Mayday/9-1-1 Field Operational Test (FOT) Design Report

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Prepared for:

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1 Introduction

Within the United States, there are significant, well-acknowledged challenges in routing and delivering Telematics Service Provider (TSP) emergency calls, and associated vehicle location and crash data information, across the nation to the appropriate local Public Safety Answering Points (PSAPs) using the local, native 9-1-1 networks. The 9-1-1 networks are local, disconnected from each other, and are not coordinated at a national level. Telematics calls must traverse long distances, far from the location of the emergency, to the national, centrally located Telematics Call Center (TCC) of the TSP. Once at the TCC, there is no existing, effective way to route these calls back to the relevant, local 9-1-1 network as an emergency call. Today, the TSP calls are routed via the Public Switched Telephone Network (PSTN) to an administrative line at the appropriate PSAP. This is accomplished by the TCC using a lookup table for these telephone numbers in a database that must be kept up to date. Since these calls come in on the administrative line, the PSAP may not give them the same priority as normal arriving 9-1-1 calls. Since these calls are PSTN voice only, many of the data features associated with 9-1-1 networks interconnecting to wireless and wireline networks are not available between the TCC and PSAPs. All of the data information must be provided to the PSAP operator verbally which can lead to mistakes and delays. The TSP Emergency Call Routing Service (TSPECRS) Concept of Operations provides more details on this issue and the type of information and data that the TSPs wish to send to the PSAPs [1]

In addition to the basic 9-1-1 data/information related to call back number, vehicle location, and vehicle identification, the TSPs are able to send to the TCC various crash data during an emergency call. Telematics emergency calls can be of three types: emergency-key-press calls, Automatic Crash Notification (ACN) calls and Advanced Automatic Crash Notification (AACN) calls. Emergency-key-press calls are also known as SOS calls. ACN calls are also known as airbag calls. Further details are in Concept of Operations Report [1].

The TSP Emergency Call Routing Service (TSPECRS) System Specification [2] specifies the architecture, interfaces/protocol and system requirements to facilitate routing of a TSP emergency call to the appropriate 9-1-1 network and PSAP, by utilizing the Wireless Service Provider (WSP) network. TSPECRS allows a TCC to make TSP emergency calls via the wireless network (and the PSTN), and make them appear as wireless E9-1-1 Phase 2 calls to the PSAPs. In addition, the TSPECRS System Specification describes procedures that would facilitate transmission of TSP data to the PSAPs via the signaling network of the WSP. This solution relies on the ongoing partnership of TSPs with WSPs to leverage existing wireless network resources with special enhancements for TSPECRS. TSPECRS specific enhancements are also required at the PSAPs and in the 9-1-1 databases to retrieve Telematics vehicle crash data from the TSPs to allow display on PSAP screens.

This document outlines the architecture, network connectivity, lab facilities and test procedures used to demonstrate and test TSPECRS. This effort and field testing was done under an SAIC contract with the State of Minnesota, called “Voice Routing for Mayday Field Operational Test,” and contract number SC # ONS02807. The overall Mayday Field Operational Test also includes testing on the data routing that is possible from a TSP and a separate series of reports are available for that portion of the test [10],[11]. The state of Minnesota received the sponsorship and funding for this program from the United States Department of Transportation – ITS Joint Program Office – Public Safety Program and National Highway Traffic Safety Administration – Emergency Medical Services Division. In particular, SAIC and Telcordia teamed with the Minnesota Department of Transportation (MNDOT) and OnStar to set up this Mayday/9-1-1 Field Operational Test (FOT) and perform the testing. In addition, this team was supported by Qwest, Hutchinson Telephone, Intrado and Independent Emergency Services (IES), providing connectivity and 9-1-1 service access, including access to twenty-two (22) PSAPs. Further, IES enhanced their 9-1-1 systems to accept additional AACN information sent to their PSAPs. This team also coordinated with Battelle, which was responsible for the evaluation of the voice routing capabilities of the Mayday/9-1-1 FOT, and sponsored by USDOT ITS-Joint program Office, Public Safety Program. In particular, the team provided input and feedback to Battelle in the development of the “Detailed Evaluation Plan,” [3] and coordinated efforts during the actual testing and evaluation phase. Additional documentation by this operational team and the evaluation team provides the FOT test results, evaluation, lessons learned and path forward. [4][5].

The following subsections detail the document purpose, scope, intended audience, document organization, and definitions.

1.1 Purpose

This document describes a proof of concept demonstration environment to support the Field Operational Test (FOT) for the TSPECRS voice routing functionality, as described in reference [2]. This document provides a description of the proposed architecture for TSPECRS, and modifications specific to this demonstration, and test procedures, used for the FOT and subsequent evaluation. The TSPECRS System Specification is a basis for this document and corresponding FOT efforts [2]. As such throughout the remainder of this document, the FOT will be referred to as the Mayday/9-1-1 FOT. In particular, the following is included in this document:

- TSPECRS network reference architecture,
- Sample TSPECRS call flow scenario,
- Description of the prototype lab environment to demonstrate, test and evaluate TSPECRS functionality,
- Network connectivity between all system elements, including 9-1-1 networks,
- Overview of the Mayday/9-1-1 FOT test plan, schedule and data gathered.

This document supports the evaluation process of the TSPECRS solution. A companion document called “Mayday/9-1-1 Field Operations Test Results and Path Forward,” provides information and detail on the Mayday/9-1-1 FOT results and path forward [4]. The FOT evaluation results are described in “Final Report: Mayday/9-1-1 FOT Analysis” developed by Battelle [5]. The document “Test Plan: Mayday/9-1-1 Field Operations Test Independent Testing of Voice Routing Functions,” authored by Battelle, lays out the evaluation and acceptance test plan, including the supporting statistical analysis to determine the success of the FOT demonstration[3].

1.2 Scope

This document provides an overview of the TSPECRS System Specification, and detailed description of the demonstration/test environment, and testing to be performed. The network operations and aspects of TSPECRS are beyond the scope of this Specification and are not of concern for this FOT.

1.3 Intended Audience

The intended audience of this document or parts thereof includes:

- Minnesota Department of Transportation (MNDOT)

- United States Department of Transportation (USDOT) ITS Joint Program Office – Public Safety Program
- National Highway Traffic Safety Administration (NHTSA) – Emergency Medical Services Division
- Telecom Infrastructure Equipment Vendors
- Telematics Service Providers
- Wireline and Wireless Carriers
- 9-1-1 Service Providers

1.4 Relationship to Other Documents

This document is based on the TSPECRS System Specification. This document references the evaluation and acceptance test plan developed by the government evaluation team headed by Battelle, and is a companion document to a test results document [3][4].

The data portion of the Mayday/9-1-1 Project has corresponding documentation in the following two documents: 1) Mayday/9-1-1 Field Operational Test Data Routing Concept of Operations Report [10] and 2) Mayday/9-1-1 Field Operational Test Data Routing Project Final Report [11].

1.5 Document Organization

The organization of the remainder of this document is as follows:

- **Section 2** provides the overview of the TSPECRS architecture and gives an example of a successful call flow.
- **Section 3** provides the network connectivity and prototype lab environment for Mayday/9-1-1 FOT testing.
- **Section 4** provides a description of FOT testing performed, schedule, and sample data collected.
- **Section 5** provides the Reference List.
- **Appendix A** provides the expansion of the acronyms used.
- **Appendix B** provides the XML Schema for the data interface between OnStar and Telcordia systems.
- **Appendix C** provides a model call center and operations environment.
- **Appendix D** provides detailed system sample call messages.

1.6 Acknowledgements

The Minnesota Department of Transportation gratefully acknowledges the invaluable contributions of the following individuals and organizations. Without their generous donation of time, experience, and expertise, the success of this project would not have been possible:

- Qwest: Patrick Gould, James Carroll, Winifred Wood, Nancy Brown
- Intrado: Ken Van Haute, Patrick Hoover
- Independent Emergency Services: Paul Mraz, Rick Morrow

- OnStar: Jasmin Jijina, Chris Oesterling
- Minnesota Department of Public Safety:: Jim Beutelspacher

1.7 Definitions

This section provides the definition of key terms used in the document. The definitions are intended to clarify the meaning of the terms.

- **Automatic Location Identification (ALI)** – The ALI refers to the automatic display at the PSAP of the caller's telephone number, the address/location of the telephone and supplementary emergency services information. This term is also used for the set of ALI records residing on a computer system database which is accessed by the PSAP to retrieve the records.
- **Home Location Register (HLR)** – The HLR is the location register to which a Telematics Mobile Station (TMS) user identity is assigned for record purposes, such as subscriber information (e.g. Electronic Serial Number (ESN), Mobile Directory Number (MDN), Profile Information, current Location, and Authorization Period).
- **Mobile Position Center (MPC)** – The MPC serves as the point of interface to the wireless network for the position determination network. The MPC serves as the entity that retrieves, forwards, stores and controls position information within the position network. It can select the Position Determination Entities (PDE) to use in position determination and forwards the position estimate to the requesting entity (e.g., ALI) or stores it for subsequent retrieval. The MPC may restrict access to position information for a Telematics Mobile Station (TMS) (e.g., require that the TMS be engaged in an emergency call or release position information to authorized entities). The MPC may use the services of an external Coordinate Routing Database (CRDB) that provides a translation between a given position, expressed as latitude and longitude, and a string of digits identifying an Emergency Services Zone (ESZ) or may perform this function internally.
- **Position Determining Entity (PDE) –** The PDE facilitates determination of the geographical position of a Mobile Station (MS). Multiple PDEs may serve the coverage area of an MPC and multiple PDEs may serve the same coverage area of an MPC utilizing different position determining technologies. A PDE will not be involved in the initial position determination of a TMS since the initial position information is provided by the TCC via the T-MSC, but may be involved in the updated position determination of a TMS.
- **Public Switched Telephone Network (PSTN)** – PSTN is the collection of interconnected systems operated by the various telephone companies and administrations (Telcos and PTTs) around the world. PSTN, in this document, refers to the fixed-line telephone network. End Office (EO) switches in the PSTN connect to the end user customer.
- **Public Safety Answering Point (PSAP)** – A PSAP is an emergency services network element that is responsible for answering 9-1-1 emergency calls.
- **Selective Router (SR)** – A SR or E9-1-1 Tandem is an emergency services network switching element that is responsible for routing incoming emergency calls to the appropriate PSAP, and may be responsible for other functions, such as redirecting calls from a primary PSAP to a secondary PSAP.
- **Selective Routing Database (SRDB)** – The SRDB is the routing table database that contains telephone number, Emergency Services Routing Digits (ESRD) or Emergency Services Routing Key

(ESRK) to Emergency Service Number (ESN) relationships, which determines the SR routing of 9-1-1 calls. An ESN is a three to five digit number representing a unique combination of emergency service agencies (Law Enforcement, Fire, and Emergency Medical Service) designated to serve a specific range of addresses within a particular geographical area, or Emergency Service Zone (ESZ). The ESN facilitates selective routing and selective transfer, if required, to the appropriate PSAP and the dispatching of one or more appropriate emergency service agencies (Police, Fire, Medical).

- **Serving MSC (S-MSC)/Visitor Location Register (VLR)** – A S-MSC in the Serving WSP network provides service to the TMS. The VLR is the location register other than the HLR used by the S-MSC to retrieve information for handling of calls to or from a visiting mobile. In most implementations, a VLR is integrated into an MSC.
- **Serving Wireless Service Provider (WSP)** – The term Serving WSP refers to a WSP that is currently providing service to the TMS. The Serving and Home WSPs of a TMS may be different WSPs.
- **Tandem MSC (T-MSC)** – The T-MSC, in the context of TSPECRS, provides specialized switching and signaling functions for completing TSPECRS calls between the TCC and the PSAP via the serving WSP network. The T-MSC has a unique data link from/to the TCC which allows receipt of information on the TMS and the sending of calling information to facilitate a call from the TCC.
- **Telematics** – Telematics refers to the communication of information to aid automobiles or their occupants.
- **Telematics call** – A Telematics call is a call from a TMS to the TCC.
- **Telematics Mobile Station (TMS)** – The TMS refers to a vehicle equipped with Telematics equipment and used to make Telematics calls.
- **Telematics Service Provider (TSP) –** The TSP provides Telematics services.
- **TSP Call Center (TCC)** – The TCC is a national or a regional answering point for Telematics calls. The TCC receives a Telematics call from TMS and makes an outgoing TSPECRS call to the PSAP that service the location of the TMS. The TCC is connected to an End Office (EO) in the PSTN that serves the TCC, and connects to the T-MSC. The TCC has a data link to the T-MSC. For the FOT, the TCC function was provided by OnStar, that is, the OnStar Call Center (OCC).
- **TSPECRS call** – The TSPECRS call refers to the Three-Way Call (3WC) leg, or call segment, from the TCC through the Serving WSP, SR, and to the PSAP.

2 Network Architecture

This section shows the TSPECRS network architecture and the enhancements to the network architecture including the network entities and associated interfaces.

2.1 TSPECRS Network Architecture

Figure 2-1 illustrates the TSPECRS architecture as specified in the TSPECRS System Specification, with the addition of the National Emergency Data Router (NEDR) to facilitate connectivity between the TCC(s) and ALI Databases (DBs) for crash data transfer. Note that the SRs, SRDBs, PSAPs and ALI DBs constitute the 9-1-1 network within a region. This 9-1-1 network is connected to the WSP network by 9-1-1 trunks connected to each S-MSC and by E2 data interfaces to the MPC of the WSP. All interfaces in the architecture are based on existing standards for 9-1-1 and wireless networks. However, as shown in the TSPECRS System Specification, all wireless system interfaces, protocols and procedures require a small enhancement to support TSPECRS. In addition, the E2 interface and/or the NEDR interfaces require an enhancement to transport the AACN information. The TCC to T-MSC data interface is new to the industry. The NEDR and its interfaces to the ALI and TCC is also new to the industry.

