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Automatic Collision Notification and Vehicle Telematics Technical Information Document (TID)



NENA Technical Information Document

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1 Executive Overview

1.1 Purpose and Scope of Document

The purpose of this “Automatic Collision Notification and Vehicle Telematics Technical Information Document” is to understand and describe in both technical and operational terms the current telematics industry and telematics emergency calls and associated information delivered to Public Safety Answering Points (PSAPs). The document scope also reflects on the current 9-1-1 infrastructure, the next generation emergency networks, and it discusses the integration of telematics emergency calls and information into those networks. This Technical Information Document (TID) will provide information to allow the National Emergency Number Association (NENA) and other interested parties to develop new communications methodologies and protocols to facilitate emergency communications between Telematics Service Providers (TSP) and PSAPs.

1.1.1 Telematics Services

A variety of services are available through telematics suppliers. Some services are only available using specific equipment and/or service vendors. Generally the services fall in five categories: emergency, navigation, convenience, vehicle, and dealer/manufacturer services. This document will address only two specific services within the Emergency Services category, and those are: Emergency Services and Telematics Call Centers.

1.1.2 Emergency Services

- **Mayday calls** – Occupant pushes button in the car to summon help
- **Automatic Collision Notification** – Call is initiated by a collision’s characteristics, without occupant intervention, usually air bag deployment or seat belt tensioning system deployment. Newer systems may be activated by impact with the car, from any direction without airbag deployment.

1.1.3 Telematics Call Centers

Telematics require that highly sophisticated technology be installed at the TSP call center. This technology enables the call center to interface with the telematics equipment installed in vehicles. The call center telephone equipment must be designed to match the equipment installed in the vehicles so that the appropriate connection is established and maintained. When on-vehicle equipment and call center equipment are connected and communicating, ancillary hardware and software must allow database lookups to determine the range of services available to the caller (per their subscriber agreement), and validate that their contract is current. Upon validation, the call center equipment and software will link the voice call, location, vehicle owner/occupant and vehicles database information, to the service provider’s console using sophisticated Computer Telephony Integration (CTI) and Automatic Call Distributor (ACD) equipment.



1.2 Reason to Implement

The Telematics industry has developed rapidly, as has the number of emergency calls forwarded to public safety dispatch facilities and PSAPs from TSP call centers on behalf of their telematics service clients. While telematics remains a very small proportion of emergency communications to PSAPs, the telematics issues are essentially the same as other sources of emergency information. Most of these emergency calls do not travel to the PSAP through existing 9-1-1 networks, and PSAPs are not receiving the increasingly available vehicle data and additional data that are available from in-vehicle telematics systems. This document will review current practice and ideas for future communication.

1.3 Benefits

Use of this “Automatic Collision Notification and Telematics Technical Information Document” will provide a basis for future consideration of communications policies and related matters, including protocols, procedures, network communications, PSAP CPE and other matters relating to the receipt of emergency calls and associated information from TSPs. This document attempts to describe in some detail the processes in use by TSPs at this time, as well as suggestions for future developments that will use the new information available to improve emergency response service to the public.

Operational Impacts Summary

The goal of this TID is to support the implementation of future communications infrastructure and processes that will limit the impact of those changes upon PSAPs; wireless, ILEC, IXC, other carriers, and upon the telematics industry as well, while taking advantage of these new services and new information to improve emergency response.

1.4 Document Terminology

The terminology used in this document has been aligned to designate definitions used within the American National Standard for Telecommunications technical standard T1.628 Emergency Calling Service, issued by the Alliance for Telecommunications Industry Solutions (ATIS).

1.5 Reason for Issue

This document is issued to consolidate information for future NENA technical activities relating to telematics, automatic collision notification and communications of telematics emergency calls to PSAPs.

1.6 Reason for Reissue

NENA reserves the right to modify this document. Whenever it is reissued, the reason(s) will be provided in this paragraph.



1.7 Date Compliance

All systems that are associated with the 9-1-1 process shall be designed and engineered to ensure that no detrimental, or other noticeable impact of any kind, will occur as a result of a date/time change up to 30 years subsequent to the manufacture of the system. This shall include embedded application, computer based or any other type application. To ensure true compliance the manufacturer shall upon request provide verifiable test results to an industry acceptable test plan such as Telcordia GR-2945 or equivalent.

1.8 Anticipated Timeline

This document provides information related to vehicle telematics emergency calling and associated information sharing. Since multiple solutions are suggested and it is not known which may be applied, timelines will be dictated by the solutions chosen for implementation.

1.9 Cost Factors

The discussion herein provides basic information that may be useful in the development of communications solutions for vehicle telematics emergency calling and associated information sharing. The document includes discussion of items that may impact costs of those solutions.

1.10 Cost Recovery Considerations

The discussion of cost recovery considerations is beyond the scope of this document. Once solutions are in the process of design and implementation, cost recovery can be addressed appropriately. In Next Generation E9-1-1 systems, telematics calls and data will “look” no different than other forms of emergency communication. They will approach PSAPs in a standardized IP format. There should be few marginal telematics costs to the PSAPs.

1.11 Acronyms/Abbreviations

This is not a glossary! See NENA 01-002 - NENA Master Glossary of 9-1-1 Terminology located on the NENA web site for a complete listing of terms used in NENA documents.

The following Acronyms are used in this document:	
ACCDEN	Access Denied
ACD	Automatic Call Distributor
ACN	Automatic Collision Notification and also known as Automatic Crash Notification
ALI	Automatic Location Identification
AMPS	Advanced Mobile Phone System
ANI	Automatic Number Identification
ANSI	American National Standards Institute



The following Acronyms are used in this document:	
ATIS	Alliance for Telecommunications Industry Solutions
BASK	Binary Amplitude Shift Key
CAD	Computer Aided Dispatch
CAMA	Centralized Automatic Message Accounting
CAS	Call path Associated Signaling
CBN	Call Back Number
CPE	Customer Premises Equipment
CRDB	Coordinate Routing Database
DOS	Denial of Service
DOT	Department of Transportation
E9-1-1	Enhanced 9-1-1
EO	End Office
ESC	Emergency Services Call
ESGW	Emergency Services Gateway
ESIF	Emergency Services Interconnection Forum
ESME	Emergency Services Messaging Entity
ESN	Electronic Serial Number
ESNE	Emergency Services Network Entity
ESRD	Emergency Services Routing Digits
ESRK	Emergency Services Routing Key
ESRN	Emergency Services Routing Number
FCC	Federal Communications Commission
GPOSDIR	GeoPositionDirective INVOKE (see JSTD-036)
gposdir	GeoPositionDirective RETURN RESULT (see JSTD-036)
GPOSREQ	GeoPositionRequest INVOKE (see JSTD-036)
gposreq	GeoPositionRequest RETURN RESULT (see JSTD-036)
GPS	Global Positioning System
HLR	Home Location Register (see ANSI-41)
IAM	Initial Address Message
IID	Incident Identification
ISDN	Integrated Services Digital Network
ISUP	Integrated Services Digital Network User Part
LEC	Local Exchange Carrier
LOCREQ	Location Request
LRO	Last Routing Option
MDN	Mobile Directory Number
MIN	Mobile Identification Number



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The following Acronyms are used in this document:	
MapInfo	Mobile Information (see JSTD-036) (MapInfo is a trademark registered name!)
MPC	Mobile Positioning Center
MPCAP	Mobile Position Capability (see JSTD-036)
MSC	Mobile Switching Center
NCAS	Non-Call path Associated Signaling
NENA	National Emergency Number Association
NG9-1-1	Next Generation 91-1
OEM	Original Equipment Manufacturer
ORREQ	Origination Request Invoke (see JSTD-036)
orreq	Origination Request RETURN RESULT (see JSTD-036)
PAM	PSAP to ALI Message
PCS	Personal Communications System
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
ROUTREQ	Route Request (see ANSI-41)
RTP	Real-time Transport Protocol
SR	Selective Router
SCP	Service Control Point (see ANSI-41)
SIP	Session Initiated Protocol
SMDPP	SMS Delivery Point to Point INVOKE (see ANSI-41)
SRDB	Selective Router Database
SS7	Signaling System 7
STP	Signal Transfer Point
TDM	Time Division Multiplexing
TCU	Telematics Control Unit
TSP	Telematics Service Provider
TTY	Telecommunications Device for the Deaf and Hard-of-Hearing
VE2	Voice over Internet Protocol E2 Interface
VLR	Visitor Location Register
VoIP	Voice over Internet Protocol
VEDS	Vehicle Emergency Data Sets
VIN	Vehicle Identification Number
VPC	Voice over Internet Protocol Positioning Center
XML	Extensible Markup Language

2 Technical Description



2.1 Vehicle Telematics

Telematics are a suite of services, some location-based, offering benefits to the automakers, dealers, commercial fleets and consumers. Consumer services include navigation and convenience assistance to the driver and emergency help. To gain access to these services the vehicle must have telematics hardware installed and, currently, contracts between the user and the telematics firms must be enacted to provide requested services.

2.1.1 Vehicle Telematics Participants

Telematics devices are available as original equipment on some new vehicles. Telematics services are provided by specialty call centers under contract with the telematics services or automaker. Currently, subscriber agreements are required to enact the services. The telematics services or automaker designates services and their elements. Subscribers then choose which of the offered services they desire to utilize. All of the above are parties to the services provided telematics subscribers.

2.1.2 Telematics Services

A variety of services are available through telematics suppliers. Some services are only available using specific equipment and/or service vendors. Generally the services fall in five categories: emergency, navigation, convenience, vehicle, and dealer/manufacturer services. Throughout this document only emergency services will be addressed other than below in 2.1.4 through 2.1.7.

2.1.3 Emergency Services

Possible life threatening:

- **“MayDay”/Emergency Calls** – Occupant pushes button in car to summon emergency help.
- **Automatic Collision Notification** – Call is initiated by a collision’s characteristics, without occupant intervention, usually air bag deployment or seat belt tensioning system deployment. Newer systems can be activated by impact with the car, without airbag deployment.

Non life threatening:

- **Breakdown Assistance** – Is a location based service and occupant pushes designated button to request roadside assistance with vehicle.
- **Stolen Vehicle Location** – Owner provides stolen vehicle report number and password with request to TSP to find stolen vehicle.



