# Next Generation 9-1-1System
# Preliminary Concept of Operations

## 1 Scope

The purpose of this document is to provide a preliminary Concept of Operations for the Next Generation (NG9-1-1) system (or "system of systems"). The U.S. Department of Transportation (DOT) understands that access to emergency services provided by 9-1-1 in today's world of evolving technology will ultimately occur within a broader array of interconnected networks comprehensively supporting emergency services, from public access to those services, to the delivery and facilitation of the services themselves. More specifically, DOT views NG9-1-1 as expanding and improving the capabilities of Public Safety Answering Points (PSAPs) through new internetworking[1] technologies. The *Next Generation 9-1-1 Initiative* is a DOT research and development project to define the system architecture and develop a transition plan that considers responsibilities, costs, schedule and benefits for deploying IP-based emergency services across the Nation. This project is leveraging work from DOT's earlier Wireless E9-1-1 Initiative, which has enhanced location capability for 9-1-1 calls placed from wireless phones.

The Federal Communications Commission (FCC) Network Reliability and Interoperability Council VII (NRIC), National Emergency Number Association, the Internet Engineering Task Force (IETF), and the Alliance for Telecommunications Industry Solutions (ATIS) Emergency Services Interconnection Forum (ESIF) have consensus-based efforts underway to develop requirements and standards for public safety, 9-1-1, and other emergency services networks. DOT expects that the products of these consensus efforts will form the foundation for NG9-1-1 Initiative engineering and demonstration projects.

The NG9-1-1 Concept of Operations is a formal document that provides a user-oriented vision of NG9-1-1 within the context of an emergency services internetwork that can be understood by stakeholders with a broad range of operational and technical expertise. It is intended to communicate the vision of this system to stakeholders so that they can be actively engaged in its development and deployment. It also serves as the foundation for the development of the NG9-1-1 requirements and to drive the design of the overall system. This document will be updated throughout the NG9-1-1 Initiative effort, as the thinking related to the implementation of NG9-1-1 capabilities becomes clearer and more precise. It is expected that under procured work to design NG9-1-1 applications, this

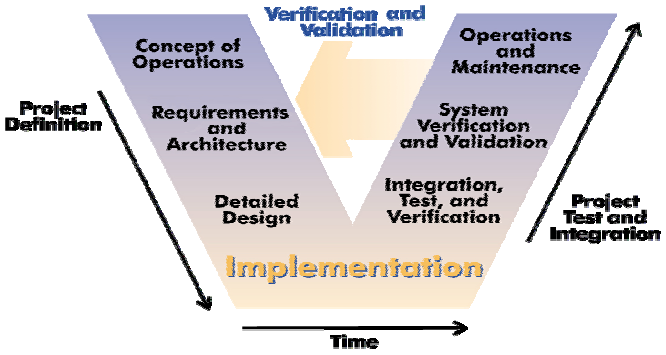



**Figure 1-1. Systems Engineering Process**

[1] "Internetwork" – to go between one network and another; a large network made up of a number of smaller networks.

document will be used as supplemental information, and will be revisited and refined into a more comprehensive NG9-1-1 ConOps document.

This outline follows the guidance in the recent Federal Highway Administration (FHWA) pooled fund study, *Developing and Using a Concept of Operations in Transportation Management Systems*,[2] which is based on the ANSI/AIAA standard, *Guide for the Preparation of Operational Concept Documents.*[3] The Concept of Operations is the first step in the systems engineering process promoted by FHWA (see Figure 1-1). The concept of operations describes broad goals, user needs, and the operating environment. It forms the basis for developing system requirements. Note: common usage in systems engineering has the terms "Concept of Operations Document" and "Operational Concept Document" as interchangeable terms.

The remainder of this document is divided into the following numbered sections:

2. User-Oriented Operational Description
3. Operational Needs
4. System Overview
5. Operational Scenarios
6. Source References

## 1.1 Purpose for Implementing a Next Generation 9-1-1 System

Trends in telecommunications mobility and convergence[4] have put the 9-1-1 system at a crossroads. The growing market penetration of both cellular and Voice-over-Internet-Protocol (VoIP) telephony have underscored the limitations of the current 9-1-1 infrastructure. The Nation's 9-1-1 system, based on decades-old technology cannot handle the text, data, images, and video that are increasingly common in personal communications and critical to future transportation safety and mobility advances. The current 9-1-1 system ". . . is an analog technology in an overwhelmingly digital world."[5]

**Table 1-1. Current and NG9-1-1 System Capabilities**

| Today's 9-1-1 | Future 9-1-1 |
|---|---|
| *Primarily voice calls via telephones* | *Voice, text, or video from many types of communications devices* |
| *Minimal data* | *Advanced data capabilities* |
| *Local access, transfer, and backup* | *"Long distance" access, transfer, and backup* |

Many of the limitations of the current 9-1-1 system stem from its foundation on 1970s circuit-switched network technology. Presently, convoluted systems are used to deliver 9-1-1 calls [6] and any location data for landline voice, landline teletype/telecommunications device for the deaf (TTY/TDD), wireless/cellular voice and

[2] Version available at http://tmcpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=38%20&new=0 on September 02, 2005.
[3] Available (for a fee) at http://webstore.ansi.org/ansidocstore/product.asp?sku=G%2D043%2D1993
[4] "Convergence" is the integration of traditional telecommunications and newer information technology services.
[5] Dale N. Hatfield, former FCC Office Chief; *A Report on Technical and Operational Issues Impacting the Provision of Wireless Enhanced 911*, October 2002
[6] The term "call" is used in this paper indicate any real time communication – voice, text, or video -- between a person needing emergency assistance and a PSAP communications officer.

VoIP 9-1-1 to the Public Safety Answering Point (PSAP). These are described briefly in Table 1-2. Each introduction of a new access technology (e.g. wireless) or expansion of system functions (e.g., location determination) requires significant engineering and system modifications.

**Table 1-2. Four Ways to Access 9-1-1 Today**

| Access Technology | Description |
|---|---|
| Landline telephone | Plain old telephone system. 9-1-1 call routing based on local exchange carrier subscriber data, which is also the source of location information |
| Landline TTY/TDD | Real time, or "conversational" text. Uses landline phone system infrastructure and 9-1-1 call routing. Requires a special TTY/TDD for the caller and the PSAP call taker. |
| Wireless | Voice calls via mobile, radio-based phones. 9-1-1 call routing is based on cellular tower location and/or mobile positioning equipment. |
| VoIP | Voice calls sent via IP-network access infrastructure. 9-1-1 call routing based on customer subscriber data. As of fall 2005, a few VoIP providers could deliver ANI and ALI information through the 9-1-1 network in some locations. |

There appears to be consensus within the 9-1-1 community on the shortcomings of the present 9-1-1 system and the need for a new, more capable system. There is general agreement on the need to take advantage of advances in information and communications technologies.

