

NENA Standards for the Provisioning and Maintenance of GIS data to ECRFs and LVFs

Abstract: This document defines operational processes and procedures necessary to support the i3 Emergency Call Routing Function (ECRF) and Location Validation Function (LVF) through the ongoing process of publishing the most current and accurate authoritative Geographic Information System (GIS) data into ECRF/LVF systems and identifies ECRF/LVF performance and implementation considerations for 9-1-1 Authorities' consideration.



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Prepared by:
National Emergency Number Association (NENA) Data Management Committee,
Provisioning & Maintenance of GIS Data to ECRF/LVFs Working Group



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1 Executive Overview

Purpose and Scope

This document defines operational processes and procedures necessary to support the i3 Emergency Call Routing Function (ECRF) and Location Validation Function (LVF). Additionally, this document identifies ECRF/LVF performance and implementation considerations for 9-1-1 Authorities' consideration.

The roles and responsibilities of 9-1-1 Authorities vary depending on jurisdictional hierarchy, resource availability, capabilities, service arrangements, and regulations and statutes. As such, 9-1-1 Authorities are expected to work with ECRF/LVF operators to further clarify and/or identify additional required services prior to development and implementation of an ECRF and LVF.

Although this document contains references to 9-1-1 Authorities' Geographic Information Systems (GISs), Public Safety Answering Point (PSAP) equipment, access and call network providers Location Information Servers (LIS), and other core functions of the Emergency Services IP Network (ESInet), their functionality and operations are out of scope for this document. NENA-STA-010, Detailed Functional and Interface Specification for the NENA i3 Solution – Stage 3 [1](commonly known as i3), contains definition of data structures and detailed functional and interface standards that are referenced in this document.

GIS data must be provisioned to ECRF/LVF systems. Provisioning of GIS data to an ECRF and LVF for NG9-1-1 is the ongoing process of publishing the most current and accurate authoritative GIS data into ECRF/LVF systems.

Reason to Implement

The primary reasons to implement these standards are to:

- Ensure consistent provisioning of data to ECRF/LVFs
- Enable compatibility between ECRF/LVF providers across ESInets
- Ensure timely activation of ECRF/LVF systems
- Aid stakeholders and 9-1-1 Authorities in future planning
- Define procedures for provisioning authoritative geospatial data sources that will constitute ECRF/LVF data

Benefits

This document benefits users and providers of ECRF/LVF services in the following manner:

- Understanding the roles and responsibilities of those using and provisioning the ECRF/LVF services;

- Assist in establishing ECRF/LVF services; and
- Understanding ECRF/LVF performance and implementation considerations.

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National Emergency Number Association
1700 Diagonal Rd, Suite 500
Alexandria, VA 22314
202.466.4911
or commleadership@nena.org

2 Document Conventions

NENA: The 9-1-1 Association improves 9-1-1 through research, standards development, training, education, outreach, and advocacy. Our vision is a public made safer and more secure through universally-available state-of-the-art 9-1-1 systems and better-trained 9-1-1 professionals. Learn more at nena.org.

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2. **MUST NOT:** This phrase, or the phrase "SHALL NOT", means that the definition is an absolute prohibition of the specification.
3. **SHOULD:** This word, or the adjective "RECOMMENDED," means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
4. **SHOULD NOT:** This phrase, or the phrase "NOT RECOMMENDED" means that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
5. **MAY:** This word, or the adjective "OPTIONAL," means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option "must" be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option "must" be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.)

These definitions are based on IETF [RFC 2119](https://tools.ietf.org/html/rfc2119).

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National Emergency Number Association
1700 Diagonal Rd, Suite 500
Alexandria, VA 22314
202.466.4911
or commleadership@nena.org

Reason for Issue/Reissue

NENA reserves the right to modify this document. Upon revision, the reason(s) will be provided in the table below.

Document Number	Approval Date	Reason For Issue/Reissue
NENA-STA-005.1-2017	February 16, 2017	Initial Document
NENA-STA-005.1.1-2017	August 10, 2017	Updated GPS definition to agree with NENA Master Glossary
NENA-STA-005.1.2-202Y	July 19, 2022	General update throughout to reflect current NENA guidance in other documents adopted since 2017.

3.1 ECRF/LVF Overview

For the complete detailed functional and interface specification for ECRF/LVF systems refer to NENA-STA-010 [1]. From a high level, the ECRF is a LoST protocol server used during 9-1-1 call routing. The server accepts routing queries containing location information (either civic address or geodetic coordinates) and a Service URN, and returns a URI used to route an emergency call toward the appropriate PSAP for the caller's location or towards a responder agency.

In the context of ECRF/LVFs, a "Service URN" is a Uniform Resource Name identifying a particular service type such as 9-1-1 PSAP, Law, Fire, Medical, Poison Control, or Coast Guard, in protocols that support general URI's such as SIP request URI's. Service URN's are generally not expected to be visible to end users. For example, the service URN for 9-1-1 is urn:service:sos.

In the context of ECRF/LVFs, a Uniform Resource Identifier (URI) is a string of characters used to identify a particular resource within an ESInet, such as a 9-1-1 PSAP, or an ECRF/LVF, or an Emergency Services Routing Proxy (ESRP). For example, a URI for a PSAP might look like sip:psap@ecrf.state.us.

An ECRF implements a spatial operation to intersect the location provided in the routing query against service area boundaries of the type specified by the Service URN. The input location may be a geodetic coordinate based location or a civic address location. Supported geodetic location types within ECRF queries are point, polygon, circle, ellipse, or arc-band. If the input location is a civic address and not geodetic coordinates, the ECRF must relate the civic address to a location in the GIS database that can be intersected with service area boundaries. NENA i3 requires input locations to the ECRF to be the original locations, and never pre-converted, such as during record load into a LIS, or by other functional elements before the ECRF such as an ESRP. The primary output from a routing query to an ECRF is a URI indicating the next-hop the call should be transferred to. As part of the process to answer a query with an authoritative response, redirection or recursion may occur. An ECRF is used to route or selectively transfer 9-1-1 calls, and receives requests from ESRPs, other ECRFs, and endpoints, using the LoST protocol defined in IETF RFC 5222 [11] as specified in NENA-STA-010 [1].

An ECRF also provides a mechanism in i3 networks for determining additional data associated with a location related to a 9-1-1 call as defined in NENA-STA-010 [1]. The ECRF has an "additionalData" service (urn:emergency:service:AdditionalData) which returns the URI to additional data associated with a location to authorized entities. Additional location data includes information such as building owner and tenant information, maintenance, security, and structural engineering contacts, BIM (Building Information Management) systems data and more. The precise xml data structure returned will be defined in future work, however the ECRF only returns a reference to

this data in the form of a URI per NENA-STA-010 [1] section 4.3.3.4. The ECRF discovers additional data when it receives a query with service URN of urn:emergency:service:AdditionalData, and a location. The additional location data URI is an attribute of civic location data in the ECRF's GIS database.

The Location Validation Function (LVF) is the i3 functional element used to validate address locations prior to use during a 9-1-1 call. Access networks that provide location information in civic address format must validate the civic address prior to use in a call, in order to verify that the location is routable for 9-1-1 and usable for dispatch. LVF is invoked at new service initiation, when location changes, and at periodic intervals (See 5.2.6). To be LVF 'Valid', a civic location must map to a location in the GIS database provisioned to the LVF such as a single address point, a single parcel / sub-parcel / building / floor / room polygon, or single point derived from an address-ranged road centerline layer (meaning the location is dispatchable). The civic address must be able to be mapped to a service area polygon of the type specified by the service URN in the validation request (meaning the location is routable). LVF primarily returns a service mapping and lists of civic address elements that are considered valid, invalid, or were unchecked. Civic address validation of geodetic locations is by definition not possible; however, a geodetic location can be submitted in an ordinary ECRF query to test whether the location can be used to successfully obtain a call routing URI.

4 GIS Data for ECRF/LVFs

4.1 Authoritative GIS Data Sources

The ECRF/LVF requires GIS data for operation. The GIS data required consists of emergency service boundaries and civic location address data. The ECRF/LVF is provisioned with authoritative GIS data for the geographic area covered by the ECRF/LVF. The authoritative source for a given GIS layer is the agency responsible for that service area and data type:

- 9-1-1 authorities are responsible for creating and maintaining, whether directly or delegated through a third party, NENA standard PSAP service area boundaries for their area of operation, and ensuring this data is provisioned to the ECRF/LVF.
- Agencies other than local addressing authorities are typically tasked with creating and maintaining GIS data used for finding civic locations both for validation and for routing. The 9-1-1 Authority is responsible for coordinating with local addressing authorities and GIS Data Providers for the provisioning of address data in a GIS format to the ECRF/LVF. Agencies other than the 9-1-1 Authority may be responsible for creating and maintaining other service area boundary types, such as law, fire, medical, poison control, coast guard, animal control, etc., and for provisioning this data to the ECRF/LVF.

In some cases, a non-9-1-1 Authority agency (law, fire, medical, poison control, coast guard, animal control, etc.) will not have the capability to create NENA standard GIS layers for their own service area boundaries, or to provision those GIS layers directly to the ECRF/LVF on their own. In this case, and by agreement the 9-1-1 Authority will prepare NENA standard geospatial data layers for their service area boundaries on their behalf. Even though a 9-1-1 Authority is acting on their behalf to create and provide GIS data to the ECRF/LVF, these other agencies are still responsible for delineating their service area boundaries and communicating the location of these boundaries effectively to the 9-1-1 Authority.

9-1-1 Authorities themselves may also sub-contract their GIS data development and/or ECRF/LVF provisioning responsibilities to a third party, including to the operator of the ECRF/LVF, or another vendor.

It is the responsibility of the 9-1-1 Authority to control what additional service area boundary types will be provisioned to the ECRF/LVF for their service area. For example, the 9-1-1 Authority may decide that “animal control” is not a required service area boundary. In this case, “animal control” service area boundaries will not be provisioned to the ECRF/LVF by animal control agencies directly, or by 9-1-1 authorities acting on their behalf.

