ILLINOIS INSTITUTE OF TECHNOLOGY

ASSURE911

NG9-1-1 Call Flow

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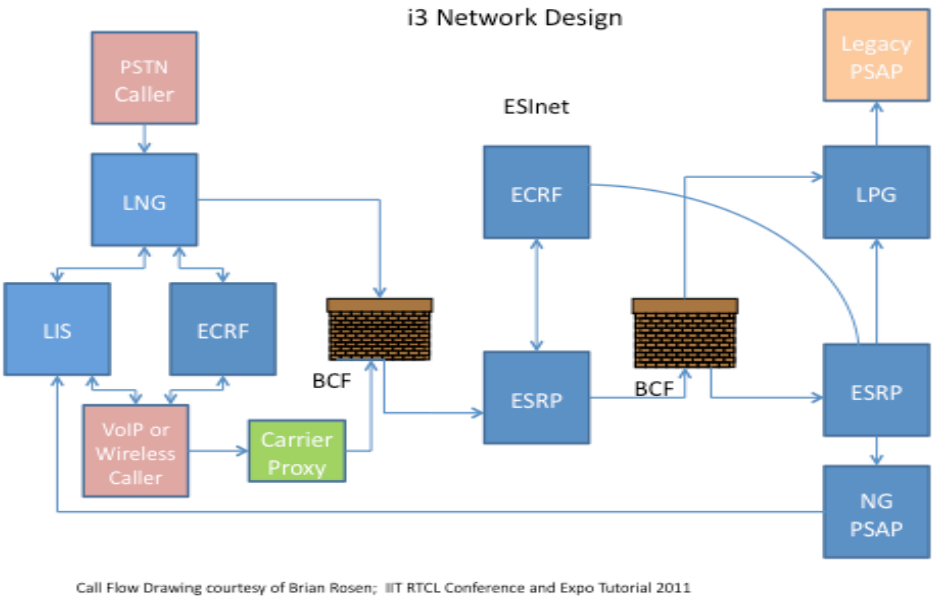

Figure 1- Call Flow Diagram

The Standard NG9-1-1 Network has the same Functional Elements (FEs) in each Data Centers for redundancy. The acronyms are explained in the text that follows. The blue boxes represent additional FEs with the i3 NENA Standard architecture and design. The FEs are repeated for ease in following the diagram to show the flow. There is a single ECRF and a single BCF, and a single ESRP for example in each of the Standard Data Centers.

The following text describes the Call Flow for the NG 9-1-1 architecture. The ***Emergency Services IP Network*** **(ESInet)** is an IP (Internet Protocol) network with no special attributes. All ESInet elements assume the ESInet is on an open Internet. (Not the public Internet.) It is open to Public Safety, not just 9-1-1. When NENA says ESInet they mean the network itself, routers and links, not the services that run on it. ESInets are built from the bottom up. Individual ESInets come together to form state ESInets and can connect to national and international ESInets. The key to network reliability is redundancy. Agencies will use many types of bandwidth to support the ESInet. The FEs listed below are redundant in the standards based NG9-1-1 Design

1. **LIS – the *Location Information Server*** stores information against some kind of key. Keys can be IP addresses, MAC addresses and telephone numbers, mostly for legacy wireline customers. The LIS uses DHCP (Dynamic Host Configuration Protocol,) the protocol that provides the IP address or HELD (a protocol identified by the IETF to deliver HTTP) an HTTP (Hypertext Translation Protocol) based location protocol. The calling device queries the LIS when it boots, periodically thereafter

(especially when the user is moving) and before the user places a call. The LIS returns a PIDF (Presence Information Data Format,) the new form of location. A PIDF can contain a civic (street address,) or geo (X Y coordinates). You can get location by value or location by reference. Location by value means the actual location is sent in the signaling. Location by reference supplies a URI (Uniform Resource Identifier,) with a SIP or HELD protocol dereference.

2. **ECRF – the *Emergency Call Routing Function*** is the heart of the NG9-1-1 routing database used for ALL calls. It is queried using the LoST (Location to Server Translation) protocol (RFC5222). It sends location (PIDF) in, plus a service URN (Uniform Resource Name) and gets a URI, typically a SIP URI of where to send the call. Conceptually the ECRF geocodes a civic address to a geo, and uses a point-in-polygon algorithm against a set of service boundary polygons that represent the area served by a PSAP. ECRF replaces the MSAG (Master Street Address Guide) and ESN (Emergency Service Number) codes. The External ECRF (sometimes called the Public LoST server) routes to the correct ESInet and the originating ESRP (Emergency Services Routing Proxy) within it. Inside the ESInet, the Internal ECRF (sometimes called the Private LoST server) routes calls to the correct PSAP.

