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NG9-1-1 Core Services: Standards and Architectures

Industry Council for Emergency Response Technologies, Inc.
iCERT Public Safety Communications Interoperability (PSCI) Working Group
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Foreword

Now more than ever, the world's citizens need the technologies and innovation embodied in the emergency response technology, software, and communications industries. The Industry Council for Emergency Response Technologies, Inc. (iCERT) is proud of its history since 2005 as the exclusive trade association representative for emergency response technology hardware, software, and services providers.

iCERT's priorities include:

1) Advocating for ***more and new*** public safety technology funding at all levels of government;
2) Growing members' organic revenue, partnerships, and total market share with exclusive and unique iCERT **business-to-business** internal opportunities;
3) Advancing connectivity solutions for public safety in conjunction with next generation IP-based emergency calling, text, and multimedia communications;
4) Promoting understanding and adoption of advanced technologies in all public safety sectors - NG9-1-1, Artificial Intelligence, Big Data, Location Technologies, Communications Networks, CAD, Cloud-Based Systems, LTE, LMR, Recording, Dispatch, and Cybersecurity (to name a few); and
5) Ensuring that issues that unfairly burden or impede the introduction of new public safety / response technologies to the marketplace are explained and accommodated before decisions are made by federal, state, and local government agencies and/or regulators.

One of the ways iCERT accomplishes these goals is through cooperative member-driven efforts, such as this white paper, which capture leading edge experiences and best practices that provide both educational and practical benefits to readers and practitioners

iCERT members know that history has repeatedly proven business leaders' expertise can assist public policymakers and government emergency communications professionals as they address complex choices regarding the installation, use, and maintenance of advanced communications, public safety, and related technologies. iCERT uses the trade association format to refine this process so that our members maximize their potential both as individuals and as organizations to achieve their desired objectives.

On behalf of iCERT's members and the emergency response technology industry, thank you for reviewing this information, and we hope that it is of benefit. Comments and questions are always welcome. Thank you.

George Kelemen
Executive Director
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* This white paper was developed by a broad cross section of industry representatives with significant expertise in Next Generation 9-1-1 standards, technologies and systems. iCERT wishes to give special acknowledgement to Michael Hooker, Bill Mertka, Christian Militeau, Fabricio Velez, and Chuck Vick for their significant contributions to its development.

Executive Summary

Next Generation 9-1-1 (NG9-1-1) planning and implementation is increasing nationwide. A key success factor in NG9-1-1 deployment is that such systems should be open standards-based to the greatest extent possible. Open standards promote competition and interoperability and play a key role in enabling a resilient end-to-end system capable of providing the seamless flow of multimedia and additional incident data from citizens to both Public Safety Answering Points (PSAPs) and First Responders (FRs) that NG9-1-1 was intended to facilitate.

This white paper is part of iCERT's contribution to the national dialogue regarding architectural options available to implement the National Emergency Number Association (NENA)[1] STA-010 i3 standard for NG9-1-1 (referred to as the "i3 standard" throughout this white paper). There are currently two architectural options available for implementing the signaling and media control functions of NG9-1-1 Core Services (NGCS).

- The first is described in the NENA i3 standard itself.
- The second is an 3GPP[2] IMS-based option described in a standard developed by the Alliance for Telecommunications Industry Solutions (ATIS)[3].

This whitepaper clarifies the relationship between these two architectural options and their associated standards and describes how they fit into the broader NG9-1-1 emergency services environment.

As a trade association, iCERT represents the interests of many of the nation's emergency response technology hardware, software, and services vendors. Therefore, iCERT recognizes the validity of both architectural options described above. They are intended to be compatible and are designed to be complementary. For more information on iCERT's policy position with regarding to NG9-1-1 standards, see the Policy Statement on NG9-1-1 released coincident with this white paper.

[1] http://www.nena.org
[2] The 3rd Generation Partnership Project (3GPP) is an umbrella term for a number of standards organizations which develop protocols for mobile telecommunications. http://www.3gpp.org/ See also Footnote 13.
[3] https://www.atis.org/

Definitions

The body of literature related to NG9-1-1 standards uses various terms and definitions when describing systems and components that constitute NG9-1-1. This section documents some of the terms that can be found in the standards and literature and is intended to aid the reader in understanding the concepts presented in this whitepaper. Acronyms are spelled out where appropriate.

