

SafeTrip-21

Federal ITS Field Tests to Transform the Traveler Experience

June 30, 2011

FHWA-JPO-11-114

Prepared by the Volpe National Transportation Systems Center



U.S. Department
of Transportation

Research and
Innovative Technology
Administration

Technical Report Documentation Page

1. Report No. FHWA-JPO-11-114		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle SafeTrip-21 — Federal ITS Field Tests to Transform the Traveler Experience			5. Report Date June 30, 2011		
			6. Performing Organization Code		
7. Author(s) Jessica Hector-Hsu, Gary T. Ritter, Suzanne Sloan, Laura Waldon, Philip Thornton, Katherine Blythe			8. Performing Organization Report No.		
9. Performing Organization Name and Address John A. Volpe National Transportation Systems Center 55 Broadway Cambridge, MA 02142			10. Work Unit No. (TRAIS)		
			11. Contract or Grant No. HW3MA1		
12. Sponsoring Agency Name and Address ITS Joint Program Office 1200 New Jersey Ave., S.E. Washington, DC 20590			13. Type of Report and Period Covered Final Report, February 2008 - June 2011		
			14. Sponsoring Agency Code HOIT-1		
15. Supplementary Notes					
16. Abstract SafeTrip-21 popularized transportation technology by making traffic and transit data available to the public via websites, smartphone apps, and other electronic media. Federal ITS field tests were carried out between November 2008 and November 2010 in partnership with state government, private companies, and universities. The results showed that public ITS research can provide a conceptual foundation for real-world and commercial products.					
17. Key Words Federal, ITS, field tests, technology, connected vehicles, smartphones, real-time information, traffic			18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 28	22. Price N/A		

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Produced by the John A. Volpe National Transportation Systems Center
for the ITS Joint Program Office
Research and Innovative Technology Administration
U.S. Department of Transportation

Improving Safety and Mobility NOW!

Travelers of the 21st century have access to technology like never before.

Automobile warning systems are helping drivers to see at night, stay in their lanes, and maintain safe tires. Portable navigation devices are helping them to avoid congestion and access location-based services. Wireless communications and smartphones are enabling transit riders to plan their commutes based on where the buses and trains actually are instead of on static schedules that don't account for delays. With this revolution in consumer electronics come new expectations — and challenges — for using Intelligent Transportation Systems (ITS) to improve everyday trips for ordinary people.

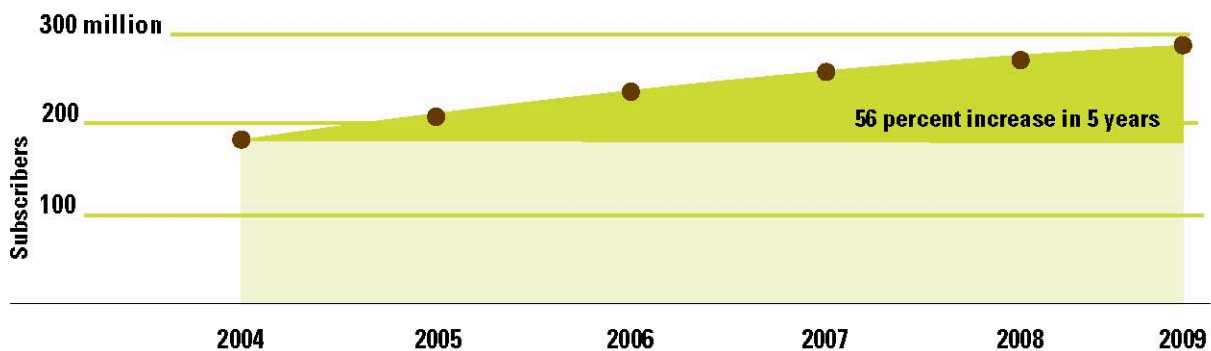
In the not-too-distant past, technology was expensive and beyond the reach of mainstream consumers. But times are changing.

Safe and Efficient Travel Through Innovation and Partnerships in the 21st Century (SafeTrip-21) is one

of the first federally funded ITS field tests to focus on market-ready consumer products and to invite the public to safely experience the benefits of emerging transportation technology. The program has allowed teams to take concepts that were previously proven in research environments and try them in real-world settings. Commuters in San Francisco can see if it makes more sense to park and take the train to work today. Road-tripping families along the Eastern Seaboard can see whether traffic on I-95 will slow their weekend travels. Construction-zone managers in North Carolina can watch for traffic backups without setting foot on the road. SafeTrip-21 has given the nation a first-hand taste of the connected environments that are revolutionizing transportation.

This document describes SafeTrip-21 and the achievements made possible through partnerships between the United States Department of Transportation (U.S. DOT) Research and Innovative Technology Administration (RITA) and state governments, private companies, and academic research institutions.

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ITS partnerships.

Ordinary people.

Ideas with a future.

SafeTrip-21 bus at the ITS World Congress in New York City, November 2008. (photo: UC Berkeley)

A New Approach to Federal ITS Field Tests

Intelligent Transportation Systems that leverage wireless communications, consumer electronics, and global positioning systems (GPS) have exploded in popularity during SafeTrip-21's short life and changed the way that the U.S. DOT thinks about technology deployments. When the program launched in 2008, the U.S. DOT's Vehicle-Infrastructure Integration (VII) program envisioned a future, connected transportation environment that would rely on Dedicated Short-Range Communications (DSRC) to provide mobility benefits and prevent automobiles from crashing into roadside objects and each other. However, the public would only be able to enjoy the benefits of the system once an extensive network of roadside sensors, operations centers, and instrumented vehicles was installed — at a significant cost to public agencies presumed to pay for it. Research tests had been successful in demonstrating

VII and DSRC concepts in controlled field test environments. The U.S. DOT needed a way to expose the public to the potential benefits of ITS technologies in order to build the case for widespread deployment and to convince decision makers to invest in it.

The idea of offering ITS functionality on common mobile devices was also beginning to take hold. Smartphones with web browsers and specialized software applications (“apps”) were just being released. Transportation agencies were collecting data about road and transit conditions and pushing this information to travelers via the internet and text messages. However, very few agencies were releasing data to freelance developers to build display tools or were leveraging public networks to gather the data.

Vehicle-Infrastructure Integration (VII) 2004 – 2008

- Connected light vehicles and infrastructure initially.
- Required extensive new infrastructure.
- Focused on predefined suite of technologies and DSRC communications for mobility and safety applications.
- Assumed major Federal involvement and investment.
- Provided long-range outlook.

SafeTrip-21

- Accelerates ITS research into real-world use.
- Pilots a model for Federal ITS field tests that:
 - Leverages existing infrastructure and technologies.
 - Invites partnerships with shared funding.
 - Focuses on sustainable, market-ready applications.
 - Deploys and shows benefits quickly.
 - Engages the public and popularizes ITS concepts.
- Helps focus future Federal research investments.

Connected Environments for Transportation 2010 – 2014

- Also connects heavy vehicles and transit.
- Incorporates new and existing technologies and infrastructure.
- Encompasses broader range of technologies and more open communications platform for mobility and environmental benefits.
- Maintains emphasis on DSRC for safety applications.
- Accommodates market-driven investment models.
- Short- and long-term phases.

