Emergent Communications 9-1-1 Software Solutions for Call Routing and Delivery

Technical White Paper

May 2017

Introduction

Emergent Communications offers the first totally "built from the ground up" NENA i3 Next Generation Internet Protocol (IP) standards based 9-1-1 emergency communications system (NG 9-1-1). Our software platform performed the basic call routing and delivery function used in the U.S. Dept of Transportation Proof of Concept 2006-2008 (US DOT POC)
https://www.its.dot.gov/research_archives/ng911/index.htm

NG 9-1-1 is designed to include shared infrastructure and services with all emergency agencies. At the heart of this infrastructure is an IP based transport network and data and/or multiple data centers. The IP network is commonly referred to as an Emergency Services IP network (ESInet). In our model the data centers will reside in the ESInet, or interface with legacy call delivery network. We have labeled these centers Public Safety Operations Centers (PSOC) for the purpose of this discussion.

The PSOC will contain the Emergency Call Routing Function (ECRF)/Location-to-Service Translation server (LoST), the Emergency Service Routing Proxy (ESRP), a Conference Server for bridging multiple parties such as caller, call taker and dispatcher or responder onto a call, a media server for recording conversations and PSAP Director (PSAPd) for call routing within the PSAP, ACD functions, call logging and call details. The call taker will use a browser based graphical user interface (GUI) to interact with all types of emergency calls. The PSOC can contain any gateways necessary (LSRG or LNG) to convert a TDM call into an IP call.

Implementing a shared infrastructure will result in less reliance on individual 9-1-1 centers having to pay for all network aspects of the system at the local level. As such, the traditional model of each PSAP having to pay for all software and hardware costs (and to manage and maintain them locally) plus network costs can be radically changed. The resulting solution is a set of coordinated applications on an IP network that serves multiple governmental functions and locations and seamlessly interfaces voice and electronic data.

Emergent's solution is uniquely positioned to benefit in this ESInet environment because of its SIP based open architecture, ability to handle multiple media types (voice, video, text and data), flexible graphical user interface, and adherence to NENA's i3 solution for NG 9-1-1.

Emergent can provide total end-to-end IP or it can provide an open architecture interface to existing PSAP systems. The solution can handle all current forms of communications (wireline or wireless) and also simplifies accommodation of future communications technologies (text messaging, video, SMS) and third party services such as Automatic Crash Notification (ACN, OnStar etc,), medical alert services and others.

Emergent's NG9-1-1 solution enables:
- Lower public capital expenditures and operating costs for emergency communication services
- More flexible, secure and robust PSAP operations
- Total Commitment to Next Gen 9-1-1 and Interoperability
- Modular and scalable architecture
- Better and more useful forms of information (data, images, and video)

Emergent's 9-1-1 patented software solution components

Emergent's 9-1-1 software solutions are designed according to recommendations and proposals by NENA for Next Generation 911 systems. The focus of the design is based on NENA i3 08-003 entitled "Detailed Functional and Interface Standards for the NENA i3 Solution".

http://www.nena.org/?page=i3_Stage3

It also complies with standards to interoperate with existing 9-1-1 and enhanced 9-1-1 systems. This is necessary for deployment until full transition to next generation 9-1-1 systems is accomplished.