2.1.4 Navigation Services:

- Operator assisted routing to a known address or business place
- Interactive voice response (IVR) or download to a navigation screen in the vehicle routing to a known address (no TSP operator involved)
- Point of Interest (POI) Lookup to find local business or visitor attractions

2.1.5 Convenience Services:

- Reservations at restaurants, hotels, airlines, tours and attractions
- Gift orders and delivery
- Personal messaging
- Personal Calling
- Remote Door Unlock

2.1.6 Vehicle Services:

- Diagnostic Code Notification
- Remote storage of intermittent problem data
- Tire pressure sensing and monitoring
- Diagnostic health check
- Real-time Preventive Maintenance
- Maintenance triage and scheduling
- Over-the-air software updates

2.1.7 Dealer/Manufacturer Services:

- New Sales Prospecting
- Relationship Marketing Assistance
- Dealer Connect services
- Owners website
- Maintenance History data and storage



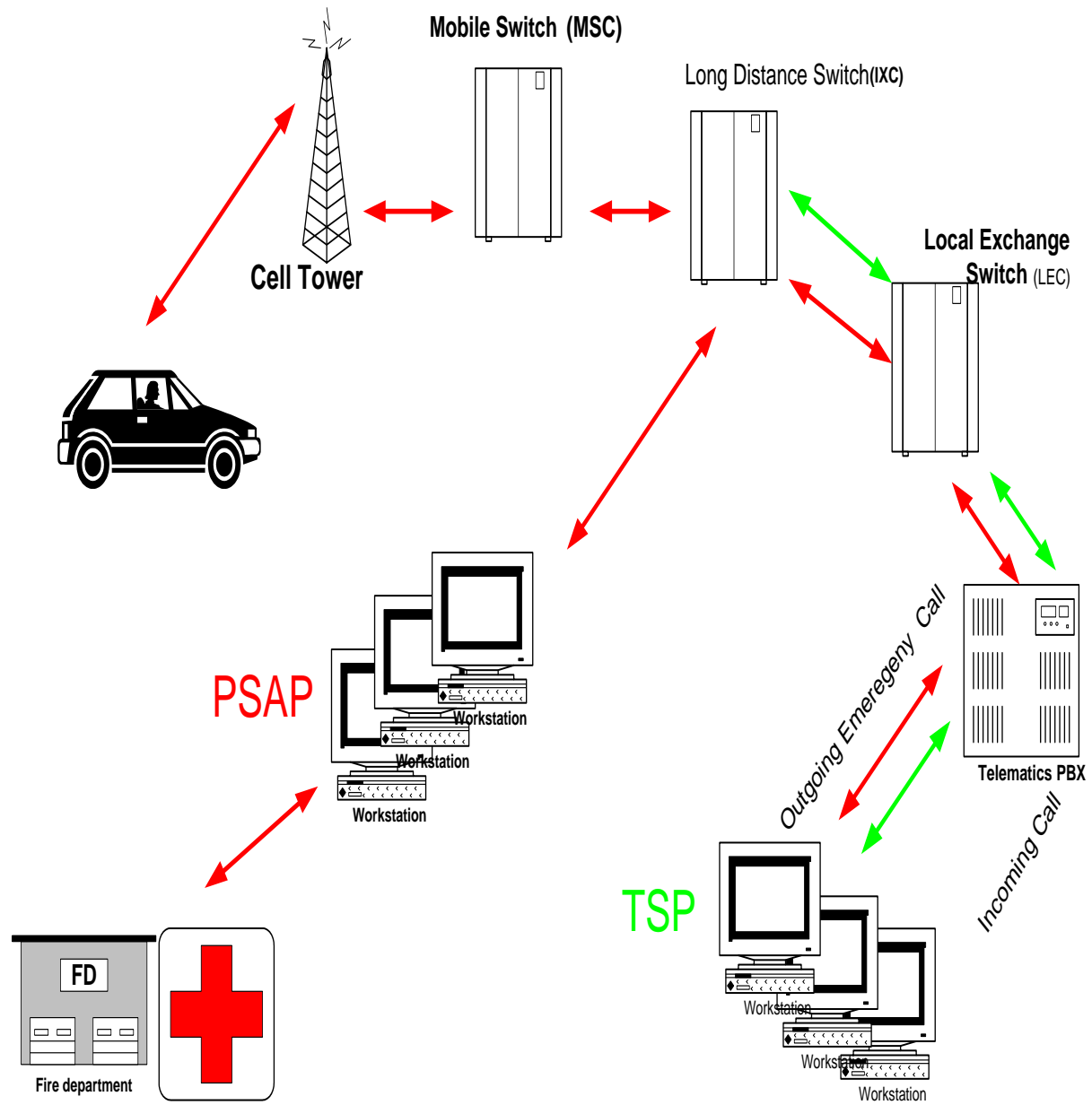
- Remote emissions testing

2.2 Current TSP Call Center Operations

Telematics require that highly sophisticated technology be installed at the TSP call center. This technology enables the call center to interface with telematics equipment installed in vehicles. Call center telephone equipment must be designed to match the equipment installed in the vehicles so that the appropriate connection is established and maintained. When the in-vehicle equipment and the call center equipment are connected and communicating, ancillary hardware and software must allow database lookups to determine the range of services available to the caller (per their subscriber agreement), and validate that their contract is current. Upon validation, the call center equipment and software will link the voice call, location, and owner and vehicle database information to the service provider's console, using sophisticated Computer Telephony Integration (CTI) Automated Call Distributor (ACD) capability will allow the call to be routed to an operator possessing the skills needed to handle the incoming call type. MayDay and ACN calls go to special operators. Location data (latitude/longitude coordinates) are interrogated to display a map at the console to indicate the calling party's location. This map is automatically scaled to display the right combination of detail to help the operator describe the location to a PSAP, if needed. It should be noted that the map data of the TSP may not match that of the PSAP. In the background, the latitude/longitude data is reverse geocoded against the map database to provide the operator with one of the following location parameters; the street address; the street address range or the street or cross street and distance. Separately, the location coordinates are used to determine the nearest or jurisdictionally appropriate PSAP and/or other public safety dispatch facility to support this incident. One or more PSAPs or dispatch facilities are listed along with their telephone numbers, which may be auto-dialed by pressing the appropriate command key. An incident record is initiated during this process and captured and time-stamped. Each and every keystroke, transfer, link or other action that takes place throughout the incident, is logged. Typically, in Mayday/emergency and ACN cases, full audio records are made of each incident.



2.2.1 TSP to PSAP Call Flow Diagram



Telematics ACN Call Flow
at the Current Time



2.2.2 TSP Call Center Protocols

Because TSPs must provide services to multiple makes and year models of vehicles, offering a variety of services, individually selected by the calling consumer customer, protocols for call center operations must be simple and driven by the console software suite. Protocols are initially directed by data included in the incoming call, such as type of call (emergency, navigation, etc); automaker or manufacturer suite of services; location of the call (English or French speaking Canadians, etc.) and other factors identified within the software/database applications.

In the case of emergency calls, the protocols help the operator determine if there are life threatening injuries or medical emergencies, immediate peril or special circumstances involving the need for public safety intervention. Based upon the resolution of those questions, public safety is immediately engaged, if available, and the caller is patched into the call taker/dispatcher if requested.

An overriding requirement of telematics emergency calls is that the operator is required to stay connected to the calling party until emergency help arrives or the caller specifically asked them to disconnect. TSPs consider these calls important opportunities to provide comfort and companionship to customers in distress.

Other types of calls have protocols to assist the operator in quickly and completely fulfilling the required needs. These protocols may involve special messaging, data transfer, looking up nearby businesses, getting reservations, mapping the fastest or most direct route to a desired destination, or other actions, many of which are stored within personal data files so that individual desires are already known at the call center operator's console.

2.2.3 Telematics Data and Sources

Telematics vehicle events generate data. Data is received from the telematics unit in the vehicle, correlated to database records maintained at the TSP, and linked to remote databases maintained by other contractors at other sites. In a crash, the data flow is increasingly rich, depending on the model and decisions of the manufacturer. Some of this data is provided at the TSP call center workstation to support the handling of the emergency incident. At least one of the major TSPs provides crash data to PSAPs or other emergency agencies as available.

2.2.4 Data that may be received from the vehicle involved in an incident:

The following identifies data elements and their sources that may exist in any telematics emergency incident. Values for these data elements and those described in the following section are contained in the Vehicular Emergency Data Set (VEDS) developed cooperatively by EMS, 9-1-1, industry, and other affected entities. See www.comcare.org/standards.

Unique telematics identification – an embedded code in on-board memory provided the TSP to link the unit to its vehicle and other data. This code could be either arbitrary, the electronic serial number



(ESN) of the embedded cell phone, the Vehicle Identification Number (VIN) of the vehicle or a code assigned or downloaded at the time the subscription was approved. It can invoke other useful information, such as the location of electrical connections, airbag trip wires for a particular car, and other hazards to responders.

Global Positioning System (GPS) data, including at a minimum the time and date of incident initialization; the latitude and longitude location of the vehicle at that time; the speed and direction of travel of the vehicle at the instant of initialization (press of the emergency button or trigger of the ACN sensors). Call type designation, based upon which button was pushed or whether the call was initiated by the ACN system (and whether that device was triggered by the air bags or the seat belt tensioning system).

Collision sensor data may be provided by the vehicle's event data recorder or dedicated on-board devices specifically for incident use. This data may include crash pulse, delta velocity, rollover indicator, rollover count, principal direction of force, final resting position, number of occupants, number of occupants wearing seat belts, video or still imagery from on-board cameras, vicinity radar signature (nearby obstacles/vehicles, etc), and other details related to the incident or vehicle at the time of this call.

The system has a two way audio connection to the hands-free, embedded communications (or to a cell phone) within the vehicle providing real-time verification and incident details from the occupants themselves or passersby. Diagnostic data generated within the diagnostic bus onboard the vehicle providing failure, component values and error codes relating to the performance of the vehicle.

2.2.5 Data Maintained at the TSPs Call Center May Include:

Vehicle records including Vehicle Identification Number (VIN), year, make, model, style, color, equipment features, and other details that are usually provided by the Original Equipment Manufacturer (OEM) automaker when the vehicle is sent to the dealer. This data provides a record of the vehicle as manufactured and may be updated to include modifications, service records, customer service details, and other details.

Subscription database records including owner name, address, services subscribed, emergency contact list, contract expiration date, telephone numbers, and the subscription agreement number.

Incident data records developed as the incident transpires including date and time of notification, time of dispatch, dispatch details, TSP actions, related records, workstation(s) assigned, specialists involved, dispatcher and call taker details, etc.

Public Safety Notification database including the name of each agency; the office street address and latitude/longitude location; agency type and type of response; agency administrative and emergency telephone numbers; date of last data verification.



Working map database(s) providing streets and roads, names and official designations, waterways and lakes, place names, municipal, county and state boundaries, railroads and other forms of mass transit, airports, and seaports

2.2.6 Databases That May be Maintained by Others and Remotely Accessed to Provide Data During the Incident:

A points of interest (or common name) database including businesses, government offices and other points of interest (such as museums, landmarks), their address and lat/long locations, telephone numbers, description and other details. Map database updates collected by the supplier and made available on a regular basis.

Manufacturers could make available other useful information, such as the location of electrical connections, airbag trip wires for a particular car, and other hazards to responders.

- Patient information sources:

There are commercial data bases (e.g. Medic Alert) where individuals have registered key medical conditions of interest to responders. Similarly, electronic health records may be available. The most accessible initial version of these is the databases of EMS ambulance providers.

