Next Generation 9-1-1 GIS Data

Requirements for 2025 and Beyond

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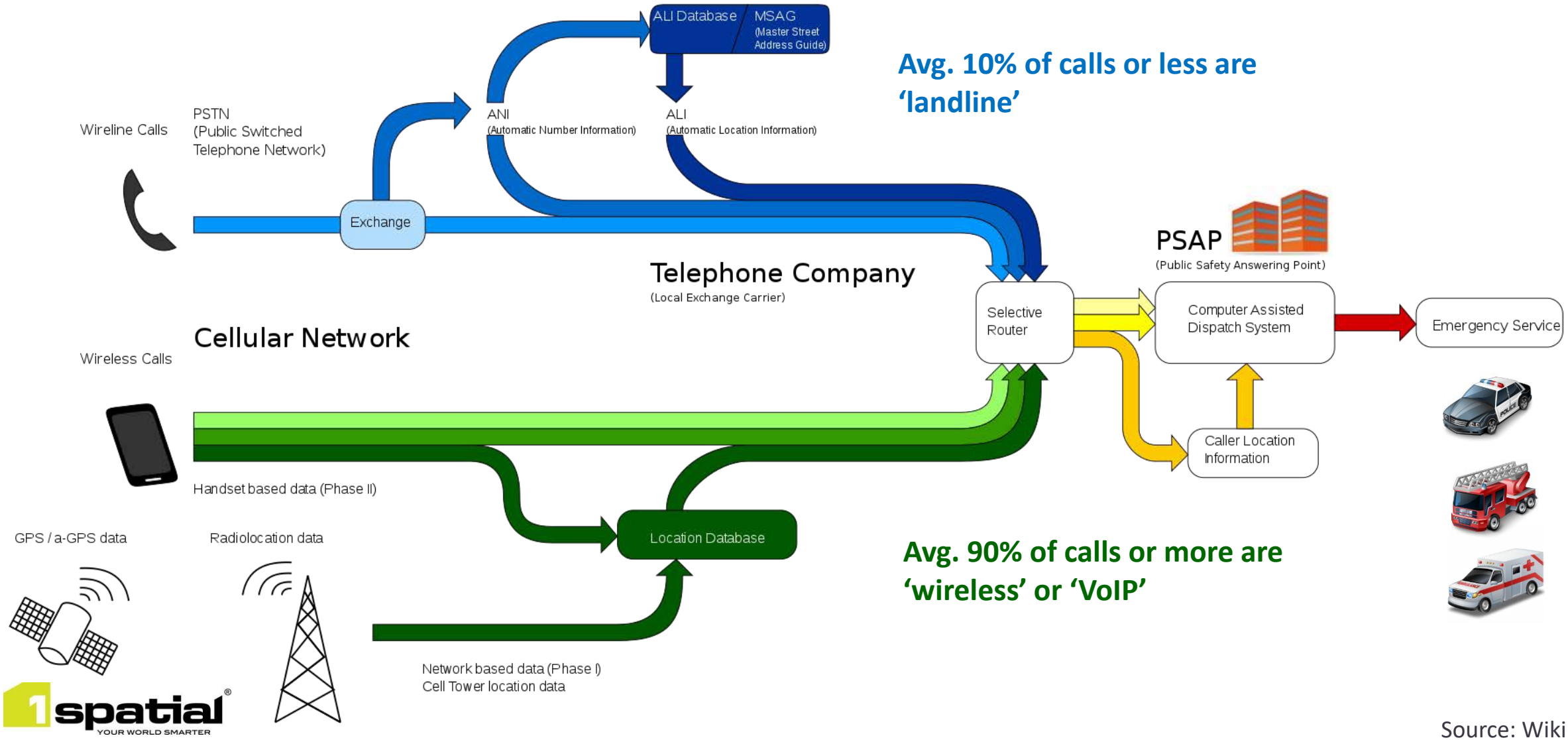
4512.27
7089.96
9326.36
9076.02
9557.54
7707.18
8631.16

9-1-1 Technology is Changing in the US

- **1968** – First 9-1-1 call made in in Haleyville Alabama.
- **1969** – Esri founded.
- **1973** – National policy setting aside 9-1-1 established.
- **1981** – first commercial GIS released (ARC/INFO).
- **2000** – 93% of US covered by 9-1-1 service.
- **2011** – First national 'Functional and Interface Standards' released for i3 (aka NG9-1-1)
- National migration from 'analog' networks to pure 'digital' now underway.
- We call this '**Next Generation 9-1-1**', or NG9-1-1 for short.
- Lots of opportunities and new capabilities will come to 3100+ counties and equivalents!
- Lots of challenges come with this change…

9-1-1 in Operation Today



Avg. 10% of calls or less are 'landline'

Avg. 90% of calls or more are 'wireless' or 'VoIP'

Source: Wikipedia

Key NG9-1-1 Terms in the Future

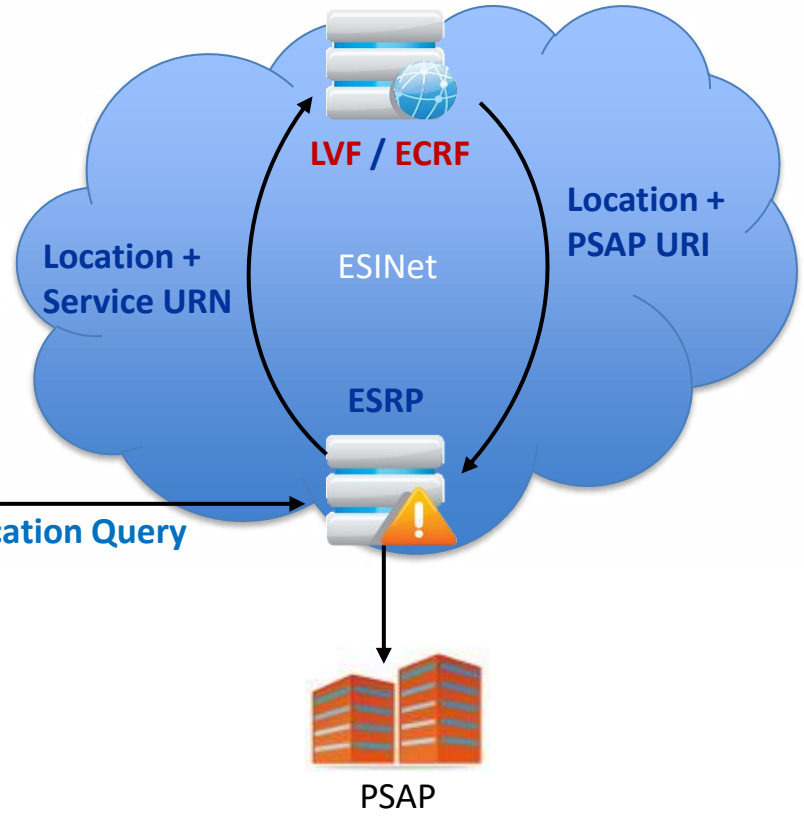
- PSAP is a **P**ublic **S**afety **A**nswering **P**oint.
- PIDF-LO (Presence Information Data Format – Location Object) will replace ALI with more location information that needs to match GIS.
- LVF validates all civic locations in data prior to inclusion in a LIS, ALI or LDB.
- ECRF provides real time PSAP routing instructions, and responder determination, for both location types.
- Civic Location has more detailed location elements than ALI.
- Geodetic Location refers to coordinates for latitude and longitude X / Y (later Z).
- Dispatchable Location, as defined by the FCC, but basically subaddressing.

Getting the Call to the PSAP

Location & Service

PIDF-LO + Service URN:
urn:service:sos

Service URN
(**U**niform **R**esource **N**ame)
Is the reference to the type of service needed.



Location & PSAP

PIDF-LO + PSAP URI:
sos@psap.austin.tx.us

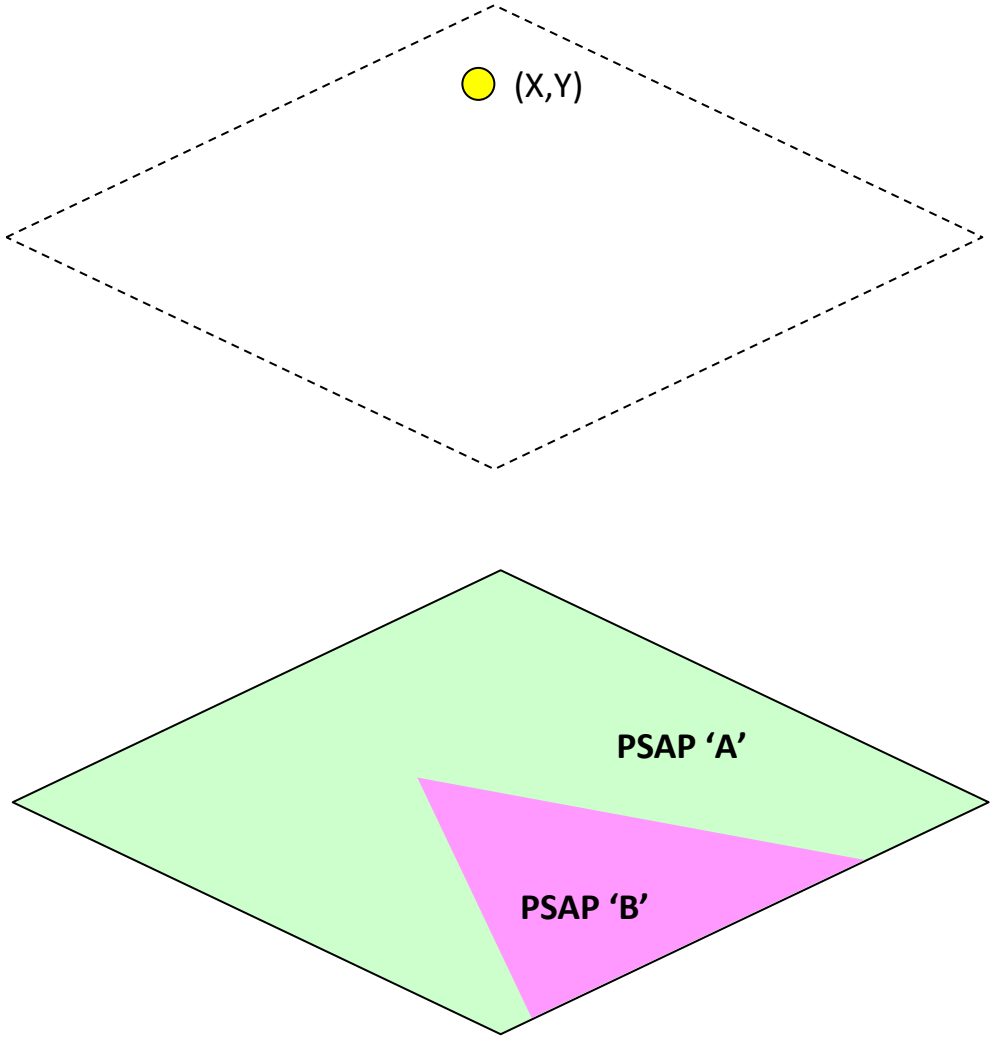
PSAP URI
(**U**niform **R**esource **I**dentifier)
Is the identifier of the PSAP to route the call to.

