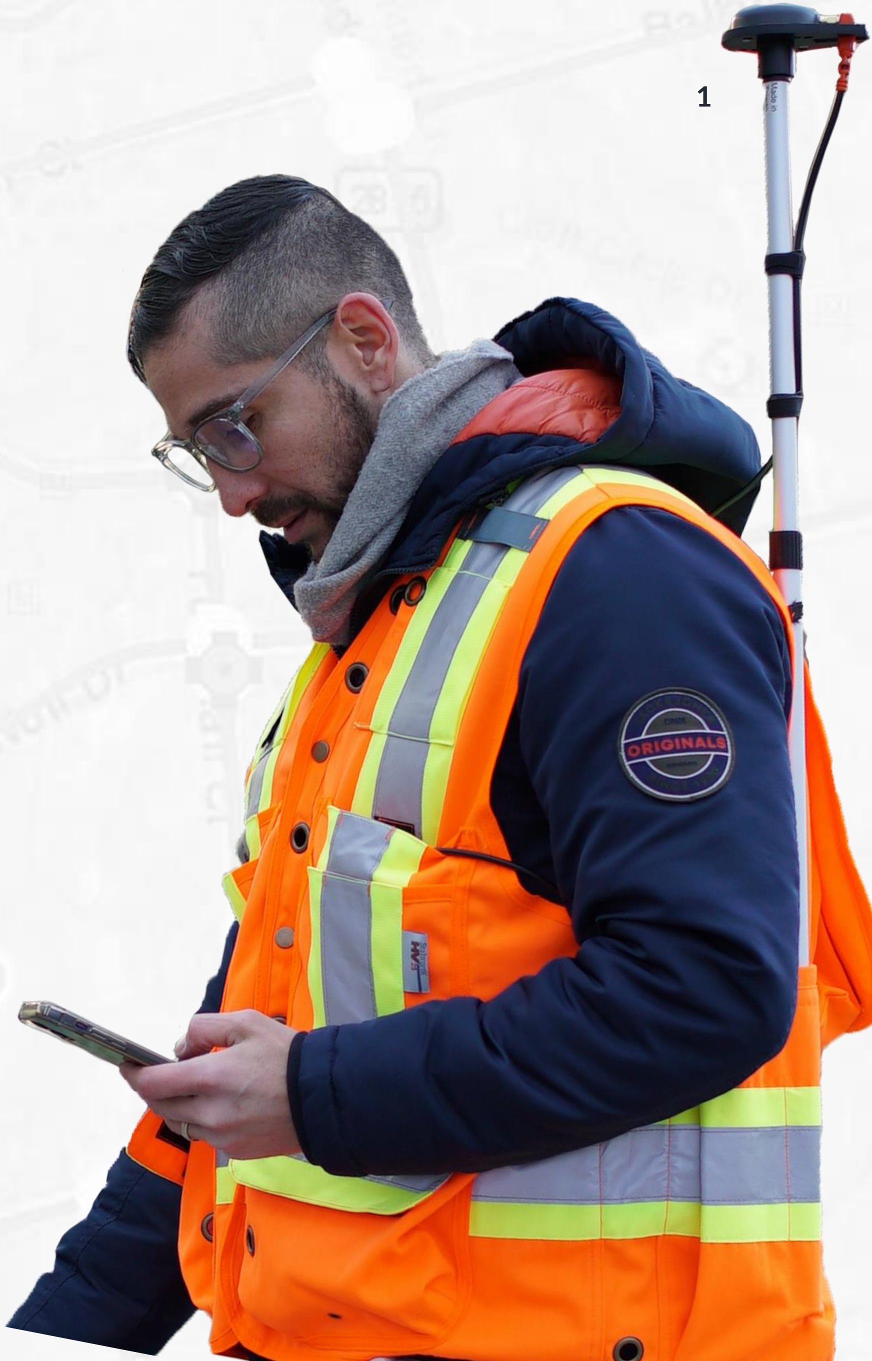
Eos Arrow GNSS Workshop with Esri ArcGIS Field Maps