   The ECRF is provisioned by the 9-1-1 Authority GIS system. GIS Polygons define the service boundaries and within minutes, new calls can be routed with new Polygons. This is useful in disaster situations. The GIS is enhanced with a "Web Feature Service" (WFS) interface that auto-provisions the ECRF and LVF. There are State ECRFs and a National Forest Guide to allow any ECRF to determine the route for any call regardless of location. If a local ECRF does not have route data for a location presented it, it can consult its State ECRF. If the location is in-state, the State ECRF will have the answer or will consult another local ECRF. If the location is out of state, the local State ECRF will consult the National Forest Guide, which has the URIs and state boundaries of all State ECRFs. The Forest Guide will consult the relevant State ECRF, which will either have the route, or will consult a local ECRF. In this way, queries for any location can be handled by any ECRF.

3. **ESRP – the *Emergency Services Routing Proxy*** is the closest thing to a Selective Router (SR) in the NG 9-1-1 architecture. The ESRP is the call routing engine. The ESRP uses the ECRF to choose a nominal next hop in routing. It then applies the route policy of the next nominal hop to determine the next actual hop. Route policy can take into account the state of the PSAPs, congestion, media server, source of the call and "suspicion level" provided by the border control function and more. Route decisions can include the next ESRP, a nominal PSAP, diversion PSAP, IMR (Interactive Media Response System) or Busy.

4. **PRF – the *Policy Routing Function*** evaluates the PSAP (Agency) controlled rules about how calls are routed in the ESRP. Inputs include the PSAP (System) state, congestion state, security posture, call suspicion, call state (SIP headers and added data) and more. The output is a routing decision. The ESRP queries the ECRF with location for the "nominal next hop. That entity's policy is obtained from a policy store and interpreted. Rules are in the form of IF "this is true", THEN do "that." "This" is the input conditions expressed with "and/or" statements. "That" is the route, the actual PSAP, diversion PSAP, IMR, or Busy. Policy is dynamic which means the capability to change it at any time to new calls route with new rules. Policy rules have a standardized format.

5. **BCF – the *Border Control Function*** provides the External security border for the ESInet and the internal isolation border for the PSAP. It has both firewall and Session Border Controller (SBC) (SIP specific) parts. It can mark calls with suspicion levels and has functions to block specific call sources. The ESInet BCF must withstand the largest feasible attack currently known to be in the

range of 10 Gigabits. The SBCs may be deployed at a State level in order to spread the cost of this large input bandwidth across many PSAPs. BCFs are recommended between ESInets and between an ESInet and an i3 PSAP.

6. **NG PSAP - the *Next Generation PSAP*** gets all calls from the ESInet via SIP (Session Initiation Protocol) protocols with Location routed by the ECRFs. The PSAP can use the ECRF/ESRP function to route to queues of call takers. All NG PSAPs are multimedia, meaning they can handle voice, video and text.

   In the NG 9-1-1 architecture it is possible to have Virtual NG PSAPs. Calls are routed to the responding agencies with the ECRF. The Emergency Information Data Document (EIDD) is used between Functional Elements (FEs) inside and between PSAPs.

7. **LNG and LPG – *Legacy Network Gateways* and *Legacy PSAP Gateways***
   There are entry and exit points to and from the ESInet which will exist as long as there are non IP communications devices in the network. They are called Legacy Network Gateways and Legacy PSAP Gateways. Inside the ESInet the architecture uses IP protocol based communications.

8. **LNG - the *Legacy Network Gateway*** serves as the bridge between the existing originating networks and the ESInet. One means of interface to the LNG for transition purposes is the existing SR interface to the LNGs. This is an initial step to bring the CAMA/MF, SS7 and ISDN PRI (Legacy Signaling protocols) interfaces to the ESInet. The LNG is always outside the ESInet. It can reside in each of the dual Data Centers housing the redundant ESInet FEs. Note: A pair of LNGs could serve a whole state. The LNG routes via the ECRF, always coming through the BCFs. The LNG always uses the ESRP to route the calls. The LNG interworks location protocols and formats between the legacy network and the ESInet. The E2 interface (wireless) or internal LIS (replaces ALI Data for wireline) faces toward the Legacy Network. The LNG either supplies location-by-value in the SIP signaling, or may supply a location reference that resolves to itself using SIP or HELD protocol towards the ESInet. This is a permanent part of the NG 9-1-1 solution as long as legacy networks are deployed. The LNG is on the Access side of the network architecture.

