*
    - *Include a "pre-alert" notification so drivers "are ready" for the information*

Networked Traveler-Transit/Smart Parking

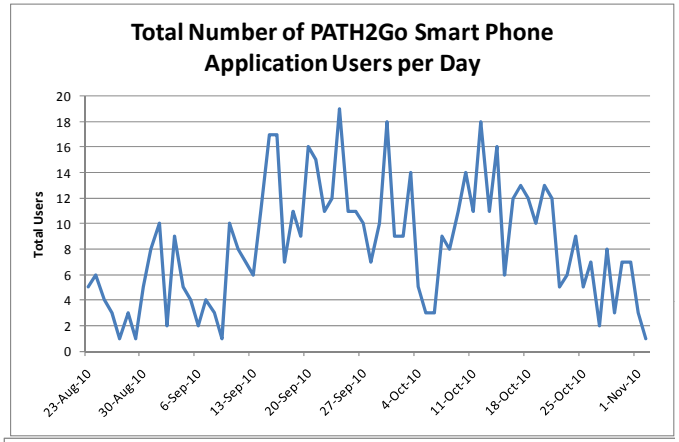
Evaluation Objectives and Activities

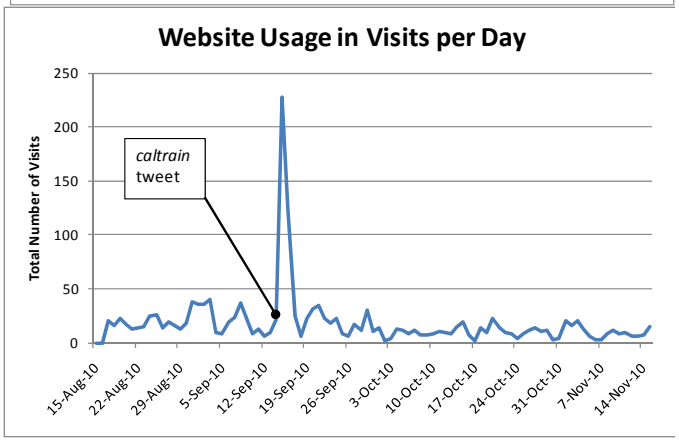
Evaluation Objective	Data Source
Observe consumer response to the NT-T/SP applications	Usage data
Understand the technical and institutional issues associated with distributing multi-modal information to smart phone users	Interviews with deployment partners
Test the ability of geo-fencing as a method to prevent distracted driving	Geo-fencing test results
Understand the development process and institutional issues associated with geo-fencing design	Interviews with deployment partners
Measure usage of the NT-T/SP applications	Usage data
Analyze the perceived accuracy and usefulness of the NT-T/SP applications	Web-based user surveys

Networked Traveler-Transit/Smart Parking

Evaluation Findings

- Observe consumer response to the NT-T/SP applications
  - 905 total registered users
  - 602 smart phone app downloads w/ use (67 percent)
  - 1,664 total website visits by 916 unique visitors (1.82 visits per user)
- Measure usage of the NT-T/SP applications
  - Targeted marketing efforts were essential to promoting use
  - Outreach via social media like Twitter can bolster usage and increase awareness of web and smart phone-based ITS applications