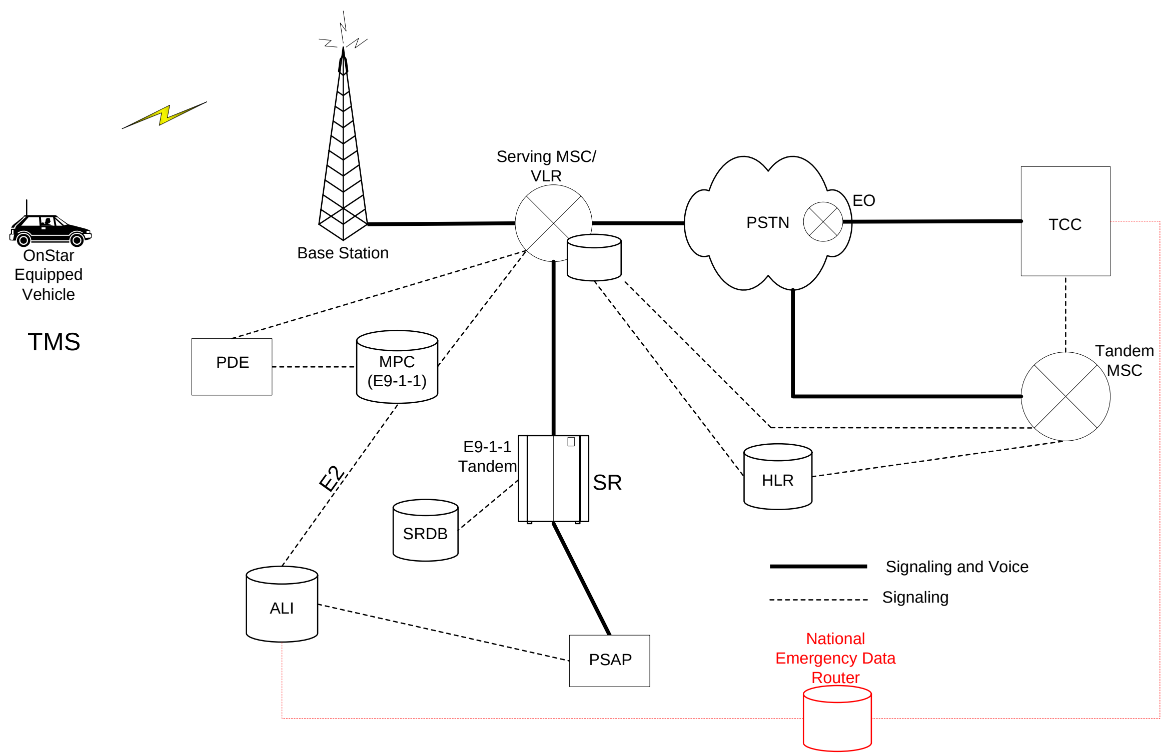


Figure 2-1 TSPECRS Architecture

2.2 Example Successful TSPECRS Scenario

TSPECRS call to a PSAP used Non-call Associated Signaling (NCAS) methodology for the FOT demonstration and Voice Routing Evaluation.

Figure 2-2 illustrates this TSPECRS message call flow. This scenario describes a successful TSPECRS call to a PSAP. The wireless network uses NCAS methodology for 9-1-1 call processing. Other example call flows are shown in the TSPECRS System Specification. Note that this figure also shows where signaling enhancements are required.

a. A TMS within an OnStar Equipped Vehicle (OEV) originates a Telematics call to the OCC (For the Demonstration, the OnStar Call Center (OCC) was the Telematics Call Center (TCC) used).

b. The Serving MSC completes the Telematics call to the OCC via the Serving WSP and PSTN.

c. The TMS over the Telematics call transmits data including Station ID (STID), vehicle's location (latitude and longitude), and AACN information when applicable. Other information such as the unit's Mobile Station ID (MSID), Mobile Identification Number (MIN) (or International Mobile Subscriber Identity (IMSI)), Mobile Directory Number (MDN), and Electronic Serial Number (ESN) is retrieved from the TCC back-end.

d. Once the TMS data transfer to the TCC is successful, the TCC switches the Telematics call to voice mode. A OCC advisor answers the Telematics call.

e. The caller, associated with the TMS, and the OCC advisor converse. The OCC advisor verifies that the call constitutes a genuine 9-1-1 emergency, and that the caller wishes that the advisor conference in a PSAP.

f. The OCC advisor receiving the emergency call from the distressed vehicle initiates an outbound data burst, over the data link, followed by a PSTN call setup request to the T-MSC. The data burst sent over the data connection, between the T-MSC and OCC, contains the latitude/longitude, MSID (MIN/IMSI), MDN, ESN and SID of the incoming emergency call from the TMS. The data burst also carries a special call setup request unique to the TSPECRS. Additionally, optional ACN data can be sent to the NEDR (not shown in Figure 2-2).

g. The T-MSC caches the information received. Also, the NEDR stores the received information and, later on request, sends the AACN data to the ALI and starts the ACN Timer (ACNT). The ALI Database also caches the crash information.

h. The T-MSC returns a Temporary Local Directory Number (TLDN) to the OCC in a data burst.

i. The TCC advisor initiates a 3Way-Call (3WC) to the TLDN on the T-MSC, and to the TMS. The call is setup to the T-MSC via the EO serving the OCC and the PSTN.

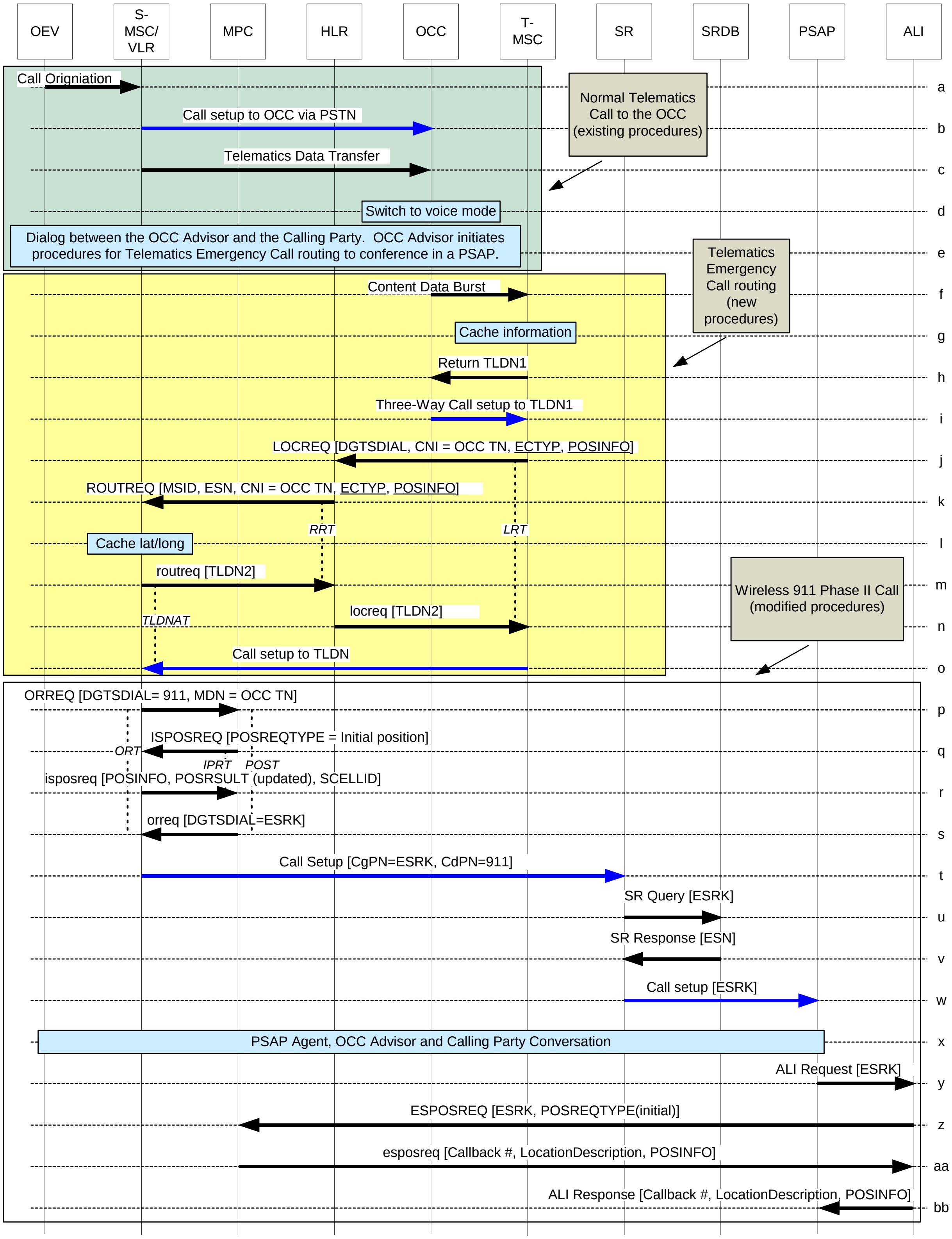


Figure 2-2: Successful TSPECRS Call – Wireless Network Uses NCAS

j. The T-MSC uses the MDN of the TMS to launch a LocationRequest INVOKE (LOCREQ) message to the HLR associated with the TMS. The T-MSC includes *EmergencyCallType* (*ECTYP*) and *PositionInformation* (*POSINFO*) parameters in the LOCREQ message. The *LOCREQ* may also include the OCC callback number as the Calling Number Identification (*CNI*). The MDN of the TMS is used in the Digits (Dialed) (*DGTSDIAL*) parameter. The ECTYP parameter indicates that this is a TSPECRS call. The T-MSC starts the Location Request Timer (LRT).

k. The HLR receives the LOCREQ message and launches a RoutingRequest INVOKE (ROUTREQ) message to the S-MSC/VLR. The ROUTREQ message includes the *ECTYP* and the *POSINFO* parameters. The HLR starts the Routing Request Timer (RRT).

   Note: If the call is handed off to another Serving MSC, the ROUTREQ message will be sent to the Anchor MSC[1]. It is irrelevant whether the TMS has subsequently handed off or not since the responsibility for setting up the call to the PSAP remains in the anchor system.

l. The S-MSC/VLR determines that this is a TSPECRS call through the presence of the *ECTYP* parameter. The S-MSC/VLR stores the contents of the *POSINFO* parameter along with the TMS callback number, MIN/IMSI and ESN of the TMS.

m. The S-MSC/VLR consults its internal data structures to determine that the TMS is already engaged in a call on this MSC (since the TMS is on the Telematics call with the TCC advisor). The S-MSC/VLR still assigns a TLDN for the TSPECRS call and returns the TLDN in the RoutingRequest RETURN RESULT (routreq) message to the HLR. The S-MSC/VLR starts the TLDN Association Timer (TLDNAT).

n. The HLR stops the RRT and sends a LocationRequest RETURN RESULT (locreq) message to the T-MSC. The TLDN is provided in the *TerminationList* (*TERMLIST*) parameter.

o. The T-MSC stops the LRT upon receipt of the locreq message. The T-MSC sets up the call to the S-MSC using TLDN. The call setup signaling includes the TLDN as the called party number and the TCC callback number as the calling party number.

p. The S-MSC/VLR receives the call from the T-MSC. The S-MSC/VLR stops the TLDNAT. The S-MSC launches an OriginationRequest INVOKE (ORREQ) message to the MPC that serves the S-MSC. The *MobileInformation* (*MOBINFO*) parameter set is not included in the ORREQ message. The S-MSC includes the TMS callback number in the *MobileDirectoryNumber* (*MDN*) parameter. The ORREQ message includes the *BillingID* (*BILLID*) parameter and may also include the *MobilePositionCapability* (*MPCAP*) parameter if this information is available from the TMS profile. The S-MSC/VLR sets the value of *Digits* (*Dialed*) parameter to digits 911. The S-MSC starts the Origination Request Timer (ORT). The MPC starts the Position Timer (POST).

   Note: The S-MSC maintains two calls references since there are two separate calls involving the S-MSC. One of the calls is between the S-MSC and the TCC and the other is between the T-MSC and the S-MSC.

[1] The MSC that is the first to assign a traffic channel to a call on origination or termination is called the Anchor MSC. For the duration of this call, this MSC is the anchor (fixed) point in the event that the TMS is handed off to other MSCs.

q. The MPC sends an InterSystemPositionRequest INVOKE (`ISPOSREQ`) message to the S-MSC/VLR and starts the Intersystem Position Request Timer (IPRT).

r. The S-MSC/VLR responds to the MPC with InterSystemPositionRequest RETURN RESULT (`isposreq`) message, which includes the *POSINFO* parameter. The `isposreq` message also includes the *ServingCellID* parameter.

s. The MPC stops the IPRT and the POST. The MPC returns an `orreq` message to the S-MSC/VLR with the ESRK (Emergency Services Routing Key).

t. The S-MSC/VLR stops the ORT. The S-MSC/VLR sets up the call to a SR, using the ESRK as the Calling Party Number and 911 as the Called Number. The S-MSC/VLR then joins the TLDN call connection from the TCC to the SR call connection.

u. The SR queries the SRDB with the ESRK

v. The SRDB returns the ESN.

w. The SR routes the call to the indicated PSAP, and includes the ESRK in the call set-up signaling.

x. The PSAP Agent communicates with the OCC advisor.

y. The PSAP sends a request to the ALI DB for information concerning the ESRK received with the call.

z. The ALI DB sends a request over the E2 interface to the MPC, requesting information on the caller with the ESRK, including location.

aa. The MPC returns information on the location and call back number for the TSPECRS call.

bb. Based on the response from the MPC, the ALI DB provides location information to the PSAP in a posinfo message. Optionally, the ALI DB can provide ACN data back to the PSAP.

Note 1: The PSAP agent may verbally request the TCC advisor to provide the TMS location information. The TCC advisor will have to switch the Telematics call to data mode and probe the TMS to provide its updated location information. Once the updated TMS location information is received, it can be provided to the ALI via another ACN Directive message. Alternatively, the first ACN directive message can provide the case ID and the OCC callback number to the ALI, which can be used by the ALI to query the NEDR for updated TMS location information.

Note 2: In the FOT, the NEDR was logically associated with the T-MSC signaling/control logic. As such, the original TCC to T-MSC data burst included the ACN information. In addition, the ACN information was sent over the E2 interface to the ALI DB on request from the PSAP. The TSPECRS System Specification shows a direct link between the TCC and ALI DBs to transfer the ACN, using an ACN Directive message and a corresponding acknowledgement message. The standards bodies may have to revisit these NEDR concept and interfaces.

3 Prototype Lab and Network Configuration for Mayday/9-1-1 Testing

This section of the document describes the full Mayday/9-1-1 FOT test configuration, in addition to more details on the message flows for a test call. In the first subsection, an overview of the entire system is provided, in addition to test call flows. In each of the subsequent subsections, a component of the configuration is described, in addition to the network connectivity.

