# Moving towards the Next-Generation 9-1-1 System

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## 1 Introduction and Overview

Below, we consider (Section 2) why simply making the existing 9-1-1 system in the United States work for VoIP is not satisfactory and only suitable as a stop-gap measure for those consumers who have migrated over to VoIP services as a replacement for their former POTS service and have every right to expect that substitute service to provide a comparable emergency response capability. We also contrast the opportunities that a modern, IP-based emergency calling infrastructure offers.

A core argument of this comment is (Section 4) that responsibility for VoIP 9-1-1 service has to be a shared one if we posit a modern multi-provider Internet that provides competition between infrastructure and service providers.

We also briefly describe (Section 5) the major standardization activities that are providing core components for a next-generation 9-1-1 service that carries emergency calls using Internet protocols from caller to PSAP.

### 1.1 Recommendations

This response makes the following recommendations and findings:

- Back-fitting VoIP into the existing 9-1-1 facilities will delay more robust, efficient and capable IP-based next-generation 9-1-1 system.
- Proposed transition ("I2") solutions may lead to misroutes for mobile and nomadic users and thus other temporary measures, such as operator-assisted 9-1-1, need to be taken to support their emergency calls until the next-generation 9-1-1 network can be built.
- The existing 9-1-1 system has reached the end of its useful technical life, making enhancements increasingly difficult and expensive.
- A successful emergency call requires the cooperation of Internet Access Provider (IAP), Voice Service Provider (VSP) and PSAP.
- Only the VSP knows that a call is an emergency call, but only the IAP knows where the caller is located.
- Having the IAP deliver location information routinely to the end user minimizes emergency calling delays, allows testing and ensures end user location privacy.

- Easy, non-discriminatory access to address verification (MSAG) and, in the near-term, ALI data will ensure speedy and cost-effective deployment of modern emergency services.
- The FCC should facilitate vendor-neutral early interoperability testing of IP-based emergency calling solutions.
- Charging monthly per-line 9-1-1 cost recovery fees is inappropriate for the range of communications services offered, such as prepay services.
- Access to essential databases needed for routing emergency calls should be available on a non-discriminatory basis to all legitimate users. Access to such information must not be used to delay entry of competitors to traditional service providers.
- To decrease cost and increase reliability, PSAPs should consider adopting IP-based technology to support Phase II wireless for circuit-switched digital cellular systems.

## 2 Limitations of old technology

The current communications technology used by PSAPs dates back to the 1970s. While it is possible to make VoIP interoperate with this technology through the NENA I1 and I2 protocols, technology limitations remain and impose severe constraints on cost effectiveness, reliability and functionality of PSAPs, for analog landline, cellular and VoIP callers. The next-generation 911 system, called I3 by NENA, can address these problems.

**Outdated technology:** The communication technology commonly used by PSAPs, CAMA (operator) trunks, severely limits the amount of data that can be transferred between the local exchange carrier and the PSAP, often to 8 or 10 digits. In addition, the CAMA trunk imposes a delay of several seconds. Similarly, many PSAPs still use low-speed modems to access the ALI database. NG911 uses standard datacommunication technology and in-band transmission of data. Without global changes, PSAPs will be able to upgrade bandwidth and technology as new transmission technology, such as WiMax or fiber-to-the-edge, becomes available.

**Expensive upgrades:** Many of the communication technologies used by PSAPs are only used for emergency calling, thus increasing their cost and delaying technology advances, as the overall market for this technology is small. NG911 is based on commercial off-the-shelf technology, allowing PSAPs to participate in the advances of that technology and significantly reducing cost.

**No global number portability:** The existing technology can work only with US numbers, not international ones. As cell phones and VoIP devices become increasingly mobile and are carried across numbering plan boundaries, these devices will not be able to be located or called back. Longer-term, many VoIP end systems may not even have telephone numbers, e.g., as is already the case for systems offered by instant messaging-focused service providers. NG911 systems carry location data in-band and have no restrictions on the number used. As VoIP systems migrate from E.164 numbers to email-like URLs, NG911 systems will be able to continue to function, without another upgrade.

**Single media:** Naturally, current PSAP technology can only handle audio and voiceband data (TTY). NG911 systems can use any media supported by the PSAP call taker equipment. For caller-to-PSAP communication, this can readily include IM and real-time text for hearing-impaired callers, pictures from cameraphones, video for sign language communications or for live incident situational awareness. In the other direction, call taker can convey instructional videos, e.g., on first-aid procedures.