Emergency Services Network (ESN). ESN is the network infrastructure providing the interconnecting emergency call routing services between Originating Service Provider (OSP) networks that originate 9-1-1 calls and the PSAPs that answer them. Legacy E9-1-1 ESNs based on TDM technology are being transitioned to NG9-1-1 ESNs based on IP technology.

IMS Multimedia Emergency Sessions (MES). Support of media other than speech or Global Text telephony (GTT) is referred to as IMS multimedia emergency session in the 3rd Generation Partnership Project (3GPP) specifications[4]. The media types that may be supported during an IMS MES include voice, real-time video, real-time text (RTT), session-mode text-based instant messaging, file transfer, etc. ATIS standards[5] define multimedia emergency services (MMES) as next generation emergency services utilizing real-time voice, video, and text between citizens and public safety. In this white paper MES, multimedia emergency call, Total Conversation emergency call, and MMES are used interchangeably.

Multimedia Emergency Services (MMES). MMES[6] are next generation emergency services utilizing real-time session-based text and other multimedia, including voice, that are based on trusted applications in support of non-voice communications between citizens and Public Safety. MMES provide secure transport of messaging and media content, and location information of the reporting device to Public Safety, in addition to providing two-way voice emergency communications between citizens and Public Safety. It is assumed that the User Equipment (UE) has a Session Initiated Protocol (SIP)[7] client capable of initiating a MMES session and the Common IMS common network will forward that request to an emergency network capable of handling the session.

Next Generation Emergency Services (NGES). NGES represents the end-to-end flow of real-time location data, multimedia emergency sessions, and other emergency data between citizens, emergency communications centers (ECCs), and first responders. As a result, it

[4] 3GPP TS 22.101 service principles for Public Land Mobile Networks (PLMNs). https://www.etsi.org/deliver/etsi_ts/122100_122199/122101/15.07.00_60/ts_122101v150700p.pdf
[5] ATIS-0700015 implementation of 3GPP common IMS emergency procedures for IMS origination and ESInet/legacy selective router termination. https://access.atis.org/apps/group_public/project/details.php?project_id=918
[6] ATIS-0700015 implementation of 3GPP common IMS emergency procedures for IMS origination and ESInet/legacy selective router termination https://access.atis.org/apps/group_public/project/details.php?project_id=918
[7] https://en.wikipedia.org/wiki/Session_Initiation_Protocol

incorporates OSP networks, NG9-1-1 systems, and Public Safety Broadband Networks (PSBNs; see definition below) and seeks to achieve full interoperability and integration between these network components.

Next Generation Emergency Services Network (NG ESN). A NG ESN is defined as an "end state" IP-based NG9-1-1 ESN providing transit, routing, and other services required to support multimedia emergency sessions between OSPs and ECCs using the Emergency Services IP Network (ESInet) as the transport medium for this data.

Next Generation 9-1-1 Core Services (NGCS). NGCS are defined as the functional elements making up the set of services needed to process, control, route, and deliver multimedia emergency sessions and emergency data between OSPs and ECCs connected via the ESInet.

Public Safety Broadband Network (PSBN). An interoperable broadband communications network used by first responders to communicate with each other and acquire and share information during emergencies, planned events, and day-to-day events. The PSBN delivers specialized mission-critical services to public safety users.

Note: Wireless networks through specialized design or specialized applications have evolved to provide the capabilities required by first responders, but not all networks that provide service to Public Safety have these capabilities and, therefore, not all networks serving Public Safety can be considered PSBNs. As noted below, First Responders may also communicate via other radio networks, such as Land Mobile Radio systems, while simultaneously using PSBN services. The term PSBN is used throughout this white paper for the reader's convenience; however, the determination of what is considered a PSBN is not included in the scope of this white paper, and iCERT is not taking a position on this determination.

Next Generation Public Safety Answering Point (NG PSAP). A NG PSAP is a PSAP capable of receiving IP-based signaling, multimedia, and additional incident data for delivery of emergency calls conformant to the NENA i3 standard. A NG PSAP is also referred to as an Emergency Communications Center (ECC) and the terms are used interchangeably in the white paper.[8]

[8] APCO Project 43 broadband implications for the PSAP, August 2017. https://psc.apcointl.org/2017/08/14/apco-releases-report-on-broadband-implications-for-the-psap/

Introduction

NG9-1-1 promises to yield significant benefits to the public and to the emergency response community. By transitioning the nation's 9-1-1 systems to more advanced communications technologies, NG9-1-1 will improve emergency response, increase system redundancy and resiliency, and enhance national security. However, NG9-1-1 is more than a simple technology upgrade. It is part of a broader effort to align our nation's emergency response systems with commercially available communication technologies that are prevalent around the world.