- Decision support tools:

Emergency Medical Dispatch (EMD) is the most common of these. New versions of EMD will be developed to take advantage of external sources of data. These include telematics data from TSPs, and predictive algorithms developed to interpret advanced automatic crash data and related information from PSAPs and bystanders (age, gender, etc).

2.2.7 Real-time Supplemental Data Sources That May be Available on Demand as needed During an Incident:

- Traffic Conditions:

Traffic reports including incidents, their location, incident details, time of notification, time cleared; current traffic flow, by speed and direction.

- Construction Information:

Construction and maintenance activities, locations, and timeframes during which they will influence traffic flow, etc.

- Weather Information:

Weather conditions, forecasts, and special alerts including roadway conditions, weather alerts, wind, rain, temperatures, etc.

2.3 TSP/PSAP Communications

Telematics subscribers' emergency calls are connected directly to the TSP call center where they are pre-screened and those true emergency calls are transferred to public safety facilities according to 10-digit telephone number information the TSPs have acquired. Percentage of emergency calls sent to PSAPs is approximately 87%, which means TSPs screen out about 13% of the calls. One TSP reports that they screened out approximately 20 percent of the emergency calls in 2006.

One TSP reports that their OEMs provide a cover over the emergency button, thus reducing the likelihood of inadvertently hitting the button. While another TSP does not follow this practice because they feel that it can make it harder for individuals, especially older citizens, to place an emergency call in a crisis.

Telematics emergency calls are transferred to PSAPs and Public Safety Agencies via the Public Switched Telephone Number (PSTN) using 10-digit telephone numbers provided by the emergency agencies themselves. In a few cases, dialable numbers have been provided that connect directly to the 911 network trunks. Calls received at the PSAP on 10-digit administrative lines may not receive the same priority as 9-1-1 calls, and could result in delays for telematics emergency calls. Moreover, the increasingly rich data available from TSPs are not typically automatically transferred to PSAPs and other emergency responders in digital data format.

Industry and PSAP consensus is that the communications be routed through the 911 network with ANI, and ALI delivered on every call. Given the very small number of telematics calls relative to the overall number of calls to 9-1-1 (less than 1000 per day nationally), ACN/PSAP solutions should be cost-effective, non-disruptive, and shown to be fully compatible with future NG9-1-1 networks.

2.3.1 Location and Callback Number

For most telematics emergency calls today, the incident location (as an approximate street address; street and cross street or latitude, longitude coordinates) and the callback number of the TSP are reported to the PSAP verbally. A TSP can bridge a 3 way conference call across its own private telephone switch for a PSAP to be able to talk directly to the occupants of a vehicle involved in the emergency. TSPs have the ability to provide location and callback number as data with the call along with other information. When PSAPs are able to receive it, this will allow PSAPs to utilize existing protocols, equipment, network and procedures. Doing so may allow uniformity between classes of calls that will allow PSAPs to standardize their procedures, using existing protocols, or develop new ones to take advantage of the new information available to them.

2.3.2 Telematics Calls

TSPs received 2,090,321 calls in 2006 and of these about 35,000 telematics emergency calls were transferred to PSAPs for emergency assistance. Each of those calls was handled entirely with verbal



communications and the incident location and the callback number of the TSP were provided along with other details. In some cases the telematics call was not the first report of the incident, although, in all cases, they included location information. PSAPs were required to manually input the verbal information received from the TSP, in order to include that data with the call when it was transferred to responding agencies. PSAPs not equipped with CAD or older CAD systems that can't handle latitude/longitude can utilize their normal call referral protocols when handling these calls.

Today, more than 200 million calls reach 9-1-1 PSAPs across the nation each year. Approximately 50 percent of those calls are from wireless phones, many of these calls do not provide related location information. Currently, TSPs receive 35,000 telematics emergency calls annually. While this may be only one telematics call for every 5700 other 9-1-1 calls, it nevertheless comprises 35,000 calls for emergency assistance. These numbers will increase as more vehicles are equipped with telematics devices.

2.4 Communications Standards

PSAPs have expressed a desire to have telematics emergency calls delivered in a fashion consistent with other incoming 9-1-1 emergency calls. TSPs have agreed and several approaches to provide this integration of communications have been explored (see exhibits in section 3). There are, however, no existing standards (other than the VEDS data standard) relating to the provision of commercial call center emergency traffic within the public 9-1-1 network infrastructure. The current consensus in the NENA NG9-1-1 process, NRIC Focus Group 1B and Focus Group 1D, and other broad architecture efforts is that the emergency systems of the future will be IP based. Voice and data from all emergency sources will be handled in generally the same way. In other words, there will be no special treatment of telematics. The payload coming from a TSP may include more information than from some other source, and thus the information technology in a PSAP may handle it in certain ways, but conceptually it will be the same as a 9-1-1 call or weather alert.

2.4.1 National Mayday Readiness Initiative (NMRI) - Standards

The National Mayday Readiness Initiative (NMRI), sponsored by COMCARE and the Department of Transportation, assessed the then-existing standards relating to TSP-PSAP communications. NMRI included NENA, APCO, telematics suppliers, and other emergency response professions. In this process they concluded that then-existing standards were inadequate for voice and data communications to emergency agencies. See www.comcare.org/NMRI

In 2002, the NMRI participants and others launched a collaborative effort to address the standards gap. Over 20 national organizations, including NENA, emergency physicians, EMS, all telematics leaders and others developed the Vehicular Emergency Data Set (VEDS), an XML standard for communicating all telematics data to PSAPs and other emergency agencies. This was first issued in



2003, when OnStar and ATX committed to using it. OnStar has been using it since 2004 in trials (e.g. Minnesota, Alabama), and now delivers actual crash data to DOT-sponsored websites in more than 10 states. A new, updated version is about to be circulated to interested parties. See www.comcare.org/telematics.html.

It is now intended that the VEDS “payload” (like all other emergency messages) would be routed by a new international standard the Organization for the Advancement of Structured Information Standards (OASIS) “Emergency Data Exchange Language (EDXL) Distribution Element” (i.e. would have the DE as a “header”). This draft standard was developed by an even broader group of emergency practitioners (including NENA) in a process sponsored by the Department of Homeland Security. It was approved as an international standard by OASIS on April 30, 2006. See http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=emergency

2.4.2 Vehicle to PSAP Communication

NMRI members discussed at length the question of whether telematics emergency calls and data should be sent directly to PSAPs (as opposed to going through a TSP first). The NMRI final report (2000) said:

“9. We encourage extensive field testing of sophisticated ACN systems, including research funded by the Federal Government, to confirm initial findings that such systems can function without significant levels of false positives, that crash data can distinguish between serious crashes and “fender benders”, and indeed can predict the probabilities of severe injury. “10. Direct delivery of telematics emergency calls and data to PSAPs should be accomplished when the affected parties agree that it is feasible and will enhance public safety.”

“10. Direct delivery of telematics emergency calls and data to PSAPs should be accomplished when the affected parties agree that it is feasible and will enhance public safety.”

“11. Direct delivery of telematics calls and data to PSAPs” simply means that the intervention of a human being at a private call center would no longer be required. Special data residing on a call center server (e.g. personal medical information) could still be “picked up” and added to the data being sent to a PSAP or EMS agency if the subscriber had paid a TSP for such a service.”

2.4.3 Delivery Outcomes

PSAPs have indicated a desire to improve communications with TSPs such as but not limited to:

- Incident location and callback number delivered as data with the call
- Incoming telematics emergency call delivered within the 911 network
- Additional telematics or ACN data delivered to the PSAP



2.4.4 Network Considerations

The 9-1-1 service was structured around the architecture and infrastructure of the wireline telephone system. Even before Basic 9-1-1 was approved, Bell Labs and some of the AT&T operating companies had been working on an enhanced 9-1-1. In 1975, Bell Labs patented a system which incorporated what is known as Automatic Number Identification (ANI) and Selective Routing. In 1980, AT&T introduced Automatic Location Identification (ALI) and Selective Transfer services that completed the minimum array of features that were associated with true wireline enhanced 9-1-1.

Over the last 40 years, technological, institutional and behavioral changes have overtaken the AT&T-dominated PSTN and its emergency call model. When 9-1-1 was introduced in 1968, the PSTN was already in the early stages of the long technological transition from an analog, electro-mechanical, circuit-switched system to a digital, electronic, packet-switched system. Today, voice, text, data, graphics, and video are being transmitted by all manner of devices in fixed, nomadic, and mobile situations. Most of these devices lack direct access to the PSTN local emergency sub-network, and useful location information is frequently problematic, or non-existent.

At present, calls such as wireless E9-1-1, ACN/TSP, and VoIP 9-1-1 use a variety of approaches for gaining access to an emergency call-handling facility and for determining caller location; these approaches have not always provided completely successful solutions. Cell phone caller location has been a challenge of long standing, yet significant progress has been made only in the last few years, and universal deployment has not been realized.

In the case of ACN/TSP calls, direct access to the PSTN-based local emergency sub-network has been lacking, and the 10-digit, dialup solution frequently employed is not ideal. (Note that while current telematics systems are digital, past telematics technology is based upon an outdated cellular technology, analog AMPS networks that are slated to be phased out within five years.)

It is anticipated that in the future, a comprehensive Internet protocol (IP) -based approach will address the access and location issues (and many others) for most communications devices and situations. While this approach will necessitate the replacement of some legacy equipment and procedures by government, enterprise, and individuals, it will greatly expand the range of options that people will have for making contact with emergency assistance services using 9-1-1 (and caller-interface surrogates).

2.5 Suggested Communications Plans

Several approaches are summarized below and included as Exhibits, in Section 3.



- One suggests a Positioning Server which will utilize the latitude/longitude coordinates of the incident site to query a database of routing instructions which are then appended to the call, re-directed to the appropriate selective router and directed to the appropriate PSAP.
- Another would utilize a network-switch-based 3 way conference call, directed by the TSP to be placed through the cell phone in the caller's vehicle to contact the local 9-1-1 directly through the serving wireless carrier's switch.
- Yet another suggestion would send an SS7 message to the wireless carrier's MSC directing it to invoke its 3 way conference feature to dial "9-1-1" (placing the call to local PSAPs according to the method in use at that particular cellular tower site) and append the callback number and provide ALI steering to obtain the location information.
- The last suggestion includes placing a Centrex block regionally to direct emergency calls to the appropriate PSAPs, as an interim method to get these calls into the 911 trunks.

These systems are focused on transmitting calls. In addition, there are relatively simple interim ways of transmitting data alone so that those agencies (911, EMS, hospitals, etc) that want it can access it, either directly on their emergency systems (e.g. CAD), or on a shared, secure web site with an electronic map.