**No mobility:** Mobile and nomadic users form an important group of current VoIP users, with very large growth rates. For example, an increasing number of enterprises and interconnected VoIP service providers offer software solutions to their employees and customers that allow roaming users to place VoIP calls, including calls to the PSTN, from hotels, WiFi hotspots or while visiting other companies. These applications are rarely used from home or a regular office, and, making user-entered location information worthless.

The NENA I1 and I2 solutions do not support nomadic or mobile VoIP users. Manual entry of location information by users would likely be wrong and may, with current technology, take up to 48 hours to be placed in the ALI database, i.e., reach the database long after the traveler has moved on. Thus, if manual entry of such information were required, it would in all likelihood be wrong and probably cause more delay and inappropriate dispatch of first responders.

The next-generation 9-1-1 system will be able to handle location information generated automatically, with no update delays.

**Limited resiliency:** The existing 9-1-1 system offers only limited resiliency. In most cases, the primary PSAP can route calls only to one alternate (secondary) PSAP. A next-generation system can route calls to any willing PSAP, allowing those PSAPs to help during catastrophic mass-casualty events, for example.

**No testability:** It is difficult to test reachability and service in today's 9-1-1 network without tying up call taker resources. For example, the authors suspect that most office workers have no idea whether they need to dial 9,9-1-1 or just 9-1-1 from their desk phone.

## 3 The Role of Location Information

Location information is a core component of the next-generation 9-1-1 system. Unlike the landline PSTN, the point of attachment to a switch does not suffice to identify the correct PSAP.

Civic or geospatial location is needed for two somewhat different purposes. First, location information is needed to route the call to the correct PSAP, then, the PSAP needs accurate, automatic location information to dispatch first responders to the correct location, particularly if the caller is unable to provide this information. In some cases, the location information needed for call routing can be less precise, as PSAPs typically cover a city, county or even parts of a state.[1]

[1] There are many peculiarities that force qualifying this statement; there does not appear to be a survey of the correlation between civic boundaries and PSAP boundaries.

# 4 Sharing Responsibility for Emergency Calls

While most of the discussion related to VoIP-based emergency calling has focused on interconnected VoIP providers, presumably under the assumption that they serve the same role as the local exchange carriers. However, this assumption ignores that there are three major participants in completing an emergency call, the voice service provider (VSP)[2], the Internet Access Provider (IAP) offering "IP dial tone" to their residential and commercial subscribers and the Public Safety Answering Point (PSAP) receiving the emergency call. Here, we assume that the IAP also operates or has access to the physical facilities used to carry the call, such as the digital subscriber lines or cable plant.[3]

In a sentence, **only the VSP knows that a call is an emergency call, but only the IAP knows where the caller is located.**

Thus, the roles and responsibilities of the IAP and VSP are complementary. The IAP has subscriber records that indicate where the customer is physically located. The VSP receives call signaling indicating an emergency call and is responsible for routing such calls.

## 4.1 The Role of the IAP

While most users will mostly have a constant pair of IAP and VSP, this is not always the case. Indeed, nomadic and mobile users are characterized by the fact that they change their temporary IAP while keeping their VSP. For example, a traveler using a WiFi (IEEE 802.11) hotspot in a coffee shop, hotel or airport will temporarily use the services of the hotspot operator. The traveler may not be personally known to the hotspot provider, e.g., if they used a scratch-off card to obtain service or if service is provided for free. (For example, many conferences provide free WiFi service, without sign-up, to their attendees, as do libraries and city parks.) However, the IAP will know the location of its 802.11 access point; the limited physical coverage of the access point ensures that the caller is within about 100 feet, typically less, of the access point. Similarly, the IAP will need to maintain accurate service address records for all of its subscribers so that it can maintain the physical infrastructure. *The IAP is thus in a unique position to provide civic or geospatial location information within the emergency call context.*

No other entity participating in the emergency call has similarly reliable, automatic and low-cost location information. In some cases, the end system may have built-in GPS capability, but GPS does not function reliably indoors at this point[4]

Since the Internet access provider does not know the identity of the caller and does not know which VSPs it might be using, only the caller can correlate the geographic location, obtained from the IAP, and the emergency call.

The current architecture envisioned by NENA and the Internet Engineering Task Force (IETF) envisions that nomadic end systems obtain their current location upon booting or roaming into a particular 802.11 base station coverage area. This ensures minimal delay in acquiring location information and allows the end system to verify reachability of emergency services before an emergency occurs.