## 1.2 Major Goals and Objectives

The primary goal of the NG9-1-1 System is to save lives, health and property by improving emergency services access and response in the United States. The state of the NG9-1-1 system also has a major effect on transportation security, mobility, and efficiency.

The NG9-1-1 System objectives that will lead to this goal include:

- Enable E9-1-1 calls from any networked communication device.
- Enable geographic-independent call access, transfer, and backup among PSAPs and between PSAPs and other authorized emergency organizations.
- Encourage an open architecture, interoperable internetwork of all emergency organizations.
- Reduce emergency services capital, operating, and maintenance costs.

## 1.3 Assumptions and Constraints

There are two major assumptions and three major constraints for the NG9-1-1 System. One assumption is that the fundamental institutional and operational frameworks for 9-1-1 services will remain in effect. That is, local government agencies will serve as answering points to receive, assess, and redirect emergency calls from the general public to appropriate responders for help. The second major assumption is that communications services will increasingly be delivered by digital-devices over IP-networks. The 9-1-1 community must react to the evolving trends in personal communications, as the telecommunications market is not driven by 9-1-1.

**Table 1-3. Assumptions Summarized**

- 9-1-1 = local
- Communications = IP
- NG9-1-1 > 9-1-1
- Phased implementation
- No federal mandate

One major constraint is that there should be no degradation in current services and capabilities. The current system is highly reliable for the customers it serves. Legacy

communication services must continue to be able to access 9-1-1 as the PSTN will remain in service in some locations for many decades. A related constraint is that neighboring 9-1-1 systems must remain viable as NG9-1-1 is incrementally deployed by localities. The reliability, robustness and security of the 9-1-1 system must not degrade as new access technologies and corresponding risks and challenges are introduced into the system. The third major constraint is that federal regulatory actions should not be the primary driving force to implement NG9-1-1. That is, the operational and economic benefits should justify the public and private transition to NG9-1-1 and not critically depend on federal regulatory or funding incentives. Timely nationwide implementation, however, may depend on regulatory and/or funding policies.

## 1.4 Intended Audience

The intended audience for this document includes the entities involved in current 9-1-1 system planning, operations, and technology; the organizations that will be involved in the development of NG9-1-1, and the organizations that will operate or produce NG9-1-1 elements. The general public is an implicit part of the intended audience, as the NG9-1-1 System must ultimately serve their needs.

The potential developers of NG9-1-1 include at least the U.S. DOT and the organization(s) that respond to the Request for Proposals when it is posted, as well as any and all interested public and private entities involved or interested in the technological enhancement of the 9-1-1 system. An expanded version of this document, prepared once an agreement is in place to develop NG9-1-1, will provide more detail in this section.

## 1.5 System Boundaries for NG9-1-1

NG9-1-1 is expected to be an interconnected system of local/regional emergency services networks. The boundaries of emergency service networks may vary, depending on local requirements and organizational frameworks. However, at the core, each local NG9-1-1 network would include one or more PSAPs and the corresponding public safety dispatching capabilities.[7] Network interfaces will be needed for incoming calls, call transfer to other PSAPs or dispatch centers outside the local network, and access to databases and services outside the network

As is the case today, personal communication devices and commercial networks will remain outside the emergency services internetwork. These devices and networks will play an integral role as they interface with the NG9-1-1 network, but their deployment is beyond the scope of this project. Call access using these technologies will be enabled by corresponding standards, protocols, policies and operational procedures.

## 1.6 Overall Vision of NG9-1-1

USDOT believes that a fundamental reexamination of the technological approach to 9-1-1 is essential as our public safety emergency service networks struggle to accommodate the challenges of wireless communications and digital devices. Cellular service and most other commercial and public safety communications systems are

[7] Increasingly, PSAP and dispatch functions are co-located at a single facility.

transitioning to IP-based networks. These technologies should enable major advances in the ability of all users and public safety responders to send or receive critical information to, from and beyond the emergency services internetwork, such as emergency calls in American Sign Language via video or medically-relevant data transmitted from a vehicle crash.

The 9-1-1 system is, and will remain, primarily a local government and communications industry responsibility. But this local focus has resulted, in the past, in fragmenting the 9-1-1 system capabilities and limiting the ability to develop and invest in new technologies. The intent of USDOT is to promote the vision for the next generation 9-1-1 system and provide leadership and resources to work with the public and private 9-1-1 stakeholders to lay out the path to achieve a vision of a nationally interoperable emergency services internetwork.

USDOT's core vision for NG9-1-1 is that this new internetwork will provide the foundation for public emergency services in an increasingly mobile and technologically diverse society and ultimately enable enhanced 9-1-1 calls from most types of communication devices. Once implemented, the NG9-1-1 System will enable:

- Quicker and more accurate information delivery to responders;
- Better and more useful forms of information (data, images, and video);
- More flexible, secure and robust PSAP operations; and
- Lower public capital and operating costs for emergency communication services.

# 2 User Oriented Operational Description

## *2.1 Operational Overview*

The mission of PSAPs remains the same within an NG9-1-1 system – to receive emergency calls from the public, ascertain the nature, status and location of the emergency, and relay the call to the appropriate public safety dispatch center for response to the emergency. The call-related expectations of the PSAPs also remain the same – "calls" should be delivered to the proper PSAP within the seconds typical at many locations in the U.S. and arrive in formats that can be readily processed.

NG9-1-1 changes the core capabilities of emergency services in three areas – (1) types of calls received; (2) ability to transfer/receive calls from PSAPs outside the local region; and (3) capability to accept additional information designed to facilitate emergency services. These are expansions of current functions, not fundamentally new roles. Presently, most PSAPs can receive wireless and wire line 9-1-1 voice calls and TDD/TTY text calls and can transfer these calls to a limited number of local/regional alternate PSAPs and dispatch centers. However, there are notable differences among PSAPs on the information that can be accepted and processed with a call. For example, as of late 2005, more than 50% of counties in the United States cannot receive the location of a wireless 9-1-1 call in their PSAPs.

These changes in core capabilities will have operational implications. Some changes in operational processes and procedures will be necessary for handling the new types of

calls and data; for working with other emergency services organizations; and purchasing, maintaining and managing new technology systems. The present local/regional government framework for PSAP and public safety communications operations will likely continue. However, the new technical capabilities (e.g. remote call acceptance and transfer) remove some of the geographic constraints on current PSAP facility location. Conversely, these new technologies require that PSAP and emergency services personnel develop new and extended working relationships with diverse and unfamiliar agencies and organizations.

