



Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

White Paper:
A Next Generation 911 Cost Study:
A Basis for Public Funding Essential to
Bringing a Nationwide Next Generation 911 Network
to America's Communications Users
and First Responders



Public Safety and Homeland Security Bureau
September 2011

Executive Summary

The nationwide 911 system enables the public to place voice calls requesting emergency assistance. This is an important and reliable service that saves lives, but it has serious limitations. The “voice-centric” legacy 911 system does not support more diverse technologies such as text messaging and streaming video, which Americans increasingly rely on to communicate. A nationwide Next Generation 911 (NG911) network will bridge this gap by providing the technical capability for Americans to contact public safety authorities using the advanced telecommunications platforms of today and tomorrow. The Federal Communications Commission (FCC or Commission) is dedicated to working closely with all stakeholders to ensure a smooth and cost-effective transition to NG911.

In this White Paper, the Federal Communications Commission’s Public Safety and Homeland Security Bureau presents a cost study on the network connectivity and call routing portion of the nationwide NG911 network.¹ This paper will guide the Commission in its NG911 policymaking, and it is offered as a resource for other federal policymakers as well as state and local governments and other stakeholders.

Introduction

To remain effective, the nation’s 911 system must evolve to accommodate the ways people communicate. Although broadband technologies are now central to how Americans communicate, a number of the public safety answering points (PSAPs) or 911 call centers that handle 911 calls still lack broadband connectivity to a service provider network, which is necessary to support the evolution to NG911.² Providing this connectivity on a nationwide scale will require substantial funding. This White Paper presents two models for achieving the required connectivity, the second of which envisions a more cost-effective deployment.

NG911 System Overview

NG911 will capitalize on advances in consumer-based electronics technology to provide a more flexible and robust 911 interface that will improve the speed, accuracy, and preparedness of emergency response. The legacy, circuit-switched model for routing 911 calls and conveying corresponding location information is increasingly obsolete and poorly suited for an environment where non-traditional voice and data communications content proliferates. When a wireless or VoIP user places a 911 call on a legacy network, the service provider handles the call with a complex system of routing, re-routing, and look-up designed to emulate the legacy technology. NG911 networks are able to take advantage of the benefits of IP-based wireless and wireline networks to route calls faster and more efficiently. Similarly, the available mission-critical data capabilities and features can provide first responders an advantage in responding to emergencies. NG911 capitalizes on these new platforms to overcome problems inherent in the legacy system and to take advantage of IP-based telecommunications’ superior bandwidth; accuracy; and flexibility in transmitting audio, video, text and data in a variety of formats.

Instead of relying on standard wireline voice communications with legacy telephone switching, the NG911 system uses digital, packet-switched IP data and voice communications. When a user places a call in a NG911

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² See Detailed Functional and Interface Standards for the NENA i3 Solution at <http://www.nena.org/standards/technical/i3-solution>

system, it uses a standardized set of IP-based technologies and applications to route the call through Internet traffic, providing intelligent routing, location information, and call signaling. Emergency calls are delivered to an Emergency Services Internet Protocol Network (ESInet),³ which can receive calls from a variety of different networks and types of networks. The ESInet then forwards the call to the appropriate PSAP. The flexibility of NG911 networks allows them to accommodate call handling by multiple entities⁴ seamlessly, while allowing network service providers to dynamically route calls around congested networks and enabling PSAPs to manage call volume more efficiently. Finally, the transition to NG911 will introduce cost-efficiencies.

Overall, NG911 networks are far more versatile than legacy 911 networks. They support voice as well as data, including streaming video, still images, and text. This flexibility in turn allows NG911 networks to accept and deliver traffic from a wide array of possible end-user devices. While a legacy 911 network can receive only voice calls, an NG911 network can accept video from a smartphone camera, voice over the voice network, VoIP-transmitted voice calls over a 3G or 4G network, or data sent by applications installed on the phone. Where legacy 911 systems are built on the assumption that a call is placed from a fixed point corresponding to a landline telephone, NG911 networks can effectively and efficiently route traffic from mobile user devices and fixed-location devices.

NG911 also has the potential to enhance the ability of PSAPs and first responders to assess and respond to emergencies based on the texts, photos, and videos that consumers send to them, combined with information they gather and correlate from other sources and databases.

Cost Study Overview

Introduction

This cost study examines two cost models for funding the construction and ongoing costs for nationwide NG911 network connectivity and call routing between the public safety answering point (PSAP) and the commercial service provider. It does not address other costs that PSAPs or carriers may incur in migrating to NG911, such as new systems located within the PSAP or upgrades to service provider networks to support NG911. The model calculates both capital or non-recurring costs and ongoing or recurring costs under two cost models validated by experts - a baseline model and a second model that assumes the realization of certain cost-efficiencies from PSAP consolidation and using hosted as opposed to dedicated networks.⁵ The inputs for both models include the number of PSAPs in the United States, NG911 bandwidth requirements, non-recurring or one-time equipment and installation costs, and recurring or ongoing costs, including operations and maintenance support.

³ An ESInet is designed as an IP-based inter-network (network of networks) shared by all agencies which may be involved in any emergency.

<http://www.nena.org/standards/technical/voip/functional-interface-NG911-i3>
<http://www.nena.org/standards/technical/voip/functional-interface-NG911-i3>

⁴ Unlike modern E911 systems, which are forced to emulate the behaviors of legacy incumbent wireline utility calls to complete calls over wireline facilities, with NG911 the IP traffic access provider, communications service provider, network operator(s), and server-side services may all be handled by different entities without sacrificing efficient IP routing.

⁵ Cost model assumptions are in Appendix A. The cost model was constructed and its assumptions were validated through a technical analysis that used data acquired from several major commercial service and industry equipment providers, their competitors, and vendors. Costs were based on appropriate comparable Request for Proposal (RFP) responses; actual proposals from service providers for similar network builds and operations; and information obtained directly from service providers, equipment vendors, and integrators. Detailed cost scenarios were also developed and compared with cost scenarios provided by service providers, equipment vendors, integrators, and public safety to further validate costs.