[2] We will use this common terminology, although multimedia service provider (MSP) would be more accurate in the longer term.

[3] We intentionally use the term IAP rather than ISP since there might be multiple non-facilities-based service providers sharing the same physical access plant. In many such cases, ISPs will also know the location of their subscribers, but may only know the billing rather than the service address.

[4] In the more distant future, other location technologies, such as providing the equivalent of assisted GPS, higher-powered geolocation satellites such as Galileo, or location technology based on HDTV signals may offer alternatives, but will require significant end system investment.

Location information is only included in emergency calls, thus ensuring end system users that their location information remains private for normal, non-emergency calls.

Known alternative means for obtaining addresses are unreliable. For example, having users enter address information is tedious and error-prone and unacceptable for nomadic and mobile users. IP-based address location is generally only accurate to, at best, within a single DSLAM or cable-headend, as the same set of IP addresses may well be re-assigned over time to different subscribers covered by that DSLAM or headend. In some cases, several DSLAMs and headend may well share the same IP address allocation mechanism, further reducing the usability of the mechanism. However, in some cases, the location may be accurate enough for call routing. There does not appear to be any investigation of how large a percentage of IP addresses would be suitable for PSAP routing, however.

Since VoIP end systems such as hardware and software phones will need to work in any access network, it is important to internationally standardize the mechanism for having end systems obtain location information. End systems can implement several such mechanisms, but must to obtain this information without manually configuring servers or other parameters.

Location determination faces additional difficulties when VPNs are used. A system may "tunnel" into an enterprise network and appear to the VSP to originate from within that network, but actually be physically located in a hotel or conference center thousands of miles away from the home network. The proposals discussed below all take this into account, but other proposals may fail under these conditions, without necessarily an indication of such failure to either end user or VSP.

There are currently three types of protocol proposals under discussion:

**Layer 2 (link layer):** Here, the link layer, such as Ethernet, distributes location information, typically by periodic broadcast on each switch port. Proposals for LLDP-MED [5] include civic and geospatial location information. This mechanism appears most applicable to wireless access points and enterprise Ethernet networks.

**Layer 3 (network layer):** Location information can also be conveyed in the Dynamic Host Configuration Protocol (DHCP) commonly used by ISPs and in enterprises to configure IP addresses and other basic network-layer information. There are standards-track proposals for delivering either geospatial [1] or civic [2] information. This approach has the advantage that common residential gateways can obtain and re-distribute the information, as almost all of these use DHCP to configure the devices located on the subscriber side. However, DHCP is not used by all access network providers, e.g., those using PPPoE (Point-to-point protocol over Ethernet).

**Layer 7 (application layer):** There are proposals (e.g., [3]) to allow end systems to query a server, presumably operated by the IAP, and obtain the current geographic location. The query key is the end systems IP address. These proposals have the advantage that they can be implemented without upgrading home routers and work in access networks that do not use DHCP, but will likely require coupling the server with the address allocation mechanism and backend customer database operated by the IAP. Many different industry players have offered suggested proposals for applications-layer query systems; but so far, none have integrated this service across layers 1-3 to provide a complete I3 911 solution.

To provide accurate location information, servers providing location information, such as DHCP servers, will need to interface with the operations support system of the IAP. This will require some

[5] LLDP-MED is a work item of TIA and based on the IEEE's 802.1AB LLDP.

software development, but in many cases such interfaces exist as they are required for authentication, authorization and accounting.

Without significant effort, coarse location information can be provided, using existing servers in many cases. This location would only identify the location of the corporate campus, DSLAM or cable headend, for example, but would in many cases be able to route the call to the appropriate PSAP. (The location information is marked appropriately so that a receiver can tell that the information does not refer to the location of the caller itself, but is only an approximation.)

It has been argued that IAPs have no obligation or interest to provide location information. However, this ignores the fact that voice services, including emergency services, contribute to the attractiveness of broadband services. Indeed, many VoIP customers order broadband so that they can use VoIP. Thus, broadband service providers indirectly benefit from these services, just as they benefit from web content and other Internet services. In addition, as discussed below, it may be appropriate to have IAPs play a role in collecting any 911-related fees.

### 4.2 The Role of the PSAP

Finally, PSAPs also have to help in transition to next-generation 9-1-1 systems, just as they had to adjust and participate when cell phones were introduced. (We assume that interconnected VoIP operators will be participating in appropriate cost recovery mechanisms.) It is likely that the basic technical solution for end-to-end Internet protocol emergency calling will be available in 2006. These can be deployed as *overlay* solutions, possibly requiring only the installation of an IP phone with display capabilities in the PSAP. Such solutions will not be able to offer full integration with Geographic Information Systems (GIS), but the initial VoIP call volume is likely to be low, as VoIP market shares for residential users is probably around 1% at this point.