Eos Positioning Systems, Esri



Meet the Presenters

Tyler Gakstatter
GNSS Expert,
Eos Positioning Systems

Doug Morgenthaler
Program Manager (Mobile Apps)
Esri

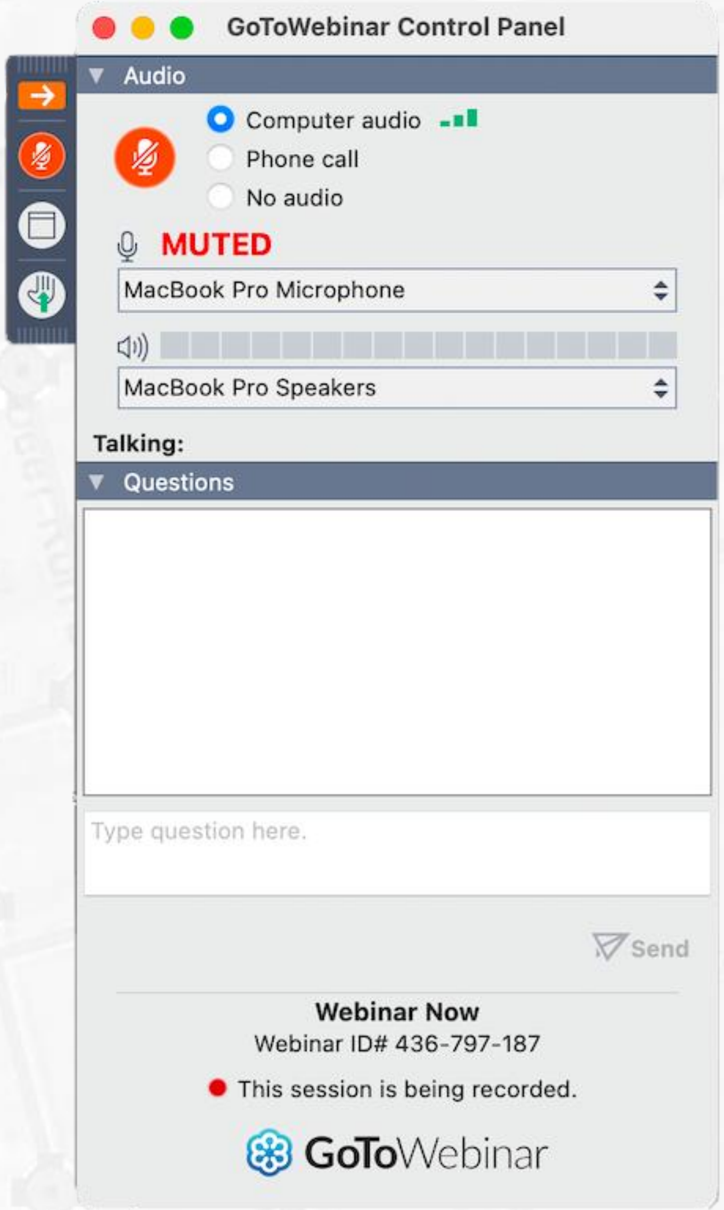
Jean-Yves Lauture
Chief Technical Officer,
Eos Positioning Systems

