

"The Path to a Needs-based 9-1-1 Network"

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Consider the following:

A young man visiting in his mother's home discovers a fire in the kitchen. He immediately picks up his mother's phone and dials 9-1-1. In the heat of the moment, he accidentally reports the fire at his own address, which is five miles away. The 9-1-1 call-taker, checking the data on the ALI screen, catches the error and asks him to verify the address. The fire department dispatches units to the proper location, and the fire is confined to the range and adjacent cabinet.

A woman leaving a shopping mall is assaulted as she enters her car, and forced into the trunk of the car as the assailants leave the mall and head east on a major freeway. The woman, who has managed to retain her cell phone, calls 9-1-1. The communications center tracks the caller as the car moves across the metropolitan area. Although the car passes through three jurisdictions, all affected law enforcement agencies receive data on the path of the vehicle, and it is ultimately stopped, the assailants arrested, and the victim rescued.

A tornado reaching F-5 strength crosses a metropolitan area, and damages to four public safety buildings are severe, forcing the evacuation of personnel from four 9-1-1 call centers. As search and rescue activities begin, an existing two-position PSAP is activated in a fifth city, expanded to four positions, and is receiving emergency 9-1-1 calls from all four affected cities. Twelve hours after the impact, a combined PSAP and Emergency Operations Center is established in a relatively undamaged school building and begins service as a 9-1-1 call center to replace the cramped two-position call center, and as a FEMA Operations Center and a Joint Information Center in accordance with National Response Plan and National Incident Management Center guidelines.

A Category 4 hurricane is moving through the Gulf of Mexico, with landfall predicted south of Brownsville. During the early morning hours, the hurricane makes a northern turn, with a new estimated landfall determined to be ten miles west of Galveston. In the eight hours prior to landfall, local and state officials are able to activate an evacuation plan, monitor traffic on all routes leading north to Houston and beyond and fully activate emergency operations centers in anticipation of the storm. Local officials are provided location information for

especially vulnerable citizens, including nursing and assisted living centers and child care facilities, as well as individuals with health and mobility challenges living in flood-prone areas.

A father is having a conversation with his daughter who is in an apartment in a city in a different state. During the conversation, his daughter's conversation turns to screams, with a loud commotion in the background, and he realizes an assault is taking place. He picks up his wireless phone and dials 9-1-1, telling the answering call-taker he wishes to report an assault in progress in another location. His call is immediately transferred to the police department in the city in which his daughter is located, police are dispatched, and a suspect apprehended.

During the second half of the Twentieth Century, advances in science and technology, coupled with increased public awareness and demands for improved services, led to improvements in the response to emergencies and the rescue/treatment of victims. The publication of such studies as "Injury in America....A Continuing Public Health Problem," and "America Burning," coupled with demands for improved response and the availability of technology and tactics developed in Vietnam and Korea, as well as the space race, resulted in large strides in response to disease, trauma, fire, and crime.

The one common factor in the increased knowledge in regard to responding to the needs of citizens in an emergency was **time**. The importance of a rapid response and intervention is a common theme.

For example, trauma experts cite a **Golden Hour** for trauma patients, a sixty-minutes time period beyond which the ability of the patient to survive major trauma begins to drop significantly due to shock and the resulting failure of multiple body systems. The restoration of normal heartbeat within three to five minutes in victims suffering from cardiac or respiratory arrest is essential to preventing brain damage or death.

Fire officials know the area of coverage for a fire doubles with every minute. In addition to improved tactics, safer vehicles, public awareness of the importance of smoke alarms, and improved responder safety, rapid intervention by a fire company is the critical factor in controlling and limiting the spread of a fire. The difference in response time can make the difference between fire fighters confining a fire to a kitchen closet of losing the entire dwelling.

Central to the rapid response and intervention so critical in all fields of emergency and law enforcement is the timely and accurate notification by citizens of the existence of an emergency and the correct location where help is needed. Therefore, a landmark in the history of public safety was the implementation of Enhanced 9-1-1 services, which began in the early 1980's and spread rapidly across the US. The concept of a single emergency number to replace dozens of emergency numbers in any given area actually began in the late 60's, but limitations to the available telecommunications networks presented major problems. Call-routing was

based upon central office boundaries, rather than political boundaries, resulting in calls often being routed to the wrong jurisdiction, or callers within a jurisdiction having no 9-1-1 service at all. In addition, no location or call-back information was available to the call-taker in the event the caller was not able to provide this information.