As noted earlier, transition technologies (NENA I1 and I2) are not able to support mobile and nomadic VoIP users. The use of such overlay services would be able to provide emergency services to such users, possibly in combination with VoIP-specific and telematics-like call centers.

## 5 Current Standardization and Prototyping Activities

While traditional 9-1-1 services were standardized nationally or, say, in North America, this approach is no longer sufficient for the next-generation emergency calling system. While backend systems can be different for each jurisdiction, end-user facing protocols and conventions must be universal, as both VoIP services and devices operate across national borders.

A number of organizations are working on standardizing the necessary technical components for next-generation emergency calling service. Here, we highlight the efforts of the Internet Engineering Task Force (IETF), the main protocol standardization body for the Internet. System architecture efforts by organizations such as NENA and VON are likely going to be covered by contributions by that organization.

Two working groups within the IETF, GEOPRIV (Geographic Location/Privacy) [6] and ECRIT (Emergency Context Resolution with Internet Technologies) [7] are addressing parts of the problem. GEOPRIV has almost completed standardizing three components of the location delivery framework,

[6] http://www.ietf.org/html.charters/geopriv-charter.html

[7] http://www.ietf.org/html.charters/ecrit-charter.html

namely a common XML format for location data (PIDF-LO [4]), a DHCP option for geospatial locations [1] and a DHCP option for civic locations [2]. All of these specifications are stable and implementable.

The ECRIT working group is focusing on identifying and routing emergency calls. Its core mission is to define a mapping protocol that translates a service indication and a geospatial or civic address to a URL identifying a PSAP or group of PSAPs. Call routing can proceed in multiple stages, so that fine-grained PSAP routing may not be visible to end systems and may take place within dedicated emergency services networks. Several protocol proposals are currently being discussed within that working group, but no consensus has been reached yet.

In addition to these standardization activities, early trials and implementations are vital to discover whether technology is likely to work and sufficiently well-specified to yield interoperable implementations. Indeed, the experience with Phase II wireless shows that not performing extensive interoperability test, conducted by neutral third parties, will likely cause interoperability problem and force the PSAP to individually test and implement special procedures with each provider. This dramatically increases costs, decreases system reliability and causes delays. Thus, we strongly recommend an early program of vendor-neutral interoperability testing with oversight by the FCC. As an example, the SIP interoperability test events [8], organized by the vendor-neutral SIP Forum, have helped to significantly increase cross-vendor interoperation for SIP-based products. These interoperability test events allow vendors to test interoperability for early production and prototype systems without these results becoming public. Additional interoperability tests and certifications may also be helpful, but are likely only definitive once deployment experience has been gathered.

Texas A&M University and Columbia University, in cooperation with PSAPs and the MapInfo corporation, have been implementing and demonstrating an early prototype system [5], using standard protocols and call routing components, using a number of open-source components. The system contains all parts of an end-to-end VoIP system, including location determination, call routing, PSAP automatic call distribution, GIS interfacing, call recording and first-responder call bridging. This demonstrates that it is possible to build prototype systems in reasonable time frames, at modest expense, but for prototype solutions to gain industry wide acceptance, IAP, VSPs and PSAPs must cooperate and federal and local governments should provide oversight to ensure that such systems meet consumer expectations.

# 6 Funding the 9-1-1 Infrastructure

The current funding mechanism for 9-1-1 services is, in many ways, not designed to maximize overall system effectiveness. It is clear that simply continuing the system by analogy, i.e., substituting VSPs collecting fees for LECs, is likely to delay implementation of a modern emergency calling system and greatly increase its cost.

While funding the current 9-1-1 system by monthly fixed fees is convenient, it should be recognized that this essentially amounts to a regressive head tax, as almost everyone uses voice communication services of some kind. It is particularly regressive in that it penalizes large families that need multiple landlines or cell phones, or want to use combinations of analog landline, cellular and VoIP communications.