Assumptions

To ensure this cost study is measurable, we have divided PSAPs into three size categories, based on the number of seats for call-takers within each PSAP:

- *Small PSAPs:* PSAPs with 5 or fewer seats.
- *Medium PSAPs:* PSAPs with 6 to 49 seats.
- *Large PSAPs:* PSAPs with 50 or more seats.

The cost study also assumes that each PSAP will provide NG911 service using one of two network architecture solutions - dedicated or hosted.

Under the dedicated solution, the PSAP owns and operates all network, call routing, and call processing equipment and leases network connectivity. The dedicated solution requires more capital expenditures and on-going cost support than the hosted solution, including the costs of operations and maintenance personnel to support the PSAP-specific NG911 infrastructure. The dedicated solution allows for greater PSAP-specific customization. Most current 911 systems are closer to the dedicated solution because most of the equipment for handling calls, such as the switch, is housed in the PSAP.

Under the hosted solution, a PSAP contracts with third party service providers for all network services and associated equipment, which are hosted offsite and are accessible by multiple PSAPs and other public safety entities. Costs are based on administrative and monthly fees. Since this approach permits the sharing of information technology and system administration resources, the hosted solution is likely to be more cost effective than the dedicated solution. However, the hosted solution may not offer as many PSAP-specific customization options.⁶ For medium PSAPs, the hosted media processing systems, such as IP-PBX and conference bridges,⁷ are located closer to the PSAP, whereas for small PSAPs, they are regionalized.⁸ This reduces the initial investment required and allows for cost-sharing among PSAPs but also limits the extent to which services can be customized.

The transition to NG911 may induce organizational as well as technological changes. Local authorities seeking to reduce costs may consolidate PSAPs or rely more extensively on hosted solutions. Since the extent of these changes is impossible to predict, this White Paper presents two deployment models, each of which assumes a particular distribution of hosted and dedicated solutions among PSAPs in the three size categories and provides an estimate of the extent to which PSAPs will consolidate.

Baseline Model (Option A)

The baseline model (Option A) assumes that a significant majority of small PSAPs will choose a hosted NG911 solution; half of medium-sized PSAPs will choose a hosted solution; and given the size and scope of PSAPs in major cities, all large PSAPs will select a dedicated solution. Option A also assumes that no PSAPs will consolidate operations as they transition to NG911.

⁶ It is possible, though, that some providers may offer the same basic software for either a hosted or dedicated solution.

⁷ Media centers or gateways, will be a distribution center for network providers that will aggregate DS-1s from multiple TDM POPs onto a single DS-3, complete calls directly to PSAPs over an MPLS network, and provide TDM-to-IP conversion and conference bridge services out of regional collocation facilities to the National Data Centers.

⁸ See architectural diagram in Appendix B.

Cost-Effective Model (Option B)

The cost-effective model (Option B) assumes that PSAP consolidation will result in a 35% decrease in the number of PSAPs as networks migrate to NG911. This model also assumes a greater reliance on hosted solutions, with 50% of large PSAPS and 75% of medium PSAPs opting for a hosted solution.

Cost Elements⁹

The core network components for a NG911 network are:

- PSAPs' access connectivity to, and service providers'¹⁰ interconnection with, the ESInet.
- The ESInet itself, which interconnects PSAPs as call-originating service providers.

Each component is discussed below.

PSAP Access

PSAPs need to access the regional ESInet using IP access connectivity. Historical trends indicate that PSAPs must provision at a minimum two, and sometimes three, physically-diverse access links to ensure adequate reliability and resiliency. The cost of providing PSAP access depends significantly on the methods used to provide redundancy and on the availability of commercial broadband access. To account for the particular challenges rural PSAPs face in securing adequate and cost-effective broadband connectivity, this study includes as a cost element special construction charges and non-recurring costs (NRC) for items needed to establish the ESInet or IP facilities.¹¹ These costs are generally incurred only once, but this study also takes into account a single equipment refresh during the projected ten-year period for certain equipment, such as routers.

As an order-of-magnitude estimate and as described in more detail below, a 10 Mbps commercial-grade circuit is likely to be sufficient to support 911 traffic for all but the largest PSAPs. This study assumes that the cost of carrying emergency calls to the boundary of the ESInet is borne by the Telecommunications Service Provider (TSP) and is thus beyond the scope of this report. If the ESInet interconnects at major interexchange points (IXPs), the costs to both the TSP and the ESInet are likely *de minimis*. Currently, there are about 85 IXPs in the United States, but they are not distributed evenly geographically, so it is likely that TSPs would have to peer privately with some ESInets. This also depends on whether the ESInet is using shared or dedicated facilities, as discussed below.

⁹ The cost elements included in this paper include everything exclusive of equipment, software, and service within the PSAP.

¹⁰ These service providers could include Commercial Mobile Radio Services (CMRS) operators or Local Exchange Carriers (LECs).

¹¹ Special construction charges may apply to the installation of certain fiber-based products. Companies typically determine whether special construction and associated charges are applicable on a case-by-case basis depending on the customer's geographic location, such as the distance to the nearest wire center or point of presence. Special types of construction may include underground service connections; aerial drop wires, underground conduit; trenching, where armored cable is laid in a trench; trench backfill expenses; cable replacement; and dismantling and removing aerial facilities, where facilities are changed from aerial to underground.

ESInet¹²

NG911 architecture relies on the ESInet to deliver voice, video, text, and data "calls" to the PSAP. There are at least three fundamental approaches to interconnecting PSAPs via an ESInet. First, the ESInet can serve as a dedicated network used solely for 911 calls and related communications, likely using Multi-Protocol Label Switching (MPLS)¹³ facilities offered by commercial service providers.¹⁴ Under the second approach, the network can be shared with other governmental or not-for-profit services. Examples of this approach include the use of a statewide IP network or the US-UCAN network that re-uses the Internet2 leased fiber infrastructure currently used to connect universities with each other.¹⁵ A third approach is to dispense with the ESInet altogether and interconnect PSAPs via the public Internet, possibly using Virtual Private Networks (VPNs). This approach has no additional costs beyond access link charges.

Cost Analysis

This analysis first determines the number of PSAPs in each size category: small, medium, and large. It then calculates non-recurring and recurring costs under each model based on the distribution among PSAPs of the two architectural solutions (dedicated or hosted) and on the total number of PSAPs requiring access to broadband fiber.