3.1 Lab and Network Test Configuration

Figure 3-1 illustrates the full test configuration for the Mayday/9-1-1 FOT. As shown, the test configuration consists of four segments, combining real live networks and laboratory systems:

- WSP and PSTN, supporting the call and data interactions with the TMS in the Mayday/9-1-1 Vehicle TEST Unit;
- OnStar Call Center Lab;
- Telcordia Lab containing the Mayday/9-1-1 prototype wireless network, that correspond to the (enhanced) WSP;
- Qwest and IES 9-1-1 networks in Minnesota, consisting of SRs, ALI DBs and PSAPs.

The OnStar lab connects to the Telcordia lab via the PSTN for voice calls and the internet for data transfer. The Telcordia lab connects to the Minnesota 9-1-1 networks via a T-1 transmission facility which contains the voice and data circuits.

The Telcordia lab prototype reflects the wireless network elements of a WSP, affected by the TSPECRS, including the MPC. In particular, the lab combines real network switching elements (i.e., 5ESS switch) for the call routing and software systems (i.e., Network Services Test System (NSTS) and host computer) to simulate the signaling/control associated with the T-MSC, HLR, MPC and the multiple S-MSCs. Thus using AIN TCAP signaling for coordination, the combination of the switch and signaling/control software systems provide full MSC capabilities as relates to the TSPECRS needs. Different elements within the NSTS/host computer perform the signaling/control functions of the S-MSC/VLR, T-MSC, HLR and MPC. For the FOT, the NEDR function was logically implemented in the T-MSC signaling/control element, allowing the AACN data received from OnStar to be transferred to the ALI DBs via the E2 interfaces. The decision to use the Telcordia laboratory equipment to represent the enhanced WSP instead of the actual wireless network elements for TSPECRS was made based on two major considerations: 1) the cost of having equipment vendors develop the new capability for the MSCs, HLR, MPC and have these capabilities deployed in OnStar’s WSP network was beyond the level of available funding and 2) the time required to develop and deploy the service was beyond the desired time frame for the Mayday/9-1-1 FOT and demonstration.

Figure 3-2 shows a high level view of the call flow for the FOT demonstration. Figure 3-3 provides a detailed view of the message and signaling flow for a call during the demonstration, and between the test elements. In Figure 3-3, the first line marked “a”, indicates a call being made from the test vehicle to the OnStar Lab/Call Center – this call actually transverses the Wireless Service Provider’s (i.e., Verizon Wireless) network, and does not use a lab network until after reaching the OnStar lab.

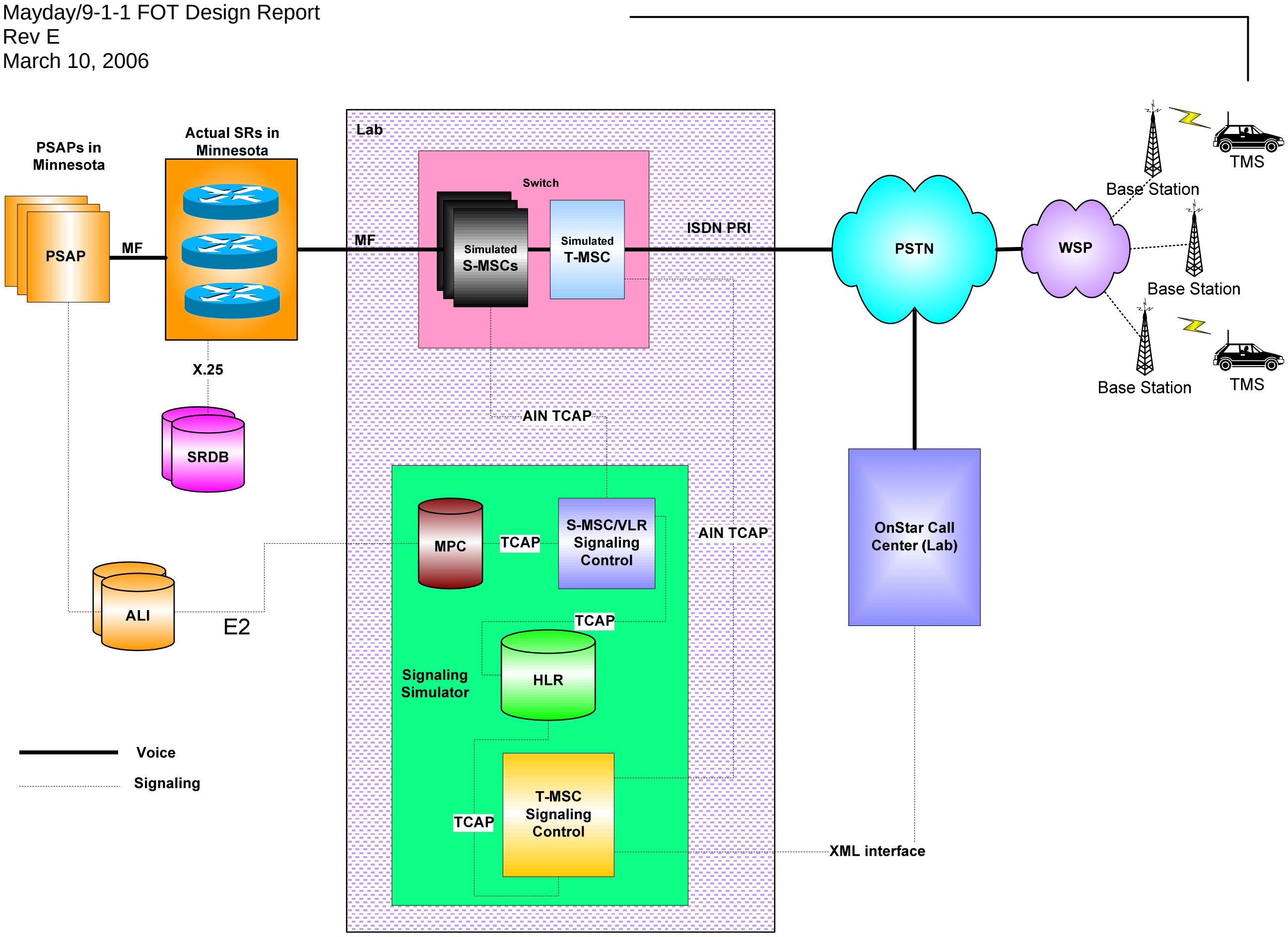


Figure 3-1 Mayday/9-1-1 FOT Test Configuration

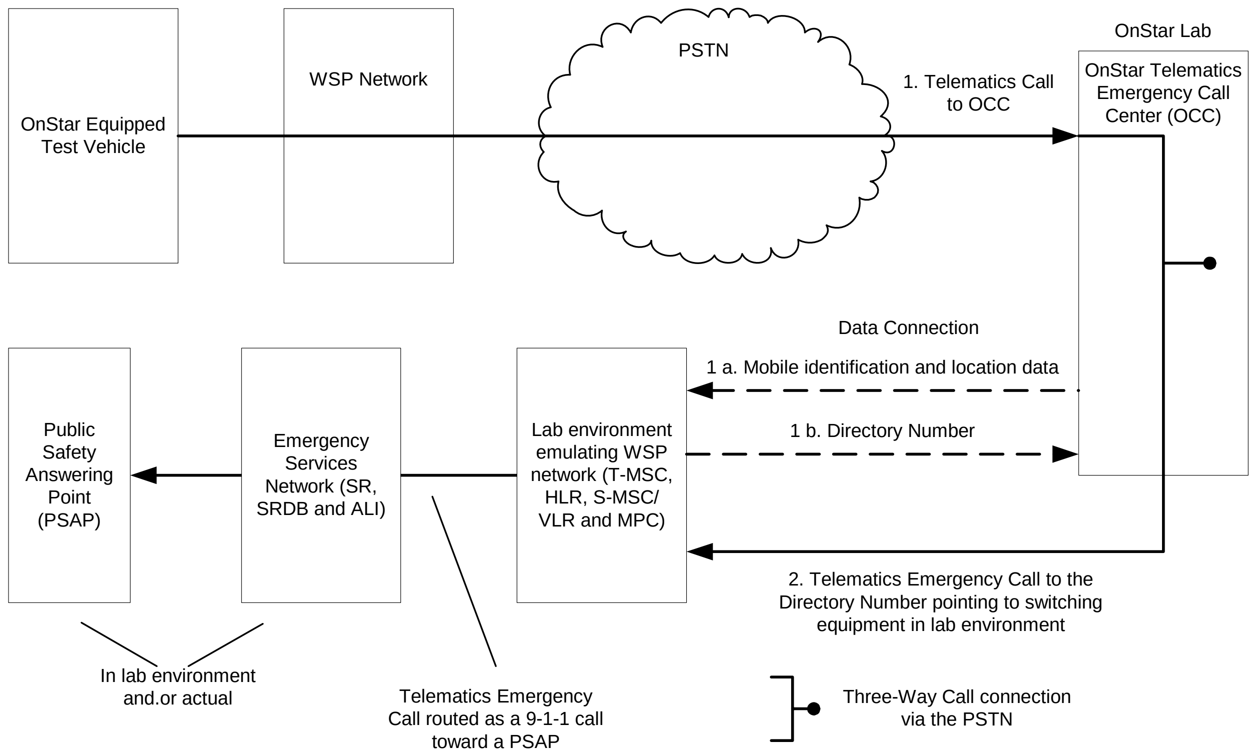
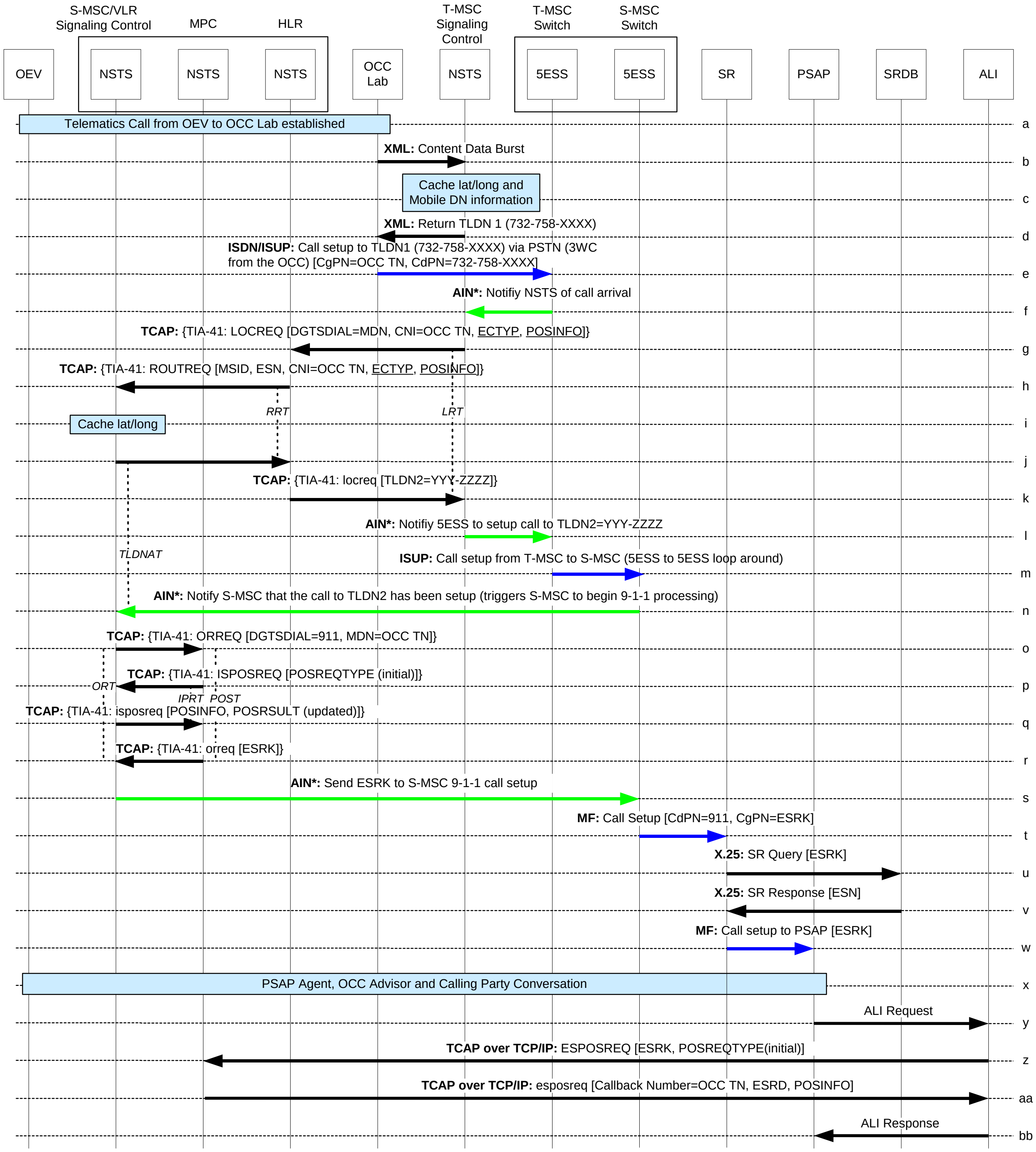


Figure 3-2 High Level Call Flow for Test Call



* AIN (TCAP) signaling only needed for the Demo   Note: Call setup with ISDN, ISUP and MF have multiple signaling messages associated with each arrow shown in the diagram

Figure 3-3 Detailed Call Flow for Test Call

3.2 Mayday/9-1-1 FOT Vehicle Test Unit

Mayday/9-1-1 FOT Vehicle Test Units were provided by OnStar. The portable test unit on the OnStar Equipped Vehicle (OEV) was designed to transmit the same information that a real installed unit would if the "SOS" button was pushed, an ACN event occurred, or an AACN event occurred. Part of the unit provided by OnStar is a computer that is used to control the scenario of interest for a particular test call. During the testing process, a vehicle operator (or test call initiator) drove to various serving areas of the selected PSAPs, deployed the test unit and initiated a test call. Figure 3-4 shows the portable test unit.

