FINAL

Evaluation Report

Evaluation of the
MAYDAY/9-1-1 Field Operational Test

Prepared for:

Federal Highway Administration

and

National Highway Traffic Safety Administration

By:

Battelle

The Business of Innovation

In Association with:

The Melcher Group

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Acknowledgement

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List of Acronyms

ACN	Automatic Crash Notification
AACN	Advanced Automatic Crash Notification
ALI	Automatic Location Identification
ANI	Automatic Number Identification
CARS	Condition Acquisition and Reporting System
CCTV	Closed-Circuit Television
E9-1-1	Enhanced 9-1-1
EMS	Emergency Medical Service
FHWA	Federal Highway Administration
FOT	Field Operational Test
GIS	Geographic Information System
IES	Independent Emergency Services, Inc.
IP	Internet Protocol
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
LAT	Latitude
LEC	Local Exchange Center
LON	Longitude
MIS	Management Information System
MSC	Mobile Switching Center
MnDOT	Minnesota Department of Transportation
NENA	National Emergency Number Association
NHTSA	National Highway Traffic Safety Administration
NG9-1-1	Next Generation 9-1-1
OOC	OnStar Operation Center
POC	Point of Contact
PSAP	Public Safety Answering Point
RTMC	Regional Transportation Management Center
SAIC	Science Applications International Corporation
SOAP	Simple Object Access Protocol
SR	Selective Router

List of Acronyms (Continued)

TDM	Time Division Multiplexing
TSP	Telematics Service Provider
TSPECRS	TSP Emergency Call Routing Service
VIN	Vehicle Identification Number
WSP	Wireless Service Provider
XML	eXtensible Mark-up Language

Executive Summary

The Minnesota Department of Transportation (MnDOT) conducted a federally funded Field Operational Test (FOT) to develop and test a MAYDAY/9-1-1 system. The system automatically routes 9-1-1 calls initiated by Telematics Service Providers (TSP) to an appropriate Public Safety Answering Point (PSAP) based on vehicle location information provided by the instrumented vehicles. This FOT voice routing solution is called TSP Emergency Call Routing Service (TSPECRS). In addition, the Automatic Crash Notification (ACN) or Advanced Automatic Crash Notification (AACN) data from the TSP are shared in real-time with MnDOT in support of emergency response and management via the Conditioning Acquisition and Reporting System (CARS[1]).

Battelle, in association with the Melcher Group, was under contract to the Intelligent Transportation System (ITS) Joint Program Office (JPO) of the U.S. Department of Transportation (USDOT) to conduct an independent evaluation of the MAYDAY/9-1-1 FOT. This national evaluation was performed under Battelle's contract DTFH61-02-C-00134, Task BA34010 with the USDOT.

The scope of this evaluation is to conduct an acceptance test on the voice routing system, TSPECRS; perform an analyses on ACN/AACN data routing, solicit feedback from the users of the voice and data routing systems, and identify potential deployment issues. This evaluation report documents the process, results, and issues encountered in this FOT, from which lessons learned can be drawn to provide guidance for the future deployment of this or a similar system.

The Problems

<u>Routing of TSP-initiated 9-1-1 Calls</u>

The MAYDAY/9-1-1 FOT intended to resolve a set of issues TSPs have encountered in interfacing with the 9-1-1 network. Such issues stem from the fact that 9-1-1 networks are locally operated while the TSP receives emergency calls from anywhere in the United States. TSP calls are directed to a central facility (e.g., OnStar Operation Center (OOC) that houses 24-7 Emergency Advisors.

Upon receipt of a distress call from an instrumented vehicle[2], the OnStar Emergency Advisor first connects with the driver over the cell phone built into the TSP vehicle system, then initiates a three-way call with a PSAP corresponding to the vehicle location. However, these long

[1] CARS is a non-proprietary, standards based condition reporting system that allows authorized users to enter, view and disseminate critical road, travel, weather and traffic information. Developed as part of a Federal Highway Pooled Fund, CARS is owned by a Consortium of States. Currently, ten states have deployed the CARS system (Minnesota, Iowa, Missouri, Alaska, Washington State, New Mexico, Kentucky, Maine, Vermont, and New Hampshire). Additional information about CARS may be found at http://www.carsprogram.org/public.htm.

[2] In the case of OnStar, the distress calls from the instrumented vehicle might include: emergency key press (also referred to as SOS), ACN (triggered by the deployment of the airbag), or AACN (triggered by the airbag or other sensors, e.g., accelerometer with additional data indicating rollover status, delta velocity (upon impact), etc.

distance calls from the central TSP emergency call centers to the PSAPs can not be automatically routed due to the local nature[3] of the 9-1-1 networks.

In response to this problem, OnStar must maintain a directory of administrative numbers and the definition of jurisdictional boundaries of some 7,000 PSAPs in the U.S. This requires OnStar to constantly verify and update the directory. Most importantly, emergency calls to a PSAP's administrative line may not receive the same priority as those placed through the dedicated 9-1-1 trunk line (i.e., native 9-1-1 calls). These calls also do not transmit critical information such as a call back number (to the telematics-equipped vehicle) and vehicle location that are being required by the wireless Enhanced 9-1-1 (also known as E9-1-1) initiative[4].

Figure E-1 provides a graphic representation of the existing OnStar 9-1-1 call procedure without the FOT solution.

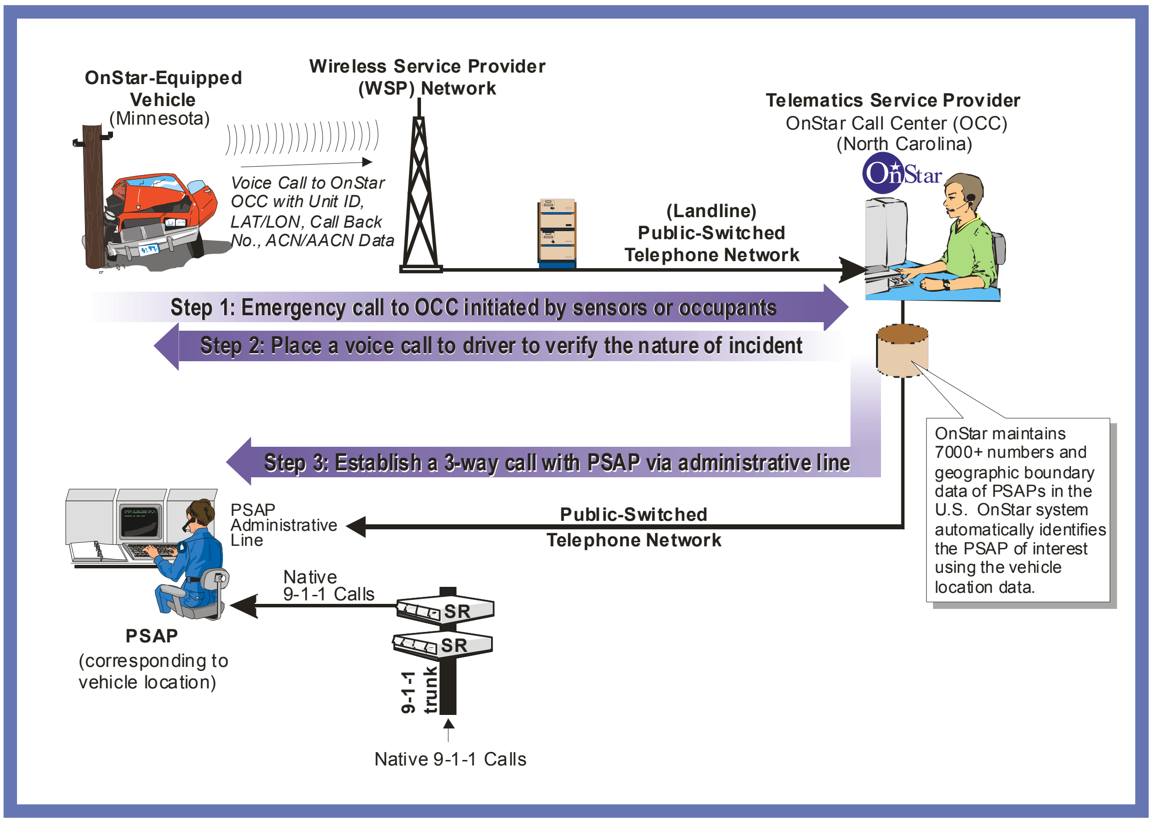

Figure E-1. OnStar 9-1-1 Call Procedure Without FOT Solution

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[3] The 9-1-1 trunk lines are all locally connected with switches to the landline and the wireless phone systems, which does not support long distance (e.g., interstate) call routing.

[4] Wireless E9-1-1 is being deployed in two phases under Federal Communications Commission (FCC) mandates. Phase one requires 9-1-1 calls dialed on a cell phone to provide a call back number to the PSAP. Phase two requires wireless service providers to provide call location data (in LAT/LON) for all wireless 9-1-1 calls and that enhancement to the PSAP system must make use of the location data.

Lack of Sharing of TSP Crash Data with Emergency Response

A unique resource of the TSP is the wealth of information it possesses on crashed vehicles and occupants. Such information is potentially beneficial to public safety. These TSP crash data come from the following sources:

- Data reported from the sensors on the telematics-equipped vehicles (e.g., deployment of airbag, severity of impact (e.g., delta velocity upon impact), rollover, vehicle location by on board Global Position System (GPS) receiver);
- Vehicle and driver data registered with TSP (e.g., basic information on the driver, special medical conditions, vehicle information such as Vehicle Identification Number (VIN), year, make, and color of the vehicle that provide useful clues for emergency response.)

These data are used only by the TSP Emergency Advisors, without violating personal privacy, in assisting three-way communications with the PSAPs during an incident. However, this requires verbal transcription of a large amount of information which could be error-prone and time consuming. Nonetheless, the emergency responders would receive this information from the PSAPs (in most instances PSAPs are different from emergency response entities) through further transcriptions. This suggests a potential benefit for data sharing between the TSP and public safety entities.

The Field Operational Test Solutions

Figure E-2 provides an illustration of the proposed FOT solutions. These solutions are discussed below.

FOT Voice Routing Solution

The solution for routing the TSP-initiated 9-1-1 calls is called the TSP Emergency Call Routing Service (TSPECRS). The solution has two components to it:

- Use a Wireless Service Providers (WSP) network to route the TSP initiated 9-1-1 calls to a local Mobile Switching Center[5] (MSC) based on the vehicle location data provided in the TSP calls (e.g., from OnStar Call Center in North Carolina to a MSC in Minnesota where the crash occurred);
- From the local MSC, the TSP 9-1-1 calls emulate a wireless E9-1-1 call and are fed into a local 9-1-1 trunk line and routed to the intended PSAP as a native 9-1-1 call. In addition, the Automatic Location Identification (ALI) database and the E2 interface that bridges the different 9-1-1 service providers[6] were modified to allow transmission of additional data, including call back number, vehicle location (in LAT/LON), and selected ACN and AACN.

[5] MSCs are operated by the wireless service providers primarily to interface between wireless and wireline calls.

[6] The 9-1-1 services in Minnesota are provided by IES and Qwest. E2 is the interface specification that defines the interconnection between different 9-1-1 service providers' ALI databases.

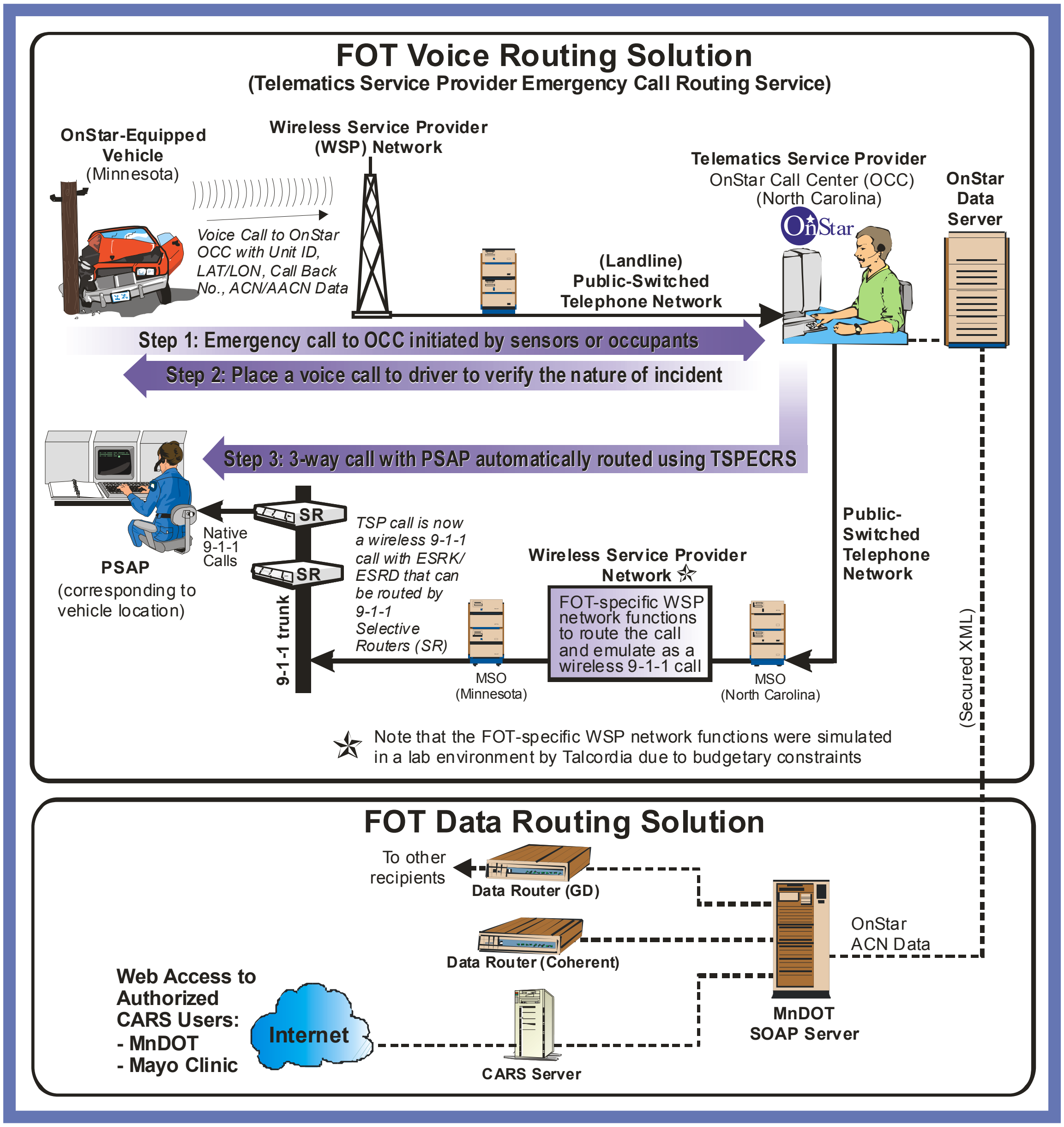

Figure E-2. High-Level FOT System Functions Illustrated

A limitation of the FOT voice routing solution relates to the lack of specific functionalities in the WSP network in support of the proposed TSP emergency call routing. This was explained in the FOT Concept of Operation and Design documents [Ref 1, 2]. Despite the technical feasibility, the deployment of the WSP specific call routing function was cost prohibitive. Such functionalities were simulated in a lab environment provided by Telcordia in support of the FOT.

FOT Data Routing Solution

The FOT data routing implementation was relatively straight forward. To share ACN and AACN data, a secured data connection between the OnStar data server and MnDOT's SOAP server was established using the industry standard eXtensible Markup Language (XML) interface. The SOAP server is accessed by MnDOT's CARS that can be accessed by the authorized users. Figure E-2 (bottom portion) illustrates the connections between subsystems in support of the data routing.

Upon receiving a distress call from OnStar-instrumented vehicles in the state of Minnesota, the available crash data (SOS, ACN, or AACN) is pushed from OnStar to the MnDOT SOAP server and further pushed to the CARS server. The role of the SOAP server is a "data broker" and thus has limited logical processing capability (e.g., performing complex rules for screening certain data elements).

Evaluation Scope

The scope of this evaluation, based on discussions with the FOT team and NHTSA, was determined to be:

- Conduct of a voice routing system acceptance test to assess the performance of the FOT solution for automated routing of the Telematics-initiated emergency calls to an appropriate PSAP as a native 9-1-1 call along with a call back number and call location data;
- As an ancillary interest, assess the performance of a data routing system that transmits available crash data from OnStar operation center to MnDOT for further distribution to users of the CARS; and
- Conduct a review of user acceptance and potential deployment issues.

Voice Routing Acceptance Testing Results

<u>Description of Field Acceptance Test</u>

A statistical acceptance sampling plan (Appendix A) was developed to assess voice routing performance. The plan identified the testing to be performed, the measures of success or failure, and the potential conclusions about overall system acceptance test performance. Depending on the acceptance test results, two different conclusions were possible:

- The system passes acceptance testing. If this conclusion was reached, depending on the exact sample results, it would be highly probable (94 percent[7]confidence) that the overall system failure rate was at or below four percent or that it was at or below five percent.
- The system fails acceptance testing. If this conclusion was reached, it would be highly probable (94 percent confidence) that the overall system failure rate exceeded one percent.

[7] When conducting a statistical test with a binomial response (yes or no) versus a continuous response, the confidence bounds do not normally exactly meet the 95% that is "standard".

The acceptance test calls were carried out by MnDOT staff in the 22 FOT PSAPs over a ten day period in August of 2005. On each sampling day, MnDOT staff proceeded to each planned location with a laptop computer (to simulate ACN/AACN data) and a portable OnStar test unit. These are shown in Figure E-3.

Figure E-3. Portable OnStar Test Unit in Support of Voice Routing Field Test

The MnDOT staff placed a call to the OnStar call center. OnStar established a three-way call with the PSAP of the originating call location as a wireless 9-1-1 call. This was done in the FOT through a laboratory environment (Telcordia) simulating a call in a wireless service provider network. The PSAPs were alerted that this was a test call so that they could defer it if there were any true 9-1-1 calls coming through at the same time. The PSAP was then asked to identify its location and what data it had received on the incoming test call. Figure E-4 below provides a visual example of the data coming in to the PSAPs. This specific image is unique to PSAPs with Independent Emergency Services (IES) as the service provider.

After completing each call, the MnDOT staff recorded required information on a data collection form then moved to the next sample location.

Voice Routing Acceptance Test Findings

- A total of 147 acceptance test sample calls were made from August 10, 2005 through August 19, 2005. Either six or seven calls were placed from each of the 22 PSAPs, reflecting the original sample plan to obtain as closely as possible an equal sample in each PSAP. All 147 of the acceptance sample calls passed the acceptance test criteria.

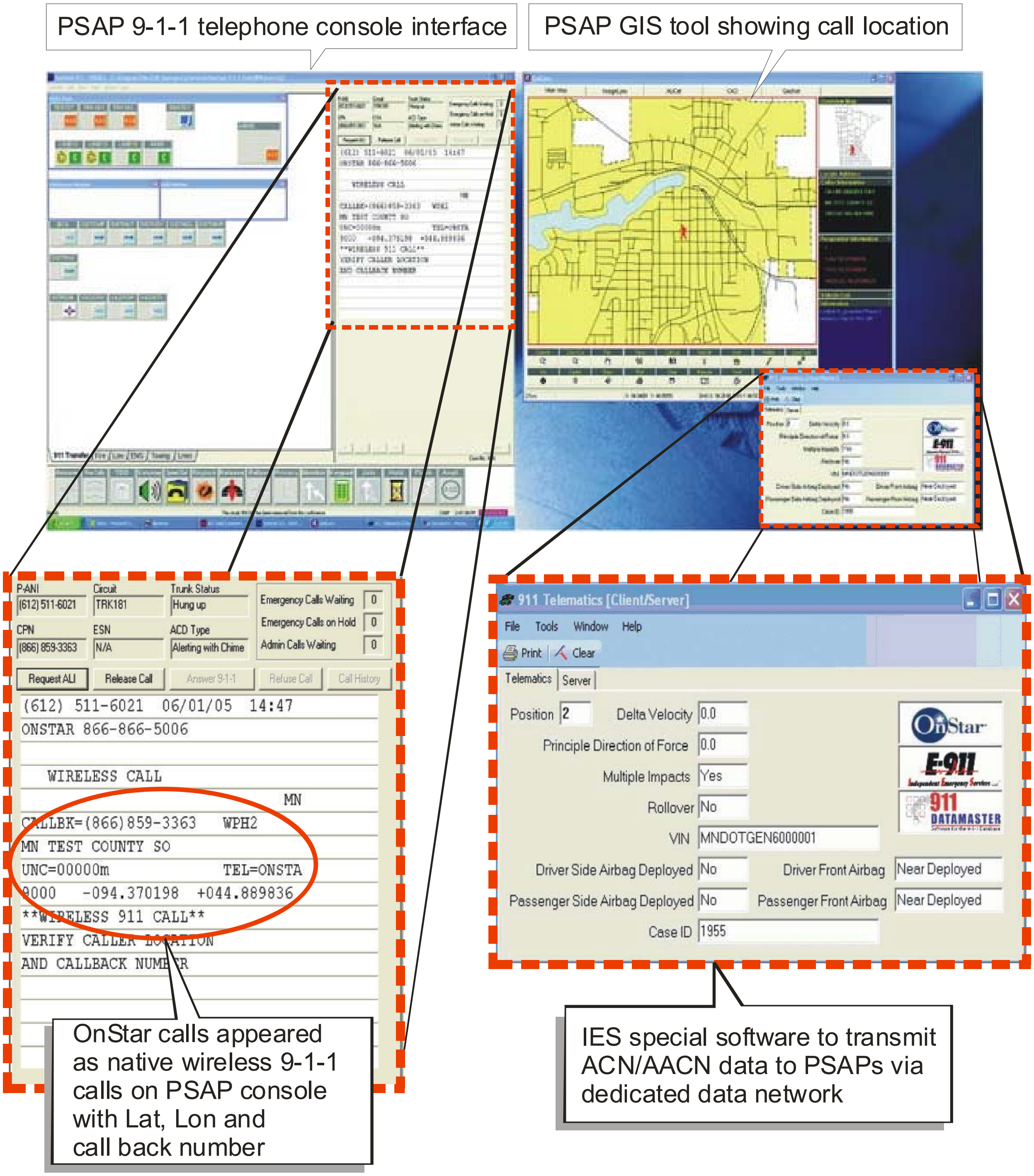

Figure E-4. Sample PSAP Incoming Call Screen (IES)

The FOT passed acceptance testing with 94% confidence that the true system failure rate is no more than four percent.

- Those test calls were delivered along with vehicle location data (LAT/LON), call back number (to OnStar unit), and ACN/AACN data (on IES supported PSAPs only).
- For the 20 acceptance sample calls made to PSAPs with the Mayo Clinic as secondary PSAP, the Mayo Clinic PSAP correctly received the call back number and latitude/longitude coordinates of the sample calls in all cases.

Data Routing Performance Evaluation Results

The data routing portion of the FOT sought to develop and test a system for a telematics service provider (e.g., OnStar) to push ACN and AACN data into a MnDOT SOAP server for further distribution to CARS.

Due to data availability, this evaluation only examined the performance of the first link of the data distribution between OnStar and SOAP server, as illustrated in the bottom portion of Figure E-2. The system performance is defined as the reliability and latency of the data transfer. Different from the voice routing evaluation, the data routing involved the transmission of actual OnStar crash data throughout the state of Minnesota.

Data Routing Evaluation Summary of Findings

- Over 41 weeks for which data were available, OnStar successfully transmitted 1,247 crash records to the MnDOT SOAP server, including 1093 SOS (emergency button pushing), 137 ACN, and 17 AACN crash records.
- Analyses of transmission logs indicated a small percent (3.9) of records failed in the transmission. However, those failures were attributable to known technical problems that arose during the FOT period (see Section 4.2.1). The FOT data routing solution has demonstrated a high reliability of 96.1%.
- The mean latency for data transmission from OnStar to MnDOT SOAP server is 0.9 seconds.

User Acceptance and Deployment Issue Evaluation Results

PSAP, Emergency Medical Service, Traffic Management Feedback

- Few of the PSAPs maintained 9-1-1 call history data in sufficient detail to statistically compare historical operational experiences with trial events. However, based upon experience, all indicated a preference for native 9-1-1 call delivery for such calls, noting that the latter insures more accurate routing, the automatic delivery of call-related data (like Automatic Number Identification[8] (ANI), ALI[9] and class of service[10]) and priority processing (i.e., call into 9-1-1 trunk as opposed to the administrative line).

- Most PSAPs were either wireless 9-1-1 Phase II ready, or deployed with one or more carriers[11]. That is, they are able to receive wireless 9-1-1 calls with a call back number and call location (LAT/LON) provided. The FOT calls were designed to emulate a wireless 9-1-1 call and thus can display call back number and location with Phase II ready PSAPs.
- Several of the PSAPs continue to work on mapping and GIS resources to support the processing of wireless-based calls. The GIS tool is part of the wireless 9-1-1 PSAP solutions to make use of the call location data for visual representation using electronic maps.
- While limited, most PSAPs had historically received telematics-based emergency calls (including OnStar) on the administrative line, and they cited positive experiences and outcomes with those calls. Also cited was the unique capability for OnStar emergency advisors to remotely flash the vehicle head lights in assisting the identification of the crashed vehicle, in the case of run-off-the-road accidents with unconscious drivers. In addition, OnStar Emergency Advisors can provide continuous update of vehicle location for incidents involving a moving vehicle (e.g., car-jacking).
- Most PSAPs stated that the location of the calling party provided by telematics service providers (historically, and, as part of the FOT) appeared to be accurate. Historically, the location information was described by the OnStar Emergency Advisor as the street address, or in the case of rural area, the main route and the nearest cross street or landmark. The FOT automatically provided the location data in LAT/LON that can be plotted using a GIS tool – conceivably a less time consuming and less error-prone approach.
- All the PSAPs interviewed currently receive telematics-initiated calls on so-called "administrative lines," or on non-native 9-1-1 trunks dedicated for such purposes. In all instances, while calls on these lines are processed identically to native 9-1-1 calls, they do receive lower call-handling priority than calls on 9-1-1 trunks (though that only becomes an operational issue when 9-1-1 call-takers are busy on other calls). Since such lines generally do not automatically provide ANI and ALI data, the PSAPs involved attempt to capture the "caller ID" of the calling party, and then poll their ALI database for location. There is a limitation of OnStar-initiated three-way calls in that they only display the number of the OnStar Operation Center in the caller ID, not the cell phone number of the crashed vehicle.