Today, citizens and first responders alike use Internet Protocol (IP)-based communications networks that support a host of multimedia applications. The long-term vision of NG9-1-1, referred to as "End State" NG9-1-1, is to transition today's legacy voice-only 9-1-1 systems to an all IP-based multimedia emergency services communications system. [9] By leveraging IP standards and technologies, NG9-1-1 will enable the transmission of videos, text, and additional data to NG PSAPs. NG PSAPs can then process and analyze this rich multimedia and data to share actionable intelligence with first responders in the field, providing an advanced end-to-end emergency response system that will improve situational awareness, shorten response times, and ultimately save lives.

Open technical standards are critical to the effective implementation and operation of NG9-1-1. The leading NG9-1-1 standard is The National Emergency Number Association (NENA) NENA-STA-010.3-2021[10] standard. There are currently two architectural options for implementing the signaling and media control requirements of the NGCS functional elements as specified in the i3 standard. Each of these options is based upon standards emanating from the Internet Engineering Task Force (IETF), the global standards development organization[11] (SDO) founded in 1986 to standardize the communications protocols used by the global Internet.

In an NG9-1-1 environment, NGCS replaces the legacy Selective Router (SR) and Automatic Location Information (ALI)-based E9-1-1 system infrastructure, while also adding additional features like multimedia processing, location-based routing, and other new features not yet available with the nation's legacy E9-1-1 systems. The NGCS functional elements making up the set of services needed to process, control, route, and deliver multimedia emergency sessions and emergency data between OSP networks and NG PSAPs connected via the (ESInet) can be placed into two distinct groups:

- Location & routing information
- Signaling & media control

[9] NG9-1-1 system initiative, final system design document, DOT, February 2009. https://www.hsdl.org/?abstract&did=37393
[10] https://www.nena.org/page/i3_Stage3
[11] https://www.ietf.org/

The architectural options currently available to vendors implementing the NGCS signaling & media control functional elements consists of two (NG ESN) reference architectures as illustrated in Figure 1:

- i3-based NG ESN (based on the NENA STA-010 i3 standard for NG9-1-1)
- IP Multimedia Subsystem (IMS)-based NG ESN (based on the NENA STA-010 i3 standard for NG9-1-1 and the Alliance for Telecommunications Industry Solutions ATIS–0500032 standard for implementation of an IMS-based NG9-1-1 service architecture)[12]

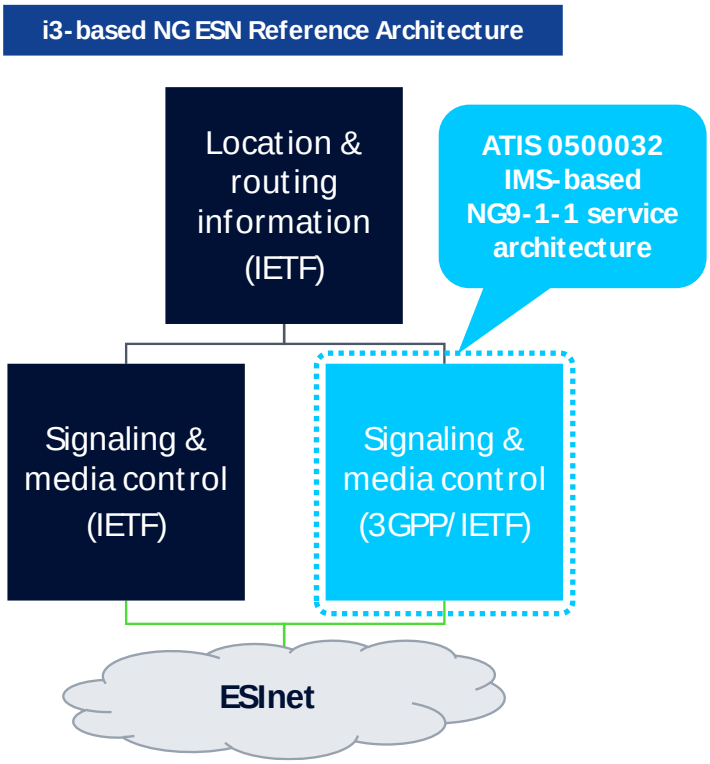

Figure 1. NG ESN architectural options for the implementation of the i3 standard.