For non-recurring access connectivity, the study takes into account the cost to upgrade from time-division multiplexing (TDM) to IP-over-fiber, the percentage of PSAPs that must upgrade to IP-over-fiber, the percentage of PSAPs that upgrade from a single fiber connection to a dual fiber connection for improved reliability, and the percentage of PSAPs requiring special construction charges to connect or upgrade broadband fiber to the PSAP. Special construction charges also vary based on the size of the PSAP and its geographic location. The analysis also includes non-recurring costs for equipment required to connect the PSAP to a hosted or dedicated network solution.¹⁶

Recurring costs include the costs of access connectivity for all PSAPs, which typically take the form of monthly fees to subscribe to a certain amount of bandwidth.¹⁷ Recurring costs under the hosted solution also include monthly fees for services hosted offsite by a third party service provider. Recurring costs under the dedicated solution also include ongoing maintenance and operations costs. Based on estimates of current costs for 911 trunking (T1 circuits) nationwide, the total yearly recurring cost could be offset by as much as \$26 M to \$55 M once NG911 networks are fully operational. This is based on a reasonable estimate of the number of trunks each PSAP has today (5 to 7 on average) at a monthly rate of \$65 to \$100 per trunk.

¹² The ESInet includes servers required to obtain and validate location information and to route calls, such as servers; Emergency Call Routing Function (ECRF); Border Control Functions (BCF); Emergency Services Routing Proxy (ESRP); Policy Store/Policy Routing Function (PSPRF); Location Validation Function (LVF); and LIS (Location Information Servers).

¹³ See http://www.cisco.com/en/US/products/ps6557/products_ios_technology_home.htmlhttp://www.cisco.com/en/US/products/ps6557/products_ios_technology_home.html.

¹⁴ The cost of a statewide dedicated ESInet depends on the geographic distribution and number of PSAPs but is likely to be substantial. Generally, the per-Mbps cost of a network decreases with capacity, so, for example, it is less expensive to build one 1 Gbps network than ten 100 Mbps networks. In addition, the ESInet should be structured to handle any reasonable denial-of-service traffic.

¹⁵ See <http://www.internet2.edu/government/docs/U.S.%20UCAN%20Internet2%20Member%20Community%20FAQ.pdf>.

¹⁶ See Figures 3 and 7.

¹⁷ See Figures 2 and 6.

For the baseline model (Option A) mentioned above, the total ten-year¹⁸ cost, including non-recurring costs and recurring costs, is \$2.68 billion. Figure 1 depicts non-recurring costs for the three size categories and the projected recurring costs.

All PSAPs	Non-Recurring Costs (NRC)
Small	\$302 M
Medium	\$776 M
Large	\$153 M
All PSAPs - Total NRC	\$1.23 B
All PSAPs - Total Recurring Costs over 10 years	\$1.45 B
All PSAPs - Total 10 year Recurring Cost + NRC	\$2.68 B

Figure 1: Baseline Model (Option A), Cost Summary

In Figure 2, the total monthly recurring costs are shown for the three size categories and projected out for a 10-year period. Based on a typical ramp-up schedule, the monthly recurring costs are modest in the first three years, after which the transition to NG911 accelerates.

	Total Monthly Recurring Costs (MRC)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Small PSAP	\$5,957,050	\$15,885,465	\$31,770,931	\$61,556,178	\$107,226,892	\$163,143,730	\$194,120,387	\$206,511,050	\$206,511,050	\$206,511,050
Medium PSAP	\$2,325,930	\$6,202,481	\$12,404,962	\$24,034,615	\$41,866,748	\$63,699,482	\$75,794,321	\$80,632,256	\$80,632,256	\$80,632,256
Large PSAP	\$663,802	\$1,770,138	\$3,540,276	\$6,859,285	\$11,948,432	\$18,179,317	\$21,631,086	\$23,011,794	\$23,011,794	\$23,011,794
Total	\$8,946,782	\$23,858,085	\$47,716,169	\$92,450,078	\$161,042,071	\$245,022,529	\$291,545,794	\$310,155,100	\$310,155,100	\$310,155,100
Net Present Value (NPV)	-\$1,448,431,006									
US 10-Year Treasury Yield rate	3.03%									

Figure 2: Option A, Recurring Costs

¹⁸ A theoretical rollout schedule for NG911 and concurrent phase-out of the baseline system spans a 10-year implementation period.

Figure 3 summarizes the non-recurring costs for the three PSAP size categories. As an example, the total NRC for small PSAPs is \$302.3 M, which includes access connectivity cost (\$144 M), hosted cost (\$54.9 M), dedicated network cost (\$61.7 M), and equipment refresh and replacement costs (\$41.7 M).

Summary of Non-Recurring Costs (NRC)														
PSAP Size	Access Connectivity Cost (NRC)							Hosted Cost		Dedicated Solution (IT infrastructure, ESInet, etc)			Equipment Refresh and Replacement	Total
	Bandwidth (BW) Connection	TDM to IP Install (NRC)	Total % PSAP's (S, M, L)	Total % Upgraded PSAP's	Total % New PSAP's	Total % PSAP's for Special construction	Total NRC Cost	Total NRC (per PSAP)	Total NRC - All PSAPs	Low Dedicated Network Cost NRC - (per PSAP)	High Dedicated Network Cost NRC - (per PSAP)	Dedicated Network Cost NRC - All PSAPs		
Small	10 Mb/s	\$1,100	80%	55%	25%	45%	\$143,998,668	\$10,000	\$54,888,000	\$500,000	\$750,000	\$61,749,000	\$41,701,707	\$302,337,375
Medium	10 Mb/s	\$1,100	19%	75%	25%	40%	\$41,617,111	\$25,000	\$16,294,875	\$750,000	\$1,500,000	\$611,057,813	\$107,035,168	\$776,004,966
Large	100 Mb/s	\$2,800	1%	100%	0%	30%	\$3,149,199	\$0	\$0	\$1,500,000	\$3,000,000	\$128,643,750	\$21,086,872	\$152,879,821

Figure 3: Options A, Non-Recurring Costs (NRC)

Figure 4 shows a year-by-year spend for all costs over the projected ten-year period under Option A. As mentioned above, Option A assumes that PSAPs would not consolidate operations as they transition to NG911.