Networked Traveler-Transit/Smart Parking

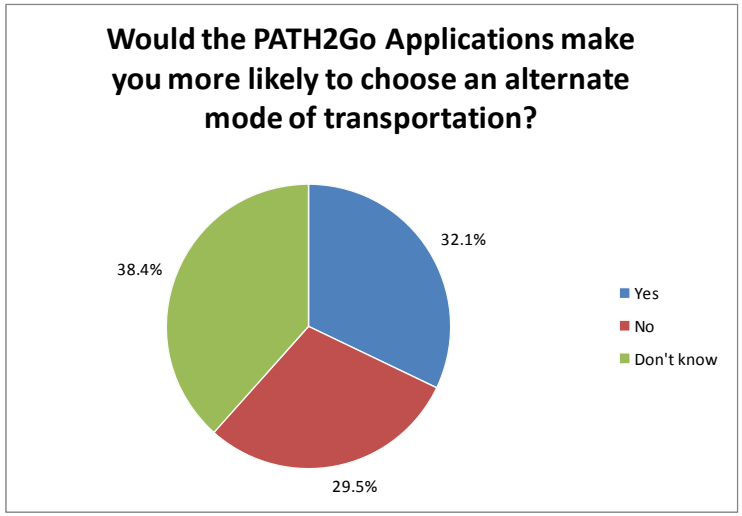
Evaluation Findings

- Test the ability of geo-fencing as a method to prevent distracted driving
  - The geo-fencing technique was effective at minimizing distracted driving but was not foolproof because of GPS limitations.
  - The effectives varied across smart phone platforms.
  - Under certain circumstances, the device blocked transit users from accessing the information.
- Understand the development process and institutional issues associated with geo-fencing design
  - A server-based geo-fencing design allowed for a thin client-side design that was less burdensome on the smart phone.
  - Prevented the design team from having to address differences in the iPhone, Android, and Windows Mobile operating systems.

Networked Traveler-Transit/Smart Parking

Evaluation Findings

- Analyze the perceived accuracy and usefulness of the NT-T/SP applications
  - Over half of survey respondents “strongly agreed” or “agreed” that the information was valuable.
  - Specifically, 66 percent of respondents indicated that having information from multiple transit agencies in one place was very useful and helpful.
- Understand the technical and institutional issues associated with distributing multi-modal information to smart phone users
  - Demonstrated the ability to integrate transit, traffic, and parking information across multiple agencies in real time.



Portable Traffic Monitoring Devices

Evaluation Objectives and Activities

Evaluation Objective	Data Source
Explore how real-time information about traffic conditions in work zones can be used effectively by a State DOT to actively manage work zones	Interviews with deployment partners
Understand the institutional issues associated with collecting and making use of real-time information about traffic conditions in work zones	Interviews with deployment partners

Portable Traffic Monitoring Devices

Evaluation Findings

- PTMDs were easy to install and maintain.
- The devices appear to have many uses and applications for the future to support operations including:
  - Incident and evacuation management
  - Development of expanded work windows
  - Capacity studies
  - Law enforcement efforts
  - Collection of travel time data for both recurring and non-recurring bottlenecks
- Challenges related to portability include battery re-charging efforts and ensuring devices stay in place.
- Overall, the devices appear to be a cost-effective and flexible means for an agency to remotely monitor traffic conditions on their roadways.

Real Time Intersection Delay

Evaluation Findings

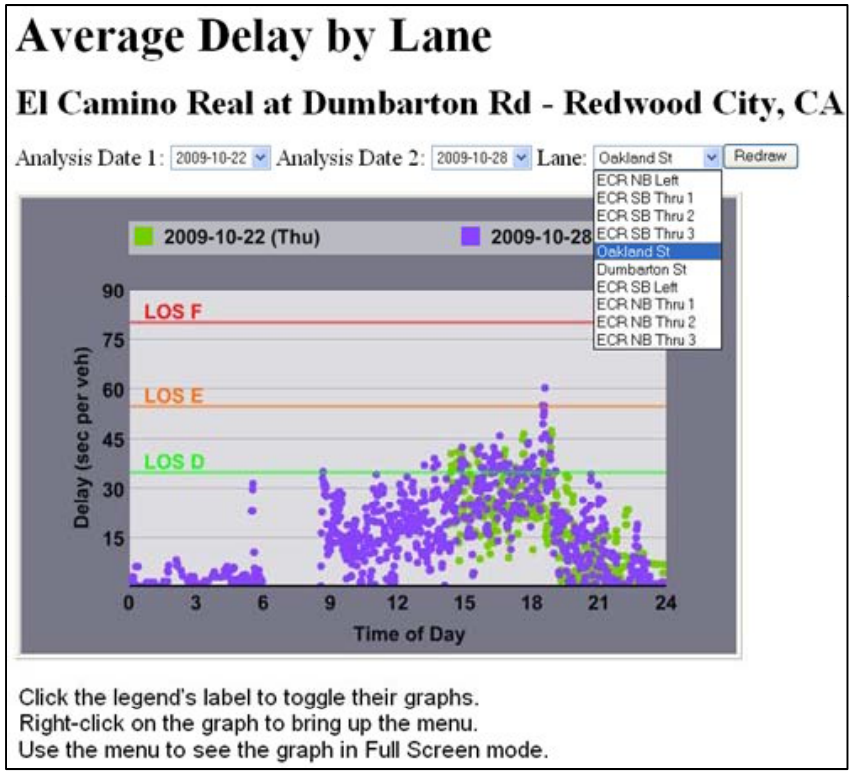
- Evaluation Objective 1 – Understand Implementation Issues
  - TrafMate 6 did not interfere with 2070 signal operations
  - Installation in less than 30 minutes
  - Loop detector cards must count vehicles
  - Loop detectors needed on all lanes; must be operational
  - Antenna placed on controller cabinet; required hole to be cut