SafeTrip-21's Criteria for Involvement

ITS solutions that:

- Provide safety, mobility, and environmental benefits.
- Can be demonstrated at the 2008 ITS World Congress in New York City.
- Deploy quickly thereafter.
- Are sustainable beyond the Federal investment.

or

ITS field test hosts that:

- Can provide a real-world test site for ITS applications.
- Have an existing infrastructure that is used by ordinary travelers.
- Will leverage proven partnerships and provide at least 50 percent in non-Federal funding.
- Can remain operational after Federal investment.

In the midst of these technical changes, the U.S. DOT RITA became intrigued with the idea of trying out a new ITS field test model — one that was outcome-oriented, accessible to the public, and self-sustaining. The model would also allow applicants to propose creative ITS solutions to stated transportation problems rather than limit them to preassumed solutions, as past field tests had done. The idea became *Safe and Efficient Travel Through Innovation and Partnerships in the 21st Century*, or SafeTrip-21.

The SafeTrip-21 initiative would encompass a wider range of technologies and vehicles of all types, including transit and commercial trucks. The initiative would align with the U.S. DOT ITS vision for using DSRC to connect vehicles and roadside devices for safety-critical applications. However, it would also accept other communications platforms and technologies that could provide immediate mobility and environmental benefits. The applications selected for SafeTrip-21 funding would be ready to deploy quickly and would serve as an inaugural field test to introduce the public to upcoming connected transportation concepts.

With the envisioned outcomes in place, potential partners were invited to demonstrate how their

ITS concepts could be used to enhance mobility, improve safety, and reduce environmental impacts for automobiles, transit, or commercial fleets in real-world settings. The original Broad Agency Announcement (BAA) solicited two types of applications: ITS solutions and real-world test beds on which solutions could be tested. (See graphic above.)

In 2008 and early 2009, the U.S. DOT issued four awards. The initial award was to a partnership spearheaded by the California Department of Transportation (Caltrans). The California Connected Traveler Test Bed proposed to improve the travel experience on the San Francisco Bay Area's congested highways, with more than 10 academic, private-sector, and operating entities. The second award was for the I-95 Corridor Coalition Test Bed, which, with its public- and private-sector partners, proposed to inform travelers about traffic along the Eastern Seaboard. The final two awards went to iCone Products LLC and TraffInfo Communications, Inc., which tested independent ITS equipment targeted at improving transportation operations on the two test beds. With that, SafeTrip-21 was ready to go. Partner agencies were on board, funding was in place with a better-than-expected cost-sharing ratio of 3:1, and real-world ITS tests were in the pipeline.

The Program Timeline

A SafeTrip-21 Begins 2/08

RITA partners with the Volpe Center to carry out a vision for accelerating adoption of VII concepts in the U.S. The team develops a project concept based on ITS activities in Europe and the results of a recent RITA Request for Information (RFI) about market-ready ITS technologies. The Volpe team visits Japan and issues an open-ended Broad Agency Announcement (BAA) to request proposals from potential partners.

B California Connected Traveler Awarded 5/08 (see pages 8 & 9)

C SafeTrip-21 Introduced at ITS World Congress with Early-Concept Connected Traveler Applications 11/08

SafeTrip-21 is unveiled at the ITS World Congress in New York City. A 1957 Plymouth Belvedere is transformed into a “smart” car at the 11th Avenue Theater, using aftermarket devices that emit “here-I-am” messages. Hundreds of attendees ride a SafeTrip bus that demonstrates location-based alerts, on-board signage, pedestrian warning messages, and signal-phase and timing (SPAT) capabilities in an operational New York Metropolitan Transportation Authority bus. RITA staff showcase websites and handheld technology at the SafeTrip-21 booth. The project receives significant media attention.

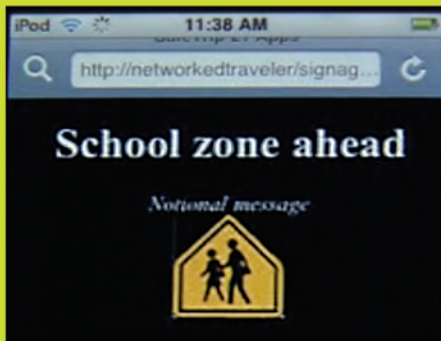
C I-95 Corridor Coalition Awarded 11/08

(see pages 10 & 11)

C iCone Products Awarded 11/08

(see pages 9 & 11)

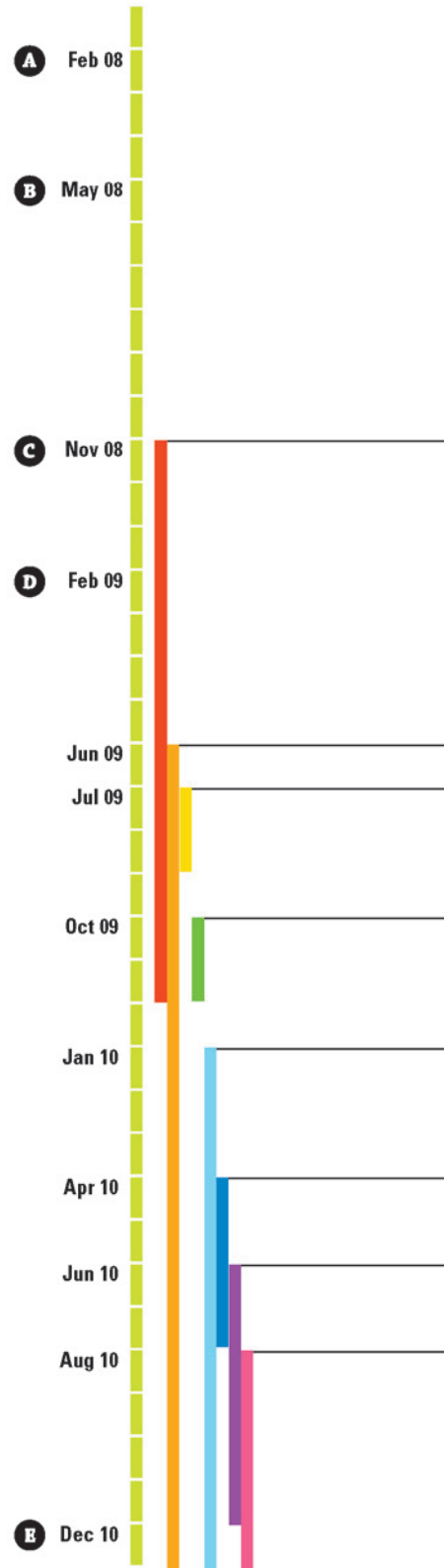
(Top) School-zone crossing signs on street trigger on-board signage alerts (center) in SafeTrip-21 bus. (Bottom) A 1957 Belvedere showcases smart-car technologies at the 11th Avenue Theater. (photos: UC Berkeley)



D TrafInfo Awarded 2/09 (see page 9)