4.2 Required GIS Datasets

NENA-STA-010 [1], Appendix B, defines the ECRF/LVF provisioning data model. The ECRF/LVF requires two types of GIS data: service area boundaries, and address location data. The ECRF/LVF does not require a wide variety of other GIS data layers that are useful for tactical dispatch mapping, such as aerial or satellite imagery, hydrography, topographic maps, fire hydrant locations, infrastructure maps, and so on. The ECRF/LVF should be thought of as using a subset of available GIS layers, and not all GIS layers used for other 9-1-1 functions.

4.2.1 Service Area Boundaries

Service area boundaries denote the geographic extent for a particular type of service, such as a 9-1-1 PSAP, or responder agency. Service areas are used by the ECRF during routing requests. A routing request to the ECRF contains the geodetic or civic location of the caller, and a service URN for the type of service being requested.

To determine next-hop routing, the ECRF intersects the location provided in the request against the service area boundary polygons of the type specified by the service URN provided in the request. For example, if the location provided in the request is a coordinate such as 34.30465, -77.96549, and the service URN in the request is urn:service:sos (meaning a 9-1-1 PSAP), then the ECRF will perform a point-in-polygon selection of the latitude / longitude coordinate against the 9-1-1 PSAP (SOS) service

area polygons provisioned to the ECRF. Service area polygons are attributed with a URI used for call routing. Service area boundaries:

- Must include the appropriate fields specified in NENA-STA-010 [1], Appendix B, SI Provisioning Data Model definitions for Service Boundary, and the NENA-STA-006 NENA Standard for NG9-1-1 GIS Data Model [5].
- Service area boundaries of the same type should not overlap. Small gaps and overlaps (such as those caused by different GIS data editing software methods, organizational processes used to create the data and different coordinate precisions used) may be automatically corrected using the service area gap/overlap handling mechanism described in NENA-STA-010 [1]. Gaps or overlaps exceeding the gap/overlap threshold parameters will result in a notification from the ECRF, and may result in incorrect 9-1-1 call routing. These discrepancies should be identified and corrected before provisioning GIS data to an ECRF/LVF when possible.
- An intentional gap or overlap may be acceptable in some circumstance. For example, some jurisdictions in the US may allow more than one volunteer EMS company to respond to an address. There are also geographic areas where no service of a particular type covers a specific geography. In these scenarios, there are intentional overlaps or gaps among service area boundaries.
- At minimum a urn:service:sos service area boundary must be present for 9-1-1 call routing. Additionally, boundaries representing subservices to urn:service:sos may be included as well as other services for selective transfer or responder determination.

4.2.2 Civic Location Data

The LVF uses GIS data to verify that 9-1-1 civic locations are valid for both routing and dispatch. The ECRF requires geospatial data to locate civic addresses to resolve routing requests that contain civic locations instead of geodetic coordinates. Below are three geospatial data feature types that can be used to validate and route civic locations:

- Points: Records in a GIS database defined by a single coordinate, and attributed with civic address components. For example, site / structure locations are commonly represented as address points.
- Polygons: Records in a GIS database defined by a set of coordinates enclosing an area, and attributed with civic address components. Examples of addressed polygons include cadastral or land parcel maps, sub-parcel polygons, building footprints, and other planimetric features indicating detail down to the floor, suite, room, and seat level in a building.

- Lines: Line segments in a GIS layer attributed with civic address components, zonal information such as community, and low and high address ranges. An example of a set of line segments containing addressing information is an address-ranged road centerline layer.

A 9-1-1 Authority may provision one or more of these geospatial data types to an ECRF/LVF. For example, a 9-1-1 Authority may use building footprint polygons for only a small area in their jurisdiction, such as a small area within a city with an active GIS department, and address-ranged road centerline layers for the rest of the county. Other 9-1-1 Authorities may rely heavily on GPS collected site / structure location data. Still others may use address points for anomalous addresses only (such as odd and even house numbers on the same side of the street), and address-ranged road centerline layers for the rest. The NG9-1-1 GIS Data Model (NENA-STA-006[5]) requires road centerline layers and site/structure address points.

ECRF/LVFs should accommodate each and any combination of these three types of data. 9-1-1 Authorities, must provision their best available GIS data for addressing to the ECRF/LVF, and the ECRF/LVF uses the best data provisioned to it for routing and validation queries. "Best" in this context is dependent on local policy, data availability/quality, and implementation of the ECRF/LVF. For new NG9-1-1 systems transitioning from legacy style systems, geospatial data must be complete, current, and at least as accurate as the legacy 9-1-1 MSAG and ALI databases, as defined in NENA 71-501 [6], Information Document for Synchronizing Geographic Information System databases with MSAG & ALI.

4.3 Optional GIS Datasets for ECRF/LVFs

An ECRF/LVF requires two types of GIS data: service area boundaries, and address location data.

However, particular ECRF/LVF implementations may take advantage of additional optional GIS datasets when available. NENA-STA-010 [1], Appendix B, SI Provisioning Data Model, and the NENA-STA-006 NG9-1-1 GIS Data Model [5] both describe additional layers:

- National subdivisions (states)
- County boundaries
- Municipal boundaries
- Unincorporated community boundaries
- Neighborhood boundaries

These GIS datasets are not necessary for answering ECRF or LVF queries. However, they can be useful to particular ECRF/LVF implementations, for example to facilitate the URI mapping of an invalid or incomplete civic location.

4.4 GIS Data Ownership, Distribution, and Sharing

NENA i3 requires all 9-1-1 Authorities to ensure GIS data provisioned to the ECRF and LVF is of the highest quality available and is developed in accordance with relevant NENA standards. The system necessarily requires distribution and sharing of GIS data; SIs provision GIS data to ECRF/LVFs, ECRF/LVFs can coalesce GIS data from multiple 9-1-1 authorities, and ECRF/LVFs may be replicated such as within a communication service provider's network.

While these functions alone do not constitute uncontrolled public release of sensitive and private GIS data, for example sub-address civic location data for a secure government facility, or personal subscriber information, 9-1-1 authorities may transmit GIS data to third party service providers. 9-1-1 Authorities' contractual agreement with service providers in receipt of said GIS data must at a minimum:

- Reflect the 9-1-1 Authority's NG9-1-1 GIS data sharing and distribution policies in accordance with local, state and federal laws;
- Have requirements and procedures for responding to GIS data extract requests;
- Address protection of GIS data from unauthorized use and/or redistribution;
- Address ownership of the GIS data;
- Describe the intended and allowed uses for the GIS data.

Sharing GIS data used for provisioning ECRF/LVFs with the public and other commercial data providers is encouraged, where such sharing does not release private or sensitive information. The benefits of freely sharing NG9-1-1 GIS base map data are in the public interest and supportive of 9-1-1.

4.5 GIS Data Standards

NENA-STA-006 NG9-1-1 GIS Data Model [5] describes GIS layers, attributes, and accuracy required for NG9-1-1 systems. Coordinate Reference System and datum is prescribed for ECRF/LVF systems. 9-1-1 authorities may opt to build and maintain GIS data natively in this coordinate system and datum, or may rely on re-projection processes executed before or after providing GIS data to a SI. ECRF/LVF coordinate system and datum requirements are as follows:

- Coordinate Reference System and Datum – Use of the World Geodetic System of 1984 (WGS84) is required for GIS information within the ECRF/LVF. All geodetic data in i3 uses WGS84 as referenced in NENA-STA-010 [1], Section 2.5.

- Geodetic parameters for WGS84 are specified by the European Petroleum Survey Group (EPSG) for both 2-dimensional and 3-dimensional geometries. For 2-dimensional geometries the geodetic parameters are required to follow EPSG::4326.
- For 3-dimensional geometries the geodetic parameters are required to follow EPSG::4979.

4.6 GIS Data Recommendations, Tradeoffs, and NENA Long Range Vision

While today's commonly available GIS data may be provisioned to the ECRF/LVF and successfully used to route a call and validate location, NENA's long range vision for the i3 solution expects the evolution of GIS data towards greater accuracy and precision. For example, today's GIS data for the location information of an apartment building may be limited to a civic address comprised of house number, leading street direction, primary road name, street suffix, city name, and state name; and expected to evolve to include building name, floor, suite, room, and even seat (as defined in NENA-STA-010 [1], Table 4-3 PIDF <civicAddress> Element Attributes and Elements). NENA envisions the potential use of 3D location information and 3D geodetic location profiles for routing purposes. The use of 3D location information enables 9-1-1 calls from the upper floors of a building to be routed differently than the lower floors. Similarly, the use of 3D geodetic location profiles enables 9-1-1 calls at sea level (on the water) to be routed differently than a call above sea level (on the bridge over the water). Presently NENA-STA-010 [1] allows 3D locations but does not require 3D location support. However, the implementation of 3D support for NG9-1-1 call routing will require additional standards work and clarification.

The pace of the GIS data evolution is related to the ability of access networks and communications service providers to include more granular civic address component data and the z coordinate in 9-1-1 call PIDF-LOs, and also the ability of address authorities to develop GIS datasets that support indoor and vertical location.

In general, address-ranged road centerline layers (RCLs) allow approximation of address locations along street centerline segments based on address house numbers and address range attributes on the segment. Sometimes, these are offset to the left or right side of the street by a preset distance based on the parity of the house number, and adjusted (as necessary) away from intersections.

In short, location points derived from road centerline layers only approximate locations. However, RCLs are frequently used for address location because they are commonly available, and also economical; a newly generated address requires no edits to the RCL as long as the house number falls within the range already assigned to a road centerline segment.

Compared to address-ranged road centerline features, site/structure address points can be more descriptive as they can be attributed with additional information such as building, floor, suite, and room. Site/structure address points also allow for greater precision and accuracy in the spatial representation of individual civic locations.

In addition, road centerlines most often represent a range of possible theoretical address locations along a street centerline segment, whereas address site/structure location points represent actual address locations. A civic address that matches a road centerline segment may not correspond to an addressed building in the real world.

A point-based address layer typically requires more resources to maintain than an address-ranged RCL. Each newly generated address requires edits to the underlying point layer.

