



9-1-1, Z-Coordinates, and 3D: What to Know for GIS Data

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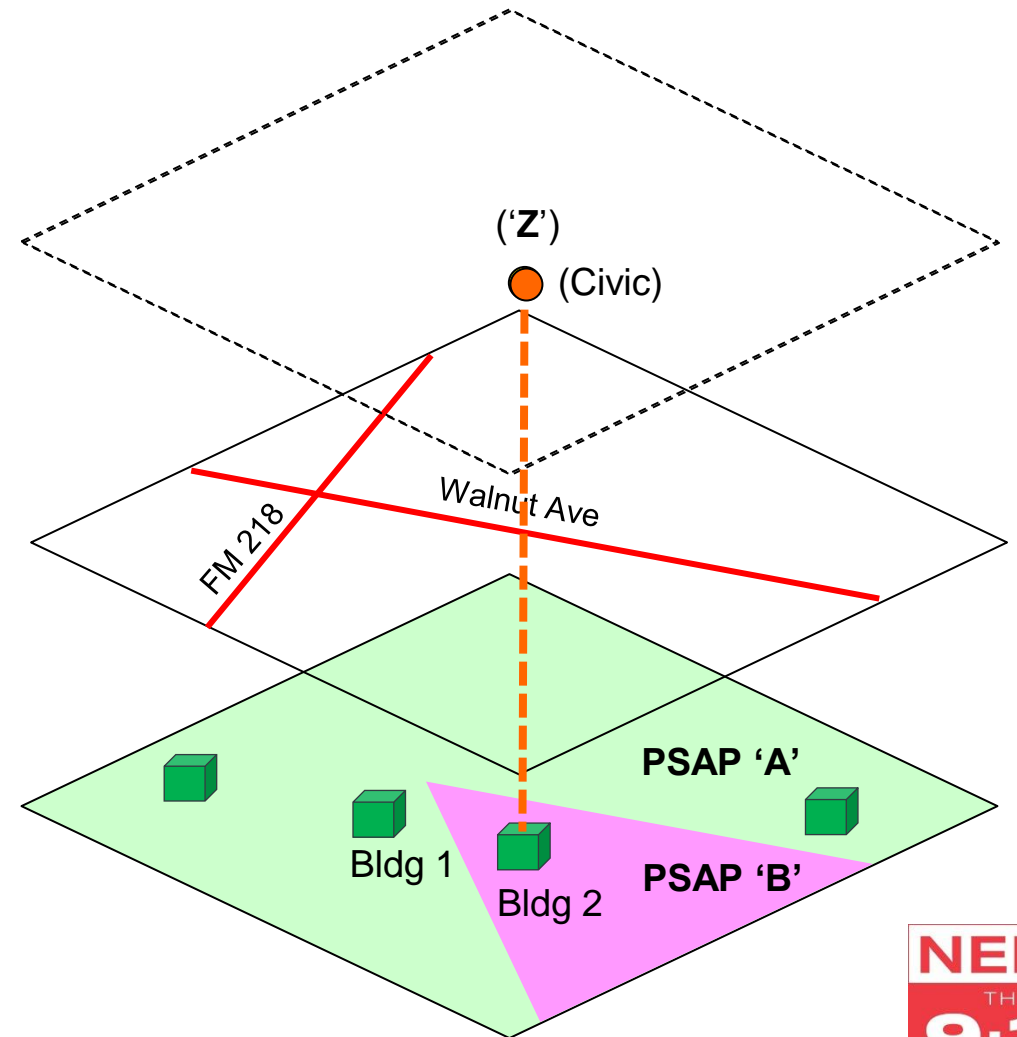
The FCC Mandate(s)

- November 2014 - FCC identified the need for improvement in location identification for 9-1-1 and created a “Roadmap” agreement between the FCC, NENA, APCO, and Service Providers, Verizon, T-Mobile, AT&T Mobility, and Dish Wireless.
- January 2015 issuance of the FCC 4th Report & Order (15-9) with new accuracy requirements for Service Providers to deliver to PSAPs/ECCs:
 - **EITHER** a Dispatchable Location (sub-addressing)
 - **OR** a Vertical Location as Z (altitude).
- October 2019, FCC 5th Report & Order (per FCC 5th Report & Order) modified vertical location metric to be delivered with an accuracy of plus or minus 3 meters.

NG9-1-1 Geospatial Call Routing

Call Routing Data Use:

- 'Geodetic' locations are plotted by their coordinates (X, Y), while 'Civic' locations are geocoded to SSAP or RCL GIS data before plotting to the PSAP and responder boundaries. How does vertical context affect this process?
- Required GIS Layers:
 - PSAP/ECC Boundaries
 - Responder Boundaries
 - Road Centerlines
 - Site Structure Address Points
 - *Building Shapes?*
 - *Terrain Surface?*



SSAP Schema Example

- This GIS schema example for SSAPs illustrates how different groups of attributes may be used in NG9-1-1.

Table 4-4 SiteStructureAddressPoint Layer

Descriptive Name	Field Name	Required	Type	Field Width
Discrepancy Agency ID	DiscrpAgID	Yes	P	100
Date Updated	DateUpdate	Yes	D	-
Effective Date	Effective	No	D	-
Expiration Date	Expire	No	D	-
NENA Globally Unique ID	NGUID	Yes	P	254
Country	Country	Yes	P	2
State or Equivalent (A1)	State	Yes	P	2
County or Equivalent (A2)	County	Yes	P	100
Additional Code	AddCode	Conditional	P	6
Additional Data URI	AddDataURI	Conditional	U	254
Incorporated Municipality (A3)	Inc_Muni	Yes	P	100
Unincorporated Community (A4)	Uninc_Comm	No	P	100
Neighborhood Community (A5)	Nbrhd_Comm	No	P	100

Descriptive Name	Field Name	Required	Type	Field Width
Address Number Prefix	AddNum_Pre	Conditional	P	15
Address Number	Add_Number	Conditional	N	6
Address Number Suffix	AddNum_Suf	Conditional	P	15
Street Name Pre Modifier	St_PreMod	Conditional	P	15
Street Name Pre Directional	St_PreDir	Conditional	P	9
Street Name Pre Type	St_PreTyp	Conditional	P	50
Street Name Pre Type Separator	St_PreSep	Conditional	P	20
Street Name	St_Name	Conditional	P	254
Street Name Post Type	St_PosTyp	Conditional	P	50
Street Name Post Directional	St_PosDir	Conditional	P	9
Street Name Post Modifier	St_PosMod	Conditional	P	15
Legacy Street Name Pre Directional*	LSt_PreDir	Conditional	P	2
Legacy Street Name*	LSt_Name	Conditional	P	75
Legacy Street Name Type*	LSt_Typ	Conditional	P	4
Legacy Street Name Post Directional*	LSt_PosDir	Conditional	P	2
ESN*	ESN	Conditional	P	5
MSAG Community Name*	MSAGComm	Conditional	P	30
Postal Community Name	Post_Comm	No	P	75
Postal Code	Post_Code	No	P	7
Postal Code Extension	PostCodeEx	No	P	4
Building	Building	No	P	75
Floor	Floor	No	P	75
Unit	Unit	No	P	75
Room	Room	No	P	75
Seat	Seat	No	P	75
Additional Location Information	Addt_Loc	No	P	225
Complete Landmark Name	LandmkName	Conditional	P	150
Milepost	Milepost	Conditional	P	150
Place Type	Place_Type	No	P	50
Placement Method	Placement	No	P	25
Longitude	Longitude	No	F	-
Latitude	Latitude	No	F	-
Elevation	Elevation	No	N	6