This white paper summarizes the technical basis for each architectural option. iCERT views these architectural options are compatible and complementary by design. It is important to note that each is based upon i3 and IETF standards and each are viable alternatives for building standards-based, interoperable NG9-1-1 systems. The architectural option used by any given solution provider will depend on the technology in use by the organization deploying the system, its future technology plans, and the operational objectives of its end-user customers.

[12] In November 2016 ATIS created the first of a series of standards for the North American market detailing how to implement signaling and media control functions for NG9-1-1 systems using IMS, an IP multimedia communications services architectural framework first standardized by the Third Generation Partnership Project (3GPP) in 2003. https://standards.globalspec.com/std/10160089/ATIS%200500032

iCERT hopes this white paper will help dispel industry confusion as it pertains to both architectural options, aid in technical understanding of the components of each architectural option, and assist the industry in building the interoperable NG9-1-1 systems the public needs and deserves.

3GPP and NG9-1-1 Standards

As previously stated, NG9-1-1 is part of a broader emergency response communications ecosystem that includes, among other functions, networks enabling consumer access to 9-1-1 systems and the PSBNs used to dispatch and facilitate communications with and between first responders. The citizen-to-authority access segment of this ecosystem is supported by wireless networks based on 3GPP standards.[13] First responders are also adopting 3GPP-based wireless services, while continuing to use Land Mobile Radio (LMR) systems.

Figure 2 illustrates how the "End State" NG9-1-1 vision fits into the broader emergency response ecosystem. NG9-1-1 standards, working in conjunction with 3GPP wireless standards, enable the end-to-end, secure, and seamless flow of real-time location, multimedia emergency sessions, and additional emergency data between citizens, NG PSAPs, and first responders.

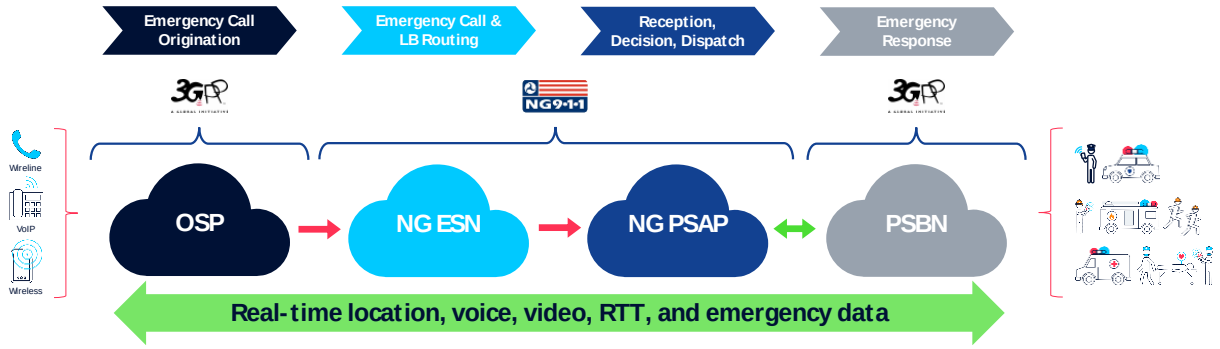

Figure 2. End-to-end secure and seamless flow of real-time location, multimedia emergency sessions (voice, video, RTT), and emergency data

[13] In 2019 approximately 80% of 911 calls originated from mobile phones [https://www.nena.org/page/911Statistics] in the United States, and approximately 90% of mobile subscriptions used 4G/LTE technology based on standards developed by 3GPP; a consortium of SDOs that includes ATIS (in the Americas), the European Telecommunications Standards Institute (ETSI), and five other SDOs representing Japan, China, Korea, and India. 3GPP's initial goal was to promote the development of global standards for third generation (3G) wireless networks but it has gone on to standardize both fourth generation (4G) and fifth generation (5G) wireless technologies as well.