ECRF Conceptual Diagram

Geodetic Example:

Location (X, Y coordinates) is compared to the

Polygon layer representing PSAPs to route to.



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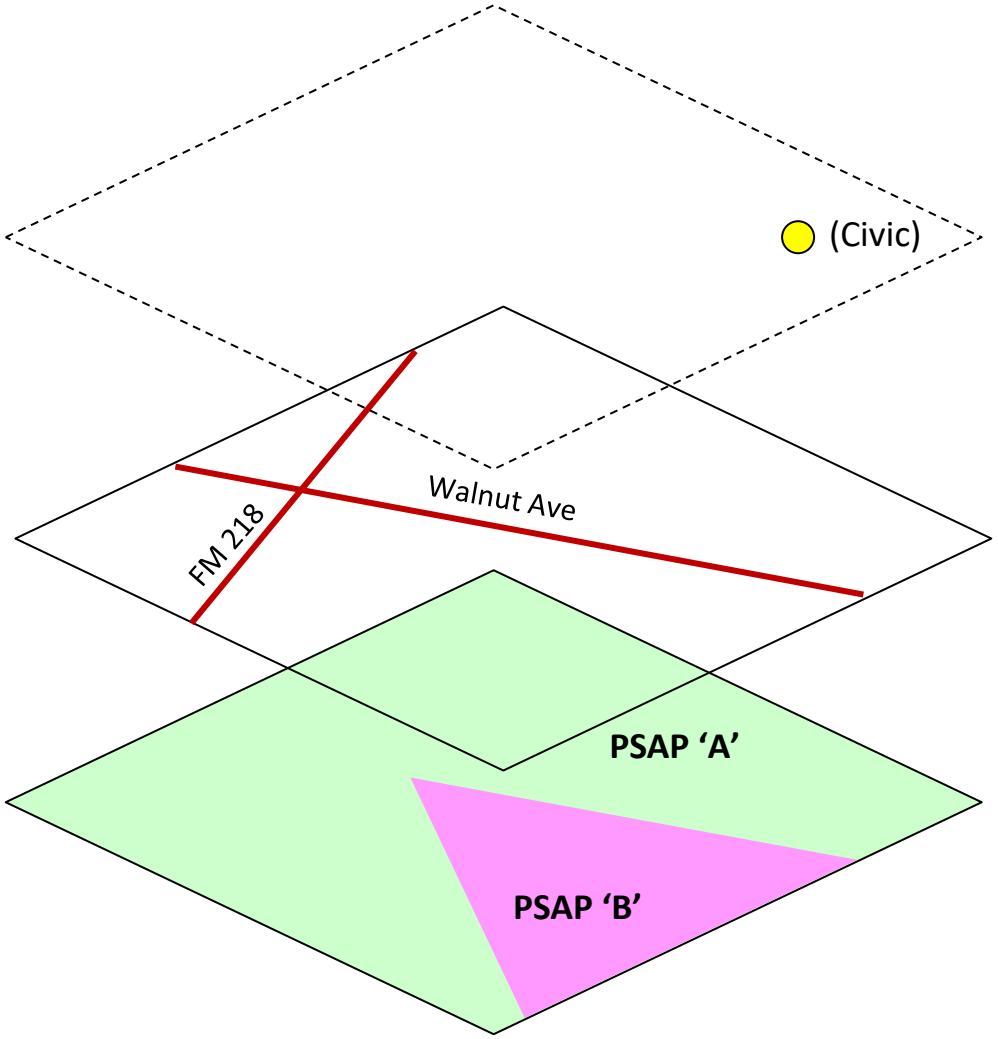
ECRF Conceptual Diagram

Civic Example 1:

Location geocoded to RCL layer then compared to the Polygon layer representing PSAPs to route to.



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FCC Driver for Better Location Determination in 9-1-1

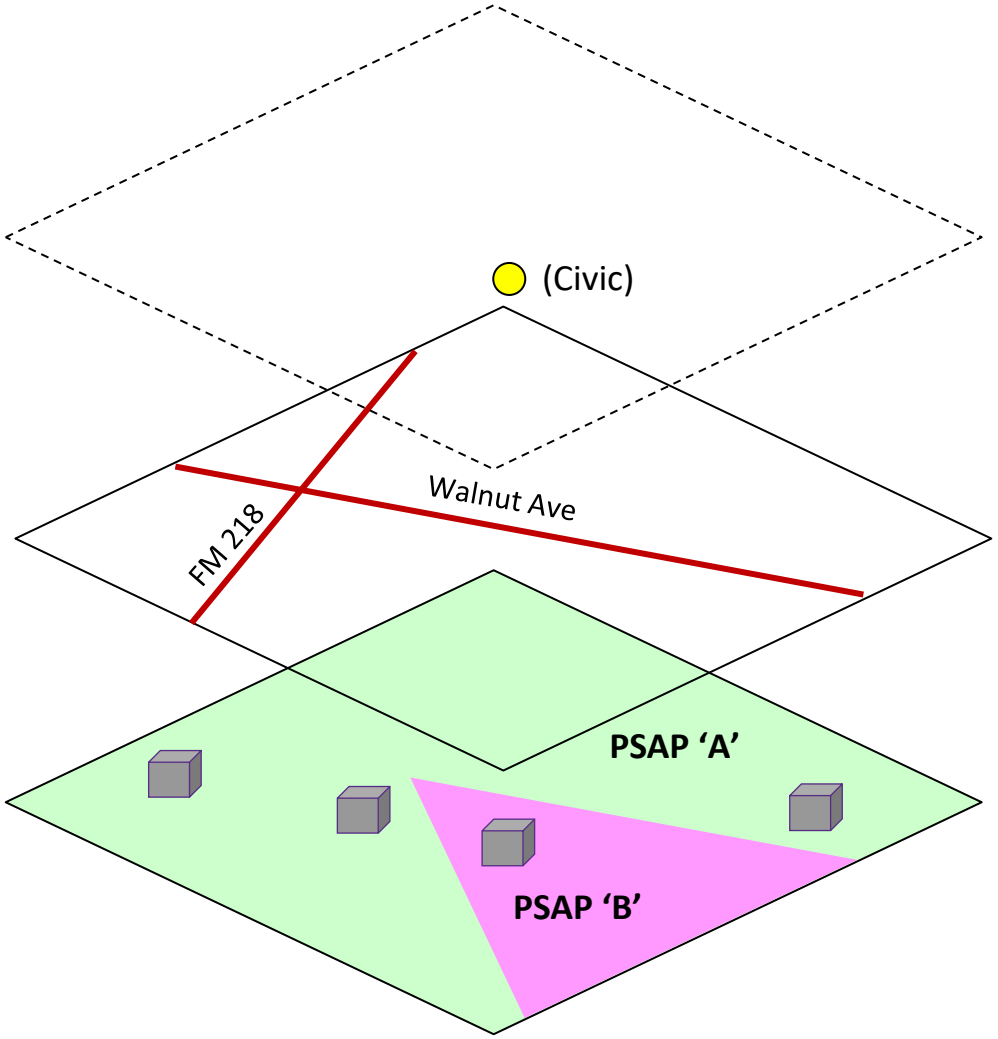
- November 2014 ‘Roadmap’ agreement established between NENA, APCO, 4 CMRS providers.
- FCC 4th report released February 3, 2015 (**FCC 15-9**).
- **FCC15-9** details new accuracy requirements for:
  - Outdoor horizontal location accuracy (X / Y)
  - Indoor horizontal location accuracy (X / Y)
  - Vertical accuracy (Z)
  - Defines ‘Dispatchable Location’ (Subaddressing)
  - National Emergency Address Database (NEAD)

ECRF Conceptual Diagram

Civic Example 2:

Location geocoded to a Site / Structure or Address Point layer then compared to the Polygon layer representing PSAPs to route to.

Only way to handle Dispatchable Location.