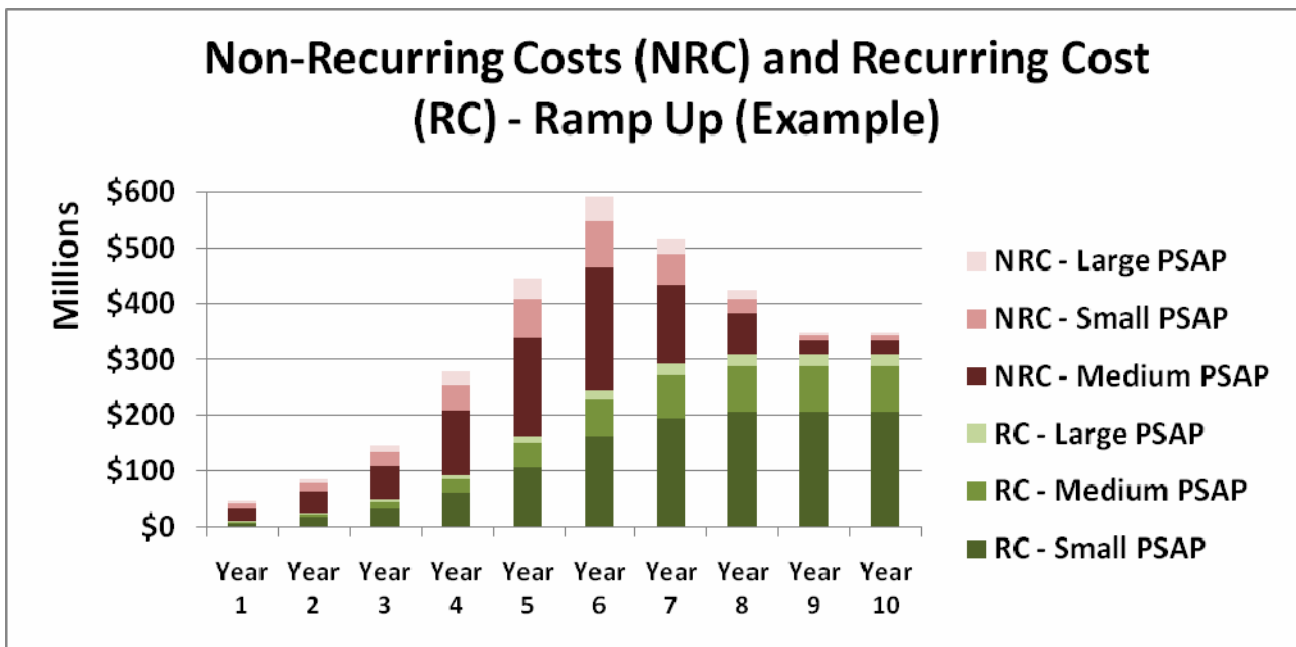


Figure 4: Option A, Year-by-Year Spend example

The cost effective model (Option B) assumes that PSAPs would consolidate operations as they migrate to NG911 and also rely more on hosted solutions. The total ten-year projected cost under this model, including non-recurring and recurring costs, is \$1.44 billion.

Figure 5 depicts non-recurring costs for the three size categories and the projected recurring costs. Because PSAP consolidations would reduce the number of PSAPs by 35% and a higher proportion of medium and large PSAPs would use hosted solutions, the non-recurring costs are lower.

All PSAPs	Non-Recurring Costs (NRC)
Small	\$203 M
Medium	\$297 M
Large	\$56 M
All PSAPs - Total NRC	\$556 M
All PSAPs - Total Recurring Costs over 10 years	\$888 M
All PSAPs - Total 10 year Recurring Cost + NRC	\$1.44 B

Figure 5: Option B, Cost-Effective Model, Cost Summary

Figure 6 shows the total monthly recurring costs for the three size categories projected out for a ten-year period. Based on a typical ramp-up schedule, the monthly recurring costs are modest in the first three years, after which the transition to NG911 accelerates.

	Total Monthly Recurring Costs (MRC)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Small PSAP	\$3,872,082	\$10,325,553	\$20,651,105	\$40,011,516	\$69,697,479	\$106,043,424	\$126,178,252	\$134,232,183	\$134,232,183	\$134,232,183
Medium PSAP	\$1,245,898	\$3,322,395	\$6,644,789	\$12,874,279	\$22,426,164	\$34,120,993	\$40,599,663	\$43,191,130	\$43,191,130	\$43,191,130
Large PSAP	\$365,847	\$975,593	\$1,951,186	\$3,780,423	\$6,585,253	\$10,019,340	\$11,921,747	\$12,682,709	\$12,682,709	\$12,682,709
Total	\$5,483,828	\$14,623,540	\$29,247,080	\$56,666,218	\$98,708,896	\$150,183,758	\$178,699,661	\$190,106,023	\$190,106,023	\$190,106,023
Net Present Value (NPV)	-\$887,799,225									
US 10-Year Treasury Yield rate	3.03%									

Figure 6: Option B, Monthly Recurring Costs

Figure 7 presents non-recurring costs for the three PSAP size categories under the cost-effective model, Option B. As an example, the total non-recurring costs for small PSAPs is \$203.2 M, which includes access connectivity cost (\$93.6 M), hosted cost (\$35.7 M), dedicated network cost (\$40.1 M), and equipment refresh and replacement costs (\$33.8 M).

Summary of Non-Recurring Costs (NRC)														
PSAP Size	Access Connectivity Cost (NRC)							Hosted Cost		Dedicated Solution (IT infrastructure, ESInet, etc)			Equipment Refresh and Replacement	Total
	Bandwidth (BW) Connection	TDM to IP Install (NRC)	Total % PSAP's (S, M, L)	Total % Upgraded PSAP's	Total % New PSAP's	Total % PSAP's for Special construction	Total NRC Cost	Total NRC (per PSAP)	Total NRC - All PSAPs	Low Dedicated Network Cost NRC - (per PSAP)	High Dedicated Network Cost NRC - (per PSAP)	Dedicated Network Cost NRC - All PSAPs		
Small	10 Mb/s	\$1,100	80%	55%	25%	45%	\$93,599,134	\$10,000	\$35,677,200	\$500,000	\$750,000	\$40,136,850	\$33,778,383	\$203,191,567
Medium	10 Mb/s	\$1,100	19%	75%	25%	40%	\$27,051,122	\$25,000	\$15,887,503	\$750,000	\$1,500,000	\$198,593,789	\$55,770,813	\$297,303,227
Large	100 Mb/s	\$2,800	1%	100%	0%	30%	\$2,046,979	\$50,000	\$1,114,913	\$1,500,000	\$3,000,000	\$41,809,219	\$10,569,277	\$55,540,388

Figure 7: Option B, Non-Recurring Costs (NRC)

Figure 8 shows a year-by-year spend for all costs over the ten-year period for Option B. As mentioned above, this option assumes that PSAP consolidations during the transition to NG911 would result in the number of PSAPs decreasing by 35%.