Used in Legacy Systems and is not used in a full NG9-1-1 implementation

Conversion

Subaddressing

Routing

3D

Location Terms in NG9-1-1

- Per NENA Practices:
 - **Stated** Location: “What is the address of your emergency?”
 - **Geodetic** Location: Coordinates (X, Y, Z)
 - **Civic** Location: A provisioned address
 - **Routable** Location: Sufficient location information to route a call via NGCS
 - **Dispatchable** Location: An estimated address/location

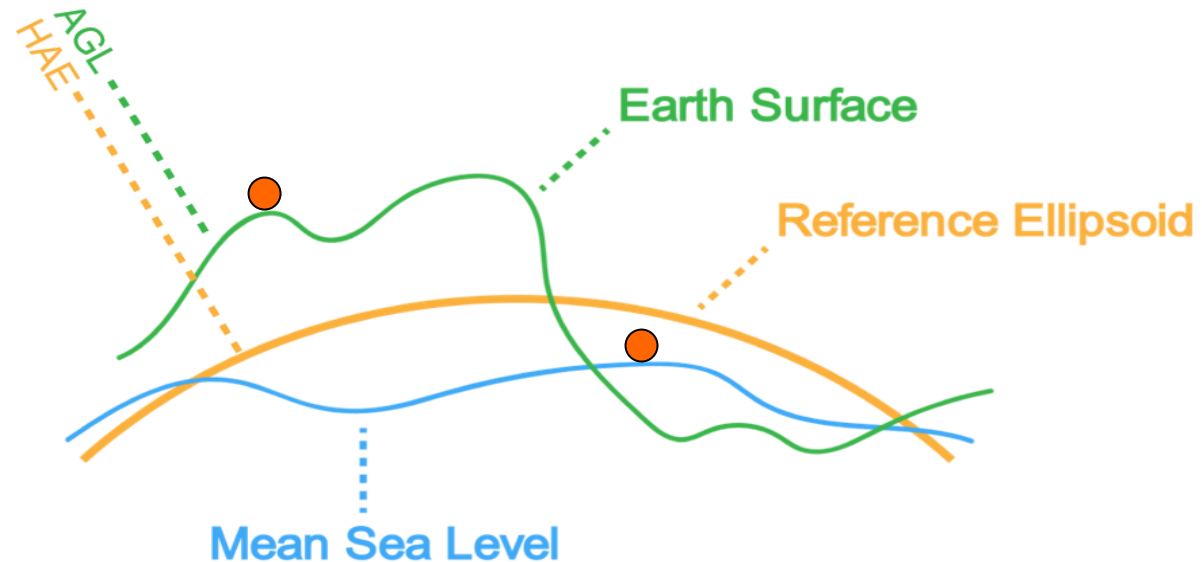
'Vertical' Location Terms

- Terms used interchangeably to describe a vertical location in 9-1-1, but should not be.
- FCC 4th R&O - wireless carriers could provide uncompensated barometric pressure (UBP) as a precursor to an actual z-axis measurement.
- Z axis as delivered today by the carriers, should only be considered as "Altitude"

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.
Height	The distance between Elevation and Altitude for a given location; is often referred to as "Height Above Ground Level" (AGL).

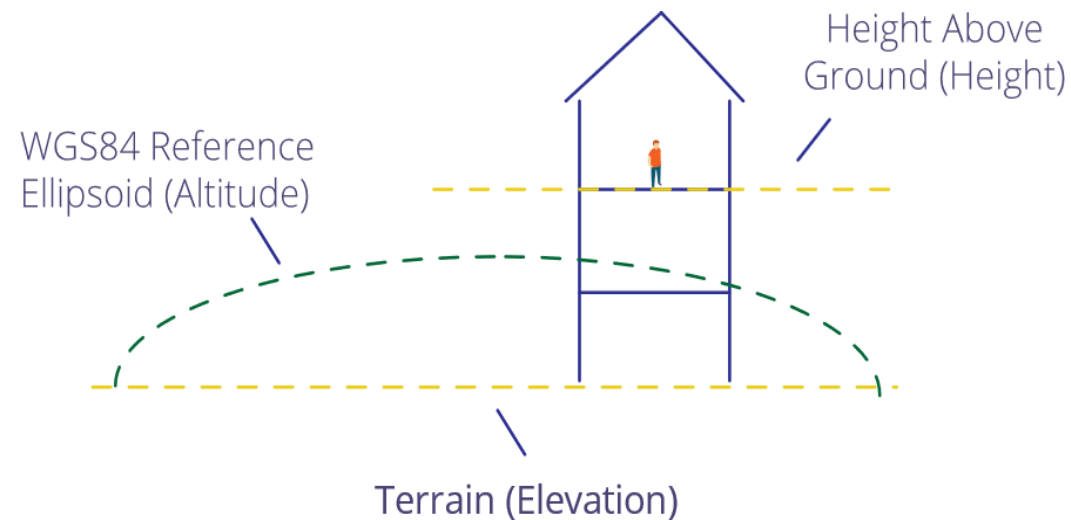
What Vertical Location Can Mean to 9-1-1

- **Earth's Surface** - what is commonly referred to as Above Ground Level or AGL.
- **Reference Ellipsoid** - a mathematical representation of the earth as a spheroid, as used by GPS systems today.
- **Mean Sea Level** - the averaged height of all sea levels.



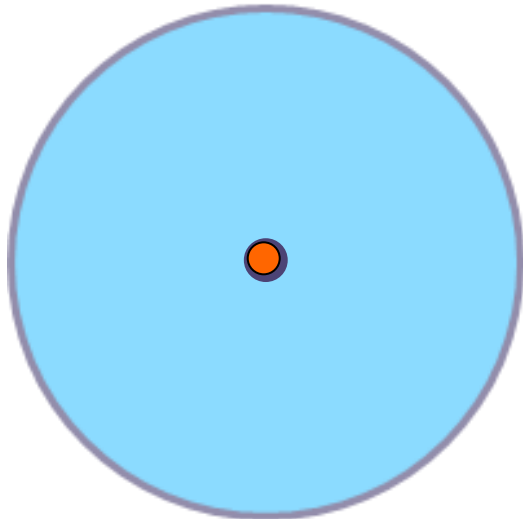
Visualizing What Vertical Location Can Mean

- Illustration of a vertical location passed on to the PSAP as a Z value, in relation to a 'spheroid' (*sphere-like but not perfectly spherical body representing averaged surface of the earth used for GPS readings*)
- May not be as useful when the location of a caller needs to be understood in terms of their height above ground or what floor they may be on.