This flow of information requires full interoperability of 3GPP-based OSP[14] networks, NG ESNs, NG PSAPs, and 3GPP-based PSBNs as well as the support of the following capabilities across the end-to-end incident call flow:

- OSPs: i3 SIP interface for originated emergency calls, emergency caller's location discovery and information, and support of MES from IP-based devices as well as multimedia emergency data from "Internet of Things" devices.
- NG ESNs: "end state" NG9-1-1 systems supporting call and multimedia control, location-based routing, service mapping, and location configuration.
- NG PSAPs: i3 SIP interface to enable receipt of native SIP sessions without the need of intervening gateways, MES and emergency caller's location support, and NG9-1-1 integrated dispatch/CAD.
- PSBNs: public safety MES support[15], public safety devices location discovery and information, and NG PSAP ↔ PSBN integration.

NGES Vision

The NGES vision is achieved when OSP networks deliver MES with location and supplemental data to NG ESNs over SIP interfaces. NG ESNs then process, control, and route MES (including the emergency caller's location information) to NG PSAPs who in turn can process, analyze, and exchange "actionable intelligence" with first responders via PSBNs.

Once a year, the National 911 Program (also referred to as the "911 Implementation and Coordination Office" or "ICO") publishes a comprehensive list of standards related to NG9-1-1[16].

Figure *3* lists some of the relevant standards to which End State systems must conform in order to enable the end-to-end exchange of real-time location, MES, and emergency data in the NGES vision.

[14] The FCC Task Force on Optimal PSAP Architecture (TFOPA) highlighted the importance of including IMS systems requirements in the planning of NG9-1-1 systems. IMS and ESInets – see Section 4.3.6 https://transition.fcc.gov/pshs/911/TFOPA/TFOPA_FINALReport_012916.pdf "

[15] NPSTC use cases & requirements for public safety MMES, November 2012. https://www.npstc.org/download.jsp?tableId=37&column=217&id=2597&file=Use_Cases_Rqmts_PS_MMES_Report_revC_121106.pdf

[16] NG9-1-1 standards and identification review, August 2020. https://www.911.gov/pdf/National_911_Program_NG911_Standards_Identification_Analysis_2020.pdf

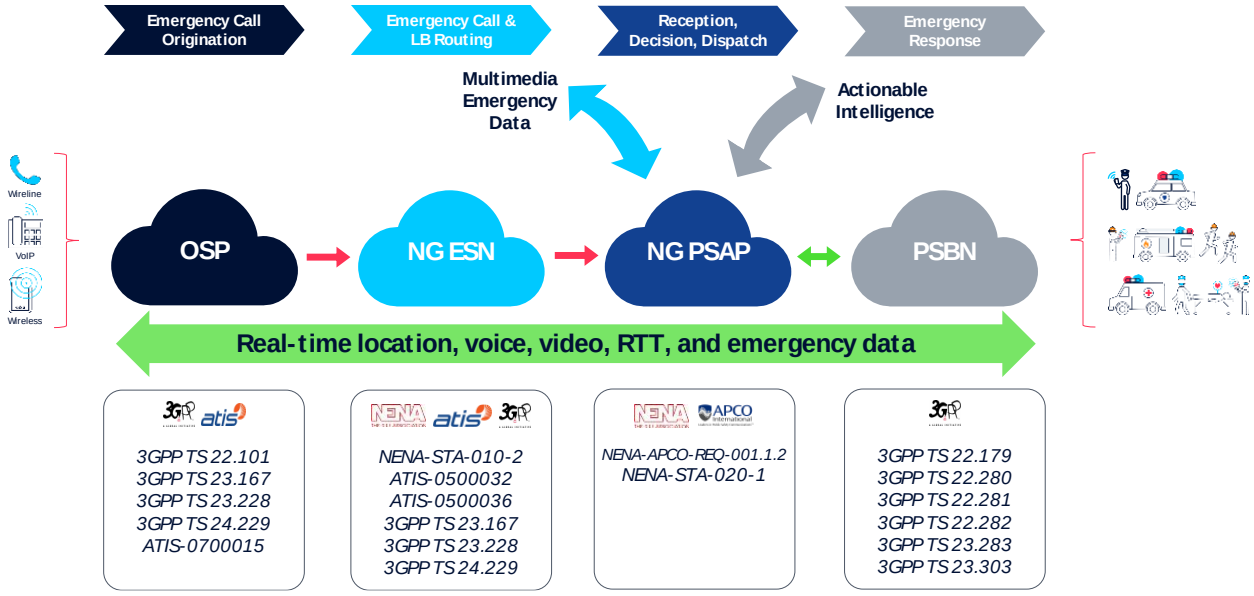

Figure 3. NGES vision and relevant standards to enable end-to-end seamless flow of real-time location, MES and emergency data between citizens, NG PSAPs, and FRs.