Real Time Intersection Delay

Evaluation Findings

- Evaluation Objective 2 – Understand technical and institutional issues
  - No technical issues
  - One minor institutional issue, regarding access to the controller cabinet

- Evaluation Objective 3 – Understand the ease of downloading the information
  - Graphical representation of delay estimates available via internet
  - Data available for download



Real Time Intersection Delay

Evaluation Findings

- Evaluation Objective 4 – Understand the usefulness of the speed and delay estimates
  - Delay estimates (by vendor) based on traditional methods

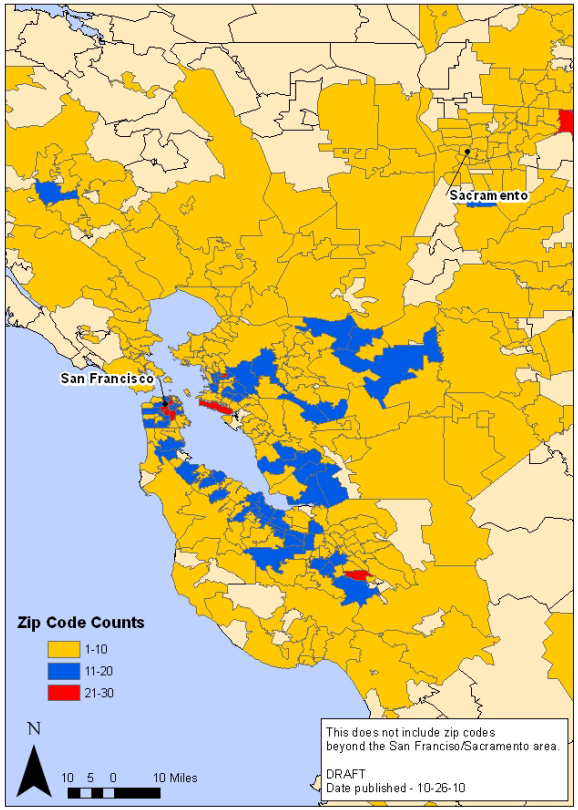
- Potential areas for future use
  - Monitor intersection delay in real time
  - Retime traffic signals
  - Enhance travel information

Mobile Millennium

Evaluation Findings

- Evaluation Objective 1 – Observe consumer response
  - Users
    - *2,200+ users despite absence of sustained public relations and limited range of supported smart phones*
    - *400/485 home/work zip codes, concentrated in the Bay Area*
    - *1/3rd users aged 36-45 years*
    - *86% users were male*
  - Pattern of use
    - *January 2009: 33% used on a daily basis*
    - *June 2009: 11% 6+ uses in past 7 days*
    - *Third of users closed application after viewing traffic conditions*
    - *Two thirds trusted their privacy was protected*

Home Zip Code Density



Mobile Millennium

Evaluation Findings

- Evaluation Objective 2 - Understand technical and institutional issues
  - Demonstrated the potential for using traffic probes as a viable alternative to traditional infrastructure based traffic data
  - Arterial traffic data within reach, although challenges remain
  - Personalized traffic information
  - Importance of an effective public-private-academic partnership
  - Transparent approach to privacy

Mobile Millennium

Evaluation Findings

- Evaluation Objective 3 – Measure usage of probe-based traffic information
  - 88% indicated they would definitely/probably use in the future
  - Core group of intensive users
  - Driver distraction
    - *1/3rd users opened the application as they started to drive*
    - *20% opened the application if they encountered traffic while driving*
- Evaluation Objective 4 – Measure accuracy of traffic information
  - Highway model; robust
  - Arterial model; varied, depending on location

Questions?