2.6 NENA NG9-1-1

Any communications standards or protocols developed as a result of this TID should fall within the guidelines developed by NENA for technical development in 9-1-1. Several years ago, NENA developed a Future Path Plan. This outlined the criteria any proposed technology should meet to be considered as viable for incorporation into the national emergency networks. The five criteria expressed in this plan were:

NENA Future Path Plan Criteria
1 – Reliability/dependability as governed by NENA's technical standards, and other generally accepted base characteristics of E9-1-1 service
2 – Service parity for all potential 9-1-1 callers
3 – Least complicated system design that results in fewest components to achieve needs
4 – Maximum probabilities for call and data delivery with least cost approach
5 – Documented procedures, practices, and processes to insure adequate implementation and ongoing maintenance for 9-1-1 systems.



More recently, NENA and a diverse group of partners are developing the Next Generation architecture for emergency communications. See www.nena.org. One of the key findings of that process is to recognize that telematics and similar emergency communications involve far more organizations than just TSPs and PSAPs. Where they involve communications between agencies in addition to 9-1-1, standards and protocols for this purpose should be developed cooperatively with such agencies.

2.7 Environmental Changes Impacting 9-1-1

When terrorists struck in New York City, Washington, DC and the Pennsylvania countryside, the impact of these acts alerted us that there was an immediate need to link every level of public safety nationwide. 9-1-1 is no longer a strictly local issue and improvements made to satisfy the telematics requirements or others must consider these national implications. We need a national inter-network linking all public safety and emergency response agencies and organizations to make data available at every level during any crisis.

2.7.1 Network Considerations

Network technologies have and are advancing at a rapid pace and that their implementation will impact solutions proposed to PSAP/TSP communications

Internet Networks: Rapid and successful growth of the Internet has dramatically demonstrated the capabilities of new network technologies to connect 9-1-1 and other emergency agencies to external data sources. Internet protocol (IP) technologies need to be applied to emergency voice and data traffic as rapidly as possible, using backbone networks, secure servers, gateways and other infrastructure to accomplish the needs of today's emergency agencies.

2.7.2 Analog Telematics

The FCC decision to allow CMRS carriers to begin replacing their analog cellular ports with digital ports, over the next five years, is already resulting in lower availability of analog circuits in cities. The 6 million legacy telematics vehicles in the field today are ALL analog cellular equipped, making them potentially obsolete in the very near future. Digital upgrades are likely to be offered for these legacy systems. AMPS communications have been favored by the telematics industry because of that service's large coverage footprint. Simply said, where there is no cellular coverage, there are no telematics services and there are no ACN alarms.

2.8 Industry Participants May Impact TSP-TSP Communications

In addition to TSPs, PSAPs, and other emergency response agencies, there are a host of other disciplines involved in or impacted by changes in telematics to public safety communications. There
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are the telematics manufacturers, who need to concur with proposed or recommended standards for telematics. The automakers decide what to install in new cars and what services will be provided to the consumer buying public. Not all telematics equipped vehicles provide emergency calling services. There are also the multiple telephone carriers involved in handling calls from telematics vehicles to the PSAP, including: wireless carriers; long distance carriers, local exchange carriers.

2.9 Summary

A few years ago less than one percent of the cars on the road carried telematics equipment, so the frequency of receiving telematics emergency calls in PSAPs was low. As the industry expands, however, more PSAPs will be receiving these ACN and “mayday” calls. The current systems and practices work reasonably well and emergency services are delivered to those who call through telematics. Improving the chain of communications will improve results and will make the work easier for PSAPs.

3 Exhibits

Several companies and individuals have considered the technologies needed to improve TSP to PSAP communications. They have submitted their suggestions in the form of white papers, which are attached hereto, without comment or editing, for further consideration as exhibits to this document.

3.1 Native 9-1-1 Delivery Using a Position Server (Intrado Inc.)

3.1.1 Overview

This solution provides a means to route emergency calls from a TSP Call Center (CC) to the correct E9-1-1 Tandem and have the call treated as a native 9-1-1 call. This solution allows delivery of the Telematics data once the call arrives at the PSAP and an Emergency Services Query Key (ESQK) to enable additional data to be retrieved, if required. It utilizes the existing local ALI database network and makes use of the Public Switch Telephone Network (PSTN) for routing of the voice path. This solution utilizes a Position Server, to provide routing instructions based upon the latitude and longitude of the caller. The TSP CC, through an Extensible Markup Language (XML) over TCP/IP interface, accesses the Position Server. The specification for this interface is provided in a separate document entitled “TSP Routing Interface using XML Elements (TRIXE)”. This interface is an open specification and has been made available to NENA.

This solution was demonstrated at the NENA national conference held June 2002 in Indianapolis, Indiana. This solution is also in operation in PSAPs within greater Harris County in Texas, and the position server is part of Intrado’s current production E9-1-1 network.



3.1.2 Solution Description

When an emergency call from a Telematics equipped car arrives at a TSP CC, it contains data that is pertinent to the location of the caller as well as collision information. The collision information provides data elements including: number of occupants, were they wearing seat belts, velocity of the vehicle, did it roll, etc. All this information is critical in evaluating the potential severity of the emergency. When the TSP attendant receives these calls, they first determine if the call is an emergency by talking with the person(s) within the vehicle (if the person is not speaking, the attendant can view the collision data for an indication of an accident). If it is determined to be an emergency, then processing the call to route based on location begins. The following paragraphs describe the solution.

When the TSP CC attendant determines the call is an emergency, they request routing instructions from a Position Server by querying the server with the latitude and longitude (and any other data relevant to the emergency) via the TRIXE interface. This is an automated process for the attendant and utilizes a Computer Telephony Integration (CTI) application to both query the Position Server and set up an outbound Conference call. Based on the latitude and longitude provided as part of the query, the Position Server determines the serving PSAP and the E9-1-1 Tandem. The Position Server stores all the received data and returns to the TSP CTI application an Emergency Service Query Key (ESQK), used to identify the serving PSAP (similar to an Emergency Service Routing Key (ESRK)), and an Emergency Service Routing Number (ESRN), used to route the call to the correct E9-1-1 Tandem. Both numbers, the ESRN and ESQK, follow the North American Numbering Plan (NANP) format.

Using the ESRN and ESQK from the Position Server response message, the TSP CTI application populates an outgoing Q.931 Call Setup message with the Called Party Number (ESRN) and the Calling Party Number (ESQK). This call is originated over a Primary Rate Interface (PRI) connection to the local End Office to establish a conference call to the PSAP. The PSTN then takes over routing of the emergency call to the E9-1-1 Tandem based on the ESRN using standard NPA-NXX routing translations.

Once the call is recognized at the E9-1-1 Tandem as an emergency, the Wire-line mode of emergency call processing takes over. That is, the ESQK (Automatic Number Identification (ANI)) is used to query the Selective Routing Data Base (SRDB) to determine the correct PSAP. The call is then routed to the PSAP and the ANI (ESQK) is out-pulsed. The PSAP queries the Automatic Location Identification Database (ALI DB) with the ESQK. The ALI DB is provisioned to steer ESQK queries to the Position Server using the existing PSAP to ALI Messaging (PAM) protocol (in the future, XML). Data that is associated with the ESQK is retrieved from the Position Server and sent back to the ALI DB, which in turn forwards the ALI record to the PSAP.

The ALI record presented to the PSAP at the NENA demonstration included the location (latitude/longitude), TSP 24x7 call back number, and minimal collision data as provided in the Supplemental data fields. The telephone number assigned to the vehicle is non-dialable and the only
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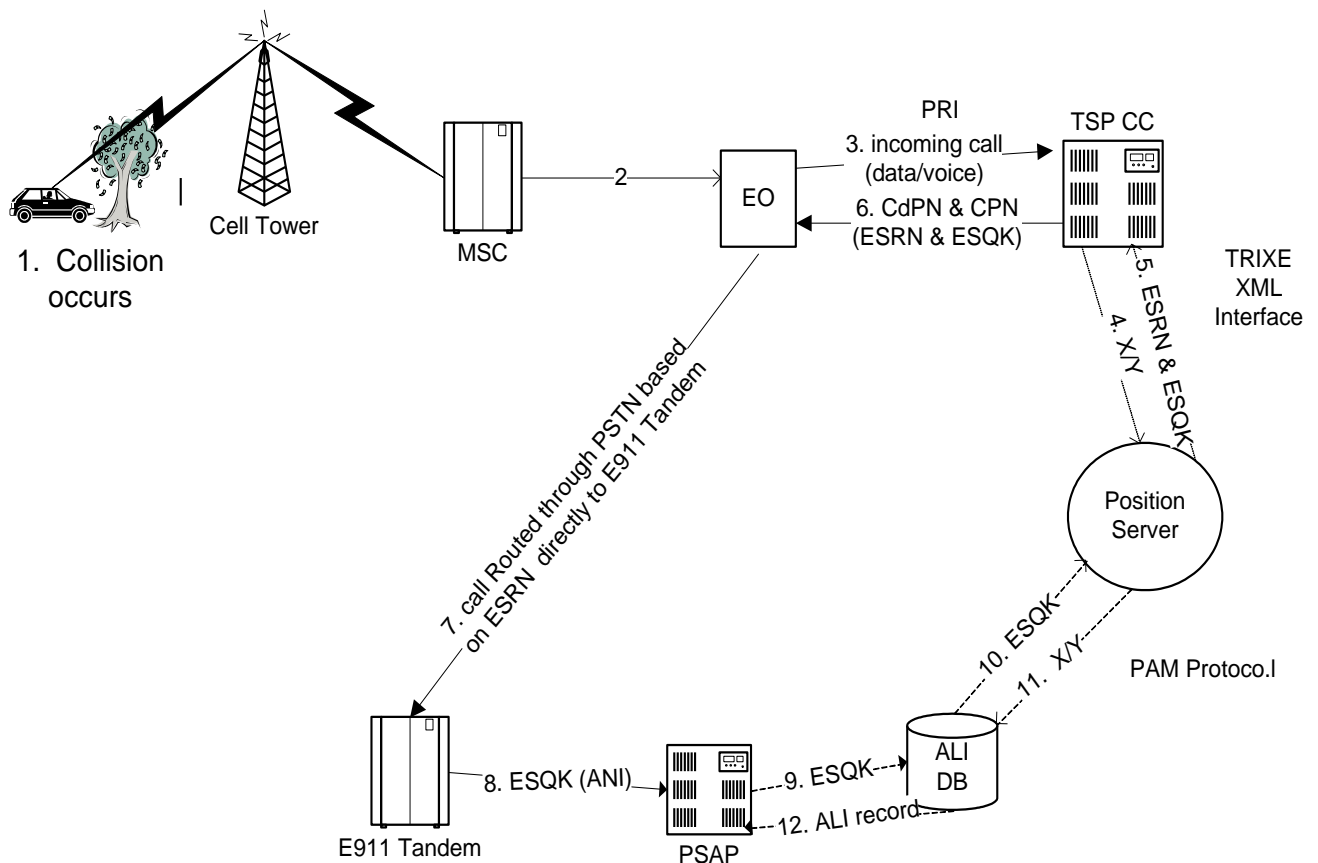


access to the person in the vehicle is through the TSP CC; hence why the TSP 24x7 call back number is essential.