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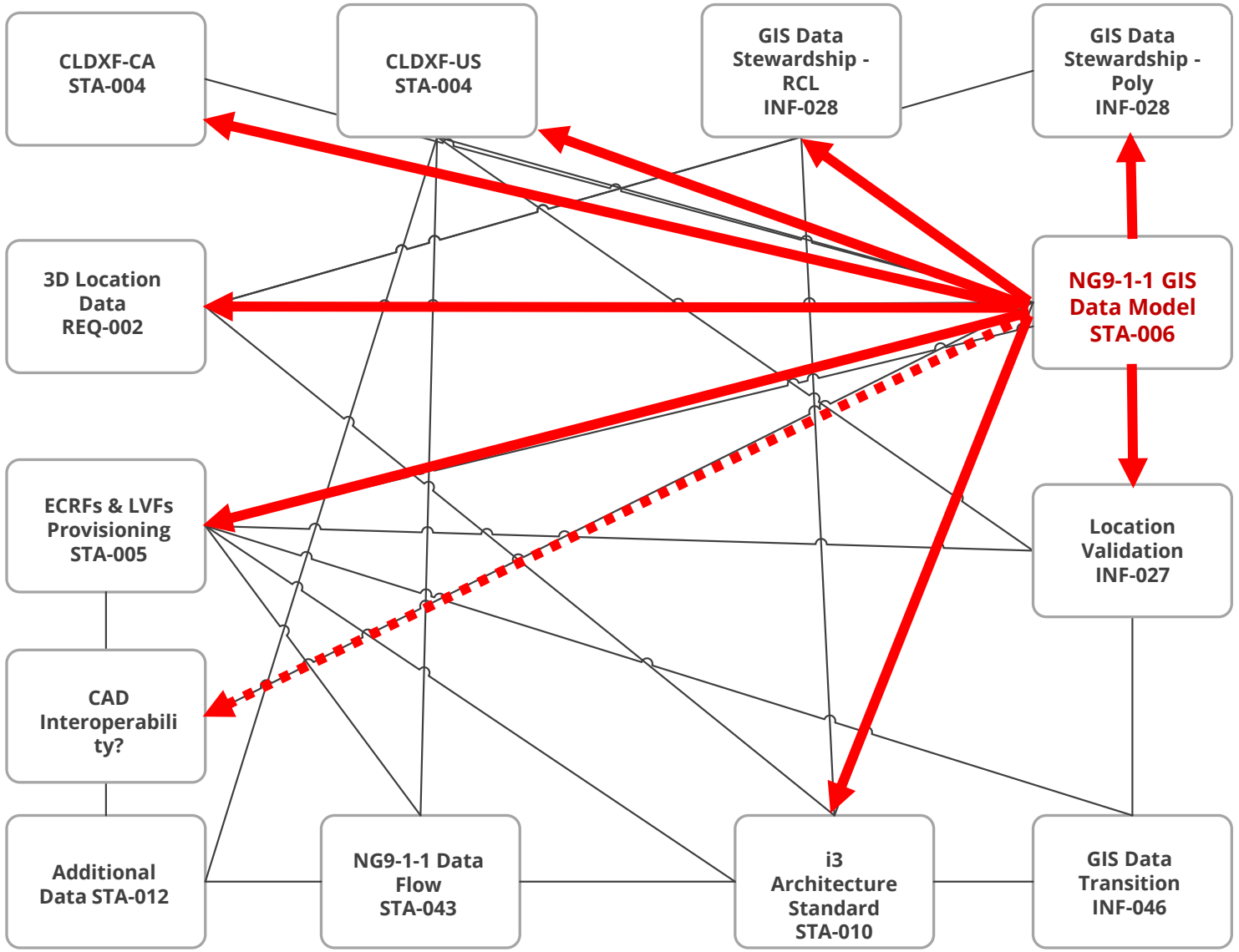
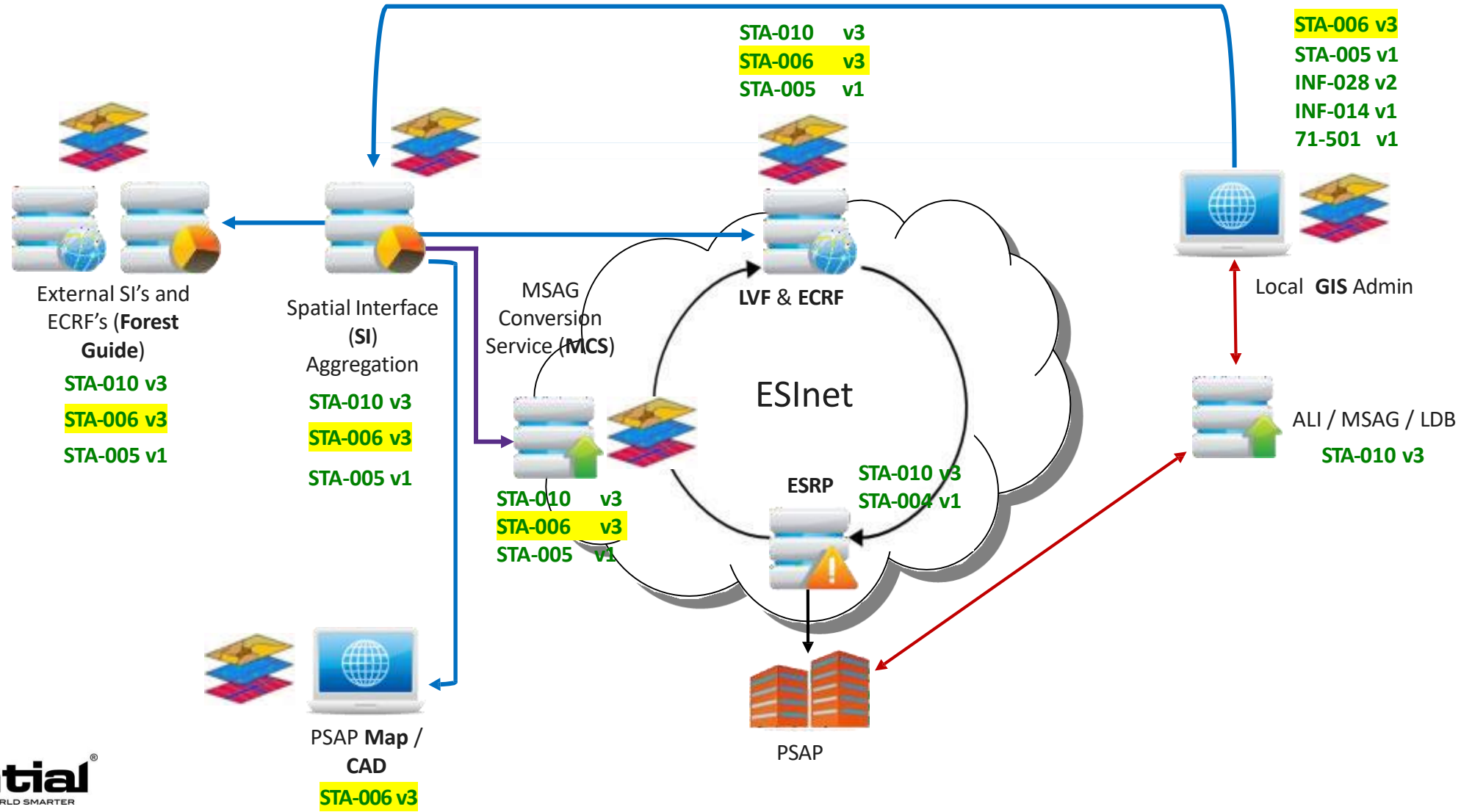
NENA Document Dependencies



Source: NENA

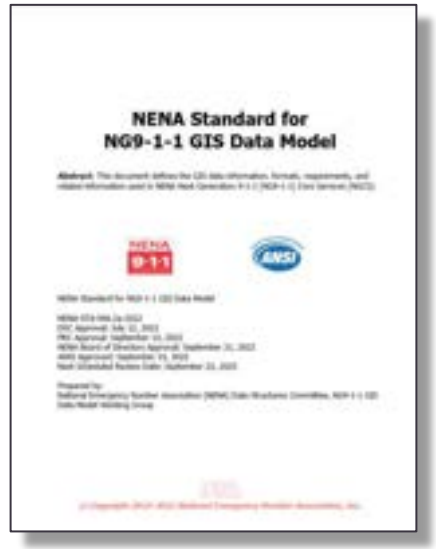
NG9-1-1 GIS Data Related Documents for Functional Elements



Source: NENA

i3 Architecture and NG9-1-1 GIS Data Model Standards

- **NENA-STA-010** i3 Standard for Next Generation 9-1-1 and **NENA-STA-006** Standard for NG9-1-1 GIS Data Model
- Sections regarding GIS data use in i3 v3:
  - Section 3.6 Spatial Interface for Layer Replication
  - Section 3.7 Discrepancy Reporting (**DR**)
  - Section 4.3 **ECRF** and **LVF**
  - Section 4.4 MSAG Conversion Service (**MCS**)
  - Section 4.5 Geocode Service (**GCS**)
  - Section 4.13 Forest Guide (**FG**)
  - Section 4.19 Map Data Service (**MDS**)
  - Section 10.32 GIS Data Layers Registry **51 at the present time**



Source: NENA

GIS Data Model v3 Standard - SSAP Schema Example

'Required' = An attribute value MUST be provided for the data field for each record. The data field MUST NOT be blank.

'Conditional' = If an attribute value exists, it MUST be provided. If no value exists for the attribute, the data field is left blank.