Although some aspects of PSAP call taking will change, it is unclear what the impact will be on call taker[8] workload. The growth of the wireless phone market in the mid 1990s led to an increase in 9-1-1 call volume. This was primarily due to the phenomena of multiple calls for some types of emergencies. For example, it is not unusual for a PSAP to receive 50 or more calls for a single motor vehicle crash. Although NG9-1-1 will permit many more ways to call 9-1-1, this will not necessarily result in more calls per emergency in the United States beyond what would already occur due to virtual ubiquity of landline and wireless phones. In this context, NG9-1-1 may foster a replacement of some calls from one communication medium to another medium.

The current financing paradigm for the 9-1-1 system operations will likely prove inadequate in the future. Surcharges, fees and taxes on telephone equipment and services fund a significant portion of the capital and operating costs for today's 9-1-1 system. Traditional landline telephone services are being replaced by wireless and VoIP services.[9] Consequently, the corresponding revenue stream for the 9-1-1 system is expected to decline. Moreover, there is reason to believe that telephony will eventually be a "free" application available to Internet users along with email, instant messaging, and other communications applications.[10] This would further undermine the telephone-dependency for 9-1-1 funding.

While new revenue sources will be needed in the future, the good news is that costs for 9-1-1 equipment and operations should drop due to the lower costs for IP-based equipment and infrastructure. The Federal Communications Commission's (FCC) Seventh Network Reliability and Interoperability Council (NRIC VII)[11] concluded that "[w]e believe there are significant cost savings to be achieved in mortality, morbidity,

[8] "Telecommunicator" and "communications officer" are other terms for these PSAP professionals.
[9] ACA International reports that 6 percent of U.S. households have replaced landline telephone service with wireless service (http://www.acainternational.org/?cid=6488). According to FCC, household telephone subscribership has declined by 3.1% from March 2003 to March 2005 (http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-258942A2.pdf ).
[10] September 2005, *The Economist* , http://www.economist.com/displaystory.cfm?story_id=4400704
[11] NRIC VII, a designated federal advisory committee, has been specifically asked to address the "future dependence of emergency communications networks on IP networks, and in particular, whether IP technologies should be used to get information to and from the PSAPs as communications networks continue to evolve."

and operations from this new internetwork and the new services it will enable, but a significant initial investment is required."[12]

## 2.2 Primary System Users and Operational Processes

The quintessential operational processes for 9-1-1 will continue within the NG9-1-1 system. The general public, PSAP call takers, public safety dispatchers, and first responders will remain as the primary users of the 9-1-1 system. However, NG9-1-1 will accept a broader range of public users. The person requesting help will no longer be limited to a telephone or TTY/TDD and may use multiple communications media in a single "call." Third party service providers, such as telematics, medical alert, central alarm monitoring, N-1-1 services, and relay services, will now have direct access into the 9-1-1 system. Ultimately, "the users of the network will be any and all organizations that improve the safety of the public by being able to exchange information in emergencies."[13] This will include the police, fire, and EMS first responders but also secondary responders such as public works agencies, towing companies, and HAZMAT remediation teams.

The table 2-1 lists the key operational capabilities of the NG9-1-1 system compared to the current system for the primary users and the implications for new procedures.

[12]Properties and Network Architectures that communications between PSAPs and emergency services personnel must meet in the near future. Network Reliability and Interoperability Council VII Focus Group 1D, Federal Communications Commission. December, 2004; p. 41

[13] ibid, p.12

**Table 2-1. Key Operational Capabilities of the NG9-1-1 System**

| User | Current Capabilities | Key Changes | New Process and Procedural Issues |
|---|---|---|---|
| General Public | • Call local 9-1-1 directly via telephone, cell phone, TTY/TDD, possibly VoIP<br>• Call PSAP indirectly (not using the 9-1-1 system) via 3rd party emergency or relay service via a broader range of communication options<br>• Deliver location and callback number, with various restrictions | • More viable options for communicating directly with PSAPs<br>• More capabilities for delivering data beyond location and callback.<br>• Direct support of 3rd party originated 9-1-1 calls<br>• More options for receiving up-to-date information, warnings and/or instructions on large-scale events.<br>• Greater ability to get through to someone who can help in disaster or other mass calling situations | • Understanding/knowing if device/service is E9-1-1 capable.<br>• Understanding/knowing qualitative differences in E9-1-1 capabilities (e.g., E9-1-1 via residential wire line provides more reliable location than cell phone from inside building)<br>• Universal access code/symbol for emergency access from all (or most) devices. "9-1-1" is not the telephone access code used by most countries.<br>• New ways to obtain, represent and convey location<br>• New ways to route a call given location<br>• New ways to obtain information related to the location, call, caller<br>• Security-related factors (certification; authentication), threats (e.g., denial of service attacks), and potentially differing impacts on citizen access depending on access service.<br>• Privacy issues. |
| PSAP Call takers | • Receive local E9-1-1 calls from telephone, cell phone, TDD/TTY, possibly VoIP users<br>• Voice, TTY/TDD text and location data are the only accessible information sources from callers.<br>• Transfer 9-1-1 call to/from a limited number of local PSAPs<br>• Handoff a 9-1-1 call to a limited number of local public safety dispatch entities | • Increased number of viable methods for receiving E9-1-1 calls (= more accessible to the public)<br>• More data available in addition to location.<br>• Capability for transferring calls to/from any emergency service entity, independent of geographic location. | • Receiving, switching, logging, etc. voice, video and text media streams<br>• Displaying, acting on and forwarding new kinds of data<br>• Training, policies and procedural issues for "long distance" 9-1-1 activities.<br>• Confidentiality issues.<br>• Network security issues |
| 3rd Party Service Providers | • Receive voice, text, data, images and video via full range of communication options<br>• Relay emergency service request to PSAP via 10-digit administrative lines, not as "native" 9-1-1 calls. | • Expect s more appropriate remote transfer capabilities as PSAP-PSAP (e.g. call delivery through the emergency services internetwork).<br>• Ability to originate 9-1-1 calls on behalf of client, with routing based on location of client<br>• Ability to supply additional data related to location, call, client<br>• Ability to have automatic conference with CSR, Call taker and client | • Certification, authentication, and other requirements for access to Public Safety Network(s). |
| Public Safety Dispatchers | • Dispatchers can receive call, ALI/ANI data, and supplemental text provided by PSAP call taker.<br>• Depending on CAD/RMS capabilities, can access and integrate additional data relevant to particular emergency.<br>• Key information relayed to responders verbally. Depending on mobile capabilities, some data can be transferred to responders. | • Additional data or links to relevant data resources will be included with all "calls." | • Information triage issues – overload issue.<br>• More devices to create "abandoned" calls.<br>• Training, policies and procedural issues. |
| First Responders | • Typically receive voice instructions from dispatcher via radio<br>• Increasing, MDTs in vehicles can receive and access additional data beyond the 9-1-1 call information | • Additional data or links to relevant data resources may be included via MDTs and other wireless devices.<br>• Improved "mobility" = improved response times (acknowledgement to transport)<br>• Improved access to up-to-date information on events.<br>• Multimedia stream access (e.g. surveillance video) | • Information triage issues – overload issue.<br>• Confidentiality issues.<br>• Network security restrictions<br>• Training, policies and procedural issues<br>• Privacy issues (transport/3rd party access) |
| Secondary Responders | • Typically, government and private secondary responders (e.g., public works, transportation, towing and recovery) are notified by public safety dispatchers via telephone<br>• Electronic notification and sharing of some incident data is operational in a few locations | • Additional data or links to relevant data resources may be included in electronic notifications.<br>• More integration into public safety incident networks<br>• Improved "mobility" = improved response times (acknowledgement to transport)<br>• Improved access to up-to-date information on events. | • Information triage issues – overload issue.<br>• Confidentiality issues ("need to know" issues)<br>• Network security issues<br>• Training, policies and procedural issues<br>• Privacy issues (transport/3rd party access |