The interface between the Position Server and the ALI DB is expected to eventually evolve to XML to allow for a larger set of data to be available to the PSAP and other Public Safety service providers.

3.1.3 Call Flow

The below diagram depicts what the above text describes:



Call Flow conditions: The collision is in Greater Harris County, Texas and the TSP CC is in Boston, Massachusetts. The call flow details follow:

1. A vehicle crashes into a tree, which activates the ACN from within the Telematics device. This causes a wireless call to be sent to the PSTN network.



2. The call is routed through a Mobile Switching Center (MSC) to the local End Office (EO) serving the TSP CC.
3. The call received at the TSP CC consists of the location, data from the collision, and the voice call. The TSP CC stores the data and then converts the call to a voice call to be serviced by an attendant.
4. The attendant at the TSP CC receives the call and determines emergency help is required. An emergency conference call through a CTI application is initiated. This causes a query containing the location (X/Y) and data to be sent to the Position Server.
5. Based on the location of the caller (X/Y), the Position Server obtains the routing number (ESRN) to the serving E9-1-1 Tandem and ESQK and returns them to the TSP CC.
6. The TSP CTI application populates the outgoing Q.931 Call Setup Message with the Calling Party Number parameter containing the ESQK and the Called Party Number parameter with the ESRN, and sends the call out over the Primary Rate Interface (PRI) interface to the PSTN to establish a conference call.
7. The call is routed through the PSTN network to the correct E9-1-1 Tandem based on the ESRN. The E9-1-1 Tandem recognizes the ESRN as an emergency number and processes the call by invoking the E9-1-1 Feature.
8. The E9-1-1 software takes over processing of the call and selectively routes the call to the PSAP based on the ESQK and transmits the ESQK to the PSAP.
9. Using the ESQK as the ANI, the PSAP launches a query to the local ALI DB to obtain the ALI record. The ALI DB steers the query request to the Position Server.
10. An ALI request message is sent to the Position Server with the ESQK as the ANI.
11. The location information and data is returned to the ALI DB in a PAM ALI response message.
12. The ALI record is displayed at the PSAP. The Supplemental data field contains the collision related data. Example ALI record as demonstrated at NENA:

Cross Country Automotive Svcs

ALT#= TELCO=CCAS
X=-92.125432 CNF= 0100
Y=+24.587323 S=000 D=000

VERIFY

VERIFY

VERIFY

IID=0010001234 ORNT=Normal
MAKE=CHEVY MDL=BLAZER
COL=BLUE HDG=190 ROLL=N
SPD=050 DVELV=99 FORCE=12 OCC=03



3.1.4 Support

Implementation of this solution will require support from the Local Exchange Carrier serving the PSAP and/or the Number Routing Authority to define the following:

- Define the ESQK ranges for each PSAP required to support TSP calls
- Define ESRN for each E9-1-1 Tandem Switch (routing number to switch)
- Switch translations required to recognize an ESRN as an emergency number

3.1.5 Benefits

- Delivers the call as native 9-1-1 using the ESRN over existing voice facilities (PSTN and/or, in the future, VoIP)
- Passes a key with the initial voice call that allows for retrieval of ALI data when the call is delivered to the PSAP
- ALI data includes location of the vehicle, IID(IID- incident ID), a callback number to the TSP CC, TSP provider name and, optionally, collision information
- The IID can be used to retrieve additional data, if applicable
- No new software to any 9-1-1 entity or PSTN node; all software modifications required are to the TSP CC and the Position Server
- Position Server can interface to with any ALI system using existing or evolving protocols (XML) and through a secure network interface.
- Utilizing existing 9-1-1 network
- Minimizes changes at the PSAP

3.2 Remote Conference Calling (MJC Thomas Inc.)

3.2.1 Overview

This solution consists of a procedure for connecting TSPs with PSAPs during telematics/ACN-triggered emergency events. Currently, when an ACN-equipped vehicle is involved in an airbag-deployed collision, the vehicle's Telematics Control Unit (TCU) automatically contacts a TSP, employing cellular technology. TSPs, however, receive incoming telematics and ACN calls originating over enormous geographic areas, and the remote distances involved present a problem.

When a TSP answers a qualifying, collision-triggered call, there would be no better way to establish quick and reliable connection with a PSAP than via the nation's existing and ever improving E9-1-1 infrastructure. Yet typically, E9-1-1 infrastructures are local, in both form and function. As a consequence, ACN calls, though confirmed as potentially life threatening emergencies, are not currently being routed through the 9-1-1 network to the appropriate PSAP. Instead, they are being bridged to PSAPs through equipment at the TSP Call Centers via 10-digit dial-up numbers over the Public Switched Telephone Network (PSTN).



This method of routing can be improved without changes of any kind to the existing E9-1-1 infrastructure. The solution involves a standard cellular service feature, a 3-way calling process that is implemented to conference a PSAP into a 2-party, collision-triggered call between an ACN-equipped vehicle and a TSP. The process has been called “Remote Conference Calling”. Remote Conference Calling allows direct connection of ACN calls between TSPs and PSAPs using the nation’s dialed 9-1-1 infrastructures. By dialing 9-1-1 from the vehicle, the process makes full use of the end-to-end benefits of the existing, local E9-1-1 infrastructure, including delivery of the specific call-back number of the involved vehicle.

Vehicles are being equipped with telematics systems having ACN features at an increasing rate, and it is important that 9-1-1 standards be established.

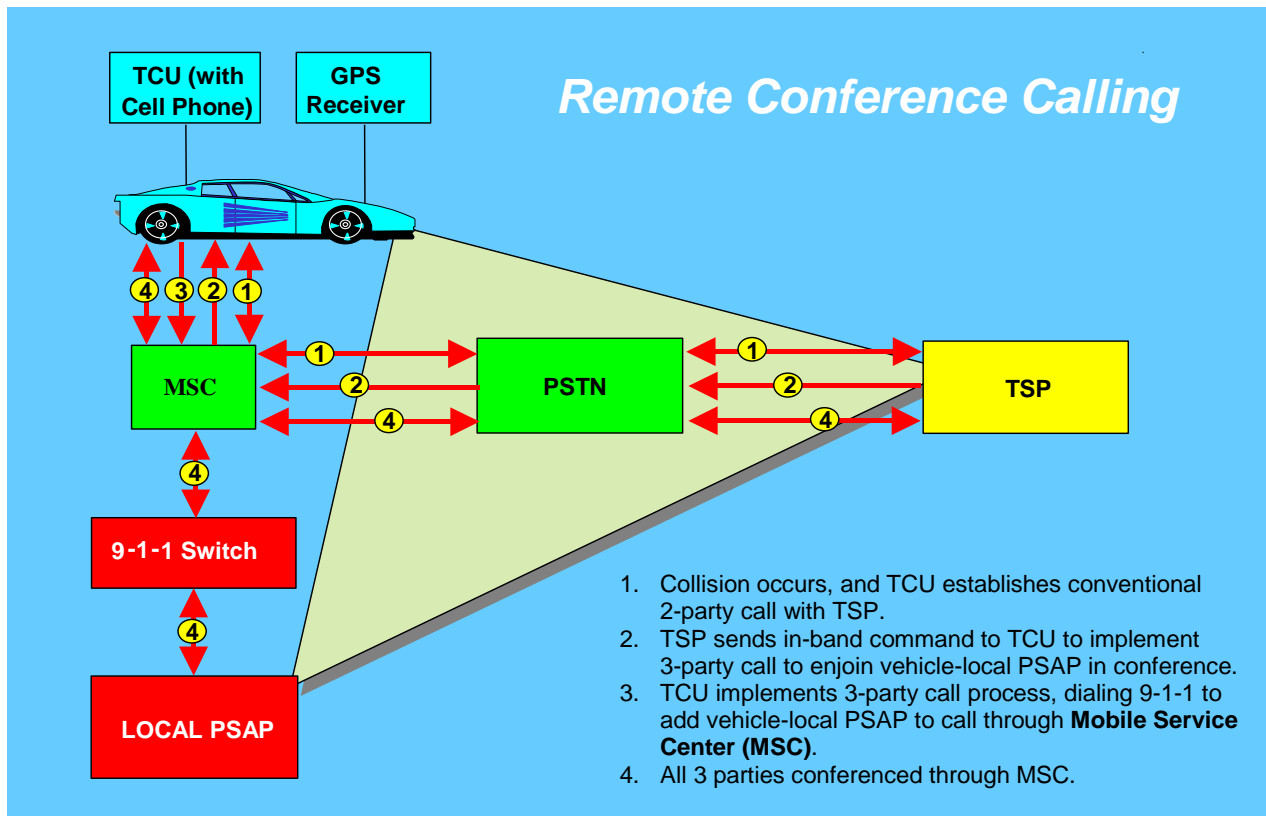
3.2.2 Remote Conference Calling Procedure

3-way calling (aka 3-party calling) is an existing, ubiquitous service offered by cellular carriers as a standard feature of their service packages. The feature allows a party on any 2-party call to “conference” a third party into the call so that all three are able to communicate. Remote Conference Calling takes advantage of this feature in such a way as to allow direct 3-way connection between an ACN-equipped vehicle, its associated TSP, and the vehicle’s local PSAP ... connecting to the PSAP over existing, local 9-1-1 trunks maintaining high level carrier quality audio through the carrier’s conferencing bridge.

3.2.3 Application

Assume that an ACN-equipped vehicle has just been involved in a serious collision, and that its ACN TCU has made cellular contact with the TSP serving the vehicle. The TCU would then set up a 3-party conference call with 9-1-1, and two important things would result. First, it is the vehicle’s local PSAP that would be enjoined in the call, since 9-1-1 would have been dialed from the vehicle; and second, a conference connection would be established between the TSP, the vehicle, and the vehicle’s local PSAP. Please see the illustration, below.





This action by the TCU can be initiated in any of the following ways:

- the TCU can set up the 3-party call upon receiving a signal from the TSP agent to do so following confirmation by the agent of a need for PSAP intervention; or
- the TCU can immediately set up the 3-party call on its own; or
- a combination of these two methods, based on predetermined severity protocols/priorities pre-programmed into the TCU.

Manually, the reader can set up a 3-way call as follows. In the midst of any 2-party wireless call, clear the dialing display, dial the number of the party to be conferenced into the call (9-1-1, if an actual ACN event), and press [Send]. When the third party (PSAP, if an actual ACN event) answers (or after 2 seconds), press [Send], again. All three parties are then enjoined in the conversation. The connection is made by the carrier's wireless switch.

Upon receiving an in-band command from the TSP to set up a 3-way conference call with 9-1-1, a distressed vehicle's ACN TCU fully and automatically implements the "manual" process just described, enjoining the TSP, the vehicle, and the PSAP in a carrier quality, 3-way conference call ... set up by dialing 9-1-1 from the vehicle, itself.