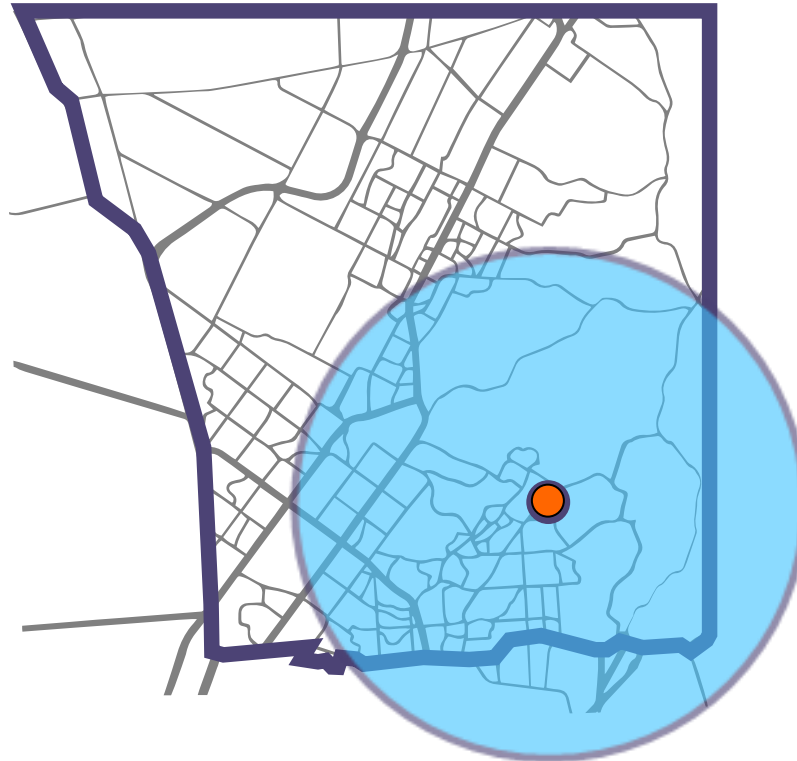


2D Geodetic Location with a Map

- 2D Geodetic Location (left) and 2D Geodetic Location with a Map (right)