The following diagram shows the different components of Emergent's 9-1-1 solutions suite. These components are as defined in the complete set of NENA's Next Generation 9-1-1 specifications.
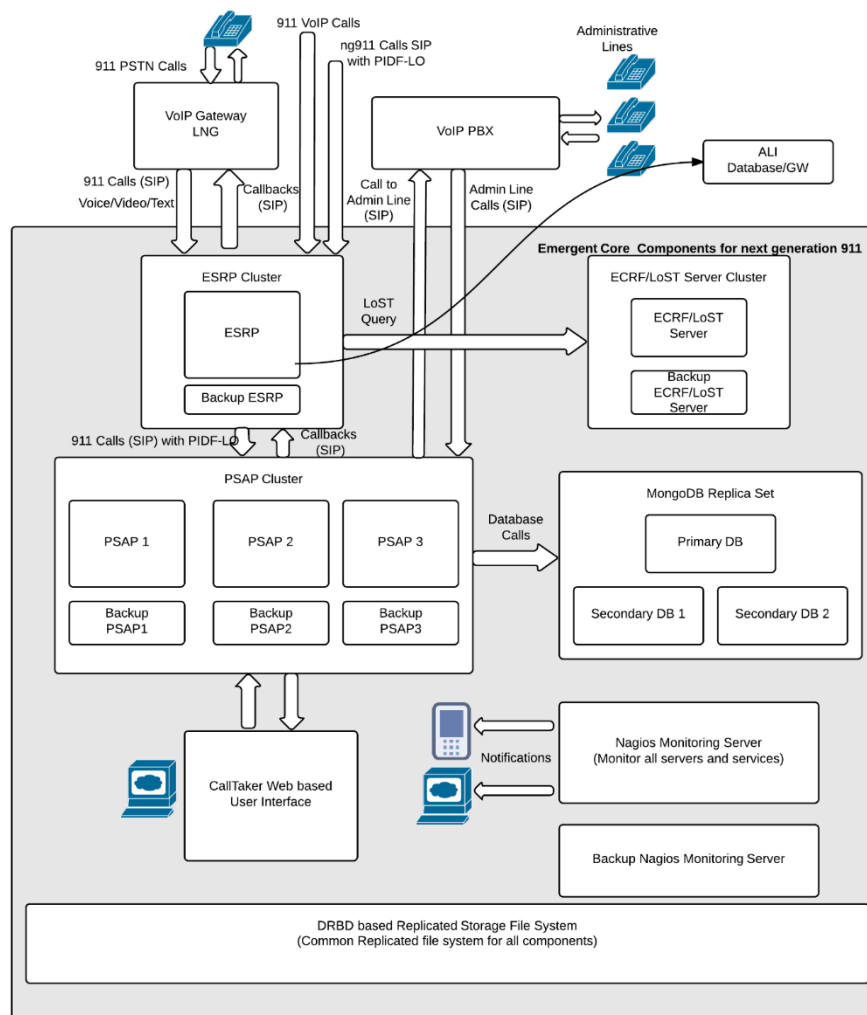
ESRP -	Emergency services routing proxy
PSAP -	Public Safety Answering Position
LoST -	Location to Service Translation
MongoDB -	NoSQL database
CallTaker -	Emergency Services Call Attendant
ECRF -	Emergency call routing function
LNG -	Legacy Network Gateway
DRBD -	Distributed Replicated Block Device

Components for Interoperability with NG 9-1-1 Networks

For next generation 9-1-1 compatibility Emergent provides the following software components

ESRP – Emergency Services Routing Proxy

ESRP is a fully i3 aligned proxy server capable of handling in excess of 2,000 calls per second. The ESRP provides an appropriate URN on a per call basis and queries the ECRF with it and a location object (PIDF-LO) to determine the next hop routing. The ESRP is a signaling proxy with media anchoring occurring further downstream at the PSAP call control server (PSAPd). The ESRP will always query the PRF (policy routing function, part of PSAPd) before initiating signaling to the next hop to ensure downstream system availability.

The functionality for routing the call is a highly customizable platform and can be adjusted in a variety of ways to provide the best possible outcome for all routine and call failure scenarios. A comprehensive set of rules can be constructed to account for all possible call situations.

The server implements all of the features and logging requirements as established in the NENA i3 detailed specifications.

ECRF/LoST Server - Emergency Call Routing Function/Location to Service Translation server

The Emergent Communications ECRF/LoST is a fully IETF standards aligned and compliant LoST server capable of providing the i3 ECRF and LVF (location validation function) functions for any project.

The ECRF/LoST server is capable of multiple hierarchical roles within an NG9-1-1 environment and can be configured as resolver (recursive/iterative), forest guide (iterative) and authoritative server. The ECRF supports all projected geodetic types including circle, ellipse, arc-band, polygons and points.

Built on proven and robust Apache Tomcat web server technology using Postgres SQL back-end database, it is fully load balanced and fault tolerant.

The LVF shall also be capable of providing a legacy MSAG should the existing ALI platform require it, The ECRF supports the OGC method of data provisioning but is designed to be flexible in the data sets that it can accept – this includes an ESRI based data provisioning model.

The server implements all of the features and logging requirements as established in the NENA i3 detailed specifications and uses standard Java/Tomcat web server logging mechanisms.

Call Taker – web based software user interface for handling emergency calls

Emergent's call handling software, **is the only stand-alone browser based call taker client on the market.** It is also the only multimedia call taker capable of receiving voice, streaming video and text calls (along with still imagery) in one unique graphical user interface i.e. no other application or client is needed to receive all future call types considered in the NENA i3 08-003 specification.

The call handling user environment is completely customizable and is set to establish profiles for each user to assure that their preferred changes to the screen "follow" them regardless of the terminal they sit at. All the call taker needs is an industry standard workstation and monitor(s) connected to the PSAP

local area network (LAN).

PSAPd– Public Safety Answering Position director (PSAPd)

The intelligence for the call handling interface is provided by PSAPd. This SIP based system provides all the call control features that the PSAP requires. The combined PSAPd /calltaker platform offer includes, but are not limited to, these features:

- Call control
- Conferencing: multi-media capable for all notes, pictures or data from caller
- Transfers: multi-media functions as conferencing
- User defined functions (call lists, speed dials, etc)

Additionally, it is used to implement call transfers and can interact with the ECRF to obtain routing instructions. PSAPd is also the entity responsible for interacting with external information sources as necessary and therefore acts as a buffer between PSAP's and elements external to the ESInet.