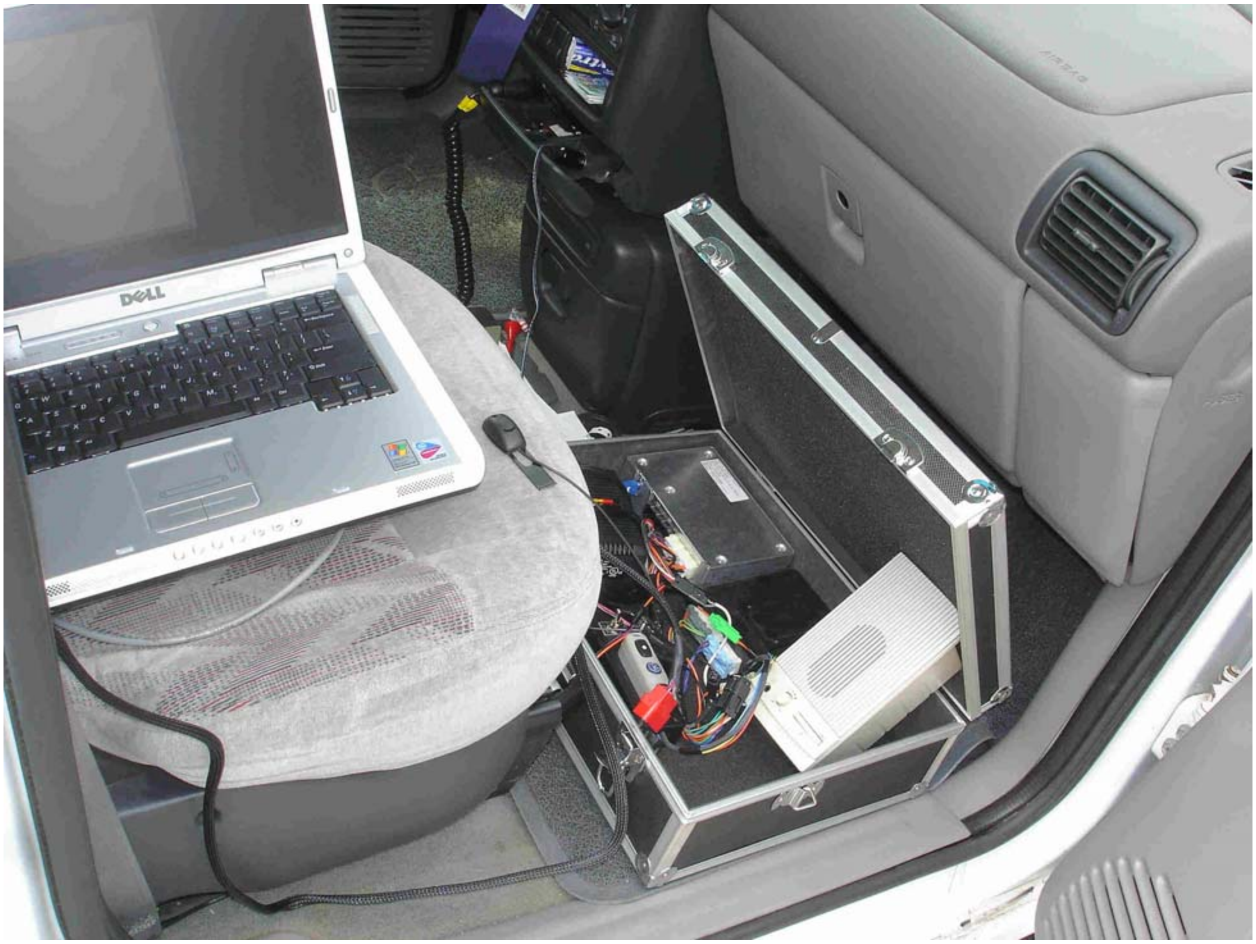


Figure 3-4 Portable OnStar Test Unit

3.3 Serving MSC

3.3.1 S-MSC TSPECRS Call Origination

For the FOT, the test call originated from a Mayday/9-1-1 FOT Vehicle Test Unit (or TMS), was routed through the MSCs of Verizon Wireless (the WSP) serving the region, and subsequently routed through the PSTN to the TCC in the OnStar lab. The actual wireless network was used, with no network modifications for this segment of the FOT call. Subsequent calls/connections, starting at the TCC and terminating on the PSAPs, relate to the new TSPECRS capabilities specified in [2] and simulated for the FOT and demonstration.

3.3.2 S-MSC TSPECRS Call Routing

For TSPECRS, the 9-1-1 calls are routed back to the S-MSC serving the TMS, and subsequently routed onto the local 9-1-1 network.

For the Mayday/9-1-1 FOT, the function of the Serving MSC for routing the calls was performed by a combination of a 5ESS switch and NSTS simulator in the Telcordia laboratory. The simulator performed the SS7 signaling using the wireless ANSI-41 protocol, and associated control functions. The 5ESS switch provided the voice switching and call routing. SS7 AIN TCAP signaling was used between the wireless simulator and the 5ESS switch to coordinate the call routing with the wireless processing, signaling and control. The 5ESS switch had four trunk groups to itself (loop around trunks) to simulate the connectivity between the T-MSC and four different S-MSCs (corresponding to the S-MSCs in the Verizon Wireless network). There were also three CAMA/MF trunk groups from the Telcordia 5ESS switch to the three Selective Routers in Minnesota (Minneapolis, Rochester and Hutchinson). Each of the CAMA trunk groups had two trunks to the SR. The simulated S-MSC had an SS7 signaling link into a Tekelec Eagle STP (in the Telcordia laboratory) for the signaling connectivity to the 5ESS (transport of AIN TCAP) and to the other wireless elements.

3.4 TSPECRS Telematics Call Center

For the FOT, a combination of OnStar's Laboratory and a live OnStar Call Center were used to model the TCC. The test call initially arrives at the OnStar Laboratory where a custom application receives the data from the Vehicle Test Unit. Upon receiving the data from the TMS in the test vehicle, the OnStar Lab application accesses a web service application at the T-MSC in Telcordia's laboratory. The OnStar TCC application sends the vehicle data to T-MSC in an XML format (schema is shown in Appendix B). The T-MSC application returns a 10 digit phone number (or TLDN) that is used to route the Mayday/9-1-1 FOT call to the simulated T-MSC at Telcordia. The call is then forwarded to the OnStar Call Center where an OnStar Emergency Advisor interacts with the test call initiator in the test vehicle. The voice call connection between the OnStar Call Center and the T-MSC is over the PSTN. The data link between the TCC at OnStar and the Telcordia T-MSC is via the internet (described in detail in sect 3.10). Appendix C shows a view of a model call center.

3.5 Tandem MSC

For the FOT, the function of the Tandem MSC (T-MSC) at Telcordia was performed by a combination of a 5ESS switch, a UNIX host and a simulator. The simulator performed the SS7 signaling using the ANSI-41 protocol, the UNIX host had a web service enabled to exchange XML data with the OnStar Laboratory; and the 5ESS switch provided the voice call switching. The TCC voice access to the T-MSC is via an ISDN Primary Rate Interface (PRI) connection to the PSTN (at the Red Bank, NJ, Verizon Central Office). Calls arrive on this PRI facility and are routed through the Telcordia lab network prior to being routed back to Minnesota and the appropriate Selective Router. The simulated T-MSC had an SS7 signaling link into a Tekelec Eagle STP, in the Telcordia lab, for the AIN TCAP interactions with the 5ESS and signaling to the other wireless elements.

While the NEDR was not physically represented in the FOT test bed, information that would normally have been sent to the NEDR was sent to the T-MSC over the XML data interface between Telcordia and OnStar systems. This information was passed to the application simulating the MPC and was available to be passed over the E2 interfaces to the ALI DBs. AACN information was passed over the E2 interface to a custom built application at the IES ALI DB. Three PSAPs and the ALI DB in the IES region were also enhanced to accept the AACN information.

3.6 Home Location Register

For the FOT, the Home Location Register (HLR) was simulated using NSTS simulator. The SS7 signaling messages exchanged between the HLR, the S-MSC/VLR and the T-MSC were formatted as described in the TSPECRS System Specification, which is an enhancement to the TIA/EIA/ANSI-41 standards. The simulated HLR had an SS7 signaling link into a Tekelec Eagle STP in the Telcordia lab for signaling connectivity to the other wireless elements.

3.7 Mobile Positioning Center (MPC)

For the FOT, the Mobile Positioning Center (MPC) was simulated using the NSTS simulator and a UNIX host. The UNIX host maintained the E2 interfaces to the ALI DBs, and the NSTS simulator processed ALI DB requests and exchanged SS7 signaling with the S-MSC. The signaling messages, exchanged between the MPC and the S-MSC, were formatted as described in the TSPECRS Specification which is an enhancement to the TIA/EIA/ANSI-41 standards. The signaling messages exchanged between the MPC and the ALI databases were formatted as described in the E2 interface documents provided by Qwest and IES [7],[9], which are based on NENA standards [6],[8]. The simulated MPC had an SS7 signaling link into the Tekelec Eagle STP, in the Telcordia lab, for the internal lab signaling interactions.

3.8 Selective Router

For the FOT, actual 9-1-1 Selective Routers (SRs) were used in Minnesota. Three SRs, two in the Qwest territory and one in the IES territory were selected for inclusion in the testing. Qwest is the major local exchange carrier. Independent Emergency Services (IES) provides 9-1-1 service to independent local exchange carriers that serve the more rural parts of Minnesota. The SRs in the Qwest territory were in Minneapolis and Rochester. The SR in the IES territory was in Hutchinson. All of the SRs were in-service Lucent 5ESS switches. For pre-FOT internal testing, an additional Selective Router (i.e., DMS 100/200) in the Telcordia lab was used at times to route to a lab PSAP. Figure 3-5 shows all of the SRs in Minnesota.

3.9 PSAPs

All PSAPs for the FOT test calls were live county or city PSAPs serving selected areas of Minnesota. In addition, IES and Telcordia had test PSAPs that were used for pre-FOT verification testing. Figure 3-5 shows the E9-1-1 network Selective Routers and county boundaries for the State of Minnesota. Note that outside of the Minneapolis/St Paul metropolitan area, most PSAPs in Minnesota are on a county basis. A select set of PSAPs were chosen to give a sample of both rural and urban PSAPs, and to provide a range of equipment types for connectivity.

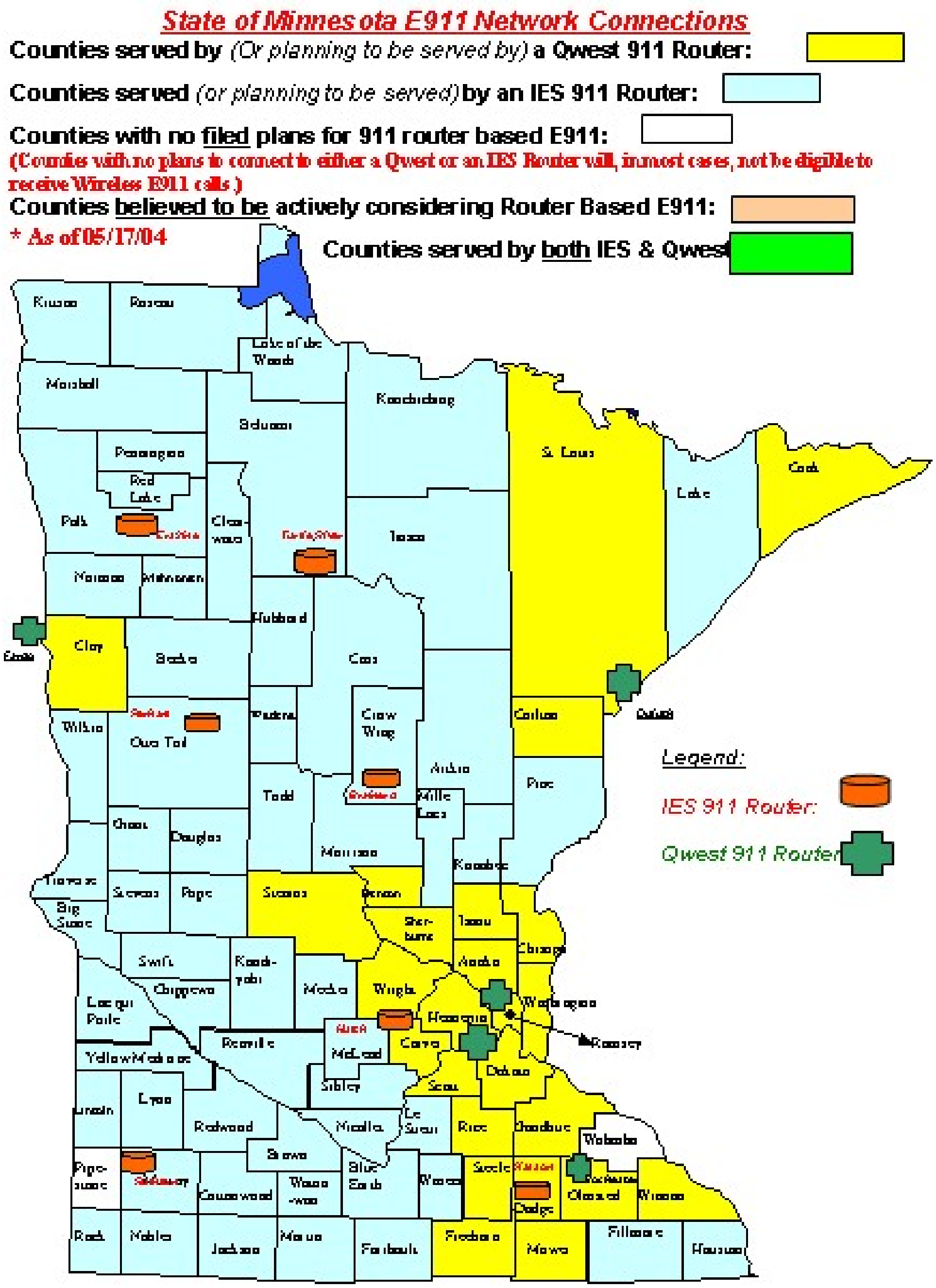


Figure 3-5 Minnesota E9-1-1 Network

3.9.1 IES Served PSAPs

The PSAPs in IES were:

- McLeod County,

- Meeker County,
- Kandiyohi County, and
- Renville County.

In addition to the normal E9-1-1 information such as lat/long, IES developed a special application in the ALI DB and three PSAPs to receive additional AACN data in the E2 message from the MPC, and display the additional crash data at the three PSAPs. For the FOT, the additional information was passed in the Location Description parameter, which is defined in the E2 standard, but using presently a non-standard coding of the XML contents, shown in Appendix B.