Sub-parcel polygons can provide perhaps the most accurate location representation for civic locations. They can be attributed down to the building, floor, suite, and room level. In addition to representing building area data, sub-parcel polygons can also be used to represent other types of areas such as parking lots, and cemeteries. Sub-parcels also avoid the problem of a discrete point on the map being mistakenly interpreted as the “exact” location of the calling device, when in reality the building or room may be the best information known about location, and may be of more use for routing and dispatching. Polygons broken down to the sub-parcel, building, floor, suite, and room level are not common today, and are quite cost prohibitive to create on a large scale.

While NENA expects today’s commonly available GIS data to be used initially for site/structure locations, NENA recommends the use of GIS data that are capable of refining down to the building, floor, suite, and room level. Requirements for this level of detail will be provided in a future version of this document or a separate NENA document.

4.7 GIS Data QA/QC Recommendations

The attribute and spatial information for ECRF/LVF GIS data must be accurate in order for 9-1-1 calls to route properly, and to properly validate civic locations.

As a result, the following quality control checks are recommended when building GIS data for ECRF/LVFs:

- Check for unintended gaps and overlaps between service boundaries.
- Check for unintended discrepancies between address-ranged road centerline layers and corresponding site/structure address points or polygons.
- Check for accurate service URI’s and URN’s in service boundary attributes.
- Validate GIS feature attributes against the NENA-STA-006 NG9-1-1 GIS Data Model[5].

- Check for GIS records with different geometry but otherwise identical attributes.

NENA also strongly recommends additional GIS data QA/QC measures when preparing for, or transitioning to, NG9-1-1. The additional measures are described in detail in NENA 71-501 [6], Information Document for Synchronizing Geographic Information System Databases with MSAG & ALI.

QA/QC measures described in this section are primarily intended to be performed before provisioning GIS data to an ECRF/LVF. When used, they are used as part of an overall GIS data quality assurance program that may include manual, automated, or semi-automated processes.

5 Provisioning GIS Data to ECRF/LVFs

5.1 Overview

All 9-1-1 authorities experience change in their GIS systems, and since these systems are used to populate the ECRF and LVF databases that provide routing and validation for locations used for emergency calls, such changes get propagated via the SI to the ECRF and LVF. The time period from when a change is made to the GIS system and the time it affects routing (or validation) of a location matters. Too long and calls arriving after the change was made but before it goes into effect at the ECRF may cause routing errors. Too short and quality assurance processes may be negatively affected and costs may rise. The total time that it takes to make a GIS data change, and have the change reflected in ECRF/LVF query responses is impacted by many factors. For example, quality assurance processes in GIS data editing and management systems take some time to operate, and the SI process takes some time to provision GIS data changes to ECRF/LVF systems.

Some layers do not need the same update time as others. All 9-1-1 Authorities should have a process to update route polygons rapidly (times measured in minutes) when they are needed, but additions to a street centerline or site/structure layer may have update times measured in hours to as much as a day. Processes that normally have long cycle times may need alternate processes that cause changes to be put into place much more rapidly when there are problems.

Note that using the "Effective Date" and "Expiration Date" attributes on GIS features in the GIS Data model and SI allows 9-1-1 Authorities to publish planned changes in advance of the actual change, in a manner that the ECRF and LVF can smoothly and rapidly effectuate a change at a specific time. Changes due to events such as annexation, or changes due to readdressing or other mass events may use this mechanism to great advantage.

The NENA i3 provisioning interface for the ECRF/LVF, according to NENA-STA-010 [1], is a GIS layer replication mechanism provided by a Spatial Interface (SI) that utilizes:

1. A Web Feature Service (WFS); an Open Geospatial Consortium (OGC) standard for insert/delete/modify operations on GIS data
2. A GeoRSS in Atom feed containing WFS commands (GeoRSS in Atom provides an XML language for web feeds containing WFS commands)

When updates to authoritative GIS data are made, such as adding streets, changing boundaries, etc., the changes are sent to the ECRF/LVF server via a SI.

Note: The ECRF/LVF provisioning mechanism described in NENA-STA-010 [1] is based on OGC 10-069r2 [10] which is a public engineering report, not a standard. The content of this document is believed to be insufficient for describing how to build interoperable implementations at this time. A future OGC specification or a future edition of NENA-STA-010 [1] will describe the protocol definitively.

When GIS data is coalesced into an ECRF/LVF, service boundary layers may have gaps and overlaps. The relevant 9-1-1 Authorities should endeavor to resolve such issues early, but despite best efforts, the ECRF/LVF may still encounter gaps and/or overlaps. ECRF/LVF systems have an automatic gap/overlap reporting feature. Error reports will be generated to the provisioning sources for resolution if coalesced service boundary layers contain gaps and/or overlaps that exceed a surface area threshold parameter (expressed in square meters). Gaps and overlaps smaller than the threshold parameter are handled by the ECRF/LVF using an algorithm of its choice. ECRF/LVF automatic gap/overlap detection and handling is described in NENA-STA-010 [1] section 4.3.4.

5.2 Provisioning Roles and Responsibilities

5.2.1 GIS Data Providers

GIS data providers create and maintain GIS data that is used by an ECRF/LVF. While a complete list of workflows and processes for GIS data providers is out of scope for this document, if supplying GIS data to a 9-1-1 ECRF/LVF system they are responsible for the following:

- Working with 9-1-1 authorities to determine policies, responsibilities, and commitments.
- Create, maintain, and document GIS data in adherence to relevant NENA standards.
- Provide the necessary infrastructure or service to keep the GIS data current in a timely fashion.
- Supply GIS data to the SI for use in an ECRF/LVF.
- Work with neighboring and associated agencies (other GIS Data Providers) to resolve boundary discrepancies. Where agencies provide services outside their

jurisdictions, inter-agency or inter-local agreements are required and must be reflected by the service area boundary GIS information provisioned by the source to an ECRF/LVF. Boundary polygons must meet the needs for 9-1-1 call routing, and are not necessarily legal or surveyed boundaries.

- Accept GAP/OVERLAP event notification from an ECRF/LVF via the SI and resolve errors prior to the 'effective' or 'expires' date/time of the provisioned GIS changes. Errors due to GIS changes with immediate or no effective date must be resolved as soon as possible.
- Validate correctness of service URN/URI attributes on provisioned service area boundary polygons, in cooperation with agency network infrastructure and service providers.

5.2.2 Spatial Interface (SI) Operator

The SI provides GIS data updates to the ECRF/LVF. 9-1-1 Authorities may choose to operate their own SIs, or utilize SI services provided by a SI operator. The SI operator provides the GIS data provisioning interface to the ECRF/LVF, and may additionally provide a repository for one or more GIS datasets from authoritative GIS data sources as described in section 4.1. SI operators:

- Provide the GIS data provisioning interface for the ECRF/ LVF
- May perform QA/QC on the GIS data, for example polygon boundary edge matching QA/QC that may be required for neighboring 9-1-1 Authorities' data and associated tasks including;
 - Refer QA/QC errors back to the originating 9-1-1 Authority(ies) for resolution;
 - Standardizes and provisions GIS data to the ECRF and LVF;
 - Subscribes to the ECRF GapOverlap event notification and refers the error to the relevant 9-1-1 Authorities for resolution;
- Participates in periodic reconciliation, at a minimum annually, between the authoritative GIS databases and the ECRF/LVF in order to ensure database synchronicity.
- Must have a process to support sending and receiving of discrepancy reports, and mechanisms to support error resolution

5.2.3 ECRF/LVF Operator

The ECRF/LVF Operator physically runs the ECRF/LVF LoST Servers. Responsibilities of the ECRF/LVF Operator role are:

- Operate an ECRF/LVF in accordance with IETF 5222 and NENA-STA-010.

- Maintain internal and external (to the ESInet) ECRF/LVF software, equipment, and mechanisms supporting reliable access to and querying of ECRF/LVFs by appropriate sources and i3 functional elements such as ESRP, LIS, and other ECRF/LVFs. Reliability service level agreements should be negotiated between the parties.
- Maintain ECRF/LVF software, equipment, and mechanisms supporting reliable layer replication defined in NENA-STA-010 to and from authorized entities.
- Ensure the internal ECRF/LVF has appropriate security controls implemented to prevent unauthorized access to and query of the ECRF/LVF; and perform appropriate security risk mitigation procedures.
- Ensure the external ECRF/LVF supports queries from appropriate sources; and perform appropriate security risk mitigation procedures as necessary.
- Ensure the ECRF/LVF has appropriate security controls implemented to prevent unauthorized access for the purposes of provisioning data and administration.
- Participate in periodic reconciliation, at a minimum annually, between the ECRF/LVF and its provisioning source in order to ensure database synchronicity.
- Must have processes to support sending and receiving of discrepancy reports.
- If the ECRF and LVF are implemented together on shared platform, then the ECRF/LVF operator must ensure the ECRF query performance is not adversely impacted by LVF queries.
- Ensure that GIS data (see section 4 – GIS Data for ECRF/LVF) is incorporated into the ECRF/LVF within a specified period of time. This time shall be determined by agreement between the ECRF/LVF operator and participating 9-1-1 Authorities, authoritative GIS data providers, and SI operators.
- Must observe and apply the 'effective' and 'expires' time/date attributes, if provided, on any GIS records provisioned to the ECRF/LVF (for example, site/structure points, road centerline segments, and service area boundaries).
- Assign expiration times to location-to-service mappings (LoST protocol RFC 5222) [14] issued by the ECRF/LVF such that mappings will expire within a specified period of time. This time shall be determined by agreement between participating 9-1-1 Authorities, authoritative GIS data providers, and SI operators. The agreements should be reviewed periodically (for example annually). In addition, those mappings must expire no later than the expiration date of GIS records used by the ECRF/LVF to generate the mappings. This in combination with the time required to incorporate GIS changes will determine the maximum amount of time that clients may continue to use previous location-to-service mappings. See section 5.3.3 for additional detail.

- Responsible for enabling their ECRF/LVF to report its coverage area and application unique string to the upstream ECRF/LVF or Forest Guide. For additional information regarding Forest Guides see NENA-INF-009 Requirements for a National Forest Guide Information Document **Error! Reference source not found.** Note that work to standardize the exchange of coverage area data is ongoing.