A brief overview of the applicable standards to OSPs, NG ESN, and PSBN is below:

- 3GPP and ATIS standards applicable to OSP networks cover the service principles for 3GPP wireless networks, the elements in the IMS Core Network (CN) required to enable IMS-Based multimedia emergency services and procedures.

- The NENA i3 standard provides a baseline architecture along with a detailed set of functional elements (known as NGCS), technical interfaces, and defines the protocols and procedures for supporting IP-Based multimedia emergency communications from OSPs to NG PSAPs.

- 3GPP standards applicable to PSBNs cover the enablers for Mission Critical Services such as Evolved Multimedia Broadcast Multicast Services, Group Communication System Enablers, Proximity Services, Mission-Critical Push-To-Talk, Mission-Critical video, Mission-Critical data, and the interworking between PSBN and LMR systems.

NENA i3 ESN Reference Architectures

Initially, NENA evaluated two architectural options for the implementation of functional elements and interface specifications of the i3 standard: [17]

- Generic SIP-based architecture (based on IETF internet standards)
- IMS-based architecture (based on 3GPP/IETF standards)

NENA chose to develop the i3 standard based on a generic SIP-based architecture and published version 2 of the standard in September 2016. NENA completed version 3 of the i3 standard in July 2021. ANSI formally accepted NENA i3v3 as an ANSI American National Standard (ANS) in October 2021.

The NENA i3 architecture working group consigned the work of defining and developing an IMS-based architecture that conformed to the signaling and media control functions requirements defined in the i3 specification to ATIS. In November 2016, ATIS completed the ATIS-0500032 standard for implementation of an IMS-based NG9-1-1 service architecture to provide transit, routing, and other services required to support citizen-to-authority MES between OSP networks and NG PSAPs.

The ATIS-0500032 standard provides an architectural option for implementing the signaling & media control functions defined in the i3-based NG ESN reference architecture using IMS CN functional entities which are part of the IMS platforms used by operators of 3GPP-based mobile broadband networks (see Figure 1).

In Figure *4*, location and routing information functions for both signaling and media control options rely on the functional elements defined in the NENA i3 standard. This further serves to emphasize the ongoing importance of the i3 standard for complete NG9-1-1 systems, regardless of the implementation option chosen for signaling and media control functions. The “bridge” between the location & routing information functions defined in the i3 standard and the signaling and media functions specified in the ATIS-0500032 standard is the LoST interface. The i3 standard defines the LoST interface and its procedures to exchange Service URN and location information to determine the next hop in the emergency call routing.

[17] NENA-08-002 functional and interface standards for NG9-1-1, version 1.0, December 2007. https://cdn.ymaws.com/www.nena.org/resource/collection/2851C951-69FF-40F0-A6B8-36A714CB085D/NENA_08-002-v1_Functional_Interface_Standards_NG911_i3