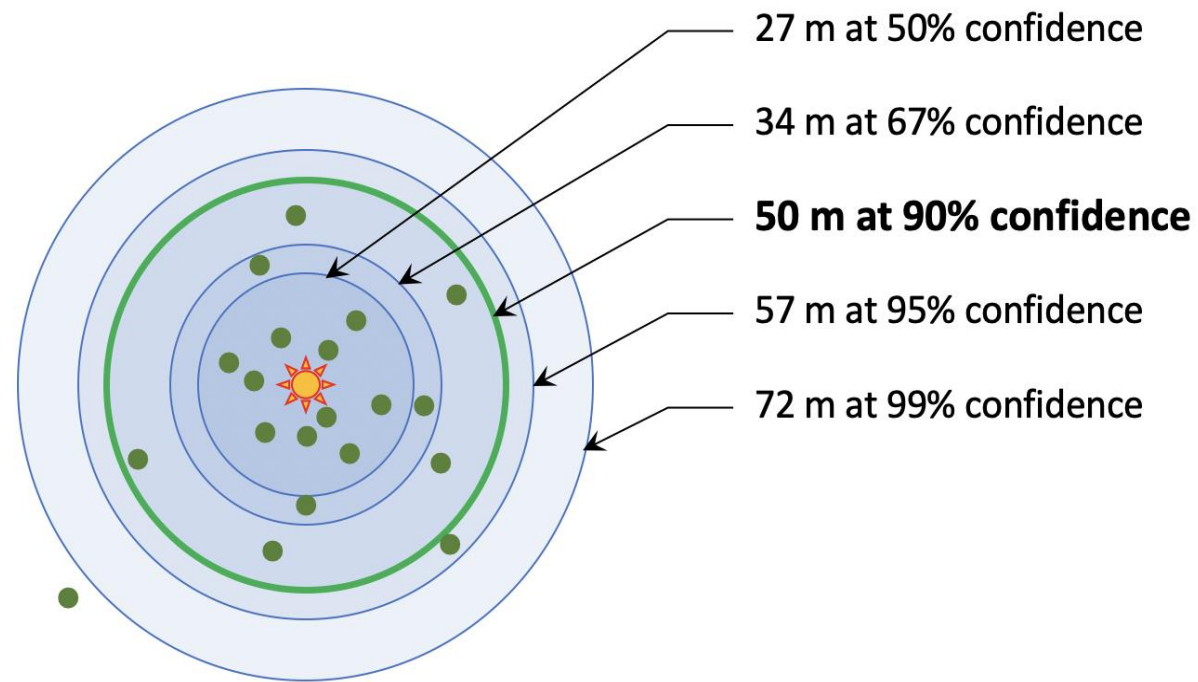
38.8506697 N
-77.0593877 W



38.8506697 N
-77.0593877 W

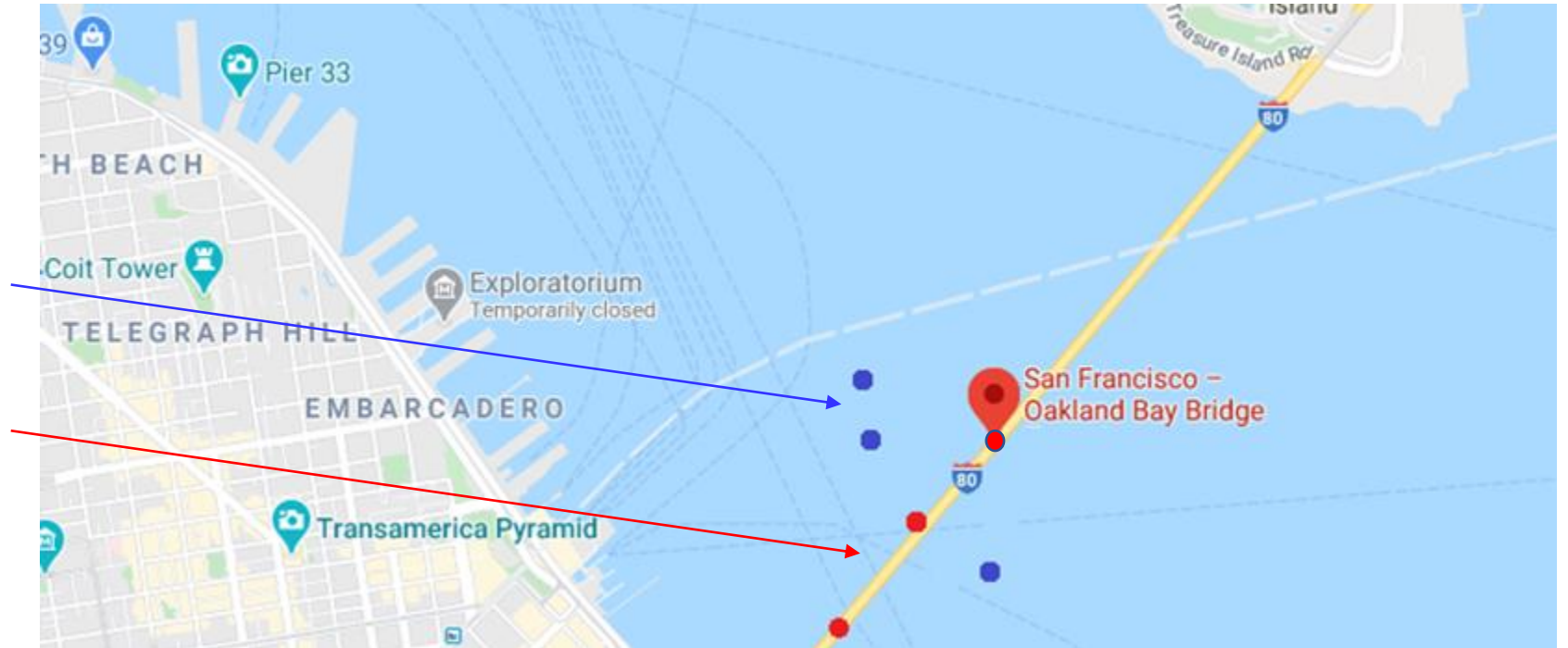
Confidence and Uncertainty in Two Dimensions

- **Uncertainty:** is the total area the location may be inside of.
- **Confidence:** is the chances that the location is within the area of uncertainty.



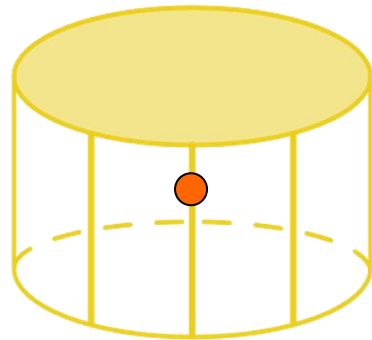
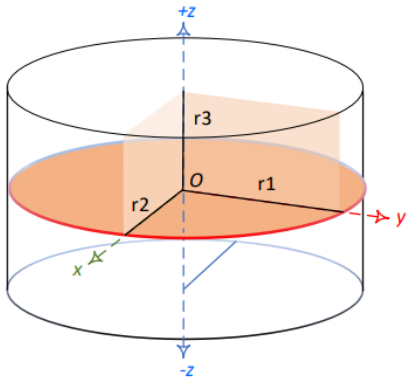
Operationalizing Z Axis Information

- Calls at **BLUE** dots represent an 'Altitude' at around local sea level
- Calls at **RED** dots represent an 'Altitude' above sea level



3D Geodetic Location Uncertainty With a Map

3D Geodetic Location (left), with uncertainty shown as a cylinder...

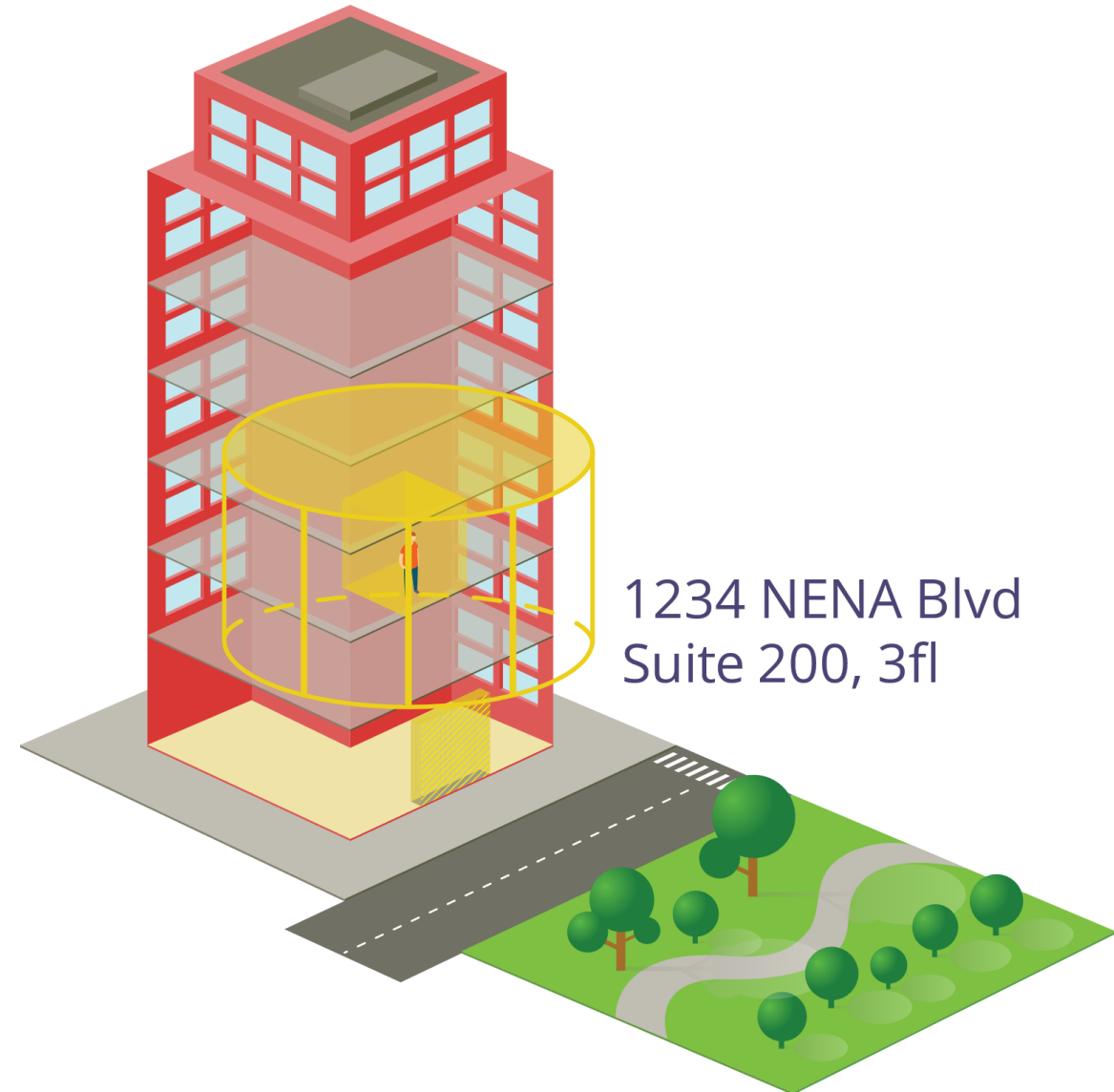


38.8506697 N
-77.0593877 W
10m Z
<50m XY <3m Z

...and 3D Geodetic Location with a 3D Map (Right).