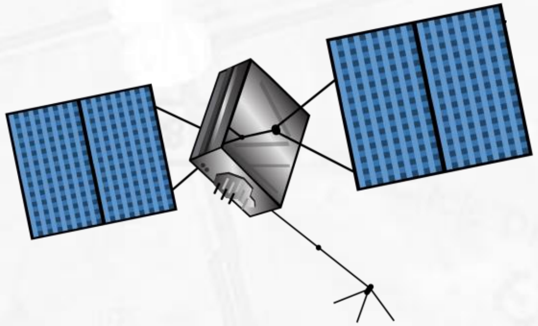
Agenda

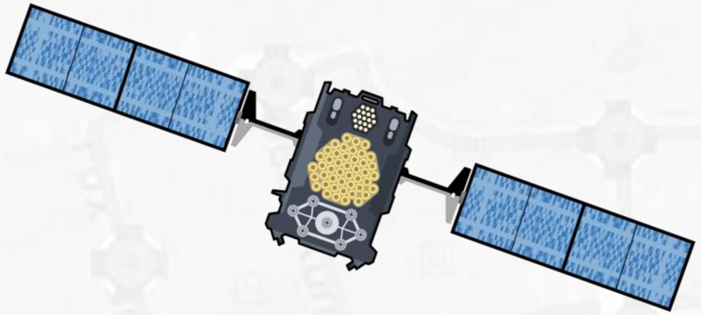
9:30 – 9:35	**Introductions**	Sarah Alban, Eos
9:35 – 9:55	**GNSS Overview**	Tyler Gakstatter, Eos
9:55 – 10:15	**ArcGIS Field Maps**	Doug Morgenthaler, Esri
10:15 - 10:35	**Setting up your web map for high-accuracy data collection with Field Maps**	Tyler Gakstatter, Eos
10:35 - 10:45	**10-MINUTE BREAK**	
10:45 – 11:15	**Outdoor Data Collection Demonstration**	Tyler Gakstatter, Eos
11:15 – 11:30	**Outdoor Demonstration Q&A**	Tyler Gakstatter, Doug Morgenthaler, Jean-Yves Lauture
11:30 – 11:35	**Reviewing Tyler’s Field Maps Data in ArcGIS Dashboards**	Doug Morgenthaler, Esri
11:35 – 12:00	**Panel Discussion, Q&A**	Tyler Gakstatter, Doug Morgenthaler, Jean-Yves Lauture

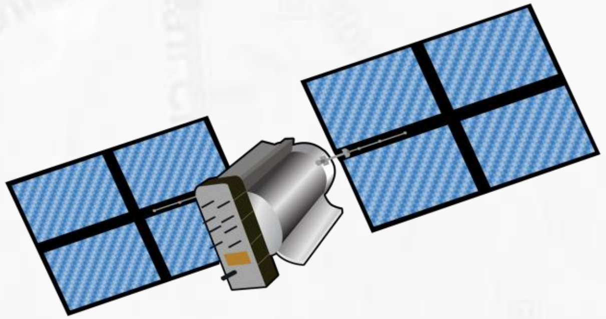
Webinar Housekeeping

- **Questions** – Enter into GoToWebinar sidebar
- **Webinar Recording** – To be emailed tomorrow
- **Handouts** – Agenda, Case Studies, Resources
- **Troubleshooting** – Close and reboot GoToWebinar









GNSS Overview

Tyler Gakstatter,

Eos Positioning Systems

What is GNSS?

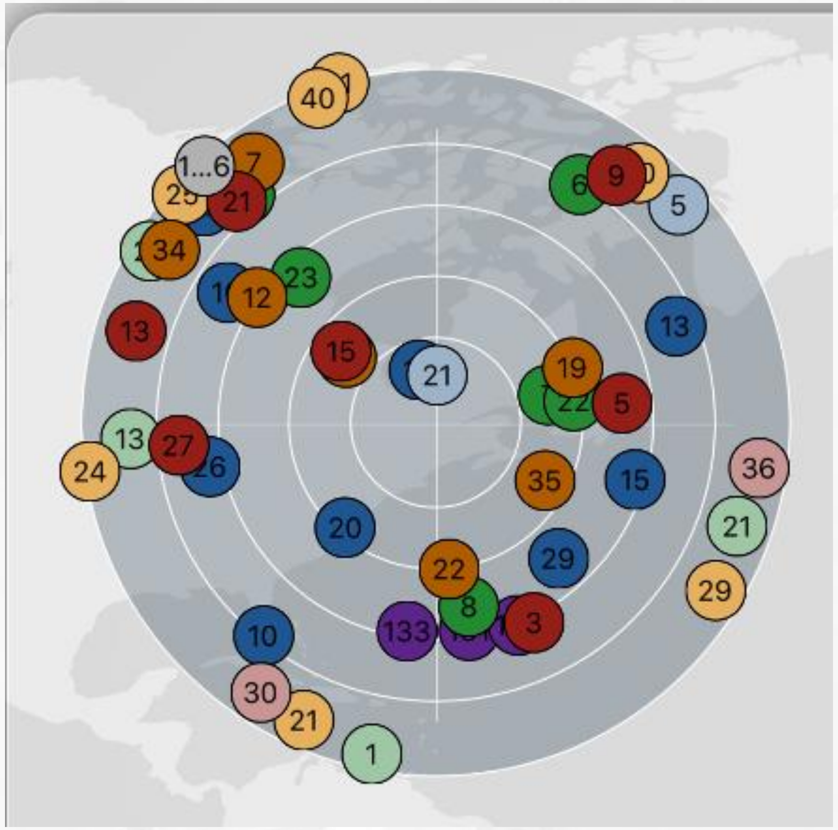
Global Navigation Satellite System (GNSS)

The Global navigation satellite system is a collection of 100+ satellites orbiting the earth divided into multiple constellations used for precise positioning.