5.2.4 9-1-1 Authority

The 9-1-1 Authority's responsibilities are:

- Identify the GIS data to be provisioned to the ECRF/LVF; authorize and make arrangements with GIS data providers needed to supply data for 9-1-1 purposes.
- Create and maintain policies that specify granularity of ECRF/LVF query responses, based on how an ECRF/LVF is deployed (for example in a regional deployment an ECRF may return a route to a PSAP, while at a state level an ECRF may return a route to a regional ESInet).
- Responsible for ad-hoc dynamic service area boundary changes and expiration management. Also, responsible for communicating changes impacting other jurisdictions, and ensuring changes are within limits allowed by inter local or other agreements.
- Responsible for coordinating and facilitating routine GIS data changes and discrepancy resolution, including between neighboring jurisdictions.
- Chooses the ECRF/LVF deployment model within the ESInet, for example including consideration of ECRF/LVF forest guides. Deployment architecture options and considerations are discussed in section 6 of this document.
- Coordinates and facilitates the interfaces and standards required for communications between ECRF/LVF operators.
- Can be responsible for provisioning GIS data from authoritative sources to the ECRF/LVF via a SI
- Sets, reviews, and refines requirements for participating entities to provision GIS data into ECRF/LVFs.
- Coordinates and facilitates configuration of ECRF default mappings.
- Ensures network access for the provisioning of GIS data to ECRF/LVFs.

5.2.5 PSAP

The 9-1-1 PSAP's responsibilities are:

- To develop operational practices and testing procedures around PSAP systems' usage of ECRF and LVF including:
 - Querying an ECRF to ascertain the appropriate response agency to serve the emergency event reported by the caller.
 - Querying an ECRF's additional location data service in order to determine additional information about a location as described in NENA STA-012 [7].
 - Querying an ECRF to determine URIs for selective call transfers.
 - Querying an LVF for the purposes of validating a user input civic location.
- Report ECRF/LVF related discrepancies identified by 9-1-1 call takers such as 9-1-1 calls routed to the incorrect PSAP, and/or containing missing or incorrect location information, and participating in the discrepancy reporting process as described in NENA-REQ-002 NG9-1-1 Data Management Requirements [4].

5.2.6 Access Network Operator

The Access Network Operator's responsibilities are:

- Must validate civic locations information placed in its LIS using an LVF.
- Anytime a civic location is changed in a LIS, such as a street name change, building name change, or any other modification of a civic location, must validate the proposed update to the civic location against the LVF data.
- Must periodically revalidate civic locations in their LIS against the authoritative LVF or LVF copy. A reasonable revalidation interval is on the order of 60-90 days. More frequent revalidation cycles may be desirable, but may not be feasible in terms of cost and network load.
- Resolve LVF failures with the subscriber, communications service provider, and/or the authoritative GIS data source as the case may be.
- Provide access to an ECRF/LVF so that calling parties or devices can learn call routing and validate their locations.

5.2.7 Communications Service Provider

The Communications Service Provider's responsibilities are:

- Must be able to query an ECRF or a similar function from within their own network to ascertain the target E911 to onward route a call.
- If the communications service provider is using an ECRF/LVF within their own network, it must be provisioned from and synchronized with authoritative ECRF/LVF data.

- If the communications service provider is using an ECRF/LVF within their own network, it must participate in periodic reconciliation, at a minimum annually, between the ECRF/LVF and its provisioning source in order to ensure database consistency (note this complete reconciliation is in addition to the recommended 60-90 day LIS revalidation described for the access network role, and is specific to the source GIS data rather than the LIS subscriber records).
- If an endpoint's location is determined by or configured with the communications service provider, then the communications service provider must assume responsibility for location validation as described for the access network operator role.
- A communications service provider must work with local 9-1-1 authorities to determine appropriate default routing to use in the event that an ECRF does not return a usable response or cannot be contacted.
- The communications service provider must participate in the misroute resolution process resulting from a misroute discrepancy report as described in the NENA-REQ-002, NG9-1-1 Data Management Requirements [4].

5.3 GIS Data Provisioning: GIS Data Change Management Operational Issues

Certain types of GIS data changes are complex and have wide-spread ramifications to the operation of the ECRF/LVF, in addition to SI and GIS data management workflows. Workflows around such changes need to be planned and coordinated. For example, GIS changes resulting from an annexation are complex because multiple disparate authoritative sources of GIS information may be involved and need to be coordinated. Similarly, changes that are time sensitive, such as temporary routing boundary changes are complex due to issues related to timing and multiple parties involved. Edge matching of service area boundaries between adjacent NG9-1-1 systems creates an additional degree of complexity. Executing such changes requires clear SI and GIS data management workflows to be defined. Improper management of such GIS changes can lead to poor GIS data quality in the ECRF/LVF which can negatively impact 9-1-1 call routing, and ultimately increase response times.

5.3.1 Annexations, Incorporations, and Dissolutions

Annexation is the incorporation of a geographic area into an existing political unit such as a country, state, county/parish, or city. An incorporation is when a geographic area is incorporated into an entirely new political unit such as a city or village. Conversely, a dissolution is when an existing political unit is officially dissolved. Annexations, incorporations and dissolutions must be reflected in GIS data changes as well as service area boundary assignment changes. Annexations, incorporations and dissolutions are planned "events" where the parties involved affect the jurisdictional changes on a

specific date and time, i.e. an “effective date/time”. Correspondingly, GIS layers utilized by an ECRF/LVF may also contain optional ‘effective’ and ‘expires’ date/time attributes informing the ECRF/LVF of a pending change. In this case, changes will not be realized in the ECRF/LVF until the designated date/times are reached.

Operational Issues:

- An annexation, incorporation or dissolution will likely require multiple changes from several parties, increasing the risk of overlaps and gaps. To mitigate the risk, an ECRF/LVF checks changes received via the SI for potential gaps and overlaps, before waiting for ‘effective’ and ‘expires’ date/time GIS record attributes to actually be reached. If found, the gap/overlap notification event is triggered giving the parties involved time to resolve the discrepancies before the annexation is implemented. It is recommended that such changes be submitted at least 14 days in advance, and that discrepancies are resolved at least 72 hours prior to the effective date/time.
- An ECRF/LVF will apply changes received from the SI WFS provisioning feed when the effective date of the change is reached, regardless of the resolution status of gap/overlap discrepancies. For gap/overlap discrepancy resolutions that exceed the effective dates, it is recommended that GIS sources resolve the discrepancies using temporary corrections while waiting for the official resolution rather than rely on ECRF internal algorithms. In the context of call routing, gaps present more risks than overlaps.
- Annexations, incorporation or dissolutions that involve authoritative GIS data providers utilizing different ECRF/LVF operators require the affected ECRF/LVF operators to communicate and cooperate in the identification and resolution of gap/overlap discrepancies.

5.3.2 Dynamic and Ad-hoc Boundary Changes

Occasionally a significant unplanned event (for example a large fire, train derailment, etc.) may result in a scenario in which it is desirable to alter local call routing during the duration of the emergency. For example, a PSAP may wish to route calls from the area near the event to a different call queue within the same PSAP, or to a mobile PSAP deployed in the field. To accommodate this change a temporary PSAP service boundary may be provisioned to the ECRF in order to route calls originating inside the emergency area as needed. In this case, the temporary routing boundary is wholly contained within the geographic extent of the parent PSAP service area boundary and there are no cross-jurisdictional issues to consider. During such an event, quickly provisioning a temporary routing boundary to the ECRF is critical; waiting for a local GIS department to make the change, may not be viable (for example if outside of normal business hours, and/or when GIS staff is unavailable).

Significant unplanned events can be envisioned that warrant a very fast service boundary change where a temporary routing boundary intersects one or more PSAP service area boundaries managed by different 9-1-1 Authorities participating in a regional NG9-1-1 ESInet. If an ECRF serving the regional ESInet supports provisioning of temporary routing boundaries that intersect multiple PSAP service area boundaries, then NENA strongly recommends that participating 9-1-1 Authorities define pre-designated entities and personnel authorized to insert temporary routing boundaries. In addition, memorandums of understanding (MOUs) and mutual aid agreements regarding dispatching emergency responders during such emergencies are encouraged.

Temporary routing boundaries must be implemented in ECRFs covering the area of the temporary routing boundary. Adding a temporary routing boundary to an ECRF that extends beyond the ECRF's coverage area is likely to be ineffective in altering call routing for calls originating outside the ECRF's coverage area.

Mechanisms and/or toolsets extending beyond the i3 GIS/SI/ECRF provisioning mechanism may be implemented to enable authorized personnel to create and administer temporary routing boundary changes quickly and on the fly. Such tools should include checks, controls, and test mechanisms to ensure validity of a temporary routing boundary before it goes live and to reduce risk of unintended call routing behavior. Auditing and logging is recommended and is left to the implementation.

Consideration could be given to usage of an 'expiration' attribute, similar to that described in the NENA-STA-006 NG9-1-1 GIS Data Model [5], for a temporary service area boundary. If the duration of an emergency event is unknown, then the value of the 'expiration' attribute may be left unpopulated. If the duration is known, as is more common for planned temporary conditions such as a public event, use of a date/time value in the 'expiration' attribute of a temporary PSAP routing boundary may be useful.

5.3.3 Service Mapping Expiration

ECRF query responses contain a <mapping> element that is the core data element in LoST, describing a service region and the associated service URI. This <mapping> element is commonly referred to as a service mapping. The <mapping> element must include an 'expires' attribute that contains the absolute time at which the mapping becomes invalid. This is not to be confused with the optional 'expires' attribute in the GIS data model. LoST permits, as an option, the values of 'NO-CACHE' and 'NO-EXPIRATION' instead of a dateTime value. The value 'NO-CACHE' is an indication that the mapping should not be cached. The value of 'NO-EXPIRATION' is an indication that the mapping does not expire.

Service mappings retrieved from an ECRF may be cached by a LoST client and/or intermediate ECRFs in order to improve system performance. While processing an emergency call, an ECRF may receive multiple requests for mapping for the same or

similar location. By caching the mapping, the load on the authoritative ECRF may be reduced. However, if a service mapping for a given service URN and location has expired, it must be refreshed from the authoritative source (either directly, or via an intermediate ECRF).