Part 3:

Synthesis of SafeTrip-21 Findings

Synthesis of SafeTrip-21 Findings Format

1. Alternative Approaches to Monitoring Traffic Conditions Data
2. Providing Useful and Usable Real-Time Traffic Conditions Information
3. Providing Multi-Modal Travel Options to Travelers
4. Providing In-Vehicle Safety Alerts in End-of-Queue Situations

Subdivided to describe findings by areas of interest:

- Design and Development
- Deployment
- Marketing
- User Experience
- Privacy
- Institutional Issues

Alternate approaches for monitoring and using traffic conditions data

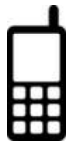
- Design and Development
  - MM and PTMD provided alternative data sources for traditional tasks
  - NT-FD and RTID used traditional data sources in new ways

- Deployment
  - MM and NT-FD, real time data was key
  - RTID and PTMD, timely and safe deployment, maintenance

Alternate approaches for monitoring and using traffic conditions data

- User Experience
  - MM and NT-FD, consumer response was positive overall
  - Future direction?
- Institutional Issues
  - Procurement processes
  - Business models
  - Public/private roles
- Privacy
  - Established processes for privacy protection
  - Transparent approach

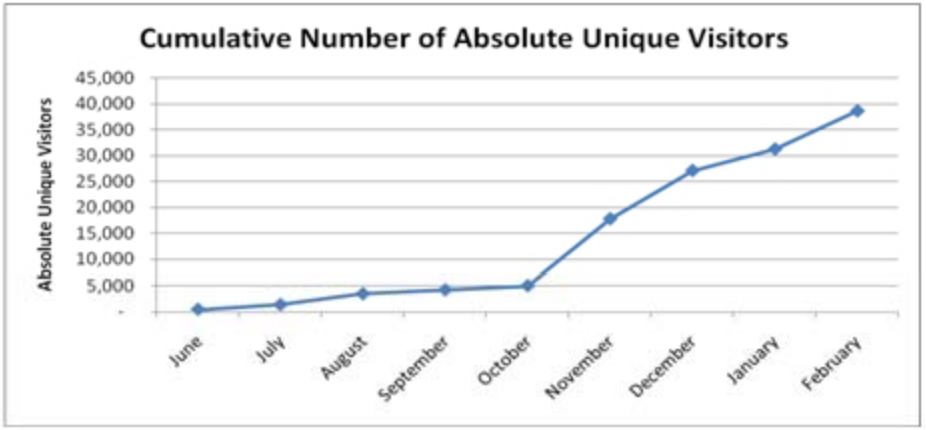
Providing useful and usable real time traffic information

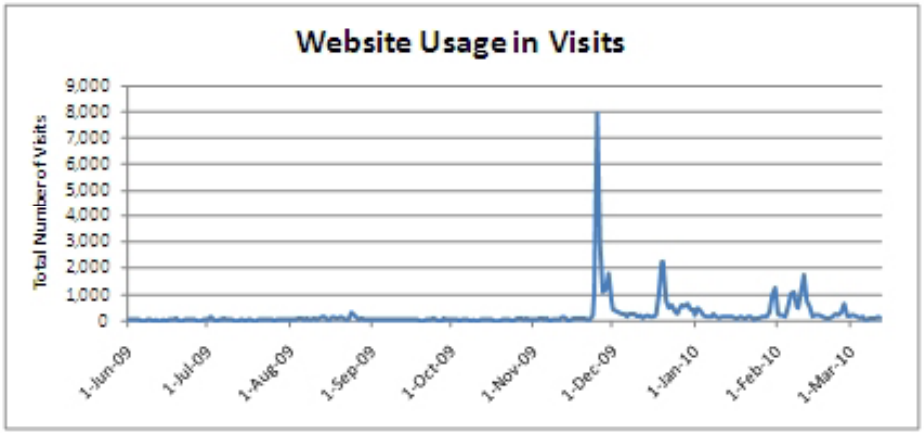


- Design and Development
  - Look to expand on previous projects and partnerships to increase scale and coverage to meet new needs.
  - Build in mechanisms for monitoring usage of the system.
  - Developing accurate, reliable arterial traffic models continues to prove challenging
- Deployment
  - Look to users for feedback on how to improve the system.
  - Establish an “ecosystem” for deployment where there is recognition among partners of their respective (but different) strengths and organization goals which also gives users a voice.

Providing useful and usable real time traffic information

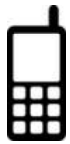
- Marketing
  - Should be a key consideration throughout system design and deployment.
  - Need for a clear and efficient means for putting information in users' hands.
  - Targeted marketing efforts are essential to establishing a user base.