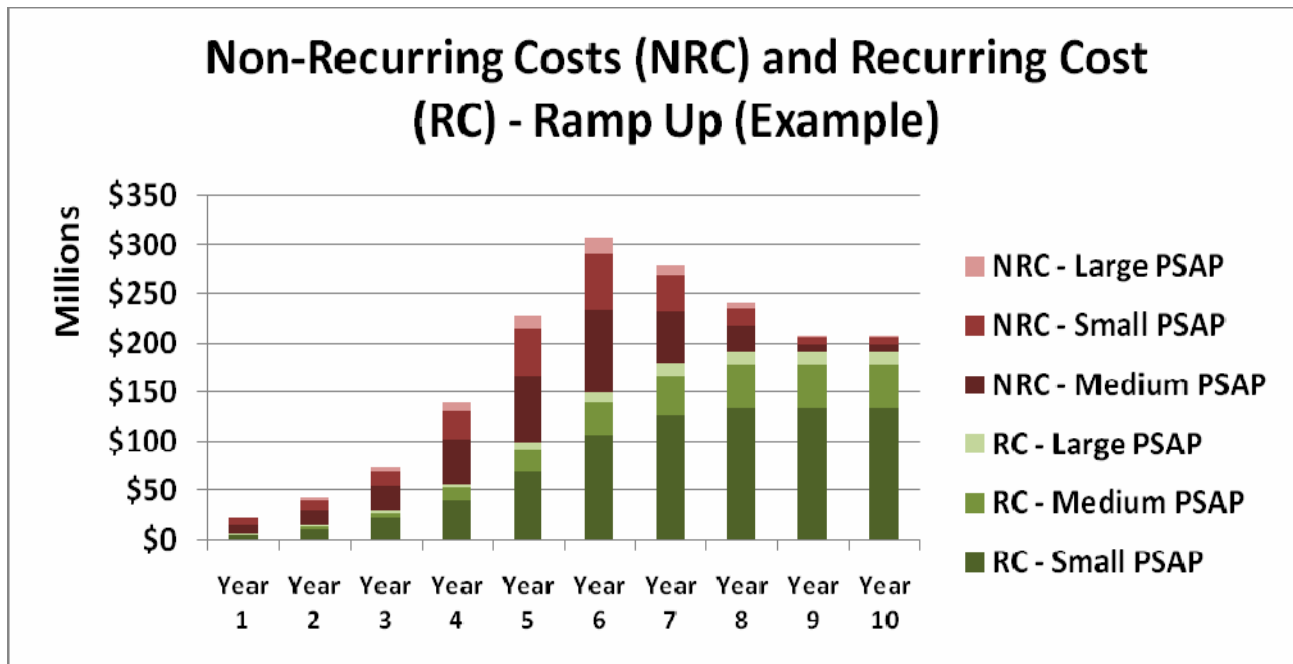


Figure 8: Option B, Year-by-Year Spend example

Appendix A – Cost Modeling Assumptions

Key Assumptions

The cost model analysis includes only costs related to connecting the PSAP to the ESInet, and the per-PSAP share of the cost of the ESInet. It intentionally excludes any NG911-related costs for upgrading PSAP facilities to support NG911, such as updating call taker stations, training, or additional technical staff. The model also does not address costs incurred by telecommunications carriers. See Figure 9 for a summary of the assumptions.

Both Option A and Option B share the following core assumptions:

1. As of July 14, 2011, the FCC PSAP registry included a total of 6,861 active PSAPs in the United States.
2. If a physical IP fiber-based access facility is not available and special construction to build fiber to support 10 Mbps or 100 Mbps fiber access is required, the special construction cost estimates are based on an average distance of one mile.
3. Monthly recurring costs (MRC) over 10 years are calculated using Net Present Value (NPV) and the US 10-Year Treasury Yield rate of 3.03% as of July 21, 2011.
4. MRC over 10 years includes an escalation of 4% during year six because contracts for customer network pricing are typically based on 36 or 60 months pricing.
5. The total MRC per PSAP for the hosted solution (call routing, infrastructure, and software) is \$1,200, regardless of the PSAP size.
6. Non-recurring costs are included for items needed to establish the ESInet or IP access facilities. These costs are not generally incurred again, but network equipment such as routers typically have life cycles that may require a refreshing of equipment. Telecommunications infrastructure equipment typically has a useful life of seven years. Therefore, the cost model assumes that starting at year eight, the capital equipment purchased in years one to three is replaced, but we assume even distribution of the cost over a five-year period in years six through ten.¹⁹
7. Use of microwave is not taken into account in calculating backhaul costs.
8. Operations and maintenance support is included as a MRC for the dedicated solution at a rate of 6% of capital cost.

Baseline Cost Model -- Option A

The baseline model, does not consider PSAP consolidation for the transition to NG911. Percentages and costs are listed below for each PSAP size class.

¹⁹ See, http://www.irs.gov/irm/part1/irm_01-035-006.html and <http://www.microsoft.com/midsizebusiness/server-replacement-cycle.msp>

Cost Effective Model -- Option B

1. Assumes PSAP consolidation during the transition to NG911, resulting in a total of 35% fewer PSAPs at the end of the migration to NG911. We do not try to estimate the consolidation for each of the three size categories. Among large PSAPs, 50% are assumed to choose a dedicated NG911 solution and 50% a hosted solution. The hosted solution for large PSAPs incurs a non-recurring cost of \$50,000.
2. Among medium PSAPs, 25% are assumed to choose a dedicated NG911 solution and the other 75% a hosted solution.