The value of the 'expires' attribute is assigned by the ECRF, in accordance with requirements agreed to between 9-1-1 authorities and ECRF/LVF operators. The value may be a static configuration such as 'NO-CACHE', or calculated based on internal algorithms of the ECRF. If 'NO-CACHE' is used, performance may suffer due to significantly increased query load. When the 'expires' attribute contains a date/time value rather than 'NO-CACHE', operational considerations and impacts around ECRF GIS data provisioning must be considered, specifically with respect to stale mappings after a service boundary update. Additionally, the ECRF must not assign expiration times to service mappings further into the future than any expiration time which may be assigned to the underlying GIS data via the 'expiration date' attribute in the NG9-1-1 GIS Data Model.

A service mapping is allowed to be cached in various locations within the call routing infrastructure when the ECRF returns a dateTime in the 'expires' attribute that causes the mapping to expire in the future.

Authoritative GIS data sources provisioning changes to an ECRF database may not immediately result in a change to call routing, as an unexpired service mapping may be cached on an ECRF client such as an ESRP or end user device. In this case the GIS data change may have no impact until cached service mappings expire.

In order to understand and operationally plan for time periods required to guarantee altered ECRF service mappings based on newly provisioned GIS data, the overall processing time required to incorporate GIS data into a live ECRF/LVF and effecting 9-1-1 call routing must be mutually agreed to between the ECRF/LVF operator and participating 9-1-1 Authorities, authoritative GIS data providers, and SI operators. This overall time cycle must include consideration of cached service mappings based on the 'expires' attribute returned in service mappings by the ECRF.

NENA recommends that ECRFs not be provisioned with the 'NO-EXPIRATION' value in the 'expires' attribute of a service mapping. If a 'NO-CACHE' value in the 'expires' attribute is used, special attention must be given to performance implications.

5.3.4 GIS record 'effective' and 'expires' attributes

The NENA-STA-006 NG9-1-1 GIS Data Model[5] includes optional 'effective' and 'expires' attributes for GIS records such as site/structure points or polygons, road centerline segments, and service area boundaries. The 'effective' and 'expires' attributes are useful for effecting planned changes scheduled to occur at a certain date and time in the future, such as annexations as described in section 5.3.1.

Risk of overlapping GIS records caused by improper usage of 'effective' and 'expires' attributes must be managed. ECRF/LVF and SI operators are encouraged to apply QA/QC checks that take 'effective' and 'expires' attributes into account.

A SI or 9-1-1 Authority is expected to eventually remove expired records from the published GIS dataset used by the ECRF/LVF so that such records do not negatively impact ECRF/LVF responsiveness.

For example, a sequence of events involving a GIS change utilizing 'effective' and 'expires' attributes is as follows:

- Starting with a record that has no 'expires' date, modify the record to add the 'expires' attribute with the date of the planned change.
- Add a record with the new change that contains the 'effective' date of the planned change and no 'expires' attribute.
- After the changed event delete the record that has expired.

5.3.5 LIS/LVF Periodic Revalidation

Presently there is no built-in i3 mechanism for an LVF to notify a communications service provider of a change in the GIS dataset published for an ECRF/LVF. As a result, an ECRF/LVF GIS data change can cause civic locations in a LIS to become invalid. The current understood method for discovering such discrepancies is periodic LIS to LVF revalidation. It is recommended that revalidation cycles are mutually agreed to by all stakeholders such as LIS and LVF operators and 9-1-1 authorities as part of a contract or operational procedure. NENA-STA-010 [1] provides additional comment on anticipated LIS to LVF revalidation frequency. Alternative mechanisms may be considered, for example allowing a communications service provider to analyze an ECRF/LVF GIS data provisioning RSS feed, and then based on delta analysis trigger revalidation proactively.

5.4 ECRF/LVF GIS Provisioning Discrepancy Reporting

Section 4.7 of this document describes GIS data QA/QC recommendations for GIS data that will be provisioned to an ECRF/LVF. The QA/QC measures described in section 4.7 are primarily intended to be performed before provisioning GIS data to an ECRF/LVF. When used, they are part of an overall GIS data quality assurance program that may include manual, automated, and semi-automated processes.

Despite best efforts to control and assure GIS data quality at or before a SI, errors may occur while provisioning ongoing regular updates of GIS records to an ECRF/LVF. Section 4.9 of NENA-STA-010 [1] describes the i3 discrepancy reporting mechanism; however, a future version of the standard is needed to fully define the relevant reports for ECRF/LVFs. When an ECRF/LVF encounters an error during a provisioning process, it

must provide a discrepancy report describing the error to the SI operator that sent the data update.

Discrepancy reporting, including ECRF/LVF provisioning discrepancy reports, is described in NENA-REQ-002 NG9-1-1 Data Management Requirements [4]. Sections 5.4.1 through 5.4.5 below describe discrepancies occurring during provisioning that trigger reports.

5.4.1 Data that cannot be provisioned to an ECRF/LVF GIS database

An ECRF/LVF's provisioning process receives GIS data changes via the NENA-STA-010 [1] described WFS based SI layer replication mechanism. Examples of data that cannot be provisioned into an ECRF/LVF GIS database include but are not limited to:

- Incorrect XML schema, or malformed XML in a WFS transaction message
- Unexpected GIS layer or attributes
- Invalid or missing geometry for a feature
- Unauthorized provisioning source

When such an error is encountered by an ECRF/LVF while processing a provisioning feed transaction, the ECRF/LVF must provide a discrepancy report to the provisioning entity. The discrepancy report is described in NENA-REQ-002 NG9-1-1 Data Management Requirements [4], and is described as the ECRF/LVF Operator to SI Operator on GIS data provisioning report.

In this case, the provisioned change is not added to the ECRF/LVF GIS database.

5.4.2 ECRF/LVF Gap/Overlap Discrepancy Reporting

When GIS data is coalesced at an ECRF/LVF, boundaries may have gaps and overlaps. NENA-STA-010 [1] defines an ECRF/LVF Gap/Overlap detection and reporting mechanism called the GapOverlap Event. The ECRF/LVF, or other integrated process, must report gaps and overlaps larger than the provisioned threshold using the GapOverlap event.

In addition, NENA-REQ-002 NG9-1-1 Data Management Requirements [4] requires a Discrepancy Report (DR) in this scenario. When a gap/overlap event is detected by an ECRF/LVF, the ECRF/LVF must provide a discrepancy report to impacted SI operators and 9-1-1 Authorities. The discrepancy report is described in NENA-REQ-002 NG9-1-1 Data Management Requirements[4], and is described as the ECRF/LVF Operator to DR Subscribers on GIS Gaps and Overlaps.

Based on detection of such a problem, the provisioned change may be added or withheld from the ECRF/LVF GIS database based on configuration. However, if an ECRF/LVF is allowed to reject changes in this category, then there must be

corresponding capability for a SI operator to override the rejection at the direction of the authoritative data source. However, such a mechanism is not currently described in the NENA i3 standard. In addition, operational impacts of a rejection breaking layer synchronization with a SI must be considered. For example, when a change to the database is dependent on a prior change being made, but the prior change was rejected, the new change could cause significant data inconsistency. These types of issues commonly require human operational analysis.

5.4.3 ECRF/LVF detected data quality problems

An ECRF/LVF can potentially detect GIS data quality problems that are not discoverable at the SI level. An ECRF/LVF is permitted to optionally implement various data checks on provisioning, and to report detected problems back to the provisioning SI. Possible examples of optional data checks an ECRF/LVF may perform on provisioning include but are not limited to:

- Topology such as overlapping or non-edge matched road centerline segments
- Road centerline segments with overlapping ranges
- Duplicate site/structure records

When such an error is encountered by an ECRF/LVF while processing a provisioning feed transaction, the ECRF/LVF must provide a discrepancy report to the provisioning entity. The discrepancy report is described in NENA-REQ-002 NG9-1-1 Data Management Requirements [4], and is described as the ECRF/LVF Operator to SI Operator on GIS data provisioning report.

Based on severity of the detected problem, the provisioned change may be added to or withheld from the ECRF/LVF GIS database. However, if an ECRF/LVF is allowed to reject changes in this category, then there must be corresponding capability for a SI operator to override the rejection at the direction of the authoritative data source. In addition, operational impacts of a rejection breaking layer synchronization with a SI must be considered. Future work is needed in this area as described in section 11.4.

5.4.4 General Provisioning Failure

A provisioning process may fail at an ECRF/LVF as a result of a system error. Types of system errors may vary from system to system and may relate to a particular implementation, configuration, application, or environmental problem.

When such an error is encountered by an ECRF/LVF while processing a provisioning feed transaction, the ECRF/LVF must provide a discrepancy report to the provisioning entity. The discrepancy report is described in NENA-REQ-002 NG9-1-1 Data Management Requirements [4], and is described as the ECRF/LVF Operator to SI Operator on GIS data provisioning report.

In this case, the provisioned change is not added to the ECRF/LVF GIS database.

5.4.5 Other ECRF/LVF Discrepancy Reports

NENA-REQ-002 NG9-1-1 Data Management Requirements [4] describes additional ECRF/LVF discrepancy reports that are not directly related to GIS data provisioning to ECRF/LVFs. ECRF/LVF implementers are encouraged to review this standard in order to support all NENA standard ECRF/LVF discrepancy reporting requirements.

6 Deployment Considerations

An ECRF/LVF sources its data from one or more SIs in the ECRF/LVF service area using a SI layer replication interface. The ECRF/LVF deployment model is similar to but independent from the SI deployment model. The SI deployment model is related to how 9-1-1 Authorities provision their GIS data to an ECRF/LVF node. The ECRF/LVF deployment model is related to how ECRF/LVF nodes are configured to provide an emergency call routing and location validation solution that meets the 9-1-1 Authorities' NG9-1-1 objectives.