3.9.2 Qwest Served PSAPs

The PSAPs in Qwest territory were in two parts of Minnesota – Minneapolis and Rochester. The Minneapolis PSAPs were:

- Anoka County,
- Carver County,
- Dakota County,
- Hennepin County,
- Scott County,
- Washington County,
- Apple Valley City,
- Burnsville City,
- Eagan City,
- Eden Prairie City,
- Edina City,
- Lakeville City,
- Minneapolis City,
- St. Paul City and
- Minnetonka City.

The Rochester PSAPs were:

- Olmsted County,

- Steele County, and
- Mower County.

In addition, some Mayday/9-1-1 FOT test calls were forwarded to the Mayo Clinic Emergency Communications (secondary PSAP). The Qwest PSAPs were not enhanced for the FOT, but accepted the normal E9-1-1 information such as lat/long.

3.10 Network Connectivity

3.10.1 OnStar Lab to Telcordia Lab

The data connection between the OnStar TCC Lab and the T-MSC in the Telcordia Lab was via the public internet for the data transfer. A web service application at the T-MSC responded to requests from the OnStar TCC lab by providing a 10-digit phone number (TLDN) that was used by the OnStar Emergency Advisor to place the Mayday/9-1-1 FOT call to the T-MSC, that was destined to the SR and the appropriate PSAP. OnStar used the PSTN to set up a three-way call with the TMS and connect to the Telcordia switch for the voice call routing. The TLDN phone number provided back by Telcordia on the data link, allowed the OnStar TCC to voice connect to the 5ESS switch via the incoming Primary Rate Interface (PRI), leased from Verizon for the purposes of this FOT demonstration. The Telcordia Lab and OnStar lab data connection had routers configured to allow the OnStar nodes to access the Telcordia web service at the T-MSC, enabling the exchange of the necessary service information. In coordination with call set-up, the data link between the OnStar Lab and the Telcordia Lab was tested to ensure that the message exchange was reliable and met the message transport time performance needs for the FOT. Figure 3-5 shows the OnStar to Telcordia connection arrangements.

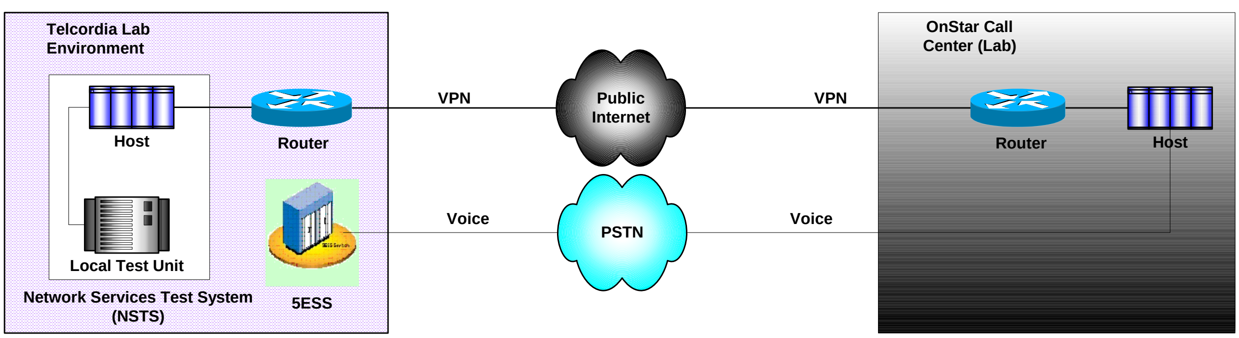


Figure 3-6 OnStar - Telcordia Connectivity

3.10.2 Telcordia Lab to Minnesota Selective Routers and ALI DBs

A T-1 transmission facility was leased from Qwest to connect the Telcordia Lab in Red Bank, NJ to a Qwest Point of Presence (POP) in Minneapolis, MN. From the T-1 POP in Minneapolis, nine DS0 circuits (connecting to the T-1 facility circuits) were leased (from Qwest and Hutchinson Telephone) to connect to the three SRs and three ALI Databases (DBs). There were two DS0 trunk circuits leased to each of the three SRs (at Minneapolis, Rochester and Hutchinson). There was one DS0 56 kbps data circuit leased to connect to each of three ALI DBs. The ALI DBs were located in Minneapolis, MN, Denver, CO, and Hutchinson, MN. The Minneapolis and Denver ALI DBs are a mated pair serving the Qwest 9-1-1 network in the Minnesota area of interest, and supported by Intrado. The Hutchinson ALI DB helped serve the 9-1-1 network in the IES territory. The DS0s connecting to the ALI DBs were used for data transport using the TCP/IP protocol. The E2 interface application protocol used the TCP/IP services for connectivity between the MPC and the ALI DBs. The E2 interface followed the NENA standard, but the interfaces were slightly different for Qwest and IES, in that the latter carried AACN data. (For the FOT, IES supported the Location Description Parameter in the E2 protocol to have non-standard XML AACN data enclosed.) The DSOs to the SRs were voice channels (i.e., 9-1-1 trunks) used to carry the emergency calls. These voice channels were CAMA trunks using MF signaling for the call set-up. The TSPECRS System Specification allows for either SS7 or MF trunk signaling, where SS7 is more forward-looking and evolvable. Although SS7 signaling could have been used for the trunk signaling, the in-band MF signaling was adequate for this FOT demo, in that proper information was sent and the extra signaling time delay was not significant for the FOT. SS7 was not used for the FOT due to the significant additional leasing expense and added complexity in the interconnection. The MF trunk signaling included the ESRK to allow the SR to route the call to the appropriate PSAP. Figures 3-6 and 3-7 show the Telcordia lab to the SRs and to ALI DBs connection arrangements.

All trunk and data circuits went through rigorous testing before acceptance of the leases, and use in the FOT. In support of the TSPECS FOT, the Minnesota Department of Public Safety made available a large set of ESRKs (or PANIs) for unique assignment to the PSAPs and provisioning of the corresponding SRs. In addition to the ESRK assignments, other data files were provided to Qwest and Intrado to facilitate the provisioning of the SRs and ALI DBs. In addition to the trunk testing to each of the SRs, all the E2 interfaces went through rigorous testing before full acceptance and use in the FOT. After all the circuits were connected and systems provisioned, end-to-end tests were done to each of the PSAPs to check for correct call routing and data transfer.

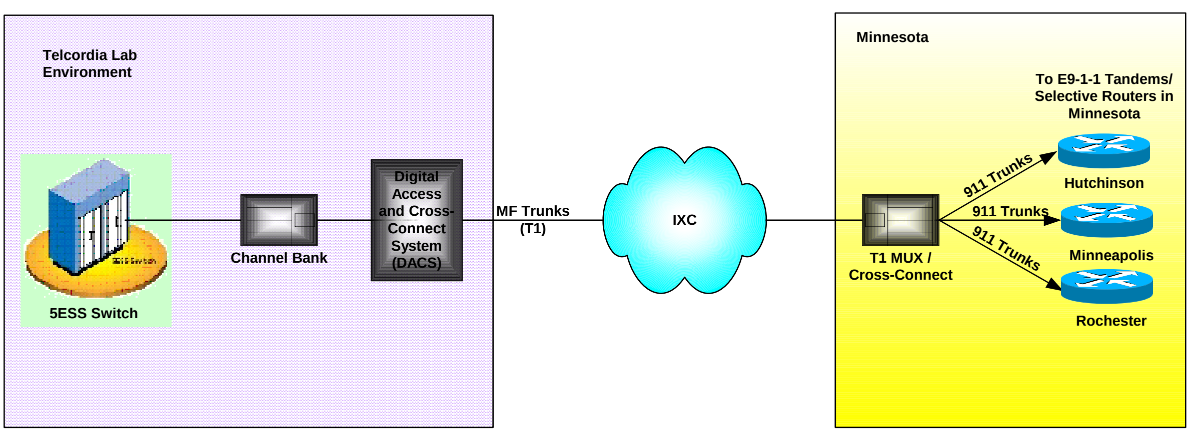


Figure 3-7 Telcordia Lab to Minnesota SR Connectivity

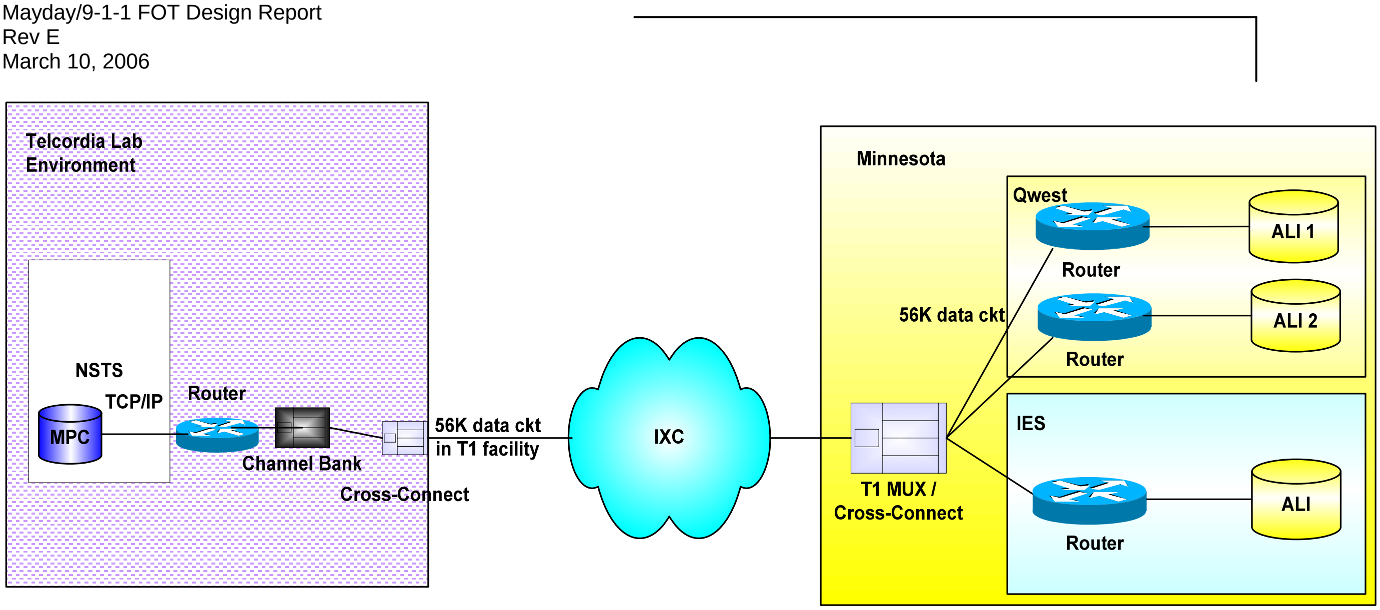


Figure 3-8 Telcordia Lab to ALI DB Connectivity

4 FOT Testing

4.1 Evaluation Team

The USDOT hired Battelle (supported by the Melcher Group) to evaluate the performance of the Mayday/9-1-1 FOT. The USDOT and Mitretek provided oversight to the evaluating group and coordinated efforts with the FOT operational team. Representatives from these organizations are listed below:

- Laurie Flaherty, NHTSA – GOTM (Government Task Manager)
- Ted Smith, Mitretek – Mitretek Analyst (Support to GOTM)
- Jeff Jenq, Battelle – Evaluation Project Manager
- Jim Goerke, Melcher Group
- Robert Krile, Battelle

4.2 Test Plan

A detailed sequential acceptance test plan was developed by the evaluation team. The details of the acceptance test plan are documented in reference [3]. The focus of the acceptance test plan is to evaluate the voice routing functionality of the TSPECRS system, which automatically routes a TSP initiated emergency call as a native 9-1-1 call to the appropriate PSAP, and includes the sending of location information, call back number and so on. The first phase of the acceptance test plan requires 147 test calls to be evenly placed to the 22 selected PSAPs. If a sufficiently small number of call failures (one or less) are observed, the test is considered a success, and the FOT is complete. If two-to-four call failures are observed, the test results are inconclusive and an additional set of calls must be completed to validate the success or failure of the Mayday/9-1-1 FOT. The test plan allowed for up to two retest efforts if the results are inconclusive. If five or more Mayday/9-1-1 FOT call failures occur, then the FOT fails the Mayday/9-1-1 FOT validation test.

Although not the focus of the evaluation team, the automatic transport of the vehicle crash data (AACN) to the IES PSAPs was available for demonstration and evaluation. Also, at the end of the FOT evaluation, available operations and qualitative feedback from selected users and stakeholders was collected and analyzed. A final evaluation report is to be provided by Battelle's team.

The acceptance test plan documented the characteristics of a successful Mayday/9-1-1 FOT test call. However, there were certain conditions that were outside the control of the project team that could cause a test call to fail. For example, the T-1 transmission facility may fail and not allow the call to be completed. If a test call failed due to any condition that was outside the control of the project team, that test call would be repeated when the condition cleared or was corrected.

4.3 Selected PSAPs

The selected PSAPs are listed in section 3.9.

4.4 Data Collection

The Minnesota Department of Transportation, with the agreement of the evaluation team, selected test call sites in each of the geographic regions supported by the 22 selected PSAPs. Coordinating with the evaluation team, a data collection form was created to record the results of each test call. The testing procedure required that the test initiator drive to a selected location; deploy the Vehicle Test Unit's GPS antenna and wait two minutes to assure GPS and satellite reception; select the test scenario on the unit; and place a call. The call (and data) would reach the OnStar Call Center Lab; a discussion would take place with the OnStar Emergency Advisor; the call (and data) would be forwarded to the Telcordia T-MSC; and subsequently routed to the appropriate PSAP, based on the received location (Latitude and Longitude) of the vehicle. A discussion would take place between the test initiator and the PSAP attendant to ensure that the proper PSAP was reached, the proper Lat/Long was received, and the appropriate "Call Back Number" was received. The results of the conversation were recorded on the data collection form by the test initiator. The forms were aggregated on a daily basis, and then forwarded electronically to the evaluation team.