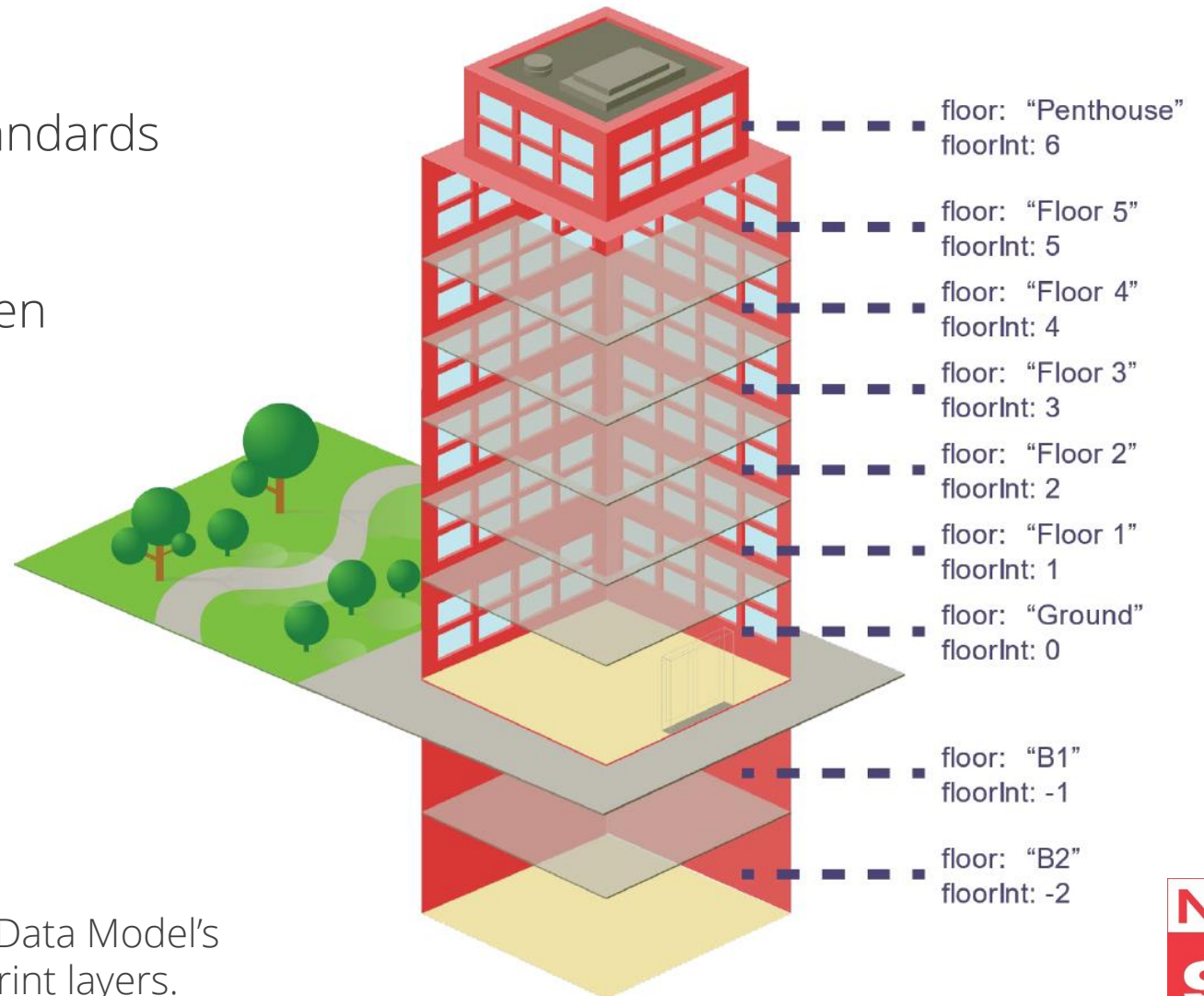
3D Dispatchable Location

- A Dispatchable Location Estimated Based on the Physical Location of a Caller in Three Dimensions.



Estimating Floor Levels

- **floorInt*** must be added to many standards that deal with location.
- This allows us to use uncertainty when estimating a floor level.



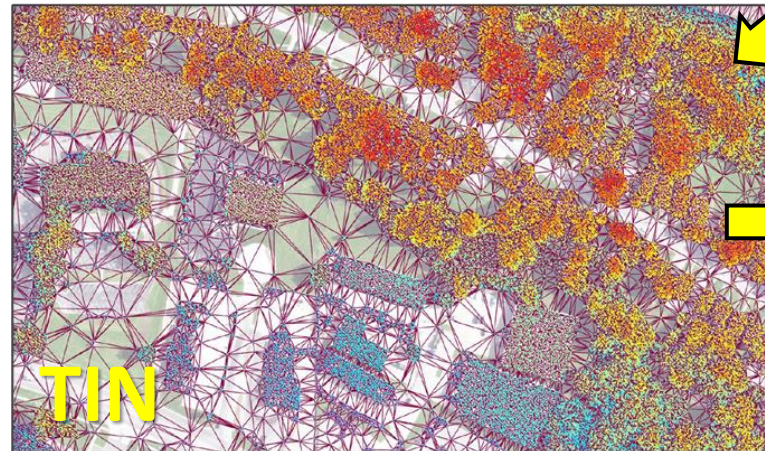
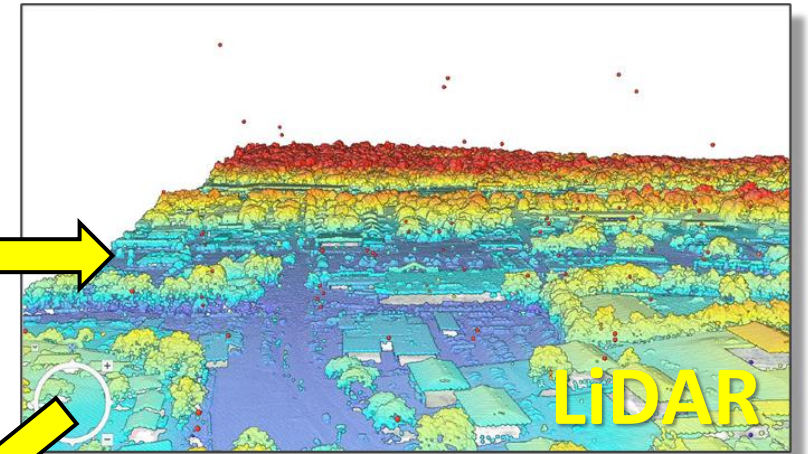
* indicates attribute to be added to NENA's GIS Data Model's Site Structure Address Point and Building Footprint layers.