The SI contains, maintains and supplies the authoritative GIS data, such that a change in the SI will be propagated to any ECRFs and LVFs interfaced to that SI system. The ECRFs and LVFs, in turn, propagate their information amongst other ECRFs and LVFs and the Forest Guide. Thus, the ECRF and LVF do not have to be provided by, or operated by the same entity. Like NENA INF-028, NG9-1-1 Transition Planning Considerations, the considerations for ECRF/LVFs and SI deployment follow the general NG9-1-1 deployment environments described by the US Department of Transportation (USDOT) Next-Generation 9-1-1 (NG9-1-1) System Initiative Transition Plan **Error! Reference source not found.** as follows:

- **Coordinated, Intergovernmental Approach:** Planned and coordinated deployments of NG9-1-1 capabilities that are governed by statewide 9-1-1 Authorities, regional Authorities, or informal mechanisms that enable a cooperative deployment.
- **Independent, Unilateral Approach:** Decentralized deployments of NG9-1-1 capabilities by local jurisdictions through independent initiatives.

6.1 Spatial Interface (SI)

The SI is the GIS data provisioning interface that publishes GIS changes via an Atom + GeoRSS feed and WFS interface for consumption by one or more ECRF/LVF nodes. 9-1-1 Authorities may choose to operate their own SIs or utilize SI services provided by a SI operator.

The SI essentially represents the "last stop" before authoritative GIS data is placed into service. This information will go on to provide a mission critical role in the routing of

9-1-1 calls and other critical services. Just prior to being published by the SI, it is expected that a number of important activities will be performed on the data. Such activities may include but are not limited to:

- Ensuring the spatial reference associated with the 9-1-1 Authority's GIS data is represented in WGS 84 coordinates;
- Resolving gap and overlap topology errors above the threshold set by target ECRF/LVF nodes (the ECRF/LVF GAP/OVERLAP threshold parameter should be collaboratively identified and communicated between parties as a matter of policy);
- Collaborating with adjacent jurisdictions to ensure service boundaries are properly edge matched;
- Ensuring consistency with the NENA-STA-006 NG9-1-1 GIS Data Model [5];
- Ensuring that 'effective' and 'expires' GIS data attributes, if used, are properly timed to avoid service interruption;
- Validating that URIs are assigned to service boundaries; and
- Ensuring that mechanisms for the dissemination and resolution of discrepancy reports are in place and operational.

While ECRF/LVF nodes do perform some validation on changes received from a SI, most errors can and should be addressed prior to a SI publishing data. It is expected that there will be different approaches for handling NG9-1-1 GIS data QA/QC and discrepancy resolution activities.

6.2 SI Deployment considerations in a coordinated, intergovernmental approach

In a coordinated approach, 9-1-1 authorities use a single shared SI to publish data to the ECRF/LVF system. In this model, GIS data from authorized sources is coalesced into a single GIS dataset that is published to the ECRF/LVF system via a single SI. In this case, 9-1-1 authorities participate in a shared GIS that includes a centralized common quality assurance program.

In this model, 9-1-1 authorities must agree to share a common SI, and to allow their authoritative GIS data to be combined into a regional dataset prior to publishing to an ECRF/LVF. Operationally, this model can provide better quality control and assurance across a regional GIS data set, and may facilitate easier managed integration into regional or state-wide NG9-1-1 systems.

Operational challenges of the coordinated approach for SI include obtaining local buy-in and participation, and possible requirements for local authorities to standardize on a new GIS data model defined by the regional authority. In addition, varying levels of

local GIS software, skills, knowledge, and staff capabilities need to be taken into account.

Alternatively, a coordinated intergovernmental approach may also allow 9-1-1 authorities to directly provision their GIS data to an ECRF/LVF system via a SI.

6.3 SI Deployment considerations in an independent, unilateral approach

In an independent approach, each 9-1-1 Authority publishes their local GIS data to an ECRF/LVF via their own SI. In this model, GIS data is coalesced by an ECRF. An ECRF/LVF must, per standards, perform automatic gap/overlap checking on service boundary data received from the multiple individual authoritative sources.

However, gap/overlap is the only required and standardized check that an ECRF/LVF must perform. Other checks such as edge matching road centerlines between data sets, validating attributes, checking address ranges, etc., are not required by standards to be performed by a coalescing ECRF.

As a result, risks exist when using an independent unilateral SI deployment approach that must be managed and mitigated. From an operational standpoint, such risk is mitigated by individual authorities performing proper data quality control, including edge matching with neighboring data sets (at a vertex to vertex level), prior to publishing data to an ECRF/LVF via a local SI.

Local authorities must not rely on an ECRF/LVF's gap/overlap detection and reporting mechanism as the primary quality control check on GIS data to be published to an ECRF/LVF.

6.4 ECRF/LVF Deployment considerations in a coordinated, intergovernmental approach

A coordinated, intergovernmental ECRF/LVF deployment implies that there is coordination and communication between ECRF/LVF nodes to form a hierarchical tree structure, with the root ECRF/LVF node of the tree knowing the coverage region(s) of the ECRF/LVF node(s) directly below it. Likewise, each ECRF/LVF node beneath the root node must know the coverage regions of the ECRF/LVF nodes directly beneath them as well, etc. The root ECRF/LVF node also has a responsibility to report its own coverage region to the Forest Guide.

In a coordinated deployment, ECRF/LVF nodes may contain authoritative mapping information, coverage regions, or a combination thereof. At a minimum, coverage region sharing (contiguous or non-contiguous) with parent ECRF/LVF nodes is critical in this type deployment in order for query recursion and iteration to occur properly.

Iterative and recursive requests to the ECRF/LVF can both occur in a coordinated, intergovernmental deployment. While it is expected that the Forest Guide will always

redirect (iterate) the decision of whether to iterate or recur from that point is better left for implementation.

6.5 ECRF/LVF Deployment considerations in an independent, unilateral approach

An independent, unilateral deployment within a given jurisdiction, such as a state, implies that ECRF/LVF nodes containing authoritative GIS data are deployed independently from one another.

ECRF/LVF nodes in an independent, unilateral approach do not share information with one another. They receive requests directed to them by a Forest Guide, or directly from a client. However, they are fully functional ECRF/LVF nodes in all other aspects.

Even though direct sharing of information between ECRF/LVF nodes does not occur in this arrangement, it is important that adjacent agencies still work together to ensure coverage regions in the Forest Guide do not overlap or have unintended gaps. ECRF operators must not declare coverage regions larger or smaller than the geographic areas they have jurisdiction over.

This type of deployment is expected to occur frequently during the early stages of NG9-1-1 as state and regional networks are built out.

6.6 Forest Guide Considerations

ECRF and LVF infrastructures make use of Forest Guides as described in IETF RFC 5582 [12]. Given a query to an area outside its coverage area, an ECRF/LVF may have the coverage regions of other ECRF/LVFs to which it could refer a query, or it would refer to a Forest Guide. The top of the tree is a state level (or equivalent) ECRF/LVF. In this architecture, there is a national forest guide that has knowledge of the state level trees. Use of Forest Guides in the NENA i3 solution including functional descriptions, interface descriptions, data structures, roles and responsibilities, and operational considerations, can be found in NENA-STA-010 [1], Section 5.13 Forest Guide. Additional information regarding Forest Guides is provided in NENA-INF-009, Requirements for a National Forest Guide **Error! Reference source not found..**

Both Forest Guides and ECRF/LVFs are LoST servers. However unlike for ECRF/LVFs, GIS data is not published to a Forest Guide via a SI. Rather, a Forest Guide maintains a LoST-sync interface defined in IETF RFC 6739 [13] for updating its coverage regions. For example, in this manner, the national forest guide exchanges mappings with other national forest guides. State mappings are exported to the national forest guide as both civic service boundaries containing a state element, and geodetic polygons representing state boundaries.

As a result, authoritative ECRF/LVFs must know their own coverage region. The coverage region of an authoritative ECRF/LVF is the geographic region within which the

ECRF/LVF is able to authoritatively answer mapping queries. Coverage regions are generally, but not necessarily, contiguous and may be represented as either a subset of a civic address or a geometric object. Presently there is not a GIS layer for ECRF/LVF coverage area defined in NENA-STA-006 NG9-1-1 GIS Data Model [5]. Similarly, there is not a standardized data structure for representing ECRF/LVF coverage areas. Early efforts at NENA ICE 4 defined interim data structures that may be used to represent geodetic and civic ECRF/LVF coverage areas, until standardized in subsequent NENA documents.

When multiple ECRF/LVFs communicate coverage regions to a Forest Guide via a LoST-sync interface, possibility exists for gaps or overlaps in ECRF/LVF coverage areas to occur in the Forest Guide. In this case, the Forest Guide may trigger a GAP/OVERLAP event notification, as described in NENA-STA-010 [1], section 5.3.5 Gap/Overlap Processing in order to alert authorized entities that resolution of a gap or overlap in coverage area may be required. If a Forest Guide receives a query containing a location falling in an overlap before the overlap has been fixed in the participating ECRF/LVF coverage areas, then the Forest Guide must choose one of the coverage regions, according to its own internal algorithms.

7 ECRF Civic Address Ambiguity Resolution

Section 5.2.1.7 of NENA-STA-010 [1] implies that if an address is blank or malformed, then a <findService> request will not be sent to an ECRF, and an ESRP will instead use default routing.

The ECRF will always attempt to reasonably determine a route using a civic location provided in an ECRF <findService> request, even if one or more elements are LVF invalid (aka a LVF invalid address).

For example, when a new phone service is established for a new construction, a data input error could occur when generating the new civic address. The location is entered into the LIS with one or more invalid elements, as identified by the LVF. A 9-1-1 call may be placed from this device prior to the discrepancies being resolved. The ECRF will still attempt to reasonably provide a route for the <findService> request.

If the ECRF is unable to reasonably determine a route given a civic location provided in a <findService> request the ECRF must return an <errors> element containing a notFound error. In this case the ESRP will use default routing.

Exact specifications for when a URI can be reasonably determined from a civic location containing one or more LVF invalid elements are not included here, or in any other standard, and are left to vendor implementations. Below are some best effort recommendations for ECRF implementers.

- Where a LVF invalid civic location maps to one and only one PSAP service area, the ECRF should return that URI.
- Where a LVF invalid civic location does not map to one and only one PSAP area, any implementation must be agreed to by the 9-1-1 Authorities and the ECRF vendors.

