

PSAP ALI Interface Issues

Next Generation Need

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Abstract:

This document describes a need for change to the interface between PSAPs and Emergency Services Networks that provides Automatic Location Information (ALI) and related emergency assistance support services. The future 9-1-1 PSAP message interface, corresponding system design and emergency services network architecture must support the evolution of E9-1-1 data communications in a secure, extensible, flexible and reliable manner. This interface replaces a design between PSAP Customer Premise Equipment and ALI Hosts that was established in the 1970s.

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1.0 Introduction

The communication between public safety agencies and supporting network elements must be dramatically different from the technologies used during the 1970s, '80s and '90s. A new approach is required to accommodate the many ways that emergency services can be requested and the response provided by the emergency service community. The role of the public safety answering point (PSAP) and related entities is expected to expand beyond traditional 9-1-1 services with higher levels of interaction, managed situational intelligence, enhanced capabilities, and more comprehensive communication and coordinated response services.

The current PSAP Automatic Location Identification (ALI) interface is drastically constrained by a limited messaging capability and a dedicated server model, fixed point-to-point communication, legacy design choices, and a lack of expandability. The legacy PSAP ALI interface designed in the 1970s has been highly leveraged to accommodate new functionality and business drivers, but, fundamentally retains the same design as when it was initially conceived. The existing infrastructure capabilities have been strained and new services have been accomplished in a shoehorn approach.

Fundamental and significant change is required to move toward an infrastructure that offers enhanced capabilities and increased change capacity to accommodate current and future emergency services operations. Some of these changes are already occurring, albeit inconsistently, such as moving toward a packet-based network for transporting ALI data. However, using Internet Protocol (IP) to encapsulate and transport the existing point-to-point messaging is only one step in the necessary evolution. Each step toward the next generation architecture should be well considered and designed before ad-hoc implementation takes the industry down wrong paths wasting precious resources, time and money. Networks and systems must be constructed with the appropriate characteristics or they will not be capable of supporting the desired functionality, flexibility or exhibit the robustness necessary for life-safety critical applications.

The desired future state will have a path from the current situation and must preserve the positive aspects of today's solutions. The desired future state must continue to support delivery of ALI data while also introducing new service opportunities:

- Allow PSAPs to receive and operate with variable and rich data types
- Bridge PSAPs together with enhanced services
- Allow other entities to interoperate with PSAPs to fulfill emergency services and complete varied functions (examples include Trauma Centers, Hospitals, Coast Guard, EMS centers, 9-1-1 Coordinators, etc.)
- Support a wide range of emergency events and responses
- Support emerging technologies, both those technologies deriving service from the 9-1-1 infrastructure via emergency requests and technologies incorporated within the 9-1-1 infrastructure to improve emergency response
- Lay a foundation for future services that we cannot yet envision

2.0 Legacy and Future Overview

The traditional PSAP and ALI messaging is a simple ASCII character text screen display delivered to the PSAP Customer Premise Equipment (CPE) from two tightly coupled ALI hosts. The ALI hosts coordinate responses to a fixed set of PSAPs that are connected to the ALI hosts over dedicated fixed point-to-point communication links. The communication links are typically private leased line four-wire circuits with asynchronous 1200, 4800, or 9600 bps modems. The PSAP “bids” the ALI hosts for ALI information. In most cases, the PSAP 9-1-1 CPE performs a “dual bid,” meaning a bid is sent to both ALI hosts immediately. In the dual bid model, the ALI hosts must coordinate to ensure that one and only one appropriate response is returned to the PSAP. Figure 2 illustrates the fixed point-to-point legacy ALI Host interface.