# 3 Operational Needs

The operational limitations of the current 9-1-1 system and related needs of NG9-1-1, noted or implied in previous sections of this document, are presented with more detail below. These limitations and new desired capabilities will form the basis for developing system requirements.

1. **Inability to receive 9-1-1 calls from other than four technologies: wire line phone; cell phone; TDD; some VoIP (see table 1-2 in earlier section).**

The public demand for non-tradition telecommunications services is increasing. These services – VoIP, instant messaging, SMS, video relay, telematics, and more – cannot use the telephone network and consequently cannot access PSAPs. Although voice and TDD text will remain at the core of emergency communications for the near term, non-traditional services will be demanded by the public and can offer new information options for improving response. New devices for callers with disabilities will supplant existing systems, offering improved access to PSAPs and responders.

2. **Inability to readily add new services or capabilities.**

Significant modifications to the 9-1-1 system were required when each of the four access technologies was added. PSAPs and commercial telecommunications providers had to make network and database changes to accommodate E9-1-1 requirements. Moreover, local public infrastructure is slow to be upgraded. There remain locations in the United States that do not yet have 9-1-1 service. Protocol and network architecture between the PSAP and the location data servers has not substantially changed since its introduction approximately 30 years ago. The legacy protocol, network architecture, and service provider relationships present significant challenges in introducing new features and advancing emergency services.[14]

3. **Inability to receive or forward "long distance" 9-1-1 calls**

Routing of emergency calls needs to be greatly improved. Current 9-1-1 systems have limited ability to route calls to backup PSAPs. What backup and overflow capability that exists is almost always to neighboring facilities. Third party call centers (such as telematics services) and VoIP applications have requirements to route an emergency call anywhere in the country. Remote calls to PSAPs are now made over 10-digit administrative lines, not as 9-1-1 calls. All emergency calls should be delivered as native 9-1-1 calls.

4. **Inability to receive or forward supplemental data other than ALI/ANI**

[14] Emergency Services Network Interfaces Task Force ("Task Force 34"), http://www.atis.org/esif/esmi.asp, accessed on October 10, 2005.

There is a great deal of information that could be made available to call takers, dispatchers and responders that could improve response, but currently we have no way to know data availability or how to route and forward the data. PSAPs and public safety dispatch centers usually cannot share supplemental data (e.g. call taker notes) electronically unless they are using the same CAD system. Third party service providers that often have valuable supplemental information on emergency status and history cannot transfer such information to PSAPs or dispatch centers.

**5. Methods and sources for location information no longer match capabilities of newer systems, nor needs of public safety**

In a non-emergency context, location is irrelevant for most "Internet" communication applications (e.g. VoIP, instant messaging). However, location is central to how 9-1-1 works. Location is used to determine which PSAP to direct a call to, which responders to dispatch, and where to dispatch them. The original system assumed a fixed relationship between a telephone number and a street address. There is great variability from community to community in how location is represented. All of these assumptions greatly limit how location can be determined, carried and reported and do not match the capabilities or need. Newer systems allow location to be delivered in the signaling with the call. Complex enterprise and service provider relationships greatly complicate designation of responsibility for who determines location, and also require that routing information be available on a global basis. Civic (street address) or geo (lat/lon) forms of location may occur in any device or service, and routing must be supported in either form any service.

**6. New security challenges**

The current telephone network system for 9-1-1 has had few hacker and denial of service attacks, but is nevertheless vulnerable. Call delivery, in IP formats, and from Internet and private networks, will offer new security risks. However, IP offers a wider range of tools and procedures to address and mitigate attacks.

# 4 System Overview

## *4.1 System Scope*

The components of today's 9-1-1 system are compared with those for NG9-1-1 system in simplified diagrams in figures 4-1 and 4-2.

The geographic scope of the NG9-1-1 is the United States, but some international connectivity should be feasible and desirable, especially at international borders. The front end (phones and carrier systems) must evolve to a single international standard, because IP technologies are not limited geographically. International roaming and nomadic operation is already occurring. Detection and routing of some IP based emergency calls to the proper PSAP will be provided by systems not U.S. based. We foresee evolution of single domain, multinational IP based communication systems; indeed, in enterprise environments, they already exist. The primary signaling and network protocols will be based on international standards (e.g. IETF).

The institutions and organizations that have roles in the deployment and operation of NG9-1-1 include:

Government Agencies
- Local, State and Federal policy, regulation, and funding
- Local and State emergency communications agencies
- Local, State and Federal emergency response agencies

Non-Governmental Organizations
- Professional and industry associations
- Standards Development Organizations
- Citizen and special interest advocacy organizations
- Private emergency response and recovery organizations
- Research and academia

IT/Telecommunications Service Providers
- "Traditional" telecommunication service providers
- "Public Safety / emergency" service providers.
- "Other" IT/telecommunication application service providers
- IP-network access infrastructure/service providers

IT/Telecommunications Equipment Providers
- Equipment and support service suppliers to "traditional" telcos.
- Equipment and support service suppliers to IT network providers.
- "Public Safety / emergency services network" equipment providers.
- Personal communication device providers

Third Party Emergency Call Centers

- Third party service providers such as telematics, poison control, medical alert, central alarm monitoring, relay services, and N-1-1 services.