The introduction of Enhanced 9-1-1 was a quantum leap in the provision of public safety communications, with selective routing, Automatic Number Identification, and Automatic Location Identification. The E9-1-1 service was feature-driven, and included call-transfer, third party conferencing, and the ability to provide location information to secondary answering points, such as fire and emergency medical units.

Our first example illustrates the advantages of the features of the E9-1-1 service. The call was routed to the appropriate responder, and when the caller failed to provide the correct address, this was corrected based on the data available to the call-taker, and an effective response created. However, even as the implementation of E9-1-1 services was spreading throughout the US, the number of callers who could not be located without the assistance of the caller was growing, primarily due to the explosive growth of wireless communications. Whereas many of the metropolitan areas that were the first to implement E9-1-1 experienced a call volume of less than 5-10% of 9-1-1 calls from wireless devices, this number expanded rapidly, until at least half of all 9-1-1 calls were made from wireless devices by 2000. In some metropolitan areas, PSAP's reported upwards of 70% of calls from wireless devices.

Enhanced 9-1-1 service, as implemented in the last quarter of the 20th Century, was primarily a switching service offered by ILEC's. As the needs of the 9-1-1 providers evolved beyond what was offered by the ILEC's, such as the ability to locate a wireless caller, service as defined by the accuracy of the location available to the call-taker deteriorated.

The growth in the extremely competitive market for telecommunications services with expanded consumer features has created a demand for the development of technologies that have far out-stripped the capabilities of the ILEC-based 9-1-1 services that have been the backbone of the E9-1-1 services since the 80's. Challenges for 9-1-1 are not limited to accurate location, but accurate routing of the call to the appropriate responding agency as well. Features which automatically routed the call to the appropriate answering center, provided call-back and location data and the ability to easily transfer the call to secondary or special crisis answering centers are limited or may not exist at all when the call originates from wireless, Voice over Internet Protocol, or other non-landline devices. VIXXI Solutions, Inc. believes the only solution to these challenges is the development and deployment of a **Needs-Based 9-1-1 network**, with products and services based on the **needs of 9-1-1 providers and their users, the citizens.**

The proposal for a Needs-based System that truly serves the needs of public safety and the public makes several assumptions:

1. A Needs-Based System must ignore technological restraints;
2. A Needs-Based system may not match current capabilities of the public switched telephone network, wireless networks, or other products and services on the table;
3. The solution that best serves the needs of the 9-1-1 providers and public safety is the best solution;
4. Planning for current and future system upgrades is currently being outpaced by changes in technology;
5. It is imperative that the solution be cost-effective;
6. It is not a foregone conclusion that Local Exchange Carriers will ultimately participate in the provision of needs-based systems.

The needs for successful 9-1-1 call completion and processing begin with three basic functions, without any one of which denies or delays caller access to emergency assistance.

These basic requirements for successful completion of the 9-1-1 call with all the information necessary to affect a response are:

1. Access – the caller must be able to access the 9-1-1 networks from any location, at any time, and with any device;
2. Routing – the call must be routed to the agency responsible for dispatching resources to the emergency. This may not be the agency that takes the original call, but any transfer or relay of information should occur quickly and seamlessly;
3. Location Data Accuracy – obviously, in order to dispatch emergency responders, the call-taker/dispatcher must know the exact location of the emergency. This is true whether the location is static or dynamic.

The chief impediment to truly accurate routing and location for ALL 9-1-1 calls is the fact that the telephone exchanges are not truly aware of a caller's location. VIXXI has developed a solution that provides a geographically aware telephone switching system with two separate products:

1. A carrier-side Geospatial Router
2. A PSAP-side Geospatial Router.

Essentially, these routers set up switching paths on the fly. If a target (an emergency caller using a wireless or other mobile device to call 9-1-1) is moving, especially from one jurisdiction to another, for example, the position of the caller may be anticipated and response created based on anticipated location. Likewise, any person entering a jurisdiction with a device

may have their position determined based on their position within a defined polygon as defined by the 9-1-1 administrator regardless of their telephone number.