Table 4-3 SiteStructureAddressPoint Layer

Descriptive Name	Field Name	Required	Type	SubType
Discrepancy Agency ID	DiscrpAgID	Yes	TEXT (100)	P
Date Updated	DateUpdate	Yes	DATETIME	-
Effective Date	Effective	No	DATETIME	-
Expiration Date	Expire	No	DATETIME	-
NENA Globally Unique ID	NGUID	Yes	TEXT (254)	P
Country	Country	Yes	TEXT (2)	P
Administrative Level 1	A1	Yes	TEXT (2)	P
Administrative Level 2	A2	Conditional	TEXT (254)	P
Additional Code	AddCode	Conditional	TEXT (6)	P
Administrative Level 3	A3	Conditional	TEXT (254)	P
Administrative Level 4	A4	Conditional	TEXT (254)	P
Administrative Level 5	A5	Conditional	TEXT (254)	P
Address Number Prefix	AddNum_Pre	Conditional	TEXT (15)	P
Address Number	Add_Number	Conditional	INTEGER	-
Address Number Suffix	AddNum_Suf	Conditional	TEXT (15)	P
Address Number Complete	AddNum_Cmp	Conditional	TEXT(42)	P
Distance Marker	DistMarker	Conditional	TEXT (150)	P
Street Name Pre Modifier	St_PreMod	Conditional	TEXT (25)	P
Street Name Pre Directional	St_PreDir	Conditional	TEXT (10)	P
Street Name Pre Type	St_PreTyp	Conditional	TEXT (50)	P
Street Name Pre Type Separator	St_PreSep	Conditional	TEXT (20)	P
Street Name	St_Name	Conditional	TEXT (254)	P
Street Name Post Type	St_PosTyp	Conditional	TEXT (50)	P
Street Name Post Directional	St_PosDir	Conditional	TEXT (10)	P
Street Name Post Modifier	St_PosMod	Conditional	TEXT (25)	P
Legacy Street Name Pre Directional*	LSt_PreDir	Conditional	TEXT (2)	P
Legacy Street Name*	LSt_Name	Conditional	TEXT (75)	P
Legacy Street Name Type*	LSt_Typ	Conditional	TEXT (4)	P
Legacy Street Name Post Directional*	LSt_PosDir	Conditional	TEXT (2)	P
ESN*	ESN	Conditional	TEXT (5)	P
MSAG Community Name*	MSAGComm	Conditional	TEXT (30)	P
Legacy County ID*	LCountyID	Conditional	TEXT (5)	P
Postal Community Name	Post_Comm	No	TEXT (40)	P
Postal Code	Post_Code	No	TEXT (7)	P
Postal Code Extension	PostCodeEx	Conditional	TEXT (4)	P
Site	Site	No	TEXT (254)	P
SubSite	SubSite	No	TEXT (254)	P
Floor Label	Floor	No	TEXT (75)	P
Floor Index	FloorIndex	No	INTEGER	-
Wing	Wing	No	TEXT (75)	P
Unit	Unit	Conditional	TEXT (75)	P
Unit Pre Type	UnitPreTyp	Conditional	TEXT (75)	P
Unit Value	UnitValue	Conditional	TEXT (75)	P
Section	Section	No	TEXT(75)	P
Row	Row	No	TEXT(75)	P
Room	Room	No	TEXT (75)	P
Seat	Seat	No	TEXT (75)	P
Location Marker	LocMarker	No	TEXT(100)	P
Additional Location Information	Addtl_Loc	No	TEXT (225)	P
Additional Data URI	AddDataURI	No	TEXT (254)	U
Place Type	Place_Type	Conditional	TEXT (50)	P
Placement Method	Placement	No	TEXT (25)	-
Longitude	Longitude	No	REAL (11,7)	-
Latitude	Latitude	No	REAL (10,7)	-
Elevation	Elevation	No	REAL (9,3)	-

Routable Location

MCS Conversion

Dispatchable Location

Altitude, Height, Elevation

Data Model v3 – Sample Attribute Definitions

5.27 Altitude

Description: The measure of the orthogonal distance from the WGS84 ellipsoid, given in meters. For Site/Structure Address Points, Altitude measures the orthogonal distance from the WGS84 ellipsoid to the surface (such as a floor or ground).
Domain: Restricted to a double-precision floating point number with a precisio nine and a scale of three (e.g., REAL (9,3)).
Example: "75.000" representing the altitude (in meters) associated with the address "123 Main Street, Suite 401"
Note: WGS84 (GPS) altitude, also known as the Z Coordinate, is measured as distance above or below the ellipsoid, which varies significantly from the geoid (approximately mean sea level). For more information, see NENA Requirements 3D Location Data for E9-1-1 and NG9-1-1, NENA-REQ-003 [24].

5.57 Left FROM Address Number

Description: In the RoadCenterLine layer, each feature has a begin point and an endpoint. The FROM Node is the begin point while the TO Node is the endpoint. Each has a left side and a right side relative to a begin node and an end node. The Left FROM address is the address number on the left side of the road segment relative to the FROM Node.
Domain: None
Example: See Figure 5-2 below
Business Rules: CLDXF-US [4]: Yes; CLDXF-CA [23]: Yes

Figure 5-2 Example of Left FROM and Left TO Addresses

Section 5 - Description of Field Names and Associated Attribute Data includes:

- Description of the data attribute
- The data attribute domain
- Examples of the attribute in use
- Business rules for the attribute
- Notes, if applicable

Source: NENA

GIS Data Model v3 Standard – Service Boundaries

- Each PSAP Boundary defines the geographic area of a PSAP(s) that has primary responsibilities for an emergency request.
- Used by the ECRF to perform a geographic query, using incoming 'geodetic' or 'civic' location information, to determine PSAP routing.
- Also defines geographic area of response services ('**Police**', Fire, EMS).
- Used by the ECRF to perform a geographic query, using incoming 'geodetic' or 'civic' location information, to determine which Emergency Service Responders are responsible for the call location.

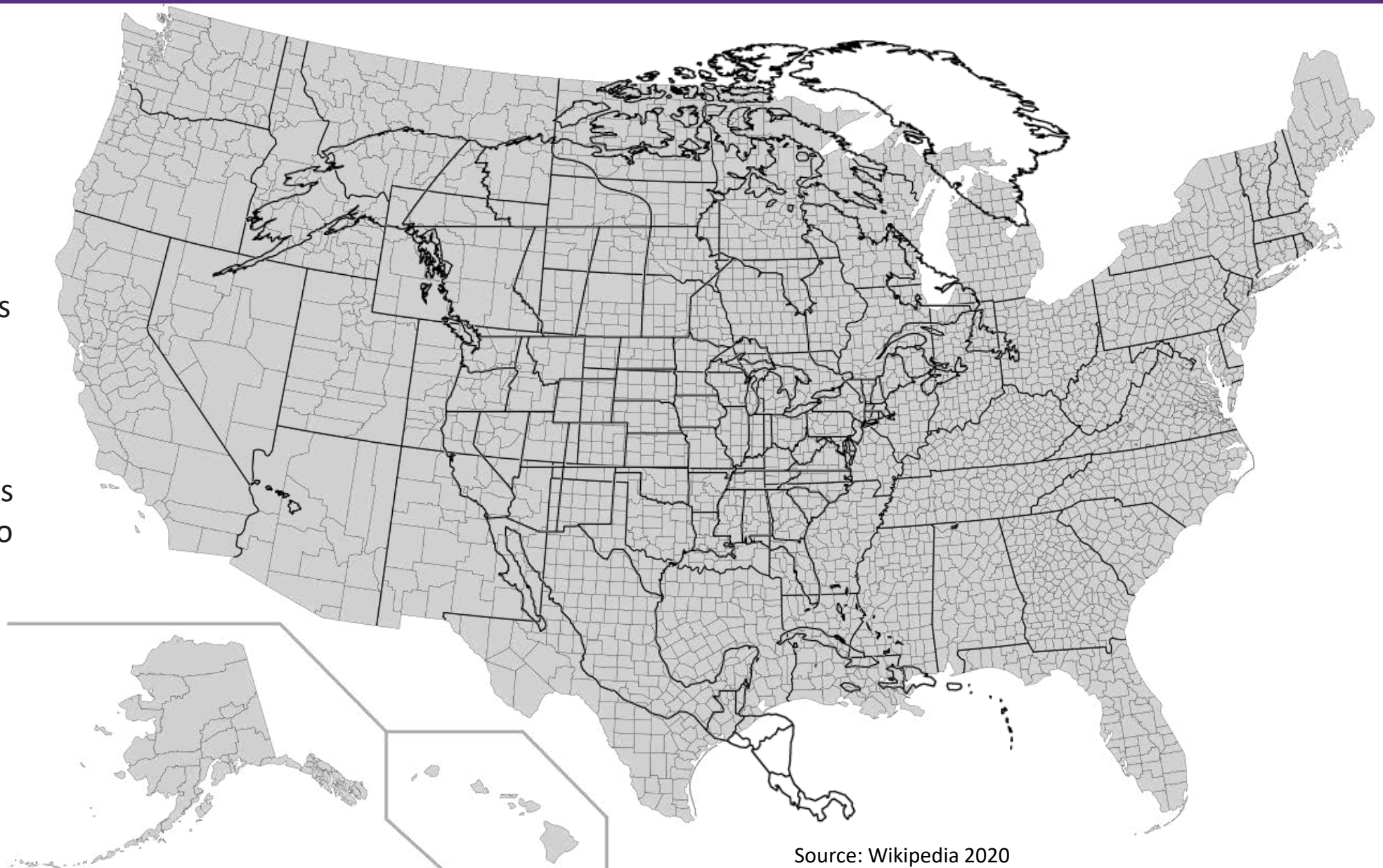
Table 4-7 Service Boundary Layers

Descriptive Name	Field Name	Required	Type	SubType
Discrepancy Agency ID	DiscrpAgID	Yes	TEXT (100)	P
Date Updated	DateUpdate	Yes	DATETIME	-
Effective Date	Effective	No	DATETIME	-
Expiration Date	Expire	No	DATETIME	-
NENA Globally Unique ID	NGUID	Yes	TEXT (254)	P
Agency Identifier	Agency_ID	Yes	TEXT (100)	P
Service URI	ServiceURI	Yes	TEXT (254)	U
Service URN	ServiceURN	Yes	TEXT (100)	U
Service Number	ServiceNum	No	TEXT (15)	P
Agency vCard URI	AVcard_URI	Yes	TEXT (254)	U
Display Name	DsplayName	Yes	TEXT (60)	P

Source: NENA

County and State Lines For NG9-1-1

- 3,243 Counties (including 136 county equivalents and District of Columbia).
- National, State and County boundary lines are essential for NG9-1-1 GIS data work.
- Gaps and overlaps ‘between’ jurisdictions are now a challenge to resolve and require more coordination.