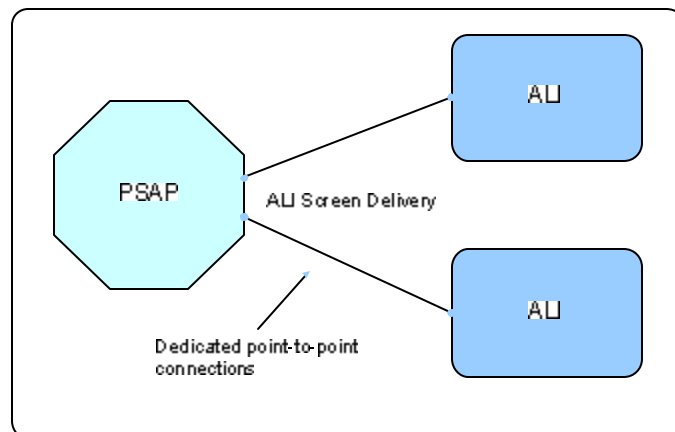


Figure 1: Legacy Dual Paired ALI interface

The PSAP 9-1-1 CPE and ALI host nominal connection model is impacted by either failure conditions or management functions. In an ALI host or transport-network failure condition, maintenance or upgrade

situation when one ALI host is not in effective communication with the PSAP CPE, the PSAP connections “go one-sided,” eliminating ALI redundancy. In the “one-sided” status the PSAP is dependant on one ALI host for delivery of all wireline ALI records and wireless call information. The one-sided situation is treated as a severe failure condition when it is due to an ALI host or network communication fault. Substantial coordination among many stake holders is required to take an ALI host out of service for any period of time and there is a heightened state of possible service outage at the PSAP(s) while ALI delivery is dependant on a single ALI host. The heightened level of coordination leading up to a routine maintenance cycle and the risk that is created are costly. These maintenance events, although infrequent, consume significant resources to plan, coordinate, communicate, manage, and execute.

A desirable model is to have PSAPs connect to one of many possible servers that can fulfill required messaging and interaction requirements in a coordinated and secure manner. These servers should be geographically and systematically diverse, should balance logical connections across supported clients and not be dependent on specific physical links in a constrained point-to-point configuration. Given currently available technology, the “dual-bid” model is no longer necessary or appropriate between PSAP 9-1-1 CPE and ESN (Emergency Services Network) elements in this configuration. Reliable transactions can be submitted from PSAP CPE and managed by ESN elements. The messaging protocol between the PSAP and network elements should accommodate a flexible message structure that immediately provides new capabilities and can evolve to support additional features. Furthermore, PSAP and network element messaging and interaction models should minimize the impact of network outages, operations, and management events.

The existing PSAP and ALI interface originated with fixed point-to-point data circuits using asynchronous 1200 bps data modems. In some cases these connections have been upgraded to use transport protocols such as x.25 or IP or slightly higher speeds. However, the logical connections and the message set that rides over them fundamentally remain point-to-point architectures and retain the inflexibility and suffer operational issues created by the tight coupling

model of a client to a specific server system and a limited or non-existent message set. The legacy PSAP ALI connection has not provided a conduit of information or resources to the PSAP much beyond the initial intent. The interface is restrictive to the point that additional information needs and services cannot be provided by the existing mechanisms. Primitive capabilities necessary to provide services and augment existing infrastructure are not possible without significant changes.

3.0 Current PSAP and ALI Interface

Today's PSAP 9-1-1 CPE fundamentally communicates with a pair of ALI hosts using a crude information exchange protocol as compared to modern computing messaging models. The interface has many inherent limitations in terms of messages that can be exchanged, situational context that can be created, and the data types that can be supported. The current synchronous request and response interface model does not allow enhanced services. For all practical purposes, the interface does not allow information to be delivered to the PSAP unless the PSAP 9-1-1 CPE submits an *ALI Request*. There is a capability to deliver a broadcast display screen, but this capability is constrained by a limited character count based on the limited "minimum standard" PSAP display and has no concept of context. Fundamentally, no information can be passed from an information source to the PSAP unless the PSAP has made a data request and the information that can be passed today is limited to the fields displayed on a traditional ALI display screen.

The current *ALI Request* scenario includes a dual bid concept where the PSAP 9-1-1 CPE submits a simultaneous ALI request on both ALI links to two separate ALI hosts. The ALI hosts are required to coordinate their response and return one response to the PSAP. If each ALI host returns a response, the PSAP 9-1-1 CPE screen may be painted twice. This isn't a problem unless the second response is inappropriate and overwrites valid screen information or the PSAP 9-1-1 CPE does not handle the multiple responses in a graceful manner, which can result in the loss of critical emergency response ALI information. The dual bid model is also time dependent within the ALI hosts processing logic, which must be able to recognize the requests as "paired" based on the request arriving within a specific time window. The dual bid model and simple screen display was a technologically appropriate model when PSAP 9-1-1 CPE equipment was a dumb display device with no programmatic capabilities for decision making or human interface display. The legacy interface was further burdened by communication over telephone lines with asynchronous modems where display characters could be lost or garbled. These reliability issues are inherently managed in an appropriately engineered IP environment. Also, today's 9-1-1 CPE is capable of implementing an intelligent end-point model and terminating an application message based protocol.