Components for interoperability with existing 911/E911 networks

For compatibility with existing and enhanced 9-1-1 systems Emergent's software components work as described below

LSRG - Legacy Selective Route Gateway

This component allows integration of NG9-1-1 Emergent PSAPs in to existing legacy 9-1-1 architecture. The LSRG terminates existing trunks from a legacy selective router, queries a location database and sends the call with the relevant location information to the appropriate ESRP for routing.

ESRP – Emergency Services Routing Proxy

The ESRP serves as the central hub for delivering all call types to downstream elements whether it is a Emergent PSAP via PSAPd or to other PSAP's, both legacy and NG. It is pivotal in querying an ECRF and applying policy to ensure calls are properly delivered.

PSAPd – Public Safety Answering Position director

Emergent's PSAPd solution can accept/transfer calls from legacy PSAP's. It can also accept legacy 9-1-1/E9-1-1 calls coming from an ESRP. Emergent's PSAP can query an ALI database for location data and allows automatic/manual rebid of location data.

Emergent's solution has been certified to work with Iowa's new IP based 911 infrastructures.

Components for system administration and monitoring

In addition to the components described above emergent provides the following components for system administration and monitoring

MongoDB NoSQL database

Emergent uses a NoSQL database to store system configuration and call detail data. Using a NoSQL database makes it easier to store rich data types. This in turn allows for a much better user experience and a system that is easy to operate, maintain and evolve to changing requirements. Modern NoSQL

databases like MongoDB have been designed to be easily scalable and handle redundancy extremely well.

Monitoring server based on Nagios

Nagios is one of the best open source monitoring system available on Linux. Emergent uses Nagios to monitor all of its servers, services and the network. Nagios provides the following features which are necessary for running a highly redundant and always available system

- Provide a user interface with current status of the system. This user interface shows which servers and services are up and which are down.
- Create alarms for system failures. Notification can be sent for these alarms by cellphone text, email, and pager and shown in the system user interface.

Linux based cluster manager

Emergent uses an industry standard Linux based cluster manager to manage primary and backup servers. If the primary server goes down, the cluster manager switches traffic to the backup servers. The whole process is automatic and provides for maximum uptime of all services. This uptime is necessary for running a system for processing emergency calls.

Replicated File storage system

To ensure protection against hard disk failures emergent uses Linux based replicated file storage system called Distributed Replicated Block Device (DRBD). If a hard disk on any server goes down the system automatically provides data from other hard disks. This is done in a seamless manner causing no downtime.

System Administration

Emergent's 9-1-1 software comes with a user interface for administrators to manage the system. The user interface allows the administrators to perform various administration tasks like:

- Creating/deleting/modifying user logins
- Specifying call distribution for incoming calls to the system. Examples are round robin, ring all, first in first out etc.
- Managing speed dials
- Create rich set of reports.

Synopsis of Features of Emergent's 9-1-1 solution

The following is a synopsis of some of the key features of Emergent's 911 software solution

- Support for different media types (voice/video/text)
- Support for 911 calls and administrative line calls
- Speed Dial
- Audio and Visual Incoming Call Alert
- Distinctive Ring for different call types.
- Display of participants for each call with ability to control audio for each participant from the user interface.
- Call Hold with call hold alert and display of call hold time. Ability to take a call off hold that

has been put on hold by another call taker.
- Call conferencing with up to 6 participants. Call conferencing is possible between call takers at different PSAP's.
- Call Transfer. Call transfer also transfers location data. Call can be transferred to another call taker on the same PSAP, at a different PSAP or at a legacy PSAP.
- Callback to caller
- Location Support. Location of the caller is displayed to the call taker.
- Support for adding discrepancy to Location data.
- Support for adding notes/location to emergency calls.
- Display status of a call to all call takers (init/ringing/active/closed)
- Show list of abandoned, queued, active and closed calls.
- Call History
- Advanced call search
- Instant Call Recall
- Call Recording
- Call Queues
- Call Monitoring/Barge-in
- Support for automatic call distribution with different strategies, round robin/ring all/random/first come first served
- Support for call distribution among different PSAPs (within the ESInet) based on policy based routing rules using ESRP functionality.
- Integration with CAD (Computer Aided Dispatch) systems
- Integration with third party mapping software
- Allow printing of call data and location data
- Manual/automatic ALI rebid
- Manual ALI query
- Support for TDD/TTY

Emergent software system design

Emergent's software system for running its 911 suite of applications has been designed to have a 99.999% uptime. It is also designed to be scalable. Scalability is achieved by adding processing resources as the system grows.