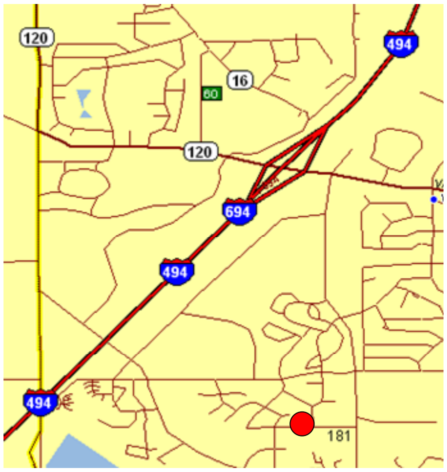
As a part of the test call process, the XML data sent from OnStar to the Telcordia Lab was saved in a date and time stamped file. These files were also forwarded to the evaluation team daily. All the above data sent to the evaluators was used to confirm the success (or failure) of the test calls.

In addition to the above, Telcordia also had real-time data available during the testing sequence, showing the full Mayday/9-1-1 messages and data, as the test call progressed through the wireless logical prototype elements in the Lab and flowed to the Minnesota 9-1-1 networks.

Section 4.4.1 shows an example of the form used by the test initiator to record data for each test call during the testing. Subsections 4.4.2 and 4.4.3 show some of the data that was collected at the Telcordia lab. Section 4.4.4 shows an example of the screens viewed at a PSAP. The sample form, XML and NSTS data (4.4.1, 4.4.2, 4.4.3, and Appendix D) are all from the sample test call.

4.4.1 Data Collection Form Example

The following figure shows an example data collection form filled out by the test initiator for each FOT test call.



PSAP: Washington County	Date/Time of Call _3:40__
Caller Name:__Susan__	Call Location: 181
Call Location Description: Near Woodbury High School On Copper Cliff Trail near intersection with Cochrane Drive Approximate GPS: 44.90941722, -92.96766	
Did call go through to OnStar Representative? _x__ Yes ___ No	
Did OnStar make contact with a PSAP _x_ Yes ___ No	
What PSAP did it make contact with? __Washington________________	
What was the Lat/Long displayed at the PSAP? Latitude ___44.909____________ Longitude ___-92.967_____________	
What was the call back number displayed at PSAP? Call Type ______866-859-3363_________Corrrect_______________ ____1____	

Figure 4-1 Data Collection Form

4.4.2 XML Data Example

The following is a textual representation of the XML data processed on a single call during the FOT:

<vei:VehicularEmergencyIncident>

<aacnDataType>

<deltaV>17.0</deltaV>

<pdof>-94.0</pdof>

<multImp>true</multImp>

<rollOv>false</rollOv>

</aacnDataType>

<airbagType>

<drDep>

<sideDep>false</sideDep>

<frtDepType>

<nearDep>true</nearDep>

<stage1>false</stage1>

<stage2>false</stage2>

<unknownDeployed>false</unknownDeployed>

</frtDepType>

</drDep>

<passDep>

<sideDep>false</sideDep>

<frtDepType>

<nearDep>true</nearDep>

<stage1>false</stage1>

<stage2>false</stage2>

<unknownDeployed>false</unknownDeployed>

</frtDepType>

</passDep>

</airbagType>

<incidentTimeStamp>2005-08-19T16:40:03<IncidentTimeStamp>

<locationType>

<latitude>44.90940856933594</Latitude>

<longitude>-92.96788024902344</Longitude>

</locationType>

<providerDataType>

<callBackNumber>A8668593363</callBackNumber>

</providerDataType>

<Cid>2667</Cid>

<vehicleDataType>

<esn>05100158198</esn>

<mdn>2483218198</mdn>

<min>2483212091</min>

<sid>14165198</sid>

<vin>MNDOTGEN6000001</vin>

</vehicleDataType>

</vei:VehicularEmergencyIncident>

4.4.3 NSTS Data Example

The following is an example of the data collected by the Telcordia Network Services Test System (NSTS), which simulated the signaling and control for the T-MSC, S-MSCs, HLR and MPC. The data in the example shows the contents of the signaling messages, with a minimal amount of detail. Appendix D shows two of these messages in full detail. The messages are traveling between the elements in the network that are simulated by NSTS. Each message that goes between elements simulated by the NSTS appears twice (once going to the STP and once from the STP). Messages between a simulated node and an actual node only appear once (going to the STP). In brief, the way to read the data is as follows:

The first field indicates the node that is generating or receiving the message.

The second field indicates direction (C=receive, T=transmit)

The third field indicates the time of day for the message.

The fourth field indicates the type of message (TCAP message: QRYP – Query with permission or RESP – Response; ISUP message: IAM – Initial Address Message, ACM – Address Complete Message, ANM – Answer Message, SUS – Suspend Message, REL – Release Message, RLC – Release Complete Message).

The fifth field indicates the SS7 Destination Point Code

The Sixth field indicates the SS7 Originating Point Code

The remaining fields are message dependent and add little to this discussion. The data that was collected had full message content for all messages, with more detailed coding available if required for analysis.

TMS C 16:41:32.141 QRYP TMSC 5ESS 1sls021 ssn247 02a903a1

TMS T 16:41:32.143 QRYP HLR TMSC 1sls007 ssn011 02a903a1

HLR C 16:41:32.187 QRYP HLR TMSC 1sls019 ssn011 02a903a1

HLR T 16:41:32.189 QRYP MSC2 HLR 1sls007 ssn012 a103a902

MSC C 16:41:32.261 QRYP MSC2 HLR 1sls019 ssn012 a103a902

MSC T 16:41:32.264 RESP HLR MSC2 1sls007 ssn013 a103a902

HLR C 16:41:32.319 RESP HLR MSC2 1sls019 ssn013 a103a902

HLR T 16:41:32.322 RESP TMSC HLR 1sls007 ssn012 02a903a1

TMS C 16:41:32.358 RESP TMSC HLR 1sls019 ssn012 02a903a1

TMS T 16:41:32.361 RESP 5ESS TMSC 1sls007 ssn247 02a903a1

MSC C 16:41:32.691 IAM MSC2 5ESS 1sls147 1 612-225-2222

MSC T 16:41:32.693 IAM 5ESS MSC2 1sls147 24 908-999-2222

MSC C 16:41:32.882 QRYP MSC2 5ESS 1sls029 ssn247 018803a5

MSC T 16:41:32.885 QRYP MPC MSC2 1sls007 ssn013 018803a5

MPC C 16:41:32.925 QRYP MPC MSC2 1sls019 ssn013 018803a5

MPC T 16:41:32.928 QRYP MSC2 MPC 1sls007 ssn014 a5038801

MSC C 16:41:32.955 QRYP MSC2 MPC 1sls019 ssn014 a5038801

MSC T 16:41:32.957 RESP MPC MSC2 1sls007 ssn013 a5038801

MPC C 16:41:32.992 RESP MPC MSC2 1sls019 ssn013 a5038801

MPC T 16:41:32.995 RESP MSC2 MPC 1sls007 ssn014 018803a5

MSC C 16:41:33.026 RESP MSC2 MPC 1sls019 ssn014 018803a5

MSC T 16:41:33.028 RESP 5ESS MSC2 1sls007 ssn247 018803a5

MSC C 16:41:33.644 ACM MSC2 5ESS 1sls147 24

MSC T 16:41:33.646 ACM 5ESS MSC2 1sls147 1

MSC C 16:41:33.874 ANM MSC2 5ESS 2sls147 24

MSC T 16:41:33.876 ANM 5ESS MSC2 2sls147 1

MSC C 16:42:41.439 SUS MSC2 5ESS 1sls147 24

MSC T 16:42:41.442 SUS 5ESS MSC2 1sls147 1

MSC C 16:42:51.670 REL MSC2 5ESS 1sls147 1

MSC T 16:42:51.671 REL 5ESS MSC2 1sls147 24

MSC C 16:42:51.799 RLC MSC2 5ESS 2sls147 24

MSC T 16:42:51.802 RLC 5ESS MSC2 2sls147 1

4.4.4 Sample PSAP Screen

A sample view of the screen seen at the IES Test PSAP is shown in the next two figures. There are two figures because the screen is divided between two monitors and in order to fit the view in the document, it is shown as separate figures.

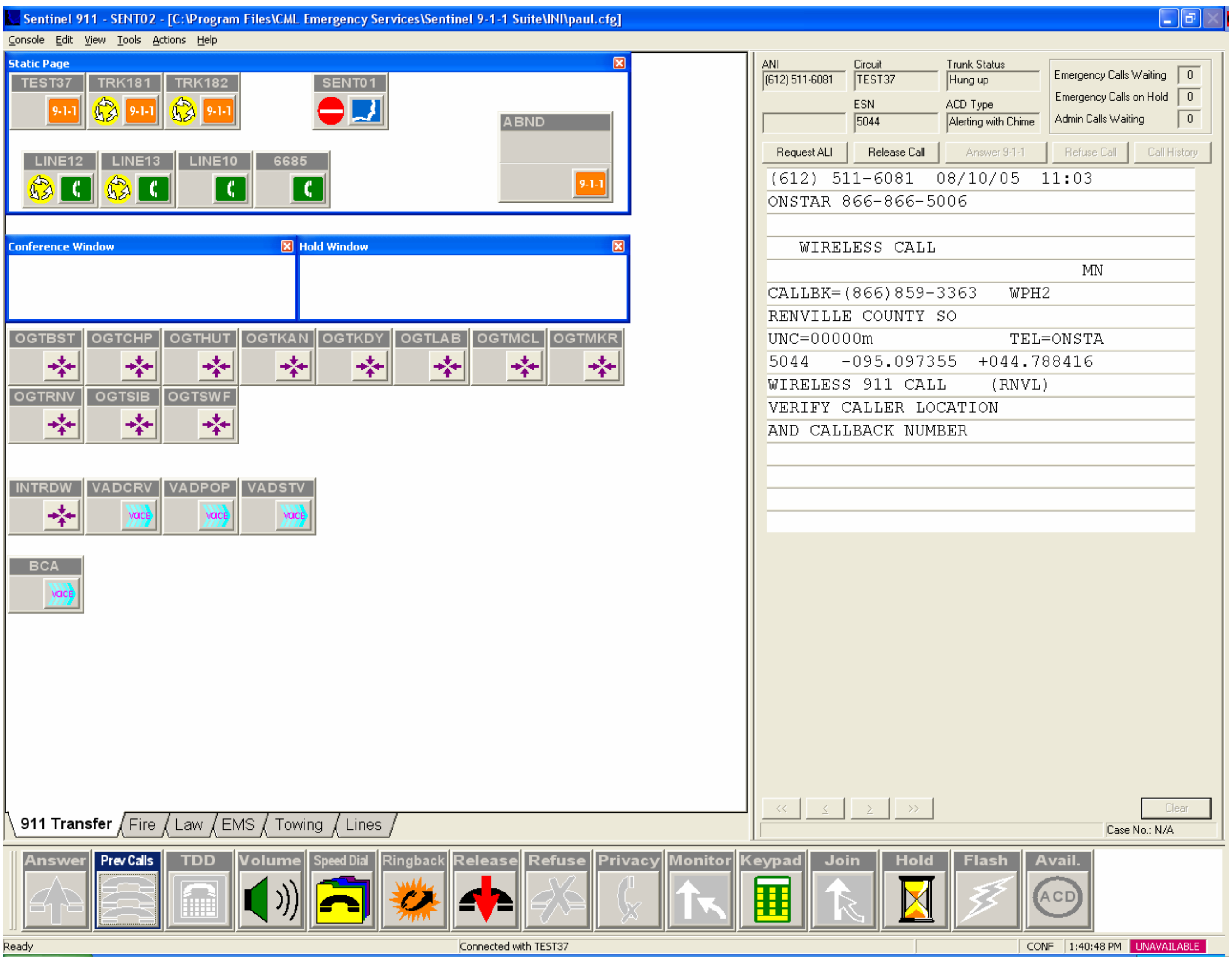


Figure 4-2 PSAP Screen (1 of 3)

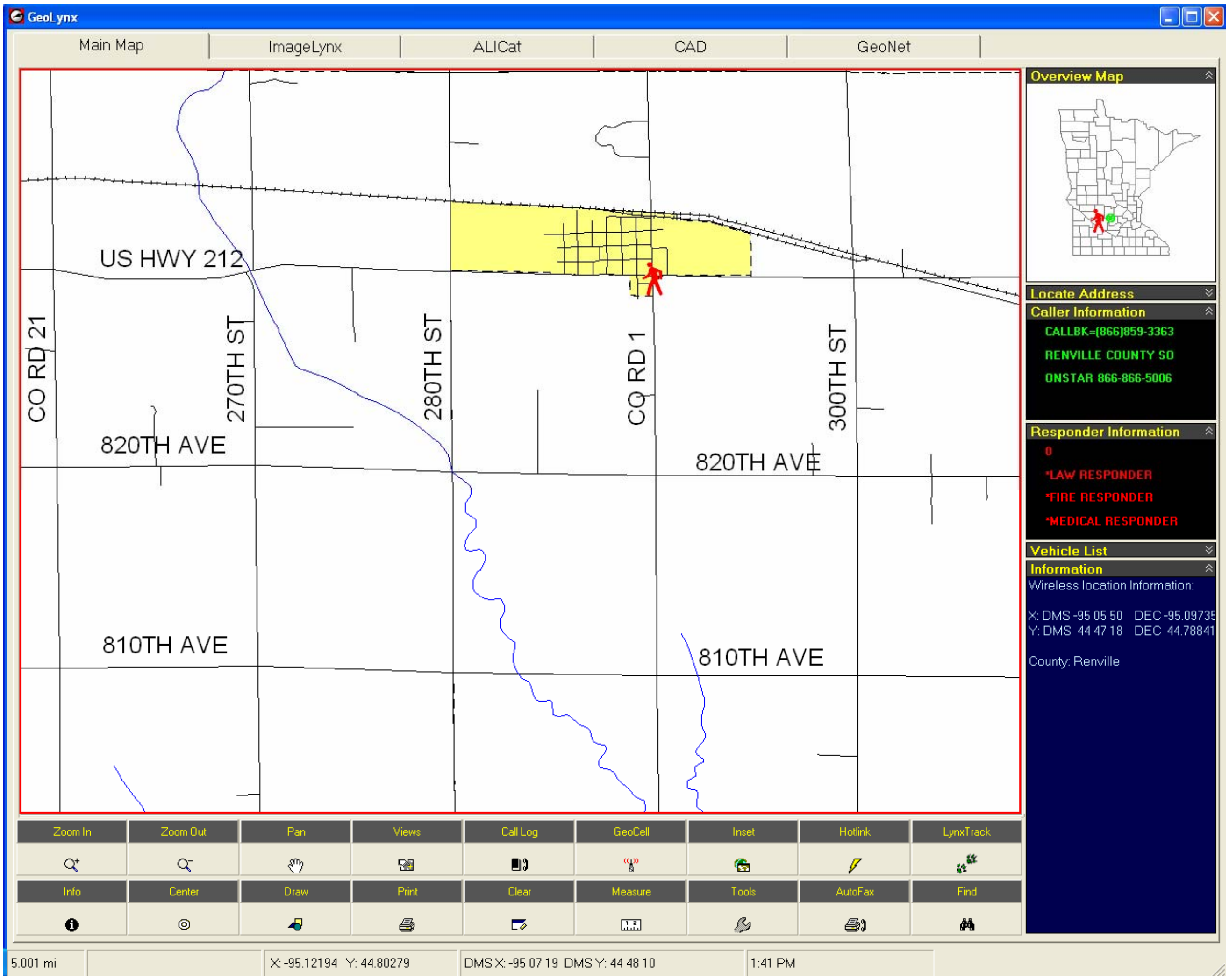


Figure 4-3 PSAP Screen View (2 of 3)