The amount of information that can be currently transported from an ALI host to a PSAP Call-taker position is greatly limited by the legacy assumption of a 16-row by 32-column display screen and the legacy capacity assumptions of the direct link between the PSAP and the ALI hosts. The ALI information is strictly positional within the transport stream and has a fixed field length based on historical field usages. Adaptation to support new requirements—such as latitude and longitude location information—has meant the use of fields that now have multiple purposes and must be deciphered based on message context. In addition, at the PSAP the ALI display character stream is often passed from the PSAP E9-1-1 CPE to Computer Aided Dispatch (CAD) applications and parsed to provide situational data for another set of critical emergency providing applications. The information passing limitations, described above, are propagated to the CAD interface and the CAD dependency on a fixed format stream creates another change inhibitor to an already strained message configuration.

The legacy interaction model and the limited data vocabulary greatly restrict foreign originating information sources from delivering information and have limited the value-added role possible for

PSAPs. None of this is surprising considering that these legacy mechanisms were meant to simply deliver a character stream that painted a small screen embedded within a PSAP Call-taker's console, were implemented at a time when software based CPE was not a viable reality and communication channels were slow and unreliable.

3.1 Example Scenario—Wireless 9-1-1 Call

An illustrative wireless FCC Phase II call scenario demonstrates how the message set limitations of the current ALI PSAP interface affect the quality of service provided to PSAPs and the layers of complexity that have been added to the ALI hosts. In this scenario a PSAP receives a 9-1-1 call with Automatic Number Identification (ANI) and requests ALI information, just as it would do with any other 9-1-1 call it might receive. The ALI Host receives the request from the PSAP and determines that this ANI is a pseudo ANI (pANI) [possibly an Emergency Service Routing Key (ESRK) or Emergency Service Routing Digits (ESRD)] corresponding to a wireless provider. The out-pulsed ANI to the PSAP is not the subscriber callback number but is actually a key corresponding to basic information that identifies the wireless carrier and may identify the cell tower from which the 9-1-1 wireless call originated or the destination PSAP designated to receive the emergency call.

The ALI Host contains a record matching the pANI to a basic set of information. Additional information about the emergency call, including caller location, must be provided by the wireless carrier's Mobile Positioning Center (MPC). The ALI Host cannot immediately provide the basic call information to the PSAP because it can only provide one response to the PSAP's bid and must attempt to retrieve the complete information from the MPC via a J-STD-036 E2 interface at the time of the call arriving at the PSAP. Since the PSAP 9-1-1 CPE ALI interface allows only one response to an ALI request, the ALI Host must attempt to collect all information before responding. The ALI Host is also attempting to ensure that the PSAP receives a response within a reasonable amount of time to support the PSAP Call-taker's cognitive analysis and prevent PSAP CPE ALI transaction failure alarms from occurring. Before submitting the MPC request, the ALI Host sets a timer to indicate how long it will wait for the MPC to respond before it provides the minimal information to the PSAP. If the MPC responds within the allotted time period, the PSAP will receive the information it expects for a wireless call. If the MPC does not respond within the time limit, the ALI Host returns basic static information to the PSAP. This basic informational response does not include any indication to the PSAP Call-taker about reason for lack of data or the nature of the situation - as to whether the information is late but expected to be available, unavailable at this time, etc. If the MPC responds after the ALI Host time period, the ALI Host cannot send the caller's location information to the PSAP in this situation because there is no outstanding ALI Request. The information will be given to the PSAP if the PSAP makes another manual request—called a *re-bid*—for the same ANI within a predetermined time period.