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[8] ANI is the technical term for call back number or caller ID

[9] In this case, call location information in LAT/LON

[10] Indication of a wireless 9-1-1 call made from a TSP

[11] Full deployment requires all wireless service providers to implement the E9-1-1 phase 2 solutions

- A few PSAPs noted that a telematics-initiated call involving a three-way conversation between the calling party, the telematics service center, and the PSAP can be complicated, but beneficial with training.
- The Minneapolis/St. Paul Metropolitan Emergency Services Board noted that the FOT voice delivery solution appeared to be a clean solution, minimizing infrastructure requirements and impact on existing 9-1-1 network configurations.
- PSAPs served by Independent Emergency Services (IES) were able to receive advanced ACN data as part of the FOT. Kandiyohi County (as the IES PSAP involved in the interviews) cited the importance of such data in processing an ACN-type emergency event, though the use of such enhanced data will require additional call-taker training.
- In a few instances, where FOT test calls failed to execute as planned, it appeared that the casual factors were outside the scope of the trial, and thus did not negatively impact the results of the FOT.
- Mayo Medical Transport, as both a secondary PSAP and a CARS data user, specifically cited the benefit of ACN/AACN incident data in responding to an emergency event. While the CARS data are limited, as is the means of access, the timely notification of an incident, along with descriptive data about the event, does facilitate emergency response.
- All interviewees agreed that the FOT appeared to reflect a successful solution to delivering a telematics-initiated 9-1-1 call to the appropriate PSAP over the existing 9-1-1 infrastructure with a call back number and call location.
- All interviewees also agreed that exploring and fostering the wider deployment of such a solution would be beneficial, both within Minnesota and elsewhere.
- The Regional Transportation Management Center (RTMC) in Roseville, MN makes effective use of the CARS data, both in support of traffic management during incidents and Department of Public Safety's (co-located with RTMC) emergency response. This center is a model for similar efforts around the country.
- The OnStar ACN/AACN data on CARS supplements the information and many resources currently possessed by the RTMC in support of traffic-related incident management. Such resources include the large number of traffic detectors and Closed Circuit Television (CCTV) cameras for detection and verification of incidents, and the ability to control traffic signals and provide traffic advisories using Dynamic Message Signs (DMS), the MnDOT web site, and the 511 traveler information system.

Telematics Service Provider Feedback

OnStar, as the telematics service provider involved in the FOT, has a long history servicing customer emergency calls and interacting with the 9-1-1 community. The Emergency Advisors receive special training in processing such calls, and specifically interfacing with 9-1-1 call takers. The following is a summary of the interview findings:

- OnStar's experience in processing customer 9-1-1 calls has been positive, as has been their working relationship with the 9-1-1 community and PSAPs.

- While the current process of handling 9-1-1 destined calls works (i.e., calling into PSAP administrative lines), the FOT solution would provide a more effective way of accomplishing the same task for the reasons cited elsewhere in this report.
- In spite of the perceived benefits of the FOT solution, OnStar indicated the need to preserve the ability to contact the PSAP via the administrative line, citing a significant portion of customer requests or events are of non-emergency nature.
- The data routing portion of the FOT was perceived as a success. OnStar indicated increased demands in recent years to provide their data to the Department of Transportation (of various levels) and emergency response community in light of management of regional natural disaster-related events.
- The deployment of FOT voice routing solution would involve significant cost, a factor impacting the potential adoption and rollout of the approach nationwide. It was evident that the WSP-specific call routing solution was cost prohibitive and a simulated approach must be used by the FOT. The cost for implementing and operating such a nation-wide system is disproportionately high considering the very small representation of telematics-initiated 9-1-1 calls. OnStar suggested broadening the users of the FOT solution to include other national security or regional public safety entities that require long distance routing of 9-1-1 calls.
- It was unfortunate that the voice routing portion of the FOT ultimately was not able to use a real wireless service provider, and was forced to simulate those functions within a lab environment. While the simulation did not negate the results of the FOT, it did impact the "field" emphasis of the operational test.
- While the setup of the FOT voice routing required an OnStar Emergency Advisor to manually dial a Temporary Location Directory Number (in order to route the call to the simulated WSP hosted in Telcordia's New Jersey facility), it was noted that that part of the process could be easily automated.
- Considerations should now be given to real world deployment of the FOT solution, recognizing wireless network functionality and impact, cost, and migration to NG9-1-1 IP-based infrastructure.

Third-Party Technical Expert Feedback

In accordance with the evaluation plan, the FOT concept, technical design, and results of the FOT were reviewed with Mr. Roger Hixson, NENA's Technical Issues Director. The interview specifically related to NENA's work in the area of Next Generation E9-1-1 systems, recognizing that the latter will ultimately generate or facilitate enhanced solutions for the objective of this FOT.

Mr. Hixson observed that, while the design involved would require new TSPECRS-specific functionality in the wireless network, a potentially challenging matter in light of evolving wireless networks, the concept and solution being tested by the FOT represented a "viable interim method" to automatically route emergency calls being generated by customers through telematics call centers to "native enhanced 9-1-1 systems in the USA." Ultimately, Mr. Hixson indicated, IP based, NG 9-1-1 systems are likely to offer "more effective and seamless solutions for ACN calls and basic data delivery, and subsequent PSAP access to supportive data from Telematics provider databases."

FOT Deployment Team Feedback

- While the development of TSPECRS voice routing was challenging, the field test was conducted successfully, and the concept/solution involved does represent a viable approach for delivering telematics-based emergency calls to the PSAP as native 9-1-1 calls.
- Several technical issues did arise during the voice routing field test, but they related to factors either outside the scope of the project, or beyond operational control of the project team. Consequently, such calls were not considered failures. For example, test calls transmitted incorrect LAT/LON were caused by incorrect use of the portable OnStar test unit and thus not counted as failures. This was discussed under the non-counted calls in Section 4.1.1.
- The TSPECRS test experiences emphasized the need for robust and redundant networks to support reliable call delivery.
- 9-1-1 call relay at the telematics provider service center should be automated to avoid manual miss-dials, a feature consistent with the intent of this FOT (i.e., to automate as much of the call delivery process as possible).
- Beyond the native delivery of 9-1-1 calls, the system also provides an opportunity to deliver additional emergency event information and data important to emergency response.
- The opportunity for real world deployment should be examined further, particularly as a migratory step to NG9-1-1 network infrastructure that may ultimately provide long-range solutions to accomplishing the goals of the FOT.

Conclusions

FOT voice routing solution, TSPECRS, passed the acceptance test

Using a statistical acceptance sampling approach, the FOT solution passed the acceptance test with no observed failures. A sequential sampling approach was used to determine if the FOT solution passed acceptance. Ultimately, this approach resulted in high confidence (i.e., 94 percent) that the true system failure rate does not exceed a relatively low value (four percent). The true system failure rate may well be even lower (e.g., the observed failure rate was zero percent), but the sample size available for the test was only sufficient to make conclusions at a level of four percent.

FOT voice routing solution leverages the phase 2 E9-1-1 implementation

The FOT voice routing solution relies on a wireless service provider to route long distance 9-1-1 calls originated from a TSP to a local MSC corresponding to the LAT/LON of the vehicle location. From there, the calls enter the 9-1-1 trunk using a modified E2 interface and emulate a wireless E9-1-1 call. This allows a phase 2 compliant PSAP to receive the calls as a native 9-1-1 call along with the LAT/LON of the vehicle location, and a call back number (to the telematics unit).

With the exception of WSP call routing, the final segment of the call delivery solution is consistent with the phase 2 E9-1-1 initiative. Feedback from the FOT team suggested that minor clarifications of ALI interface are needed due to the ambiguity in current E2[12] interface definition, in support of the call and data routing on the local 9-1-1 trunks.

The implementation of WSP call routing will require additional standards[13] development and commitments from a WSP to implement the solution on all switches across the U.S. Given the competition from other standards development activities in the telecommunication community, the telematics-specific standards might not receive priority because of its small market share. Nevertheless, the FOT solutions are technically feasible and are consistent with wireless E-9-1-1 standards in the final call delivery stage.

It is noted, however, that WSP migration to Third and Fourth Generation wireless service may facilitate this process by providing more effective and flexible switching and routing platforms for such matters.

FOT data routing achieved high reliability

Over the 41 week period of the operational test, the FOT demonstrated it could reliably and quickly transmit OnStar crash data to a MnDOT SOAP server, from where it could be accessed by CARS and other third parties. The reliability was 96.1% and the few failures observed were traced to a known computer problem that would not be expected to occur in a production system. The average latency of data transmission was less than one second (i.e., 0.9 seconds).

The data routing evaluation reflects only a portion of the system's reliability from an end user perspective since it does not include information for the links between the MnDOT SOAP server and other servers that ultimately make the information available to users (e.g., CARS). Nevertheless, it can be concluded that the first step in the data routing process does not introduce any lack of reliability or speed.

[12] E2 defines the interconnection specifications between 9-1-1 service providers.
[13] NENA TIA TR45.2 9 [for CDMA] needs to be worked to standardize TSPECRS.

Favorable user acceptance to the FOT voice routing service (PSAP)

The PSAP user community generally found both the intent and nature of the trial to be beneficial to the effective delivery of a telematics-based emergency call that must be delivered to a Public Safety Answering Point. The routing of such calls to the correct PSAP is more accurate and reliable, and the time involved to process the calls is minimized by automatically identifying the location. The native delivery of calls in this manner also insures that the calls involved will receive the same priority as any other 9-1-1 calls.

While nearly all the PSAPs involved in the trial indicated positive historical experiences with OnStar calls, they also indicated that this type of delivery would enhance service and minimize confusion in terms of the description of location.

FOT data routing solution is a cost effective way for sharing ACN data

While the migration of the emergency response community to next generation IP-based network infrastructure may provide the ultimate solution to sharing voice and data conducive to emergency services, the data sharing mechanism utilized in the FOT does provide an effective and immediate way to take advantage of data generated during a telematics emergency event. Deploying new and advanced network infrastructure may take time, particularly in a ubiquitous way, this FOT offers an immediate step in that direction.

This solution can be deployed with minimum cost, and states should explore the opportunity represented here to take advantage of their highway and traffic information systems to benefit both incident management and emergency response.

FOT voice routing benefits OnStar operations

Finally, FOT voice routing capability substantially enhances the quality of service OnStar provides to its customers. Having the service available in times of emergency is an important reason why many customers subscribe to the telematics service. Insuring more accurate and timely response to customer emergency requests improves the service involved. It also enhances the opportunity for a mutually beneficial relationship with the PSAP community, a matter of equal importance.

1.0 Introduction

The Minnesota Department of Transportation (MnDOT) conducted a federally funded Field Operational Test (FOT) to develop and test a MAYDAY/9-1-1 system. The system automatically routes 9-1-1 calls initiated by Telematics Service Providers (TSP) to an appropriate Public Safety Answering Point (PSAP) based on vehicle location information provided by the instrumented vehicles. This FOT voice routing solution is called TSP Emergency Call Routing Service (TSPECRS). In addition, the Automatic Crash Notification (ACN) or Advanced Automatic Crash Notification (AACN) data from the TSP are shared in real-time with MnDOT in support of emergency response and management via the Conditioning Acquisition and Reporting System (CARS).

Battelle, in association with the Melcher Group, was under contract to the Intelligent Transportation System (ITS) Joint Program Office (JPO) of the U.S. Department of Transportation (USDOT) to conduct an independent evaluation of the MAYDAY/9-1-1 FOT. This national evaluation was performed under Battelle's contract DTFH61-02-C-00134, Task BA34010 with USDOT.

The scope of this evaluation is to conduct an acceptance test on the voice routing system, TSPECRS; perform an analyses on ACN/AACN data routing, solicit feedback from the users of the voice and data routing systems, and identify potential deployment issues. This evaluation report documents the process, results, and issues encountered in this FOT, from which lessons learned can be drawn to provide guidance for the future deployment of this or a similar system.

1.1 Organization of this Document

Section 2.0 provides a description of the FOT. Specifically, Section 2.1 describes the problems related to the routing of Telematics-initiated 9-1-1 calls and the lack of sharing of the TSP data. Section 2.2 describes the solutions developed by the FOT. Section 2.3 provides a brief overview of the field operational tests conducted over the FOT voice and data routing systems.

Section 3.0 provides a description of the evaluation approach, including Evaluation Objectives and Scope (Section 3.1), System Performance Evaluation Approach (Section 3.2), and User Acceptance and Deployment Issues Evaluation Approach (Section 3.3).

Section 4.0 presents the Evaluation Findings. Section 4.1 describes the voice routing system field test procedures and results. Section 4.2 describes the analyses and results in support of the assessment of the FOT data routing performance. Section 4.3 presents the findings of user acceptance of the FOT systems and feedback from FOT deployment team and third-party experts.

Section 5.0 presents the conclusions. In particular, Section 5.1 presents a summary of findings related to the evaluation hypotheses. Section 5.2 provides conclusions based on the quantitative and qualitative evaluation results.

2.0 Description of MAYDAY/9-1-1 Field Operational Test

The partners under this FOT included the MnDOT (lead agency), the State of Minnesota 9-1-1 authority, OnStar as a TSP, SAIC as the FOT system integrator, Telcordia Technologies (developed voice routing solution), General Dynamics (developed ACN data routing interface), Coherent Solutions (developed ACN data routing interface), and Castle Rock Consultants (developer of the Condition Acquisition and Reporting System (CARS) and the SOAP server).

Technical support was acquired from the 9-1-1 service providers Independent Emergency Service (IES) Inc. and Qwest Communications Inc., and Intrado that maintains the Automatic Location Identification (ALI) database for Qwest-supported PSAPs. In addition, 22 PSAPs and the Mayo Clinic (serves as an Emergency Medical Service (EMS) responder and a secondary PSAP) participated in the conduct of field acceptance testing as well as other evaluation activities.

2.1 The Problems

Routing of TSP-initiated 9-1-1 Calls

The MAYDAY/9-1-1 FOT intended to resolve a set of issues TSPs have encountered in interfacing with the 9-1-1 network. Such issues stem from the fact that 9-1-1 networks are locally operated while the TSP receives emergency calls from anywhere in the United States. TSP calls are directed to a central facility (e.g., OnStar Operation Center (OOC) that houses 24-7 Emergency Advisors.

Upon receipt of a distress call from an instrumented vehicle[14], the OnStar Emergency Advisor first connects with the driver over the cell phone built into the TSP vehicle system, then initiates a three-way call with a PSAP corresponding to the vehicle location. However, these long distance calls from the central TSP emergency call centers to the PSAPs can not be automatically routed due to the local nature[15] of the 9-1-1 networks.

In response to this problem, TSPs must maintain a directory of administrative numbers and the definition of jurisdictional boundaries of some 7,000 PSAPs in the U.S. This requires the TSPs to constantly verify and update the directory. Most importantly, emergency calls to a PSAP's administrative line do not receive the same priority as those placed through the dedicated 9-1-1 trunk line (i.e., native 9-1-1 calls). These calls also do not automatically transmit critical information such as a call back number (to the telematics-equipped vehicle) and vehicle location

[14] In the case of OnStar, the distress calls from the instrumented vehicle might include: emergency key press (also referred to as SOS), ACN (triggered by the deployment of the airbag), or AACN (triggered by the airbag or other sensors, e.g., accelerometer with additional data indicating rollover status, delta velocity (upon impact), etc.

[15] The 9-1-1 trunk lines are all locally connected with switches to the landline and the wireless phone systems, which does not support long distance (e.g., interstate) call routing.

that are being required by the wireless Enhanced 9-1-1 (E9-1-1). Nor are such calls consistent with the intent behind FCC rule making that addresses such needs for wireless 9-1-1 calls.[16].

Figure 2-1 provides a graphic representation of the existing OnStar 9-1-1 call procedure without the FOT solution.

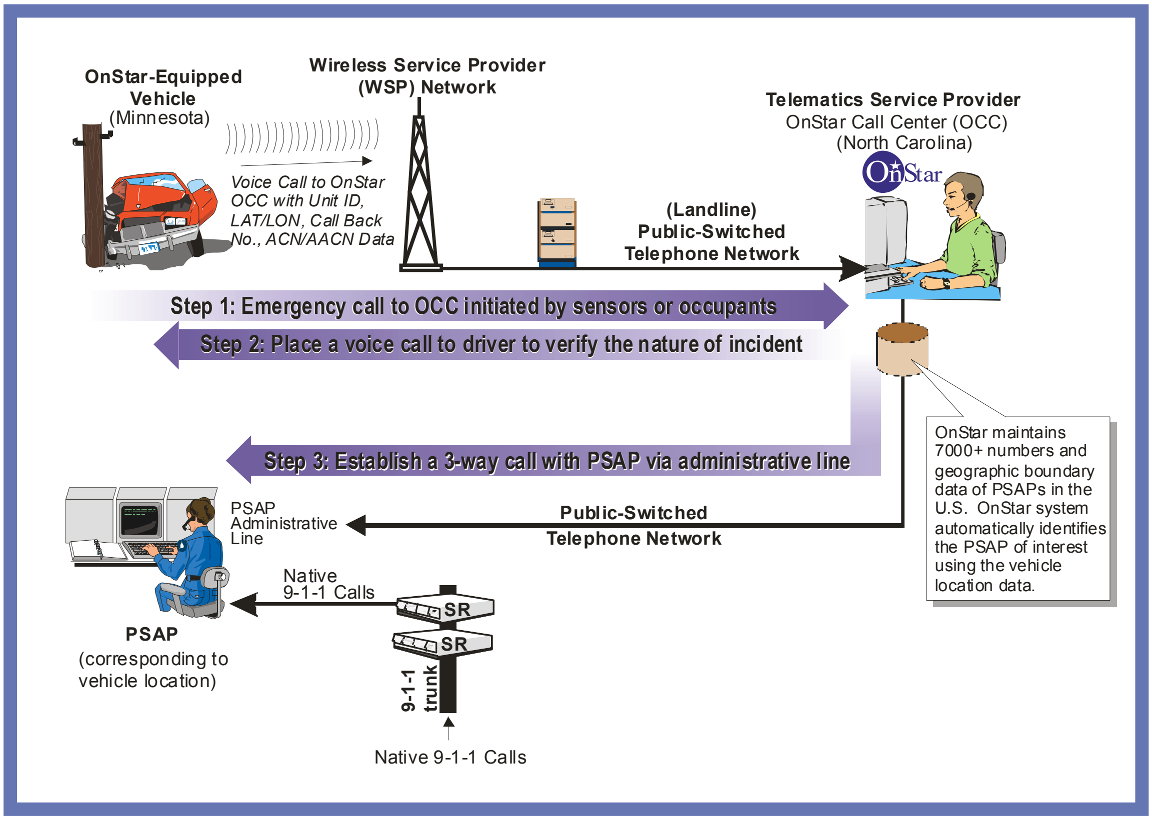


Figure 2-1. OnStar 9-1-1 Call Procedure Without FOT Solution

Lack of Sharing of TSP Crash Data with Emergency Response

A unique resource of the TSP is the wealth of information it possesses on crashed vehicles and occupants. Such information is potentially beneficial to public safety. These TSP crash data come from the following sources:

---

[16] The wireless E911 program is divided into two parts or phases. Phase I requires carriers, upon valid request by a local PSAP, to report the telephone number of a wireless 911 caller and the location of the antenna that received the call. Phase II requires wireless carriers to provide far more precise location information, within 50 to 300 meters in most cases. See Action by the Commission June 12, 1996, by Report and Order and Further Notice of Proposed Rulemaking (FCC 94-102; RM-8143). For further information, see: http://www.fcc.gov/911/enhanced/.

- Data reported from the sensors on the telematics-equipped vehicles (e.g., deployment of airbag, severity of impact (e.g., delta velocity upon impact), rollover, vehicle location by on board Global Position System (GPS) receiver);
- Vehicle and driver data registered with TSP (e.g., basic information on the driver, special medical conditions, vehicle information such as Vehicle Identification Number (VIN), year, make, and color of the vehicle that provide useful clues for emergency response.)

These data are used only by the TSP Emergency Advisors, without violating personal privacy, in assisting three-way communications with the PSAPs during an incident. However, this requires verbal transcription of a large amount of information which could be error-prone and time consuming. Nonetheless, the emergency responders would receive this information from the PSAPs (in most instances PSAPs are different from emergency response entities) through further transcriptions. This suggests a potential benefit for data sharing between the TSP and public safety entities.

2.2 The Field Operational Test Solutions

The MnDOT MAYDAY/9-1-1 FOT intended to develop and demonstrate a solution that could provide automatic routing of the TSP-initiated emergency calls connected to an appropriate PSAP as a native wireless E9-1-1 call with vehicle location data and a call back number provided. Also, additional information available from a TSP's ACN or AACN systems can be transmitted to the PSAPs along with the 9-1-1 calls which can be useful in support of incident response.

In parallel with the automatic voice routing, a data routing feature of the FOT transmits TSP ACN and AACN data from OnStar to MnDOT's SOAP server and can be accessed by authorized users via the CARS. The provision of additional crash information is expected to enhance decision-making in incident response and management by the Emergency Medical Service (EMS) and MnDOT traffic incident management.

Figure 2-2 presents a high-level architecture diagram of the FOT system. An extensive discussion of the technical specifications and functional requirements of the FOT solution can be found in the various FOT reports [Ref 1, 2, 3, 4].

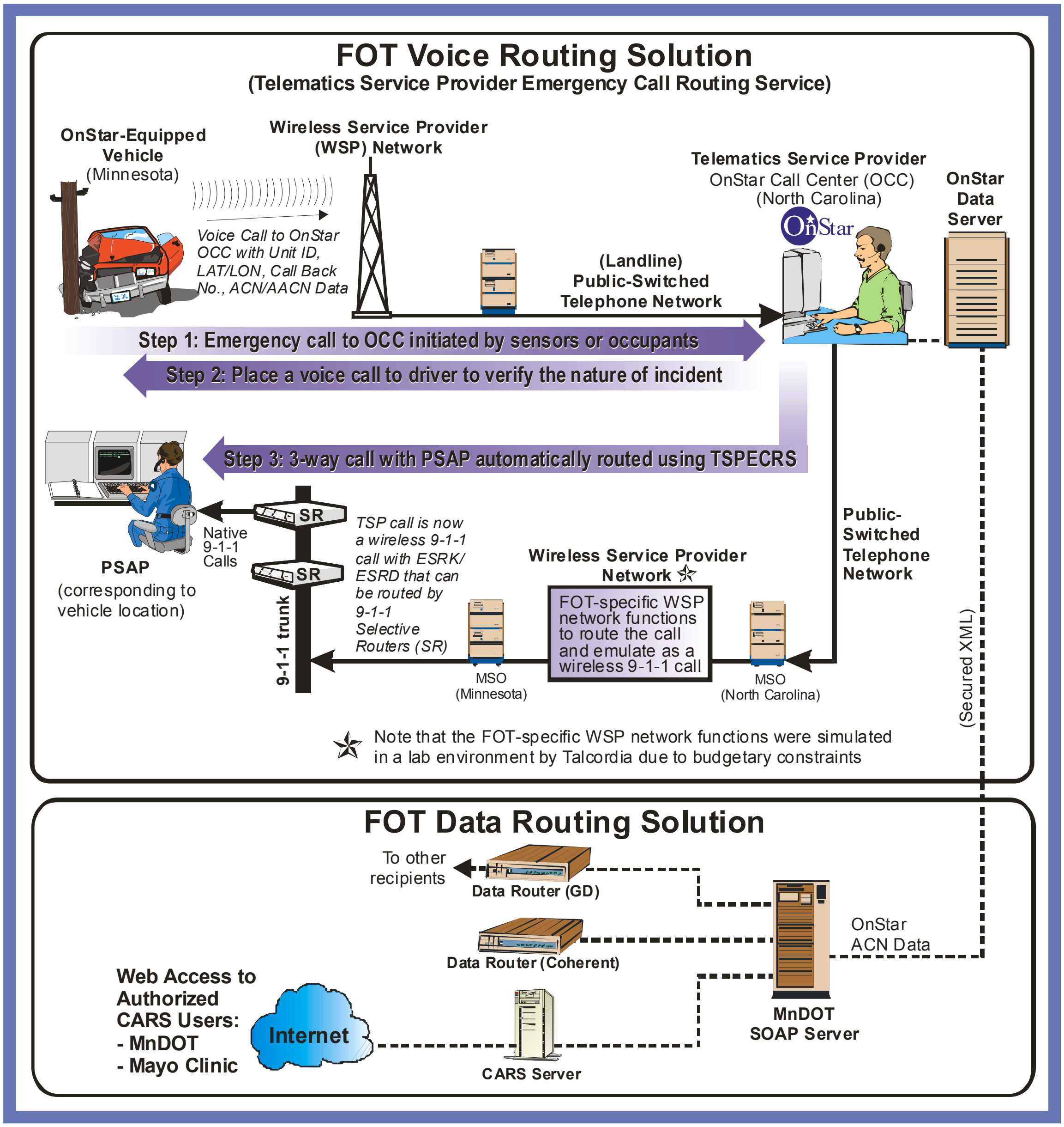


Figure 2-2. High-Level FOT System Functions Illustrated

FOT Voice Routing Solution

The solution for routing the TSP-initiated 9-1-1 calls is called the TSP Emergency Call Routing Service (TSPECRS). The solution has two components to it:

- Use a WSP network to route the TSP initiated 9-1-1 calls to a local Mobile Switching Center[17] (MSC) based on the vehicle location data provided in the TSP calls (e.g., from OnStar Call Center in North Carolina to a MSC in Minnesota where the crash occurred);

[17] MSCs are operated by the wireless service providers primarily to interface between wireless and wireline calls.

- From the local MSC, the TSP 9-1-1 calls emulate a wireless E9-1-1 call and are fed into a local 9-1-1 trunk line and routed to the intended PSAP as a native 9-1-1 call. In addition, the Automatic Location Identification (ALI) database and the E2 interface that bridges the different 9-1-1 service providers[18] were modified to allow transmission of additional data, including call back number, vehicle location (in LAT/LON), and selected ACN and AACN. A description of data elements included in the FOT voice routing is provided in Section3.2.1.1 Description of Field Test.

A limitation of the FOT voice routing solution relates to the lack of specific functionalities in the Wireless Service Provider (WSP) network in support of the proposed TSP emergency call routing. This was explained in the FOT Concept of Operation and Design documents [Ref 1, 2]. Despite the technical feasibility, the deployment of the WSP specific call routing function was cost prohibitive. Such functionalities were simulated in a lab environment provided by Telcordia in support of the FOT.

<u>FOT Data Routing Solution</u>

The FOT data routing implementation was relatively straight forward. To share ACN and AACN data, a secured data connection between the OnStar data server and MnDOT's SOAP server was established using the industry standard eXtensible Markup Language (XML) interface. The SOAP server is accessed by MnDOT's CARS that can be accessed by the authorized users. Figure 2-2 (bottom portion) illustrates the connections between subsystems in support of the data routing.

Upon receiving a distress call from OnStar-instrumented vehicles in the state of Minnesota, the available crash data (SOS, ACN, or AACN) is pushed from OnStar to MnDOT SOAP server and further pushed to CARS server. The role of the SOAP server is a "data broker" and thus has limited logical processing capability (e.g., performing complex rules for screening certain data elements).