9. **LPG – the *Legacy PSAP Gateway*** allows existing non upgraded PSAPs to connect to the ESInet. In some cases, there will not be any Legacy PSAPs inside the network, but there will be adjacent Legacy PSAPs off net until all PSAPs are converted to NG i3 PSAPs. The LPG has a full NG/SIP interface facing the ESInet and an SR/ALI interface facing the Legacy PSAP. No upgrades are needed at the neighboring Legacy PSAPs but the GIS must be compatible with Next Generation technology. In some cases, there is an option to extend a piece of equipment called the EG, the Extended Gateway to the neighboring Legacy PSAP location to hand off/transfer calls as needed. The LPG is a temporary measure and is used for Egress until after the Selective Routers (SRs) have been decommissioned and the neighboring agencies are upgraded to NG 9-1-1.

10. **Addressing** - The form of address is changing from MSAG to “LVF Valid”. LVF is the Location Validation Function. This change introduces a few new address elements, for example, the prefix for a street type. Addresses inside the NG9-1-1 standard systems are conformant to the new FGDC (Federal Geographic Data Committee) standards. Note: The Federal Geographic Data Committee (FGDC) is an interagency committee that promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. This nationwide data publishing effort is known as the National Spatial Data Infrastructure (NSDI). The NSDI is a physical, organizational, and virtual network designed to enable the development and sharing of this nation's digital geographic

information resources. FGDC activities are administered through the FGDC Secretariat, hosted by the U.S. Geological Survey.

The biggest change: no allowances for local variations in addresses. All fields must be used as defined. Some public safety entities have spent several years updating the addresses in their jurisdictions to conform to additional data fields. All addressing is based on GIS entries. If the Public Safety entity changes the GIS, it changes everything and allows for flow through provisioning. The new form of address is the PIDF. PIDFs are XML (Extensible Mark-up Language) objects which can contain geographic or civic locations, which can be passed by value or reference. The PIDF is more or less the equivalent of an ALI record, but there is ultimately no requirement for a centralized ALI database. PIDFs are stored in a LIS and sent with the call and passed around as XML objects. LISs are typically operated by access networks, or, in the case of the LNG, by the LNG operator. In some cases LNG Operator is the Public Safety entity. .

11. **LVF – the *Location Validation Function*** is used by the LIS Operator to validate location before loading it into the LIS. Similar to MSAG validation, the LVF verifies that the location matches a known address within the 9-1-1 Authority's service area. It is like the ECRF, using the same protocols and same data. The LVF can validate to the street address not just address range. It can also validate to the building, floor, and unit (apartment, suite, etc.,) and room.

12. **Multimedia** – Multimedia means the PSAP, Bridge and Logger must handle multimedia, the i3 way using standardized interfaces. Video requirements drive ESInet sizing requirements. Brian Rosen's Rule of Thumb: 2Mb/PSAP + 2Mb per Position. As the PSAPs add positions this is an engineering requirement to augment the bandwidth proportionately.

13. **Additional Data**

NG9-1-1 is by definition Multimedia capable: Voice, text and video. In the beginning you may have only audio operational but eventually all media will flow. If a Carrier does not support video they do not have to deliver it. It is not an option for the NG PSAP to accept less than all media types when the caller is ready. It is assumed Video Relay will send video as soon as the PSAPs can handle it. Text standards are evolving.

Call data is supplied by service providers in the path and possibly the device itself, signaled with the call, by value or by reference. Contains: Service Provider Contact data, Subscriber data, Service data (Class of Service equivalent), and a Hook for device-specific data such as sensors, telematics, etc.

Caller data is specific to the caller, (home, work or cell provide the same data). Can be signaled with the call or queried from a database. It contains: Contact Data, Emergency Contact Data, Medical Data, etc.

Location data is specific to the location of the call; two calls from the same location will have the same location data. An ECRF query with a special service URN yields a URI to the data. Contains: Building Owner/Tenant Contact information, Floor Plans, Alarm and Sensor data, Control Panel data and more.

Inside the PSAP Data - Further NENA development is underway to define standards between FEs inside a PSAP. These standards are built around a new data structure, the Emergency Incident Data Document (EIDD), which contains all of the information a PSAP knows about an incident. An incident is a real world event, like a car crash or a burglary, which may have several 9-1-

1 calls associated with it. The EIDD is used between FEs in a PSAP and between PSAPs to pass data about an incident.

14. **The Bridger and Logger** have to handle multimedia i3 standards.

15. **Additional Data:**
    Refer to NENA i3 Standards page 194 Figure 7-1 for a Diagram.

16. **Dispatch - *There are no ESZ/ESNs in NG 9-1-1***. The PSAP queries the ECRF with the location of the caller and a "service URN" for the service they want: police fire, EMS, poison control, mountain rescue, coast guard, etc. Service areas will be driven by Polygons in the GIS. Adding new services and Polygons is relatively easy. There are standard mechanisms to do Call Transfers or send data EIDD to the dispatched agencies.

17. **CAD** – There are new and expanded interfaces to CADs. The standards allow the call taker CAD exchange. Any call can be answered by any PSAP and all data to manage the call is included.