Large PSAPs

- Large PSAPs have 50 or more call taker positions; currently, approximately 1% of all PSAPs fall into this category.
- 100% of large PSAPs are assumed to choose dedicated NG911 systems for Option A, and 50% are assumed to choose dedicated NG911 systems for Option B.
- Large PSAPs are assumed to require 100 Mbps IP transport facilities, with a MRC of \$8,750.
- 30% of large PSAPs are assumed to require special construction charges for IP facilities averaging \$132,000 each.
- NRC per PSAP for dedicated network costs is divided into two classes: \$1,500,000 for 75% of the PSAPs and \$3,000,000 for 25% of the PSAPs. This division takes into account the range of possible dedicated network costs.
- All of the large PSAPs are assumed to upgrade IP facilities to dual 100 Mbps IP access.
- In Option A, the large PSAPs incur no MRC for the hosted solution because they are assumed to own and operate all of the infrastructure equipment.

Medium PSAPs

- Medium PSAPs are characterized as having between 6 and 49 call taker positions; currently, approximately 19% of all PSAPs fall into this category.
- 50% (Option A) or 75% (Option B) of medium PSAPs are assumed to choose the hosted solution with national data centers for databases (to house the NG911 applications and call routing databases) and regional media gateway deployments, for hosted equipment and services closer to PSAPs. The remaining PSAPs are assumed to choose a dedicated solution.
- Medium PSAPs are assumed to require 10 Mbps IP transport facilities with a MRC of \$1,150.
- 75% of the medium PSAPs are assumed to upgrade IP access facilities to dual 10 Mbps connectivity.
- 40% of medium PSAPs are assumed to require special construction charges for IP facilities averaging \$75,000 each.
- For the hosted solution, the total NRC and additional equipment cost is assumed to be \$25,000.

- NRC per PSAP for the dedicated network is \$750,000 (for 75% of the PSAPs) to \$1,500,000 (for 25% of the PSAPs).

Small PSAPs

- Small PSAPs have between one and five positions; approximately 80% of PSAPs are in this category.
- 98% of small PSAPs are assumed to choose national data centers for databases (to house the application and databases) and regional media gateway deployments (hosted equipment and services regionally located across the US).
- 2% of small PSAPs are assumed to choose a dedicated solution.
- 55% of small PSAPs are assumed to upgrade IP facilities to dual 10 Mbps connectivity; the others are assumed to already have the necessary connectivity. 45% of small PSAPs are assumed to require special construction charges for IP facilities averaging \$55,000 each.
- NRC per PSAP for the dedicated network is assumed to be \$500,000 (for 75% of the PSAPs) to \$750,000 (for 25% of the PSAPs).
- Small PSAPs are assumed to require 10 Mbps IP transport facilities with an MRC of \$1,150 for each circuit.
- For the hosted solution, the total NRC and cost of additional equipment is assumed to be \$10,000 per month.

Parameters	Small PSAPs	Medium PSAPs	Large PSAPs
Seat size	1-5	6-49	50+
Percentage of PSAPs of each size	80 %	19 %	1 %
PSAPs selecting the hosted solution (Option B)	98 %	50 % (75%)	0 % (50%)
Bandwidth required	2 x 10 Mbps	2 x 10 Mbps	2 x 100 Mbps
PSAPs upgraded with dual fiber access	55 %	75 %	100 %
PSAPs that incur special construction costs for installing new or upgrading existing fiber	45 %	40 %	30 %
Non-recurring cost (NRC) for network access (\$M)	0.5 ... 0.75	0.75...1.5	1.5...3.0
Monthly cost for fiber lease	2 x \$1,150	2 x \$1,150	2 x \$8,750
NRC for hosting services	\$10,000	\$25,000	\$50,000
Monthly recurring charge (MRC) for hosting services	\$1,200	\$1,200	\$1,200

Figure 9 – Key Assumptions

Bandwidth Requirements

- Each call taker can be active on one call at a time, for either voice combined with video or standalone surveillance/traffic camera video. All call taker positions should be able to use all network functions simultaneously; thus, we take into account peak usage when all call takers are busy, not average usage.
- We assume that each active voice call needs 80 Kbps, based on a voice bit rate of 64 Kbps with G.711 encoding plus IP packetization overhead. (Unlike with traditional PSAPs, calls that are queued or on hold do not consume bandwidth.)
- Each call taker watches one video stream, at approximately 1.6 Mbps per call taker position.
- The bandwidth needed for text (RTT, SMS, and instant messaging) is generally considered to be negligible compared to the bandwidth needed for audio and video.

- Data (e.g., access to location data or maps) for each call taker is small. We assume that each PSAP needs approximately 1 Mbps for data. In both the hosted and dedicated solutions, mapping and similar data will likely be cached within the PSAP.
- Network bandwidth is typically sold in steps, not by the kilobit. Therefore, we assume 10 Mbps and 100 Mbps, even though the needs may fall between those values.
- While bandwidth needs may not be fully symmetric, commercial-grade access at the 10 Mbps and 100 Mbps bandwidth levels are typically symmetrical, so we make no special provisions for asymmetric access.