E Projects Completed 12/10

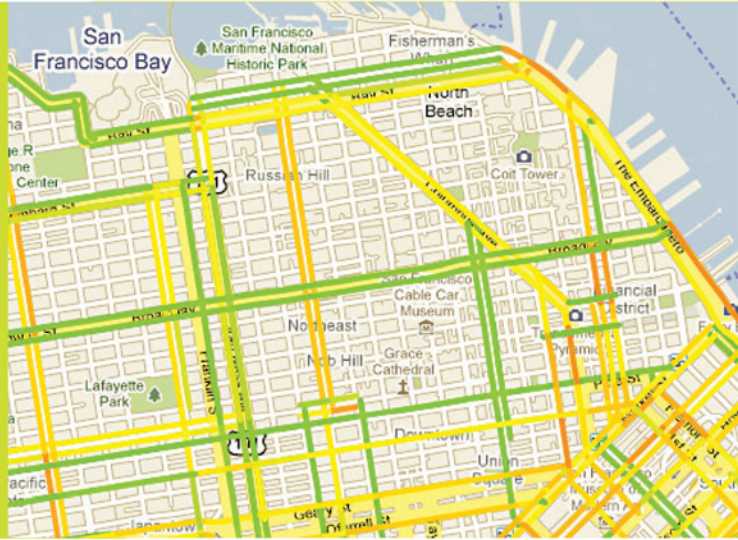
Results of SafeTrip-21 tests inform ongoing Federal policy and pilot deployments.



Test Dates

Mobile Millennium 11/08
(see page 9)

Mobile Millennium Visualizer uses color-coded map to show traffic conditions in San Francisco. (image: CCIT)



Long Distance Trip Planner 6/09 (see page 11)

iCones: Portable Traffic Monitoring Devices
(NC) 7/08 – 8/08 (see page 11); (CA) 9/09 – 1/10 (see page 9)

Intersection Delay Monitoring 10/09 – 11/09 (see page 9)

Public Traffic Map Displays 1/10 (see page 11)

BWI Airport Ground Access Information System 4/10 (see page 11)

Networked Traveler: Foresighted Driving 7/10 (see page 9)

Networked Traveler: Transit and Smart Parking 8/10 (see page 9)

Transit rider views real-time train arrival times on PATH2Go using mobile device. (photo: PATH)



The California Connected Traveler Test Bed

Improving Bay Area Mobility

The California Connected Traveler Test Bed was a \$14.6 million public-private effort led by Caltrans that spanned several rail, bus, and highway corridors in the San Francisco Bay Area. Between October 2008 and November 2010, five ITS applications were evaluated.

The California Connected Traveler Test Bed leveraged long-standing partnerships between Caltrans, the operator of many of the major highways in and around the Bay Area, and two University of California at Berkeley transportation research centers, the

California Partners for Advanced Transit and Highways (PATH) and the California Center for Innovative Transportation (CCIT). The project also gave team members new opportunities to work with key transit agencies along the San Francisco Peninsula, private-sector companies, and the Metropolitan Transportation Commission (MTC). The five project applications were aimed at solving some of San Francisco's pressing transportation issues: rear-end collisions on expressways, commuters stuck in traffic on Highway 101 when a nearby Caltrain commuter rail can offer a quicker trip, and full parking lots or confusing bus-train transfers that deter people from trying transit.



1 Mobile Millennium Where there are cars, there's sure to be congestion. That's why Mobile Millennium, a public-private research partnership among Caltrans, CCIT, and NAVTEQ/Nokia, tested a traffic-monitoring system that used GPS-enabled smartphones to gather and share real-time traffic information. Mobile Millennium used unprecedented techniques to protect user privacy, integrate cell-based probe data with sensor data, and target data collection to selected locations and times. The application was a forerunner in safe, phone-based data collection and data fusion algorithms, paving the way for future traffic data systems.

2 Networked Traveler: Foresighted Driving Wouldn't it be nice to know about upcoming slow traffic before you see it? Networked Traveler: Foresighted Driving, a test partnership with Caltrans, PATH, NAVTEQ/Nokia, and Nissan Motor Company, tested and evaluated a driver notification system that audibly alerts travelers about slow or stopped traffic ahead. The project explored the realm of "situational awareness" that makes drivers aware of their surroundings but encourages them to make adjustments before hazards are imminent. The research provided some of the functionality that will be available in a future connected-vehicle environment by leveraging existing roadside sensors, cellular networks, and consumer devices to trigger alerts as a prelude to DSRC-based systems.

3 Networked Traveler: Transit and Smart Parking "Should I drive or take the train today? Is there parking at my station? How does my choice effect my environmental footprint?" Networked Traveler: Transit and Smart Parking tried to help commuters answer these questions by providing real-time transit and parking information via the internet and smartphone applications. Spearheaded by Caltrans in conjunction with CCIT, PATH, MTC, San Mateo County Transit District (SamTrans), Santa Clara Valley Transportation Authority (VTA), and ParkingCarma, the project had the added benefit of providing the transit agencies with information on the locations of trains and buses. This project was the first to integrate real-time information

from multiple San Francisco Peninsula transit providers and combine it with freeway traffic and parking information. Commuters can use the PATH2Go apps and website to compare the cost, time, and environmental impacts of taking public transit instead of driving. They can also view real-time parking availability. Transit riders can receive transfer information and bus-stop/station alerts while they are on buses and trains.

4 Portable Traffic Monitoring Devices It may look like an ordinary orange traffic barrel, but the iCone is much more. Designed by iCone Products LLC, these portable ITS devices are equipped with advanced sensors and communications technology that collect and transmit work-zone traffic data. Highway officials can access the data via the internet, allowing them to easily view conditions at multiple locations along a corridor. They can use the information to determine appropriate times to close work zones or redirect traffic to ease congestion. Caltrans tested the barrels on the Bay Bridge during a closure over Labor Day weekend in 2009, at several other work zones, and during the 2010 Rose Bowl Parade in Pasadena.



(photo: Calmar Research)

5 Intersection Delay Monitoring System Isn't it great when you get a continuous chain of green lights? TraffInfo Communications, Inc., along with Caltrans, tested an application that collects traffic volume and timing information at traffic signals to estimate delays to cars. The system continuously collects data that are not typically available from traffic signal controllers and makes them available to highway operators over the internet. The information can then be used to retime signals, create demand-based network plans, and even tell the public how to avoid congestion.

The I-95 Corridor Coalition Test Bed

Showcasing Interstate Traveler Information

The I-95 Corridor Coalition Test Bed was a \$6.4 million project that spanned the I-95 Corridor between Maine and Florida. From summer 2009 to fall 2010, four ITS applications were tested.

SafeTrip-21 enabled an established team of the I-95 Corridor Coalition, the University of Maryland, and several private-sector companies (including INRIX, PBS&J, EnterInfo, and KMJ Consulting) to expand an existing vehicle-probe project and make the data available, free to the public. The program also provided opportunities for new, informal collaboration with Baltimore/Washington International (BWI) Thurgood Marshall Airport and the Washington Metropolitan Area Transit Authority (WMATA) to emphasize multimodal partnerships that would benefit the interstate and its communities.

Stretching more than 1,900 miles through 15 states, Interstate 95 is the main north-south route along the Eastern Seaboard. Whenever there's construction, a weather event, or holiday travel, a significant number of people are affected by the resulting traffic congestion. The I-95 test bed projects were designed to help travelers avoid delays along this major thoroughfare by offering information on traffic conditions and transit options.