In this FOT, CARS provides the interface for the end users of OnStar crash data, including authorized MnDOT staff/facilities and Emergency Medical Services (e.g., Mayo Clinic). It is important to note that CARS is a system deployed by MnDOT originally to support the collection and dissemination of road condition data. CARS is an Internet-based system. That is, an authorized user can access CARS using an Internet browser with a password. The majority of CARS users are within MnDOT (e.g., districts and traffic management facilities) and few are outside of MnDOT (e.g., Mayo Clinic). The FOT data routing included OnStar crash data as part of the accident events in CARS. The OnStar data can be viewed by all authorized CARS users along with other road condition-related events. Figure 2-3 illustrates how OnStar crash data are displayed in CARS. Table 2-1 summarizes the data obtained from OnStar in support of data routing.

[18] The 9-1-1 services in Minnesota are provided by IES and Qwest. E2 is the interface specification that defines the interconnection between different 9-1-1 service providers' ALI databases.

Table 2-1. OnStar Data in Support of Data Routing

OnStar Data Transmitted to MnDOT SOAP Server	Type OnStar Events		
	SOS	ACN	AACN
Provider Name/ID	X	X	X
Incident ID	X	X	X
VIN	X	X	X
Date	X	X	X
Time Received	X	X	X
Latitude and Longitude	X	X	X
Datum[19]	X	X	X
Call Back Number	X	X	X
Vehicle Manufacturer, Make, Model, Year	X	X	X
Device Event Type		X	X
Event Verified		X	X
Delta Velocity, Direction of Force			X
Which airbags deployed			X
Rollover information			X
Multiple Impacts			X

When OnStar data are received by CARS, they are organized in the standard CARS data fields including:

- Location – contains the LAT/LON in the OnStar data;
- Key phrase – contains the best descriptor of the event (e.g., "accident" is used for all OnStar events);
- Start/end time or duration – a default value of one hour[20] is assigned to OnStar events. The expired events are automatically removed from and archived by the CARS;
- Additional information – is a free-form text comment field that includes summary text of all available OnStar crash data as discussed in Table 2-1. This information is displayed when an OnStar event is selected by clicking on the accident icon, as shown in Figure 2-3.

[19] Datum is a math model which depicts a part of the surface of the earth. Latitude and longitude lines on a paper map are referenced to a specific map datum. The map datum selected on a GPS receiver needs to match the datum listed on the corresponding paper map in order for position readings to match.

[20] It is difficult to predict the duration of an incident. The default one hour duration was a design decision.

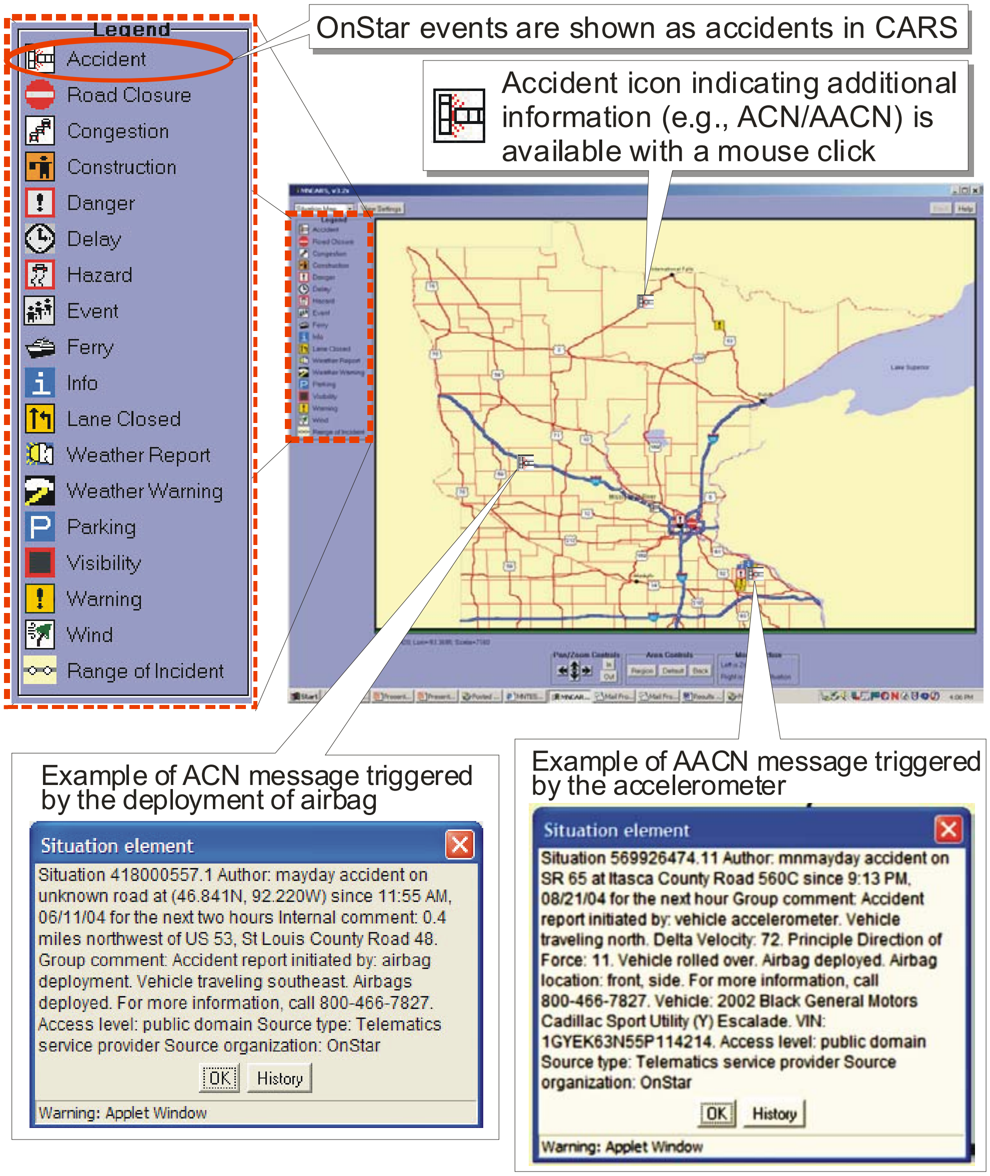


Figure 2-3. Sharing of ACN and AACN Data on CARS

2.3 Overview of Field Operational Test Solutions

This section provides an overview of the field tests involved in the FOT. More details of the test procedures can be found in Section 3 – Evaluation Approach and Section 4 – Evaluation Findings. There were two components to this FOT: the field testing of the automatic voice routing of Telematics-initiated 9-1-1 calls, and a demonstration of the dissemination of OnStar crash data on MnDOT's CARS.

Voice Routing Field Test

After the TSPECRS voice routing system was developed and preliminarily tested, a formal field acceptance test was conducted. The acceptance test was designed based on a statistical sampling framework developed by Battelle. The objective was to assess system reliability in terms of expected maximum system failure rate. The evaluation and FOT teams agreed that the acceptance test must be conducted using simulated calls, instead of live OnStar emergency calls. This decision was based on the concerns of potential liability and logistical[21] issues involved.

The field acceptance test required MnDOT to provide a field test engineer to initiate simulated OnStar calls at pre-determined (thus verifiable) locations. Such calls were made from a portable unit that provides the same functionality as those installed on an OnStar-equipped vehicle. OnStar Emergency Advisors were trained to answer the test calls and establish a three-way call, using TSPECRS, with the participating PSAP. Twenty-two PSAPs in the state of Minnesota participated in the acceptance test.

When the test call finally reached the PSAP, the MnDOT test engineer verified with the 9-1-1 operator, over the cell phone built in the portable OnStar unit, to determine if the correct PSAP was connected as well as the call back number and location data transmitted along with the call. The testing process was facilitated by Battelle, and all paper and electronic logs were independently audited and results assessed with the FOT team. The field test was conducted over a ten day period in August of 2005. More details on the statistical sampling design, test procedure, and results are presented in Section 3 - Evaluation Approach and Section 4 – Evaluation Findings.

Data Routing Demonstration

The data routing system is functionally independent from the TSPECRS. Live OnStar crash events in the state of Minnesota were used to support the data routing demonstration during the FOT period. The FOT successfully demonstrated the transmission of live OnStar crash data to MnDOT's SOAP server and further disseminated to end users (MnDOT and Mayo Clinic) via CARS. The data routing demonstration lasted from October 15, 2004 to September 1, 2005. The evaluation of data routing was focused on the performance (in terms of reliability and latency) of data communications between OnStar and MnDOT SOAP servers.

[21] It could take a long time to obtain the needed sample size from the 22 participating PSAPs due to the relatively infrequent accidents involving an OnStar-instrumented vehicle in the state of Minnesota.

3.0 Evaluation Approach

3.1 Evaluation Objectives and Scope

The objective of the FOT was to demonstrate an innovative solution for automated routing of Telematics-originated emergency calls to an appropriate PSAP as a native 9-1-1 call, and the real-time sharing of the Telematics crash data with various emergency response and management entities via MnDOT's CARS system.

The basic objectives of this independent evaluation were:

- to test and assess the performance of the automated voice routing and data routing capabilities developed by this FOT.
- to examine the acceptance to the FOT application by the users of the voice and data routing systems.
- to identify, analyze and document deployment issues in support of future deployment of this or a similar system.

It is important to note that the evaluation study takes into consideration the known constraints of the FOT. Such constraints include:

- Lack of an existing wireless service provider (WSP) in support of the routing of the 9-1-1 calls as part of the proposed FOT voice routing solutions. As a result, WSP functionalities were simulated in the laboratory environment developed by Telcordia. A dedicated T1 data link was used to provide and emulate the connection between the simulated WSP in Telcordia's New Jersey facility and 9-1-1 trunk in Minnesota. These alternative settings represent an additional source of potential problems.
- It was not feasible to test live emergency calls for the automated voice routing function. Simulated telematics calls made from portable test units (i.e., emulating the instrumented OnStar vehicles), and dedicated OnStar Emergency Advisors and selected PSAP operators were used in conducting the field test. Due to the simulated nature of the FOT (i.e., not routing the actual OnStar calls), the human operators' involvement is thus limited to verifying the performance of the technology (i.e., confirming the reception of calls and data) rather than experiencing the operational improvements brought along by the FOT.
- While the FOT voice routing solution included the transmission of call location data along with the 9-1-1 calls, the partial implementation of the PSAP system (e.g., the lack of integration with the Geographic Information System (GIS) in support of the call location identification) prevents the full benefits of the FOT application to be realized.

In assessing the attainment of the evaluation objectives, one must consider the limitations imposed by the above constraints.

The scope of this evaluation, based on discussions with the FOT team and NHTSA, was determined to be:

- Conduct of a voice routing system acceptance test in assessing the performance of the FOT solution for automated routing of the Telematics-initiated emergency calls to an appropriate PSAP as a native 9-1-1 call along with a call back number and call location data;
- As an ancillary interest, assessment of the performance of a data routing system that transmits available crash data from OnStar operation center to MnDOT for further distribution to users of the CARS; and
- Review of user acceptance and deployment issues.

The evaluation approach discussed in this section is organized with respect to the quantitative analysis of system performance (Section 3.2) and qualitative evaluation of user acceptance and deployment issues (Section 3.3).

3.2 System Performance Evaluation Approach

Compared to the existing TSP emergency call procedure, the FOT voice routing and data sharing procedure incorporates two important differences:

- After initiation of an OnStar call, the OnStar customer service representative establishes a 3-way call through the 9-1-1 Selective Routers to the appropriate PSAP rather than through the PSAP administrative numbers. Also, data regarding vehicle location (i.e., LAT/LON), call back number, and ACN (or AACN) are sent automatically along with the OnStar voice call and do not need to be relayed verbally.
- OnStar provides a data link (using XML) for crash data that are transmitted to the MnDOT SOAP server, from which the crash data are distributed via CARS to the authorized users in support of emergency response and management and to emergency medical service providers (e.g., Mayo clinic).

The approaches for evaluating the voice and data routing are described in Sections 3.2.1 and 3.2.2, respectively.

3.2.1 Voice Routing System Acceptance Testing

The voice routing is a core functional element of the proposed FOT technologies that allows emergency calls initiated by OnStar customers to be routed, via an OnStar Emergency Advisor, and delivered to appropriate PSAPs as a native 9-1-1 call. With the inherent ability of OnStar to locate a calling customer, the FOT voice routing technology was designed to take advantage of existing wireless 9-1-1 call delivery infrastructure, and improve or enhance the processing of telematics-based emergency events.

The purpose of acceptance testing was to establish that the system for routing a voice call from an OnStar Emergency Advisor through to the appropriate PSAP operates reliably and accurately. The approach for conducting the acceptance test was to perform a field evaluation where wireless OnStar calls are placed in 22 PSAPs[22] throughout the state of Minnesota. For each call, data are collected regarding the success or failure of the voice routing system to establish a connection with the appropriate PSAP through the 911 trunk line and to accurately transmit data (e.g., latitude/longitude, call back number, and available ACN/AACN data) related to the original call. Each sample call is ultimately determined to be a success or a failure relative to the system requirements.

3.2.1.1 Description of Field Acceptance Test

The field test applied a statistical acceptance sampling approach to the evaluation of the FOT voice routing functionality so that one of two ultimate conclusions could be reached:

1. The system **passes** final validation testing. The statistical interpretation is that there is insufficient evidence to reject an initial assertion that the overall system failure rate is less than one percent. The sample size and acceptance criteria are such that this conclusion is protected from error with 94 percent confidence that the true system failure rate does not exceed four percent.

2. The system **fails** the final validation test. The statistical interpretation is that there is sufficient evidence (with 94 percent confidence) to conclude that the true system failure rate is greater than one percent.

The selection of a four percent failure rate against which to conclude system passing and a one percent failure rate against which to conclude system failure were decisions of the client. These are reasonable levels of performance for this type of system. Note that the 94 percent confidence levels are slightly lower than the general statistical standard of 95 percent.[23] This is a result of the discrete (versus continuous) nature of counting numbers of successes and failures.

Secondary objectives were to assess whether ACN/AACN data were correctly transferred in those PSAP areas where this functionality is enabled and whether call data would be successfully routed to the Mayo Clinic in those areas where this capability is routinely required.

The selected acceptance sampling design utilized a sequential approach. Under this approach, a total planned sample size of 294 calls is split into two sampling stages of 147 calls. At the conclusion of the first stage, the total system errors are tabulated and one of three conclusions is reached:

[22] County PSAPs include: Meeker, Renville, Kandiyohi, McLeod, Carver, Hennipen, Anoka, Washington, Dakota, Scott, Olmsted, Mower, and Steele Counties. City PSAPs include: Minnetonka, Eden Prairie, Edina, Minneapolis, St. Paul, Eagan, Apple Valley, Burnsville, and Lakeville.

[23] When conducting a statistical test with a binomial response (yes or no) versus a continuous response, the confidence bounds do not normally exactly meet the 95% that is “standard”.

1. If zero or one errors are found, the system is concluded to pass the acceptance test.
2. If two to four errors are found, a conclusion of acceptance or failure is postponed until another stage of 147 calls is completed. After completion of the second stage, the total errors (first stage plus second stage) are tabulated and if the number is six or less, the system passes acceptance. If the errors total seven or more, the system fails acceptance.
3. If five or more errors are found, the system is concluded to fail the acceptance test.

This sequential acceptance sampling plan is beneficial because, for a given total sample size, it produces close to the same statistical properties (i.e., confidence levels for correctly concluding the system passes or fails acceptance given true population error rates) of a single stage acceptance sampling plan but with a possibility of reaching an early conclusion. In this case, a conclusion of passing acceptance can be reached in one half the samples compared to a single stage acceptance sampling plan. The statistical derivation related to this sampling plan is provided in Appendix A.

The overall acceptance test design for this evaluation also included provisions for retesting if the system failed its initial acceptance test. However, these options did not prove necessary as the system passed acceptance on its initial sample. More detailed discussion of the acceptance testing design is provided in the Detailed Evaluation Test Plan [Ref 5].

Field Testing

The acceptance test calls were carried out by MnDOT staff in the 22 FOT PSAPs over a ten day period in August of 2005. In advance of the test, Battelle provided MnDOT with a sampling schedule that listed each of the PSAPs and a corresponding required number of sample calls. This initial sample selection contained as close as possible to an equal sample size[24] for each of the 22 PSAPs. Upon receiving the required numbers of samples, MnDOT staff identified sample locations. These were selected with some effort to provide geographic spread in the respective PSAP areas.

On each sampling day, MnDOT staff proceeded to each planned location with a laptop computer (to simulate ACN/AACN data) and a portable OnStar test unit. These are shown in Figure 3-1.

[24] Approximately 6 to 7 calls are allocated for each PSAP.

Figure 3-1. Portable OnStar Test Unit in Support of Field Test

The MnDOT staff placed a call to the OnStar call center. OnStar established a three-way call with the PSAP of the originating call location as a wireless 9-1-1 call. This was done in the FOT through a laboratory environment (Telcordia) simulating a call in a wireless service provider network. The PSAPs were alerted that this was a test call so that they could defer it if there were any true 9-1-1 calls coming through at the same time. The PSAP was then asked to identify its location and what data it had received on the incoming test call. Figure 3-2 below provides a visual example of the data coming in to the PSAPs. This specific image is unique to PSAPs with IES as the service provider.

For each sample call, the MnDOT staff recorded the following information on a data collection form:

- the PSAP from which they were calling (usually prepopulated)
- the date and time of the call
- the caller name
- the call location (usually prepopulated with the planned location to include an identification number, a location description, and approximate GPS coordinates).
- whether the call went through to the OnStar Emergency Advisor
- whether OnStar made contact with a PSAP and, if so, which PSAP
- the latitude and longitude transmitted to the receiving PSAP
- the call back number transmitted to the receiving PSAP
- a code for call type (one of a number of simulated ACN/AACN crash data records)
- (in selected PSAPs) simulated ACN/AACN data – see below
- (in selected PSAPs) confirmation that a secondary PSAP (Mayo) received the callback number and latitude/longitude data

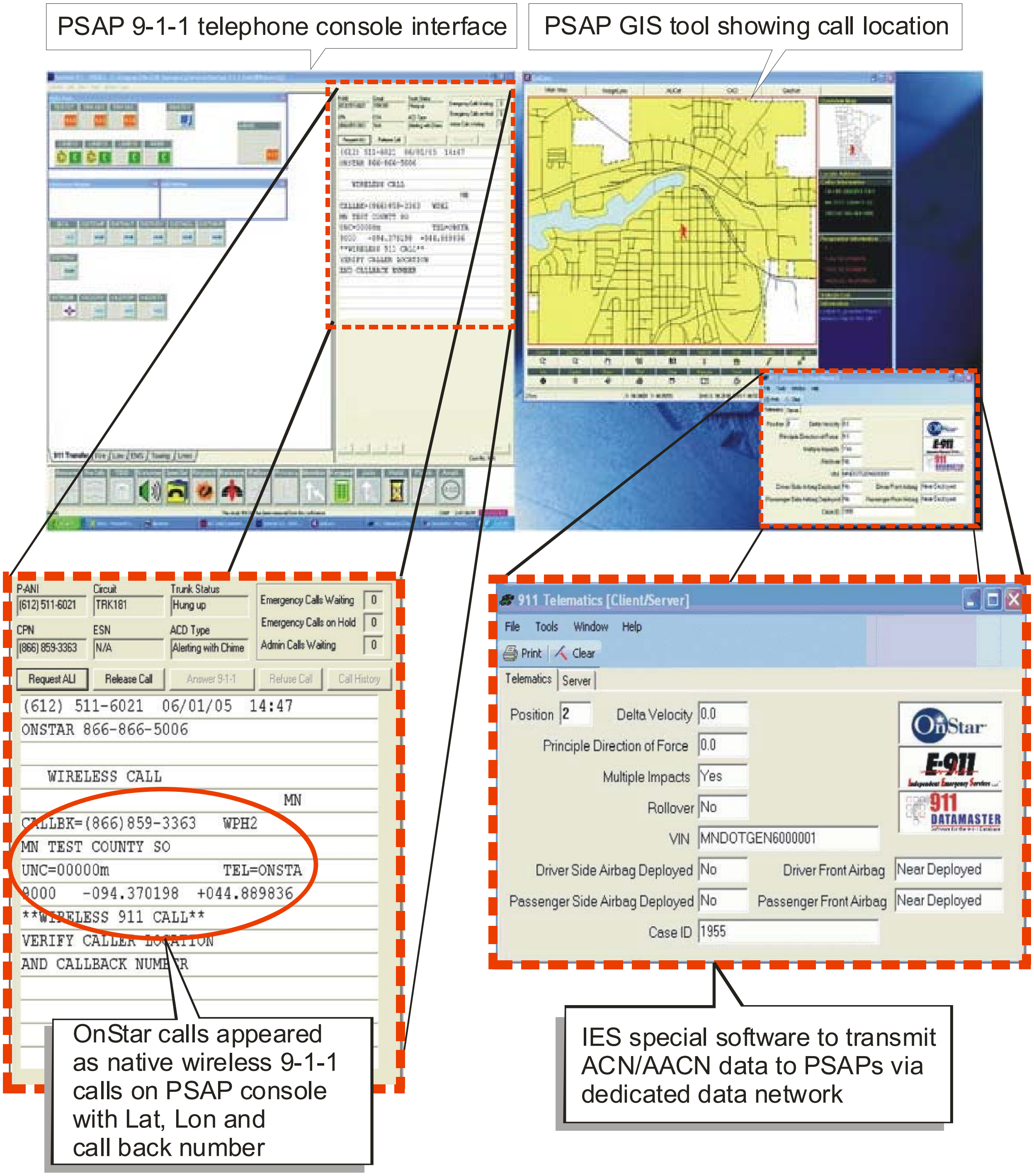
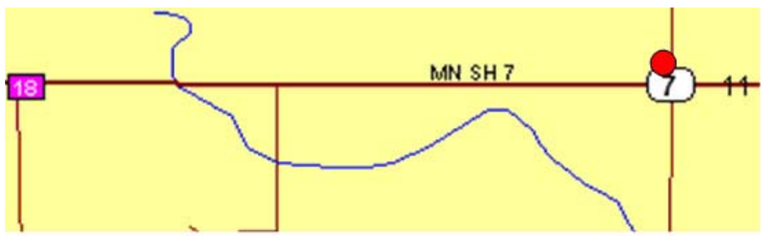


Figure 3-2. Sample PSAP Incoming Call Screen (IES)

After completing each call, the MnDOT staff recorded required information on a data collection form then moved to the next sample location. A sample data collection form is shown in Figure 3-3 below.

While there were no requirements in the acceptance test plan related to the sample time of day, MnDOT staff attempted to perform the test calls over a range of daytime hours. Calling after normal working hours was not operationally possible. Also, calling during morning or evening rush hours was deemed inappropriate since it had higher potential to interfere with true 911 calls due to the higher expected load.

Some issues unrelated to the FOT solution prevented successful calls from being made. In these cases, either additional calls were made from the same location or alternative locations were chosen. A discussion of those non-counted calls is provided in Section 4.1.1-Test Results.



PSAP: McLeod County	Date/Time of Call _______
Caller Name:_________	Call Location: 1
Call Location Description: Highway 7 and County 15 Location is just past "Glencoe 10 Miles" south sign (east of Silver Lake) Approximate GPS: 44.90718667, -94.13465278	
Did call go through to OnStar Representative? ___ Yes ___ No	
Did OnStar make contact with a PSAP ___ Yes ___ No	
What PSAP did it make contact with? ____________________	
What was the Lat/Long displayed at the PSAP? Latitude ________________ Longitude ________________	
What was the call back number displayed at PSAP? ________________________________	Call Type _______

Figure 3-3. Example Data Collection Form from FOT Acceptance Sampling

Two special evaluations were conducted as part of the acceptance sampling.

Three PSAPs with IES as the 9-1-1 service provider (Kandiyohi, Renville, and McLeod) had the capability to receive ACN and AACN data with each call. For these areas, the PSAP was also asked to read back the simulated AACN data that was transmitted to them when OnStar relayed the call to them. These data included:

- Delta Velocity
- PDOF (Principle Direction of Force)
- Multiple Impacts
- Rollover
- Driver Side Airbag Deployed
- Driver Front Airbag Deployed
- Passenger Side Airbag Deployed
- Passenger Front Airbag Deployed

For this evaluation, a set of ten different simulated AACN data sets was produced. Each of the ten was used at least once in the testing to simulate an emergency call from OnStar-equipped vehicle. These data sets are stored on the laptop computer as part of the portable test unit as shown in Figure 3-1. The ten AACN data sets are shown Table 3-1 below.

Table 3-1. Simulated AACN Data Sent as Part of Acceptance Sampling

Data Category	Simulated AACN Data Sets									
	1	2	3	4	5	6	7	8	9	10
Delta V	17	32	10	32	22	22	32	20	20	20
Principle Direction of Force (PDOF)	-94	-91	176	-91	88	-88	-91	180	149	0
Multiple Impacts	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Rollover	no	no	no	no	no	no	no	no	no	no
Driver Side Airbag Deployed	no	no	no	yes	no	no	no	no	no	no
Driver Front Airbag Deployed	near deployed	blank	blank	blank	blank	near deployed	near deployed	blank	blank	blank
Passenger Side Airbag Deployed	no	no	no	yes	no	no	no	no	no	no
Passenger Front Airbag Deployed	near deployed	blank	blank	blank	blank	near deployed	near deployed	blank	blank	blank

The PSAPs with capability to receive the AACN data had a separate application on their ALI. This is shown in the bottom right hand section of Figure 3-2 above. Note that Position, VIN, and Case ID are fields that were not evaluated.[25]

The Olmsted, Mower, and Steele PSAPs use the Mayo Clinic as a secondary PSAP and emergency responding entity (EMS). Therefore, in these three areas, sample calls were routed on to the Mayo Clinic after completing the sample call to the PSAP. Whether the Mayo Clinic

[25] IES, one of the Minnesota 9-1-1 service providers, developed additional software to transmit ACN data to their serviced PSAPs via a separate network connection. This feature is not part of the FOT scope.

received the correct call back number and latitude and longitude for the original call were separately recorded for these sample calls.

Though examined, successful ACN/AACN data transfer and Mayo Clinic call forwarding were not required for formally assessing passing or failing acceptance testing of the FOT solution.

At the conclusion of each test day, the data collection forms were scanned into PDF files and sent to Battelle. In parallel to these sampling activities, Telcordia (who provided simulated wireless service provider network functions) archived the recorded date and time of each test call along with the transmitted latitude and longitude data sent from the OnStar unit. These call records were also electronically sent to Battelle.

Battelle conducted a detailed audit by comparing the information on the data collection forms and electronic logs provided by Telcordia. Discrepancies in the two records were discussed and resolved with the FOT team. After this QA review, all sample call records were entered into an Access database. The acceptance data are included as Appendix B.