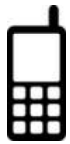
(example from I-95 Corridor Test Bed – real-time traffic conditions and travel times website)

Providing useful and usable real time traffic information



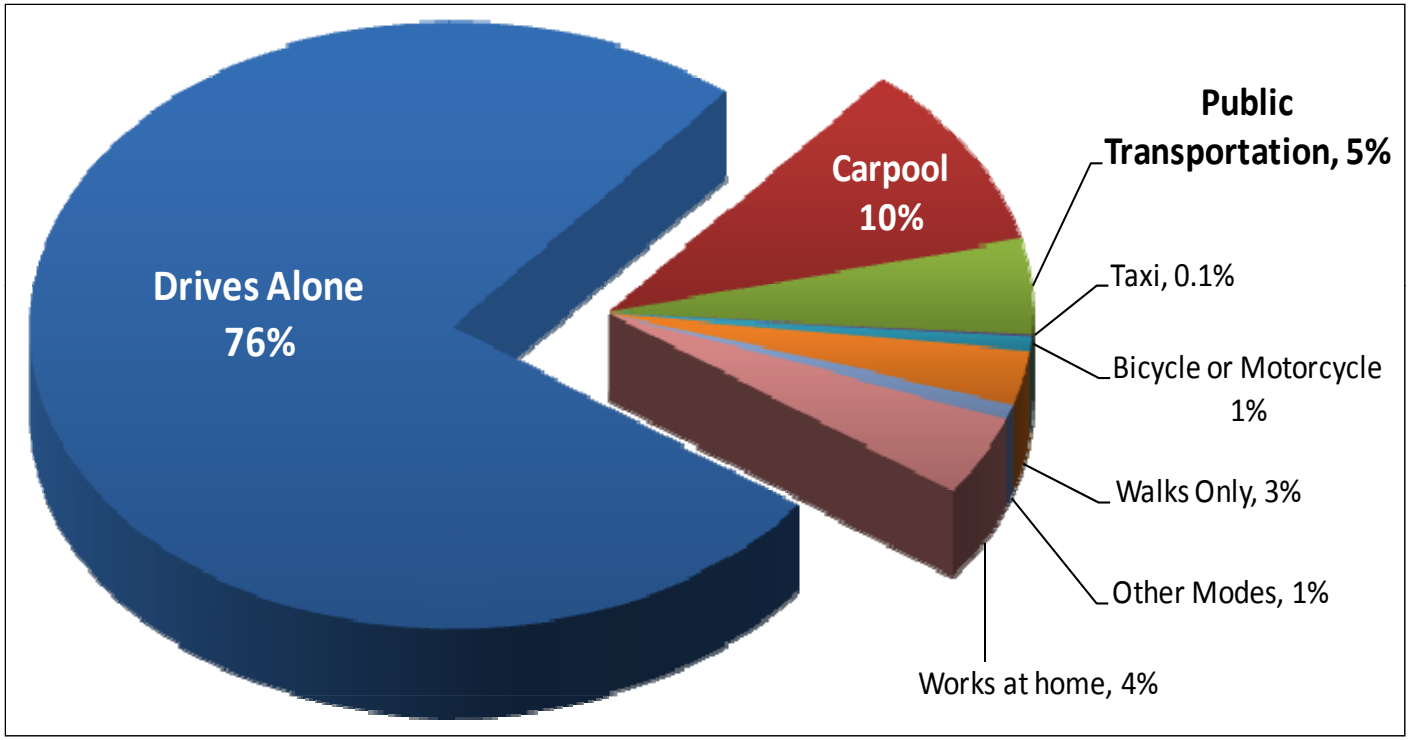
- User Experience
  - User perceptions of the usefulness and accuracy of the information being provided are key to success.
  - Users take comfort from knowing current traffic conditions, and the ability to make more informed travel decisions.
  - Users often desire personalized information relative to their travel or commute.
- Privacy
  - When smart phones are used as probes, there is a potential for privacy concerns related to tracking. There are several ways to address these issues:
    - Privacy protecting methods (VTLs)
    - Transparency with participants.