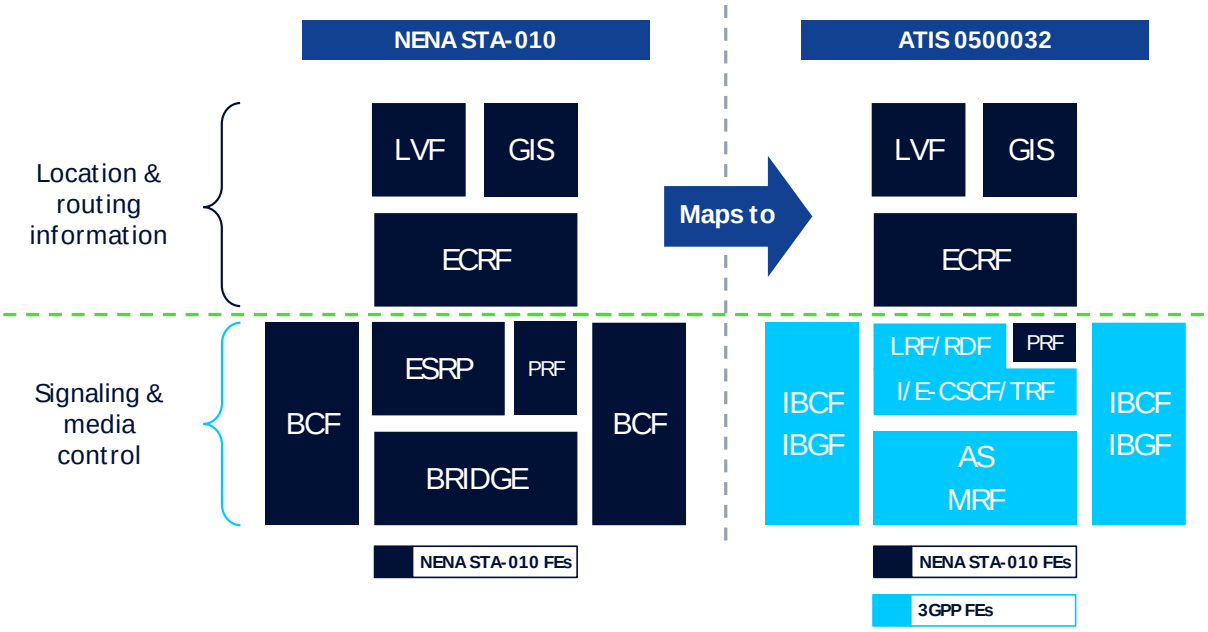

Figure 4. NENA STA-010 and ATIS-0500032 NG ESN reference architectures

ATIS' goal was to produce a standard method for operators of mobile broadband networks to offer NG9-1-1 services using their IMS platforms, while maintaining consistency and interoperability with the design goals and interfaces of the NENA i3 standard. ATIS' IMS-based NG ESN architecture is also complemented by the i3 standard to address the interconnection from legacy OSP networks as well as emergency calls delivered to legacy PSAPs.

The ATIS-0500032 and ATIS-0500036[18] standards also ensure the IMS-based NG ESN architecture is fully compatible and seamlessly interoperable with the i3-based NG ESN architecture. This ensures a NG PSAP can interconnect effectively with both an i3-based NG ESN or an IMS-based NG ESN.

[18] ATIS-0500036 standard for IMS-based next generation emergency services network interconnection. https://global.ihs.com/doc_detail.cfm?document_name=ATIS%200500036&item_s_key=00767955

Conclusion

NG9-1-1 standards will play a critical role in advancing the future vision of NGES by supporting the integration and full interoperability of OSP networks, NG ESNs, NG PSAPs, and PBSNs. Regarding NG ESNs, the ATIS-0500032 and NENA-STA-010 standards both offer acceptable options for implementing the signaling and media control functions within a NG ESN. Moreover, they are intended to be compatible and designed to be complementary. Both ATIS IMS-based and NENA i3-based NG ESN architectural options have their respective place in today's NG9-1-1 environments, and both are supported by iCERT for the roles they play in the overall NG9-1-1 ecosystem.

APPENDIX: Standards Development Organization (SDO) Overview

Having set the stage of the white paper's intent, it's relevant to consider some facts about each SDO behind the i3 / IMS standard architectural options. The following paragraphs discuss some of the standards and technologies developed by each SDO that has worked on the issue of architectural options for implementing the signaling and media control requirements in the i3 standard.

3rd Generation Partnership Project (3GPP)

In today's highly mobile society, approximately 80% of 9-1-1 calls originate from multimedia-capable wireless communications networks[19]. These networks conform to the standards developed by the 3rd Generation Partnership Project or 3GPP and are operated by Commercial Mobile Radio Service (CMRS)[20] providers. Today, first responders are starting to leverage these same 3GPP-based wireless networks to access mission-critical services in the field. Legacy LMR and public safety broadband will continue to co-exist for some time in the public safety ecosystem. While the trend towards moving mission-critical voice from being exclusively LMR-based is unmistakable, certain LMR features, like highly survivable subscriber equipment (SE) and higher penetration signaling, not easily addressed by today's PSB systems, will insure a mixed first responder technology environment, consisting of both legacy LMR and 3GPP-based broadband systems, will exist for some time.