3.2.1.2 Evaluation Hypotheses and Measures of Performance

Table 3-2 provides a summary of hypotheses, measures of performance (MOP), and data sources to be examined in the voice routing system testing.

Table 3-2. Hypotheses, Measures of Performance, Data Sources for Voice Routing Test

Area of Interest	Hypotheses	MOPs	Data Sources
Voice Routing System Reliability	In response to an OnStar call, - The OnStar Customer Service Representative can establish a 3-way call to the 911 system which goes to the correct PSAP considering the call location. - The 911 system at the responding PSAP will receive accurate transmission of LAT/LON, OnStar unit call back number, and additional ACN/AACN data	• (Acceptance achieved) Estimated maximum system failure rate and confidence level • (Acceptance not achieved) Estimated minimum system failure rate and confidence level	• Acceptance sampling results from simulated test calls

3.2.1.3 Data Collection

Because of the liability concerns and logistical difficulties in sampling live OnStar 9-1-1 calls, the sample design utilized simulated OnStar calls placed in the field for evaluating the system. The following test protocols were followed for the test evaluations:

- A sampling schedule was prepared which identified the number of test calls to be made from each PSAP in the FOT. The field tester identified a set of locations in each PSAP selected to provide a reasonable geographic spread throughout the PSAP.
- The field tester obtained a portable OnStar unit for initiating simulated OnStar calls.
- The field tester took the portable OnStar unit to a specified location within the designated PSAP, according to the sampling schedule.
- The field tester filled out a data entry form. The field tester accurately recorded time of day and then pushed the OnStar button. The field tester recorded whether a connection was made to an OnStar Emergency Advisor. (Note that OnStar Emergency Advisors were trained in support of the acceptance test.) If a connection was made, the tester recorded whether the OnStar Emergency Advisor set up a 3-way call to a PSAP. If so, the tester recorded the connected PSAP. Finally, the tester verified and recorded the latitude and longitude information directly communicated to the answering PSAP as well as the call back number.

Upon completion, the tester moved to the next specified location and repeated the above procedures. At the end of the day, after properly recording and checking data, the field tester transmitted the data entry forms to Battelle.

3.2.1.4 Analysis

The acceptance test plan was structured to incorporate the following concepts:

- It provided known protection against falsely accepting a system with an unacceptably high failure rate.
- It provided known protection against falsely rejecting a system with an acceptable failure rate.
- It utilized a stage-wise statistical approach to sampling (Appendix A). This is valuable to limit the total number of calls by permitting early acceptance or failure decisions to be reached. In the case of early failure, this would provide an opportunity for the FOT team to make changes to the system and then test again for acceptance.

Determination of the tolerable rates for false acceptance and false rejection was made in consultation with the MnDOT FOT team and NHTSA. Those rates were partially determined by the maximum number of sample calls that could be made due to budget or time constraints. A consensus was reached with the FOT team and NHTSA that no more than 500 calls could ultimately be placed during the acceptance sampling test.

From these broad requirements, an acceptance sampling plan[26] was developed that consisted of two phases:

[26] The sampling plan was approved as part of the FOT voice routing detailed test plan [Ref 5].

- Initial Validation Test Phase – a total of twenty calls are placed from three PSAPs to determine that all aspects of data collection were operating as planned.
- Final Validation Test Phase – based on the stage-wise sampling design, approximately 140 test calls are placed as a first stage. These are evenly distributed throughout the 22 participating PSAPs. The results of this stage are evaluated to decide if the second stage of testing is needed. Results from the Initial Validation Test Phase may be counted for the Final Validation Test Phase if they do not exhibit any failures.

Once the sample calls had been placed and data are collected for each one, the sample data collection forms were returned to Battelle. Battelle then categorized each call as a success or failure with regard to system reliability and data integrity.

Factors outside the control of the FOT were not considered in determining success or failure. For instance, a call that was not completed due to lack of cell service was not evaluated as either a success or a failure and was omitted from the results. These non-counted calls were discussed in the evaluation results to provide potentially useful information about the FOT.

3.2.2 Data Routing System Performance Analyses

As an ancillary objective of the FOT, live OnStar crash data in the state of Minnesota were automatically transmitted to the MnDOT SOAP server. From there, they were available to CARS and other data servers. The evaluation of the data routing system focused on reliability and latency of the data transfer between OnStar and the SOAP server.

3.2.2.1 Evaluation Hypotheses and Measures of Performance

Table 3-3 describes hypotheses, measures of performance (MOP), and data sources to be examined in the data routing system performance testing.

Table 3-3. Hypotheses, Measures of Performance, and Data Sources for Data Routing Test

Area of Interest	Hypothesis	MOPs	Data Sources
Data Routing System Reliability	All OnStar incident data designed to be sent to the MnDOT SOAP server are sent reliably and accurately, and in a timely fashion.	• Estimated proportion of OnStar data records accurately received by SOAP server • Estimated time to transfer data	• Weekly summary report produced by OnStar of calls sent by type (SOS, ACN, AACN), number of failures, and average transmission time.

3.2.2.2 Data Collection

During the FOT period, OnStar produced a weekly report tabulating the number of calls routed to the MnDOT SOAP server by type (e.g., SOS, ACN, and AACN) with counts of failed transmission records and the average transmission time. These weekly reports were transmitted to MnDOT and were aggregated into a single spreadsheet covering the weeks of the FOT. These data were provided to Battelle in support of the evaluation.

3.2.2.3 Analysis of Data Transmission Logs

The data routing system was first activated on May 19, 2004. The Field Operational Test period for the functionality began October 15, 2004 and concluded on September 1, 2005. The basis for the evaluation of the data routing system performance is an Excel spreadsheet provided by MnDOT that summarized weekly data transmission performance over the period from May 25, 2004 to September 18, 2005. To match the operational test period, this evaluation only covers the 47 weeks starting with October 11, 2004 and concluding with September 4, 2005. Note that the reporting of data on a weekly basis prevented an exact match with the operational test period. Within this 47 week period, six of the weeks are omitted because MnDOT had no record of receiving the automated e-mail containing weekly summary from OnStar. This evaluation uses all available data for the remaining 41 weeks of the operational test period. The data are shown for reference in Appendix C.

For each week in the period, the total number of Minnesota calls sent by OnStar and received by the SOAP server of type AACN, ACN, and SOS were tabulated, followed by the number of failures. SOS calls are those for which an OnStar user pushed the emergency button and the OnStar Emergency Advisor established a three-way call with a PSAP. ACN and AACN calls refer to those which are automatically made by the OnStar device when it detects a collision. These calls transmit vehicle identification and location data as well as airbag deployment information. The AACN includes additional fields such as Delta Velocity, Principle Direction of Force, and Rollover status. Latency was recorded as the average delivery time in seconds for the transmitted data.

The following analyses were conducted:

- The proportion of all OnStar records that were successfully logged into the MnDOT SOAP server was calculated.
- The average time required for transfer of records from OnStar to the SOAP server was calculated.

3.3 User Acceptance and Deployment Issues Evaluation Approach

3.3.1 Objectives

The objective of this portion of the evaluation is to document the institutional and technical challenges of the FOT, with an emphasis on the data and voice routing solutions to broader, more ubiquitous applications, including, but not limited to public safety, emergency response, transportation management and related activities. Complimentary to the quantitative assessment of system performance, as discussed in Section 3.2, perceptions of the FOT users provided valuable insights for gauging the success of the FOT.

The users assessed in this evaluation include PSAP operators, call takers and OnStar Emergency Advisors who potentially benefit from the voice routing feature of the FOT system; and emergency responders and traffic operation managers who might benefit from the data routing system that shares the OnStar ACN data via the CARS. Acceptance and satisfaction with the FOT by these users were examined through personal interviews or small group discussions.

Equally important, this evaluation identifies and documents technical and operational issues that must be addressed in support of future deployment of a similar system. Such issues are examined along the following basic FOT objectives.

- Automatically routing telematics-based 9-1-1 calls to appropriate PSAPs.
- Ability to deliver such calls on 9-1-1 trunks like a native 9-1-1 call.
- Improved interaction between OnStar Emergency Advisors and PSAP call-takers.
- Reduced TSP system maintenance requirements.
- Improved emergency medical response and incident management resulting from better information.
- Applicability of the FOT solution to other service environments and geographic areas.

3.3.2 Evaluation Hypotheses and Measures of Performance

Hypotheses as specified in Table 3-4 guided the analysis and were tested with the data and observations obtained in the user acceptance and the deployment issues evaluations.

3.3.3 Data Collection

3.3.3.1 User Acceptance

Acceptance of the FOT application by the user group community was assessed through structured interviews with selected representatives of each user group, as described below.

9-1-1 Call Delivery and Processing

OnStar

Selected OnStar Customer Service and corporate representatives were interviewed. Access to and the selection of those interviewees were closely coordinated with appropriate OnStar corporate representatives, as were the timing and location of the interviews involved. The interviews were structured around a set of standard questions (as presented in Evaluation Findings, Section 4.0), consistent with the intent, scope and goals of the FOT.

Table 3-4. Hypotheses, Measures of Performance, Data Sources for User Acceptance and Deployment Issues Evaluation

Areas of Interest	Hypotheses	MOPs	Data Sources
User Acceptance (OnStar)	OnStar Emergency Advisors perceive the process and application to benefit TSP call processing. OnStar Management Representatives perceive the process and application to generally benefit corporate service goals. OnStar prefers this solution to current practice. OnStar believes this solution facilitates interaction with PSAPs. Automatic communication of location (and, thus, routing of the call) is inherently less error-prone. The total time of call processing is perceptibly reduced.	• Perceptions of operational benefits in facilitation of call processing and timeliness, accuracy of call routing, and PSAP interaction. • Reduced system maintenance by eliminating the need to update PSAP administrative numbers. • Reported technical and operational issues associated with the FOT test.	• Structured interviews with OnStar Emergency Advisors. • Structured interviews with OnStar Corporate representatives.
User Acceptance (PSAP)	PSAP call-takers perceive the FOT application to be beneficial. PSAP call-takers prefer this solution to current practice. PSAP call-takers believe this solution facilitates interaction with the OnStar Call Center. Automatic communication of location (and, thus, routing of the call) is inherently less error-prone The total time of call processing is perceptibly reduced. PSAP Authority (cognizant 9-1-1 entity) perceives the process and application to be beneficial. State 9-1-1 Point-of-Contact perceives the process and application to be beneficial.	• Perceived benefits by PSAP and other 9-1-1 representatives, including the facilitation of call processing and timeliness, reliability of call routing, and OnStar interaction. • Reported technical and operational issues associated with the FOT test. • Depending upon available PSAP Management and Information System (MIS) capabilities and records, comparative test call duration with historical precedent (i.e., dialing into PSAP administrative line).	• Structured interviews with PSAP call-takers and other 9-1-1 representatives. • PSAP MIS data, as available and appropriate.
User Acceptance (Medical Responders)	Medical responders (Mayo Clinic) perceive the ACN data to be beneficial. Medical responders (Mayo Clinic) are more informed with ACN data in response to the traffic-related incidents. The ACN data are provided in a timely manner via CARS. The vehicle location	• Medical responders' (Mayo Clinic) perception of benefits, including the facilitation of incident information sharing and access. • Perceived better decision making due to crash information provided by ACN.	• Selected structured interviews with appropriate Mayo Clinic representatives.

Table 3-4. Hypotheses, Measures of Performance, Data Sources for User Acceptance and Deployment Issues Evaluation (Continued)

Areas of Interest	Hypotheses	MOPs	Data Sources
	representation on CARS is accurate and useful.	• Medical responders (Mayo Clinic) reported technical and operational issues associated with the use of ACN data. • Stated Medical responders (Mayo Clinic) willingness to promote and accommodate nationwide deployment of the FOT solution.	
User Acceptance (State Traffic Operations)	State traffic operation users perceive the ACN data to be beneficial. Such users desire permanent deployment of the application. The state traffic operation is more informed with ACN data in response to and management of traffic-related incidents. The ACN data are provided in a timely manner via CARS The vehicle location representation on CARS is accurate and useful	• State traffic operation users' perception of benefits, including the facilitation of incident information sharing and access. • Reported technical and operational issues associated with the use of ACN data. • Willingness to promote and accommodate nationwide deployment of this or a similar solution.	• Selected structured interviews with appropriate State traffic Operation users' representatives.
Expandability beyond MN	OnStar believes that the benefits of the FOT solution warrant its application beyond Minnesota.	• Stated willingness to promote nationwide deployment of the FOT solution. • Technical and operational issues involving national deployment.	• Selected structured interviews with user community representatives.
Expandability (Multiple TSPs)	FOT Public safety users believe that the benefits of the FOT solution warrant its application to other Telematic Service Providers.	• Perceptions of benefit ubiquity and application to other service providers.	• Selected structured interviews with appropriate OnStar representatives.
NG9-1-1	The FOT solution is consistent with standards and related work currently being conducted on NG9-1-1 migration by NENA.	• Consistency with NENA Future Path Plan, guidelines and standards.	• Interviews with appropriate NENA representatives.

PSAPs and 9-1-1 Authorities

Selected PSAP 9-1-1 call-takers were interviewed. These interviews were coordinated with appropriate PSAP management and 9-1-1 authority points-of-contact (POCs). Again, the interviews were structured around a set of standard questions, consistent with the intent, scope and goals of the FOT, and were facilitated by MnDOT, as well as the POCs involved (state and local). Interviews included PSAPs and 9-1-1 authorities reflecting an appropriate cross-section of the larger PSAP community involved in the FOT.

Five PSAPs were selected, including: Meeker County (IES), Olmsted County (Qwest), Anoka County (Qwest), City of Burnsville (Qwest), and the City of Minneapolis (Qwest). The Mayo Clinic was involved, as both a secondary PSAP, and, as an ACN data user (emergency response). IES and Qwest[27] are the two companies that provide 9-1-1 trunk lines in the state of Minnesota. These PSAPs provide a good mix of PSAP environments, including both 9-1-1 Service Providers (i.e., Quest, IES), service environment (i.e., urban, suburban, rural), and size of PSAP.

In addition, representatives of local and state 9-1-1 authorities were interviewed regarding their operational responsibilities and involvement with the FOT.

Information Sharing and Data Users

Mayo Clinic as a Responder

The Mayo Clinic and the Mayo Medical Transport, as emergency medical responding and treatment service entities, currently have access to real-time ACN data shared through MnDOT's CARS. Interviews with selected Mayo Clinic representatives were conducted and structured around both the nature of the data access, and the utility of the information. Questions of utility emphasized both transport and treatment. The scheduling of those interviews was facilitated by MnDOT.

[27] IES provides the 9-1-1 trunk line and maintains the selective router (SR). Qwest provides the 9-1-1 trunk but selective routers are maintained by Intrado.

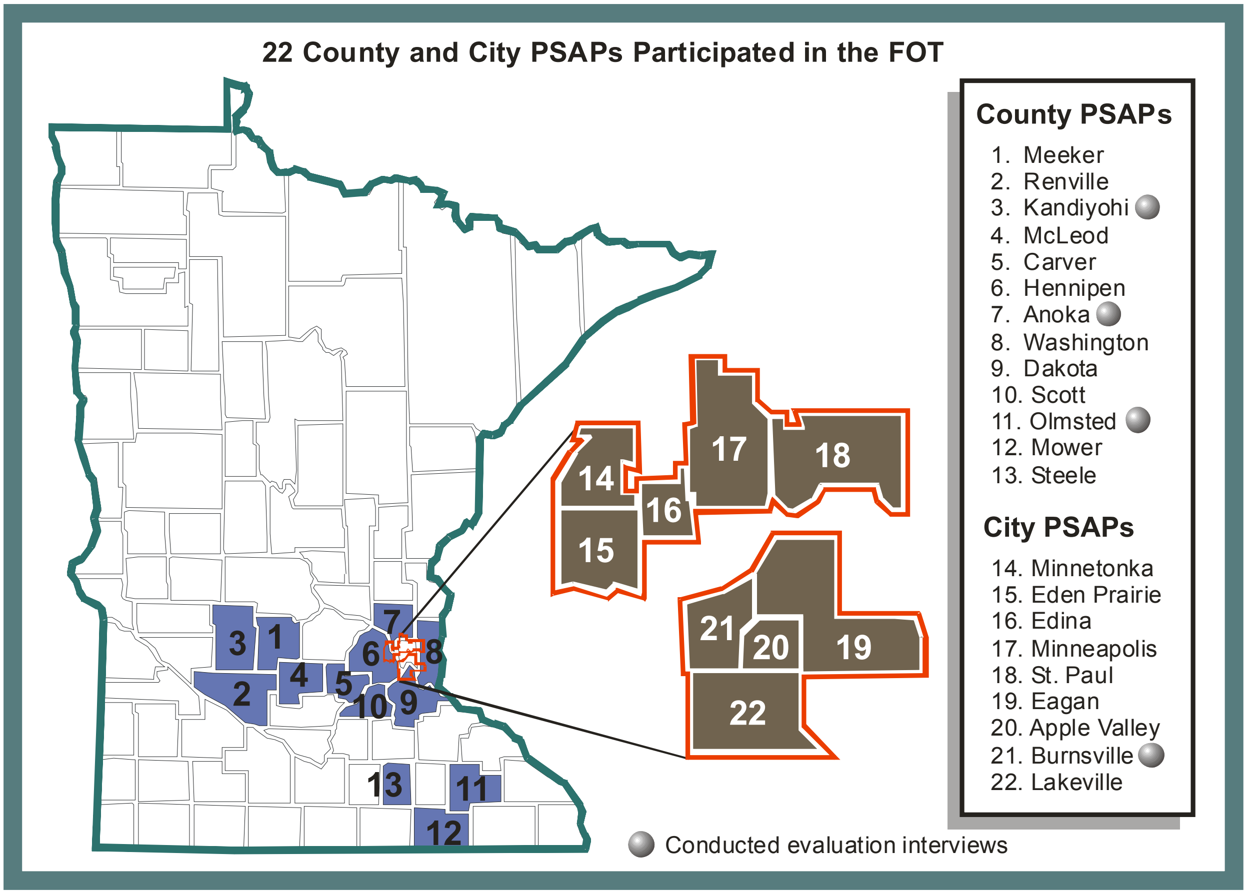


Figure 3-4. Twenty-Two PSAPs Participated in FOT

<u>MnDOT Traffic Operation Center</u>

Any additional incident data are important to MnDOT in support of traffic management operations. ACN or AACN data provide additional information for gauging the nature and severity of an accident, with which MnDOT could make informed decisions in diverting traffic or advising drivers of the delay using available traffic management resources (e.g., Dynamic Message Signs, web site, or 511). To that end, interviews were conducted with MnDOT Traffic Operation Center personnel involved in consuming ACN/AACN-related CARS data for the purpose of traffic and incident management. Questions were structured around the history of that use (to the extent that such data have been available), the nature of its access, and its utility to incident management. Suggestions for enhancement were solicited as well. The interview was conducted at the Roseville Regional Transportation Management Center (RTMC), a MnDOT facility specifically designed to support traffic and incident management, which combines maintenance dispatch, traffic security and operations, and is co-located with state public safety.

3.3.3.2 Deployment Issues

The evaluation team reviewed the results of the test with key members of the FOT implementing team, and explored the opportunity and appropriateness of applying the FOT solution to other states and provider environments. Interviews were conducted with technical contributors to the FOT solution, including both data and voice routing system designers and integrators. Questions were structured around these results, and emphasized universal applicability in light of ongoing institutional and technical changes in the telecommunications industry. The evaluation reviewed the "simulation" features of the voice routing components of the voice routing test and identified impacts that simulation may have had on test results.

The evaluation examined the consistency of the FOT approach with NG9-1-1 standards and operational requirements currently being developed by the National Emergency Number Association (NENA) and related organizations. Future path planning for Next Generation 9-1-1 (NG9-1-1) infrastructure generally involves trusted IP-based networks, interconnected to provide interoperability, robustness, universality, and flexibility. The delivery of 9-1-1 calls, along with the essential information and data both to support that delivery and to facilitate emergency response will most likely occur over the same network infrastructure. While the functional nature of routing and delivery of any kind of 9-1-1 call will still occur over such a network, the way that is brought about will change. The nature of NG9-1-1 network infrastructure may ultimately offer more effective pieces to the solution being examined, and that was explored in light of the "universality" question.

Specifically, reviews of the FOT solution were conducted jointly with NENA's Technical Issues Director, appropriate NENA Technical Committee members and FOT implementing team members regarding this ancillary objective.

3.3.4 Analysis

3.3.4.1 Assessment of User Acceptance

Interview data were analyzed to assess user perceptions about the effectiveness and utility of the FOT approach to accessing and processing telematics-related incident data and emergency requests. Ultimately, user acceptance will depend upon user perception of three things: whether that approach is believed to work, how well it is believed to works, and how universal users think it might be. The analysis reconciled both the qualitative and quantitative results of the evaluation with these three questions.

For telematics service providers, successful implementation of FOT voice routing or a similar solution will provide a quicker and more accurate way to forward an emergency 9-1-1 type call to the "correct" PSAP as a native 9-1-1 call. A similar technical approach can save time, is more efficient and less costly (obviates the need to maintain a separate PSAP access directory, for example), and ultimately provides better service to customers. For PSAPs, such calls are delivered in a more timely way (a critical safety factor), are processed the same way other 9-1-1 calls are processed (i.e., over 9-1-1 trunks, and thus they receive the same priority), and are more likely to be delivered to the correct PSAP, and provided a call back number and location information (i.e., LAT LON). Questions to both user groups helped validate these assumptions.

It is important to point out that the user acceptance analysis for the voice routing is likely to be limited by the "trial" nature of the FOT (i.e., OnStar 9-1-1 calls were simulated). While that should not impact the basic question of the FOT (e.g., "does it work"), it will be a factor to consider in assessing "how well it works" in terms of operational improvement.

Different from voice routing test, actual telematics incident data are made available in near real-time to various authorized users of MnDOT CARS. The Mayo Clinic, for example, serving both secondary PSAP and first responder functions, is interested in telematics incident data for the sake of facilitating emergency response and treatment. Questions regarding the usefulness for positive patient outcomes, and the support of early response are most relevant. MnDOT, on the other hand, might be more interested in better information in support of traffic management during incidents, and faster incident clearance resulting from better coordination with response agencies (e.g., public safety, first responder, etc.). Therefore, questions dealing with the utility of reported incident data (including, but not limited to data format, timeliness, user interface and accuracy) are important.

3.3.4.2 Assessment of Deployment Issues

Feedback from the deployment team and third party technical experts was compiled and documented in support of decisions regarding the future deployment of potential FOT solutions. The assessment of deployment issues addresses the same factors associated with deployment issues as are addressed for user acceptance: Does the approach work? How well does it work? What is its potential for wider applicability?

4.0 Evaluation Findings

The evaluation findings are organized in three sections. Section 4.1 reports the acceptance test results of the FOT voice routing system. Section 4.2 presents the assessment of the performance of the data routing which shares the OnStar crash data with MnDOT for further dissemination on CARS. While the first two sections focus on quantitative evaluation of the FOT performance, Section 4.3 provides findings and discussion based on interviews with the key stakeholders of the FOT, including telematics service provider, PSAP operators, call-takers, first responders, traffic operators, the Minnesota 9-1-1 program manager, and FOT team members.

4.1 TSP Voice Routing Field Test

The TSP voice routing field test was undertaken to determine whether the MnDOT MAYDAY/9-1-1 FOT solution demonstrates adequate reliability in routing TSP-initiated emergency calls to an appropriate PSAP with vehicle location (in latitude and longitude) and call back number.

Section 4.1.1 presents and discusses the test results. Section 4.1.2 provides a summary of the findings of the testing.

4.1.1 Test Results

The field test consisted of 190 test calls made over eight days in mid-August of 2005. Analysis of the test results consisted of first determining whether each call should be counted as an acceptance test record or as a non-counted record. The official acceptance test calls were then further examined to determine if they passed or failed acceptance. Table 4-1 below shows the summarized results of the acceptance test.

Table 4-1 contains a separate line for each PSAP in the evaluation, identifying its name, the date acceptance sampling was performed, and the planned number of calls for that PSAP. It then shows the actual number of sample calls made with separate columns for the counts of calls that passed acceptance, failed acceptance, or were not counted toward the acceptance test. The reasons for non-counted calls are discussed later in this section. The table contains AACN transfer and Secondary PSAP Routing (Mayo) statistics where these capabilities were available.

Table 4-1. Summary Results of FOT Acceptance Testing of Voice Routing Functions

PSAP (County)	Date Sampled	Planned Sample Calls	All Sample Calls			AACN Data[1]			Secondary PSAP (Mayo) Routing[1]	
			Acceptance		Not Counted	Correct	Incorrect	Not Counted	Success	Failure
			Pass	Fail						
Kandiyohi	8/10/2005	6	6	0	4	4	1[3]	1[4]		
Renville	8/10/2005	7	7	0	3	6	0	1[4]		
McLeod	8/11/2005	7	7	0	4	6	0	1[4]		
Meeker	8/11/2005	7	7	0	8					
Carver	8/11/2005	7	7	0	3					
Anoka	8/12/2005	7	5	0	3					
	8/19/2005		2	0	0					
Hennepin	8/12/2005	7	7	0	0					
Minnetonka	8/12/2005	6	6	0	1					
Eden Prairie	8/12/2005	7	7	0	1					
Olmsted	8/15/2005	7	7	0	3				7	0
Mower	8/15/2005	7	6[2]	0	2				6	0
Steele	8/15/2005	7	7	0	0				7	0
Dakota	8/15/2005	6	6	0	1					
Minneapolis	8/16/2005	6	6	0	3					
Edina	8/16/2005	7	7	0	0					
Scott	8/17/2005	7	7	0	1					
Lakeville	8/17/2005	7	7	0	1					
Burnsville	8/17/2005	6	6	0	0					
Apple Valley	8/17/2005	7	7	0	0					
Eagan	8/17/2005	6	6	0	1					
St. Paul	8/18/2005	7	7	0	3					
Washington	8/19/2005	6	7[2]	0	1					
Total		147	147	0	43	16	1	3	20	0

[1] Where applicable from the Acceptance Calls

[2] Missed last Mower call made up with one extra call in Washington

[3] The recorded AACN data does not match the reported call type

[4] PSAP operator did not have the telematics application open

Table 4-1 shows the following:

- A total of 147 acceptance test sample calls were made from August 10, 2005 through August 19, 2005. Either six or seven calls were placed from each of the 22 PSAPs, reflecting the original sample plan to obtain as closely as possible an equal sample in each PSAP. All 147 of the acceptance sample calls passed the acceptance test criteria.

The FOT passed acceptance testing with 94% confidence that the true system failure rate is no more than four percent.