Elevation (DEM) –Terrain (DTM)-Surface Modeling (DSM)

- This will be a new layer (required) added to the NENA NG9-1-1 GIS Data Model.
- Also provides background on what Digital Elevation Modeling is.
- Some sections on the subject in NENA-REQ-003.1-2022 are:
 - Resolution of Elevation Models
 - NENA Digital Elevation Model Level-of-Detail
 - Comparing Different Resolutions
 - Constructing Digital Elevation Models with LiDAR
 - Sources of Elevation Models
 - Location Datum Transformation Challenges

DEM-DTM-DSM Examples

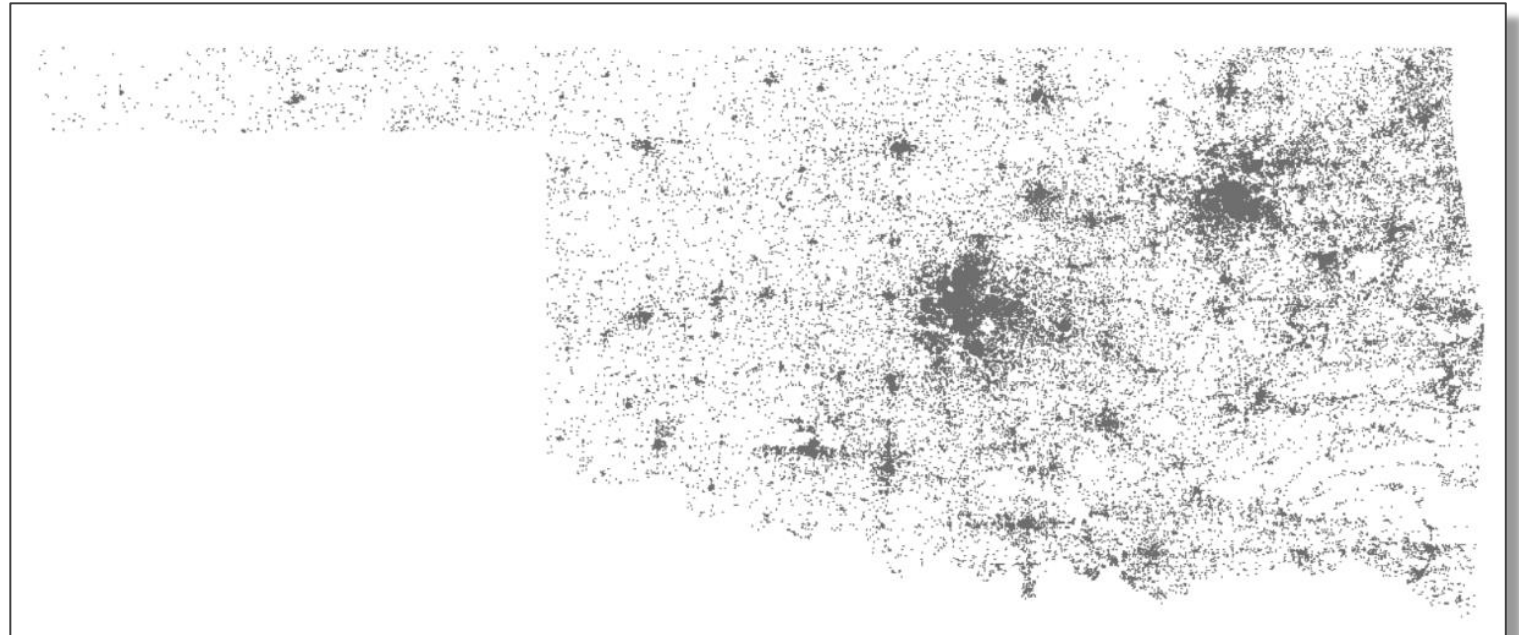
- This will be a new data layer in the NENA NG9-1-1 GIS Data Model v3
- Reference Terrain Data is already available




Data for Rendering Buildings

Oklahoma Building Data Coverage from USGS

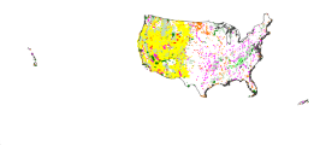
- Taking footprint data and applying height to each, a 3D shape for the building can be displayed
- These 3D shapes can be sliced into floors and Floor information provisioned for them
- Building footprint data is generally available online today via USGS, FEMA, and Microsoft



USGS National Map Website

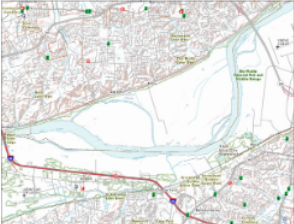


Extents: National, North America
ScienceBase Tag: [Small-scale Datasets - Transportation](#) **ScienceBase:** [532c5b23e4b0cd7393d07783](#)



Structures - National Structures Dataset

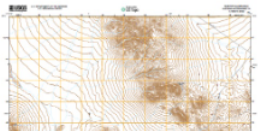
USGS data portray selected structures data, including the location and characteristics of manmade facilities. Characteristics consist of a structure's physical form (footprint) function, name, location, and other detailed information about the structure. The types of structures collected are largely determined by the needs of the disaster planning and response and homeland security organizations.



[More Info](#)
Refresh Period: Monthly
ScienceBase Tag: [National Structures Dataset \(NSD\)](#)
Extents: National, State

[Data Gov](#)
Formats: Shapefile, FileGDB, GeoPackage, All
ScienceBase: [4f70b240e4b058caae3f8e1b](#)

Topo Map Data and Topo Stylesheet



[More Info](#)
Refresh Period: As needed
ScienceBase Tag: [Combined Vector](#)
Extents: 7.5 x 7.5 minute

[Data Gov](#)
Formats: FileGDB, Shapefile, GeoPackage
ScienceBase: [topo-template](#)

USGS National Structures Data

- Structure Points and Structure Polygons for the US are available online from the National Map holdings via USGS
 - Structure Polygons include fields for high and low elevation
 - Structure Points include fields for the address
- Take note of listed **‘Production’** and **‘Load’** dates for how current the data is

The image displays two 'Identify' windows from a GIS application. The left window shows a structure polygon with the following data:

Field	Value
outbldg	0
height	0
sqmeters	1341.249023
sqfeet	14437.070313
h_adj_elev	0
l_adj_elev	0
fips	40009
prod_date	8/21/2018
usng	14S ME 41853 0664
longitude	-99.639521
latitude	35.301522
image_name	1030010066CA2B0
image_date	3/25/2017
val_method	Automated
remarks	
uuid	{c609c0b0-8247-4...
shape_Leng	0.00193
shape_Area	0
ObjectID	80630