I-95 Corridor Coalition Field Test Partners



1 Long Distance Trip Planner What's the impact of travel time information on long-distance travel planning? That's what the I-95 Corridor Coalition set out to find with the Long Distance Trip Planner, a fully interactive website that provides the public with real-time information on speed and travel time between key cities. It is the only system that provides traveler information for thousands of miles along the entire corridor, across state and city boundaries. The information was available to the coalition and its members in the past, but SafeTrip-21 allowed the partners to expand coverage and build a free trip planner for the public.

2 Public Traffic Map Displays Would you take a different route home from the mall or shop longer if you were aware of local traffic delays? That was the question behind placement of flat-panel screens at the Tyson's Corner Center Mall and two Virginia Department of Transportation (VDOT) welcome centers. The screens provide travelers with traffic information that they can use but might not otherwise seek out. Many traveler information systems require savvy consumers to locate them, whereas these traffic displays are easy for everyone to find.



(photo: SAIC)

3 BWI Airport Ground Access Information System Figuring out the best way to get to and from an unfamiliar airport can be a challenge. The I-95 Corridor Coalition tested a traveler information system that provides multimodal ground transportation information to and from BWI Airport. A kiosk, website, and mobile application became available in early 2010. The application combines schedule, price, and location information for several Capital Area transit agencies and private transportation providers, piquing the interest of travelers and the airport in multimodal information services.



(photo: SAIC)

4 Portable Traffic Monitoring Devices Could traditional traffic barrels be used to monitor construction sites? iCone Products LLC tested the application of portable data collection devices at three work zones in North Carolina in the summer of 2009. North Carolina Department of Transportation (NCDOT) construction managers used the same radar-based devices that were used in California to monitor speeds and backups at work zones from offsite locations via the internet. Managers used the data to identify critical problem areas along work zones and implement location-specific interventions. Similar to its impacts in California, the iCone devices allowed NCDOT managers to cost-effectively monitor work zones and ease traffic delays from afar.

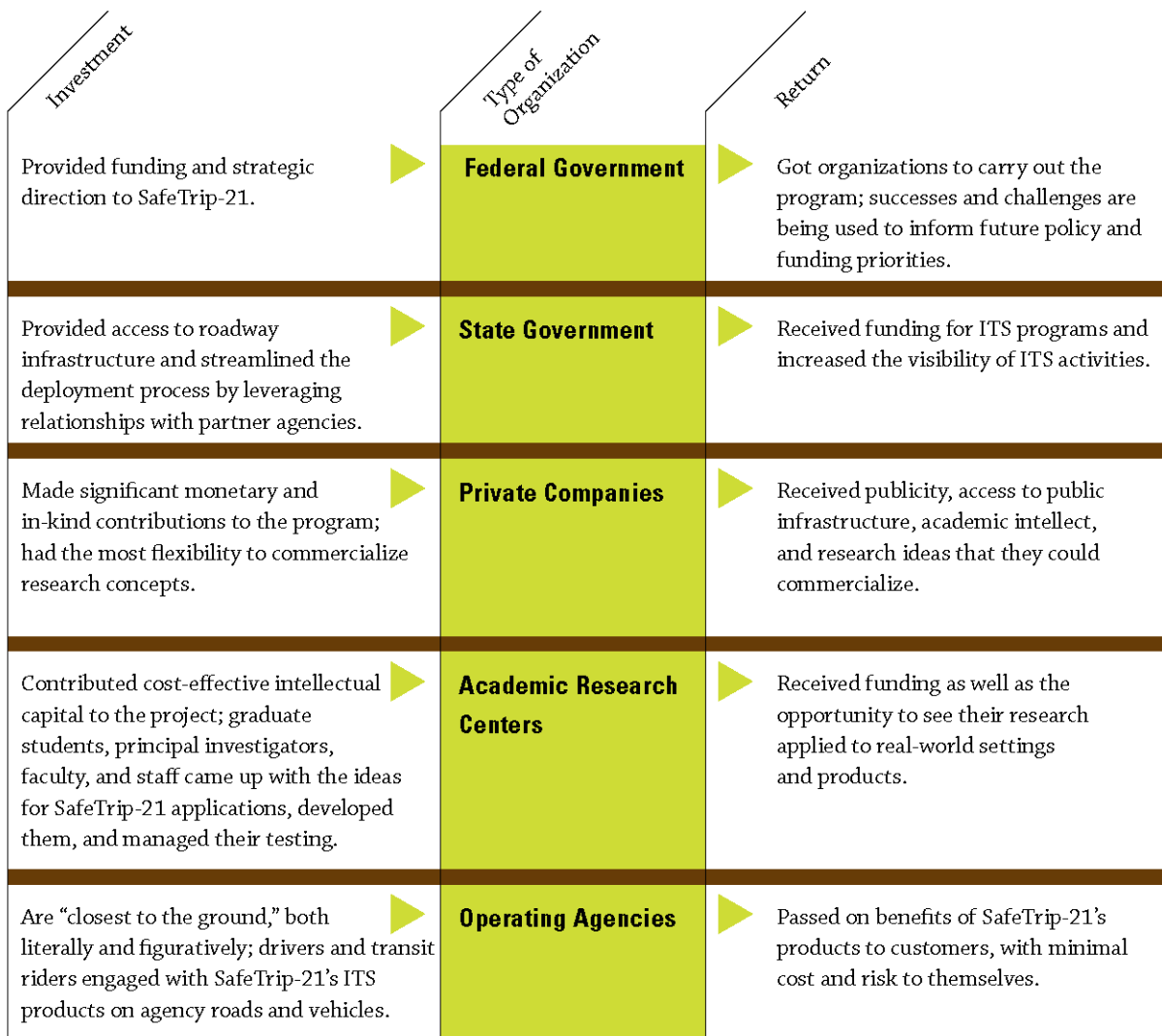
Partnering for Success

Incorporating partnerships into SafeTrip-21's design

The Intelligent Transportation Systems (ITS) Joint Program Office (JPO) and the Volpe Center — sister organizations within the U.S. DOT RITA — joined together to award SafeTrip-21 grants in 2009. The relationship was strategic: the ITS JPO had funding for field tests and the Volpe Center had the expert staff to solicit and oversee the grants.

The Volpe Center entered into agreements with the primary SafeTrip-21 partners: Caltrans, the I-95 Corridor Coalition (via the University of Maryland), iCone, and TraffInfo. These primary partners then carried out the work under the oversight of the Federal partners.

The teams led by Caltrans and the I-95 Corridor Coalition were responsible for providing the non-Federal portion of the cost-share, delivering proposed applications,





SafeTrip-21 leveraged partnerships to incorporate Federal research into commercial products.

and running the tests. The diverse partnerships allowed team members to make unique contributions to the project and to experience mutual gain that would not have been possible if the entities had acted alone.