- For the 20 acceptance sample calls made to areas with IES as the 9-1-1 service provider, simulated AACN data were transmitted with each call.
    - Three of these calls were not considered because the PSAP operator did not have the application active at the time of the call to receive these additional data.
    - Of the remaining 17 calls,
        - 16 (94 percent) calls reported AACN data that matched the simulated data sent by the MnDOT sample team according to their recorded sample logs.
        - the one AACN failure was a call from Kandiyohi at 10:21 AM on August 10, 2005. The sample data collection log shows a simulated call type of "7" but the recorded data reported by the PSAP matches a simulated call type of "9". It is therefore most likely that this was simply a data recording error on the part of the sample collector and not an error in transmission of AACN data by the FOT or in reporting by the PSAP.
- For the 20 acceptance sample calls made to PSAPs with the Mayo Clinic as a secondary PSAP, the Mayo Clinic PSAP correctly received the call back number and latitude/longitude coordinates of the sample calls in all cases.

Data Quality Issues

Several calls were made where the reported latitude and longitude coordinates did not match their planned locations within the 0.01% criteria identified above. These included:

- A 10:21 AM call from Kandiyohi on August 10
- A 9:17 AM call from Olmsted on August 15
- An 11:54 AM call from Renville on August 10
- A 2:05 PM call from Eden Prairie on August 12, and
- A 1:59 PM call from Eagan on August 17

For the first call, review of the data records revealed that the reported coordinates matched that of an attempted sample call made immediately prior to this call at another location. For the last three calls, their data forms contain notes specifying why the call was not made exactly from the planned location. It is not known why the second call's coordinates did not match the plan. However, in all five cases the reported coordinates matched those of the Telcordia data logs. This means that the reported latitude and longitude, while not matching the planned location, was consistent with the data actually sent by the OnStar test unit. Since the acceptance test only applies to FOT functions, these calls were all judged to be successful. In several other cases with non-matching planned to reported coordinates, the data were not counted toward the acceptance test and were replaced by additional sample calls. These points are discussed in greater detail below.

In seven instances, the data recorded for longitude on the data form was not a negative number. (Locations with similar latitude but positive longitude as the test points in Minnesota correspond to Northern China near the border with Mongolia.) This was considered to be a tolerated error made either by the data collector or by the PSAP operator and the test calls were not counted as errors for the acceptance test. In three other instances, a minor omission or data transmission on the data collection forms were not considered to constitute test failure. These issues actually support the value of automatic data transmission rather than verbal communication with regard to accuracy.

Spatial and Temporal Distribution of Sample Calls

Although not required, it was considered desirable to have calls made in diverse geographic regions throughout the FOT area. Figure 4-1 below shows the geographic sample locations of the calls as relayed by the PSAP and recorded in the data collection forms. Note that the desired diversity of locations appears to have been met. It should be pointed out that the PSAPs included both county areas and towns/cities (e.g. Minneapolis, Apple Valley). In the towns and cities, the smaller geographic area necessarily forced the sample locations to be more closely clustered.

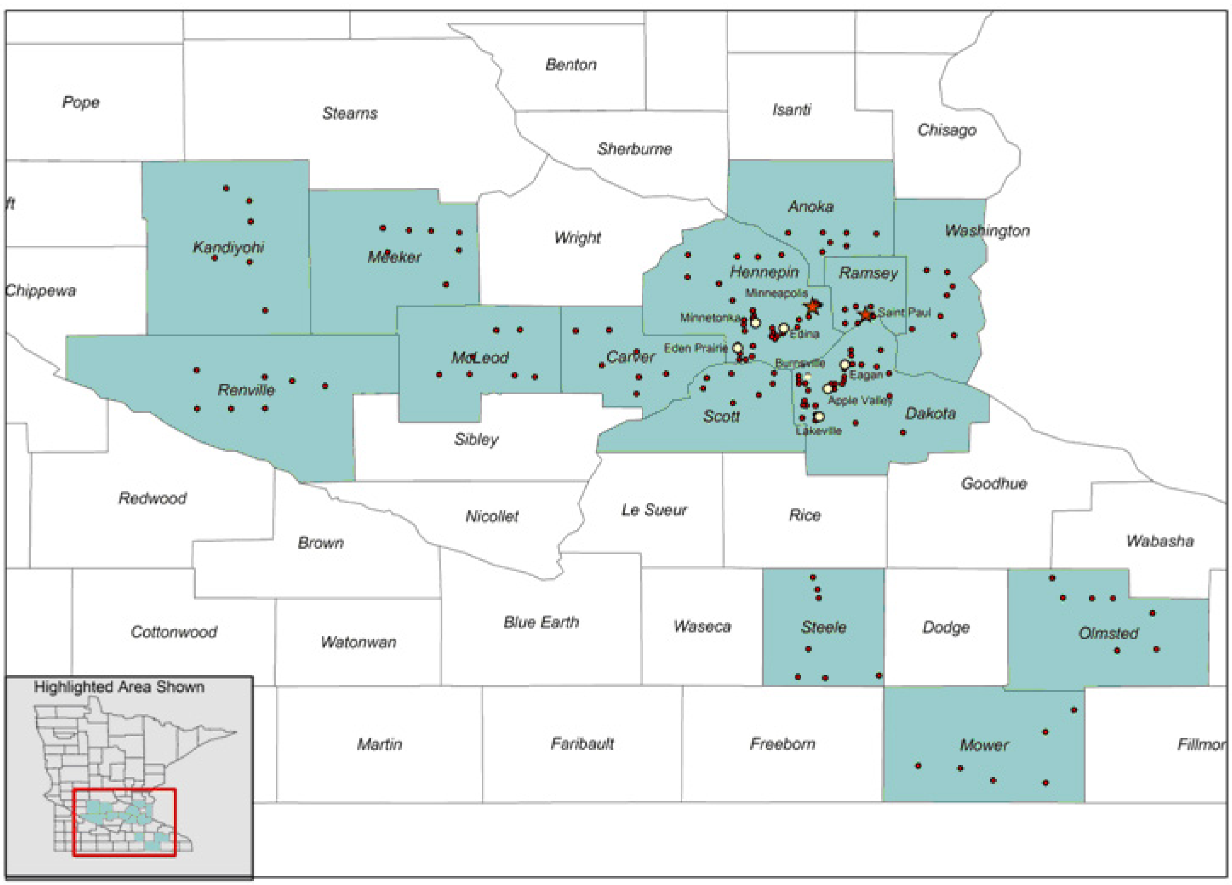


Figure 4-1. Spatial Distribution of FOT Voice Routing Acceptance Test Calls

Similar to the geographic diversity, it was desired, but not required that calls be placed at different sample times. It was not operationally feasible to make calls outside normal working hours. However, the calls made did show distribution over many hours of the day. Figure 4-2 illustrates this through a histogram of the 147 acceptance test calls.

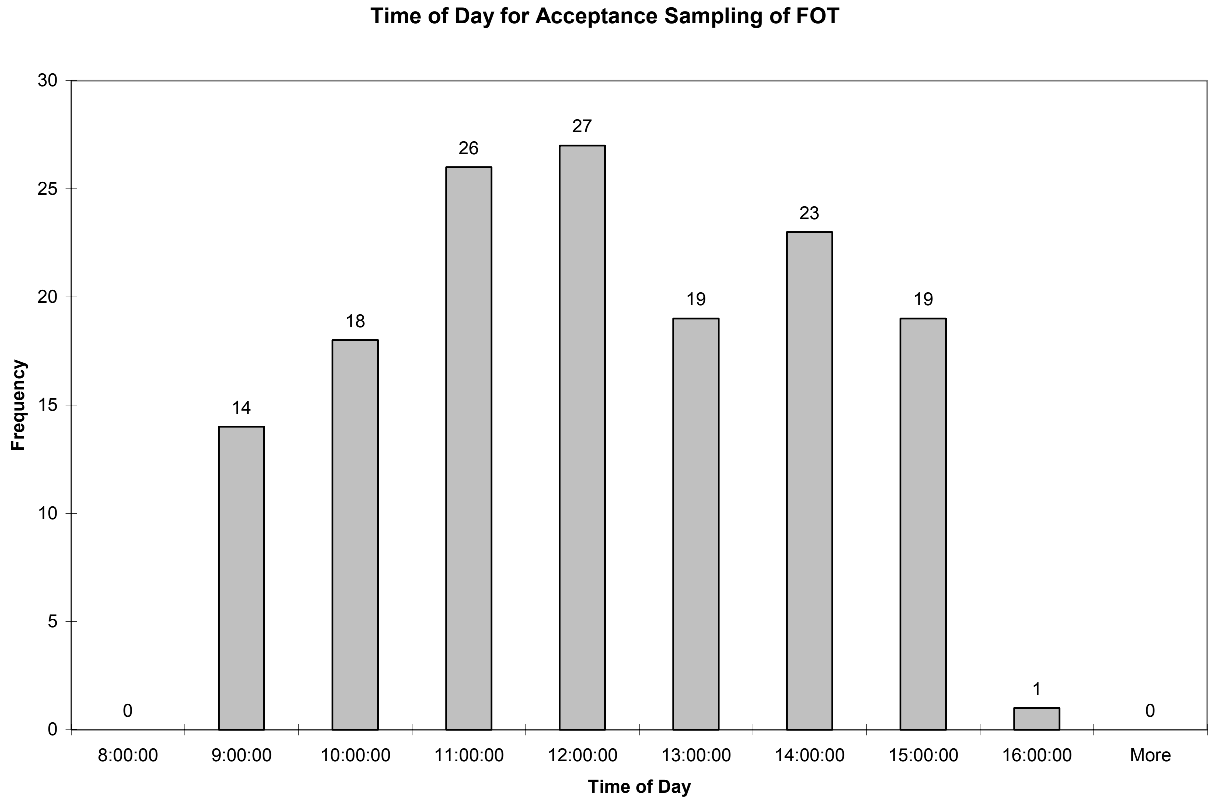


Figure 4-2. Temporal Distribution of FOT Acceptance Testing of Voice Routing Functions

<u>Non-Counted Calls</u>

In addition to the acceptance sample calls, a number of additional calls were placed as part of the acceptance test where the full acceptance criteria were not satisfied. Under investigation, it was determined in each of these cases that the reason for the failures was outside the control of the FOT. By agreement in the original acceptance test plan, these calls were categorized as neither successes nor failures with regard to the acceptance test. Though not included in the evaluation of acceptance, the issues encountered on these calls are nevertheless informative to the FOT. There were 43 such calls throughout the acceptance test period. They represent a small number of reasons. Each reason and accompanying frequency of occurrence is provided below.

1) An incorrect latitude/longitude of (0,0) transmitted by the portable OnStar unit (13 occurrences) – This issue is related to turning on the external, portable OnStar unit for the first time after a shutdown. The issue was identified before the acceptance test and

provisions were made so OnStar would not try to forward calls that have a (0,0) value for latitude and longitude.

2) Call is not picked up by OnStar Emergency Advisors and call eventually times out (20 occurrences) – The reason for each occurrence of this problem is not known but it may have been due to routing problems internal to OnStar and/or congestion in the OnStar call center where the test calls (by design) had lower priority than true OnStar emergency calls. Regardless, it was agreed that this issue was not under the control of the FOT.

3) OnStar Emergency Advisor's call encounters busy signal (1 occurrence) – It was discovered that the Telcordia primary rate interface (T1 line) to Verizon was not working which prevented OnStar from calling Telcordia. This line is outside the FOT control.

4) GPS coordinates passed through OnStar were from a previous call (4 occurrences) – This issue is related to a warm start (i.e., like cycling the ignition) of the OnStar unit. It occurs when a GPS lock has not been established and the OnStar unit transfers the last known latitude and longitude coordinates. In the acceptance test, this even resulted in occurrences where the call was routed to the wrong PSAP when the MnDOT staff person had moved from one PSAP area to another and the first call in the new PSAP area was transmitting GPS coordinates for the last location in the previous PSAP area. By verifying that the recorded coordinates reported by the PSAP matched those of the Telcordia data transmission logs, it was determined that the FOT process was operating properly. Therefore, these sample calls could legitimately be considered to pass acceptance, which did occur in a few occasions (see Data Quality Issues above). The non-counted occurrences of this phenomenon were cases that the evaluation team elected to repeat or replace the sample calls with others that did not have this issue.

5) ALI record (with latitude and longitude) was not received at PSAP (2 occurrences – Anoka County PSAP, August 12, 2005) – Investigation of this issue provided no specific reason for the failed transmissions except they were shown not to be attributable to the FOT. Telcordia's logs show the LAT/LON data were received from OnStar and were subsequently sent to the ALIs. It is therefore assumed that the failure was at the PSAPs or ALIs, and this is outside the control of the FOT.

6) OnStar incorrectly routed call (3 occurrences) – This appears to have been an OnStar training issue and is not attributable to the FOT.

4.1.2 Summary of Findings

- Using a statistical acceptance sampling approach, the FOT solution passed the acceptance test. Passing the acceptance test corresponds to 94 percent confidence the true system failure rate does no exceed four percent.
- In 147 sample calls placed throughout 22 PSAPs, there were no observed errors within the control of the FOT with regard to transmitting latitude, longitude, and call back number from the OnStar test unit at the test location through to the proper responding PSAP. Hence, the observed failure rate was zero percent.
- Similarly, there were no observed errors in the 20 sample calls that further forwarded this location and call back number data to another PSAP (Mayo Clinic).

- In a limited test of 17 sample calls to an area with IES as the 9-1-1 service provider, the ability to transfer AACN data through the OnStar call was also confirmed. There was one error in this evaluation that appears to be a data entry rather than a system error.
- The acceptance test demonstrated the success of the FOT solution in routing data with voice to achieve increased speed and accuracy in transmitting critical 9-1-1 call information to PSAPs.

4.2 ACN/AACN Data Routing Evaluation

The data routing portion of the FOT sought to develop and test a system for a telematics service provider (e.g., OnStar) to push ACN and AACN data into a MnDOT SOAP server for further distribution to CARS.

Due to data availability, this evaluation only examined the performance of the first link of the data distribution between OnStar and SOAP server, as shown in Figure 4-3. The system performance is defined as the reliability and latency of the data transfer. Different from the voice routing evaluation, the data routing involved the transmission of actual OnStar crash data throughout the state of Minnesota.

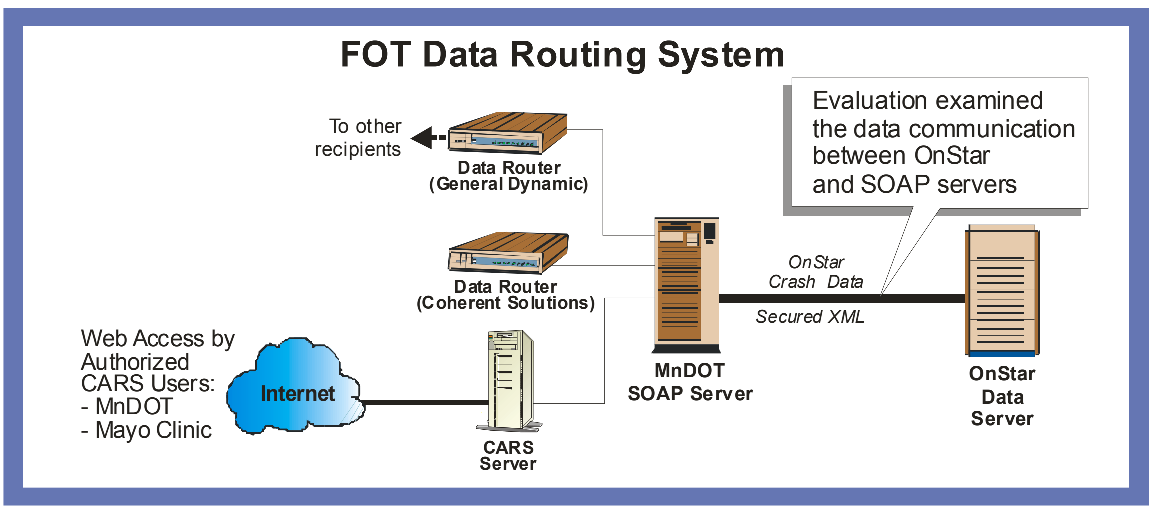


Figure 4-3. Focus of Data Routing Performance Evaluation

Section 4.2.1 contains the results of the characterization of the data routing system and its estimated reliability and latency. Section 4.2.2 summarizes the findings of the evaluation.

4.2.1 Analysis Results

The data routing function from OnStar to the SOAP server was characterized through basic summary statistics and was then analyzed for both reliability and latency. Different from the voice routing test, the data routing portion of the FOT transmitted the actual OnStar accidents in Minnesota over the period of the FOT.

Characterizing the System Usage

Over the 41 weeks for which data were available, OnStar transmitted 1,297 crash records to the SOAP server. Fifty of these calls failed to be received and are discussed further below. Of the 1,247 calls that were successfully received, there were:

- 17 AACN calls (1%)
- 137 ACN calls (11%)
- 1093 SOS calls (88%)

Over each week, the total number of calls received varied. After August 7, 2005, the number dropped considerably as OnStar stopped sending SOS calls to the SOAP server. During the rest of the time period (and ignoring the weeks where no data are available) OnStar sent an average of 34 calls per week to the SOAP server. The week with the most calls was August 1 – August 7, 2005 when 50 total calls were delivered. This is shown graphically in Figure 4-4. The figure also shows the relative number of calls for each type of success (AACN, ACN, and SOS) as well as any failures. As noted above, the sharp dropoff after week 63 corresponds to OnStar discontinuing transmission of SOS calls.

Reliability of Data Transmission

In two weeks during the period, there were instances of failed transmission of crash data. These consisted of:

2005.04.18-to-2005.04.24	14 failures
2005.04.25-to-2005.05.01	36 failures

The failures were due to a computer security key not being updated. This prevented any files from being exchanged.

While these failures were explained and resolved, they do serve to illustrate the potential for failures in this or any data network systems. Over the 41 weeks a total of 50 test failures were observed compared to 1,297 total OnStar calls (successes and failures). This represents a failure rate of 3.9%.

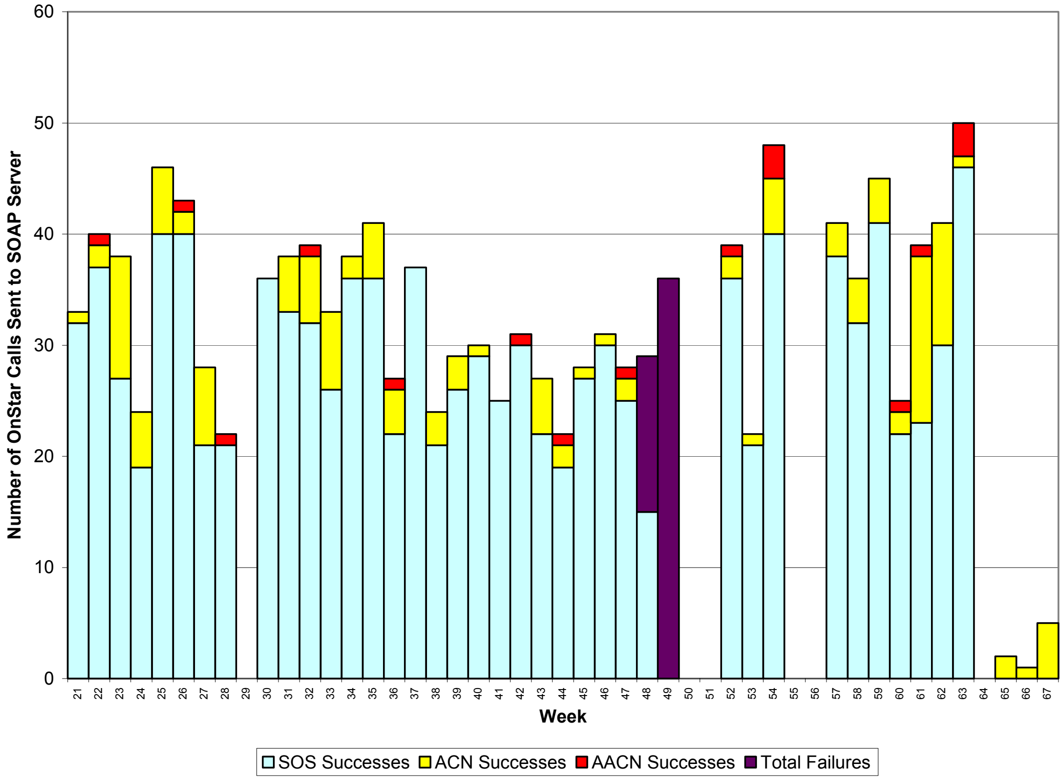


Figure 4-4. FOT Data Routing Calls from OnStar to SOAP Server October 11, 2004 – September 4, 2005

Latency

In evaluating latency of the transmission system, the objective is to determine an average delivery time per call. Even though we do not have the delivery time for the individual call records, we can determine the overall average delivery time per call as:

$$\bar{x} = \frac{\sum_{i=1}^{n} c_i \bar{x}_i}{\sum_{i=1}^{n} c_i}$$

where

i is the week number
n is the total number of weeks (=41)
c_i are sums of AACN, ACN, and SOS successful calls for each week
$\bar{x}_i$ are the average call times for each week

This calculation may not perfectly match the value obtained with individual call records due to rounding issues. However, it is expected to be close.

The mean latency is 0.9 seconds.

It is concluded that the first stage of the data routing functionality within the FOT demonstrated high reliability (96.1%) in delivering every OnStar record sent to the SOAP server. Aside from a few anomalous cases, these records were sent in an average of less than one second.

Many other factors may be considered in evaluating the data routing function. This evaluation did not have a means for independently verifying that the tabulated calls were the only ones sent by OnStar or for independently validating the accuracy of the data elements transferred. It is assumed these summaries were correctly prepared by OnStar. This evaluation also did not have the raw data of transmission time for each call so that the variability in transmission time could not be analyzed. However, the very low average transfer times likely make any issues of transmission time variance insignificant on the scale observed (i.e., less than one second). More importantly, though, this evaluation did not have a means to evaluate the full time interval of relaying the OnStar data to the CARS database- a true latency measure from an end user's stand point.

4.2.2 Summary of Findings

- The evaluation of the FOT data routing function considered only delivery times for (data) calls made by the OnStar Call Center to the SOAP server for OnStar incidents occurring in Minnesota. Dissemination from SOAP server to CARS and other data servers could not be evaluated with the available information. Therefore, caution should be exercised in generalizing the results of this evaluation to the data routing portion of the FOT.
- The large majority (88%) of calls made were SOS (emergency button pushes) with about an order of magnitude less ACN calls (11%) and another order of magnitude less AACN calls (1%). The higher percentage of ACN over the AACN calls reflects the larger installed base of the basic ACN instrumented vehicles, based on the feedback from OnStar. The calls averaged about 34 per week during most of the evaluation period and never exceeded 50 in any one week.
- The overall failure rate of the data routing function from the OnStar Call Center to the SOAP server from September 27, 2004 through September 4, 2005 was 3.7% of the OnStar calls sent. All the failures represented special causes that were isolated and believed to be fixed.
- Excluding a few unusually long delivery times, the vast majority of calls were delivered to the SOAP server in an average of less than one second. Minimal latency is important for its intended application. While it takes time for a Telecmatics Emergency Advisor to set up a 3-way call with an appropriate PSAP, it is imperative to provide the available ACN or AACN data in a timely fashion to assist decision making in emergency response.
- In the FOT setting, when PSAPs or medical responders (e.g., Mayo Clinic) receive 9-1-1 calls from the OnStar, they could expect an icon corresponding to the reported incident to

pop up overlaying on the digital map provided by the CARS. By clicking on the icon using a computer mouse, additional ACN or AACN data, if available, will be displayed. This evaluation confirmed that the data link between the OnStar Call Center and the SOAP server was operating properly. The evaluation, however, did not examine the data communications between the SOAP server and CARS, based on a decision with the FOT team.

4.3 User Acceptance and Deployment Issues Evaluation Results

This section documents the findings from the interviews with the key stakeholders of the FOT, including for voice routing: PASP operators, call takers, and OnStar; and for data routing: emergency responders and MnDOT traffic operation managers who share the OnStar ACN data via the CARS. In addition, deployment issues and broader implications were gathered through interviews with the FOT team, the Minnesota 9-1-1 program manager, and the NENA technical issues director.

4.3.1 PSAP, Medical Responder, 9-1-1 Program Manager, Traffic Operator Feedback

4.3.1.1 Interview Results

The PSAP interviews were structured around a set of standard questions, consistent with the intent, scope and goals of the FOT, and addressed the following subject areas:

- PSAP Operational Environment
- Experience receiving and processing wireless 9-1-1 calls (both Phase I and Phase II)
- Facility operational and technical capacities and limitations
- GIS and mapping capability (both “mapped ALI”, and CAD)
- Historical experience with TSP calls
- Identification of incident-related location information
- Potential use of geo/coordinate based location identification
- Feedback on field test
- Suggestions for future improvements
- Observations about expanded use of FOT solution

The Mayo Clinic and the Mayo Medical Transport, as emergency medical responding and treatment service entities, currently have access to real-time ACN data shared through MnDOT’s CARS. Interviews with selected Mayo Clinic representatives were conducted in conjunction with the process outlined above, and addressed the following subject areas:

- Operational Environment
- Nature of CARS access
- Frequency of use

- Utility of the information involved (both transport and treatment—i.e., positive patient outcome, and facilitating early response)
- History of use and benefits of the ACN data, during the period such data has been available
- Perception of information timeliness and accuracy
- Problems encountered
- Suggestions for future improvements
- Observations about expanded use of FOT solution

The benefit of incident data is also important to MnDOT and traffic management operations. To that end, interviews were conducted with individuals involved in processing ACN/AACN-related CARS data for the purpose of coordinated traffic incident management. Topics included the following:

- Operational Environment
- Nature of CARS access
- Frequency of use
- Utility of the information involved for the sake of managing traffic operations (including data format, timeliness, and user interface)
- History of use
- Perception of information timeliness and accuracy
- Problems encountered
- Suggestions for future improvements
- Observations about expanded use of FOT solution

Five primary PSAPs were selected for post test interviews, including the counties of Kandiyohi, Olmsted, and Anoka, and the cities of Burnsville and Minneapolis. These PSAPs provided a good mix of PSAP environments, including 9-1-1 Service Provider (i.e., Quest and IES), PSAP service environment (i.e., urban, suburban, rural), and size of PSAP. The Mayo Clinic was involved as both a secondary PSAP (emergency response), and, as a CARS data user, as was the Roseville Regional Transportation Management Center (RTMC). A majority of the above interviews took place during the week of September 19, 2005, and involved five coordinated meetings.

In many locations around the country, 9-1-1 services are often funded, coordinated and/or facilitated by cognizant 9-1-1 authorities or agencies specifically established for that purpose. Such authorities range from regional, multi-jurisdictional coordinating bodies, to state agencies or functions. That is true in Minnesota as well, and two such organizations were specifically involved in this FOT and interviewed, including the Minnesota Statewide 9-1-1 Program

(Department of Public Safety) and Minneapolis/St. Paul Metropolitan Emergency Services Board.