8 ECRF Additional Data Discovery Usage

NENA STA-012 [7], NG9-1-1 Additional Data, covers the format of additional data associated with a call, a location, and a caller. NENA-STA-010 [1] addresses the interfaces for discovering the additional data. Together with the SIP Invite and PIDF-LO, additional data associated with a call has the ability to look at other data sources to assist in determining the appropriate call routing and handling. The document describes several additional data structures:

Additional data associated with a call presents device specific information such as type of service for the calling device (wireless, wireline, VoIP, pay/coin telephones, unattended sensor, etc.), as well as device type (cordless handset, fixed telephone, mobile handset, satellite phone, alarm system, data sensor, etc.). The data structure also supports URIs to non-NENA XML schemas for exposing device/service specific additional data structures such as the Vehicle Emergency Dataset (VEDS). This data structure is not discovered by an ECRF.

Additional data associated with a caller presents human information such as caller vCard and emergency contacts. NENA may need to coordinate with electronic medical records providers and developers in order to create standards and frameworks for accessing and controlling the use of electronic health records within NG9-1-1 additional data. This data structure is not discovered by an ECRF.

Additional data associated with a location presents information associated with a building such as building name, owner and tenant information, structural engineering contacts, entrance information, floor plans, sensors, alarms, fire control panels, and a variety of other information. The additional data associated with a location data structure is discovered by an ECRF.

8.1 ECRF Responsibilities for Discovering Additional Data Associated with a Location

It is important to note that the GIS database provisioned to an ECRF does not contain the additional location data structures themselves (building owner, tenant, alarms, fire panels, floorplans, etc.). However, the ECRF is used to discover a URI pointing to the necessary data structure. The ECRF has an "additionalData" service (urn:emergency:service:additionData). When the additionalData service URN is provided with a findService request to an ECRF along with the location being queried,

the ECRF returns a URI for an XML data structure containing the data associated with the location to authorized entities. When a PSAP or responder needs additional data about a location they will query the ECRF, get the URI, and retrieve the data from that URI.

The mechanism for populating the GIS database provisioned to the ECRF with these URIs is not yet defined, but may be specified in future versions of NENA-STA-010 [1]. Similarly, the additional location data itself must conform to a schema that is not yet defined. The URI will contain an HTTPS scheme and a normal i3 data rights management mechanism will be applied to the data.

- It is anticipated that the 9-1-1 Authority will have a mechanism to accept URIs from building owners and tenants. The URIs will be manually or automatically propagated to the authority's GIS system where they will be replicated to the ECRF.
- Similarly, it is expected that additional location information systems will include workflows and methods for populating premise information by building owners and tenants. While it is true that other elements within an emergency response enterprise may have a role in soliciting such information, such as a fire department collecting information about structures within their jurisdiction, building owners and tenants themselves are the authoritative source for information in the additional location information system described here. Additional location information systems need to assure information quality control, change management, and expiry. Such requirements are not yet defined but may be specified in future versions of NENA-STA-010 [1] or NENA 71-001 [7], and are outside the scope of ECRF/LVF roles and responsibilities described here.
- Collecting and updating premise information by building owners and tenants and its use by PSAPs and responders is complicated by issues associated with maintaining accuracy of the information. While some PSAPs and responders may take the position that no information is better than possibly outdated or inaccurate information, both the users and the providers of such information who deem it valuable, even though it may not be accurate, will need protection from liability concerns that arise from such inaccuracy.

When an ECRF receives a query with a service URN of urn:emergency:service:additionalData and location information in geodetic form, it should return an appropriate URI based on the location information in the query. In this case where the input location is geodetic, geographic operators such as intersection and proximity can be used to locate the nearest site/structure attributed with additional location information URIs. This mechanism will be described in a future version of NENA-STA-010 [1].

9 Impacts and Considerations

9.1 Operations Impacts Summary

NG9-1-1 will have a profound impact on the operation of 9-1-1 services and PSAPs. In particular, MSAG and ALI systems will be replaced with ECRF/LVF and LIS systems. ECRFs and LVFs are provisioned with GIS data. As a result, 9-1-1 authorities will be required to build and maintain GIS databases for 9-1-1 that meet new benchmarks for uniformity, data accuracy, and timeliness. These GIS databases will be the primary authoritative source for location-based call routing and location validation information. This document describes many operational impacts related to provisioning and maintenance of GIS data for ECRF/LVF systems. It is anticipated that during the transition to NG9-1-1 various combinations of MSAG and ECRF/LVF systems may co-exist, thus having additional operational impacts that are not examined in this document.

9.2 Technical Impacts Summary

This document is intended to improve success of ECRF/LVF deployment by providing clarifications around interactions between the Spatial Interface (SI) and the ECRF/LVF and the importance of GIS data readiness. Improper provisioning of GIS data to ECRF and LVF systems can ultimately result in misrouted 9-1-1 calls.

9.3 Security Impacts Summary

ECRF/LVF systems utilize IP technologies for supporting query/response as well as GIS data. ECRF/LVFs may of necessity be connected, indirectly through the ESInet, to the Internet to accept queries. This means that ECRF/LVF systems may experience deliberate attack. The types of vulnerabilities that ECRF/LVF systems must be protected against fundamentally differ from E9-1-1 systems. Thus, new security mechanisms are required that impact implementation and operation of ECRF/LVF systems, as well as external systems that interact with an ECRF/LVF such as SIs and other ECRF/LVFs. Additional consideration should be given to GIS data protection, access rights, integrity and recovery, because the GIS directly drives the routing infrastructure.

Security mechanisms for transaction protection, authentication, integrity protection, privacy and rights management, and Internet vulnerability protection are generally described in NENA-STA-010 [1]. In addition, NG9-1-1 Security is also discussed in NENA 75-001 NG9-1-1 Security (NG-SEC) [8], and NENA 75-002 NG9-1-1 Security Audit Checklist [9].

9.4 Recommendation for Additional Development Work

This is the first edition of this document. There are several sections where it is noted that further work is needed, and future editions will cover topics in more depth. The following table lists sections in this document that refer to possible future work.

Section	Reference for future work
4.2.1	Further work needs to be done around the ECRF/LVF gap/overlap detection mechanism as noted in the NENA i3 standard. In particular, it is not clear how to measure gaps versus intentional areas of no coverage. Work in the forest guide working group has reinforced necessity for this capability.
4.3	Text in this section pertaining to LVF may need to change as a result of work in process by the Location Validation Consistency Work Group, in particular with respect to optional GIS layers which may no longer be relevant for LVF attribute checking scenarios.
5.3.5	A 9-1-1 Authority may provision a GIS update to an LVF that causes a civic location in LIS to become wholly or partially invalid. This discrepancy may not be realized until the LIS performs a periodic revalidation. However, a 9-1-1 call may be placed from a device associated with the civic location before the periodic revalidation occurs, resulting in a 9-1-1 call misroute. Further work should be considered in this area.
5.4.2, 5.4.3	If an ECRF/LVF is allowed to reject certain changes, then there should be corresponding capability for a SI operator to override the rejection at the direction of the authoritative data source. However, such a mechanism is not currently described in the NENA i3 standard. In addition, operational impacts of a rejection breaking layer synchronization with a SI must be considered.
6	Per NENA-STA-010 [1] a Spatial Interface (SI) provides the OGC/WFS/ATOM GIS data provisioning feed mechanism for ECRF/LVF systems. As noted in NENA-STA-010 [1] this interface is based on an OGC engineering report that is not a standard. At this time it is believed the OGC document is insufficient for creating interoperable solutions. A future version of the OGC document or STA-010 [1] is required to define the protocol definitively. In the meantime, alternative GIS data provisioning mechanisms may emerge.
6.6	GIS data layers representing an ECRF/LVF coverage and/or a standardized data structure for ECRF/LVF coverage areas is needed.

6.4	Further work needs to be done around defining civic and geodetic representations of ECRF/LVF coverage areas, and also around describing and defining the mechanisms for provisioning or discovering ECRF/LVF coverage area representations. This is essential for ensuring the ability for routing between ECRF/LVF nodes in a tree.
6.4	Given a query to an area outside its coverage area, an ECRF/LVF may have the coverage regions of other ECRF/LVFs to which it could refer a query, or it would refer to a Forest Guide. Further work needs to be done to define rules for interpretation of civic and geodetic coverage areas, and for how to refer queries when there are ambiguities.
Various Sections	The document could be made clearer by adding diagrams showing relationships between ECRF/LVF, SI, and LIS systems, and GIS databases.

9.5 Anticipated Timeline

The collection and development of ECRF/LVF data must precede the implementation of ESInets. Ample time for ECRF/LVF data acquisition and development, including QA/QC, is essential to ensure the optimal performance of the ESInet. Based on the development of Wireless Phase 2 (WPH2) GIS data, it is estimated that ECRF/LVF GIS data acquisition and development could take from months to years, depending on the amount of data involved and the resources available at each site. Maintenance of ECRF/LVF geospatial data is an ongoing activity with no end date.

9.6 Cost Factors

Spatial call routing and location validation are new functions in NG9-1-1 that require high quality GIS data to operate correctly, and new NENA standards for GIS data are being developed concurrently with this document. The creation of compliant GIS data will be a significant undertaking and may incur substantial costs. In some cases, 9-1-1 entities may be able to leverage existing GIS datasets to reduce, but not eliminate these costs.

The provisioning of GIS data to ECRF/LVFs will require new processes to be developed and may require new capabilities to be added to existing systems. The choice of provisioning mechanism, the possible aggregation of data from multiple sources, and the extent of quality control and quality assurance procedures incorporated into these processes will all affect costs.

GIS data maintenance costs will be incurred on an ongoing basis. The scope of GIS data maintenance must include a process to rectify errors reported by service providers for locations believed to be valid, but which do not match authoritative GIS data. The

costs associated with data maintenance may vary substantially depending on the quality of the GIS data.

9.7 Cost Recovery Considerations

Traditionally, 9-1-1 data development and maintenance is one of several 9-1-1 cost components supported through the collection of fees and surcharges on wireline and wireless telephone service. This document assumes that the traditional funding mechanism is insufficient to address 1) the reduction in fee and surcharge collection due to changes in the telecommunications industry; and 2) the implementation and maintenance of a replacement 9-1-1 system.