Figure 4-1. Call Flow and Elements in Today's 9-1-1

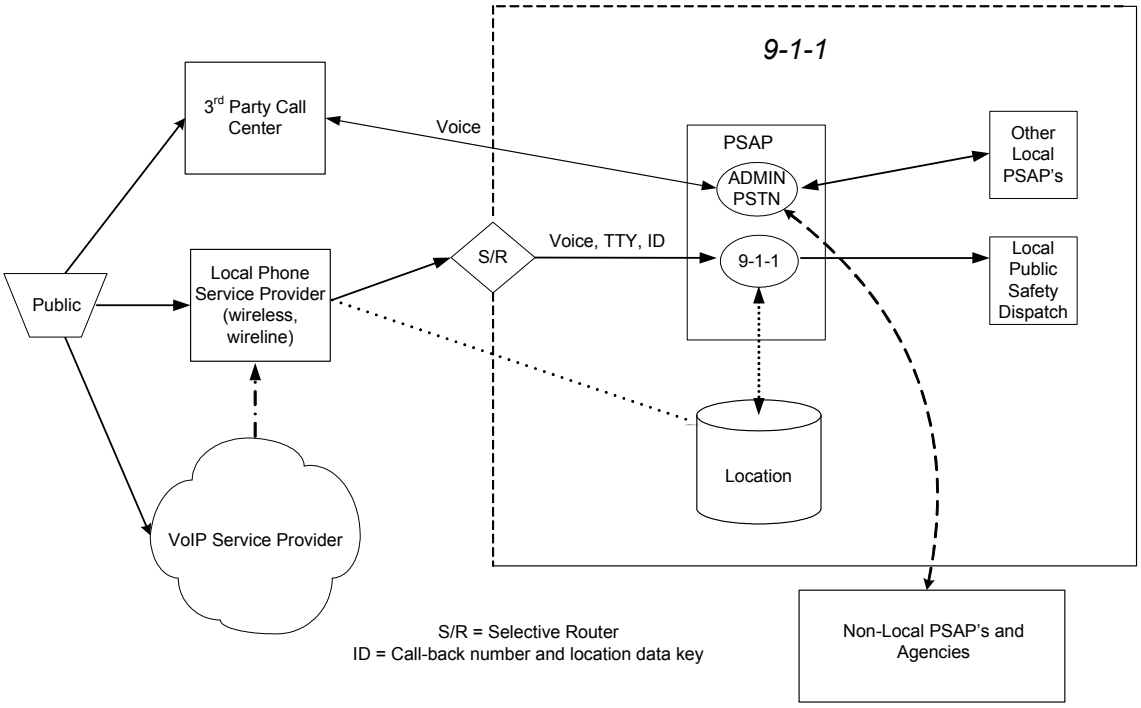
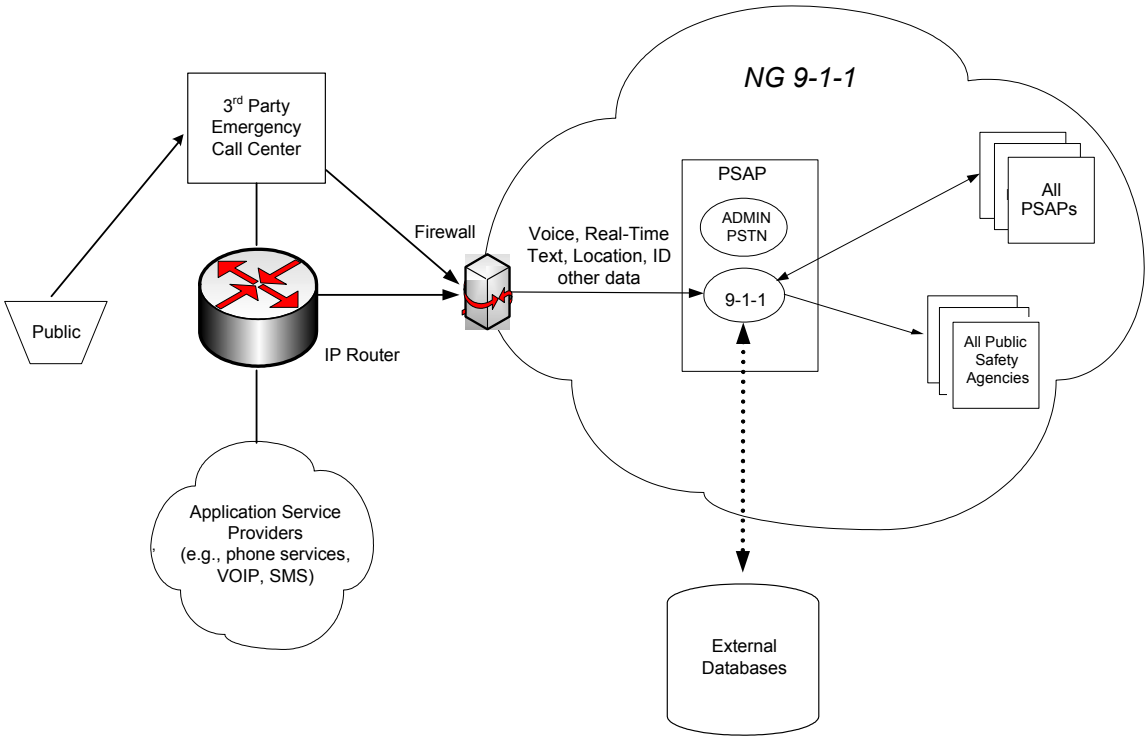



Figure 4-2. Call Flow and Elements in NG 9-1-1



## 4.2 System Interfaces

The internal interfaces between the components of the NG9-1-1 network elements and the external interfaces to components outside of the core NG9-1-1 system are identified in this section. Assumptions made regarding whether a component is internal or external may change as system development progresses.

Internal interfaces include:

- Interface between PSAP Customer Premise Equipment (CPE) and the emergency services network. IP-Capable PSAPs would have a direct connection to the network.
- Interface between PSAP CPE and internal data sources, such as mapping software and GIS.
- Interface between CPE and public safety dispatch systems.
- Human-machine interface between call takers and CPE (e.g., mic, headset, keyboard, video).

External interfaces may include:

- Interface between personal IP-communications applications to NG9-1-1 emergency services network for call routing to the appropriate PSAP. This network IP interface implies a number of additional interfaces outside of the NG9-1-1 network including (1) interface to a location information function and (2) interface to emergency services routing table/database; (3) human-machine interface between caller and the communications device, this further implies that "9-1-1" or some emergency access code can be entered via the device and application.
- Interface between the emergency services internetwork and IP-Capable PSAP via some form of local firewall and router.
- Interface between legacy (PSTN) communications applications and the emergency services internetwork. Ultimately, the legacy service will be expected to provide its own internal IP conversion gateway and then link to the IP router/gateway interface. During the transition to "full" NG9-1-1, local 9-1-1 authorities may opt to keep existing connections to PSTN selective routers operational. A gateway between the selective router and the emergency services internetwork may be required.
- Interface between legacy PSAPs and emergency services internetwork. Legacy PSAPs would connect via an external gateway that would provide signal conversion to/from the NG9-1-1 system and IP-Capable PSAPs and other emergency services entities.
- Interface between 3rd party emergency service providers and emergency services internetwork.
- Interface between IP-Capable PSAP and external data/information sources (e.g., location data; medical information).