The partnerships also required compromise and sacrifice. Private-sector partners tended to have short timelines and discrete outcome-oriented objectives, while academic partners focused on ongoing learning and research impacts. Operating entities had constraints to implementing field tests on their properties, which the partners had to accommodate in their experiments. Several layers of agreements between the ITS JPO, the Volpe Center, the primary partners, and their subsidiaries required formal adjustments whenever the project schedule changed significantly, which led to delays and occasional stop-work periods. Moreover, each test bed had to collect at least as much internal funding as the government was providing to the projects, meaning that several entities would also have a financial stake in the outcome.

Finally, the program required an independent evaluation. The ITS JPO contracted with private companies Science Applications International Corporation (SAIC)

and Delcan to conduct this evaluation. The evaluation team had access to test participants and partner data but otherwise remained independent. The SafeTrip-21 partners accommodated the evaluation team's requests, and the evaluation team was respectful of the partners' limitations, forging a working relationship to achieve their different objectives.

ITS partnerships.

Ordinary people.

Ideas with a future.

Test Results

SafeTrip-21 raised awareness of transportation technology and offered significant exposure to ITS. Through the program:

- **Thousands of professionals from 66 countries** had the opportunity to preview SafeTrip-21 applications and ride the demonstration bus at the 15th World Congress on ITS in New York City.
- More than **85,000 people** were directly exposed to ITS concepts by using SafeTrip-21 websites and applications, responding to user surveys, and participating in focus groups.

- Test bed activity spanned transportation infrastructure in 16 states.
- Over **160 news articles and press releases** were written on the program and its projects.
- Presentations related to SafeTrip-21 were given at **six major conferences** over three years.

In addition to SafeTrip-21's broad programmatic exposure, individual projects yielded the interesting findings summarized in the following table. See "Further Reading" on page 25 for more details.

Project and Reach	Results in Brief
<p>Mobile Millennium</p> <p>2,241 unique downloads and 2,000 registered users between November 2008 and November 2009.</p>	<p>Travelers are willing to share their data in exchange for traffic information. At SafeTrip-21's start, nobody knew if the public would trust a third-party application to collect data from their phones, even if they were to receive traffic data in exchange. It turned out that 68% of respondents to a June 2009 Nokia user survey indicated that they trusted the system to protect their privacy, and an overwhelming majority indicated that mobile traffic applications are useful. Probe data can be used to model traffic on roads with uniform traffic conditions. The team wanted to see if it could use data from phones to accurately describe traffic, using computer models. The results of highway model tests showed a high degree of accuracy, while arterial model results varied with traffic conditions. Ground-truth tests using up to 20 probe vehicles and Bluetooth readers on an urban arterial (San Pablo in Berkeley) showed a 7% average arterial model error. Similar tests on a more heavily congested arterial (Van Ness in San Francisco) showed a higher average error of 28.68%.</p>
<p>Networked Traveler: Transit and Smart Parking (NT: Transit)</p> <p>900 registered PATH2Go users in the first 4 months of operation. In a typical day, up to 20 users opened the application and 25 users visited the website.</p>	<p>Travelers like having integrated parking, transit, and traffic information. Two-thirds of survey respondents indicated that they found PATH2Go useful, accurate, and helpful in reducing their wait times. More than half said that the system helped them consider transit as a more viable choice. It is possible to restrict access based on the travel mode of users. The project demonstrated an unprecedented geo-fencing application that allowed transit rider use and prevented driver use. This feature annoyed 70% of evaluation survey respondents, but it provided a jumpstart for future research into safeguarding apps to prevent distracted driving.</p>
<p>Networked Traveler (NT): Foresighted Driving</p> <p>24 trained test drivers commuted with instrumented cars for 1 week with alerts and 1 week without alerts.</p>	<p>Real-time situational awareness alerts help to influence driver behavior, with minimal annoyance or distraction. Test participants used the brakes slightly less aggressively during the morning peak commute and off-peak hours when they were receiving alerts. Drivers also told researchers that 51.9% of the alerts they received made them more aware of their surroundings and that 37.6% caused them to reduce their speeds. Survey results showed that the alerts did not annoy or distract participants much if at all.</p>

Project and Reach

Intersection Delay Monitoring System

The system operated on a busy Caltrans signal in Palo Alto for 12 days in fall 2009.

Results in Brief

Agencies can remotely monitor traffic delays at operational traffic signals. Transportation agencies typically check to see if traffic signals are properly timed by observing waiting vehicles or setting up expensive temporary data collection equipment. The innovative Intersection Delay Monitoring System allowed Caltrans to formally monitor a signal remotely by collecting timing, cycle length, and volume data from the Caltrans 2070 controller and making it accessible over the internet, without interfering with normal operations of the controller.

Long Distance Trip Planner

A total of 62,000 visitors went to the website over the evaluation period from June 2009 to October 2009.

Cross-jurisdictional traffic information is valuable when travel conditions are unusual. Baseline usage of the website hovered around 25 – 50 visitors per day in the first few months of operation (June – October 2009). However, during November 2009, website usage increased from 2,000 to 20,000 visitors in one month due to Thanksgiving weekend traffic and major marketing efforts (see “Engaging the Public” on page 17). After that, usage remained a bit higher (about 200 visitors per day) and doubled or tripled on days when there were winter storms. Evaluation survey respondents indicated that they consulted the website most often when they were making out-of-town trips.

BWI Ground Access Information System

21,000 unique visitors went to the website and kiosk over 8 months, with about 1,000 – 4,000 per month.

Airport travelers can learn of new transit options from ground transportation information systems, even though practical implementation may be a challenge. Some 30% of surveyed website users learned about a new transit option (bus, rail, or shuttle) to or from the airport, and 11 people reported that they tried one option because of the site. The partners did find that small details — the location of the kiosks, the types and quantity of marketing, the regional travel options included, and practical issues with the kiosk operation — complicated implementation and limited usage.

Public Traffic Map Displays

Traffic data were shown on 5 screens in Tysons Corner Center Mall and at 2 VDOT welcome centers on I-95.

Travelers are open to changing their routes based on publicly displayed traffic information. Over half of surveyed VDOT welcome center visitors said that they would consider changing their plans if screens showed major traffic ahead. Mall visitors and employees also thought it would be very useful to see incident information and traffic conditions before leaving. Yet **location is critical.** Most (78%) of surveyed mall visitors did not see the screens until they were surveyed. In addition, the evaluation team observed that screens near the rest rooms in one welcome center were more popular because they were available 24 hours a day and many people passed by them. The screens in the other welcome center were placed in locations where staff could help interpret them, but they were unavailable after 5 p.m. and attracted only travelers who were already seeking out tourist information.

Portable Traffic Monitoring Devices (PTMDs)

12 PTMDs were used at 6 sites in California and 6 were used at 3 work zones in North Carolina.

Portable ITS devices help work-zone managers. NCDOT and Caltrans staff interviewed by the evaluation team found that the PTMDs were easy to place, maintain, and initialize. It was convenient for them to monitor work-zone speeds from the internet because they could make decisions about opening lanes or redirecting traffic without physically visiting the work site. Also, the GPS locators in the iCones made the devices easy to recover when they were moved or stolen.