Interview questions for the above organizations covered the following subject areas:

- Nature and responsibilities of the authorities involved
- Involvement with the FOT
- Suggestions for future improvements
- Observations about expanded use of FOT solution
- Future organizational plans for such applications

4.3.1.2 Summary of Findings

The results of the interviews were fairly consistent among all the PSAPs visited and interviewed. Following is a summary of those interviews, and the agencies' observations and experiences with the FOT:

- Few of the PSAPs maintained 9-1-1 call history data in sufficient detail to statistically compare historical operational experiences with trial events. However, based upon experience, all indicated a preference for native 9-1-1 call delivery for such calls, noting that the latter insures more accurate routing, the automatic delivery of call-related data (like Automatic Number Identification[28] (ANI), ALI[29] and class of service[30]) and priority processing (i.e., call into 9-1-1 trunk as opposed to the administrative line).
- Most PSAPs were either wireless 9-1-1 Phase II ready, or deployed with one or more carriers[31]. That is, they are able to receive wireless 9-1-1 calls with a call back number and call location (LAT/LON) provided. The FOT calls were designed to emulate a wireless 9-1-1 call and thus can display call back number and location with Phase II ready PSAPs.
- Several of the PSAPs continue to work on mapping and GIS resources to support the processing of wireless- calls. The GIS tool is part of the wireless 9-1-1 PSAP solutions to make use of the call location data for visual representation using electronic maps. Figure 4-5 shows several of the PSAPs where interviews were conducted.
- While limited, most PSAPs had historically received telematics-based emergency calls (including OnStar) on the administrative line, and they cited positive experiences and outcomes with those calls. Also cited was the unique capability for OnStar Emergency Advisors to remotely flash the vehicle head lights in assisting the identification of the crashed vehicle, in the case of run-off-the-road accidents with unconscious drivers. In

[28] ANI is the technical term for call back number or caller ID

[29] In this case, call location information in LAT/LON

[30] Indication of a wireless 9-1-1 call made from a TSP

[31] Full deployment requires all wireless service providers to implement the E9-1-1 phase 2 solutions

addition, OnStar Emergency Advisors can provide continuous update of vehicle location for incidents involving a moving vehicle (e.g., car-jacking).

- Most PSAPs stated that the location of the calling party provided by telematics service providers (historically, and, as part of the FOT) appeared to be accurate. Historically, the location information was described by the OnStar Emergency Advisor as the street address, or in the case of rural area, the main route and the nearest cross street or landmark. The FOT voice routing solution automatically provided the location data in LAT/LON that can be plotted using a GIS tool – conceivably a less time consuming and less error-prone approach.
- All the PSAPs interviewed currently receive telematics-initiated calls on so-called "administrative lines," or on non-native 9-1-1 trunks dedicated for such purposes. In all instances, while calls on these lines are processed identically to native 9-1-1 calls, they do receive lower call-handling priority than calls on 9-1-1 trunks (though that only becomes an operational issue when 9-1-1 call-takers are busy on other calls). Since such lines generally do not automatically provide ANI and ALI data, the PSAPs involved attempt to capture the "caller ID" of the calling party, and then poll their ALI database for location. The limitation of OnStar-initiated three-way calls, however, only display the number of the OnStar Operation Center in the caller ID, not the cell phone number of the crashed vehicle.
- A few PSAPs noted that a telematics-initiated call involving a three-way conversation between the calling party, the telematics service center, and the PSAP can be complicated, but beneficial with training.
- The Minneapolis/St. Paul Metropolitan Emergency Services Board noted that the FOT voice delivery solution appeared to be a clean solution, minimizing infrastructure requirements and impact on existing 9-1-1 network configurations.
- PSAPs served by Independent Emergency Services (IES) were able to receive advanced ACN data as part of the FOT. Kandiyohi County (as the IES PSAP involved in the interviews) cited the importance of such data in processing an ACN-type emergency event, though the use of such enhanced data will require additional call-taker training.
- In a few instances, where FOT test calls failed to execute as planned, it appeared that the casual factors were outside the scope of the trial, and thus did not negatively impact the results of the FOT.
- Mayo Medical Transport, as both a secondary PSAP, and, as a CARS data user, specifically cited the benefit of ACN/AACN incident data in responding to an emergency event. While the CARS data are limited, as is the means of access, the timely notification of an incident, along with descriptive data about the event, does facilitate emergency response.
- All PSAP interviewees agreed that the FOT appeared to reflect a successful solution to delivering a telematics-initiated 9-1-1 call to the appropriate PSAP over the existing 9-1-1 infrastructure with a call back number and call location.
- All interviewees also agreed that exploring and fostering the wider deployment of such a solution would be beneficial, both within Minnesota and elsewhere.

- The Regional Transportation Management Center in Roseville, MN makes effective use of the CARS data, both in support of traffic management during incidents and DPS emergency response. This center is a model for similar efforts around the country. Figure 4-6 shows selected applications of ACN data in CARS by MnDOT RTMC.
- The OnStar ACN/AACN data on CARS supplements the information and many resources currently possessed by the RTMC in support of traffic-related incident management. Such resources include the large number of traffic detectors and Closed Circuit Television (CCTV) cameras for detection and verification of incidents, and the ability to control traffic signals and provide traffic advisories using Dynamic Message Signs, the MnDOT web site, and the 511 traveler information system.

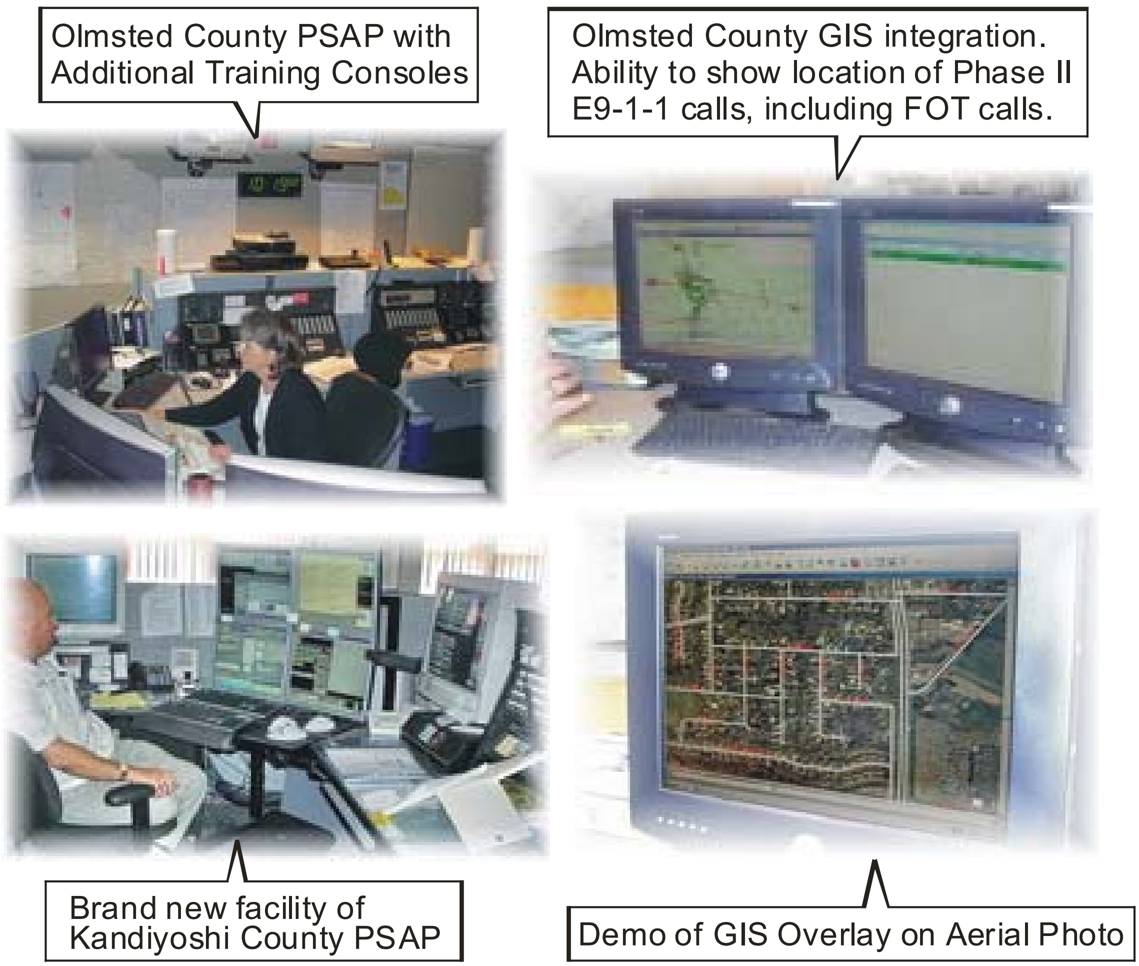


Figure 4-5. Selected PSAPs where Interviews Were Conducted

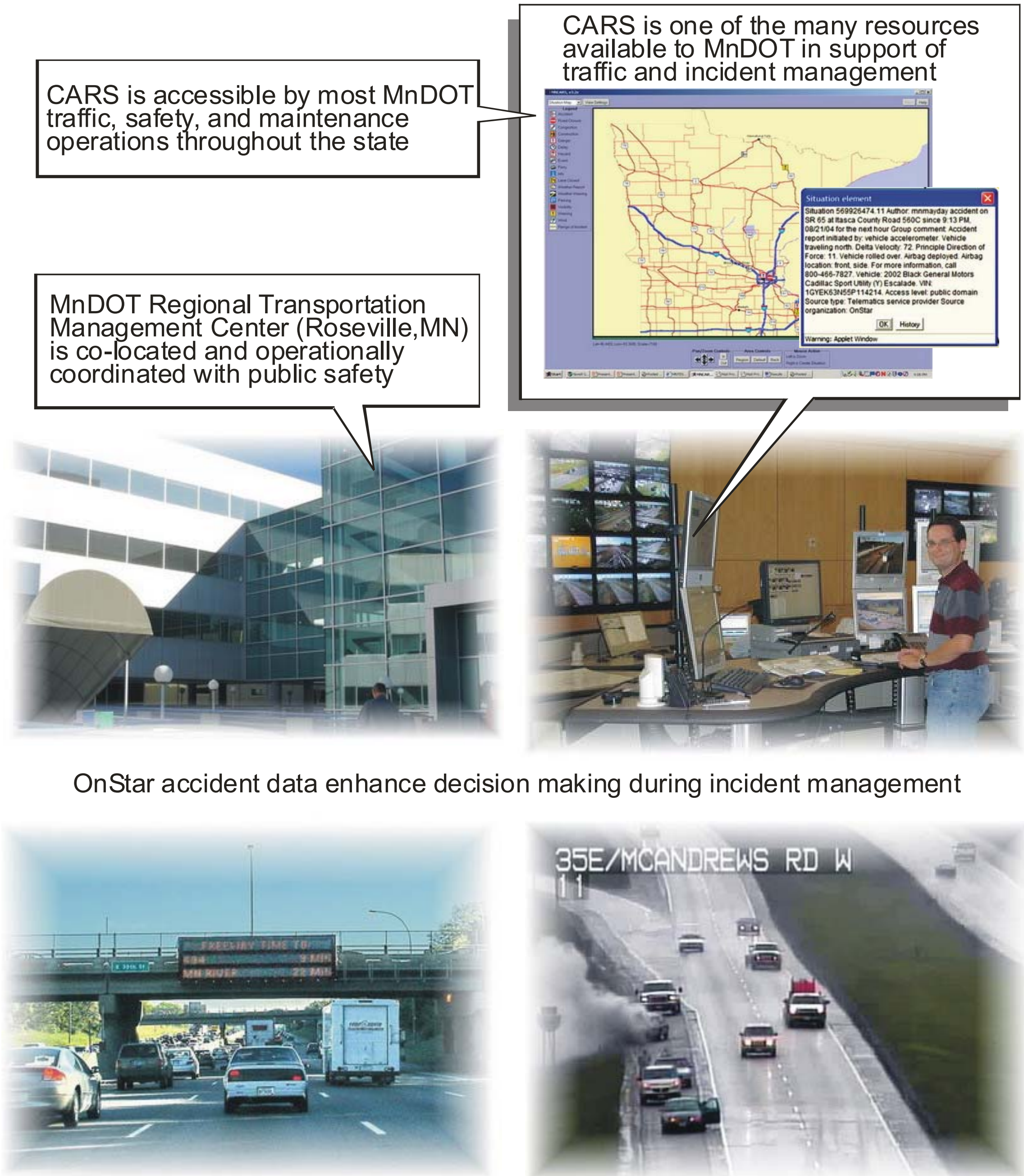


Figure 4-6. Use of ACN Data in CARS by MnDOT RTMC

4.3.2 Telematics Service Provider Feedback

4.3.2.1 Interview Results

OnStar customer service and corporate representatives were interviewed on October 19, 2005 at OnStar headquarters in Detroit, Michigan. That interview was structured around the following areas:

Emergency Advisors

- General operational responsibilities
- Existing emergency call processing protocol
- Experience in responding to emergency calls
- As a subset of the above, experience in working with PSAPs
- Roles and responsibilities as it pertains to the FOT
- Suggestions for future improvements
- Observations about expanded use of FOT solution

Corporate Representatives (representing corporate planning, industry affairs and service development)

- OnStar employee role and responsibility
- Corporate experience in responding to emergency calls
- Corporate emergency call processing policy
- Involvement with the trial
- Suggestions for future improvements
- Observations about expanded use of FOT solution

4.3.2.2 Summary of Findings

OnStar, as the telematics service provider involved in the FOT has a long history servicing customer emergency calls, and interacting with the 9-1-1 community. Emergency Advisors receive special training in processing such calls, and specifically interfacing with 9-1-1 call takers. The following is a summary of the above interview meeting, and the observations and FOT experiences shared:

- OnStar's history in processing customer 9-1-1 calls has been positive, as has been their working relationship with the 9-1-1 community and PSAPs.
- While the current process of handling 9-1-1 destined calls works (i.e., calling into PSAP administrative lines), the FOT solution would provide a more effective way of accomplishing the same task for the reasons cited elsewhere in this report.
- In spite of the perceived benefits of the FOT solution, OnStar indicated the need to preserve the ability to contact the PSAP via the administrative line, citing a significant portion of customer requests or events are of non-emergency nature.

- The data routing portion of the FOT was perceived as a success. OnStar indicated increased demands in recent years to provide their data to the Department of Transportation (of various levels) and emergency response community in light of management of regional natural disaster-related events.
- Nationwide deployment of the FOT voice routing solution would involve significant cost, a factor impacting the potential adoption and rollout of the approach nationwide. It was evident that the WSP-specific call routing solution was cost prohibitive and a simulated approach must be used by the FOT. The cost for implementing and operating such a nation-wide system is disproportionately high considering the very small representation of telematics-initiated 9-1-1 calls. OnStar suggested broadening the users of the FOT solution to include other national security or regional public safety entities that require long distance routing of 9-1-1 calls.
- It was unfortunate that the voice routing portion of the FOT ultimately was not able to use a real wireless service provider, and was forced to simulate those functions within a lab environment. While the simulation did not negate the results of the FOT, it did impact the "field" emphasis of the operational test.
- While the setup of the FOT voice routing required an OnStar Emergency Advisor to manually dial a Temporary Location Directory Number (in order to route the call to the simulated WSP hosted in Telcordia's New Jersey facility), it was noted that that part of the process could be easily automated.
- Considerations should now be given to real world deployment of the FOT solution, recognizing wireless network functionality and impact, cost, and migration to NG9-1-1 IP-based infrastructure.

4.3.3 Implications for NG9-1-1

4.3.3.1 Third Party Technical Review

In accordance with the evaluation plan, the FOT concept, technical design, and results of the field test were reviewed with Mr. Roger Hixson, NENA's Technical Issues Director. The interview specifically related to NENA's work in the area of Next Generation E9-1-1 systems, recognizing that the latter will ultimately generate or facilitate enhanced solutions for the objective of this FOT.

Mr. Hixson observed that, while the design involved would require new TSPECRS-specific functionality in the wireless network, a potentially challenging matter in light of evolving wireless networks, the concept and solution being tested by the FOT represented a "viable interim method" to automatically route emergency calls being generated by customers through telematics call centers to "native Enhanced 9-1-1 systems in the USA." Ultimately, Mr. Hixson indicated, IP based, NG 9-1-1 systems are likely to offer "more effective and seamless solutions for ACN calls and basic data delivery, and subsequent PSAP access to supportive data from Telematics provider databases."

4.3.3.2 Summary of Findings

The following summarizes the NENA observations provided above:

- The FOT Concept of Operations does offer an effective solution to the delivery of telematics-based 9-1-1 calls to PSAPs in a fashion consistent with the normal and native delivery of wireless 9-1-1 calls.
- This solution would require new functionality in the wireless 9-1-1 network infrastructure, and that in turn would presumably involve cost.
- Ultimately, the IP-based next generation 9-1-1 infrastructure (both wireline and wireless) deployment will provide more effective and seamless solutions for the delivery of ACN/AACN data and telematics emergency calls.
- However, the FOT voice routing solution could provide an effective migratory step in that direction.

4.3.3.3 Project Team Observations

In accordance with the FOT Evaluation Plan, a post-trail project team member interview was conducted on November 10, 2005. The intent of the interview was to give all team members an opportunity to comment on the results of the FOT; solicit lessons learned and observations about the potential for FOT concept application in real world environments. Much of that discussion is also reflected in the FOT project reports [Ref 2, 3].

4.3.3.4 Summary of Findings

- While the development of TSPECRS voice routing was challenging, the field test was conducted successfully, and the concept/solution involved does represent a viable approach for delivering telematics-based emergency calls to the PSAP as native 9-1-1 calls.
- Several technical issues did arise during the voice routing field test, but they related to factors either outside the scope of the project, or beyond operational control of the project team. Consequently, such calls were not considered failures. For example, test calls transmitted incorrect LAT/LON were caused by incorrect use of the portable OnStar test unit and thus not counted as failures. This was discussed under the non-counted calls in Section 4.1.1.
- The TSPECRS test experiences emphasized the need for robust and redundant networks to support reliable call delivery.
- 9-1-1 call relay at the telematics provider service center should be automated to avoid manual miss-dials, a feature consistent with the intent of this trial (i.e., to automate as much of the call delivery process as possible).
- Beyond the native delivery of 9-1-1 calls, the system also provides an opportunity to deliver additional emergency event information and data important to emergency response.

- The opportunity for real world deployment should be examined further, particularly as a migratory step to NG9-1-1 network infrastructure that may ultimately provide long-range solutions to accomplishing the goals of the FOT.

5.0 Conclusions

This section presents conclusions based on the findings from the evaluation of system performance and feedback from users and FOT developers. The objectives and hypotheses originally proposed in the Evaluation Plan are revisited in light of the data and findings.

5.1 Evaluation Hypotheses and Findings

The evaluation hypotheses associated with the FOT voice and data routing system performance and user acceptance were identified and discussed in the evaluation approach sections. Table 5-1 presents each of these hypotheses and summarizes the findings relevant to each of them.

Table 5-1. Hypotheses Addressed by the Evaluation

Objectives	Hypotheses	Findings
Evaluation of Voice Routing System Performance		
Testing FOT Voice Routing System Reliability	The OnStar Customer Service Representative can establish a 3-way call to the 911 system which goes to the correct PSAP considering the call location.	• A total of 147 acceptance test calls were made from a portable unit (emulating OnStar system). Those calls were answered by OnStar Emergency Advisors and successfully connected with PSAPs corresponding to the vehicle location using FOT voice routing solution. • Those test calls were delivered along with vehicle location data (LAT/LON), call back number (to OnStar unit), and ACN/AACN data. • Based on a staged statistical sampling design, the FOT voice routing system passed acceptance testing with 94% confidence that the true system failure rate is not more than four percent. • The acceptance test was conducted from August 10, 2005 through August 19, 2005 involving 22 PSAPs, OnStar Emergency Advisors, and MnDOT field test engineers who initiated test calls from pre-determined locations. The test procedures and acceptance test were developed and facilitated by Battelle. The test results were audited and validated by Battelle based on the statistical sampling design previously developed in the evaluation plan.
	The 911 system at the responding PSAP will receive accurate transmission of LAT/LON, OnStar unit call back number, and additional ACN/AACN data (if available).	
Evaluation of Data Routing System Performance		
Testing Data Routing System Reliability	All OnStar incident data designed to be sent to the MnDOT SOAP server are sent reliably and accurately, and in timely fashion.	• Over 41 weeks for which data were available, OnStar successfully transmitted 1,247 crash records to the MnDOT SOAP server, including 1093 SOS (emergency button pushing), 137 CAN, and 17 AACN crash records. • Analyses of transmission logs indicated a small percent (3.9) of records failed in the transmission. However, those failures were attributable to known technical problems that arose during the FOT period. The FOT data routing solution has demonstrated a high reliability of 96.1%. • The mean latency for data transmission from OnStar OCC to MnDOT SOAP server is 0.9 seconds.

Objectives	Hypotheses	Findings
Evaluation of User Acceptance		
Assess User Acceptance (OnStar)	OnStar Emergency Advisors perceive the process and application to benefit TSP call processing.	• Emergency Advisors indicated that it was easy to see that this kind of call routing and delivery would be preferable.
	OnStar Management Representatives perceive the process and application to generally benefit corporate service goals.	• While OnStar's history in processing customer 9-1-1 calls has been perceived to be positive, OnStar management indicated this was a much preferable method to handle such calls.
	OnStar prefers this solution to current practice.	• While the current process of handling 9-1-1 destined calls works, the FOT solution would provide a much more effective way of accomplishing the same task. • The current access to PSAP administrative line is still needed to facilitate the events of a non-emergency nature.
	OnStar believes this solution facilitates interaction with PSAPs. Automatic communication of location (and, thus, routing of the call) is inherently less error-prone.	• This type of solution automates the routing and delivery of customer 9-1-1 calls in a native way. • The ability to transmit call back number, call location, and ACN/AACN data saves time and reduces human errors.
	The total time of call processing is perceptibly reduced.	• The automation of the call delivery process inherently saves time, particularly in situations involving manual miss-dial.
Assess User Acceptance (PSAP)	PSAP call-takers perceive the FOT application to be beneficial.	• While historical experiences with OnStar-based 9-1-1 calls have been positive, most call-takers did perceive the trial and the solution involved to be beneficial.
	PSAP call-takers prefer this solution to current practice.	• Conceptually, most call-takers did indicate a preference for this type of solution (delivering such calls in a native way, similar to traditional 9-1-1 calls). • All the PSAPs interviewed currently receive telematics-based calls on so-called "administrative lines," or on non-native 9-1-1 trunks dedicated for such purposes. In all instances, while calls on these lines are processed identically to native 9-1-1 calls, they do receive lower call-handling priority than calls on 9-1-1 trunks (though that only becomes an operational issue when 9-1-1 call-takers are busy on other calls). Since such lines generally do not automatically provide ANI and ALI data, the PSAPs involved attempt to capture the "caller-ID" of the calling party, and then poll their ALI database for location.
	PSAP call-takers believe this solution facilitates interaction with the OnStar Call Center.	• To the extent that such call delivery minimizes routing problems, and time expended to communicate location, interaction with the OnStar Call Center is better supported.
	Automatic communication of location (and, thus, routing of the call) is inherently less error-prone	• Automating the process avoids problems traditionally associated with manually communicating the location involved, and insures more accurate call routing and delivery. The transmitted LAT/LON can be plotted on PSAP's GIS system in support of the call location identification.
	The total time of call processing is perceptibly reduced.	• While the automation of this process does noticeably save time, the reliability of call routing, coupled with

Objectives	Hypotheses	Findings
		the native delivery of such calls is the primary benefit.
	PSAP Authority (cognizant 9-1-1 entity) perceives the process and application to be beneficial.	• All interviewed PSAPs indicated a preference for native 9-1-1 call delivery for telematics-initiated calls, noting that the latter insures more accurate routing, the automatic delivery of call related data (like ANI, ALI and class of service) and priority processing.
	State 9-1-1 Point-of-Contact perceives the process and application to be beneficial.	• The Minnesota State 9-1-1 Coordinator supported the conclusions of the PSAPs involved in the trial.
Assess User Acceptance (Medical Responders)	Medical responders (Mayo Clinic) perceive the ACN data to be beneficial.	• Mayo Medical Transport, as both a secondary PSAP, and as a CARS data user, specifically cited the benefit of ACN incident data in responding to an emergency event.
	Medical responders (Mayo Clinic) are more informed with ACN data in response to the traffic-related incidents.	• While the CARS data are limited, as is the means of access, the timely notification of an incident, along with descriptive data about the event, does facilitate emergency response. • Mayo Clinic routinely accesses ACN/AACN data via CARS.
	The ACN data are provided in a timely manner via CARS.	• While data delivery is timely, the information access on CARS is a manual process[32], and could be further enhanced or automated.
	The vehicle location representation on CARS is accurate and useful.	• Mayo Clinic has found ACN/AACN data to be both accurate and useful.
Assess User Acceptance (State Traffic Operations)	State traffic operation users perceive the ACN data to be beneficial.	• To the extent that such data facilitates incident management, and traffic operations, the data are very useful.
	Such users desire permanent deployment of the application.	• Such users urged both deployment of the application, and its promotion beyond the geographic scope of the trial.
	The state traffic operation is more informed with ACN data in response to and management of traffic-related incidents.	• The ACN/AACN provides a wealth of information regarding the accidents. Such information is supplemental to other traffic surveillance and incident management tools.
	The ACN data are provided in a timely manner via CARS.	• The system, as it is currently working, does appear to provide ACN/AACN data in a timely way. • The data routing evaluation results showed, in average, it takes less than a second for OnStar to transmit ACN/AACN data to MnDOT.
	The vehicle location representation on CARS is accurate and useful	• Experiences indicate that location identification is both accurate and useful due to the provision of LAT/LON provided by the GPS-equipped OnStar vehicles.
Evaluation of Deployment Issues		
Assess Expandability beyond MN	The project partners believe that the benefits of the FOT solution warrant its application beyond Minnesota.	• All project team members recommended that the FOT solution and concept be further examined for real world deployment, within and beyond Minnesota.

[32] CARS does not alert users of the new events (e.g., OnStar accidents) in a particular geographic area. A user must proactively and constantly looks for new events of interest being populated.

Objectives	Hypotheses	Findings
Expandability (Multiple TSPs)	FOT public safety users believe that the benefits of the FOT solution warrant its application to other Telematic Service Providers.	• The solution offers a generic, non-Telematics Service Provider specific approach to service customer 9-1-1 call delivery.
Consistency with NG9-1-1	The FOT solution is consistent with standards and related work currently being conducted on NG9-1-1 migration by NENA.	• The FOT solution represents a viable migratory step in that direction, though ultimately NG9-1-1 architecture may offer more effective solutions for such matters (for that part of the PSAP community that is able to migrate to such).