National and international standards will be required for many of the interfaces noted in this concept. The area of standards related to IP-networks, applications, and protocols is new to 9-1-1 systems. Potential standards for implementation will likely be developed by entities including, but not limited to IETF, ATIS/ESIF, International Telecommunications Union (ITU), Telecommunications Industry Association (TIA), 3rd Generation

Partnership Project (3GPP), the Association of Public-Safety Communications Officials - International (APCO), and NENA.

Potential exists to create international standards for many or all of these interfaces. This would improve the ability of the nation to respond to cross border incidents, as well as create a much larger market for the same systems, which would lower overall costs and increase choice. To do so would require cooperation with other standards bodies including the European Telecommunications Standards Institute (ETSI).

## *4.3 System Capabilities (Functions)*

This section presents the high-level functional capabilities of the NG9-1-1 System, most of which have been noted or implied in other sections of this document. Many of these are fundamental aspects of the current 9-1-1 system. NG9-1-1 will expand today's 9-1-1 system to address the demands of new communications technologies and services and their operational needs. Detailed system requirements are not presented here as they are beyond the scope of this document. However, the assumptions and constraints presented in section 1.3 imply some high-level requirements.

**1. Call delivery**

Calls along with some "call back" and location-related information will be delivered by a communications service application and an access network to the emergency services network.

**2. Call routing**

Based on caller location and PSAP operational status, the call will be routed to the most appropriate PSAP.

**3. Call congestion control**

Call volume can exceed the ability of PSAP staff to respond ideally. PSAPs should decide call treatment in overload situations, including, but not limited to, dynamically reroute to other suitable and available PSAPs, use interactive voice response, provide a "busy" signal, or generate other automatic, informative replies to callers.

**4. Call "presentation"**

Call content and related information is currently presented to call takers via headphones, computer screen, and TTY/TDD screens. For NG9-1-1, additional communications media (e.g., IM, video) will need to be presented. Multiple communication and information sources will need to be integrated into the communication officer display system. Call volume and workload will continue to need to be balanced among call takers.

**5. Call location and address validation**

Location determination is and will remain the responsibility of entities outside of the 9-1-1 emergency services network. Currently, location of E9-1-1 calls is determined by the local exchange carrier through subscriber records for the landline phone number or by

the wireless carriers through positioning technologies placed in their networks, handsets, or some combination. For new emergency access communication applications, the user, application service, and/or access infrastructure provider will need to determine and input location data to support call routing and emergency response.

The PSAP CPE and call taker will receive location information data directly in the call data transmission or via a pointer/link to an outside database for location information retrieval. The PSAP CPE and call taker will receive or interpret information to ensure the location is valid for emergency dispatch.

Civic (street address) location information must be validated before it is used for routing or dispatch. New mechanisms, and more standardized and commercially viable representation for location, must be developed. More specific location information (e.g., building, floor, room.) will be provided for most larger facilities. Geospatial information from wireless providers may be converted to street address text, displayed with mapping/GIS software, or some combination at the PSAP.

**6. Call back ability**

The PSAP call taker will be able to initiate a call back to the initiating party in the event the original connection is lost. Currently, a call back number is provided in the landline and wireless E9-1-1 call transmission. Newer systems may present call back information that is not a telephone number and that information may be for any nation or domain (due to roaming and nomadic operation).

**7. Call transfer to responder dispatch center**

Calls may be transferred to a dispatch center (when that function and organization is different from the PSAP/call taker) to dispatch police, fire, medical or other emergency services. Currently, call information and supplemental data can be transferred only to entities, usually local, connected via the same information systems. Calls may arrive with new media forms (e.g., video, IM). New information and media sources will be available to dispatchers, responders and their management.

**8. Call transfer to other PSAPs**

Incorrect location or routing data or other factors could result in call delivery to an inappropriate PSAP. IP based systems could potentially misroute calls anywhere, even to other countries. The PSAP should have to ability to transfer this call and any associated data to any other PSAP. Currently, this is possible to PSAPs connected to the same selective router.

**9. Dispatch data entry for non-local PSAPs.**

In disaster or other major incidents, call takers as well as responders are overwhelmed. IP based routing will allow calls to be answered by any PSAP, but without any way to get relevant information to responders, or to provide important information from responders to callers (such as evacuation orders), there is little point in exploiting these capabilities. Today, a random set of callers gets through to the PSAP and we return busy to the rest. Busy tells callers no help will be forthcoming, but does not let responders decide how

best to deploy scarce resources. NG9-1-1 will permit call takers in distant PSAPs to answer the call, determine basic caller information, enter it into databases accessible to local responders, and provide information from responders to be given to callers. Responders can retrieve information from these databases to make triage decisions, and deploy their resources most effectively.

### 4.4 Maintenance and Technical Support Environment

The core operating environment for PSAP call takers is not expected to fundamentally change in an NG9-1-1 system – one-on-one interaction with persons in need of help, working from call centers, identify and facilitate emergency response, while using similar hardware interfaces. However, there will be new capabilities and redundancies. From the operational and maintenance perspective, we expect that many changes will be needed in technical staff skills, equipment, and vendor requirements. System operations, across many new functional organizations with little E9-1-1 experience, must be designed and tested before transition to live service. The emergency services community will not have the luxury of learning how to run NG9-1-1 over months and years, as was the case with the simpler current E9-1-1 system.

## 5 Operational Scenarios

Scenarios are used here to illustrate the NG9-1-1 concept by describing key users' perspectives in a variety of circumstances.

### 5.1 Telematics and NG9-1-1

Dorothy Jones is a 75 year-old diabetic attending her grandchild's birthday party. Despite inclement weather and approaching darkness, Dorothy ignores the wishes of her family and friends, and decides to head home that same evening. "Don't worry," says Dorothy, "I'll take the back roads. And I'll stay far away from those maniacs on the highway," reassuring other guests on her way out the door. On a desolate rural highway halfway home, however, Dorothy suddenly feels weak and shaky, symptoms she recognizes as a warning of impending insulin shock. She reaches for her purse, which contains her emergency glucose, and realizes that she left her purse and her cell phone at the party.