Engaging and Safeguarding the Public

Before SafeTrip-21, Federal ITS field tests had involved recruited test subjects in controlled research environments or vehicles. SafeTrip-21 sought to invite the general public to treat their unique personal transportation environments as the research settings. This goal proved to be challenging from the outset. Partners had to minimize risk — allay safety concerns about cell phone usage, privacy concerns about GPS tracking, and research concerns about treatment of human subjects — while maximizing participation. Partners also had to figure out how to carry out the tests in such a way that they could solicit feedback from users without deterring or encumbering them.

Engaging the Public

SafeTrip-21 partners had plans for making their systems available to the public, but nobody was prepared for the amount of effort that would be required to capture — let alone keep — the attention of travelers.

Get the public's attention. SafeTrip-21 researchers learned that just because you build great technology does not mean that people will use it. Partners had to leverage existing media outlets and look for creative ways to get people to participate.

The NT: Transit Project partnered with MTC, which had a pre-existing audience of drivers looking for traffic information on its 511 transportation website, and leveraged that site to run promotions about PATH2Go in the summer of 2010. The direct link brought a flood of new users in the first few days after launch. The I-95 Corridor Coalition issued a press release

directing holiday travelers to the Long Distance Trip Planner during the 2009 Thanksgiving week. The story was picked up by media outlets nationwide, including *USA Today*, the *Washington Post*, NPR, ABC, and FOX TV, and 10,000 additional people visited the website.

Make it accessible. SafeTrip-21 partners needed to make their applications easily accessible to the public. However, technical complications and changing safety policy threatened to hamper accessibility.

Smartphones run on many different operating systems, which means that if you want to design an application for different phones, you have to create a separate app for each operating system. The NT: Transit Project initially created an app for Windows Mobile but found that it held a very small share of the smartphone market in California. In order to expand its user base, the team developed iPhone and Android apps. While Android app development and release went smoothly, the app for the iPhone was delayed in the approval process. Releasing the system on three operating systems made both development and access challenging. The team also found that the geo-fencing capability developed for the project occasionally blocked transit riders.

NT: Foresighted Driving also faced difficulty reaching the public when growing concern over distracted driving caused partners to restructure the study to eliminate uncontrolled use by the general public. Instead of providing awareness alerts via cell phones, the research team instrumented study vehicles that could provide alerts over vehicle sound systems. This change allowed

the partners access to more thorough data on driver behavior but limited the test to 24 study participants.

The I-95 Corridor Coalition's Long Distance Trip Planner and BWI Airport Ground Access Information System teams made minor alterations to their systems so that functionality with the potential to distract drivers could not be accessed from smartphones. Vehicle passengers were also unable to access the website as a result.

Keep them coming back. A key to ensuring a new product's success is to entice users to return to it again and again.

The Long Distance Trip Planner found that most travelers seldom take long-distance trips, so they have limited occasion to use a website that provides long-distance travel times. A survey showed that users look for the information when traffic conditions are unusual. Severe

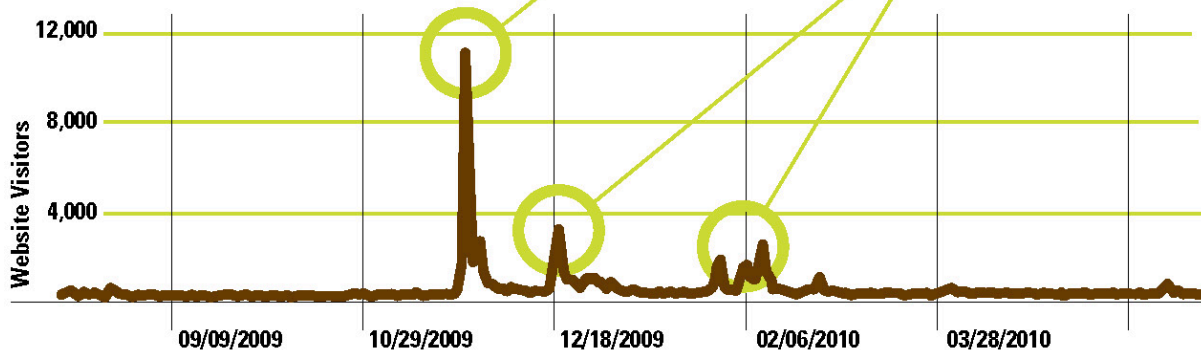
blizzards in the spring of 2010 drove many users to the Trip Planner website, but after the weather improved, website usage dropped closer to pre-existing levels.

It is common for smartphone apps to be used only once or twice, and the partners found this to be true for SafeTrip-21 as well. Mobile Millennium found that most users turned on the application less than twice a week. Partners concluded that people may be more likely to use traffic probe programs that are bundled with other software and location-based services.

The partners for NT: Transit found that a high percentage of users never even looked at their mobile app after downloading it, and a very small percentage used it more than once or on an ongoing basis.

In light of this, the partners had to carefully interpret usage data relative to the goals of the project: Is the goal to keep people coming back all of the time or to be

The statistics for www.i95travelinfo.org show peak usage during the Thanksgiving weekend after the website was featured in several news articles. More people also visited the website during two major blizzards. (photos: PATH/SAIC)



there when people need the information even if they visit infrequently?

Gather feedback about users' experiences. User feedback is an important gauge of whether new applications and products are having their intended effects. SafeTrip-21 partners needed to ask for input without encumbering users with so many requests that they stopped coming back or started ignoring partner communications.

The Long Distance Trip Planner, Mobile Millennium, NT: Transit, and NT: Foresighted Driving tests and evaluations utilized web surveys to capture feedback. Response rates varied, but all of the surveys provided useful insights. The Long Distance Trip Planner evaluation survey received 251 responses (60 percent of the estimated statistically valid sample size), but provided some surprising results (70 percent of respondents

were over the age of 50, indicating adoption by more than tech-savvy youth) and affirmed the public's desire for traveler information (the vast majority of respondents found the information valuable). Mobile Millennium partner Nokia received over 600 responses to two voluntary user surveys, a 23 percent average response rate. These responses confirmed user interest in accurate traffic data despite inconsistent usage of the system.

The evaluation contractor for Tyson's Corner Center Mall ran a focus group on the Public Traffic Map Displays, but because it was reaching out to people who may or may not have seen the displays, the feedback was mainly theoretical. Respondents offered comments such as, "I like this information, and I would probably find it useful," which provided insights to the team even though they may not be representative of the general public.

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The PATH2Go application displays a warning to indicate that it will not work in a moving automobile.
(photo: PATH)



The partners and contractors learned that it was more difficult to get good feedback than they had expected. They realized that, for optimal success, the mechanisms for feedback need to be designed into projects from the beginning.

Safeguarding the Public

Safety concerns and cell phone usage. At SafeTrip's start, smartphones and custom software applications were about to take the world of transportation by storm. Partners anticipated the trend and proposed several projects involving phones. They mindfully adhered to prevailing safety standards, ensuring that all cell-based aspects of the projects be operable "hands-free" and used cautiously in a vehicular environment. As the months passed, the potential dangers of cell phone use (hands-free or otherwise) in any moving vehicle became better understood. In response to an evolving safety environment and an emerging zero-tolerance policy within the U.S. DOT, members of the I-95 Corridor Coalition and the California Connected Traveler partnership altered several of the tests to eliminate any possibility of driver distraction. NT: Transit Parking took the policy change as a challenge to innovate. The researchers applied "geo-fencing" concepts (the use of GPS location information to alter software behavior), turning off their application when it appeared to be in use by a driver in a car but leaving it on when in use by a transit rider.