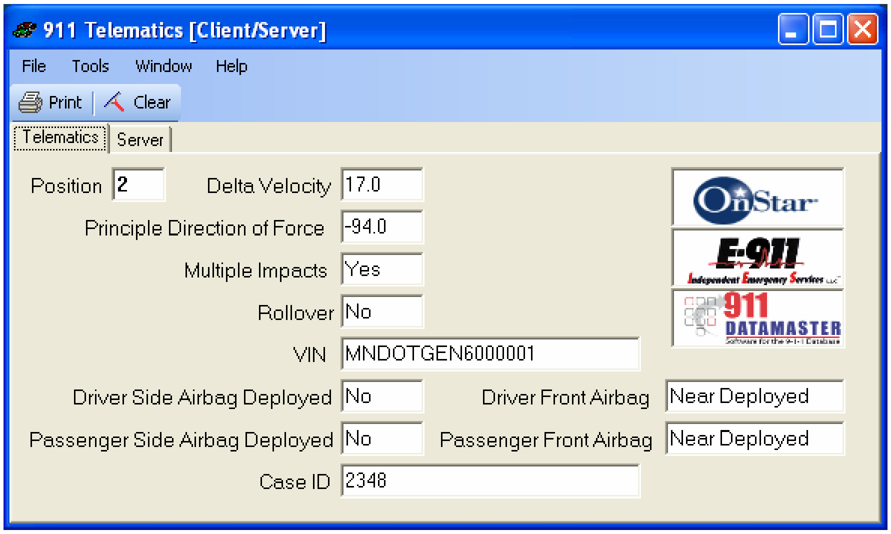


Figure 4-4 PSAP Screen (3 of 3) IES Special Application

4.5 Test Schedule

The first phase of the Mayday/9-1-1 FOT testing started on August 10, 2005 and ended on August 19, 2005. Since all test calls were successful, a second phase of test calling was not necessary. There were a few conditions that were beyond the control of the project team that required some test calls to be redone.

5 References

[1] Telematics Service Provider Emergency Call Routing Service (TSPECRS) Concept of Operations, Telcordia Technologies, SAIC, July 8, 2004.

[2] Telematics Service Provider Emergency Call Routing Service (TSPECRS) System Specification, Telcordia Technologies, SAIC and OnStar, November 14, 2003.

[3] Detailed Test Plan – Mayday/9-1-1 Field Operation Test Independent Testing of Voice Routing Functions, Battelle, August 4, 2005.

[4] Final Report: Mayday/9-1-1 Field Operational Test (FOT) Results and Path Forward, Telcordia Technologies, SAIC, and MNDOT, March 2006.

[5] Final Report: Mayday/9-1-1 Field Operations Test Analysis, Battelle, Date TBD.

[6] NENA Recommendation 05-XX, NENA Standard for the Implementation of the Wireless Emergency Service Protocol E2 Interface via TCP/IP, October 2002.

[7] IES – Dynamic ALI Interface Specification, Document Number: IES0120, Revision E, October 25, 2002.

[8] NENA Recommendation 02-10, Recommended Formats & Protocols For ALI Data Exchange, ALI Response & GIS Mapping, January 2002.

[9] Qwest Detailed SR/ALI to MPC/GMLC Interface Specifications for TCP/IP Implementation of TIA/EIA/J-STD-036E2, Issue 1.11, April 2004.

[10] Mayday/9-1-1 Field Operational Test Data Routing Concept of Operations Report, Minnesota Department of Transportation, June 1, 2004

[11] Mayday/9-1-1 Field Operational Test Data Routing Project Final Report, Minnesota Department of Transportation, TBD

Appendix A – Acronyms

3WC – Three-Way Call

ACD – Automatic Call Distributor

ACN – Automatic Crash Notification

AACN –Advanced Automatic Crash Notification

ALI – Automatic Location Identification

CAS – Call Associated Signaling

CRDB – Coordinate Routing Database

CRM – Customer Relationship Management

DOT – Department of Transportation

E9-1-1 – Enhanced 9-1-1

EO – End Office

ESC – Emergency Services Call

ESN – Electronic Serial Number or Emergency Service Number

ESRD – Emergency Services Routing Digits

ESRK – Emergency Services Routing Key

ESZ – Emergency Services Zone

NCAS – Non-Call Associated Signaling

HLR – Home Location Register

IAM – Initial Address Message

IP – Internet Protocol

LEC – Local Exchange Carrier

LRT – Location Request Timer

MDN – Mobile Directory Number

MIN – Mobile Identification Number

MPC – Mobile Position Center

MPCAP – Mobile Position Capability

MS – Mobile Station

MSC – Mobile Switching Center

NEDR – National Emergency Data Router

NENA – National Emergency Number Association

NHTSA – National Highway Traffic Safety Administration

OCC – OnStar Call Center

ORT – Origination Request Timer

OEV – OnStar Equipped Vehicle

PDE – Position Determination Entity

POP – Point of Presence

POST – Position Timer

PSAP – Public Safety Answering Point

PSTN – Public Switched Telephone Network

RRT – Routing Request Timer

SID – System ID

SR – Selective Router

SRDB – Selective Router Database

TCC – TSP Call Center

TCP – Transmission Control Protocol

TIA – Telecommunications Industry Association

TMS – Telematics Mobile Station

TSP – Telematics Services Provider

TSPECRS – Telematics Services Provider Emergency Call Routing Service

VLR – Visitor Location Register

WCM – Wireline Compatibility Mode (ESRK-based Wireless E9-1-1)

WSP – Wireless Service Provider

XML – eXtensible Markup Language

Appendix B – XML Schema for TCC to T-MSC/NEDR Interface

The TCC to NEDR interface shall use XML schema for delivery of ACN information. XML interface via HTTPS Simple Object Access Protocol (SOAP) invocation shall be used for Mayday/9-1-1 FOT demonstration and evaluation.

The following crash data was delivered to the TMSC/NEDR by the TCC:

- Delta V (Delta Velocity in mph): XML type is double, Example value: 14.0
- PDOF (Principle Direction of Force in degrees): XML type is double, Example value: 18.0
- Multiple Impacts: XML type is boolean, Example values: true, false
- Rollover: XML type is boolean, Example values: true, false
- VIN (Vehicle Identification Number): XML type is string, Example value: FAKEC13154B0056EX
- Airbags Deployed consists of the following boolean (true or false) parameters: Driver Side Airbag Deployed, Driver Front Airbag Near Deployed, Driver Front Airbag Stage1, Driver Front Airbag Stage2, Driver Front Airbag Unknown Deployed, Passenger Side Airbag Deployed, Passenger Front Airbag Near Deployed, Passenger Front Airbag Stage1, Passenger Front Airbag Stage2, Passenger Front Airbag Unknown Deployed
    - The Driver Side Airbag Deployed indicates whether or not the driver side airbag was deployed, and Passenger Side Airbag Deployed indicates whether or not the passenger side airbag was deployed.
    - The 4 Driver Front Airbag parameters indicate the state of deployment for the driver front airbag.
    - The 4 Passenger Front Airbag parameters indicate the state of deployment for the passenger front airbag.

The following is the XML Schema that was used for the XML interface between the OnStar Lab and the Telcordia Lab.


```
<?xml version="1.0" encoding="UTF-8"?>

<wsdl:definitions targetNamespace="http://axisws" xmlns="http://schemas.xmlsoap.org/wsdl/"
xmlns:apachesoap="http://xml.apache.org/xml-soap" xmlns:impl="http://axisws"
xmlns:intf="http://axisws" xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:tns2="http://CallManager.asd.onstar.com" xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
xmlns:wsdlsoap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">

 <wsdl:types>

  <schema targetNamespace="http://CallManager.asd.onstar.com"
xmlns="http://www.w3.org/2001/XMLSchema">

   <import namespace="http://schemas.xmlsoap.org/soap/encoding/"/>

   <simpleType name="DeviceEventType">
```

```
  <restriction base="xsd:string">
   <enumeration value="ACN"/>
   <enumeration value="AACN"/>
   <enumeration value="E-KEY"/>
  </restriction>
 </simpleType>
 <complexType name="AACNDataType">
  <sequence>
   <element name="deltaV" type="xsd:float"/>
   <element name="deviceEventType" nillable="true" type="tns2:DeviceEventType"/>
   <element name="multipleImpacts" type="xsd:boolean"/>
   <element name="pdof" type="xsd:float"/>
   <element name="preCrashHeading" type="xsd:float"/>
   <element name="rollOver" type="xsd:boolean"/>
  </sequence>
 </complexType>
 <complexType name="AirbagDeployedType">
  <sequence>
   <element name="nearDeployed" type="xsd:boolean"/>
   <element name="stage1" type="xsd:boolean"/>
   <element name="stage2" type="xsd:boolean"/>
   <element name="unknownDeployed" type="xsd:boolean"/>
  </sequence>
 </complexType>
 <complexType name="AirbagLocationType">
  <sequence>
```

```
   <element name="frontDeployedType" nillable="true" type="tns2:AirbagDeployedType"/>
   <element name="sideDeployed" type="xsd:boolean"/>
  </sequence>
 </complexType>
 <complexType name="AirbagType">
  <sequence>
   <element name="driverDeployed" nillable="true" type="tns2:AirbagLocationType"/>
   <element name="passsengerDeployed" nillable="true" type="tns2:AirbagLocationType"/>
   <element name="rearImpact" type="xsd:boolean"/>
   <element name="unknownDeployed" type="xsd:boolean"/>
   <element name="unknownNearDeployed" type="xsd:boolean"/>
  </sequence>
 </complexType>
 <complexType name="LocationType">
  <sequence>
   <element name="latitude" type="xsd:float"/>
   <element name="longitude" type="xsd:float"/>
  </sequence>
 </complexType>
 <simpleType name="DatumType">
  <restriction base="xsd:string">
   <enumeration value="WGS84"/>
   <enumeration value="NAD83"/>
  </restriction>
 </simpleType>
 <simpleType name="ProviderDataSourceType">
```

```
    &lt;restriction base="xsd:string"&gt;
     &lt;enumeration value="CVO"/&gt;
     &lt;enumeration value="PSA"/&gt;
     &lt;enumeration value="PSAP"/&gt;
     &lt;enumeration value="RAP"/&gt;
     &lt;enumeration value="TSP"/&gt;
    &lt;/restriction&gt;
   &lt;/simpleType&gt;
   &lt;complexType name="ProviderDataType"&gt;
    &lt;sequence&gt;
     &lt;element name="callBackNumber" nillable="true" type="xsd:string"/&gt;
     &lt;element name="datum" nillable="true" type="tns2:DatumType"/&gt;
     &lt;element name="eventVerified" type="xsd:boolean"/&gt;
     &lt;element name="incidentOriginator" type="xsd:boolean"/&gt;
     &lt;element name="providerDataSource" nillable="true" type="tns2:ProviderDataSourceType"/&gt;
     &lt;element name="providerName" nillable="true" type="xsd:string"/&gt;
    &lt;/sequence&gt;
   &lt;/complexType&gt;
   &lt;complexType name="VehicleDataType"&gt;
    &lt;sequence&gt;
     &lt;element name="esn" nillable="true" type="xsd:string"/&gt;
     &lt;element name="mdn" nillable="true" type="xsd:string"/&gt;
     &lt;element name="min" nillable="true" type="xsd:string"/&gt;
     &lt;element name="sid" nillable="true" type="xsd:string"/&gt;
     &lt;element name="vin" nillable="true" type="xsd:string"/&gt;
```

```
  &lt;/sequence&gt;
 &lt;/complexType&gt;
 &lt;complexType name="EmergencyIncidentType"&gt;
  &lt;sequence&gt;
   &lt;element name="aacnDataType" nillable="true" type="tns2:AACNDataType"/&gt;
   &lt;element name="airbagType" nillable="true" type="tns2:AirbagType"/&gt;
   &lt;element name="incidentTimeStamp" nillable="true" type="xsd:dateTime"/&gt;
   &lt;element name="locationType" nillable="true" type="tns2:LocationType"/&gt;
   &lt;element name="providerDataType" nillable="true" type="tns2:ProviderDataType"/&gt;
   &lt;element name="tccCaseid" nillable="true" type="xsd:string"/&gt;
   &lt;element name="vehicleDataType" nillable="true" type="tns2:VehicleDataType"/&gt;
  &lt;/sequence&gt;
 &lt;/complexType&gt;
&lt;/schema&gt;
&lt;/wsdl:types&gt;
 &lt;wsdl:message name="getTLDNRequest"&gt;
   &lt;wsdl:part name="in0" type="tns2:EmergencyIncidentType"/&gt;
 &lt;/wsdl:message&gt;
 &lt;wsdl:message name="getTLDNResponse"&gt;
   &lt;wsdl:part name="getTLDNReturn" type="xsd:string"/&gt;
 &lt;/wsdl:message&gt;
 &lt;wsdl:portType name="Enterprise"&gt;
   &lt;wsdl:operation name="getTLDN" parameterOrder="in0"&gt;
     &lt;wsdl:input message="impl:getTLDNRequest" name="getTLDNRequest"/&gt;
     &lt;wsdl:output message="impl:getTLDNResponse" name="getTLDNResponse"/&gt;
   &lt;/wsdl:operation&gt;
```

```
  </wsdl:portType>

  <wsdl:binding name="EnterpriseSoapBinding" type="impl:Enterprise">
    <wsdlsoap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
    <wsdl:operation name="getTLDN">
      <wsdlsoap:operation soapAction=""/>
      <wsdl:input name="getTLDNRequest">
        <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://axisws" use="encoded"/>
      </wsdl:input>
      <wsdl:output name="getTLDNResponse">
        <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://axisws" use="encoded"/>
      </wsdl:output>
    </wsdl:operation>
  </wsdl:binding>

  <wsdl:service name="EnterpriseService">
    <wsdl:port binding="impl:EnterpriseSoapBinding" name="Enterprise">
      <wsdlsoap:address location="http://localhost:8080/WebModule/services/Enterprise"/>
    </wsdl:port>
  </wsdl:service>
</wsdl:definitions>
```

Appendix C – Model Call Center & Operations Environment

Functional Block Diagram

Figure C-5-1 illustrates the high level functional block diagram of a model call center.