Mary presses the emergency button on her vehicle's telematics system, which automatically dials a third-party private emergency call center, also known as a telematics response center. Currently, Mayday systems do not automatically dial 9-1-1, minimizing "false alarms" for Public Safety Answering Points. Lucky, the car was not resting in a wireless "dead zone," and her call could be completed through the nearest wireless tower. Upon pressing the button, a voice channel is opened between the third-party center and the driver. The telematics response center specialist knows immediately the woman's name, the operating status and make/model of her vehicle, and her exact location from GPS satellites or other wireless location technologies. The specialist -- who is a former 9-1-1 call taker -- talks with Dorothy, going through a comprehensive protocol to confirm what has happened.

With a call up between Dorothy and the Telematics Service Provider (TSP), the specialist initiates a 3rd party 9-1-1 call. Because it is a 3rd party call, the call is routed based on Dorothy's location and not the location of the TSP. The call is automatically established as a three-way conference call with Dorothy, the specialist and the PSAP call taker. The PSAP call taker sees on her screen that the call is a 3rd party call, and it identifies Dorothy (and her location) as well as the specialist and the TSP. Although located in a different state, the Response Center (as a trusted party) delivers Dorothy's voice call and pertinent data via the IP-based emergency services internetwork. Working hand-in-hand with the private call center specialist, the PSAP operator notifies and transfers all pertinent response data to the nearest EMS dispatch center, which immediately sends an ambulance to Dorothy's location. If there had been a crash, other data about the crash would also have been transmitted. The system actually knows that it is Dorothy. If Dorothy had called from her cell phone, or her home phone, the system could identify Dorothy as the same person. Dorothy has opted in to a database that contains her medical information, and the call taker can access it directly. In addition, Dorothy's database entry includes a request to automatically notify her son, and the system places a call to her family to notify them of the situation. The son can be automatically added to the conference call if desired. At all times, the victim's privacy is secure.

As EMS arrives, Dorothy is losing consciousness. The ambulance has no problem locating Dorothy, as the TSP ensures her car lights are flashing and periodically sounds the horn. EMS, because they know about her diabetic condition, can rapidly evaluate her situation, provide Dorothy with emergency medical care, and transports her to the hospital, where her data has been received and medical professionals are awaiting her arrival. She is treated and released to her family, who met her at the hospital and took her home.

## *5.2 Interactive Text Scenario*

Just after sunrise on a June morning, Joe is taking his dog Ivan on their usual walk through the neighborhood. Joe notices that quite a bit of smoke is coming out of the *Paint and Detailing Unlimited* garage. He immediately grabs his wireless PDA/cell phone. While most of Joe's neighbors would have placed a voice call in this situation, Joe is profoundly deaf and interactive text is his media of choice. Now that his county's PSAP is on the emergency services internetwork, a 9-1-1 text stream is delivered as an E9-1-1 call with the usual location and callback information included in a wireless call. The PSAP call taker, through interactive text, asks Joe for more details about the situation and relays the information to the Fire dispatcher. Concerned about the potential for a HAZMAT-related incident, the PSAP asks Joe to use the camera feature on his PDA/cell phone to quickly take some pictures of the garage and transmit them via the 9-1-1 link.

Joe heads for home after the fire department arrives, reflecting on how his option for communicating with emergency services has improved. Joe has a Voice/Text-over-IP phone at home that both he and the hearing members of his family use. He also uses sign language via his IP-video system whenever appropriate. Video Relay Services (VRS), where a hearing "call taker" interprets sign language and relays via voice, are essential when Joe has to communicate with someone who only has a plain old voice telephone.

All the VRS organizations are able to deliver an emergency call as a native 9-1-1 call to any IP-PSAP in the U.S. If Joe calls 9-1-1 from his video phone, a VRS operator is automatically added as a 3rd party to the call, because his "caller preferences" are set to add VRS. If Joe were to first have contacted the VRS and the VRS operator determined that this was really a 9-1-1 call, he would have been able to re-originate the call as a 3rd party 9-1-1 call, routed on Joe's location, with automatic 3-way video and audio.

Joe notes on how useful this would have been when he was 5 years old and his Mom slipped on rug, knocking herself unconscious. Even if Joe's household had had a TTY/TDD device, he could not read or write well enough to have used it. However, he could certainly sign and had the presence of mind to run to a neighbor who called 9-1-1. Similar mechanisms are used to automatically engage language translation services when the language preference of a caller is not English.

## *5.3 PSAP Backup/Overload Scenario*

Hurricane Laurie, a category 3 storm, is a cutting a swath through Louisiana. The primary PSAP in [St. Elmo's] Parish is taking the hardest hit. Phone lines and power lines are down in much of the southern part of the State. Even though the center is fully staffed and its communications systems are still operational, more cell phone and Internet messages are coming in than can be handled. Fortunately, PSAPs in the northern part of Louisiana and in Mississippi and Texas can handle the overflow, and can completely take over for the St. Elmo's PSAP if it should be rendered inoperable by the hurricane. Location information arrives with most calls, and even though the call may be received anywhere in a three-state region, the calls can be transferred to the appropriate first response dispatch center. During the height of the storm, response must be triaged. However, a common, distributed database/GIS contains and charts each on-going emergency and its status. Call takers at any answering PSAP put data into the database and can advise callers of evacuation recommendations for the area from which they are calling. Immediate access to the database is invaluable to the public safety agencies throughout the course of any large-scale event. Used during the actual response, identifying routes of travel, evacuation points, inventory and vendor lists are just a few examples of how having access to "just in time" data will benefit the overall response.

Years earlier, when Hurricane Katrina hit, some PSAPs were off-line for almost a week. IP emergency service networks were then installed in the Gulf Coast states and inter-county and inter-state procedures and protocols were established for emergency and disaster backup operations. The new, much more robust and fault tolerant internetwork and procedures made all the difference this time.

# 6 Source References

Primary sources of information used in this document were published and working draft documents from the Federal Communications Commission, National Emergency Number Association, the Internet Engineering Task Force (IETF), and the Alliance for Telecommunications Industry Solutions (ATIS) Emergency Services Interconnection Forum (ESIF).

- *Network Architecture Properties in 2010, Extending E9-1-1 to Satellites, and Generic Architectures to Support Video and Advanced Services;* Network Reliability and Interoperability Council (NRIC) VII Focus Group 1B, Federal Communications Commission (FCC); June, 2005. *Long Term Issues for Emergency/E9-1-1 Services*; (Draft). – These documents are designed to provide a set of specific recommendations regarding future emergency communications network properties, and their capability by 2010 to support the exchange of voice, data, text, photographs and live video through the emergency services internetwork to the PSAP and beyond.