9.8 Additional Impacts (non-cost related)

Except as noted below, the information or requirements contained in this NENA document are not expected to impact other NENA standards documents. This document makes extensive reference to NENA-STA-010, Detailed Functional and Interface Specification for the NENA i3 Solution – Stage 3 [1], managed by the VoIP/Packet Technical Committee Long Term Definition Working Group. NENA-STA-010 [1] is a normative reference for this document. No information or requirements put forth in this document modify or otherwise impact normative requirements described in NENA-STA-010 [1].

This document makes extensive reference to the NENA-STA-006 NG9-1-1 GIS Data Model [5]. NENA-STA-006 NG9-1-1 GIS Data Model [5] is normative for the NG9-1-1 GIS Data Model. No information or requirements put forth in this document modify or otherwise impact normative GIS data model requirements described in NENA-STA-006 NG9-1-1 GIS Data Model [5].

Similarly, NENA-STA-004, Next Generation 9-1-1 (NG9-1-1) United States (US) Civic Location Data Exchange Format (CLDXF) Standard [3] describes the minimum standard for civic address locations and their attributes. Nothing in this document is intended to change or modify this standard but instead to put it to good use.

In contrast, NENA-REQ-002 NG9-1-1 Data Management Requirements [4] defines requirements for discrepancies, audits, and reports associated with processes within the Next Generation 9-1-1 (NG9-1-1), including for ECRF/LVF systems. Information and requirements in section 5.4 of this document impact NENA-REQ-002 NG9-1-1 Data Management Requirements [4].

10 Abbreviations, Terms and Definitions

See the NENA Knowledge Base for a Glossary of terms and abbreviations used in NENA documents. Abbreviations and terms used in this document are listed below with their definitions.

<i>Term or Abbreviation (Expansion)</i>	Definition / Description
<i>ALI (Automatic Location Identification)</i>	The automatic display at the PSAP of the caller's telephone number, the address/location of the telephone and supplementary emergency services information of the location from which a call originates.
<i>ECRF (Emergency Call Routing Function)</i>	A functional element in NGCS (Next Generation Core Services) which is a LoST protocol server where location information (either civic address or geo-coordinates) and a Service URN serve as input to a mapping function that returns a URI used to route an emergency call toward the appropriate PSAP for the caller's location or towards a responder agency.
<i>EPSG (European Petroleum Survey Group)</i>	A group formed in 1986 comprised of specialist surveyors, geodesists and cartographers from Oil Companies based in Europe and having international operations, which maintains and publishes a data set of parameters for coordinate reference system and coordinate transformation description.
<i>ESInet (Emergency Services IP Network)</i>	An ESInet is a managed IP network that is used for emergency services communications, and which can be shared by all public safety agencies. It provides the IP transport infrastructure upon which independent application platforms and core functional processes can be deployed, including, but not restricted to, those necessary for providing NG9-1-1 services. ESInets may be constructed from a mix of dedicated and shared facilities. ESInets may be interconnected at local, regional, state, federal, national and international levels to form an IP-based inter-network (network of networks). The term ESInet designates the network, not the services that ride on the network.

<i>Term or Abbreviation (Expansion)</i>	Definition / Description
<i>ESRP (Emergency Services Routing Proxy)</i>	An i3 functional element which is a SIP proxy server that selects the next-hop routing within the ESInet based on location and policy. There is an ESRP on the edge of the ESInet. There is usually an ESRP at the entrance to an NG9-1-1 PSAP. There may be one or more intermediate ESRPs between them.
<i>GIS (Geographic Information System)</i>	A system for capturing, storing, displaying, analyzing and managing data and associated attributes which are spatially referenced.
<i>GPS (Global Positioning System)</i>	The Global Positioning System (GPS) is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
<i>HTTP (Hypertext Transfer Protocol)</i>	Hypertext Transport Protocol typically used between a web client and a web server that transports HTML and/or XML.
<i>HTTPS (Hypertext Transfer Protocol Secure)</i>	HTTP with secure transport (Transport Layer Security or its predecessor, Secure Sockets Layer)
<i>ICE (Industry Collaboration Event)</i>	A NENA testing event that brings together vendors in an open, supportive, and collaborative environment that foster a spirit of technical cooperation with a goal of accomplishing standards-based NG9-1-1.
<i>IETF (Internet Engineering Task Force)</i>	Lead standard setting authority for Internet protocols.
<i>IP (Internet Protocol)</i>	The method by which data is sent from one computer to another on the Internet or other networks.

<i>Term or Abbreviation (Expansion)</i>	Definition / Description
<i>LIS (Location Information Server)</i>	A Location Information Server (LIS) is a functional element that provides locations of endpoints. A LIS can provide Location-by-Reference, or Location-by-Value, and, if the latter, in geodetic or civic forms. A LIS can be queried by an endpoint for its own location, or by another entity for the location of an endpoint. In either case, the LIS receives a unique identifier that represents the endpoint, for example an IP address, circuit-ID or Media Access Control (MAC) address, and returns the location (value or reference) associated with that identifier. The LIS is also the entity that provides the dereferencing service, exchanging a location reference for a location value.
<i>LoST (Location to Service Translation) Protocol</i>	A protocol that takes location information and a Service URN and returns a URI. Used generally for location-based call routing. In NG9-1-1, used as the protocol for the ECRF and LVF.
<i>LVF (Location Validation Function)</i>	A functional element in an ESInet that is a LoST protocol server where civic location information is validated against the authoritative GIS database information. A civic address is considered valid if it can be located within the database uniquely, is suitable to provide an accurate route for an emergency call and adequate and specific enough to direct responders to the right location.
<i>MSAG (Master Street Address Guide)</i>	A database of street names and house number ranges within their associated communities defining Emergency Service Zones (ESZs) and their associated Emergency Service Numbers (ESNs) to enable proper routing of 9-1-1 calls.

<i>Term or Abbreviation (Expansion)</i>	Definition / Description
<i>NENA (National Emergency Number Association)</i>	NENA (National Emergency Number Association) is referred to as The 9-1-1 Association, which is fully dedicated to the continued improvement and modernization of the 9-1-1 emergency communication system. NENA's approach includes research, standards development, training, education, certification, outreach, and advocacy through communication with stakeholders. As an ANSI-accredited Standards Developer, NENA works with 9-1-1 professionals, public policy leaders, emergency services and telecommunications industry partners, like-minded public safety associations, and more. Current NENA activities center on awareness, documentation, and implementation for Next Generation 9-1-1 (NG9-1-1) and international three-digit emergency communication systems. NENA's worldwide members join with the emergency response community in striving to protect human life, preserve property, and maintain the security of all communities.
<i>OGC (Open Geospatial Consortium)</i>	A standards development organization that promulgates standards for the global geospatial community.
<i>PIDF-LO (Presence Information Data Format - Location Object)</i>	Provides a flexible and versatile means to represent location information in a SIP header using an XML schema.
<i>PSAP (Public Safety Answering Point)</i>	A physical or virtual entity where 9-1-1 calls are delivered by the 9-1-1 Service Provider.
<i>QA/QC (Quality Assurance / Quality Control)</i>	QA is the maintenance of data at a required level of quality through each step or process of preparation. QC is the system of maintaining standards during the development of data.

<i>Term or Abbreviation (Expansion)</i>	Definition / Description
<i>RCL (Road Centerline)</i>	A GIS feature that represents a centerline of a roadway. Each RCL segment has a beginning point, end point and consequently a direction of flow from beginning to end. A RCL typically has street number range information (High and Low) attributed to each segment in order to facilitate geocoding.
<i>RFC (Request for Comments)</i>	A document published by the Internet Engineering Task Force (IETF). Note that the name is a historic artifact — An RFC is finalized. RFCs are never revised; updates are published as new RFCs. Errata are noted separately. (Documents for which input and comments are requested are called Internet Drafts. Most RFCs are originally published as an Internet Draft).
<i>RSS (Really Simple Syndication)</i>	A method of using standard web feed formats to publish information using a standard XML file format.
<i>Service Mapping</i>	The end result of a LoST findService request to an ECRF which places a 9-1-1 call at exactly one location in a service area polygon for a PSAP (e.g., one address point in the Site/Structure Address Points layer, or a valid house number in the Road Centerlines layer). This term describes the mapping data elements (service region and associated URI) that are used by the ECRF to route a 9-1-1 call when requested by an ESRP or other ECRFs or endpoints.
<i>SI (Spatial Interface)</i>	A standardized interface between the GIS data and the functional elements that consume GIS data, such as the ECRF, LVF, Map Database Services, etc.
<i>SIP (Session Initiation Protocol)</i>	A protocol specified by the IETF (RFC 3261) that defines a method for establishing multimedia sessions over the Internet. Used as the call signaling protocol in VoIP, NENA i2 and NENA i3.

<i>Term or Abbreviation (Expansion)</i>	Definition / Description
<i>URI (Uniform Resource Identifier)</i>	An identifier consisting of a sequence of characters matching the syntax rule that is named <URI> in RFC 3986. It enables uniform identification of resources via a set of naming schemes. A URI can be further classified as a locator, a name, or both. The term "Uniform Resource Locator" (URL) refers to the subset of URIs that, in addition to identifying a resource, provides a means of locating the resource by describing its primary access mechanism (e.g., its network "location"). The term "Uniform Resource Name" (URN) has been used historically to refer to both URIs under the "urn" scheme [RFC2141], which are required to remain globally unique and persistent even when the resource ceases to exist or becomes unavailable, and to any other URI with the properties of a name. An example of a URI that is neither a URL nor a URN is sip:psap@example.com.
<i>URN (Uniform Resource Name)</i>	A type of URI. Uniform Resource Names (URNs) are intended to serve as persistent, location-independent, resource identifiers and are designed to make it easy to map other namespaces (which share the properties of URNs) into URN-space. An example of a URN is urn:service:sos.
<i>VEDS (Vehicle Emergency Data Set)</i>	A uniform data set for the collection and transmission of Advanced Automatic Collision Notification (AACN) data by automotive Telematics Service Providers (TSPs).
<i>VoIP (Voice over Internet Protocol)</i>	A technology that permits delivery of voice calls and other real-time multimedia sessions over IP networks.
<i>WFS (Web Feature Service)</i>	A web service that allows a client to retrieve and update geospatial data encoded in Geography Markup Language (GML).

11 Recommended Reading and References

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Members	Employer
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