All of Emergent's 9-1-1 software suite runs on Redhat Enterprise Linux 6 based servers. Each physical server is virtualized into many virtual machines. Virtualization allows for:

- faster server provisioning
- increased disaster recovery
- improvements in uptime
- the ability to spread heavy traffic volume across multiple servers

The following diagram shows the system architecture
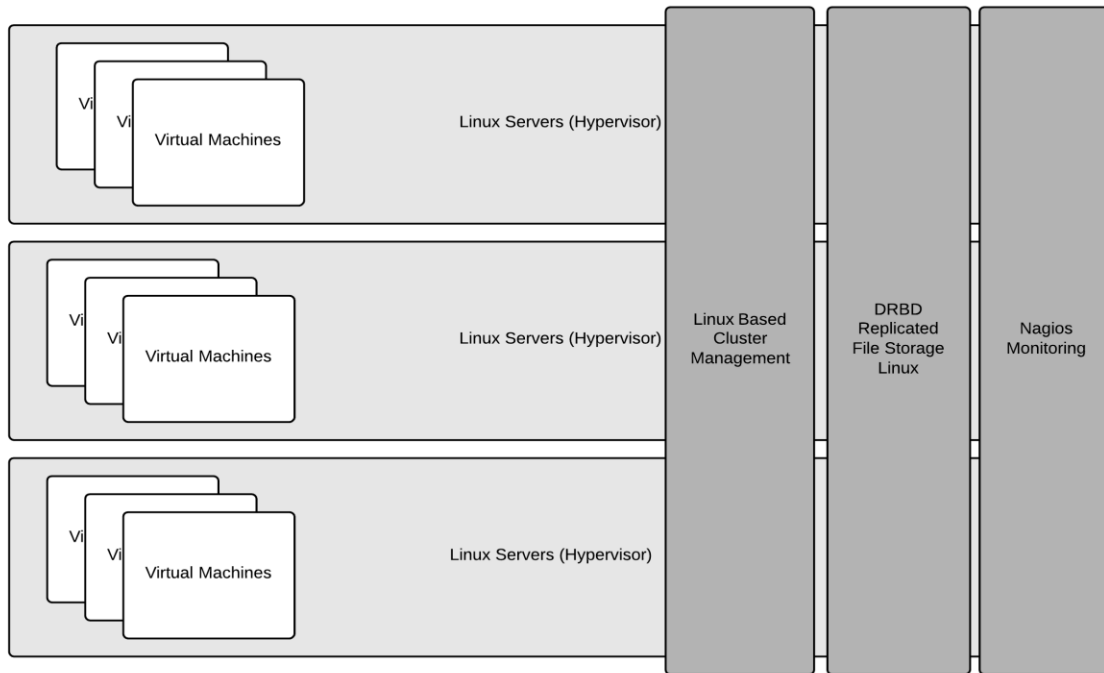
Emergent's system design relies heavily on Linux based software for managing redundancy and scalability.

Redundancy

Every element of the Emergent's software suite is designed for redundancy.

Most of the servers like PSAP, ECRF/LoST and ESRP are configured with backup servers in a cluster. If the primary server goes down, the cluster management software detects it and automatically routes traffic to the backup servers. One or more backup servers for each component can be configured. Monitoring software also generates alarms in case of failure events. The alarms can let the operation engineer's work on fixing the problem, while the backup servers handle the workload providing continuous uptime.

Primary and backup servers are deployed on different physical hardware and on different data centers if possible, providing for hardware and data center failure redundancy.

Database redundancy is achieved by using standard MongoDB practice of creating a replica set of one primary and two secondary database servers. All MongoDB clients' always connect to this replica set. The database virtual machines are always deployed on different physical servers or data centers as needed to protect from physical hardware and data center failures.

File System Redundancy

Protection against disk failures is achieved using a Linux based distributed replicated file storage system. If a disk on a physical server goes down, the Linux based DRBD software automatically gets/writes data from replicated storage volumes. All the storage is shared and performed on DRBD based devices.

Scalability

One of the advantages of having virtualization is easy scalability. If a virtual machine needs additional processing power it can be either migrated to another more powerful server or allocated additional CPUs and memory resources within the same physical server as needed.

Additional PSAP's can easily be added to the system by adding new virtual machines or adding more physical servers.

Monitoring

Monitoring of servers, software services, network and network resources is critical to maintaining a system with 99.999% uptime. Emergent uses one of the industry's best open source monitoring system based on Nagios to achieve the same.

All servers along with different aspects of a server's health like CPU load, memory usage, network usage etc. are monitored. Nagios is also setup to monitor all software services necessary for the proper functioning of the system. Monitoring also allows for warnings before a system failure occurs. This allows operation engineers to prevent system failure by taking necessary preventative action in advance.

In case of a failure, notification events/alarms are sent. Notifications can be sent over different channels including email/pager/text messages. This can allow operation engineers to address alarms 24/7.