Small Market – Hosted Solution

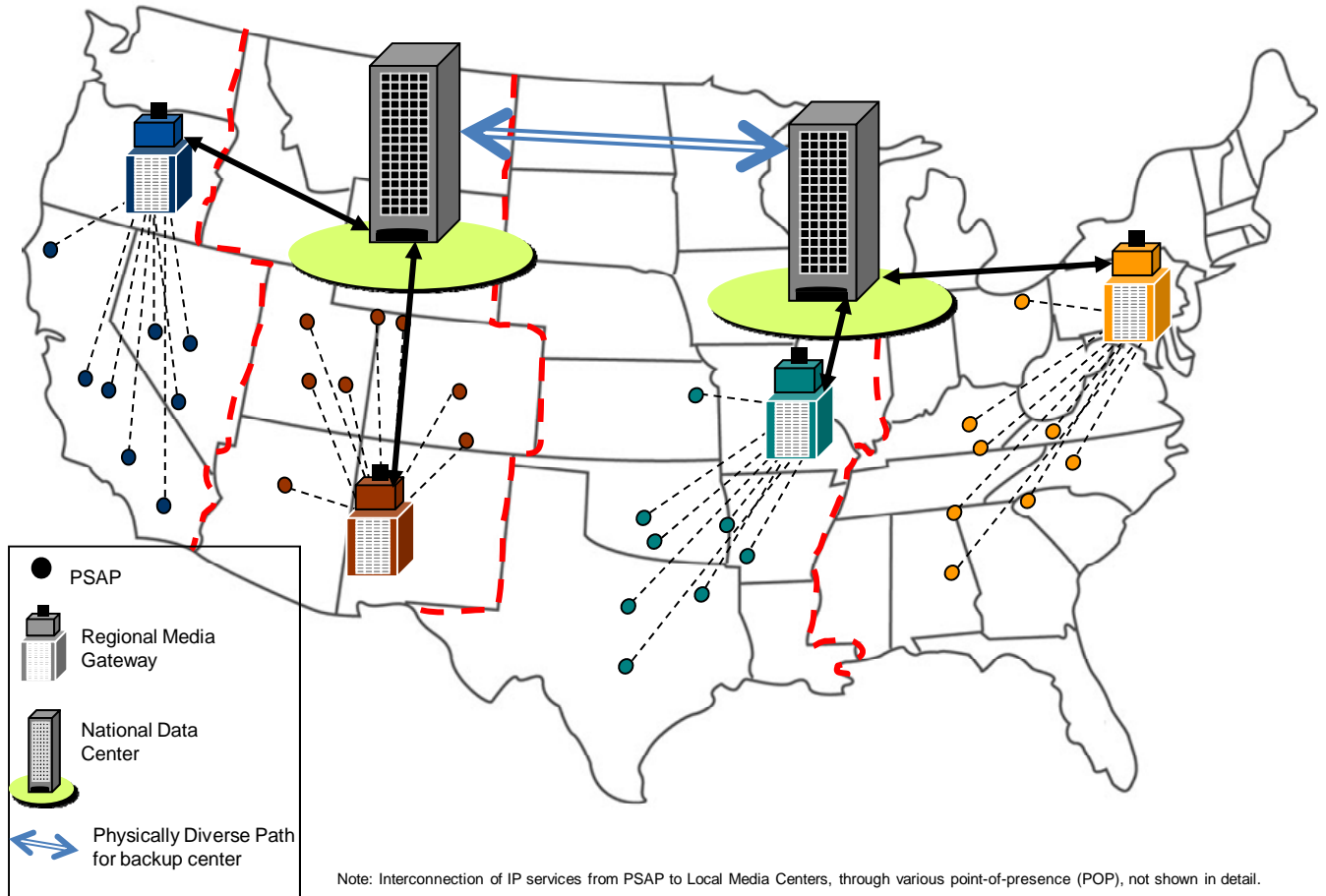


Figure 9 - Small PSAP Hosted Solution (Example)

Medium Market – Hosted Solution

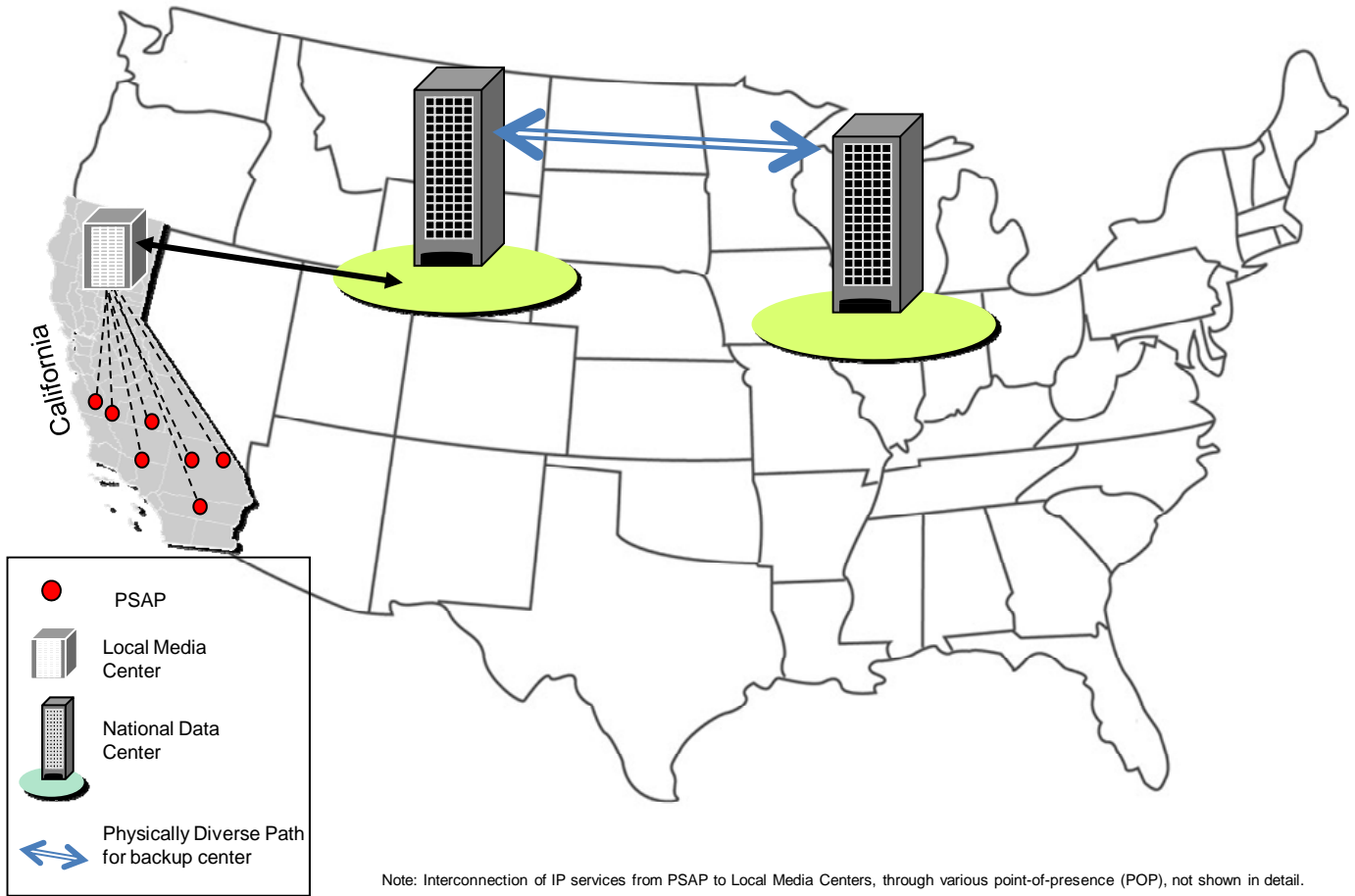


Figure 10 - Medium PSAP Hosted Solution (Example)