The PSAP may disconnect from the call at any time without affecting the connection between the TSP and the vehicle. Similarly, the TSP may disconnect from the call at any time without affecting the connection between the PSAP and the vehicle. The call is terminated in its entirety when the vehicle disconnects from it. The TSP can choose to maintain control over the call by simply staying on the line, and continuing its remote control of the vehicle's ACN System and associated cellular subsystem.

3.2.4 Impact

No changes of any kind are required in the E9-1-1 infrastructure or in the cellular network to implement this procedure. Nor are any hardware changes or additions required in the TCUs that are being installed in vehicles. The only change that must be made is that the programming of Telematics Control Units must incorporate the ability to perform the functions described.

3.2.5 Advantages

9-1-1 is dialed directly from the vehicle. Consequently:

- call routing is determined by local 9-1-1 authorities, conforming to local practice for wireless calls
- call is completely routed and delivered on the Nation's high priority 9-1-1 network
- vehicle's 10-digit call-back number is delivered with the call
- wireless Phase I and Phase II data is delivered as available
- 9-1-1 emergency dialing greatly reduces reliance on, and need for, 10-digit PSAP databases
- no changes need to be made to the network or at the PSAPs

3.3 ACN Communications Using TTY (ACNovations)

3.3.1 Overview

This proposal describes a method for directly communicating digital text data from a vehicle to a PSAP in a form that can be received, understood, processed, and recorded by the PSAP. The method also supports the sending of key-tap commands (see 3.3.8g) from a PSAP to an ACN-capable vehicle to control predetermined functions of the vehicle.



The method uses only equipment and infrastructures

that are already fully in-place and in-operation. This method does not require any changes or additions to PSAPs, nor does it require any changes or additions to telecommunications infrastructures or processes.

To accomplish these ends, the method promotes the shared use of existing TTY equipment and procedures ubiquitous to the nation's PSAPs. It has been dubbed **ACN/TTY**. See 3.3.8f for background information on TTY.

3.3.2 Background

The concept of a vehicle's Telematics Control Unit (TCU) dialing directly into the 9-1-1 network has been difficult to bring to fruition for lack of a universal way to deliver data to PSAPs without modifications to the 9-1-1 network and/or receiving equipment at the PSAP. If a 9-1-1 call were to be received without data today from an ACN vehicle, and if the vehicle's occupants were unconscious or incoherent, the PSAP calltaker would answer a silent line, and would most likely terminate the call.

In 1990, the Americans with Disabilities Act (ADA) were signed into law. The Act prohibits discrimination against people with disabilities in employment (Title I), in public services (Title II), in public accommodations (Title III) and in telecommunications (Title IV). Title IV has been and is being enforced to require that all PSAPs be equipped with TTY equipment in order to be capable of telecommunicating with hearing and speech impaired persons. Consequently, all PSAPs must already be equipped for TTY telecommunications, as required by Federal law since 1990.

3.3.3 Introduction

Not all ACN-equipped vehicles will necessarily be subscribed to a Telematics Service Provider (TSP). Consequently, it is essential that ACN-capable TCUs be able to dial directly into 9-1-1 and to directly convey helpful data to PSAPs in the absence of a TSP.

It is essential to the nation's 9-1-1 systems that any ACN/PSAP process be ubiquitously compatible. What works when 9-1-1 is dialed in Pennsylvania must also work when 9-1-1 is dialed in California ... or Michigan, etc. There are more than 6,500 PSAPs in the United States. Upgrading all of the nation's PSAPs and network infrastructures to accommodate technologies not now in place for receiving and processing downloaded ACN data would be prohibitively expensive and disruptive. Realistically, it seems unlikely it would happen anytime in the near future.

Additionally, it would be quite beneficial for a PSAP calltaker to be able to remotely execute certain command functions over a remote, crashed vehicle. A couple of examples include: unlocking the vehicle's doors; and switching back/forth between voice and data. Commands are simple key tap sets that may be executed manually or automated (see 3.3.7g). Initiation of a 9-1-1 call by a vehicle's ACN TCU would automatically enable its (normally disabled) remote-command-compliance function for the duration of the incident. In some cases, such remote, PSAP-initiated



command functions will help prevent complications from escalating into problems that could have been totally avoided.

3.3.4 Application

The already-fully-in-place ubiquity of TTY throughout the nation's E9-1-1 systems provides an established infrastructure that can be exploited for ACN data communications. Configuring ACN-capable vehicles to transmit telematics ACN data to a PSAP in TTY format requires only that the necessary programming code be added to a TCUs expanded firmware. Doing so represents an essentially insignificant cost and disrupts no existing services or infrastructures. Since the nation's PSAPs and communications infrastructures are already TTY capable, all necessary information could then be transferred directly from a vehicle's telematics system to any PSAP in the nation with no changes or additions required in the operation or equipment of those PSAPs.

Additionally, this process does not depend upon a national spatial routing database that requires constant, non-regulated updating. Implementation requires only an application software upgrade in vehicle telematics devices. The process has been successfully field-demonstrated on multiple occasions (see 3.3.7a). This solution, in and of itself, provides a means by which ACN data can be communicated today to a PSAP in digitized text form without any action by the occupants of the vehicle.

Direct ACN/TTY 9-1-1 dialing would be triggered in conformance with pre-approved multi-factor algorithms approved by the public safety community to eliminate any incident created by accidental air bag deployment ... or by any single, uncorroborated indicator of a collision.

Incident data, arriving at a PSAP via TTY signaling, can be read off the screen immediately ... as it's arriving. Consequently, there is no perceptual delay in the receipt and comprehension of the information being delivered. TTY signaling proceeds at a rate of a little over 6 characters per second. That's about a word and a half per second, which is just about the average rate of reading comprehension for most people. In other words, the data comes in just about as quickly as it can be read and absorbed by the average person.

A typical, conventional TTY call begins with the repetitive sending of two Baudot bit frequencies (1400 and 1800 Hz), comprising a message precursor. The exact content of this message precursor is unimportant, and no formal standard exists for it (see 3.3.7b); however, the "warbling" presence of repetitive Baudot frequencies on a call is distinctive and easily identifiable, both by the human ear and by automated detection devices.

Once TTY communications have been established, the PSAP calltaker can send TTY commands back to the ACN system in the vehicle from any standard TTY keyboard, causing both ends to switch back-and-forth between Voice Mode and TTY Mode ... at will ... and under PSAP control.



With subsequent, optional upgrades at PSAPs, voice and TTY data can be multiplexed and transmitted simultaneously, eliminating any need to switch between the two. This process is accomplished by separating the 300-to-3000 Hz. (see 3.3.7c) telephony audio band into two sub-bands/channels: a band centered on 1400 Hz. (ranging from about 1300-to-1500 Hz.) dedicated exclusively to TTY digital data; and the entire remainder of the audio band dedicated exclusively to voice. See 3.3.7d for detailed, background information.

In this multiplex mode, only the 1400 Hz. frequency need be used to transmit data. Its 1800 Hz. conventional TTY counterpart is unnecessary. A technique known as Binary Amplitude Shift Keyed (BASK) modulation is employed to define the data bits in the data stream. Using only the single 1400 Hz. frequency optimizes the bandwidth dedicated to voice by narrowing the bandwidth that must be dedicated to data (i.e., a 200 Hz. slice centered on 1400 Hz.). Utilizing the 1400 Hz. frequency, as opposed to the 1800 Hz. frequency, avoids defiling the critical 1800-to-2500 Hz. “strongest consonant range” of speech (see 3.3.7e).

Complementing conventional TTY signaling with multiplexing to transfer ACN data provides an ideal, fully transitional solution to the problem. Conventional “basic” TTY signaling (see “Illustration 1”) is used to initiate ACN contact with 9-1-1 facilities, via which method any existing PSAP can receive and display any/all ACN information transmitted, whether or not upgraded to multiplexing capabilities.



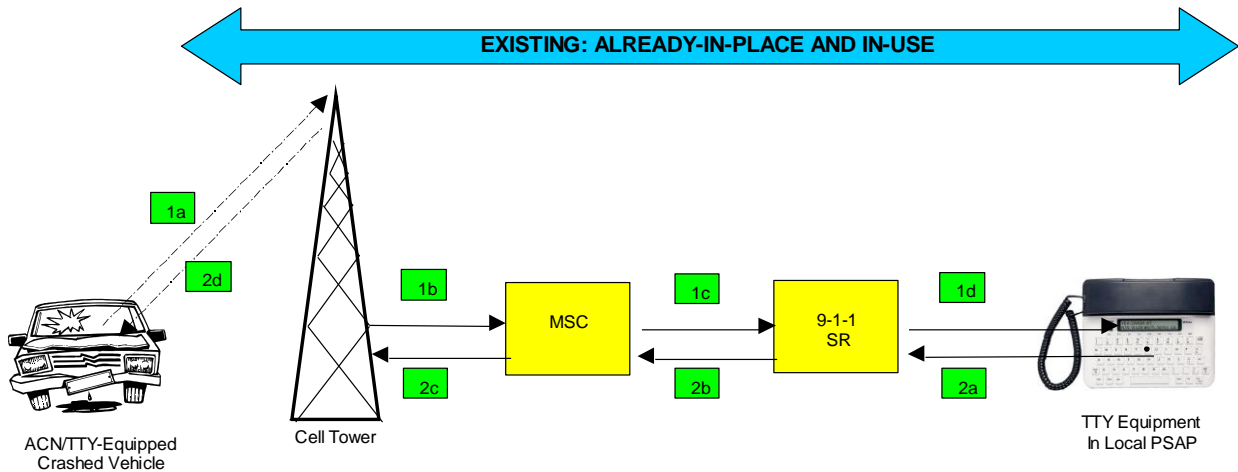


ILLUSTRATION 1: BASIC ACN/TTY

This illustration describes ACN/TTY in its most basic form. See 3.3.7h.

1. When crashed vehicle's ACN-capable Telematics Control Unit (ACN/TCU) detects and confirms a collision, it dials 9-1-1, is placed in direct contact with Local PSAP (1a, 1b, 1c, and 1d), and sends predetermined ACN data to TTY Equipment in Local PSAP.
2. PSAP can then send keytap TTY commands back to vehicle's ACN/TCU (2a, 2b, 2c, and 2d). A few examples include: switch to voice mode; unlock car doors; turn engine off; (re)send location; etc. PSAP can continue issuing commands to vehicle, including switching back-and-forth between voice and TTY modes at will. Vehicle's ACN/TCU self-enables its remote-command-compliant mode when it automatically dials 9-1-1.

If/when a PSAP does decide to upgrade its equipment to enable multiplexing and automated detection of ACN data on the line, such a PSAP can instantly and automatically switch to the multiplexing mode on a call, whereupon it can immediately initiate voice communication while simultaneously receiving ACN data on the data channel. Thus, such "upgraded" PSAPs can start to receive data and initiate voice contact with the occupants of a crashed vehicle immediately upon answering an incoming ACN call (see "Illustration 2").