The PSAP 9-1-1 CPE model is equally complicated with timer and time-out action models designed to support the legacy unreliable message transport and re-bid scenarios. The PSAP 9-1-1 CPE has no obvious mechanism to implement with the ALI Host to indicate new call-related ALI bid, re-bid, and location update requests, so the message purpose is left to context assumptions, or specific fields—such as position identifier, trunk identifier and ALI response fields that have been “overloaded” to identify special circumstances. These “tricks” are often implemented in mutually exclusive configurations for different PSAPs, leading to more layers of complication and further industry confusion.

If the ALI Host receives subsequent PSAP re-bid requests, the ALI Host must determine whether to send the previous information received from the MPC, request new MPC information, handle time-out scenarios, and handle situations where this might be a new 9-1-1 call using the same pANI. The scenario is further complicated because the ALI Host does not know when this call ends and another call with the same pANI begins. So an elaborate scheme of timers is used to

“stale” the information received from the MPC and determine whether it should be returned on subsequent PSAP requests or new requests should be submitted to the MPC by the ALI system.

The current wireless 9-1-1 call processing model and PSAP 9-1-1 call handling scenario are far from optimal. While the ALI Host is requesting information from the MPC, the PSAP Call-taker is connected to an emergency caller who is possibly in a life and death situation where any bit of information might help determine the best course forward. Ideally, the PSAP should be given information as soon as it is available, but the ALI Host is restricted from doing so based on the current system design restrictions and operational model. The ALI Host currently cannot immediately tell the PSAP 9-1-1 CPE that this is a wireless call without rendering it impossible to provide contextual call information later, and due to the technology overhead it takes to determine location for a wireless subscriber, the PSAP may wait 10 to 15 seconds to receive minimal information.

The wireless 9-1-1 call ALI retrieval scenario puts the PSAP Call-taker in a guessing game. The PSAP Call-taker does not know when the wireless call location information becomes available and does not know how often re-bids should be submitted to receive initial or new information.

Illustratively, many PSAP Call-takers have been trained not to push the “re-bid” ALI button repeatedly in hopes of getting caller information because this could swamp the ALI system or MPC such that no response would be provided. These wireless 9-1-1 call scenarios occur thousands of times a day across North America and represent only one aspect of the expanding gap between efficient public safety and the underlying infrastructure.

4.0 Replacement System Design Criteria

High standards are expected of the 9-1-1 emergency response infrastructure, including the areas of: security, reliability, availability, survivability, maintainability, manageability, monitor-ability, upgrade-ability and evolve-ability. Also, the total cost of the infrastructure and PSAP CPE must be within business acceptable ranges both from an initial cost and long-term cost of ownership and operation perspective. Obviously, to obtain the goals in all these areas requires trade-offs and a level of complexity. A design goal is to limit the complexity and administration necessary at a PSAP site to reduce situations where coordination of administered parameters is necessary to modify the ESNNet environment.

The Internet Protocol (IP) is an industry standard foundation for building robust application environments. The future messaging layers utilized need to be a combination of standard application tools, secure TCP/IP communication sockets, and layered application messaging.

The computing infrastructure interfacing PSAPs to the emergency services network has a substantial influence on the structure of the application messaging protocol. Application system-to-system connection models vary greatly but can be generalized as either fixed point-to-point connections or dynamic application connections established based on need. Other considerations are the amount of effort required to determine a host to connect to and the effort required to setup a connection. Higher levels of security, such as TCP/IP Secure Socket Layer (SSL) Public Key Cryptography further add complexity and setup overhead.

The connection model utilized needs to reduce overhead setup concerns (associated with models that set-up per transaction) while providing a mechanism for monitoring and alarming and provides a means of assuring system survivability in the event of component failure by continuously assuring that multiple paths to operability exist. The ESNNet environment should constantly exercise those facilities that are required to be performed during abnormal or failure conditions and not rely on failure situations to test service availability aspects of the overall solution.

The future interface between the PSAP and Emergency Services Network must support a rich dialog that allows incorporation of future services. As illustrated in figure 2, the existing NENA XML proposal wraps the current ALI interface with XML syntax, but, does not fundamentally change the interaction model between the PSAP and Emergency Services Network. The future interface must build upon the XML data definition foundation and go beyond the existing paradigm to use our industry's change capacity to implement substantial change.