The polygons defined on the digital map represent jurisdictional or service boundaries for purposes of routing the original call and/or determining which units will respond. Because the geospatial router uses polygons defined on a digital map instead of trunk groups to determine the destination of a phone call, back-up PSAP's, temporary crisis centers, or other temporary arrangements may be established immediately upon recognition of the need.

VIXXI Solutions believes the ultimate needs-based system will provide for the following capabilities, in addition to the basic functions of access, call-routing, and location data accuracy:

- Look-ahead conference capability
- Dynamic PSAP reconfiguration
- Instant Call Center and/or EOC Configuration
- Universal transferability
- Integration of multiple functions
- Data sharing among multiple PSAP's
- Robust networks
- Scalable services and networks
- Seamless transition from legacy systems
- Secure systems, networks, and data

Remember our scenarios at the opening of this paper? Scenarios two, three, four and five represent solutions possible after deployment of a geospatial 9-1-1 emergency network:

Look Ahead Conference Capability – When the target being tracked during a wireless call is moving, the geo-based network will detect any potential changes in jurisdiction as the caller approaches city limits, county lines, or other changes in jurisdiction. As the caller nears and/or crosses into another jurisdiction, the 9-1-1 call center for that jurisdiction is added into a conference arrangement with the original call-taking authority. The network connects all PSAP trunks, and, as a geo-based system, does not route to a ten-digit number, but can flag a call as a 9-1-1 call and assign it the priority normally assigned 9-1-1 calls.

Dynamic PSAP Reconfiguration – Instant Call Center and/or EOC Configuration - the call-routing data base may be instantly reconfigured in a geospatial network by simply redrawing the polygons which define routing PSAP's for a geographic area defined by jurisdictional boundaries. Based upon the location of the call within the polygon, the call is routed to a contingency, back-up, or expanded PSAP depending on the need. Additional premise equipment and additional personnel increase the call-take capacity during an emergency, but call routing and call data recovery occur with the definition of the polygons on the geo-based network. This may be used for an emergency expansion of an existing PSAP or the establishment of a back-up PSAP and/or EOC in an undamaged, secure facility.

Universal Transferability – If the emergency 9-1-1 network is not dependent on tandem switches, 9-1-1 calls and the accompanying data may be transferred to any call-taking center in the US.

Integration of Multiple Functions – All functionality of public safety communications and its support functions, such as Computer Aided Dispatch system, may be held in the geo-based networks.

Data Sharing – The networks enable one jurisdiction to share data with other agencies, particularly during a developing situation, as well as other data sources such as NCIC, state or federal law enforcement, hazardous material information, poison control information, etc. This information could be shared with a wide area, or specific PSAP's as determined by the situation.

Robust Networks – Networks must be capable of continuous operation, with duplicate facilities, the capability to self-diagnose problems in the network, self-healing, and able to bypass compromised nodes.

Scalable – Networks should be capable of expansion to accommodate growth in traffic or new service arrangements without compromising existing service.

Seamless – With geo-based networks, providers may add functionality or even convert to the geo-based networks without changing existing PSAP equipment.

Security - Security must be a high priority for any network or system that provides emergency services. A single net-based system provides some advantages in protecting the network against intruders or hackers. The system should have the same basic security concepts as identified by the Department of Defense in a Network Operations Concept of Operations:

1. Ensuring systems and networks that deliver information are available;
2. Ensuring information can move freely from one point to another;
3. Ensuring information is protected at the right level.

In conclusion, the Enhanced 9-1-1 service provided through traditional landline phone service providers was a tremendous improvement over the previous methodology, which consisted of multiple emergency service numbers without means of accurately routing and locating callers, and served the citizens of the US well. The current reality is, however, that the legacy system's ability to provide accurate routing and location deteriorates as customers choose communications services other than traditional landline.

It is imperative that systems are developed and deployed that meet the needs of the public and the public safety providers. These systems are already under development, or in the testing phase, and will offer not only accurate location data, but additional services as well, and will move public safety telecommunications to the point where the NENA goal of "Any Call, Any Time, Any Device," may be realized.