Source: Wikipedia 2020

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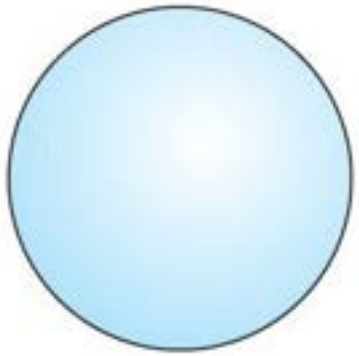
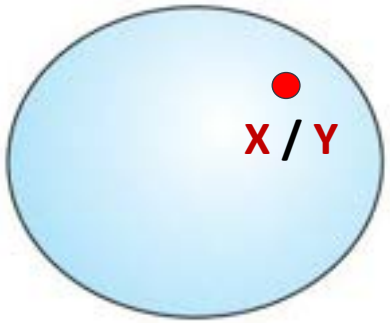
What is a Datum and Why You Need to Know

- In a GIS, a ‘Spheroid’ mathematically approximates the shape of the Earth. (Earth is not a sphere)
- A ‘Datum’ defines the position of a spheroid relative to the center of the Earth.
- Datums are needed by a GIS to perform horizontal and vertical calculations (ex. plotting wireless calls).
- The NAD83 datum replaced NAD27 and is the most common datum in 9-1-1.



Sphere



Spheroid
(Ellipsoid)

Term	Description
Altitude	The measurement of the device's orthogonal distance from WGS84 ellipsoid. Often referred to as "Height Above Ellipsoid" (HAE). This is equivalent to the term "Z Coordinate" in previous editions of the NENA Master Glossary.
Elevation	The orthogonal distance of the Earth's surface from the WGS84 ellipsoid at a provided location and the ground level's altitude. Sometimes referred to as ‘above sea level’.
Height	The distance between Elevation and Altitude for a given location; is often referred to as "Height Above Ground Level" (AGL).

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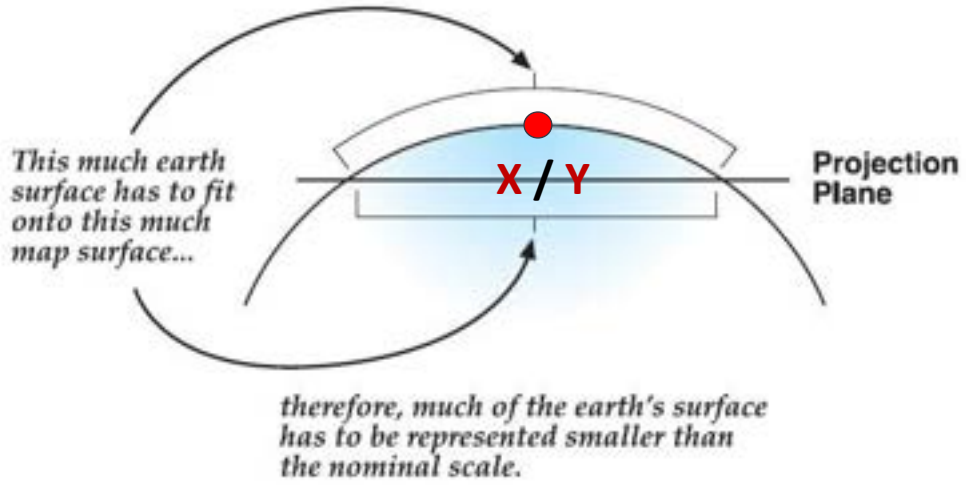
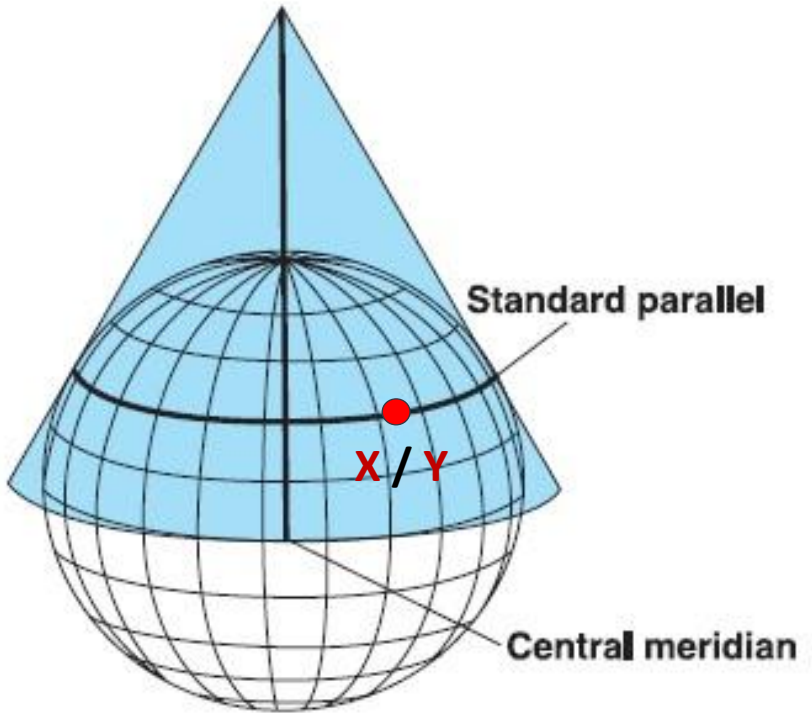
Esri ‘Understanding Map Projections’ 2000

OK, So What is a Projected Coordinate System Then?

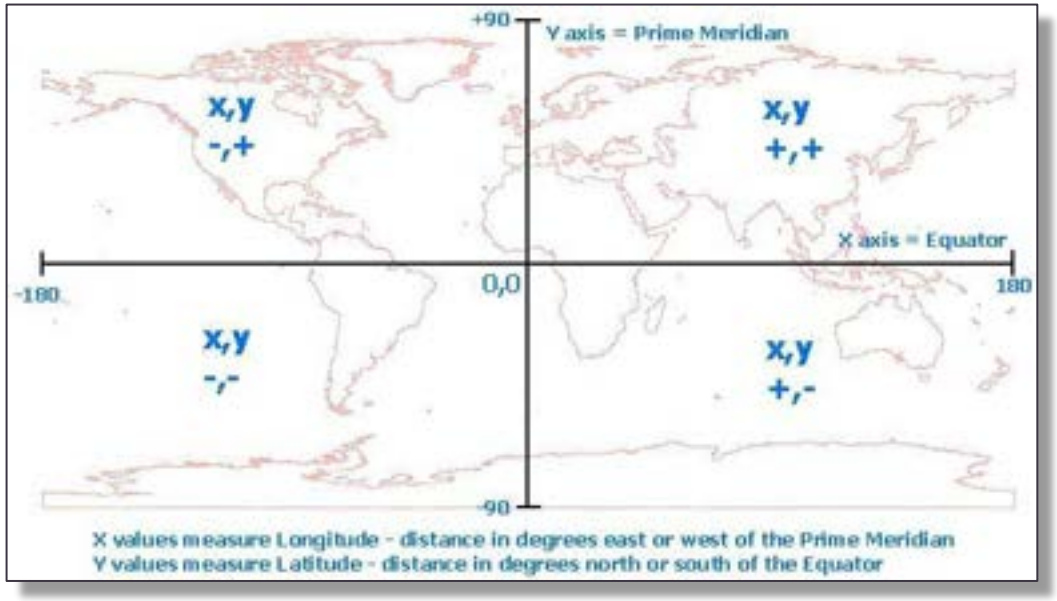
- To minimize geometric distortion for a specific area, an appropriate ‘projected coordinate system’ is selected in a GIS (ex. State Plane), which works in conjunction with a datum (ex. NAD83)