Providing useful and usable real time traffic information



- Institutional Issues
  - A formal process for assessing user needs should be included in the project plan.
  - Providing travel information in public places necessitates creativity and targeted marketing efforts to make potential users aware of the service.
  - Further innovation is needed to put timely and useful travel information at travelers' fingertips while keeping drivers from being distracted.

Providing multi-modal travel options to travelers



Source: Data from American Community Survey conducted by the US Census Bureau. Figure developed by SAIC.

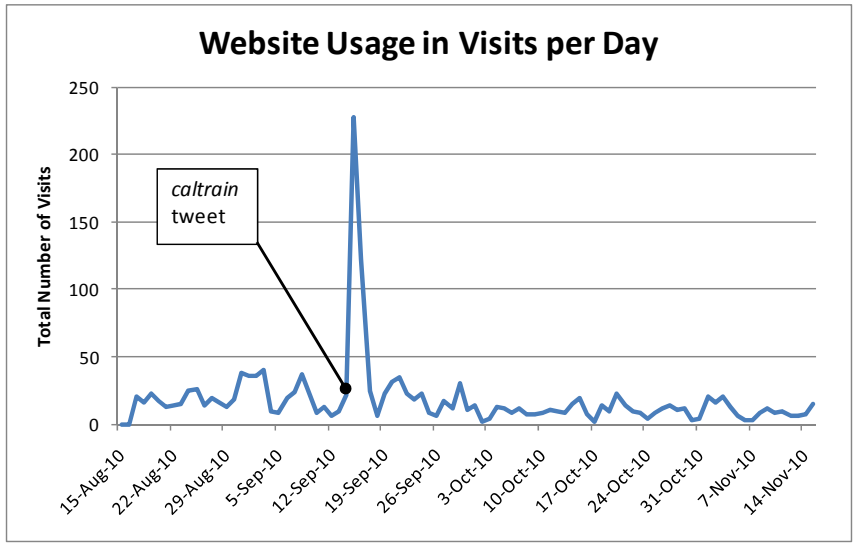
Principal Means of Transportation to Work, 2009

Providing multi-modal travel options to travelers

- Design and Development
  - Leverage existing traveler information to develop a single system that provides users with multi-modal information in one location.
  - Applications can save users time and make considering alternate modes less of a hassle.
  - Leverage open source data as much as possible.
  - Develop one system that can feed multiple interfaces – web, mobile, kiosk, etc.
- Deployment
  - Consider deployment environment when planning (e.g., reaching the masses in a major metro area).
  - Cooperation and continued dialogue are essential to successful deployment.

Providing multi-modal travel options to travelers

- Marketing
  - Establish a method for tracking application usage prior to launch and throughout deployment. Usage data will help gauge effectiveness of marketing efforts and determine system acceptance and performance.
  - Include a user exposure question (i.e., How did you learn about NT-T/SP test?) in any user survey efforts.
- User Experience
  - Survey results indicated that multi-modal information makes travelers feel more confident about using transit and alternate travel options.
  - Results also indicated that providing multi-modal information can increase satisfaction with and improve perception of the agency providing the information.
  - Preliminary user needs assessments, beta testing, and focus for on-going feedback are essential to improving design, identifying bugs, and achieving better overall performance and usefulness.



Providing multi-modal travel options to travelers

- Institutional Issues
  - It is challenging to integrate a wide variety of information from different sources into a single system.
  - It is important to:
    - *Identify essential stakeholders and ensure clear and consistent communication as well as written agreements.*
    - *Establish a concept of operations and leverage existing information or open source data during project development.*
    - *Incorporate a formal process for identifying user needs which can result in greater initial user satisfaction/attention and less development changes after initial launch*
    - *Identify a comprehensive approach to user requirements analysis and include it as part of the initial project schedule and budget discussions.*

Providing in-vehicle safety alerts in end-of-queue situations

- Design and Development
  - Evolved over time; modifications necessitated by policy changes and re-scheduling
- Deployment
  - Close coordination of participant recruitment, testing, and evaluation
  - Participant responses collected through online survey and debrief interviews
- Marketing
  - No marketing per se; but information gleaned from participants' "willingness to pay" for the alerts

Providing in-vehicle safety alerts in end-of-queue situations

- User Experience
  - Was found to be useful, timely, relatively accurate, more aware of traffic conditions (situational awareness)
  - Not distracting
- Privacy
  - Essentially a non-issue
- Institutional Issues
  - Coordination between PATH, Caltrans, and UC Berkeley was the primary consideration (schedule, budget, design)

Synthesis of SafeTrip-21 Findings

LESSONS LEARNED

Collaboration and Partnerships

The SafeTrip-21 Initiative identified risks related to large-scale collaboration and mitigating factors to promote effective partnerships.