Privacy concerns for participants. Several SafeTrip-21 applications used data from participants' GPS-enabled smartphones to provide location-specific information. Partners wanted to protect the privacy of their participants as much as possible, recognizing that the product's commercial viability may be dependent upon maximum privacy protection. The Mobile Millennium partners applied their previously developed concept of Virtual Trip Lines (VTLs) to address privacy concerns associated with gathering speed and location data from

private cell phones. Whenever a probe passes a geographic point where the researchers have placed a VTL, the phone provides a speed update only so that travel time can be estimated without compromising personal information. The system aggregates data from many users and stores it in such a way that it is impossible to assemble an identifiable profile of any user.

Research concerns and human subjects testing. The University of California at Berkeley has a Committee for the Protection of Human Subjects (CPHS) that serves as an Institutional Review Board (IRB) to review all research projects involving human subjects. The test protocols for Mobile Millennium and the Networked Traveler projects were reviewed and approved by CPHS. The I-95 Corridor Coalition also had the University of Maryland IRB review and approve the mobile aspect of the BWI Airport Ground Access Information System.

"The SafeTrip-21 program was instrumental in accelerating our efforts to provide real time travel information to the users of the I-95 corridor. We were able to get timely and accurate information to the travelers in the nation's most heavily traveled corridor, which would not have been possible without the assistance provided by the SafeTrip-21 program. The result was a travel information program greatly benefiting all the users of the corridor."

— George Schoener, Executive Director
I-95 Corridor Coalition

Learning from SafeTrip-21

SafeTrip-21's pioneering approach to field tests resulted in unprecedented opportunities to leverage non-Federal funds and expose the public to ITS concepts. However, it also came with the need to balance competing priorities to deliver something that the government would find acceptable, the operating partners would find useful, the academic partners would find brilliant, and the public still would be willing to try. All involved parties — from the funding agency (the ITS JPO) to the administering entity (the Volpe Center) to the primary partners (Caltrans and the I-95 Corridor Coalition) and their teams — learned about give-and-take, patience, and the need to stay focused on the goals of the program when circumstances required changes to the experiments. While the partners may benefit most from SafeTrip-21's lessons, their experiences may prove valuable to future Federal ITS field tests.

Leverage Formal and Informal Partnerships.

SafeTrip-21 partners faced several significant issues in working together across multiple agencies — namely, the need to coordinate schedules, to agree upon project scope, and to communicate effectively to get things done. Strong relationships were both required in the initial SafeTrip-21 solicitation and essential in addressing the issues that came up along the way. History and formality also affected the partnerships.

New partnerships needed to work out their relationships across organizations and tackle the technical aspects of their programs, while pre-existing partnerships could focus on technical work straightaway because they already had working relationships. This made development faster and more straightforward.

In the California Connected Traveler partnership, Caltrans, PATH, CCIT, and Nokia had worked together

previously. Other organizations were new to the team. Given that so many entities contributed to the test bed, managing and maintaining a team approach was an ongoing challenge for Caltrans.

In the I-95 partnership, the I-95 Corridor Coalition and its contractors had a direct and clear relationship that came from previous collaboration. However, the informal external partners such as VDOT and BWI Airport offered much more uncertainty. While the long-standing partners had a plan and a project schedule that they were working toward, the new partners' primary focus was on their organizations' day-to-day operations, which made the SafeTrip-21 activities a secondary focus.

The SafeTrip-21 partnerships between Federal agencies and the partnering leads were formalized through Cooperative Agreements — legal documents between the U.S. Federal government and another public entity when that entity conducts work on behalf of the government. The partnerships between other team members were based on some formal and some informal contracts. The Cooperative Agreements and formal contracts were the most cumbersome to change and update throughout the life of the project, but they were also respected and honored by all team members. The challenges stemming from the formal contracts were exacerbated when the State of California changed its contracting procedures mid-way through the project. Approvals that previously could move through Caltrans in weeks now had to be reviewed by a separate agency and took months, which affected the schedule on many occasions.

On the other hand, the informal working relationships offered flexibility that allowed projects to evolve with time, but they were also less restrictive to informal partners, which occasionally led to delays and disagreements. For example, one partner team had an informal

agreement with a transit agency to install equipment on buses; the team had an aggressive schedule in mind, but the transit agency needed more time to address internal concerns and ensure that the partners' work did not disrupt its operations. The SafeTrip-21 partners had to wait patiently until the agency was ready and adjust their project schedule accordingly.

Stay Focused Yet Flexible.

The ability to shift focus and keep on track in the face of unexpected external factors was a critical part of testing and evaluation. Flexibility was key in these projects, and the SafeTrip-21 teams were put to the test when two major factors altered their projects: the economic decline and policy changes regarding distracted driving.

The downturn in the economy shifted Federal priorities, raising the profile of the Federal stimulus package above all else. The economy also impacted SafeTrip-21 partners, with Caltrans compelled to implement a one-day-per-week staff furlough for cost savings, resulting in a shorter work week for Caltrans partners.

A Federal focus on the dangers of distracted driving caused the partners to pause and ultimately changed the way that mobile applications were tested. For NT: Transit, partners geo-fenced their technology to ensure that drivers weren't accessing their application behind the wheel. NT: Foresighted Driving also altered field tests to mitigate the potential for distracted driving, using specially equipped vehicles and trained drivers as opposed to members of the general public with their own cars and cell phones.

Manage Expectations.

SafeTrip-21 focused on applications that were deployment-ready or near-deployment-ready. The project demonstrated multiple applications, including Mobile Millennium, iCone, and elements of NT: Transit, along with other applications that were not continued into

field operational testing, at the ITS World Congress in New York City in November 2008. However, several of the applications took another six to 18 months longer to develop and scale up for public deployment. While the project afforded the flexibility to push out the schedule, the longer development period exposed it to the risk of external changes that would further affect the project development process. In the case of NT: Foresighted Driving, concerns regarding distracted driving arose during the extension (after the original targeted completion date) that required it to be redesigned before it could be field tested and thus delay it further.

Expect the Cutting Edge to Change Quickly.

SafeTrip-21 and its ITS applications started on the cutting edge in 2008. However, being a forerunner was risky and uncertain. Smartphone and web technologies were rapidly changing during the project development periods, so the partners had to learn as they went. This approach sometimes led to delay or change. For example, bus location data were not available to the public when NT: Transit partners began their application development. They worked closely with two peninsula transit agencies to get special access to data when it was available and install collection systems of their own when it was not — no small feat. Just a year later, several transit agencies across the Bay Area began making their data available to the public on the internet, free of charge.

Approach Success Carefully.

Partners found that some agencies are concerned with success because customers may come to expect or demand an application if they like it. This realization underscored the importance of partnerships in creating cost-effective and sustainable services.