The right window shows a structure point with the following data:

Field	Value
FID	0
Shape	Point
permanent_	c8b89d16-8522-40b8-ae65-26ac8582c3f9
source_fea	OK000232
source_dat	6b9ba7c7-01a1-487c-97d6-b09bc2b5ee24
source_d_1	740 TNMC Update 12/2/2021
source_ori	U.S. Geological Survey
data_secur	5
loaddate	12/2/2021
fcode	74034
name	Sayre Police Department
islandmark	0
pointlocat	1
admintype	0
addressbui	
address	1000 North 4th Street
city	Sayre
state	OK
zipcode	73662-2220
gnis_id	2757717
foot_id	
complex_id	
ObjectID	1

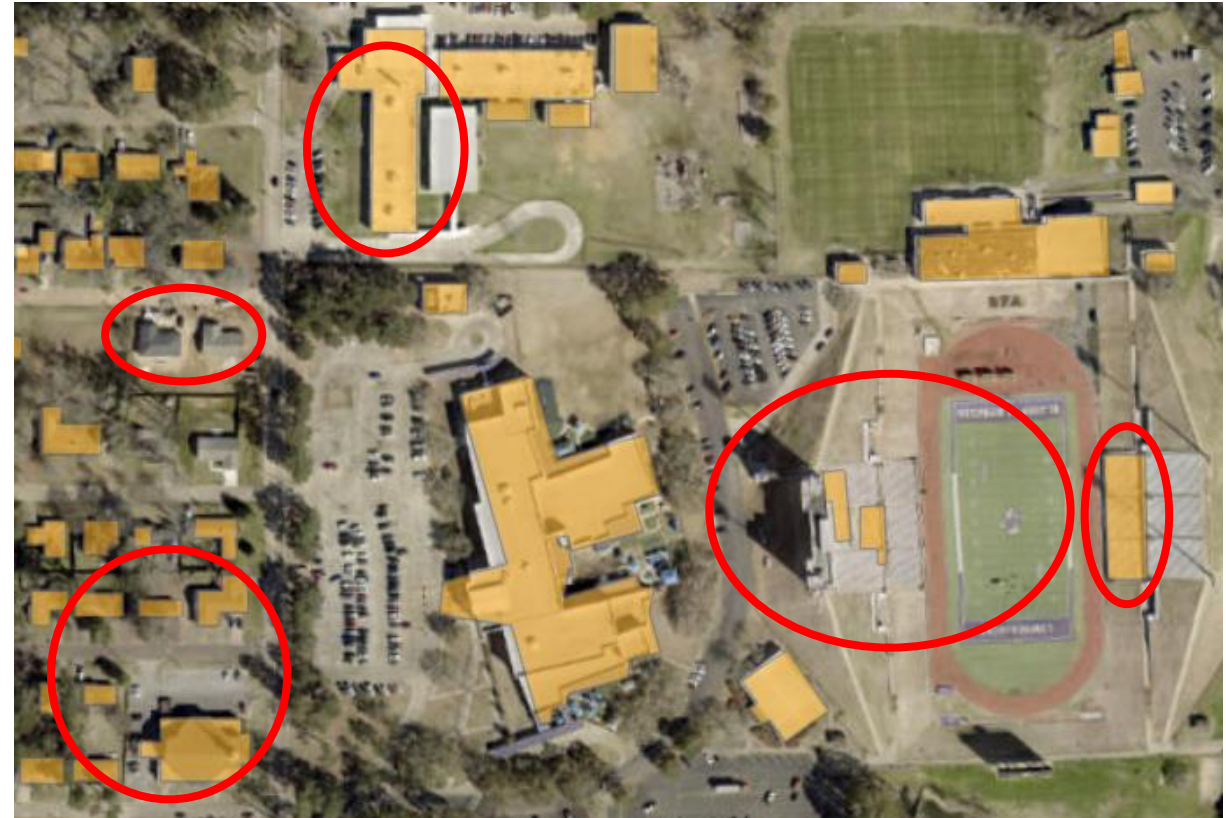
The map on the right shows a light green polygon representing the Sayre Fire Department and a red square representing the Sayre Police Department. The text 'Sayre Fire Department' and 'Sayre Police Department' is overlaid on the map.

'FEMA' and 'Microsoft' Structure Data

Note significant **variation** in feature capture between these two sources



FEMA



Microsoft

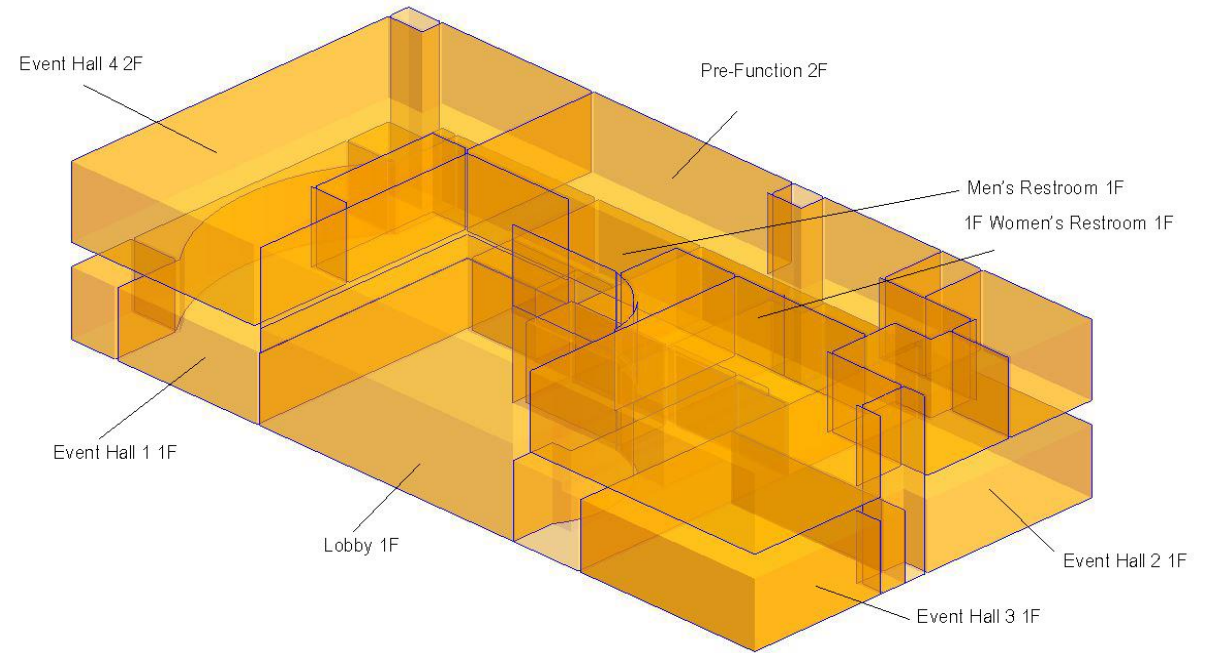
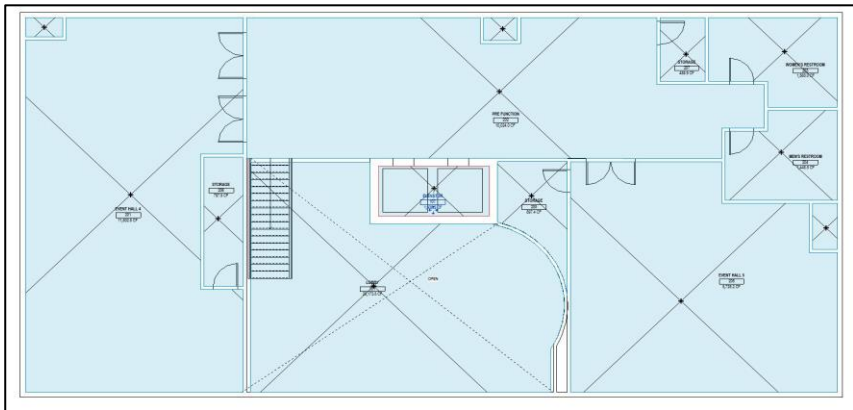
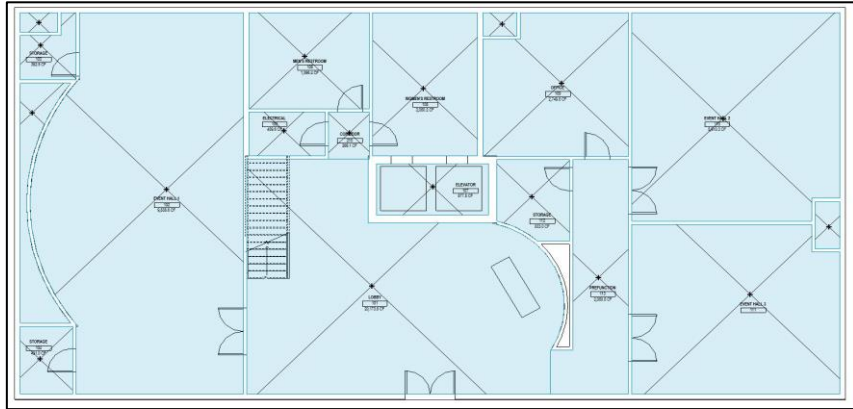
Building Extrusion Using Footprint + Height