Large Market – Dedicated Solution

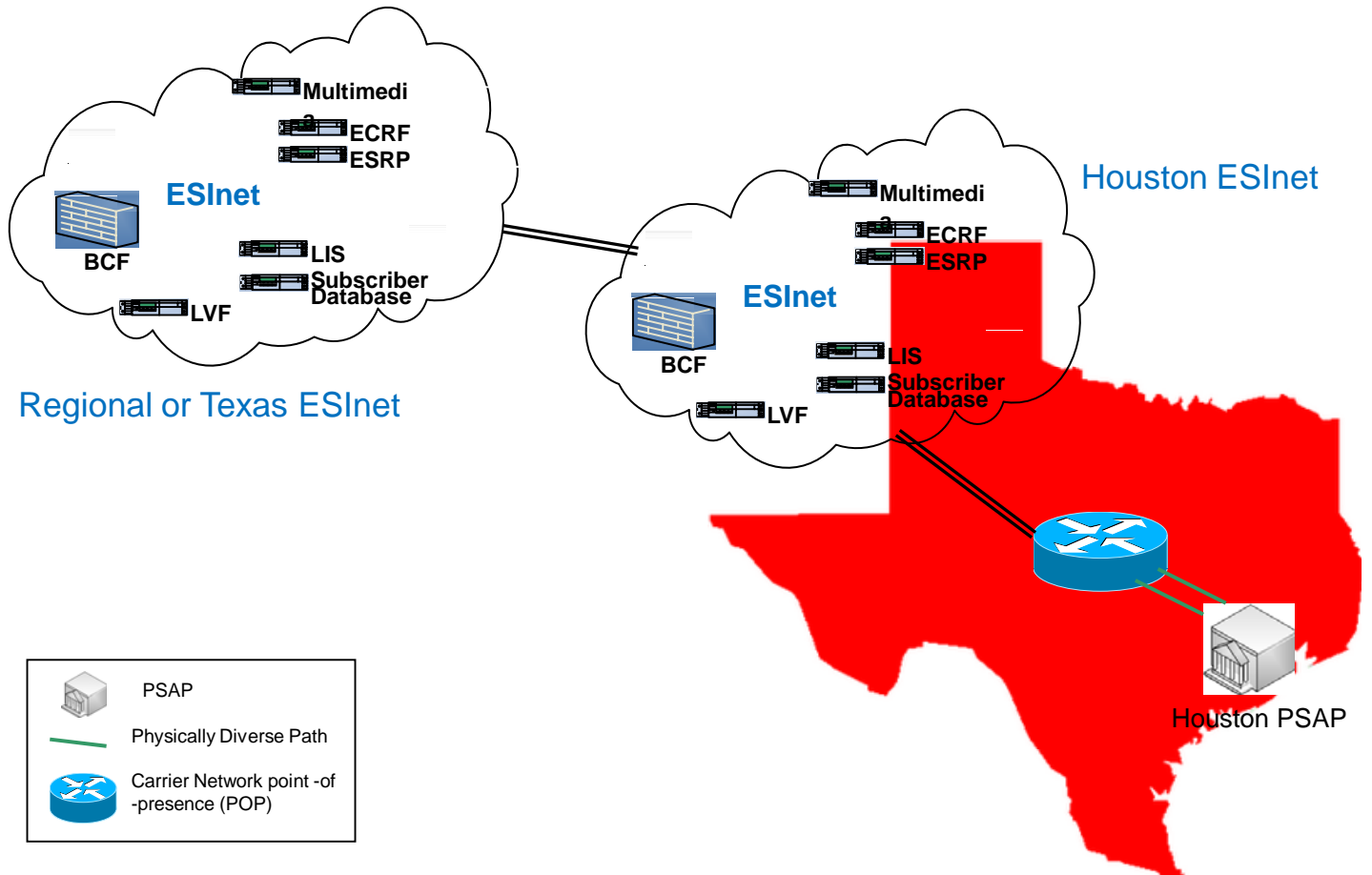


Figure 11 - Large PSAP Dedicated Solution (Example)

Appendix C – Network Cost Elements

<ul style="list-style-type: none"> • NENA i3 Core Components 	<ul style="list-style-type: none"> – <i>Border Control Functions (BCF) for IP connectivity from call originators (either dedicated to 911 or shared with other emergency services)</i> – <i>Emergency Call Routing Function (ECRF)</i> – <i>Location Validation Function (LVF)</i> – <i>Emergency Services Routing Proxy (ESRP)</i> – <i>Policy Store/Policy Routing Function (PSPRF)</i> – <i>Location Information Servers (LIS)</i>
<ul style="list-style-type: none"> • Multiprotocol Label Switching (MPLS) Network (Could be LEC-supplied or State owned/operated) 	<ul style="list-style-type: none"> – <i>Fiber access connectivity – 10 Mbps and 100 Mbps</i>
<ul style="list-style-type: none"> • Software external to the PSAP 	<ul style="list-style-type: none"> – <i>Data collection, security, identity management, aggregation, GIS functionality (largely re-used, but new to PSAPs), DBMS and ALI equivalent software (transitional)</i>
<ul style="list-style-type: none"> • Gateways 	<ul style="list-style-type: none"> – <i>Legacy 911 tandems and/or gateways from originating trunk (911 tandems not used) (May include location database store if ALI equivalent not used)</i>
<ul style="list-style-type: none"> • Other included elements 	<ul style="list-style-type: none"> – <i>Firewall, offsite backup data, Uninterrupted Power Systems (UPS), power supplies, power cords and cables</i>

Figure 12 - Network Cost Elements