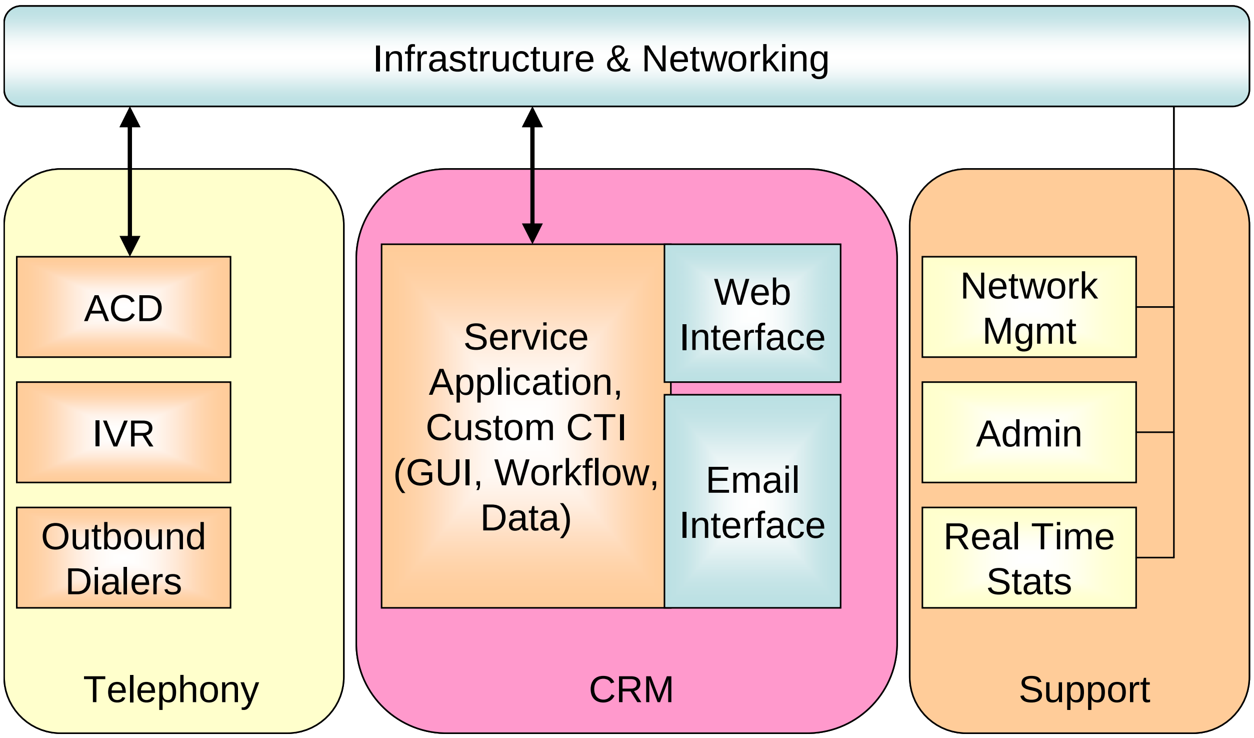


Figure C-5-1 Model Call Center – Functional Block Diagram

A Telematics Service Provider typically provides real-time help 24 hours a day, 365 days a year. The following subsections provide details about the various components in a typical TCC.

Infrastructure & Networking

A TCC has interfaces to the PSTN network via an End Office (EO), as well as, the ability to contact or be contacted by a TMS over a voice and/or data connection. A TCC also has interfaces to the PSAP administrative line, as well as other outbound and inbound voice call connectivity over the PSTN and data connectivity over the IP network.

Telephony

Automatic Call Distribution (ACD)

The TCC has an ACD to distribute TSPECRS requests to available Call Center personnel based on call type and other criteria. Emergency calls are given highest priority and are typically handled by a specially trained team of emergency advisors. For the purposes of the FOT, a special events team of Call Center personnel serviced the test calls.

Interactive Voice Response (IVR)

For the purposes of the FOT, incoming TSPECRS call requests might be routed to an IVR, while the call termination to the PSAP is in progress. The IVR provides the requisite announcements to the Telematics subscriber.

Outbound Dialer

The TCC may have an outbound dialer to facilitate accessing PSAPs directly over administrative lines and for attempting to reach the Telematics subscriber if the inbound emergency call is disconnected or if the FOT requires it.

Customer Relationship Management (CRM)

The TCC CRM production implementation consisted of various service applications and databases for providing assistance to the Telematics subscribers. Some of the services may include: automatic notification of air bag deployment, stolen vehicle location, remote door unlock, emergency services dispatch, roadside assistance, remote diagnostics, route support, convenience services and concierge.

These applications define the workflows and provide the GUI interfaces to the Call Center personnel, and may also provide web and email interfaces.

The applications utilized for the FOT are distinct from the production applications by design, so as not to jeopardize the integrity of live emergency call handling for Telematics subscribers. The live OnStar TCC was linked with the lab TCC, which provided the new XML data interface and call routing to the T-MSC at the Telcordia lab facility. In addition, the specially trained OnStar call taker was provided with visual prompts to support the dialogue during the FOT calls.

Support

The Support function consists of Network Management, administration and monitoring of real-time performance of the Call Center operations. The monitoring may include the generation of periodic measurement reports.

Appendix D – Detailed System Call Messages

The following is a sample of three of the ANSI-41 coded TCAP messages used in the signaling for the FOT, as seen at the NSTS.

********** 16:41:32.143 D Packet (# 35853), DTE Node 3 Link 0 **********

Raw Data (hex):

8c 8c 3f 93 02 e0 e5 01 e0 e5 07 09 80 03 05 07 02 c1 0c 02 c1

0b 59 e2 57 c7 04 02 a9 03 a1 e8 4f e9 4d cf 01 01 d1 02 09 0f

30 44 81 07 00 15 04 00 00 01 01 84 09 01 00 01 0a 42 38 12 02

19 95 03 00 15 04 96 01 03 9f 50 09 02 30 21 0a 00 00 00 00 00

9f 81 2a 01 01 e1 15 c0 06 05 08 13 61 04 30 c1 08 00 00 3f df

04 bd e3 b7 c2 01 11

MSU - Length Indicator: 63, Priority: 1

Service Indicator: SCCP message (0x03)

Subservice Field: National network (0x02)

SCCP message (0x03)

DPC: 229 224 2

OPC: 229 224 1

SLS: 7

UDT unitdata (0x09)

Protocol Class: 0 (0x00)

Message handling: Return message on error (0x08)

Called Party Address:

Route on destination point code (0x01)

National address indicator coding (0x01)

Subsystem Number: IS41

(12) (0x0c)

GT indicator: No global title included (0x00)

Calling Party Address:

Route on destination point code (0x01)

National address indicator coding (0x01)

Subsystem Number: IS41

(11) (0x0b)

GT indicator: No global title included (0x00)

Data Field Length: 89 (0x59)

TCAP Package Type: Query With Permission (0xe2)

Class: Private Use: Usage in National TCAP/Private TCAP (0x03)

TCAP Message length: 87 (0x57)

Transaction ID: (0xc7)

Origination ID: 2 169 3 161 (0x02a903a1)

Component Sequence, ID Length = 79

Invoke Component (Last), ID Length = 77

Invoke ID: (0x01)

Private TCAP Operation Code, Length = 2

Reply Not Required (0x00)

IS-41 MAP Location Request

Parameter Sequence, ID Length = 68

Billing ID:

Anchor SID: 0051

Anchor switch number: 40

ID number: 000010

Segment counter:

Number of intersystem handoffs: 1

Digits:

Type of Digits: Dialed (Called Party Number) (0x01)

Nature of Number: National - No Presentation Restriction (0x00)

Numbering Plan: Unknown or Not Applicable, Numbering Plan (0x00)

Encoding: BCD (0x01)

Digits: 248-321-2091

MSC ID:

SID : 21 (0x00 0x15)

SWNO: 4 (0x04)

System My Type Code:

AT&T (0x03)

Calling Party Digits 1: (Ext. Decode)

Type: ANI (Calling Party Number) (0x02)

Nature of Number: National - No Presentation Restriction (0x00)

Numbering Plan: Telephony Numbering (0x02)

Encoding: BCD (0x01)

Routing Digits: 000-000-0000

Emergency Call Type: (Ext. Decode)

Length: 1

TSPECRS (0x01)

Position Information: (Ext. Decode)

Length: 21

Generalized Time (0xc0)

Length: 6

Date: 8-19-2005

Time:16:40:03

Geographic Position (0xc1)

Length: 8

LPRI/Screening 00

Type of Shape 00

Encoded Lat = 0x3fdf04

Encoded Long = 0xbde3b7

Position Source (0xc2)

Length: 1

Handset GPS (0x11)

********** 16:41:32.189 D Packet (# 35860), DTE Node 3 Link 2 **********

Raw Data (hex):

8c 8c 33 93 05 e0 e5 02 e0 e5 07 09 80 03 05 07 02 c1 0d 02 c1

0c 4e e2 4c c7 04 a1 03 a9 02 e8 44 e9 42 cf 01 01 d1 02 09 10

30 39 81 07 00 15 04 00 00 01 01 89 03 05 10 01 88 05 42 38 12

02 19 95 03 00 15 04 96 01 03 9f 81 2a 01 01 e1 15 c0 06 05 08

13 61 04 30 c1 08 00 00 3f df 04 bd e3 b7 c2 01 11

MSU - Length Indicator: 51, Priority: 1

Service Indicator: SCCP message (0x03)

Subservice Field: National network (0x02)

SCCP message (0x03)

DPC: 229 224 5

OPC: 229 224 2

SLS: 7

UDT unitdata (0x09)

Protocol Class: 0 (0x00)

Message handling: Return message on error (0x08)

Called Party Address:

Route on destination point code (0x01)

National address indicator coding (0x01)

Subsystem Number: IS41

(13) (0x0d)

GT indicator: No global title included (0x00)

Calling Party Address:

Route on destination point code (0x01)

National address indicator coding (0x01)

Subsystem Number: IS41

(12) (0x0c)

GT indicator: No global title included (0x00)

Data Field Length: 78 (0x4e)

TCAP Package Type: Query With Permission (0xe2)

Class: Private Use: Usage in National TCAP/Private TCAP (0x03)

TCAP Message length: 76 (0x4c)

Transaction ID: (0xc7)

Origination ID: 161 3 169 2 (0xa103a902)

Component Sequence, ID Length = 68

Invoke Component (Last), ID Length = 66

Invoke ID: (0x01)

Private TCAP Operation Code, Length = 2

Reply Not Required (0x00)

IS-41 MAP Routing Request

Parameter Sequence, ID Length = 57

Billing ID:

Anchor SID: 0051

Anchor switch number: 40

ID number: 000010

Segment counter:

Number of intersystem handoffs: 1

Mobile Serial Number: 84935048 (0x05 0x10 0x01 0x88)

Mobile Identification Number: (MIN) 2483212091

MSC ID:

SID : 21 (0x00 0x15)

SWNO: 4 (0x04)

System My Type Code:

AT&T (0x03)

Emergency Call Type: (Ext. Decode)

Length: 1

TSPECRS (0x01)

Position Information: (Ext. Decode)

Length: 21

Generalized Time (0xc0)

Length: 6

Date: 8-19-2005

Time:16:40:03

Geographic Position (0xc1)

Length: 8

LPRI/Screening 00

Type of Shape 00

Encoded Lat = 0x3fdf04

Encoded Long = 0xbde3b7

Position Source (0xc2)

Length: 1

Handset GPS (0x11)

********** 16:41:32.264 D Packet (# 35869), DTE Node 3 Link 4 **********

Raw Data (hex):

aa a4 3a 93 02 e0 e5 05 e0 e5 07 09 80 03 05 07 02 c1 0c 02 c1

0d 26 e4 24 c7 04 a1 03 a9 02 e8 1c e9 1a cf 01 01 d1 02 09 10

30 11 95 03 00 1a 02 9f 57 09 09 09 09 0a 16 22 52 22 22

MSU - Length Indicator: 58, Priority: 1

Service Indicator: SCCP message (0x03)

Subservice Field: National network (0x02)

SCCP message (0x03)

DPC: 229 224 2

OPC: 229 224 5

SLS: 7

UDT unitdata (0x09)

Protocol Class: 0 (0x00)

Message handling: Return message on error (0x08)

Called Party Address:

Route on destination point code (0x01)

National address indicator coding (0x01)

Subsystem Number: IS41

(12) (0x0c)

GT indicator: No global title included (0x00)

Calling Party Address:

Route on destination point code (0x01)

National address indicator coding (0x01)

Subsystem Number: IS41

(13) (0x0d)

GT indicator: No global title included (0x00)

Data Field Length: 38 (0x26)

TCAP Package Type: Response (0xe4)

Class: Private Use: Usage in National TCAP/Private TCAP (0x03)

TCAP Message length: 36 (0x24)

Transaction ID: (0xc7)

Responding ID: 161 3 169 2 (0xa103a902)

Component Sequence, ID Length = 28

Invoke Component (Last), ID Length = 26

Invoke ID: (0x01)

Private TCAP Operation Code, Length = 2

Reply Not Required (0x00)

IS-41 MAP Routing Request

Parameter Sequence, ID Length = 17

MSC ID:

SID : 26 (0x00 0x1a)

SWNO: 2 (0x02)

Destination Digits: (Ext. Decode)

Type: Last Calling Party (0x09)

Nature of Number: International - No Presentation Restriction (0x01)

Numbering Plan: Unknown/Not Applicable (0x00)

Encoding: BCD (0x01)

Routing Digits: 612-225-2222