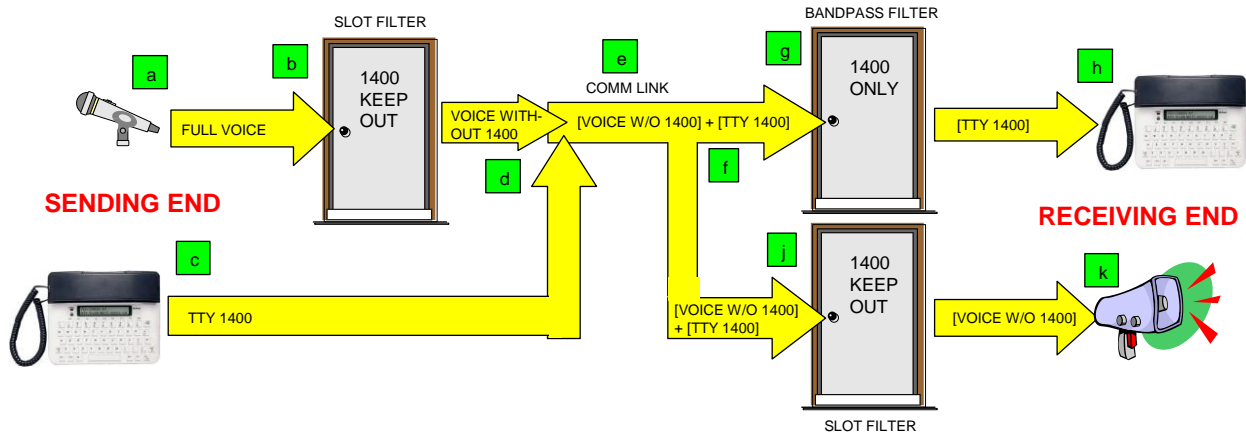


ILLUSTRATION 2: (OPTIONAL) MULTIPLEXED VOICE + TTY (ADVANCED ACN/TTY)

1. Full-spectrum, normal voice frequencies are generated, 'a', at the Sending End and passed through slot filter 'b'. The filter blocks a tight band of frequencies, centered on 1400 Hz., but passes all other voice frequencies.
2. TTY-capable device 'c' can send signals at the same time, generating (only) a precise 1400 Hz. Signal (TTY 1400).
3. At point 'd', the voice signal (which has no 1400 Hz. component) is merged with the TTY 1400 signal, and the mixed signals are transmitted over communications link 'e' to the Receiving End.
4. At the Receiving End, the mixed signals are passed through two filters, 'g' and 'j'.
5. Filter 'g' is a 1400 Hz. bandpass filter, which allows only the 1400 Hz. TTY signal through, blocking all of the transmitted voice frequencies, and passing the clean 1400 Hz. Signals to TTY-capable device 'h' at the Receiving End.
6. Filter 'j' blocks the 1400 Hz. TTY signal, but passes all of the transmitted voice signals to speaker 'k', producing voice audio devoid of TTY 1400 signal tones.
7. For ACN communications, the PSAP is the Receiving End when the vehicle is the Sending End, and the vehicle is the Receiving End when the PSAP is the Sending End. Vehicle and PSAP must each be equipped for both Sending and Receiving.

Further, if a PSAP has upgraded its equipment to be able to communicate in multiplex mode, there is no reason why the same upgrade standard cannot also switch communications protocols ... to any other set of protocols. As one example, Binary Amplitude Shift Key (BASK)/Baudot signaling might still be used, but the Baud rate increased to facilitate more rapid data transfer, such as 110 Baud instead of the conventional 45.45 Baud rate. Similarly, such an upgrade standard can also incorporate an error detection process (checksum) to flag data bit errors, automatically recognizing/rejecting bad data, and initiating corrective action (e.g., request resends, etc).

A comprehensive preliminary set of protocols already exists, created to govern the Connexis field demos described briefly in 3.3.8a. Representatives of the automotive and telematics industries can join with representatives of the E9-1-1 sector in a cooperative effort to modify or replace these existing protocols.

Capabilities beyond "Basic ACN/TTY", described above, will be referred to as Advanced ACN/TTY capabilities. Such Advanced ACN/TTY capabilities should be incorporated in TCUs integrally with

Basic ACN/TTY. Then, at any subsequent time, a simple runtime command from an “advanced” PSAP will automatically switch a vehicle’s ACN TCU from Basic TTY mode into Advanced ACN/TTY mode. Such a scheme allows an easy, smooth transition from current to more advanced equipment and technology at each individual PSAPs own best rate ... when each individual PSAP is ready to upgrade (if ever) ... without affecting any other entities, systems, or infrastructures.

Co-applying TTY resources for the transmission of ACN data is a process that is particularly well suited to PC-based E9-1-1 Intelligent Work Stations. Typically, such PC-based terminals directly import TTY communications, displaying the results on their screens. Many also incorporate integrated mapping capabilities. Such terminals can easily parse location information from the incoming ACN/TTY data stream, and automatically map the location on the screen for the calltaker. This function-ability has been successfully demonstrated in field tests [see 3.3.7a, sub-notes 1) and 2)].

3.3.5 Impact

As stated previously, the nation's PSAPs are already TTY capable, and all necessary information can be transferred directly from a vehicle's telematics system to any PSAP in the nation as is ... i.e., requiring no changes or additions to the operation or equipment of those PSAPs. If/when a PSAP facility upgrades its equipment to permit multiplexing, simultaneous voice and data communications are made possible, and data communications can be made at increased Baud rates.

Perhaps most important is the fact that a migration path is inherent in this methodology, thereby permitting the most basically equipped PSAP to upgrade to Advanced ACN/TTY at its own pace. If and when it’s ready to do so, it needs simply to upgrade its own equipment ... requiring no changes to the infrastructure (i.e., the existing PSTN and then-existing vehicular telematics systems). In the meantime, any PSAP can still receive all transmitted ACN data and can send back commands to ACN-equipped vehicles.

Regardless of evolving technology as we move forward to NG9-1-1, it seems unlikely voice-band TTY communications will become obsolete in the foreseeable future. Existing voice-band TTY equipment and its use are too deeply invested in the traditions and pocketbooks of the speech-and-hearing-impaired community. Consequently, whether viewed as a currently deployed medium that can be exploited to transmit ACN data or as no more than a transitional step to more advanced means, it seems highly unlikely the use of TTY will become obsolete for a very long time.

Even next generation 911 (VoIP) networks must maintain the logical voice channel ... the channel also used for ACN/TTY.

In summary the viable direct dialing of 9-1-1 by a vehicle's telematics/ACN system is completely feasible and ready-for-use today and in the future without any changes to the 9-1-1 network or to the nation’s PSAPs.



3.3.6 Advantages

Once firmware (application program) has been included in a vehicle's TCU, all other equipment and elements required for complete functioning are already in place and in use.

Consequently, ACN/TTY:

- requires no funding
- is immediately ubiquitous
- is immediately usable
- is fully compatible with all systems delivering voice
- is compatible with the transmission of ACN and/or supplemental text data:
- directly from a crashed vehicle to a PSAP
- directly from a TSP to a PSAP

3.3.7 Reference Notes

- a. All of the following demonstrations were conducted successfully. Each included multiple transmissions of ACN Data via 9-1-1 cellular calls routed by the local E9-1-1 system to the PSAP indicated. All transmissions successfully communicated predetermined ACN parameters to the PSAP. All transmitted ACN Data was simulated ... i.e., vehicles were not actually crashed. Pre-recorded, canned data was transmitted in Demo Items 1 and 2. Real-time data was transmitted in all other demo items. TTY commands were successfully transmitted from PSAP-to-vehicle in Demo Items 3 and 4. Demo Items 3 and 4 were conducted by Connexis (see <http://www.connexis.com>).
 - 1) Demonstrations at Gloucester County PSAP (New Jersey) on 10/4/05.
 - 2) Separate demonstrations at Burlington and Camden Counties' PSAPs (New Jersey) on 10/5/05.
 - 3) Expanded demonstrations at Burlington County PSAP (New Jersey) on 3/8/06. Expanded capabilities included concepts complementing and providing a redundant back-up source for the direct transmission of data from vehicles to PSAPs (details are outside the scope of this paper).
 - 4) Demonstrations similar to those on 3/8/06 were conducted in Michigan on 5/24/06 and 5/25/06.
- b. The informal standard for the TTY "message precursor" comprises repeated taps on the space bar.
- c. Typically, the telephony voice band is considered to encompass 300-to-3000 Hz.
- d. Back in the 1970's, Motorola developed a frequency-division-multiplexing process for sending telemetry signals completely within the telephony voice audio band. EKG traces were transmitted, simultaneously with voice and mutually without interference, from remote on-site paramedic units to overseeing doctors in emergency rooms. This process is still in use today.



This voice-plus-EKG process is accomplished by separating the 300-to-3000 Hz. (see 3.3.7c, above) telephony voice audio band into two sub-bands/channels: a band centered on 1400 Hz. (ranging from about 1300-to-1530 Hz.) is dedicated exclusively to the telemetry channel; and the entire remainder of the audio band is dedicated exclusively to voice. A 1400Hz. carrier is amplitude-modulated by the (very low frequency) EKG signal and transmitted on the telemetry channel from the remote paramedic unit to the hospital. Usurping this particular slice of the voice spectrum from the voice channel leaves the critical speech “intelligibility ranges”^o untouched (see 3.3.7e, below).

Paramedics at a remote treatment site can converse, free of mutual interference, with an overseeing doctor in a hospital ER as that doctor simultaneously views the patient’s EKG in real-time.

Similarly, for this ACN/TTY application, the 300-to-3000 Hz. telephony audio band can be separated into two voice-plus-TTY sub-bands/channels: a band centered on 1400 Hz. (ranging nominally from 1300-to-1500 Hz.) dedicated exclusively to **TTY digital data**; and the entire remainder of the audio band dedicated exclusively to voice.

In the multiplex mode, only the 1400 Hz. frequency is used to transmit data. As explained in the text, the **Binary Amplitude Shift Keyed (BASK)** modulation technique is employed to define the data bits in the data stream.