- Established and respectful working relationships facilitate a shared team vision and a sense of ownership, which serve as a solid foundation for a successful deployment.
- Documenting the vision through a concept of operations is one way to keep stakeholders on the same page. .
- It is not sufficient to find consensus at the concept formation stage; sustained regular communications among partners is needed.
- Conflicts in collaborative relationships can carry directly into the technology.
- Formal agreements can facilitate working relationships and communication protocols.
- Interactions between commercial and non-commercial entities require unique understanding and planning.
- Transportation professionals and system engineers need to develop a shared understanding and language.

Collecting & Using Traffic Data

The SafeTrip-21 Initiative demonstrated the feasibility of alternative approaches to collect and use traffic data.

- Traffic model development can benefit from integrating traffic probe data with other sources for both freeways and arterials.
- There is potential for using traditional traffic data in new and innovative ways.
- The ability to deploy a traveler information concept is only as successful as the availability, timeliness, and accuracy of its data sources.
- ITS has the potential to enhance monitoring and maintenance of traffic signal plans.
- Practical concerns of transportation professionals dominated their acceptance of traffic data devices.

Driver Experience & Distraction

<u>The SafeTrip-21 Initiative identified aspects of information delivery and design which appeals to users and improves the user experience.</u>

- Stakeholder relationships will not necessarily be transparent to users.
- The importance of assessing user needs early and often should not be underestimated.
- Understanding user expectations and users' desire for efficiency are important for providing a usable interface and effective service.

<u>The SafeTrip-21 Initiative developed new approaches to address distracted driving.</u>

- "Geo-fencing" is a promising approach to limiting driver distraction.

Privacy & User Acceptance

<u>The SafeTrip-21 Initiative explores issues of privacy related to user acceptance.</u>

- Creative privacy protection procedures can be reassuring to users of personal devices providing probe data.

- Reciprocity and transparency related to the collection of personal information are potential success factor for ensuring acceptance by travelers.

Development & Deployment

<u>The SafeTrip-21 Initiative indicates success factors related to effective development and meaningful deployment.</u>

- Keeping solutions simple enables progress and optimizes chances for success.
- Existing open-source data is becoming an important component of efficient system development.
- Redundancy in system design and monitoring minimizes failure risks.
- It is important to not underestimate the complexity and resources associated with tools/techniques for conducting field studies.
- Performance monitoring during deployment facilitates technical improvements.
- Low frequency of use is not necessarily a negative indicator.
- When considering how to proceed following a test deployment, it is important to clarify the roles of the private and public sector.

Marketing

<u>The SafeTrip-21 Initiative highlights the increasing role of traditional and innovative marketing in transportation systems.</u>

- Providing travel information in public places necessitates creativity to make potential users aware of the service.
- Social media is an increasingly powerful tool, especially in promoting mobile applications.
- Traditional press releases are still effective in reaching large media outlets.
- Marketing efforts should not only be directed at consumers but at transportation professionals' networks.

Cross-modal Travel

<u>The SafeTrip-21 Initiative explored ways to support users in making cross-mode travel decisions.</u>

- Travelers place value on being able to compare real-time choices from a single source in part because it increased their confidence in their decisions.
- It is difficult to assess mode shift.

Key Findings: Future Research

<u>The SafeTrip-21 Initiative suggests future research opportunities.</u>

- Arterial model development is a complicated issue that would benefit from continuing research and the development of new techniques.
- Transportation agencies will have to address the need for new procurement methods to acquire data and information services.
- To maximize the potential of using transit data, there is a need for a national standard.
- Continuing research is needed to identify contributing factors and the cost-benefit balance required to induce mode-shift.
- Further innovation is needed to provide timely and useful travel information at the fingertips of travelers while keeping drivers from being distracted.
- The potential impact of social networking related to travel and transportation is not well-understood.

Questions?

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National Evaluation of the SafeTrip-21 Initiative
Combined Final Report
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Thank You

- All reports are expected to be published Summer 2011.
  http://www.its.dot.gov/library/its_ntl.htm
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