Sustaining ITS Applications Beyond SafeTrip-21

Successful ITS research results in products that can be used in the real world and sold in the global marketplace. SafeTrip-21 intentionally sought ITS concepts that had the potential for sustainment without ongoing Federal investment. Public-sector proponents have adopted and supported some projects beyond the original field-test phase; other projects have become the basis for commercial products. Nearly all of the applications will have a life beyond SafeTrip-21. Partnerships were key to making such an outcome possible.

- *Mobile Millennium*: Mobile Millennium's VTL concept and arterial traffic model remain on the cutting edge of probe research. Nokia has incorporated "traffic-aware" routing features in commercial products based on lessons learned from Mobile Millennium. CCIT has a contract with IBM to continue research on the traffic algorithms it developed.
- *NT: Transit*: PATH2Go is still the only application in the Bay Area to combine real-time traffic, parking, and transit data from several agencies. Its geo-fencing techniques remain unique and will inspire future research. PATH has a contract with Caltrans to continue development of the application in 2012. Caltrans and PATH continue to partner with MTC to build applications that will encourage commuters to take transit.
- *NT: Foresighted Driving*: The results of this test will inform future Federal research on vehicle-based safety alerts. PATH has been invited by Euro-FOT (<http://www.eurofot-ip.eu/>) to present this project and describe the state of practice of passive safety research in North America.
- *Intersection Delay Monitoring System*: The Trafmate 6 is being enhanced by its developers, who hope to implement pilot projects with other states in the near future. The device was nominated by Caltrans for an American Association of State Highway and Transportation Officials (AASHTO) Technology Implementation Group (TIG) Award in 2010.
- *BWI Ground Access Information System*: The I-95 Corridor Coalition continues to work with BWI and other airports to explore opportunities for the system.
- *Portable Traffic Monitoring Devices*: iCones and Calmar data services are still in use by NCDOT and Caltrans. The devices also continue to be sold and operated throughout the United States by the parent company Calmar.
- *I-95 Long Distance Trip Planner*: The I-95 Corridor Coalition has agreed to continue operation of the application for a year beyond SafeTrip-21.
- *Public Traffic Map Displays*: VDOT and partners have already agreed to continue operation of the displays, including the SafeTrip-21 content at the welcome centers and at Tysons Corner Center Mall.

“SafeTrip-21 gave us an excellent opportunity to showcase some of the innovations my company had developed We found the partnership model utilized in SafeTrip-21 to be quite effective in providing even a small business such as ours a national platform for technology demonstration.”

— Sudhir Murthy, Owner, TrafInfo



“The SafeTrip-21 program provided a forum where agencies focused on the issues of work-zone traffic control and future technologies like iCone. In our minds, this has helped advance traffic control methods at partner agencies”

— Ross Sheckler, Calmar Researcher

1. NT: Foresighted Driving (image: PATH and ©2011 Google)
2. Intersection Delay Monitoring System (photo: TrafInfo)
3. I-95 Long Distance Trip Planner (image: www.i95travelinfo.net)
4. Public Traffic Map Displays (photo: SAIC)



Contributing to Future Connected Environments for Transportation

SafeTrip-21 is a story of research and testing, partnerships and collaboration, commitment and dedication. It is also a story of bringing transportation technology to the public as a taste of the future. The program rode a wave of innovation that has swept over the nation, and it offers valuable insight into the value of publicly facing ITS technologies. Looking ahead, the U.S. DOT continues its mission to “provide the Nation with a national, multimodal transportation system that

features a connected transportation environment among vehicles of all types, the infrastructure, and portable devices which will serve the public good.” The concepts demonstrated through SafeTrip-21 — multiple communications platforms, innovative applications derived from the marketplace, and sustainable test beds that remain in service beyond Federal investment — are helping to make this vision a reality.

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“Over the next decade, travelers are going to see access to real-time information become ubiquitous, through all types of media, but especially on smartphones. The Connected Traveler research project gave a preview of that future experience, and advanced the body of knowledge that will enable this vision to become a reality.”

— Greg Larson, Chief of the Office of Traffic Operations Research, Caltrans

Project	Further Reading
SafeTrip-21	Science Applications International Corporation (SAIC). "National Evaluation of the SafeTrip-21 Initiative – Combined Final Report." Report no. FHWA-JPO-11-088. March 2011.*
Connected Environments for Transportation	http://www.its.dot.gov/
BWI Ground Access Information System	SAIC. "National Evaluation of the SafeTrip-21 Initiative: I-95 Corridor Coalition Test Bed Final Evaluation Report: Providing Multi-modal Travel Information to Airport Users." Report no. FHWA-JPO-11-011. December 2010.*
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Networked Traveler: Foresighted Driving	Nowakowski, Christopher, et al. "SafeTrip-21 Initiative: Networked Traveler – Foresighted Driving Field Experiment Final Report." April 2011. SAIC. "National Evaluation of the SafeTrip-21 Initiative, Evaluation Report: Networked Traveler – Foresighted Driving." Report no. FHWA-JPO-11-012. January 2011.*
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Public Traffic Map Displays	SAIC. "National Evaluation of the SafeTrip-21 Initiative: I-95 Corridor Coalition Test Bed Final Evaluation Report: Displaying Travel Times in Public Areas." Report no. FHWA-JPO-10-061. August 2010.*
Real-Time Intersection Delay Monitoring System	http://www.trafinfo.com SAIC. "National Evaluation of the SafeTrip-21 Initiative (Final Evaluation Report): Real Time Intersection Delay." Report no. FHWA-JPO-11-006. September 2010.*

*Available online at the National Transportation Library (ntl.bts.gov)

Acknowledgments. SafeTrip-21 field operational tests were a cooperative endeavor of the United States Department of Transportation (U.S. DOT) Research and Innovative Technology Administration (RITA) and more than 20 partners. RITA gratefully recognizes the efforts of its collaborators, including:

- AAA Mid-Atlantic
- AAA of Northern California, Nevada and Utah
- Baltimore Washington International Airport
- California Center for Innovative Transportation (CCIT), University of California at Berkeley
- California Department of Transportation (Caltrans)
- California Partners for Advanced Transit and Highways (PATH), University of California at Berkeley
- Delcan
- EnterInfo
- I-95 Corridor Coalition
- iCone Products LLC
- INRIX
- John A. Volpe National Transportation Systems Center
- KMJ Consulting
- Metropolitan Transportation Commission (MTC)
- Mr. Matthew Coogan
- NAVTEQ/Nokia
- New York Metropolitan Transportation Authority (MTA)
- Nissan Motor Company
- North Carolina Department of Transportation (NCDOT)
- ParkingCarma
- PBS&J Corporation
- Peninsula Congestion Relief Alliance
- RITA Intelligent Transportation Systems Joint Program Office (ITS JPO)
- San Francisco Traffic Management Association (SFTMA)
- San Mateo County Transit District (SamTrans)
- Santa Clara Valley Transportation Authority (VTA)
- Science Applications International Corporation (SAIC)
- SpeedInfo
- Telvent
- TrafInfo Communications, Inc. (TrafInfo)
- Tyson's Corner Center
- University of Maryland
- Virginia Department of Transportation (VDOT)
- Volkswagen/AG
- Washington Metropolitan Area Transit Authority (WMATA)