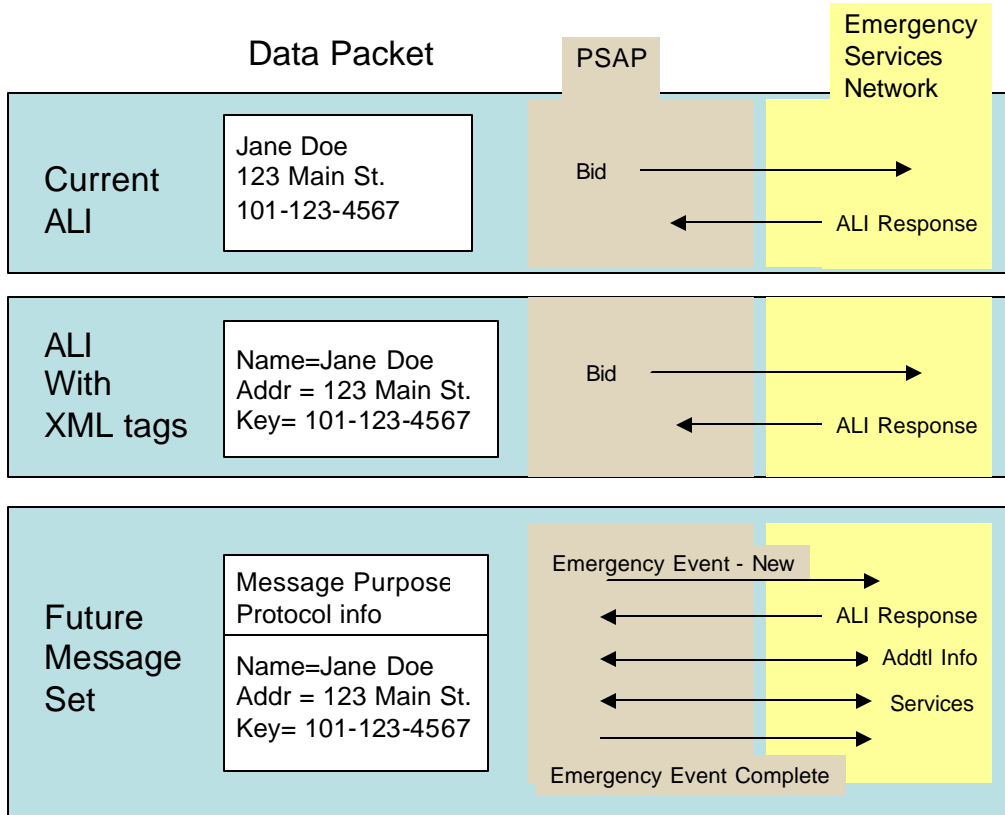


Figure 2: PSAP and Emergency Service Interface Directions

5.0 Future PSAP and Emergency Services Network Interfaces

The Emergency Services Network (ESNet) will be a packet based messaging infrastructure with flexible connectivity models. A fundamental element of this vision is to enhance the services provided to PSAPs, enable network and remote based services, and broaden the number of participants who can provide services within the network framework. Additional services become enabled with application messaging between elements providing a robust, flexible and evolvable framework. A completely new message set between the PSAP and the ESNet to meet current and envisioned future needs. Additionally, this message set can be used to bring in other appropriate entities to monitor, support, or participate in the varying types of emergency events that can occur.

In the most general case, the ESNet should be able to access one of many ALIDB server instances to retrieve ALI information. The ALIDB is one of many sources from which the Emergency Services Network will retrieve information.

5.1 Future PSAP and ALI Physical Architecture

The foundation for communicating between PSAPs, other Emergency Service providers, and the ESNNet is a secured, managed IP network using reliable but dynamic application-level connection models. This will greatly differentiate the next generation from past point-to-point oriented transport and application communication protocols. The future Emergency Service Providers and ESNNet interaction must be engineered for dramatic improvements in reliability, availability, and survivability.

The current ALI fixed point-to-point communication model does not offer flexibility or expandability. However, compared to IP-based networks it does offer a relatively high degree of security given its limited access paradigm, fixed point-to-point design and dedicated function system ports. To achieve the same or a higher degree of security in an IP network requires careful network engineering and use of sophisticated but well known security capabilities. Overall security is achieved by considered design that includes tightly coupled interaction between system components and not simply by add-on security “*wrappers*” after the fact. Specific constructs must be created and followed in the application-to-application domain in order to achieve required security and integrity goals.