- e. More information on the topic of speech intelligibility can be gleaned from a 2005 paper by Meyer Sound Laboratories, Inc., entitled "Factors That Affect Intelligibility in Sound Systems". The paper states that the two "heavy" voice bands are 135-to-400 Hz. (fundamental range) and 1800-to-2500 Hz. (strongest consonant range).
- f. The acronym "TTY" describes devices, protocols, and systems used for two-way text conversation over the PSTN. Such devices (with associated protocols) are also referred to as text telephones. The term TTY came into use in the U.S. because the technology was borrowed from the Teletypewriter industry. TTY devices and protocols are the primary tools used by speech or hearing impaired people for telephone conversation. The dominant TTY protocol is ANSI/TIA/EIA 825, entitled "A 45.45 Baud FSK Modem"; however, other protocols are also used. Some examples include: TurboCode; HiSpeed; and Bell 103. The ITU/CCITT (the International Telecommunications Union, formerly the International Telegraph and Telephone Consultative Committee) has approved V.18, a standard that promotes universal design by incorporation of TTY into digital products. In addition to supporting 45.45 and 50 TTY Baud rates, it supports DTMF, EDT, V.21, and V.23 standards, which are used in Europe. As used herein, the term TTY refers to any and all such devices and protocols used for text conversation over the PSTN by speech or hearing impaired people.
- g. ACN/TTY key tap commands are 4-character commands of the form s[]s[], where [] represents a command-specific text character (occurring twice in the code sequence). Each



such code set can be quickly/easily entered on a keyboard by rocking two fingers back-and-forth, (at least) twice, between the “s” key and the command-specific key represented by the square brackets []. A few sample commands used in prior demonstrations (see 3.3.7a, above) include:

- **stst**, which means “switch to **T**alk (voice) mode;
 - **sIsl**, which means (re)send **L**ocation; and
 - **sksk**, which means goodbye, hang up and terminate the call.
 - Obviously, many other commands can be sent in the same format. The key combinations are selected to be unique, and not normally found in ordinary human text. Another important example is **smsm**, which means switch to **M**ultiplex mode (or any other communications protocol predetermined by a combined telematics and 9-1-1 cooperative group).
- h.** Illustration 1 depicts the most basic form of ACN/TTY. Basic ACN/TTY requires no upgrades to function fully at a PSAP. It also comprises the initial contact mode for switching to multiplexed TTY mode ... or to some other communications protocol (see 3.3.7g, immediately above). Protocol switching applies only to PSAPs that have elected to upgrade to more sophisticated communications. In such cases, the initial contact phase of an ACN/TTY communication can be fully automated so that it occurs transparently to the calltaker within the first 1 or 2 seconds of the call. Similarly, an appropriately upgraded system can parse the incoming text for location information, and then map it automatically on the calltaker’s screen.

3.4 Native 9-1-1 Delivery Using Voice over Internet Protocols (VOIP), (TCS)

3.4.1 Overview

This solution provides a means to route emergency calls from a TSP Call Center (CC) to the correct E9-1-1 Tandem via Voice over Internet Protocols (VoIP) and a nationwide network of Emergency Service Gateway (ESGWs). Based upon the NENA VoIP i2 architecture, emergency wireless calls arriving at the TSP CC can be converted to VoIP, and thus transported to any local ESGW, to be converted back to Time Division Multiplex (TDM) and delivered to the E911 Selective Router for delivery to the PSAP via the E911 network. Through the use of Emergency Service Query Key (ESQKs), this solution allows the PSAP to retrieve ALI data via steered queries to a VoIP Positioning Center (VPC). This solution requires no changes in the current operational procedures at the TSP CC, although it is possible to enhance the current operations if the TSP CC desired to do so via an Extensible Markup Language (XML) over TCP/IP interface to access the VPC. The specification for this interface could be Vehicle Emergency Data Set (VEDS), developed by



ComCare and various telematics providers. This interface is an open specification and has been made available to NENA.

3.4.2 Solution Description

When an emergency call from a Telematics equipped car arrives at a TSP CC, it contains data that is pertinent to the location of the caller as well as collision information. The collision information provides that is critical in evaluating the potential severity of the emergency. When the TSP attendant receives these calls, they first determine if the call is an emergency by talking with the person(s) within the vehicle (if the person is not speaking, the attendant can view the collision data for an indication of an accident). If it is determined to be an emergency, then processing the call to route based on location begins. The following paragraphs describe the solution.

When the TSP CC attendant determines the call is an emergency, they request routing instructions from an Emergency Routing Data Base (ERDB). The ERDB can be an existing local database used by the TSP CC for determining call routing, or it can be a remote ERDB provided by a third party. The telematics equipment in the vehicle will generate a lat/long. The ERDB will enter the lat/long into the ERDB database, which will identify the correct PSAP for that location. Alternatively, this process can be automated. The PSAP will be identified by a dialable 10-digit number. The TSP CC operator will initiate a three-way conference with that PSAP by dialing the designated number.

The call will be routed to a VoIP call server. The server can be accessed via the Public Switch Telephone Network (PSTN) or it may be internal to the equipment at the TSP CC. If the call server is accessed via the PSTN, the call server will query a VPC for call routing instructions, and provide the VPC with the callback number of the TSP CC. If the call server is accessed via VoIP, the TSP CC could forward location info and other call details using VEDS or NENA i2 standards.

Based on the dialed phone number from the TSP CC, the VPC determines the intended PSAP and selective router and then assigns an ESQK, ESRN, and Last Routing Option (LRO), per NENA i2 standards. The VPC stores all the received data and returns to the call server an Emergency Service Query Key (ESQK), used to identify the serving PSAP (similar to an Emergency Service Routing Key (ESRK)), and an Emergency Service Routing Number (ESRN), used to route the call to the correct E9-1-1 Tandem.

Using the ESRN and ESQK from the VPC response message, the VoIP call server establishes Real-time Transport Protocol (RTP) across the internet and delivers the call to the appropriate ESGW, which converts the call from Session Initiated Protocol (SIP) to TDM and routes the call to the correct selective router as determined by the ESRN. The Selective Router uses the ESQK to query the Selective Routing Data Base (SRDB) to determine the correct PSAP. The call is then routed to the PSAP and the ANI (ESQK) is transmitted with the call to the PSAP. The PSAP queries the Automatic Location Identification Database (ALI DB) with the ESQK. The ALI DB is provisioned to

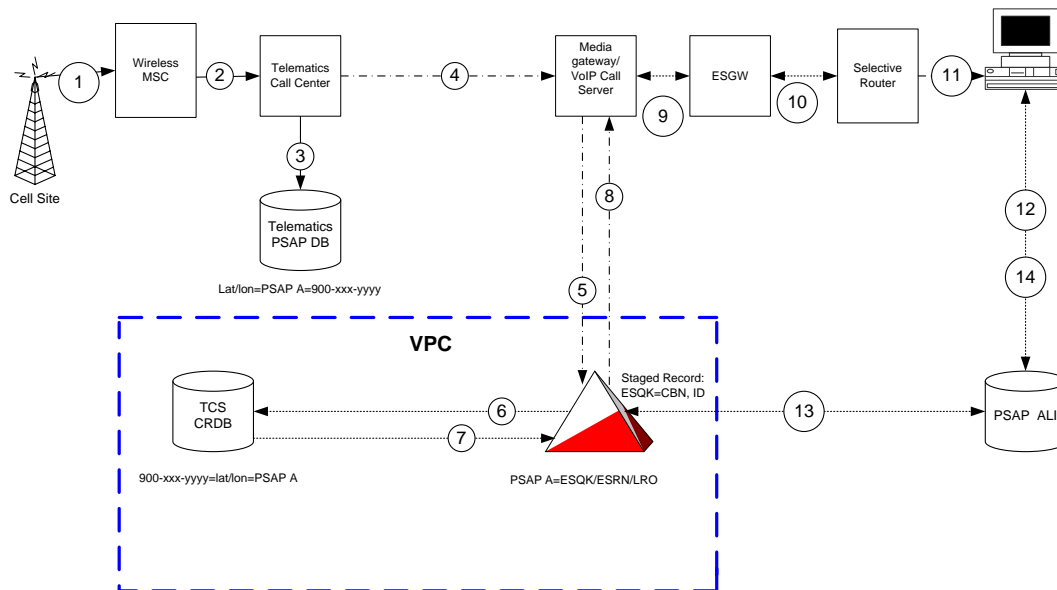


steer ESQK queries to the VPC using the existing ALI protocol (PAM, VE2, NENA or XML). The data associated with the ESQK is retrieved from the VPC and sent back to the ALI DB, which in turn forwards the ALI record to the PSAP.

In the most rudimentary form, the ALI record presented to the PSAP would include the TSP 24x7 call back number (CBN), and identification of the TSP. The telephone number assigned to the vehicle is non-dialable and the only access to the person in the vehicle is through the TSP CC; hence, why the TSP 24x7 call back number is essential. Depending upon the data transmitted from the TSP CC to the VPC, additional ALI data could include the lat/long of the incident, plus some minimal additional data that could be parsed into various supplemental fields in the ALI message.

3.4.3 Call Flow

The figure below depicts what the above text described:



The call flow details follow:

1. A telematics device initiates a call to a local cellular tower which is forwarded to the serving MSC. This causes a wireless call to be sent to the PSTN network.
2. The call is routed through a Mobile Switching Center (MSC) to the local End Office (EO) serving the TSP CC.
3. The call received at the TSP CC consists of the location, data from the collision, and the voice call. The attendant at the TSP CC receives the call and determines emergency help is required. The attendant queries the local ERDB with the location of the caller (lat/long) to

determine which PSAP should receive this call. The ERDB provides the PSAP info and a 10-digit phone number for that PSAP.

4. The attendant establishes a conference call by dialing the 10-digit number. The call is passed via the PSTN to a VoIP call server.
5. Based upon the dialed digits, the VoIP call server determines that this is an emergency call and queries the VPC for routing instructions by forwarding the dialed digits.
6. The VPC queries the ERDB to determine the proper PSAP based upon the forwarded digits.
7. The VPC assigns an ESQK designated for that PSAP and stages a record with the ESQK and CBN and NENA ID of the telematics provider.
 8. The VPC responds to the routing query with the ESQK, ESRN and LRO.
9. The VoIP call server uses the ESRN to determine the appropriate ESGW and routes the call appropriately.
10. The ESGW converts the SIP protocol to TDM, and uses the ESQK to determine the correct PSAP and routes the call appropriately.
11. The selective router delivers the call and the ESQK to the PSAP
12. The PSAP queries the ALI database with the ESQK.
13. The ALI steers the query to the correct VPC per the ESQK. The VPC responds to the ALI query with the staged ALI record for that ESQK.
14. The ALI forwards the data to the PSAP.

3.4.4 Benefits

- Delivers the call as native 9-1-1 using the ESRN over existing voice facilities.
- Passes a key with the initial voice call that allows for retrieval of ALI data when the call is delivered to the PSAP
- ALI data includes a callback number to the TSP CC, TSP provider name, Incident ID (IID) and, optionally, lat/long and collision information
- The IID can be used to retrieve additional data, if applicable (possible web interface from PSAP to a secure site for the collision data or other)
- No new software to any 9-1-1 entity or LEC interfaces.
- A single, nationwide solution using existing infrastructure that is not reliant upon individual LECs to adopt new procedures or routing protocols.
- Treatment of enhanced vs. basic PSAPs is transparent to the TSP CC.



4 References

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