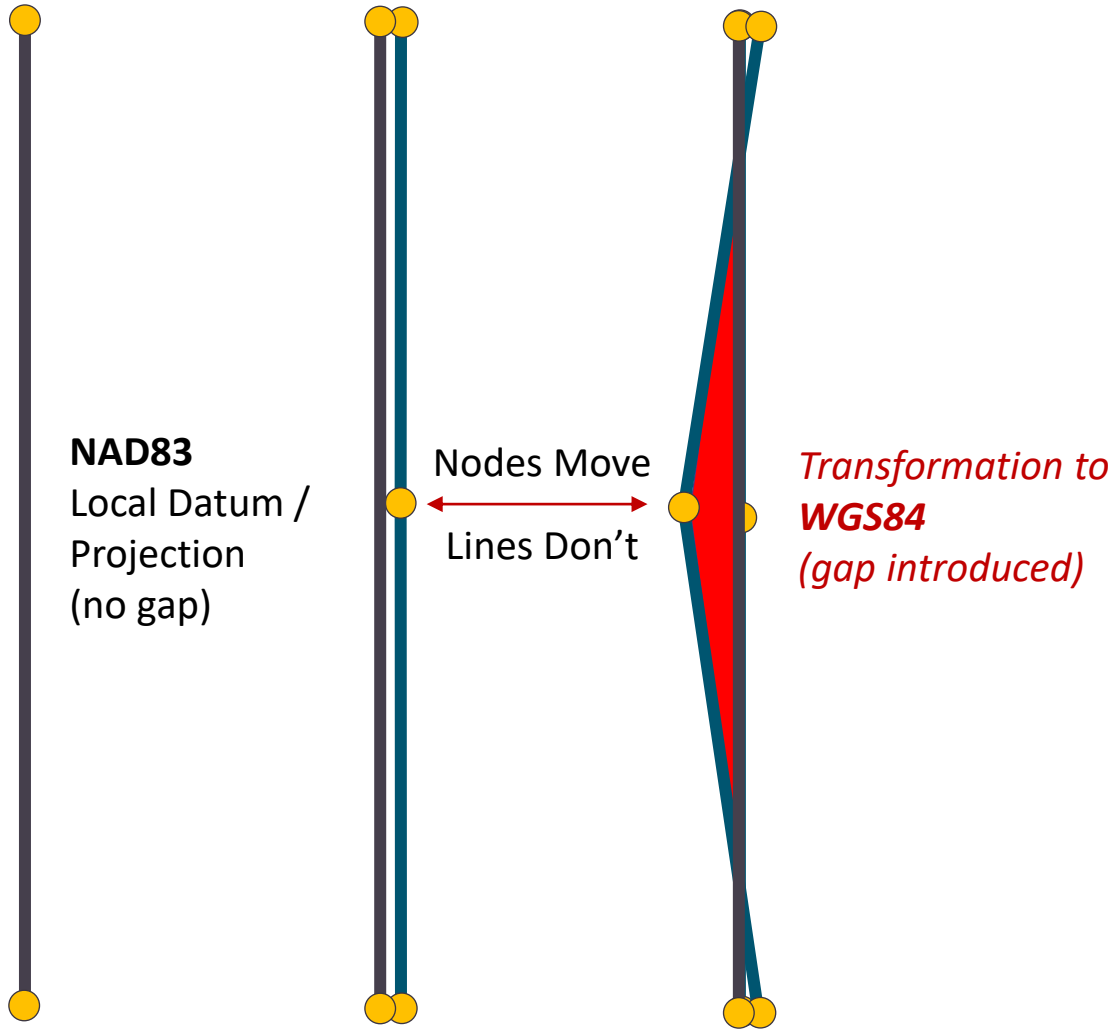


Esri ‘Understanding Map Projections’ 2000

Polygon Edge Alignment



- **ALL NGCS GIS Data** must be converted into WGS84 format for use in NGCS systems.
- Coincident boundary lines should line up by vertices.
- ArcGIS has tools that can help facilitate this.
- Commercial QC tools can check for problems with this.
- It's about the geometry!



Validation & 'Civic' Tabular Searches

PIDF-LO Element	CLDXF Element
country	Country
A1	State
A2	County
A3	Incorporated Municipality
A4	Unincorporated Community
A5	Neighborhood Community
RD	Street Name
PRM	Street Name Pre Modifier
PRD	Street Name Pre Directional
STP	Street Name Pre Type
STPS	Street Name Pre Type Separato
STS	Street Name Post Type
POD	Street Name Post Directional
POM	Street Name Post Modifier
HNO	Address Number
HNP	Address Number Prefix
HNS	Address Number Suffix
MP	Milepost
BLD	Building
LOC	Additional Location Information
FLR	Floor
UNIT	Unit
ROOM	Room
SEAT	Seat
PCN	Postal Community Name
PC	Postal Code
LMK	Complete Landmark Name
LMKP	Landmark Name Part
PLC	Place Type

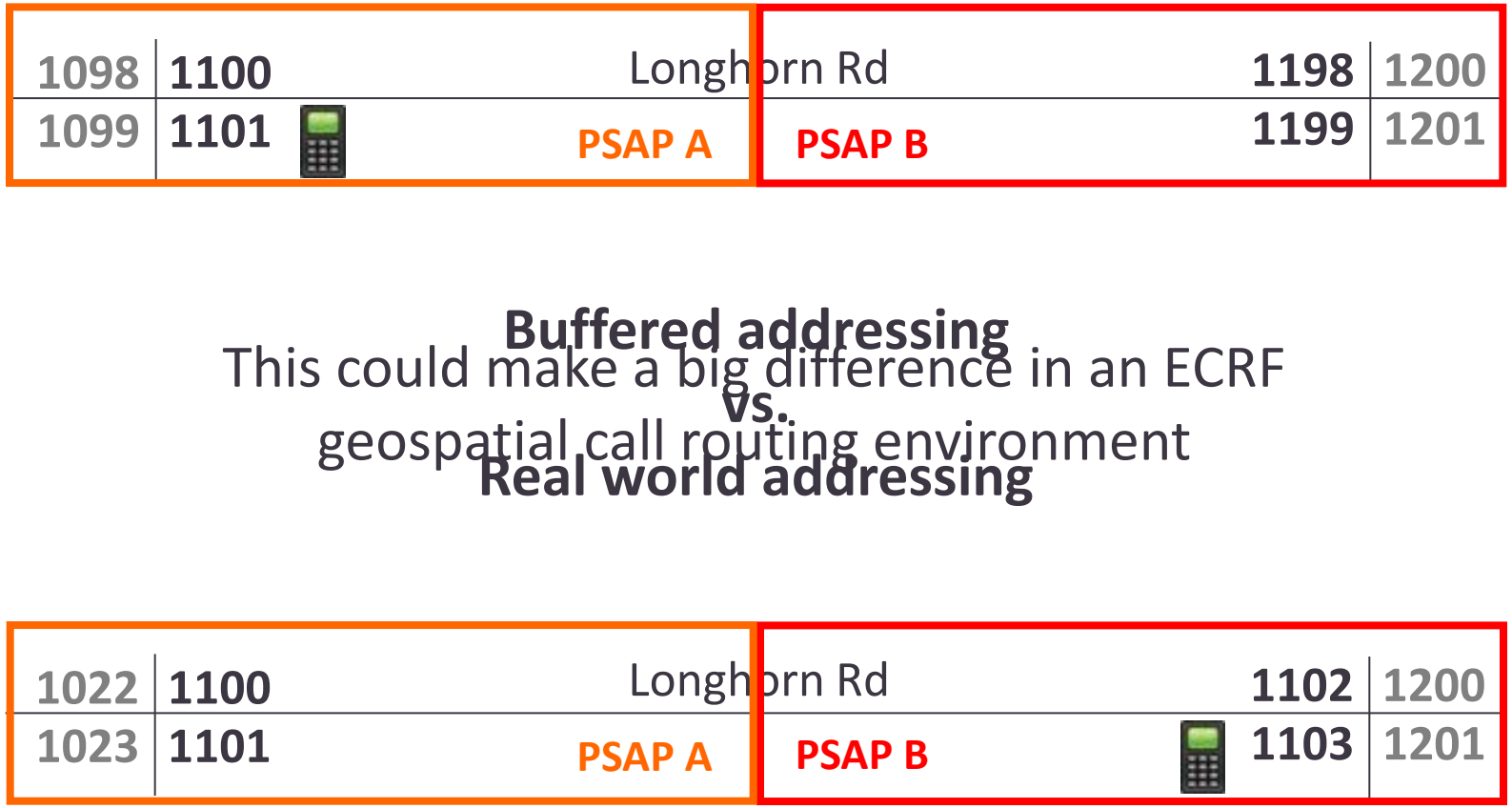
Validation and search hierarchy

PIDF-LO	Description	Example (fictional)
<Country>	2-letter ISO code	US
<A1>	State	NY
<A2>	County	Kings County
<A3>	Incorporated Municipality	New York
<A4>	Unincorporated Community	Manhattan
<A5>	Neighborhood Community	Morningside Heights
<RD>	Street Name	Broadway
<PRM>	Street Name Pre Modifier	
<PRD>	Street Name Pre Directional	
<STP>	Street Name Pre Type	
<STPS>	Street Name Pre Type Separator	
<STS>	Street Name Post Type	Avenue
<POD>	Street Name Post Directional	North
<POM>	Street Name Post Modifier	Extension
<HNO>	Address Number	123

Example: PIDF_LO Content

NOTE: HNO = Address Number (per RFC 5139)

Road centerline Address Ranges for NG9-1-1 Call Routing



Where will ‘1103 Longhorn Rd’ route?

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i3 Architecture Standard Geocode Service (GCS)

- Section 4.5 describes a web service that provides geocoding and reverse-geocoding as two function calls:
  - **Geocode**: which takes a PIDF-LO, as described in RFC 4119, and updated by RFC 5139 and RFC 5491, which contains a civic address, and returns a PIDF-LO containing a geodetic representation for the same location.
    - Locates a civic address, represented by the input PIDF-LO, by finding a match in its site/structure address points or road centerlines, and uses the matching feature to obtain a geodetic location that represents the civic address. It constructs a PIDF-LO with the geodetic location.
  - **ReverseGeocode**: which takes a PIDF-LO as described in RFC 4119 and updated by RFC 5139 and RFC 5491, which contains a geodetic representation, and returns a PIDF-LO that contains a civic address for the same location.
    - The ReverseGeocode function works in the same manner. It converts geodetic representation of the location to civic address in PIDF-LO format.
- The GeoCode Service is provisioned using the same mechanism as is used to provision the ECRF and LVF: layer replication from the master SI.