There are a number of longer-term difficulties: By their nature, VSPs are not bound by jurisdiction and can operate from any country. Indeed, it has become popular for some to use VSPs that are located

[8] http://www.sipit.net/

in their country of heritage, as these services often offer the cheapest calls to family and relatives living there. Also, many customers use multiple VSPs, either because they are still exploring options or to arbitrage calling rates to different locales. There are a large number of VSPs that offer free on-net calling, with no monthly fees, charging only for PSTN calls. Thus, a fee based on percentage of service costs appears more appropriate for VoIP services without monthly fees. Those services are typically transaction-oriented, with subscribers dropping in and out of subscriptions month to month. Transaction-oriented subscribers have more limited relationships with VSPs and thus, it may be more difficult to consistently collect fees from these subscribers.

Even if a VSP wants to collect fees, the multitude of jurisdictions and fee submission mechanisms makes this exceedingly difficult. Since the service and billing address do not need to be the same, users could sometimes obtain service in no-cost jurisdictions, while using the service elsewhere.

Auditing foreign VSPs for compliance is likely to be far more difficult than domestic ones. In the interest of public safety, sudden failure of emergency call services for customers of such VSPs is highly undesirable. If fees were to be collected by emergency call routing intermediaries, these intermediaries may have difficulty ascertaining the number of active subscribers, particularly in cases where the VSP offers prepaid services.

From a public policy perspective, use of multiple communication devices that are capable of calling 9-1-1 should be encouraged. These devices are often used to report incidents that are affecting others or to report threats to public safety, thus benefitting the community at large at least as much as the bearer of the communication device.

Finally, the current system is based on charging per phone number and month. However, in the long term, the notion of one phone number per "line" or per household will no longer hold. It is likely, as already occurs for presence-based services operated by large Internet "portal" companies, that users can choose any number of identifiers. It is likely that each member of a household, for example, will have his or her own name. In some cases, families and small businesses will own their own domain name, available for a few dollars a year, and create identifiers at will, maybe even for special temporary purposes.

Thus, charging 9-1-1 fees per phone number or similar approximations is likely to be grossly unfair and inefficient. Doing so may sadly leave a relatively small proportion of VSP subscribers who use PSTN-numbering resources with the costs of broader NG911 upgrades.

Therefore, as VoIP replaces traditional telephone services, IAPs should be considered as a long-term means of collecting such fees. We understand that a "connections-based" approach to universal service contributions has been considered by the FCC. The reasons for recommending that approach in the universal service context also make sense in the area of cost recovery for NG911 service.

(From a tax theory perspective, separating paying for emergency services and the telecommunication access to such services seems arbitrary and artificial in a world where almost all access to such services is not through public call boxes, but rather through telecommunications services.) Using IAPs has a number of advantages:

- Since IAPs must own physical infrastructure in the jurisdictions that they serve, they can readily maintain relationships to 9-1-1 authorities in those jurisdictions. Indeed, in many cases, they already have to submit franchise fees and similar fees to local jurisdictions.

- Particularly VSPs with global presence may only serve a very small number of customers in each jurisdiction, but under more regressive proposals they would still have to process and submit payments to thousands of jurisdictions, each with their own rates, mechanisms and payment schedules. On the other hand, most IAPs serve large fractions of the broadband users in each jurisdiction, thus making collection and fee rendering far more efficient for both service provider and 9-1-1 jurisdiction.[9]

- The service location of the user is most likely the user's residence, removing the incentive of obtaining voice service in a low-cost jurisdiction.

- The IAP needs to provide location information and thus has an interest in recovering costs related to that infrastructure.

Overall, there is an opportunity of dramatically reducing the cost of the next-generation 9-1-1 system, making it share the drastic reductions in hardware and software costs enjoyed by other information technology users. Consider the following back-of-an-envelope calculation:

- There are approximately 6,000 PSAPs in the United States, each with, on average 2.5 call taker stations. Thus, even a complete upgrade of the workstation infrastructure would require only 15,000 PCs, with a high-end estimate of a cost of $30 million, including local network infrastructure, occurring roughly every five years. (Cost for GIS systems are currently apparently much larger on a per-seat basis, but it appears unfair to burden VoIP with a complete overhaul of the GIS infrastructure, given that most stationary and nomadic users will be able to deliver civic addresses that do not require GIS for dispatch.)

- Purely from a capacity perspective, a single modern database server could route all United States 9-1-1 calls[10]. This is clearly undesirable from a reliability perspective, but per-county servers with mutual back-up can offer reliability far exceeding the current 9-1-1 infrastructure. As a high-end estimate, 3,000 such call-routing and database servers would suffice, adding annual costs of $1.5 million.