- Factors for rendering extruded polygons for 3D buildings:
 - Footprint* - the dimensions of the building footprint
 - Base height* - elevation of the building footprint
 - Building height* - height of exterior building structure
 - Level spacing - one or more vertical distances between internal floors



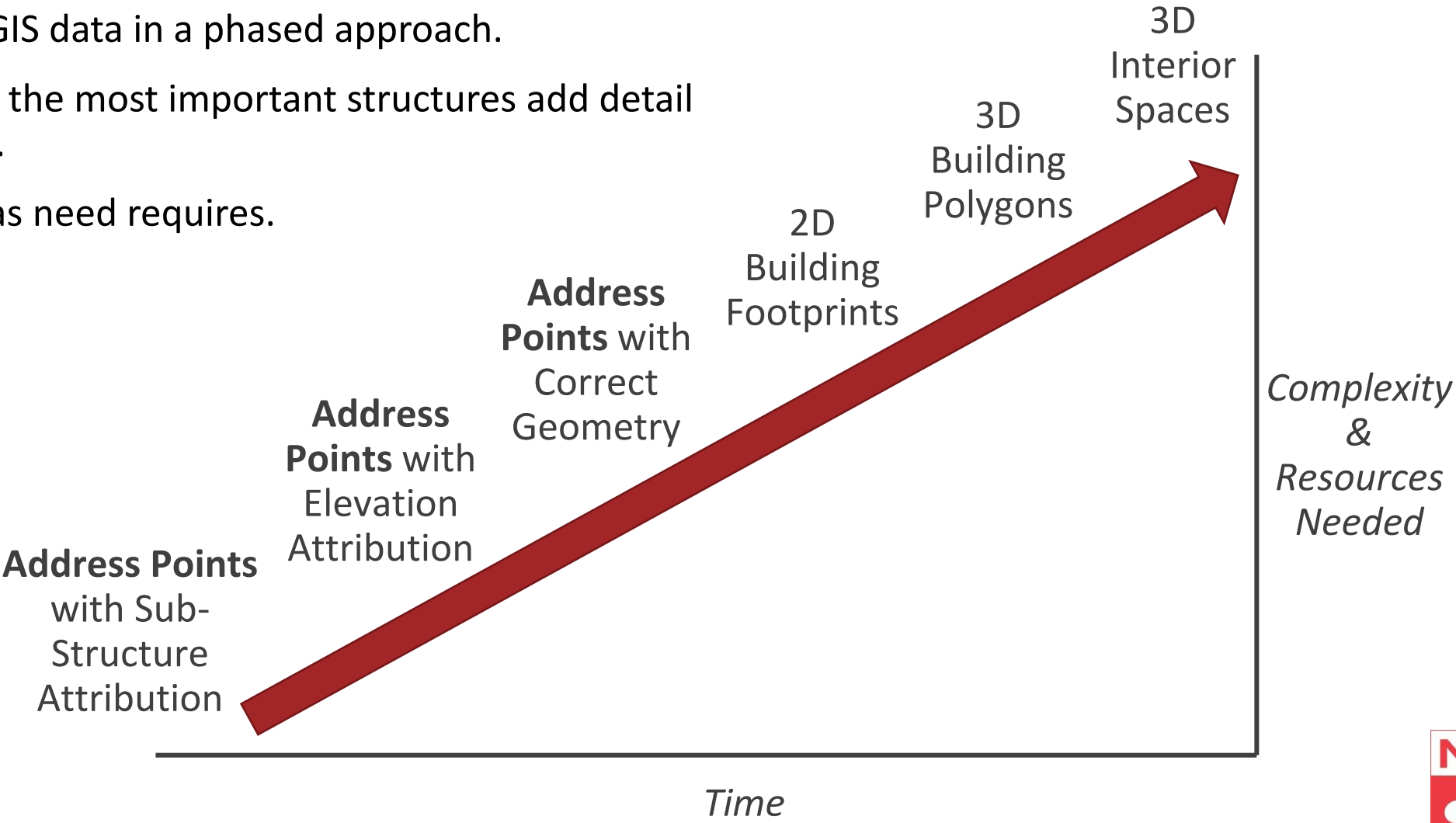
* Indicates an attribute needed in NENA's GIS Data Model v3.

Room Display – In 2D vs. 3D



GIS Data Roadmap / Migration to 3D

- Build 3D GIS data in a phased approach.
- Start with the most important structures add detail over time.
- Advance as need requires.



Questions?

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