5.2 Conclusions

Based on the quantitative and qualitative components of the evaluation, this section presents the main conclusions from the evaluation of the MAYDAY/9-1-1 FOT.

<u>FOT voice routing solution, TSPECRS, passed the acceptance test</u>

Using a statistical acceptance sampling approach, the FOT solution passed the acceptance test with no observed failures. A sequential sampling approach was used to determine if the FOT solution passed acceptance. Ultimately, this approach resulted in high confidence (i.e., 94 percent) that the true system failure rate does not exceed a relatively low value (four percent). The true system failure rate may well be even lower (e.g., the observed failure rate was zero percent), but the sample size available for the test was only sufficient to make conclusions at a level of four percent.

<u>FOT voice routing solution leverages the phase 2 E9-1-1 implementation</u>

The FOT voice routing solution relies on a wireless service provider to route long distance 9-1-1 calls originated from a TSP to a local MSC corresponding to the LAT/LON of the vehicle location. From there, the calls enter the 9-1-1 trunk using a modified E2 interface and emulate a wireless E9-1-1 call. This allows a phase 2 compliant PSAP to receive the calls as a native 9-1-1 call along with the LAT/LON of the vehicle location, and a call back number (to the telematics unit).

With the exception of WSP call routing, the final segment of the call delivery solution is consistent with the phase 2 E9-1-1 initiative. Feedback from the FOT team suggested that minor clarifications of ALI interface are needed due to the ambiguity in current E2[33] interface definition, in support of the call and data routing on the local 9-1-1 trunks.

The implementation of WSP call routing will require additional standards[34] development and commitments from a WSP to implement the solution on all switches across the U.S. Given the

[33] E2 defines the interconnection specifications between 9-1-1 service providers.
[34] NENA TIA TR45.2 9 [for CDMA] needs to be worked to standardize TSPECRS.

competition from other standards development activities in the telecommunication community, the telematics-specific standards might not receive priority because of its small market share. Nevertheless, the FOT solutions are technically feasible and are consistent with wireless E-9-1-1 standards in the final call delivery stage.

It is noted, however, that WSP migration to Third and Fourth Generation wireless service may facilitate this process by providing more effective and flexible switching and routing platforms for such matters.

FOT data routing achieved high reliability

Over the 41 week period of the operational test, the FOT demonstrated it could reliably and quickly transmit OnStar crash data to a MnDOT SOAP server, from where it could be accessed by CARS and other third parties. The reliability was 96.1% and the few failures observed were traced to a known computer problem that would not be expected to occur in a production system. The average latency of data transmission was less than one second (i.e., 0.9 seconds).

The data routing evaluation reflects only a portion of the system's reliability from an end user perspective since it does not include information for the links between the MnDOT SOAP server and other servers that ultimately make the information available to users (e.g., CARS). Nevertheless, it can be concluded that the first step in the data routing process does not introduce any serious lack of reliability or speed.

Favorable user acceptance to the FOT voice routing service (PSAP)

The PSAP user community generally found both the intent and nature of the trial to be beneficial to the effective delivery of a telematics-based emergency call that must be delivered to a Public Safety Answering Point. The routing of such calls to the correct PSAP is more accurate and reliable, and the time involved to process the calls is minimized by automatically identifying the location. The native delivery of calls in this manner also insures that the calls involved will receive the same priority as any other 9-1-1 calls.

While nearly all the PSAPs involved in the trial indicated positive historical experiences with OnStar calls, they also indicated that this type of delivery would enhance service and minimize confusion in terms of the description of location.

FOT data routing solution is a cost effective way for sharing ACN data

While the migration of the emergency response community to next generation IP-based network infrastructure may provide the ultimate solution to sharing voice and data conducive to emergency services, the data sharing mechanism utilized in the FOT does provide an effective and immediate way to take advantage of data generated during a telematics emergency event.

Deploying new and advanced network infrastructure may take time, particularly in a ubiquitous way, this FOT offers an immediate step in that direction.

This solution can be deployed with minimum cost, and states should explore the opportunity represented here to take advantage of their highway and traffic information systems to benefit both incident management and emergency response.

FOT voice routing benefits OnStar operations

Finally, FOT voice routing capability substantially enhances the quality of service OnStar provides to its customers. Having the service available in times of emergency is an important reason why many customers subscribe to the telematics service. Insuring more accurate and timely response to customer emergency requests improves the service involved. It also enhances the opportunity for a mutually beneficial relationship with the PSAP community, a matter of equal importance.

References

[1] Concept of Operation – Minnesota Department of Transportation Telematics Services Provider Emergency Call Routing Service (TSPECRS), Telcordia Technologies, SAIC, July 8, 2004

[2] MAYDAY/9-1-1 Field Operational test (FOT) Design Report, Revision D, Minnesota Department of Transportation, SAIC, Telcordia, March 3, 2006

[3] MAYDAY/9-1-1 Field Operational Test (FOT) Results and Path Forward Report, Revision D, Minnesota Department of Transportation, SAIC, Telcordia, March 3, 2006

[4] Minnesota MAYDAY/9-1-1 Field Operational Test (FOT) Data Routing Project, Final Report, Minnesota Department of Transportation, February 6, 2006

[5] Detailed Test Plan – MAYDAY/9-1-1 Field Operational Test: Independent Testing of Voice Routing Functions, Battelle, August 4, 2005

Appendix A:

Sampling Theory for Voice Routing Field Test

Appendix A: Sampling Theory for Voice Routing Field Test

The theory behind the staged statistical sampling design for the conduct of the acceptance test of the voice routing system is discussed in this section.

The acceptance test developed for this application begins with the following considerations.

1. System failure rate (p_0) and probability of error in concluding acceptance test failure (α) – It is initially proposed that a system failure rate of less than one percent is desired. For this acceptance test procedure, we will collect a data sample and count the number of failures found in this sample. We will then compare the proportion of failures in the sample against the desired system failure rate. If the estimate is much greater than one percent, we will conclude that the true system failure rate is likely greater than one percent. However, there is a possibility that we could make this conclusion in error (i.e., even though the sample failure rate was high, the true system failure rate could be one percent). The probability of this error is denoted α, and we desire that it be a low value. This value is commonly set at approximately five percent for acceptance sampling.
2. Tolerable upper limit on system failure rate (p_1) and corresponding probability of error in failing to reject initial assumption (β) – If the true system failure rate exceeds the desired one percent threshold, the sample failure rate may not be high enough to recognize this. For any value over one percent, there is a probability β that we will fail to conclude the system failure rate is over one percent. We desire that β be a small value (as with α, the value is commonly set at approximately five percent for acceptance sampling) at some true system failure rate greater than the desired system failure rate. This point is often referred to as the tolerable upper limit. We initially propose a tolerable upper limit on system failure rate of five percent.
3. For sampling efficiency, the smallest sample size (n) and acceptable number of failures (c) that meet the criteria above should be selected.

Noting that the sample response measurements for this acceptance test fall into only two categories (success or failure), the acceptance test quantities can be related by the following equations, based on the binomial probability distribution:

$$\alpha = \sum_{i=c+1}^{n} \binom{n}{i} p_0^{\,i} (1 - p_0)^{n-i}$$

$$\beta = \sum_{i=0}^{c} \binom{n}{i} p_1^{\,i} (1 - p_1)^{n-i}$$

where

$0 < p_0 < p_1 < 1$ and $0 \le c < n$

n and c are integers

From our initial requirements of the acceptance testing, we have established target values for p_0 (0.01), α (0.05), p_1 (0.05), and β (0.05). Since these equations produce discrete values, it is not necessarily possible to solve the two equations exactly for desired n and c. Instead, we develop a solution by fixing p_0 and p_1 and then experimenting with different values of n and c, searching for corresponding α and β reasonably close to the desired values.

For this particular acceptance test, an appropriate solution is found at n=147 and c=3 with p_0=0.01, p_1=0.05, α=0.06 and β=0.06. This leads to the following test,

1. Select a sample of 147 items and count the number of failures.
2. If the number of failures is 3 or less, there is not sufficient evidence to disprove an initial hypothesis that the true system failure rate is less than one percent and the test passes acceptance. It is possible this conclusion is incorrect (i.e., that the true system failure rate is greater than one percent). However, if the true system failure rate is five percent more, there is only a six percent chance of this error. Above a five percent system failure rate, this probability is even lower.
3. If the number of failures is 3 or more, there is sufficient evidence to disprove an initial hypothesis that the true system failure rate is less than one percent and the test fails acceptance. It is possible this conclusion is incorrect (i.e., that the true system failure rate is one percent or less). However, if the true system failure rate is one percent, there is only a six percent chance of this error. Below a one percent system failure rate, this probability is even lower.

The practical interpretation of this test is:

- If the test passes acceptance, we are fairly certain that the true system failure rate does not exceed five percent;
- If the test fails acceptance, we are fairly certain that the true system failure rate is not less than one percent; and
- If the true system failure rate is between one and five percent, there is a definite risk that we passed acceptance when we should not have.

Reducing Tolerable Upper Limit

From the test above, true system failure rates between the p_0 and p_1 values are a problem because there is a definite risk in these cases that an acceptance sample will pass for these values when it should have failed. Therefore, it is desirable to make p_1 as close as possible to p_0. However, for a fixed p_0, α, and β, this can only be done by increasing the sample size n. Modifying the acceptance sample plan above, p_1 can be reduced to four percent for n=294 and c=6 with p_0=0.01, p_1=0.04, α=0.03 and β=0.05.

Though this acceptance test has slightly better α and β and is not exactly comparable to the original test, it does show that we essentially need to double the sample size to get a one percent reduction in the tolerable upper limit.

Staged Sequential Sampling

If acceptance samples are not collected all at one time, it may be possible to evaluate the sample results as they are obtained. The acceptance test criteria can be modified in this case to allow consideration of these interim sample results as a means of coming to an early conclusion of whether an acceptance test passes or fails. The general procedure would be to collect a predetermined number of samples and then evaluate the number of failures. If at or below a certain number, c_{1A}, conclude the acceptance test passes. If at or above another number, c_{1R}, which is greater than c_{1A}, the acceptance test fails. If the number of failures falls between c_{1A} and c_{1R} then complete another stage of sampling. At the end of this second stage of sampling, compare the cumulative failures to a new set of acceptance limits to determine acceptance, failure, or continuation. This process can continue for as many stages as desired before reaching a final stage, where the cumulative number of failures from all stages is compared to a single acceptance limit, c_T. If the cumulative total of failures from all stages is at or below the limit, the acceptance test passes. Otherwise, it fails.

If the desired acceptance plan has two stages of sampling, the previous equations can be modified to account for a potential additional stage of sampling by

$$\alpha = \sum_{i=c_{1R}+1}^{n_1} \binom{n_1}{i} p_0^{\,i}(1-p_0)^{n_1-i} + \sum_{j=c_{1A}+1}^{c_{1R}-1} \binom{n_1}{j} p_0^{\,j}(1-p_0)^{n_1-j} * \sum_{k=c_T+1-j}^{n_2} \binom{n_2}{k} p_0^{\,k}(1-p_0)^{n_2-k}$$

$$\beta = \sum_{i=0}^{c_{1A}} \binom{n_1}{i} p_1^{\,i}(1-p_1)^{n-i} + \sum_{j=c_{1A}+1}^{c_{1R}-1} \binom{n_1}{j} p_1^{\,j}(1-p_1)^{n_1-j} * \sum_{k=0}^{c_T-j} \binom{n_2}{k} p_1^{\,k}(1-p_1)^{n_2-k}$$

where

n_1 and n_2 are the numbers of samples for the two stages, respectively

c_{1A} and c_{1R} are the acceptance and rejection numbers of failures for the first stage of sampling

c_T is the acceptance limit at the end of a second stage (if one is needed)

$0 < p_0 < p_1 < 1$ and $1 \le c_{1A} + 1 < c_{1R} - 1 \le n_1 - 1$

and $c_T \ge c_{1R} - 1$ and $n_2 \ge c_T - c_{1A}$

n_1, n_2, c_{1A}, c_{1R}, and c_T are integers

A final solution that satisfies the equations above is n_1=147, n_2=147, c_{1A}=1, c_{1R}=5, c_T=6 with p_0=0.01, p_1=0.04, α=0.06 and β=0.06. The test is completed as:

1. Select a sample of 147 items and count the number of failures.
2. If the number of failures is 1 or less, there is not sufficient evidence to disprove an initial hypothesis that the true system failure rate is less than one percent and the test passes acceptance.
3. If the number of failures is 5 or more, there is sufficient evidence to disprove an initial hypothesis that the true system failure rate is less than one percent and the test fails acceptance.

4. If the number of failures is 2, 3, or 4, no immediate conclusion is reached about acceptance or failure. Instead, another sample of 147 items is taken, the failures are counted, and these failures are added to the original stage failures.
   a. If the aggregate number of failures is 6 or less, there is not sufficient evidence to disprove an initial hypothesis that the true system failure rate is less than one percent and the test passes acceptance.
   b. If the aggregate number of failures is 7 or more, there is sufficient evidence to disprove an initial hypothesis that the true system failure rate is less than one percent and the test fails acceptance.
5. It is possible that an overall passing acceptance result from this test (regardless of whether it happens in the first or second stage of sampling) is incorrect (i.e., that the true system failure rate is greater than one percent). However, if the true system failure rate is four percent or more, there is only a six percent chance of this error. Above a four percent system failure rate, this probability is even lower.
6. It is possible that an overall failing acceptance result from this test (regardless of whether it happens in the first or second stage of sampling) is incorrect (i.e., that the true system failure rate is one percent or less). However, if the true system failure rate is one percent, there is only a six percent chance of this error. Below a one percent system failure rate, this probability is even lower.

Relative to the single stage sample plan of 147 samples, this final sample plan provides the desired protection against the lower tolerable upper limit at four percent instead of five percent. However, it could require two stages, or 294 samples to achieve this. Relative to the single stage sample plan of 294 samples, this final sample plan provides the possibility of finishing sampling in half the total number of samples. However, its α and β are not quite as good as the single stage sample plan. Balancing these two considerations, the two-stage sample is recommended for this particular application.

Appendix B:

Data Collected for Acceptance Test of FOT Voice Routing Functionality

TimeOfCall	Time of Day	CallerName	PSAP	LocationID	CallTypeID	CorrectLatitude	CorrectLongitude	OnStarSuccess	PSAPSuccess	ReceivedPSAPID	ReceivedLatitude	ReceivedLongitude	ReceivedCorrectCallbackNumber	Comments	UsedForAcceptanceTest	SecondaryPosition	SecondaryDeltaVelocity	SecondayPDOF	SecondaryMultipleImpact	SecondaryRollover	SecondaryDriverSideAirBagDeployed	SecondaryDriverFrontAirBagDeployed	SecondaryPassengerSideAirBagDeployed	SecondaryPassengerFrontAirBagDeployed	SecondaryCaseID	SecondaryPSAPConfirm
10-Aug-05	8:16		Kandiyohi County	1				FALSE	FALSE				FALSE	Bad GPS Coordinate, call not delivered	FALSE				FALSE	FALSE						FALSE
10-Aug-05	8:19		Kandiyohi County	1				FALSE	FALSE				FALSE	Call transferred to OnStar Lab and then to emergency advisor, no answer- this usually indicated a queue for emergency calls and after a set time period the call is timed out and dropped	FALSE				FALSE	FALSE						FALSE
10-Aug-05	8:22	Bernard	Kandiyohi County	1	1	44.96518611	-94.89398389	TRUE	TRUE	1	44.965	-94.893	TRUE		TRUE	2	17	-94	TRUE	FALSE	No	Near Deployed	No	Near Deployed	2459	FALSE
10-Aug-05	8:39	Bernard	Kandiyohi County	2	2	45.11000333	-94.94055194	TRUE	TRUE	1	45.109	-94.94	TRUE		TRUE	2	32	-91	TRUE	FALSE	no		no		2460	FALSE
10-Aug-05	8:59	Bernard	Kandiyohi County	3	3	45.23021111	-94.93686222	TRUE	TRUE	1	45.23	-94.937	TRUE		TRUE	1	10	176	TRUE	FALSE	no		no		2461	FALSE
10-Aug-05	9:10	Barbra	Kandiyohi County	4	4	45.29197444	-94.94071611	TRUE	TRUE	1	45.292	-94.94	TRUE	PSAP closed telematic application after previous phone call. Application was not active so the data was not displayed.	TRUE				FALSE	FALSE						FALSE
10-Aug-05	9:24	Barbra	Kandiyohi County	5	5	45.32923944	-95.00968278	TRUE	TRUE	1	45.329	-95.008	TRUE		TRUE	1	22	88	TRUE	FALSE	no		no		2463	FALSE
10-Aug-05	9:36		Kandiyohi County	6				FALSE	FALSE				FALSE	Call dropped at OnStar	FALSE				FALSE	FALSE						FALSE
10-Aug-05	9:37	Mike	Kandiyohi County	6	6	45.21194528	-95.00215361	TRUE	FALSE	3			FALSE	Call did not go through to PSAP, network maintenance at telcordia at time of call.	FALSE				FALSE	FALSE						FALSE
10-Aug-05	10:21	Bridget	Kandiyohi County	9	7	45.12182111	-95.04419333	TRUE	TRUE	1	45.211	-95.002	TRUE	Lat/Lon looks to be from previous observation and I made long "-"- rtk	TRUE	2	20	149	TRUE	FALSE	no		no		2466	FALSE
10-Aug-05	10:57	Regina	Renville County	3	3	44.78801639	-95.09732972	TRUE	TRUE	2	44.788	-95.097	TRUE	Operator did not have telematics application activated before the first call came through	TRUE				FALSE	FALSE						FALSE
10-Aug-05	11:11	Regina	Renville County	4	4	44.672335	-95.09611361	TRUE	TRUE	2	44.672	-95.096	TRUE		TRUE	1	32	-91	TRUE	FALSE	yes		yes		2468	FALSE
10-Aug-05	11:22	Bridget	Renville County	5	5	44.67247083	-94.99500667	TRUE	TRUE	2	44.672	-94.995	TRUE	Made longitude "-" - rtk	TRUE	1	22	88	TRUE	FALSE	no		no		2469	FALSE
10-Aug-05	11:30	Angela	Renville County	6	6	44.67355056	-94.89436528	TRUE	TRUE	2	44.673	-94.895	TRUE		TRUE	1	22	-88	TRUE	FALSE	no	Near deployed	no	Near deployed	2470	FALSE
10-Aug-05	11:39		Renville County	7				FALSE	FALSE				FALSE	Call transferred to OnStar Lab and then to emergency advisor, no answer-- this usually indicated a queue for emergency calls and after a set time period the call is timed out and dropped	FALSE				FALSE	FALSE						FALSE
10-Aug-05	11:41		Renville County	7				FALSE	FALSE				FALSE	Call transferred to OnStar Lab and then to emergency advisor, no answer-- this usually indicated a queue for emergency calls and after a set time period the call is timed out and dropped	FALSE				FALSE	FALSE						FALSE
10-Aug-05	11:43		Renville County	7				FALSE	FALSE				FALSE	Call transferred to OnStar Lab and then to emergency advisor, no answer-- this usually indicated a queue for emergency calls and after a set time period the call is timed out and dropped	FALSE				FALSE	FALSE						FALSE
10-Aug-05	11:46	Mike	Renville County	7	7	44.76730639	-94.89485222	TRUE	TRUE	2	44.767	-94.894	TRUE	There were 4 calls made at this location, 3 of the four did not get answered by an onstar operator. This usually occurs when the call times out, indicating that no operators are available because they are handling emergency calls	TRUE		32	-91	TRUE	FALSE	no	Near deployed	no	Near deployed	2474	FALSE
10-Aug-05	11:54	Bridget	Renville County	8	8	44.75543417	-94.81304	TRUE	TRUE	2	44.76	-94.843	TRUE	I did not make the call at the same location as the approximate GPS coordinate. County road 3 is co-located with 212. I was supposed to make it from the portion that heads south off of 212, I made the call from the location that heads north off of 212.	TRUE		20	180	TRUE	FALSE	no		no		2475	FALSE
10-Aug-05	12:05	Regina	Renville County	9	9	44.74005972	-94.71536278	TRUE	TRUE	2	44.74	-94.715	TRUE		TRUE		20	149	TRUE	FALSE	no		no		2476	FALSE
11-Aug-05	8:05		McLeod County	10				FALSE	FALSE				FALSE	Bad GPS signal on first call	FALSE				FALSE	FALSE						FALSE
11-Aug-05	8:08	Barbra	McLeod County	10	10	44.76750306	-94.09096056	TRUE	TRUE	5	44.767	-94.09	TRUE	call was sucessful with exception of additional data at PSAP because Telematics application was not turned on before the call was made.	TRUE				FALSE	FALSE						FALSE
11-Aug-05	8:23		McLeod County	9				FALSE	FALSE				FALSE	call dropped at OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	8:24	Mike	McLeod County	9	9	44.77204833	-94.15071778	TRUE	TRUE	5	44.772	-94.15	TRUE		TRUE		20	149	TRUE	FALSE	no		no		2490	FALSE
11-Aug-05	8:50	Barbra	McLeod County	1	1	44.90718667	-94.13465278	TRUE	TRUE	5	44.907	-94.134	TRUE		TRUE		17	-94	TRUE	FALSE	no	Near Deployed	no	Near Deployed	2491	FALSE
11-Aug-05	8:59	Natasha	McLeod County	2	2	44.906165	-94.20572528	TRUE	TRUE	5	44.906	-94.205	TRUE		TRUE		32	-91	TRUE	FALSE	no		no		2492	FALSE
11-Aug-05	9:11	Barbra	McLeod County	3	3	44.82718528	-94.27549056	TRUE	TRUE	5	44.827	-94.275	TRUE		TRUE		10	176	TRUE	FALSE	no		no		2493	FALSE
11-Aug-05	9:20	Natasha	McLeod County	8	8	44.77552778	-94.28441417	TRUE	TRUE	5	44.775	-94.284	TRUE		TRUE		20	180	TRUE	FALSE	no		no		2494	FALSE
11-Aug-05	9:28		McLeod County	7				FALSE	FALSE				FALSE	call was dropped at OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	9:29		McLeod County	7				FALSE	FALSE				FALSE	call was dropped at OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	9:30	Barbra	McLeod County	7	7	44.77439611	-94.37497194	TRUE	TRUE	5	44.774	-94.374	TRUE		TRUE		32	-91	TRUE	FALSE	no	Near Deployed	no	Near Deployed	2497	FALSE