- In addition, PSAPs would have to acquire redundant broadband access. Even the smallest commercial symmetric access, such as fractional T-1 or symmetric DSL, is likely to be sufficient for all but the largest PSAPs. Total cost here depends on the number of PSAPs serving VoIP users and the distribution of their sizes and are harder to estimate. Broadband prices should be decreasing significantly, even if only the prices in other countries are a guide. A reasonable estimate for today is about $50/month for each concurrently active voice circuit, thus adding about $9 million in operational cost each year.

- System administration costs are significant, but can be amortized by sharing such services among PSAPs, e.g., through a service provider. At an industry-standard ratio of 1:20, about 750 system administrators are needed. At a loaded salary of $100,000/annum,

- Call routing software costs are likely to be modest if commercial off-the-shelf technology is used.

- Data maintenance costs need to be amortized. The primary effort will be maintaining the MSAG database, as is already done today.

[9] To avoid charging the same household twice, broadband subscribers that maintain a circuit-switched landline connection should be exempted from 9-1-1 charges.

[10] On average, there are "only" about 6 emergency calls per second placed in the United States. Modern call routing servers, so-called SIP proxy servers, can handle hundreds to thousands of calls a second.

In summary:

| Cost item | U.S. cost (millions) |
|---|---:|
| Call taker workstations | $ 6.0 |
| Call routers | $ 1.5 |
| Network access | $ 9.0 |
| System administration | $75.0 |
| Annual cost | $91.5 |

Given roughly 100 million households in the United States, a $1/household and year fee could recover the total replacement of the system.

This is clearly only an order-of-magnitude estimate that does not include MSAG maintenance, but should give an indication what a total replacement of the system would cost in hardware, amortized over a five-year horizon.

Thus, it is clear that the dominating cost is not hardware or software, but rather personnel, even if call takers are not counted[11].

## 7 Access to Data

One of the great unknowns in the transition to a next-generation 9-1-1 system is access to crucial call routing data. In the next-generation system, classical ALI databased will no longer be needed, but there are two potential data bottlenecks, namely location data and MSAG data:

First, IAPs could charge monopoly prices for access to customer location data, particularly if VSPs have to buy this data from IAPs. Since many IAPs will also likely be competing as VSPs, there is a strong incentive for such IAPs to make access to location data difficult or expensive for their voice service competitors. (Conversely, if IAPs can retain part of the 9-1-1 charge, they can easily use this to cross-subsidize their VSP operations.)

Similarly, access to MSAG data is necessary for any VSP that wants to do call routing. The current ownership of MSAG data appears to be murky, as it is often prepared and maintained by PSAPs, but housed and collected by data providers or ILECs. Delaying access to MSAG data can further delay deployment of next-generation VoIP systems and can be used by incumbents to delay entry by new competitors. Since the underlying street and service area data is public, appropriate safeguards should be put in place to speed access to that data, e.g., by considering data licenses modeled on the Creative Commons licenses [12].

In addition, there are currently two large maintainers of address information, namely the various 9-1-1 agencies and the United States Postal Service. The two addressing systems are similar, although in some jurisdictions, jurisdiction names and postal community names differ. It would benefit the emergency services community if the address verification efforts of the USPS can speed deployment of modern emergency calling services[13]

Thus, strong regulatory efforts may be needed to ensure non-discriminatory and cost-effective access to crucial call routing data.

[11] An order-of-magnitude estimate would put the cost of call taker salaries at several billion dollars a year, assuming approximately 60,000 call takers.

[12] http://creativecommons.org/

[13] For example, the USPS maintains records that capture every street address, including street numbers, while MSAG data usually only captures street address ranges and thus is unable to detect mistakes in the entry of house numbers.

## 8 Phase II Wireless Integration

The implementation of Phase II enhanced 9-1-1 services has taken much longer and cost much more than originally anticipated, with only about 30% of the United States population benefitting from such access. Costs have increased since cellular location information needs to be funneled, by reference, through the needle's eye of the PSAPs data interface, significantly increasing cost and complexity, often requiring per-carrier arrangements and testing.

Instead, it should be considered to have cellular carriers provide calls and location information in-band, using the same technologies to be used for VoIP calls. This will likely significantly decrease call setup delays, increase interoperability and avoid many of the ILEC-mobile operator interface issues complicating today's efforts.

## 9 Conclusion

In this document, we have tried to illustrate that only a rapid transition from temporary "quick fix" integration of VoIP with PSAPs is able to leverage the capabilities of next-generation 9-1-1 systems and avoid a repeat of the high costs and delays experienced for Phase II wireless 9-1-1 services.

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