In the transport security domain, a two-way public key cryptography scheme is the most widely adopted method for achieving authentication of two participating computing platforms and encrypting their communication to prevent unauthorized access to private information. These capabilities are well known, broadly available, and are relatively inexpensive to implement. The ESNNet design must incorporate various levels of security, some complimentary and some integrated with application-level exchange mechanisms.

The network and application layers must accommodate a mechanism for clients—such as PSAP 9-1-1 CPE and other systems—to dynamically identify available hosts. These connections cannot be static and single sourced or the reliability and management issues will not change from the legacy PSAP and ALI interface. In addition, the ESNNet elements need not be paired as in the legacy ALI Host paradigm. The ESNNet construction must complement the application message layer protocols to achieve availability through redundant network paths, redundant network elements, and flexible application messaging interaction scenarios. The ESNNet large network operation should be abstracted to a single PSAP, but each PSAP must still gain the benefits in reliability, availability, and performance from a solution of redundant network fabric and servers.

The connection model will most likely include Secure Sockets Layer (SSL) TCP/IP interfaces using Public Key Infrastructure (PKI) exchange of digital certificates to verify client and server identities. The connection capability should include negotiation of connection parameters, which can be used to manage deployment of different versions of message set protocols.

5.2 Future PSAP and ESNNet Protocol

The future PSAP and ESNNet communication protocol and interaction models must include flexibility in the dialog between PSAPs and ESNNet elements and introduce mechanisms to access and deliver additional information and capabilities to connect the PSAP to future services. The message set must be extensible to allow additional emergency service providers to participate in emergency response functions or provide a gateway function to external processing elements that may provide the native interface to additional service providers.

The message set must enable an advanced ESNNet design that offers increased flexibility, increased reliability, and future services. The message set must introduce modern security capabilities and lay a foundation for evolution to advanced service requesting devices, technologies, and coordinated responding actions. Future services should include the following:

- Improved communication and information delivery, including higher interaction models with varying originating device types
- Enhanced algorithms for retrieving relevant information
- Event correlation, event management and event reporting tools
- Advanced media and data type delivery
- Administrative, feature, and PSAP self-managed control interfaces
- Integration with advanced selective routing, call routing, and call transfer logic

The PSAP and ESN Net Message Set must be a bi-directional message set, meaning that messages can originate from either the PSAP or the ESN Net. The message set must create context for a particular emergency call event so that services can be associated with the event over the duration of the event. The Message Set must be based on established technologies and protocols such as TCP/IP, HTTP, SSL, XML, and SIP/SDP.

The PSAP Message Set and the ESN Net infrastructure must further define the ability to plug in additional services. This type of framework will enable new and innovative features or applications to be added incrementally over time. It is expected that services will be a mixture of data services, multi-media, and voice. The introduction of VoIP will offer a broad range of services at the PSAP that must be coordinated with data services.

6.0 Success Criteria

The transition to the future PSAP and ESN Net Message Set and the corresponding network architecture must be an evolutionary effort. Functional capabilities and technology will be introduced incrementally and as seamlessly as possible. However, significant changes must be made at times in order to move to the future state. These transitions must be planned to minimize impact on existing operations and leverage as much of the existing technology as possible.

Fundamentally, success will be determined by providing an infrastructure that increases emergency response capabilities. The current legacy limitations of the ALI interface are negatively impacting public safety and stifle creativity and innovation. At the same time, the legacy infrastructure will be supported and offered a transition path to more advanced features and services. As the legacy barriers are removed, features and capabilities that have been discussed for years, but left on the drawing board, can be resurrected. New models of operation can be introduced to extend services, use new emergency response technology, and accommodate emerging commercial communication devices and safety products.

The foundation for the future is a new network and computing paradigm for 9-1-1 and emergency services. The emergency community must work together to create a future solution to current technical and business problems. The change opportunities must be used to make substantial and lasting change that establishes a solid foundation. The foundation must enable new services and lead us to an environment where change is easier to accomplish.