- *Communication Issues for Emergency Communications Beyond E911: Report #1, Properties and Network Architectures That Communications Between PSAPS ad Emergency Services Personnel Must Meet in the Near Future.* NRIC VII Focus Group 1D, FCC. December 2004. – *Communication Issues for Emergency Communications Beyond E911: Final Report - Properties and network architectures for communications between PSAPs and emergency services organizations and personnel.* The purpose of these documents is to describe the properties that network architectures for communications between PSAPs and emergency services personnel must meet.

- *Draft i3 Requirements*. National Emergency Number Association (NENA) VoIP Technical Committee Long Term Definition Working Group. September 2005. This document provides requirements for a NENA-recommended standard for the i3 architecture for end-to-end emergency calling over IP-networks.

- *Requirements for Emergency Context Resolution with Internet Technologies.* Internet Engineering Task Force. October 2005. http://www.ietf.org/internet-drafts/draft-ietf-ecrit-requirements-01.txt - This document enumerates requirements for emergency calls placed by the public using voice-over-IP (VoIP) and general Internet multimedia systems, where Internet protocols are used end-to-end.

- The ATIS-ESIF Emergency Services Network Interfaces Task Force 34 will define a new messaging and interaction protocol between PSAPs and Emergency Services Networks that goes significantly beyond the paradigms that exist to provide those services today. Various summaries and briefing materials are available at the Task Force 34 website at http://www.atis.org/esif/esmi.asp. The Task Force 34 messaging and interaction protocol will be specified as an American National Standard (ANS).

Draft versions of the standard are proprietary and are not available to the general public.

# Appendix A: Acronyms

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|---|---|
| ANSI/AIAA | American National Standards Institute / American Institute of Aeronautics and Astronautics |
| ACA International | The Association of Credit and Collection International |
| ALI | Automatic Location Identification |
| ANI | Automatics Number Identification |
| APCO | Association of Public Safety Communications Officials |
| ATIS-ESIF | Alliance for Telecommunications Industry Solutions - Emergency Services Interconnection Forum |
| CAD/RMS | Computer Aided Dispatch / Records Management System |
| CAMA | Centralized Automated Messaging Accounting |
| CPE | Customer Premise Equipment |
| E9-1-1 | Enhanced 9-1-1 |
| ECRIT | Emergency Context Resolution with Internet Technologies |
| EMS | Emergency Medical Services |
| FCC | Federal Communications Commission |
| FHWA | Federal Highway Administration |
| GIS | Geographic Information Systems |
| GPS | Global Positioning System |
| HAZMAT | Hazardous Material |
| HMI | Human-Machine Interface |
| IETF | Internet Engineering Task Force |
| IM | Instant Message |
| IP | Internet Protocol |
| ISDN | Integrated Services Digital Network |
| ITU | International Telecommunication Union |
| MDT | Mobile Data Terminal |
| MSC | Mobile-services Switching Centre |
| NENA | National Emergency Number Association |
| NG9-1-1 | Next Generation 9-1-1 |
| NRIC | Network Reliability and Interoperability Council |
| POTS | Plain Old Telephone Service |
| PSAP | Public Safety Answering Point |
| PSTN | Public Switched Telephone Network |
| QoS | Quality of Service |
| RFA | Request For Action |
| SMS | Short Message Service |
| SS7 | Signaling System 7 |
| TBD | To Be Determined |
| TCP | Transmission Control Protocol |
| TDM | Time Division Multiplex |
| TIA | Telecommunications Industry Association |
| TLS | Transport Layer Security |
| TSP | Telematics Service Provider |
| TTY/TDD | Teletypewriter / Telecommunications Device for the Deaf |
| UDP | User Datagram Protocol |
| URI | Uniform Resource Identifier |
| USDOT | United States Department of Transportation |
| VoIP | Voice-over-Internet-Protocol |

# Appendix B: Glossary

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| **Analog** | A representation of an object that resembles the original. Analog devices monitor conditions, such as movement, temperature, and sound, and convert them into comparable electronic / mechanical patterns. For example, an analog watch represents the planet's rotation with the rotating hands on the watch face. |
| **Circuit-Switch** | The establishment, by dialing, of a temporary physical path between points. The path is terminated when either end of the connection sends a disconnect signal by hanging up. |
| **Digital** | Traditionally, it means the use of numbers and the term comes from digit or finger. Today, digital is synonymous with computer. |
| **Firewall** | The primary method for keeping a computer secure from intruders. It allows or blocks traffic into and out of a private network or the user's computer. |
| **Gateway** | A computer that performs protocol conversion between different types of networks or applications; a computer that acts as a go-between for two or more networks that use the same protocols. |
| **Internetwork** | To go between one network and another; a large network made up of a number of smaller networks. |
| **IP** (Internet Protocol) | The part of TCP/IP that performs the addressing functions for networks. |
| **Network** | An arrangement of devices that can communicate with each other. |
| **Packet(s)** | A block of data that is transmitted over the network in a packet-switched system. |
| **Packet-Switch** | A network technology that breaks up a message into small packets for transmission. Each packet contains a destination address. Thus, all packets in a single message do not have to travel the same path. As traffic conditions change, they can be dynamically routed via different paths in the network, and they can even arrive out of order. The destination computer reassembles the packets into their proper sequence. |
| **Protocol** | The format and procedure that governs the transmitting and receiving of data. |
| **PSAP** (Public Safety Answering Point) | A generic name for a municipal or county emergency communication center dispatch agency that directs 9-1-1 or other emergency calls to appropriate police, fire, and EMS agencies and personnel. |

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| **Router** | A network device that forwards packets from one network to another. Based on internal routing tables, routers read each incoming packet and decide how to forward it. |
| **SMS** (Short Message Service) | A text message service that enables short messages of generally no more than 140 - 160 characters in length to be sent and transmitted from a cell phone. Short messages are stored and forwarded at SMS centers, which means you can retrieve your messages later if you are not immediately available to receive them. |
| **TCP** (Transmission Control Protocol) | It's the reliable transport protocol within the TCP/IP protocol suite that ensures that all data arrives accurately and 100% intact at the other end. |
| **Telematics** | Originally coined to mean the convergence of telecommunications and information processing, this term later evolved to refer to automation in automobiles. GPS navigation, integrated hands-free cell phones, wireless communications and automatics driving assistance systems all come under the "telematics umbrella". |
| **Telephony** | "Sound over distance"…it refers to electronically transmitting the human voice. |
| **VoIP** | A telephone service that uses the Internet as a global telephone network. |
| **Wire line** | Same as landline/land-based, that is, refers to standard telephone and data communications systems that use in-ground and telephone pole cables. |