Given the global significance of 3GPP standards to modern communications networks, it is pertinent to briefly explain what 3GPP is and where the organization came from. 3GPP was originally founded in December 1998 by uniting the world's leading telecommunications SDOs to work on the then state-of-the-art 3G network standards. Since its founding, 3GPP has gone on to standardize 4G and now 5G wireless network standards that are in use across the globe and is now poised to begin working on 6G standards as well. 3GPP is made up of the following global SDOs acting as Operating Partners (OPs): the Alliance for Telecommunications Industry Standards (ATIS) in the Americas, the European Telecommunications Standards Institute ETSI) in Europe and five (5) other global SDOs representing Asian nations (Japan, China, Korea, and India). 3GPP is the world's preeminent telecommunications SDO, developing the standards that have propelled the global wireless telecommunications revolution.

3GPP standards[21] aim to enable wireless network users to access a wide range of telecommunications and IP-based multimedia services, regardless of whether they are deployed in OSP networks or used by first responder broadband communication networks in the field.

[19] National 911 progress report, National 911 Program, November 2019. https://www.911.gov/pdf/National-911-Program-Profile-Database-Progress-Report-2019.pdf

Furthermore, 3GPP standards provide the capabilities and mechanisms required to offer high quality of service wireless communications (similar to that provided by fixed networks) and carrier-grade access for emergency and mission-critical services. In short, 3GPP standards have amply demonstrated their success as enablers of global communications of all types, including and especially mission-critical services[22] in recent years.

Alliance for Telecommunications Industry Solutions (ATIS)

In November 2016 ATIS, one of the 3GPP signatory SDOs, created the first of a series of standards for the North American market detailing how to implement signaling and media control functions for NG9-1-1 systems using the IMS, an IP multimedia communications services architectural framework first standardized by 3GPP in Release 5 in 2003 (current 3GPP release version is Release 16, completed in the summer of 2020). IMS has been a part of Mobile Network Operator core networks for over 15 years and is a mature SIP multimedia session processing system. It provides a stable, IMS-based foundation upon which to build out the signaling and media control functions of NG9-1-1 systems, which are designed to replace legacy E9-1-1 infrastructure. The ATIS IMS-based NG ESN architecture borrows heavily from the i3 standard (discussed below), where appropriate. NG9-1-1 systems utilizing the ATIS standard for signaling and media control would nevertheless rely upon, the i3 standard for location and routing control. To be clear, the complementary nature of IMS and i3 allows the IMS-based standard to be used for signaling and media control functions within a complete NG ESN, while interoperating with Functional Elements built upon NENA standards for functions not specifically defined in the ATIS standard.

National Emergency Number Association

Founded in 1982, NENA: The 9-1-1 Association, is recognized as a leading authority on Public Safety 9-1-1 communications, both nationally and internationally. NENA possesses extensive expertise in the development of standards used by the 9-1-1 industry for many years.

Among the standards developed by NENA is NENA i3 Standard for Next Generation 9-1-1, commonly simply referred to as NENA “i3.” To-date, every state, regional, and / or local NG9-1-1 procurement has involved a NENA i3-based solution. More specifically at a state level, 29 of 50 states have procured NG9-1-1 Next Generation Core Services, all based on the NENA i3 standard.[23]

The NENA i3 Architecture Working Group developed NENA-STA-010 standard for NG9-1-1 to provide, among other features, the base set of core services required to process and interconnect emergency calls from commercial carriers destined for PSAPs. The PSAPs, in turn, use the information provided by 9-1-1 callers to dispatch emergency first responders to assist these callers. The i3 standard is based on IETF Request For Comments (RFCs), as the 3GPP

[23] https://www.911.gov/pdf/National_911_Program_NG911_Interstate_Playbook_Chapter_4.pdf

standards are, and it defines a new set of FEs, technical interfaces, and the protocols & procedures required to enable IP-based multimedia emergency communications to replace legacy 9-1-1 systems.

The NENA NG9-1-1 standards also includes additional material regarding the use of Geographic Information Systems in NG9-1-1, for example, that are not explicitly referred to in the ATIS IMS-based NG ESN architecture but are incorporated into it by way of reference to the NENA body of work. The i3 standard covers topics beyond signaling and media control, as mentioned, but this paper concentrates on “comparing and contrasting” the signaling and media control functions of each architectural option, as it is understood, as outlined above, that NG9-1-1 systems using the ATIS standard for signaling and media control would have to also use NENA i3 defined element for location and routing functions. To summarize our conclusions about these architectural options based upon the analysis of them documented in this paper, it is clear the signaling and media control requirements of the i3 standard can be achieved using the two different, albeit complementary, approaches described in this white paper.