TimeOfCall	Time of Day	CallerName	PSAP	LocationID	CallTypeID	CorrectLatitude	CorrectLongitude	OnStarSuccess	PSAPSuccess	ReceivedPSAPID	ReceivedLatitude	ReceivedLongitude	ReceivedCorrectCallbackNumber	Comments	UsedForAcceptanceTest	SecondaryPosition	SecondaryDeltaVelocity	SecondaryPDOF	SecondaryMultipleImpact	SecondaryRollover	SecondaryDriverSideAirBagDeployed	SecondaryDriverFrontAirBagDeployed	SecondaryPassengerSideAirBagDeployed	SecondaryPassengerFrontAirBagDeployed	SecondaryCaseID	SecondaryPSAPConfirm
11-Aug-05	10:04		Meeker County					FALSE	FALSE				FALSE	Bad GPS signal after system was rebooted due to power cord coming unplugged	FALSE				FALSE	FALSE						FALSE
11-Aug-05	10:07		Meeker County					FALSE	FALSE				FALSE	No connection to OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	10:10		Meeker County					FALSE	FALSE				FALSE	No connection to OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	10:18		Meeker County					FALSE	FALSE				FALSE	No connection to OnStar (verified there was a problem at the OnStar lab)	FALSE				FALSE	FALSE						FALSE
11-Aug-05	10:59	Bridget	Meeker County	2	2	45.14448722	-94.31730889	TRUE	TRUE	6	45.144	-94.317	TRUE	Notified of emergency situation from dispatchers who requested no calls for the next 30 minutes	TRUE				FALSE	FALSE						FALSE
11-Aug-05	11:37	Marlin	Meeker County	6	6	45.13875333	-94.52933861	TRUE	TRUE	6	45.139	-94.529	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	11:48	Bridget	Meeker County	7	7	45.21067	-94.54281028	TRUE	TRUE	6	45.21	-94.542	TRUE	Made longitude "-" - rtk	TRUE				FALSE	FALSE						FALSE
11-Aug-05	12:02		Meeker County	5				FALSE	FALSE				FALSE	No answer from OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	12:05		Meeker County	5				FALSE	FALSE				FALSE	No answer from OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	12:07	Donnell	Meeker County	5	5	45.2035925	-94.46529028	TRUE	TRUE	6	45.203	-94.465	TRUE	Made longitude "-" - rtk	TRUE				FALSE	FALSE						FALSE
11-Aug-05	12:15		Meeker County	4				FALSE	FALSE				FALSE	No answer at OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	12:17	Tara	Meeker County	4	4	45.20242639	-94.39955472	TRUE	TRUE	6	45.202	-94.399	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	12:24		Meeker County	3				FALSE	FALSE				FALSE	No answer from OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	12:27	Natasha	Meeker County	3	3	45.19732083	-94.31600583	TRUE	TRUE	6	45.197	-94.316	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	12:42	Barbra	Meeker County	1	1	45.04259694	-94.35520556	TRUE	TRUE	6	45.042	-94.355	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	13:19	Barbra	Carver County	3	3	44.904585	-93.96925833	TRUE	TRUE	6	45.042	-94.355	TRUE	Call contained old GPS coordinate from previous call so it was routed to Meeker County	FALSE				FALSE	FALSE						FALSE
11-Aug-05	13:23	Natasha	Carver County	3	3	44.904585	-93.96925833	TRUE	TRUE	7	44.904	-93.968	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	13:33	Mike	Carver County	2	2	44.90615667	-93.86936111	TRUE	TRUE	7	44.906	-93.869	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	13:53	Bridget	Carver County	5	5	44.80214778	-93.89125611	TRUE	TRUE	7	44.801	-93.891	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	14:05	Barbra	Carver County	6	6	44.84275556	-93.78753611	TRUE	TRUE	7	44.842	-93.787	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	14:15		Carver County	7				FALSE	FALSE				FALSE	No answer from OnStar	FALSE				FALSE	FALSE						FALSE
11-Aug-05	14:16	Cindy	Carver County	7	7	44.76669472	-93.78160694	TRUE	TRUE	7	44.766	-93.781	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	14:24	Marlin	Carver County	8	8	44.71688472	-93.7879875	TRUE	TRUE	7	44.716	-93.788	TRUE		TRUE				FALSE	FALSE						FALSE
11-Aug-05	14:31		Carver County	9				FALSE	FALSE				FALSE	Bad GPS signal after system reset because I unplugged the power cord	FALSE				FALSE	FALSE						FALSE
11-Aug-05	14:35	Tara	Carver County	9	9	44.77653	-93.69983083	TRUE	TRUE	7	44.776	-93.699	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	8:50		Anoka County	7				FALSE	FALSE				FALSE	No answer from OnStar call center	FALSE				FALSE	FALSE						FALSE
12-Aug-05	8:52	Cindy	Anoka County	7	7	45.19398944	-93.07408083	TRUE	TRUE	8	45.194	-93.073	TRUE	Assumed data entry error of -93.738 s/b -93.0738 - rtk	TRUE				FALSE	FALSE						FALSE
12-Aug-05	9:02	Cindy	Anoka County	8	8	45.19626	-93.16247917	TRUE	TRUE	8			TRUE	Call to PSAP, no ALI record received, verified ALI connection up and operational, potential error at PSAP?	FALSE				FALSE	FALSE						FALSE
12-Aug-05	9:13	Cindy	Anoka County	9	9	45.15689361	-93.16282861	TRUE	TRUE	8			FALSE	Call to PSAP, no ALI record received, verified ALI connection up and operational, potential error at psap?	FALSE				FALSE	FALSE						FALSE
12-Aug-05	10:07	Cindy	Anoka County	10	10	45.167725	-93.21158	TRUE	TRUE	8	45.166	-93.212	TRUE	Forgot to enter yes for callback number provided - rtk	TRUE				FALSE	FALSE						FALSE
12-Aug-05	10:25	Mike	Anoka County	1	1	45.13962833	-93.23422389	TRUE	TRUE	8	45.139	-93.234	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	10:35	Natasha	Anoka County	3	3	45.19772889	-93.23285111	TRUE	TRUE	8	45.197	-93.232	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	10:47	Alicia	Anoka County	2	2	45.19668833	-93.33596972	TRUE	TRUE	8	45.196	-93.335	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	11:04	Mike	Hennepin County	1	2	45.1310175	-93.3559225	TRUE	TRUE	9	45.131	-93.355	TRUE	Unsure call type is 2 but we entered this	TRUE				FALSE	FALSE						FALSE
12-Aug-05	11:17	Natasha	Hennepin County	2	2	45.12446139	-93.42631806	TRUE	TRUE	9	45.124	-93.426	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	11:26	Cindy	Hennepin County	3	3	45.12597333	-93.48784333	TRUE	TRUE	9	45.125	-93.487	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	11:39	Cindy	Hennepin County	4	4	45.13084028	-93.63441667	TRUE	TRUE	9	45.13	-93.634	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	11:48	Natasha	Hennepin County	5	5	45.06510806	-93.63580139	TRUE	TRUE	9	45.065	-93.635	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	11:58	Alicia	Hennepin County	6	6	45.04530222	-93.54234806	TRUE	TRUE	9	45.045	-93.542	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	12:16	Tara	Hennepin County	8	8	44.99477083	-93.50229972	TRUE	TRUE	9	44.994	-93.502	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	12:34	Regina	Minnetonka	5	5	44.96521028	-93.44204861	TRUE	TRUE	10	44.965	-93.442	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	12:46	Regina	Minnetonka	4	4	44.94923861	-93.43846778	TRUE	TRUE	10	44.949	-93.438	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	12:53	Regina	Minnetonka	3	3	44.94177861	-93.44151139	TRUE	TRUE	10	44.941	-93.441	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	13:10		Minnetonka	7	7	44.93702528	-93.46723694	TRUE	TRUE	10	44.936	-93.467	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	13:19	Marlin	Minnetonka	8	8	44.92255917	-93.46839889	TRUE	TRUE	10	44.921	-93.468	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	13:24	Cindy	Minnetonka	10	10			FALSE	FALSE				FALSE	Call forwarding error at OnStar	FALSE				FALSE	FALSE						FALSE
12-Aug-05	13:29	Tara	Minnetonka	10	10	44.90398639	-93.46554833	TRUE	TRUE	10	44.904	-93.465	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	13:38	Tara	Eden Prairie	1	1	44.86376222	-93.48592694	TRUE	TRUE	11	44.863	-93.485	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	13:46	Regina	Eden Prairie	2	2	44.85444139	-93.48587361	TRUE	TRUE	11	44.854	-93.486	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	13:52		Eden Prairie	3	3			FALSE	FALSE				FALSE	No answer from OnStar	FALSE				FALSE	FALSE						FALSE
12-Aug-05	13:53		Eden Prairie	3	3	44.83619028	-93.48014639	TRUE	TRUE	11	44.836	-93.479	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	13:59	Regina	Eden Prairie	4	4	44.81871861	-93.48198389	TRUE	TRUE	11	44.818	-93.481	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	14:05	Alicia	Eden Prairie	5	5	44.81946056	-93.46343083	TRUE	TRUE	11	44.82	-93.454	TRUE	This location is in a construction zone: Call was made approx here (a little east and north of initial point)	TRUE				FALSE	FALSE						FALSE
12-Aug-05	14:11	Gatha	Eden Prairie	6	6	44.82815778	-93.44403306	TRUE	TRUE	11	44.828	-93.444	TRUE		TRUE				FALSE	FALSE						FALSE
12-Aug-05	14:23	Gatha	Eden Prairie	9	9	44.85942417	-93.44111056	TRUE	TRUE	11	44.859	-93.441	TRUE		TRUE				FALSE	FALSE						FALSE

TimeOfCall	Time of Day	CallerName	PSAP	LocationID	CallTypeID	CorrectLatitude	CorrectLongitude	OnStarSuccess	PSAPSuccess	ReceivedPSAPID	ReceivedLatitude	ReceivedLongitude	ReceivedCorrectCallbackNumber	Comments	UsedForAcceptanceTest	SecondaryPosition	SecondaryDeltaVelocity	SecondaryPDOF	SecondaryMultipleImpact	SecondaryRollover	SecondaryDriverSideAirBagDeployed	SecondaryDriverFrontAirBagDeployed	SecondaryPassengerSideAirBagDeployed	SecondaryPassengerFrontAirBagDeployed	SecondaryCaseID	SecondaryPSAPConfirm
15-Aug-05	8:07	Steve	Olmsted County	1				FALSE	FALSE				FALSE	Bad GPS	FALSE				FALSE	FALSE						FALSE
15-Aug-05	8:14	Bernard	Olmsted County	1	1	44.16825028	-92.54986111	TRUE	TRUE	12	44.168	-92.55	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	8:23	Terry	Olmsted County	2	2	44.10925694	-92.51800917	TRUE	TRUE	12	44.109	-92.518	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	8:33	Barbra	Olmsted County	3	3	44.10797306	-92.43190028	TRUE	TRUE	12	44.107	-92.431	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	8:41		Olmsted County	4				FALSE	FALSE				FALSE	No answer from OnStar	FALSE				FALSE	FALSE						FALSE
15-Aug-05	8:42	Bernard	Olmsted County	4	4	44.10797917	-92.36912639	TRUE	TRUE	12	44.107	-92.369	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	9:05	Marlin	Olmsted County	5	5	44.06417611	-92.2508175	TRUE	TRUE	12	44.064	-92.25	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	9:17	Bridget	Olmsted County	6	6	43.956325	-92.23938722	TRUE	TRUE	12	44.052	-92.249	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	9:33		Olmsted County	7				FALSE	FALSE				FALSE	No Answer from OnStar	FALSE				FALSE	FALSE						FALSE
15-Aug-05	9:35	Ticey	Olmsted County	7	7	43.95252528	-92.35678444	TRUE	TRUE	12	43.952	-92.356	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	10:00	Alicia	Mower County	1	1	43.77577722	-92.48486889	TRUE	TRUE	12	43.952	-92.356	TRUE	Got old GPS from 9:35 call -- Routed to Olmsted	FALSE				FALSE	FALSE						FALSE
15-Aug-05	10:04	Alicia	Mower County	1	1	43.77577722	-92.48486889	TRUE	TRUE	13	43.775	-92.484	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	10:19	Ticey	Mower County	2	2	43.70991	-92.56990111	TRUE	TRUE	13	43.71	-92.569	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	10:34	Marlin	Mower County	3	3	43.5581675	-92.569325	TRUE	TRUE	13	43.558	-92.569	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	10:45	Natasha	Mower County	4	4	43.56564833	-92.72501333	TRUE	TRUE	13	43.565	-92.725	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	10:54	Marlin	Mower County	5	5	43.60135028	-92.82344417	TRUE	TRUE	13	43.601	-92.823	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	11:06	Natasha	Mower County	6	6	43.6088175	-92.94928639	TRUE	TRUE	13	43.608	-92.949	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	11:15	Terry	Mower County	7	7	43.67359528	-92.93848861	TRUE	TRUE	13	43.608	-92.949	TRUE	Same GPS as previous call	FALSE				FALSE	FALSE						TRUE
15-Aug-05	11:41	Alicia	Steele County	3	3	43.87770389	-93.06549778	TRUE	TRUE	14	43.8776	-93.065	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	11:54	Marlin	Steele County	4	4	43.87037361	-93.226205	TRUE	TRUE	14	43.87	-93.226	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	12:06	Bernard	Steele County	5	4	43.87345833	-93.30628972	TRUE	TRUE	14	43.873	-93.306	TRUE	Made longitude "-" - rtk	TRUE				FALSE	FALSE						TRUE
15-Aug-05	12:20	Ticey	Steele County	6	6	43.95720222	-93.27646028	TRUE	TRUE	14	43.957	-93.276	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	12:33	Bernard	Steele County	8	8	44.10881278	-93.24515472	TRUE	TRUE	14	44.108	-93.245	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	12:38	Alicia	Steele County	9	9	44.13406583	-93.24909083	TRUE	TRUE	14	44.134	-93.249	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	12:46	Alicia	Steele County	10	10	44.17018861	-93.26256833	TRUE	TRUE	14	44.169	-93.261	TRUE		TRUE				FALSE	FALSE						TRUE
15-Aug-05	13:52	Barbra	Dakota County	6				FALSE	FALSE				FALSE	Bad GPS, call not routed (reboot computer)	FALSE				FALSE	FALSE						FALSE
15-Aug-05	13:56	Steve	Dakota County	6	6	44.63052861	-93.13608194	TRUE	TRUE	15	44.631	-93.136	TRUE	Made longitude "-" - rtk	TRUE				FALSE	FALSE						FALSE
15-Aug-05	14:08	Barbra	Dakota County	7	7	44.6017825	-92.9942675	TRUE	TRUE	15	44.601	-92.994	TRUE		TRUE				FALSE	FALSE						FALSE
15-Aug-05	14:19	Marlin	Dakota County	4	4	44.71076694	-93.03462333	TRUE	TRUE	15	44.71	-93.034	TRUE		TRUE				FALSE	FALSE						FALSE
15-Aug-05	14:31	Barbra	Dakota County	3	3	44.77774639	-93.03613833	TRUE	TRUE	15	44.778	-93.035	TRUE		TRUE				FALSE	FALSE						FALSE
15-Aug-05	14:39	Barbra	Dakota County	10	10	44.79738639	-93.07294861	TRUE	TRUE	15	44.797	-93.072	TRUE		TRUE				FALSE	FALSE						FALSE
15-Aug-05	14:49	Ryan	Dakota County	9	9	44.84741444	-93.060745	TRUE	TRUE	15	44.848	-93.058	TRUE	Made longitude "-" - rtk	TRUE				FALSE	FALSE						FALSE
16-Aug-05	8:46		Minneapolis					FALSE	FALSE				FALSE	start up test call bad gps	FALSE				FALSE	FALSE						FALSE
16-Aug-05	8:59	Bridget	Minneapolis	1	1	44.98173278	-93.24274306	TRUE	TRUE	16	44.981	-93.242	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	10:05	Marlin	Minneapolis	2	2	44.97633056	-93.25874917	TRUE	TRUE	16	44.976	-93.258	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	10:16	Alicia	Minneapolis	4	4	44.98955667	-93.25527278	TRUE	TRUE	16	44.989	-93.255	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	13:00		Minneapolis					FALSE	FALSE				FALSE	rebooted computer	FALSE				FALSE	FALSE						FALSE
16-Aug-05	13:18	Donnell	Minneapolis	3				FALSE	FALSE				FALSE	No GPS	FALSE				FALSE	FALSE						FALSE
16-Aug-05	13:22	Terry	Minneapolis	3	3	44.94606167	-93.27541583	TRUE	TRUE	16	44.946	-93.275	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	13:32	Alicia	Minneapolis	5	5	44.93773611	-93.30344528	TRUE	TRUE	16	44.937	-93.303	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	13:41	Donnell	Minneapolis	6	6	44.91525917	-93.30873444	TRUE	TRUE	16	44.915	-93.309	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	13:56	Alicia	Edina	1	1	44.91220417	-93.3525275	TRUE	TRUE	17	44.911	-93.352	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	14:02	Steve	Edina	2	2	44.89649861	-93.35157417	TRUE	TRUE	17	44.896	-93.351	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	14:13	Terry	Edina	6	6	44.88836694	-93.36824139	TRUE	TRUE	17	44.888	-93.368	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	14:23	Barbra	Edina	7	7	44.88006556	-93.3758525	TRUE	TRUE	17	44.88	-93.375	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	14:29	Bridget	Edina	8	8	44.88736139	-93.38581278	TRUE	TRUE	17	44.887	-93.385	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	14:34	Bernard	Edina	9	8	44.8998875	-93.38082056	TRUE	TRUE	17	44.899	-93.381	TRUE		TRUE				FALSE	FALSE						FALSE
16-Aug-05	14:42	Terry	Edina	10	10	44.91327278	-93.38357167	TRUE	TRUE	17	44.913	-93.383	TRUE		TRUE				FALSE	FALSE						FALSE

TimeOfCall	Time of Day	CallerName	PSAP	LocationID	CallTypeID	CorrectLatitude	CorrectLongitude	OnStarSuccess	PSAPSuccess	ReceivedPSAPID	ReceivedLatitude	ReceivedLongitude	ReceivedCorrectCallbackNumber	Comments	UsedForAcceptanceTest	SecondaryPosition	SecondaryDeltaVelocity	SecondaydPDOF	SecondaryMultipleImpact	SecondaryRollover	SecondaryDriverSideAirBagDeployed	SecondaryDriverFrontAirBagDeployed	SecondaryPassengerSideAirBagDeployed	SecondaryPassengerFrontAirBagDeployed	SecondaryCaseID	SecondaryPSAPConfirm
17-Aug-05	8:58		Scott County					FALSE	FALSE				FALSE	Test Call - no GPS	FALSE				FALSE	FALSE						FALSE
17-Aug-05	9:00	Jorge	Scott County	9	9	44.74654528	-93.38218361	TRUE	TRUE	19	44.746	-93.382	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	9:11	Bernard	Scott County	8	8	44.77837167	-93.37897306	TRUE	TRUE	19	44.7778	-93.379	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	9:27	Ticey	Scott County	7	7	44.77718556	-93.50475028	TRUE	TRUE	19	44.777	-93.505	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	9:38	Bridget	Scott County	1	1	44.76419639	-93.57816333	TRUE	TRUE	19	44.764	-93.578	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	9:50	Natasha	Scott County	2	2	44.73296139	-93.58909639	TRUE	TRUE	19	44.732	-93.589	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	10:02	Jorge	Scott County	6	6	44.68933222	-93.50090667	TRUE	TRUE	19	44.688	-93.501	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	10:13	Marlin	Scott County	10	10	44.71333333	-93.42401028	TRUE	TRUE	19	44.713	-93.424	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	10:36		Lakeville					FALSE	FALSE				FALSE	Battery died on call and after reboot got no gps	FALSE				FALSE	FALSE						FALSE
17-Aug-05	10:38	Regina	Lakeville	1	1	44.64486444	-93.29427778	TRUE	TRUE	20	44.644	-93.294	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	10:48	Marlin	Lakeville	3	3	44.63825	-93.25492528	TRUE	TRUE	20	44.638	-93.254	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	10:54	Regina	Lakeville	2	2	44.65519167	-93.25382111	TRUE	TRUE	20	44.655	-93.253	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:03	Bernard	Lakeville	7	7	44.68165028	-93.25530222	TRUE	TRUE	20	44.681	-93.255	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:09	Bridget	Lakeville	8	8	44.68158444	-93.28148417	TRUE	TRUE	20	44.681	-93.281	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:14	Terry	Lakeville	9	9	44.68256778	-93.2914175	TRUE	TRUE	20	44.682	-93.291	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:20	Regina	Lakeville	10	10	44.69659917	-93.28733806	TRUE	TRUE	20	44.696	-93.287	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:30	Regina	Burnsville	7	7	44.72725611	-93.27776056	TRUE	TRUE	21	44.727	-93.278	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:40	Regina	Burnsville	8	8	44.74787222	-93.28487583	TRUE	TRUE	21	44.747	-93.284	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:46	Regina	Burnsville	5	5	44.74715361	-93.30367528	TRUE	TRUE	21	44.747	-93.303	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:53	Bridget	Burnsville	4	4	44.75885139	-93.30353694	TRUE	TRUE	21	44.758	-93.303	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	11:59	Ticey	Burnsville	3	3	44.77096444	-93.30411167	TRUE	TRUE	21	44.77	-93.303	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	12:08	Barbra	Burnsville	10	10	44.77109306	-93.27806778	TRUE	TRUE	21	44.771	-93.278	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	12:27	Regina	Apple Valley	6	6	44.73549722	-93.21731056	TRUE	TRUE	23	44.735	-93.216	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	12:36	Donnell	Apple Valley	5	5	44.73082806	-93.19917917	TRUE	TRUE	23	44.73	-93.199	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	12:48	Ticey	Apple Valley	7	7	44.7463275	-93.1960475	TRUE	TRUE	23	44.746	-93.196	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	12:54	Tara	Apple Valley	8	8	44.74673778	-93.20773444	TRUE	TRUE	23	44.747	-93.207	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:03	Regina	Apple Valley	3	3	44.74599972	-93.17564	TRUE	TRUE	23	44.745	-93.175	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:09		Apple Valley	2	2	44.75647	-93.16973833	TRUE	TRUE	23	44.756	-93.169	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:15	Regina	Apple Valley	1	2	44.76821889	-93.1690233	TRUE	TRUE	23	44.768	-93.169	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:24	Donnell	Eagan	6	6	44.79066417	-93.16861361	TRUE	TRUE	23	44.768	-93.169	TRUE	Old GPS to Apple Valley	FALSE				FALSE	FALSE						FALSE
17-Aug-05	13:27	Donnell	Eagan	6	6	44.79066417	-93.16861361	TRUE	TRUE	22	44.79	-93.169	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:35	Bernard	Eagan	5	5	44.80557972	-93.166405	TRUE	TRUE	22	44.805	-93.166	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:42	Marlin	Eagan	3	3	44.80541694	-93.14501778	TRUE	TRUE	22	44.805	-93.144	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:49	Bridget	Eagan	4	4	44.80418722	-93.11791639	TRUE	TRUE	22	44.804	-93.118	TRUE		TRUE				FALSE	FALSE						FALSE
17-Aug-05	13:59		Eagan	2	2	44.83148333	-93.14835194	TRUE	TRUE	22	44.827	-93.147	TRUE	Call not made from exact location but in vicinity	TRUE				FALSE	FALSE						FALSE
17-Aug-05	14:06	Terry	Eagan	1	2	44.84696583	-93.1487875	TRUE	TRUE	22	44.846	-93.148	TRUE		TRUE				FALSE	FALSE						FALSE
18-Aug-05	9:06		St. Paul					FALSE	FALSE				FALSE	Bad GPS no call	FALSE				FALSE	FALSE						FALSE
18-Aug-05	9:17	Terry	St. Paul	2	2	44.97666472	-93.09061778	TRUE	TRUE	18	44.975	-93.09	TRUE		TRUE				FALSE	FALSE						FALSE
18-Aug-05	9:27	Marlin	St. Paul	1	1	44.95249417	-93.10425222	TRUE	TRUE	18	44.952	-93.104	TRUE		TRUE				FALSE	FALSE						FALSE
18-Aug-05	9:36	Natasha	St. Paul	8	8	44.94691806	-93.08234389	TRUE	TRUE	18	44.946	-93.082	TRUE		TRUE				FALSE	FALSE						FALSE
18-Aug-05	9:45	Alicia	St. Paul	6	6	44.92673722	-93.1288975	TRUE	TRUE	18	44.926	-93.128	TRUE		TRUE				FALSE	FALSE						FALSE
18-Aug-05	9:54	Bridget	St. Paul	5	5	44.92694194	-93.16648833	TRUE	TRUE	18	44.926	-93.166	TRUE		TRUE				FALSE	FALSE						FALSE
18-Aug-05	10:08		St. Paul	4	4	44.96783278	-93.16740861	TRUE	FALSE				FALSE	No GPS update-- Call not delivered to PSAP	FALSE				FALSE	FALSE						FALSE
18-Aug-05	10:13		St. Paul	4	4			TRUE	FALSE				FALSE	Wrong number-- OnStar might have misdialed	FALSE				FALSE	FALSE						FALSE
18-Aug-05	10:18	Bridget	St. Paul	4	4	44.96783278	-93.16740861	TRUE	TRUE	18	44.968	-93.167	TRUE		TRUE				FALSE	FALSE						FALSE
18-Aug-05	10:34	Terry	St. Paul	3	3	44.97743194	-93.13487778	TRUE	TRUE	18	44.977	-93.135	TRUE		TRUE				FALSE	FALSE						FALSE
19-Aug-05	9:41		Washington County					FALSE	FALSE				FALSE	startup bad gps	FALSE				FALSE	FALSE						FALSE
19-Aug-05	9:49	Terry	Washington County	10	10	44.89094417	-92.84264306	TRUE	TRUE	24	44.89	-92.842	TRUE		TRUE				FALSE	FALSE						FALSE
19-Aug-05	10:03	Alicia	Washington County	182	2	44.94851778	-92.88303278	TRUE	TRUE	24	44.947	-92.883	TRUE		TRUE				FALSE	FALSE						FALSE
19-Aug-05	10:15	Natasha	Washington County	183	3	45.01024306	-92.86351111	TRUE	TRUE	24	45.01	-92.863	TRUE		TRUE				FALSE	FALSE						FALSE
19-Aug-05	10:22	Steve	Washington County	184	4	45.03703222	-92.84687639	TRUE	TRUE	24	45.037	-92.846	TRUE		TRUE				FALSE	FALSE						FALSE
19-Aug-05	10:30	Regina	Washington County	8	8	45.07945889	-92.86236333	TRUE	TRUE	24	45.077	-92.863	TRUE	Call made south of intersection, not east	TRUE				FALSE	FALSE						FALSE
19-Aug-05	10:37	Mike	Washington County	9	9	45.08511694	-92.92415972	TRUE	TRUE	24	45.085	-92.924	TRUE		TRUE				FALSE	FALSE						FALSE
19-Aug-05	11:23	Natasha	Anoka County	9	9	45.15689361	-93.16282861	TRUE	TRUE	8	45.156	-93.162	TRUE		TRUE				FALSE	FALSE						FALSE
19-Aug-05	11:31	Regina	Anoka County	8	8	45.19626	-93.16247917	TRUE	TRUE	8	45.196	-93.162	TRUE	Forgot to enter yes for callback number provided - rtk	TRUE				FALSE	FALSE						FALSE
19-Aug-05	15:40	Susan	Washington County	181	1	44.90941722	-92.96766	TRUE	TRUE	24	44.909	-92.967	TRUE		TRUE				FALSE	FALSE						FALSE

Appendix C:

Data Summaries for FOT Data Routing Performance

Week	Dates	Successful Call Deliveries			Total Failures	Average Delivery Time (Seconds)
		AACN	CAN	SOS		
19	2004.09.27-to-2004.10.03	0	4	21	0	0.76
20	2004.10.04-to-2004.10.10	0	4	31	0	0.91
21	2004.10.11-to-2004.10.17	0	1	32	0	1.00
22	2004.10.18-to-2004.10.24	1	2	37	0	0.80
23	2004.10.25-to-2004.10.31	0	11	27	0	0.79
24	2004.11.01-to-2004.11.07	0	5	19	0	0.71
25	2004.11.08-to-2004.11.14	0	6	40	0	0.85
26	2004.11.15-to-2004.11.21	1	2	40	0	0.77
27	2004.11.22-to-2004.11.28	0	7	21	0	23.25
28	2004.11.29-to-2004.12.05	1	0	21	0	0.64
29	2004.12.06-to-2004.12.12					
30	2004.12.13-to-2004.12.19	0	0	36	0	0.89
31	2004.12.20-to-2004.12.26	0	5	33	0	0.84
32	2004.12.27-to-2005.01.02	1	6	32	0	0.82
33	2005.01.03-to-2005.01.09	0	7	26	0	0.91
34	2005.01.10-to-2005.01.16	0	2	36	0	0.71
35	2005.01.17-to-2005.01.23	0	5	36	0	0.80
36	2005.01.24-to-2005.01.30	1	4	22	0	0.93
37	2005.01.31-to-2005.02.06	0	0	37	0	0.81
38	2005.02.07-to-2005.02.13	0	3	21	0	0.96
39	2005.02.14-to-2005.02.20	0	3	26	0	0.86
40	2005.02.21-to-2005.02.27	0	1	29	0	0.77
41	2005.02.28-to-2005.03.06	0	0	25	0	0.84
42	2005.03.07-to-2005.03.13	1	0	30	0	0.81
43	2005.03.14-to-2005.03.20	0	5	22	0	0.96
44	2005.03.21-to-2005.03.27	1	2	19	0	0.91
45	2005.03.28-to-2005.04.03	0	1	27	0	0.75
46	2005.04.04-to-2005.04.10	0	1	30	0	0.84
47	2005.04.11-to-2005.04.17	1	2	25	0	0.79
48	2005.04.18-to-2005.04.24	0	0	15	14	0.80
49	2005.04.25-to-2005.05.01	0	0	0	36	0.00
50	2005.05.02-to-2005.05.08					
51	2005.05.09-to-2005.05.15					
52	2005.05.16-to-2005.05.22	1	2	36	0	0.82
53	2005.05.23-to-2005.05.29	0	1	21	0	0.91
54	2005.05.30-to-2005.06.05	3	5	40	0	0.90
55	2005.06.06-to-2005.06.12					
56	2005.06.13-to-2005.06.19					
57	2005.06.20-to-2005.06.26	0	3	38	0	0.83
58	2005.06.27-to-2005.07.03	0	4	32	0	1.64
59	2005.07.04-to-2005.07.10	0	4	41	0	0.76
60	2005.07.11-to-2005.07.17	1	2	22	0	0.84
61	2005.07.18-to-2005.07.24	1	15	23	0	0.79
62	2005.07.25-to-2005.07.31	0	11	30	0	0.85
63	2005.08.01-to-2005.08.07	3	1	46	0	0.78
64	2005.08.08-to-2005.08.14					
65	2005.08.15-to-2005.08.21	0	2	0	0	1.00
66	2005.08.22-to-2005.08.28	0	1	0	0	1.00
67	2005.08.29-to-2005.09.04	0	5	0	0	0.60