Source: NENA

GIS Data Model v3 Standard – NENA Global Unique ID (NGUID)

- NENA Global Unique IDs (NGUIDs) must required for all GIS data in NG 9-1-1. (Section 3.6)
- Format recommended in the GIS Data Model:
  - **Uniform Resource Name or URN** *(ex. urn:emergency:uid:gis)* – standardized unique prefix defines class of IDs associated with GIS data. Data provisioning entities maintain local Unique ID numbers for all features in their GIS.
  - **Layer Indicator** *(ex. RCL)* – shorter name for the GIS data layer to which the features are associated, as defined by the 'GIS Data Layers Registry' in the i3 standard NENA STA 010.
  - **Local Unique ID** *(ex. AD873541 F41C 409E A0BE 1B0C583902A4)* – a GIS numeric and/or text "locally assigned ID,". Local ID MUST be unique within dataset for all features associated with a specific Agency Identifier.
  - **Agency Identifier** *(ex. nortexrpc.org)* – a fully qualified domain name (FQDN) representing the GIS Data Provider "Agency." Agency is as defined in NENA STA 010. FQDN is obtained from Domain Name System (DNS) registrar.
- Example: **urn:emergency:uid:gis: RCL: {AD873541 F41C 409E A0BE 1B0C583902A4}: nortexrpc.org**

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Source: NENA

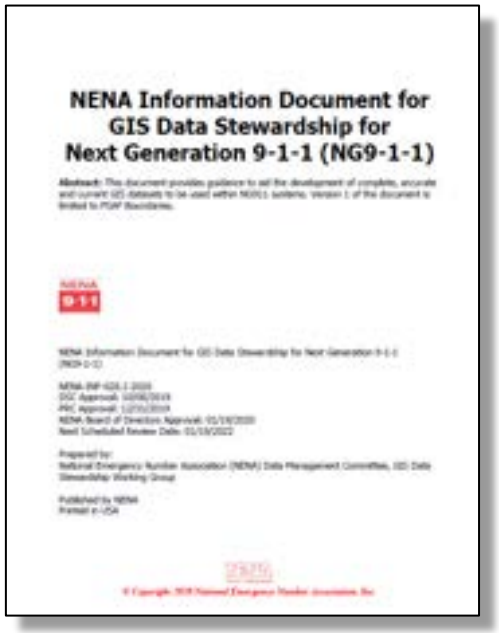
Data Model v3 – 3D GIS Support

- Following the guidance created and provided in the NENA 3D REQ Document:
  - Added Vertical Measurement Terms (Altitude, Height) and updated Elevation
  - Added “Floor Index”
  - Updated SSAP Placement Method Registry to accommodate 3D GIS Requirements
  - Added initial support for 3D building shapes (2D Address Polygons)

Source: NENA

NG9-1-1 GIS Data Stewardship for NG9-1-1

- Current version of **NENA-INF-028.2-2021** covers:
  - Section 4: General Requirements
    - Accuracy (Horizontal & Vertical)
    - Database Precision
  - Section 5: Civic Location Layers
    - Road Centerlines
    - Phased Approach for Creation
  - Section 6: Service Boundary Layers
    - ESNs/ESZs
    - PSAPs
    - Law, Fire, EMS
    - Phased Approach for Creation
  - Section 7: Long Term Maintenance of NG9-1-1 GIS Data
    - Road Centerlines
    - Service Boundaries
- Site, Structure, and Address Point (SSAP) Best Practices WG to follow (Date TBD).


NENA Information Document for GIS Data Stewardship for Next Generation 9-1-1 (NG9-1-1)

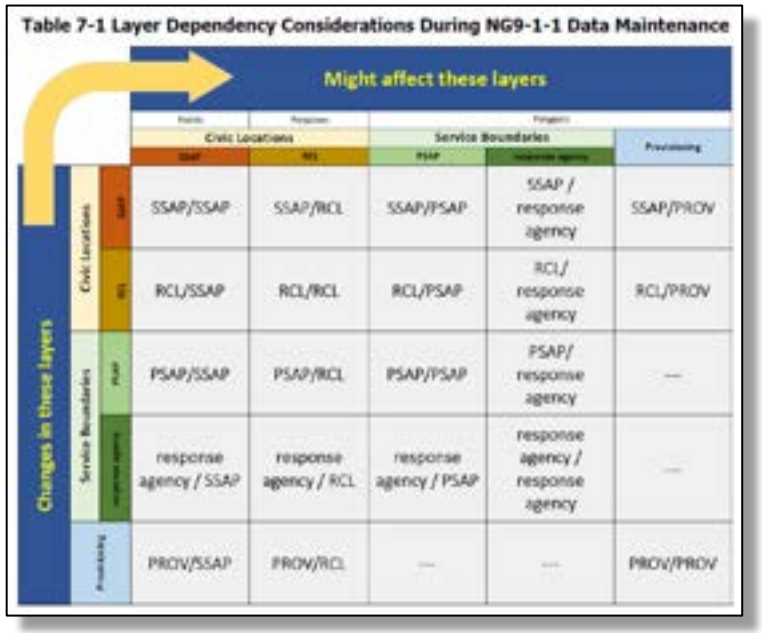


Table 7-1 Layer Dependency Considerations During NG9-1-1 Data Maintenance

Might affect these layers

Changes in these layers	Civic Locations: SSAP	Civic Locations: RCL	Service Boundaries: PSAP	Service Boundaries: response agency	Provisioning
Civic Locations: SSAP	SSAP/SSAP	SSAP/RCL	SSAP/PSAP	SSAP / response agency	SSAP/PROV
Civic Locations: RCL	RCL/SSAP	RCL/RCL	RCL/PSAP	RCL/ response agency	RCL/PROV
Service Boundaries: PSAP	PSAP/SSAP	PSAP/RCL	PSAP/PSAP	PSAP/ response agency	—
Service Boundaries: response agency	response agency / SSAP	response agency / RCL	response agency / PSAP	response agency / response agency	—
Provisioning	PROV/SSAP	PROV/RCL	—	—	PROV/PROV

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Source: NENA

Geometry Stewardship Considerations Covered

- When and where to split.
- Single and multiple Polygons.
- Cul-de-Sacs / Coves.
- Driveways.
- Geometry of intersections.
- Digitized direction.
- ‘Spatial’ gaps and overlaps.
- ‘Range’ gaps and overlaps.
- ‘Potential’ vs ‘Actual’ ranges.
- Right and left side vs jurisdictions.
- Coincident vs parallel geometry.
- Ramps and frontage roads.
- Snap-to-points for intergovernmental coordination.
- Phase approach to developing, revising and maintaining RCL data.

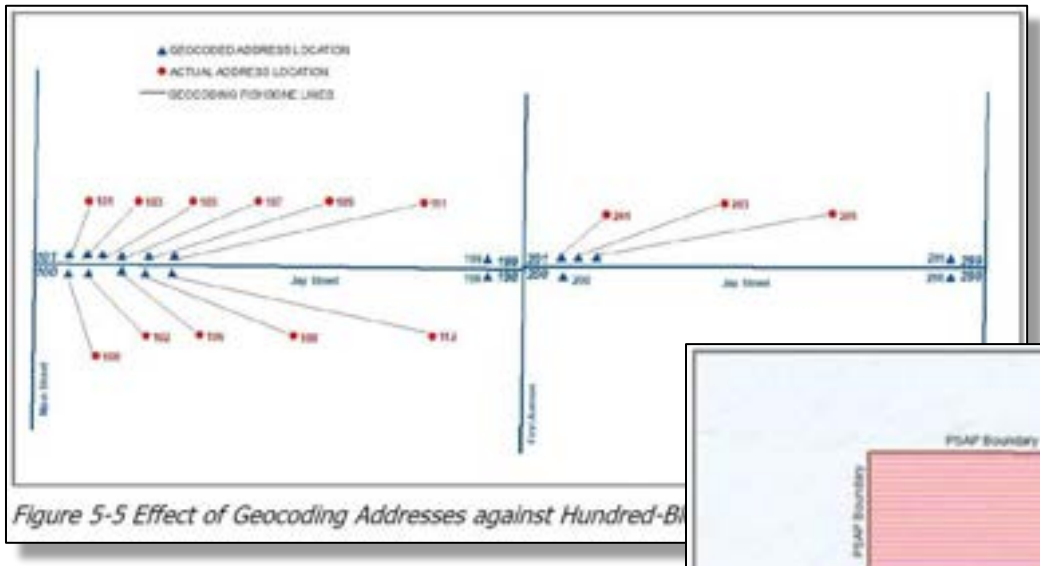
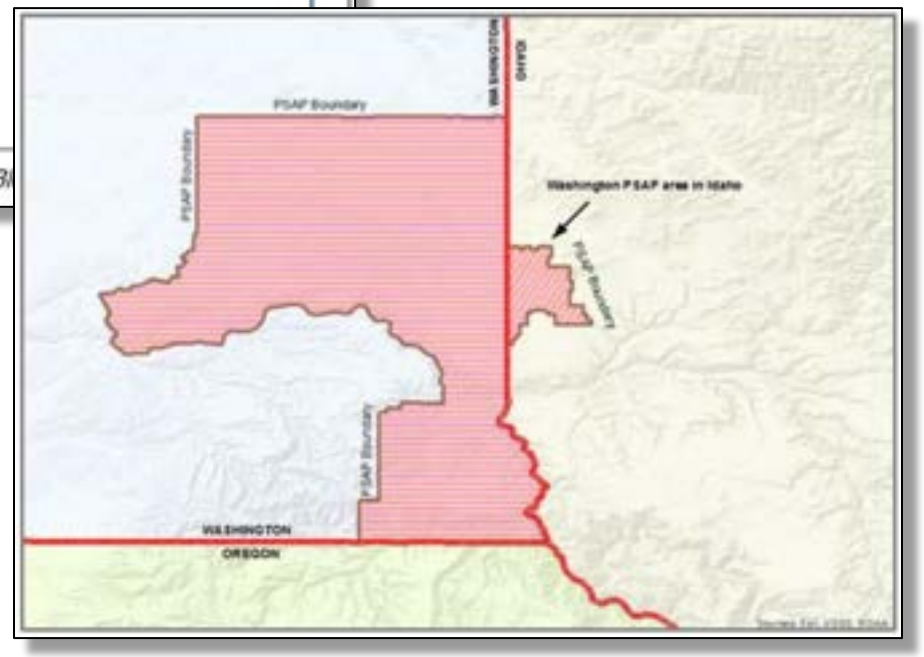


Figure 5-5 Effect of Geocoding Addresses against Hundred-Bl



Source: NENA

Polygon Boundaries for NG9-1-1 Call Routing

- Inaccurate boundary lines may cause routing issues.
- Polygon boundaries should be the #1 priority for review/updating.

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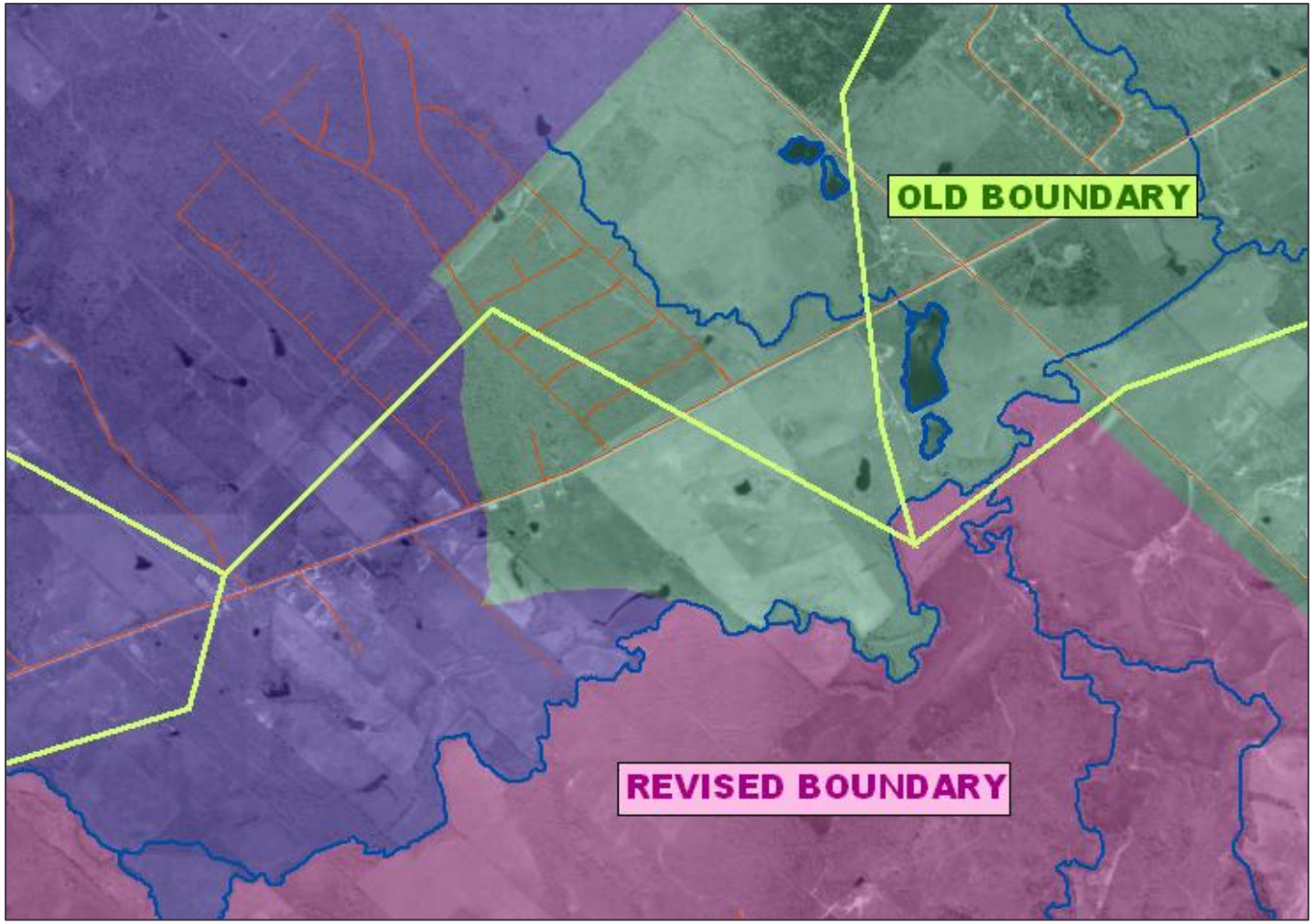
Polygon Boundary Level of Detail vs Accuracy



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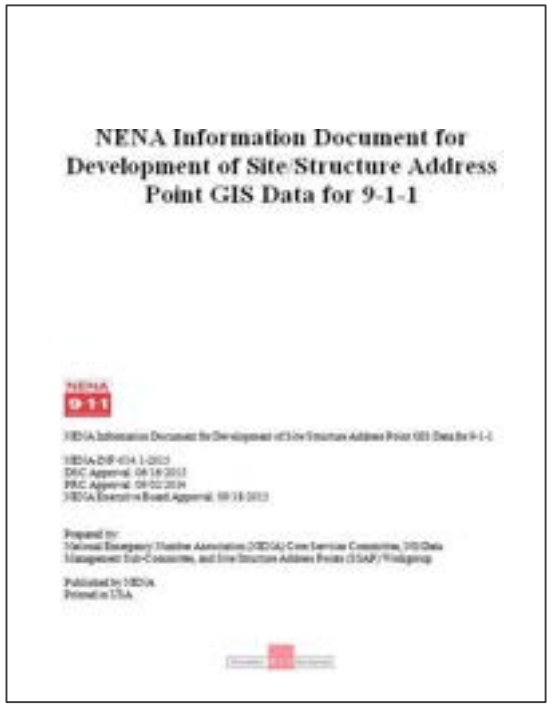
Information Document for Site Structure Address Point GIS Data for NG9-1-1

- **NENA-INF-014** (2015) provides guidelines to support, but are not limited to:
  - NG9-1-1 Validation
  - NG9-1-1 Call Routing
  - 9-1-1 Map Display
  - Computer Aided Dispatch (CAD)
  - Vehicle Routing
  - Emergency Notification
- Contents:
  - Placement Methodologies (Geocoding, Parcel, Site, Structures, Property Access)
  - Best Practices
  - Sub Addresses
  - Accuracy Considerations
  - Metadata


NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1

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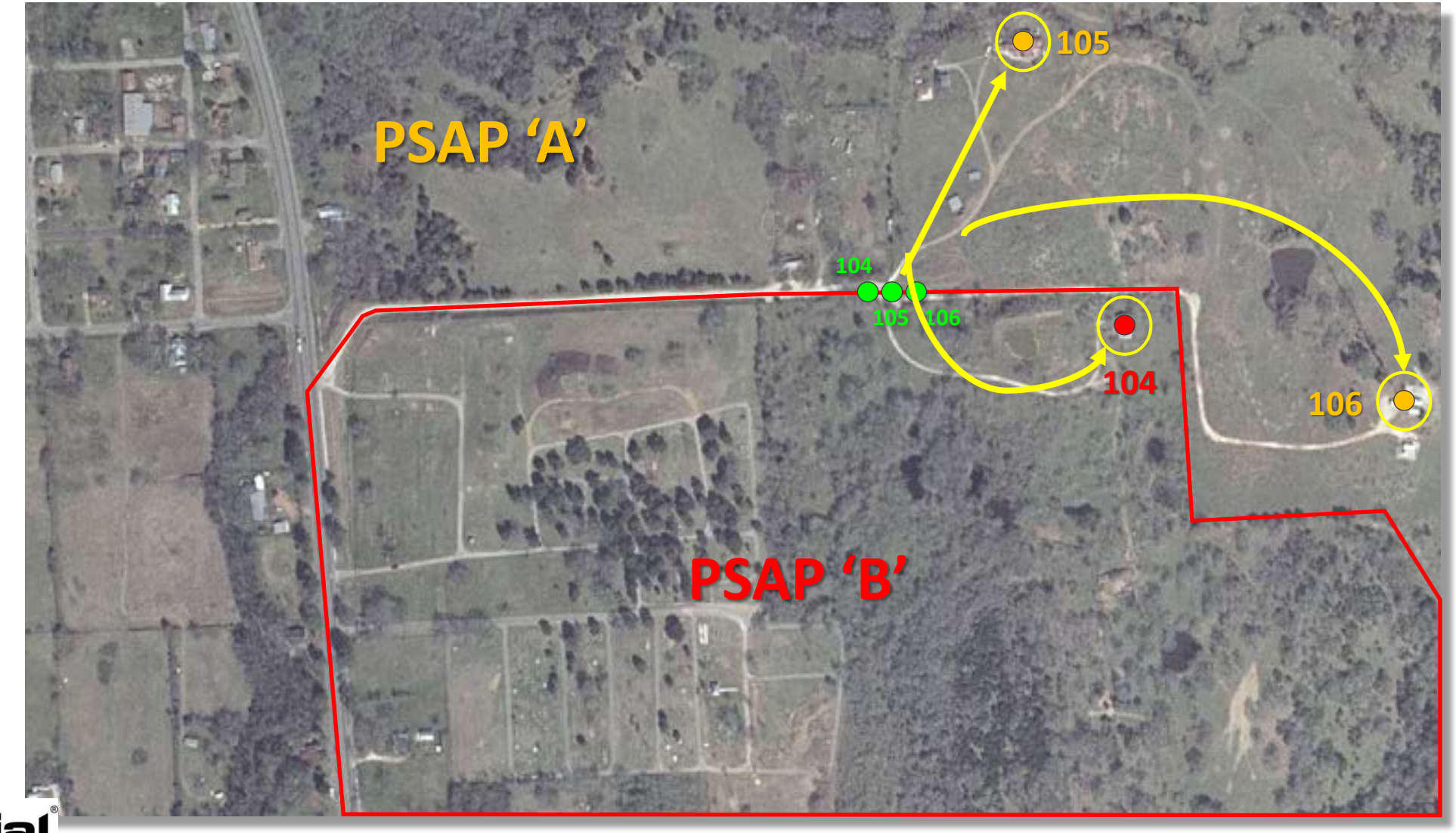
Source: NENA

Site Structure Address Points for NG9-1-1 Call Routing



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Questions?

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