Positions obtained using GNSS can be as accurate as sub-centimeter.

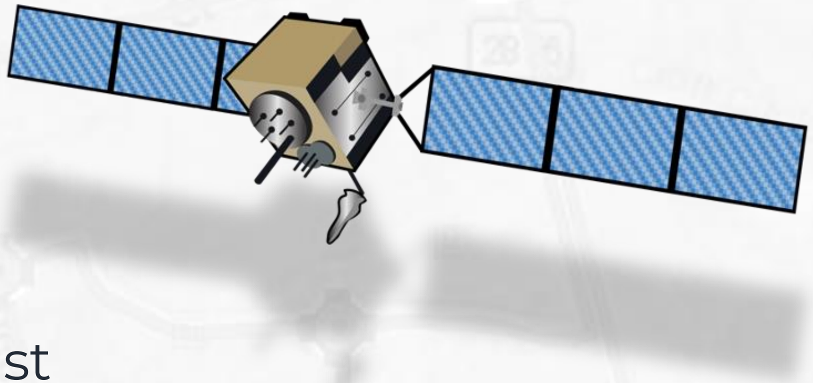
Major Satellites Constellations:

- GPS – U.S. Air Force/Space Force (USA) **31**
- GLONASS – Roscosmos (Russia) **24**
- Galileo – European Space Agency (EU) **24**
- BeiDou (China National Space Administration (China) **44**



Sky Plot – A graph often used to display satellites in view.

Using GNSS



- 106 total satellites available to anyone with the hardware capable of using the signals.
- Usage is receiver dependent. Satellites broadcast one-way signals for users to intercept and use for positioning.
- Signals from at least 4 satellites are needed to obtain a position.
- All positions determined by receiver algorithm

Accuracy Levels

• **Consumer** Grade 2-4 meters	Autonomous
• **Recreational** Grade 1-2 meters	
• **Sub-meter** Grade 50cm – 1 meter	Differential GPS - **SBAS** or beacon
• **Decimeter** grade(Sub-foot) 10cm	PPP
• **Survey Grade** 1-3 cm	**RTK**

Poll Question

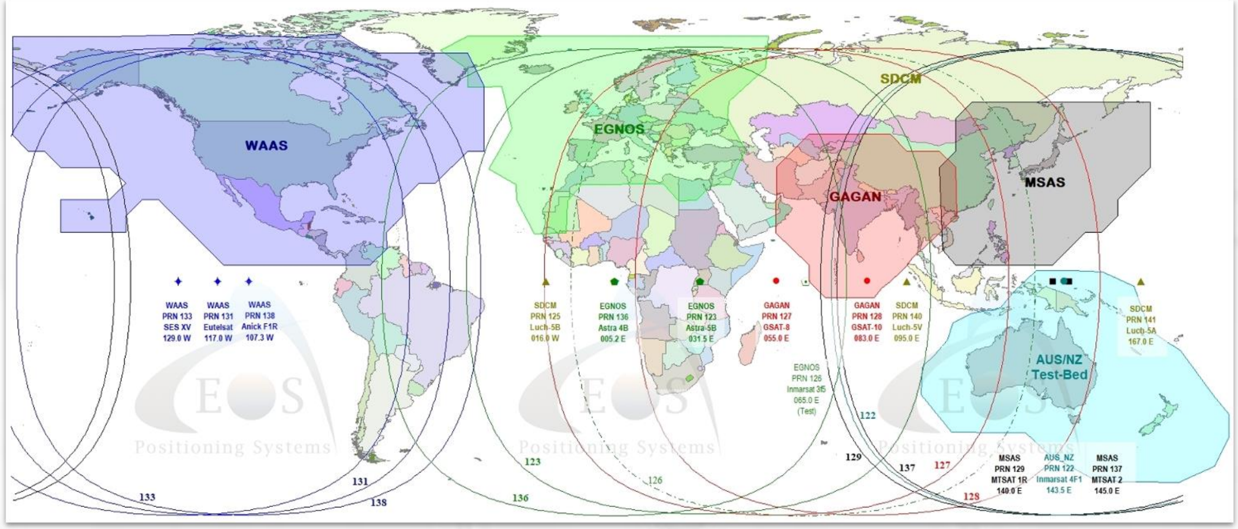
What minimum accuracy do you need to perform your work today?

GNSS Corrections

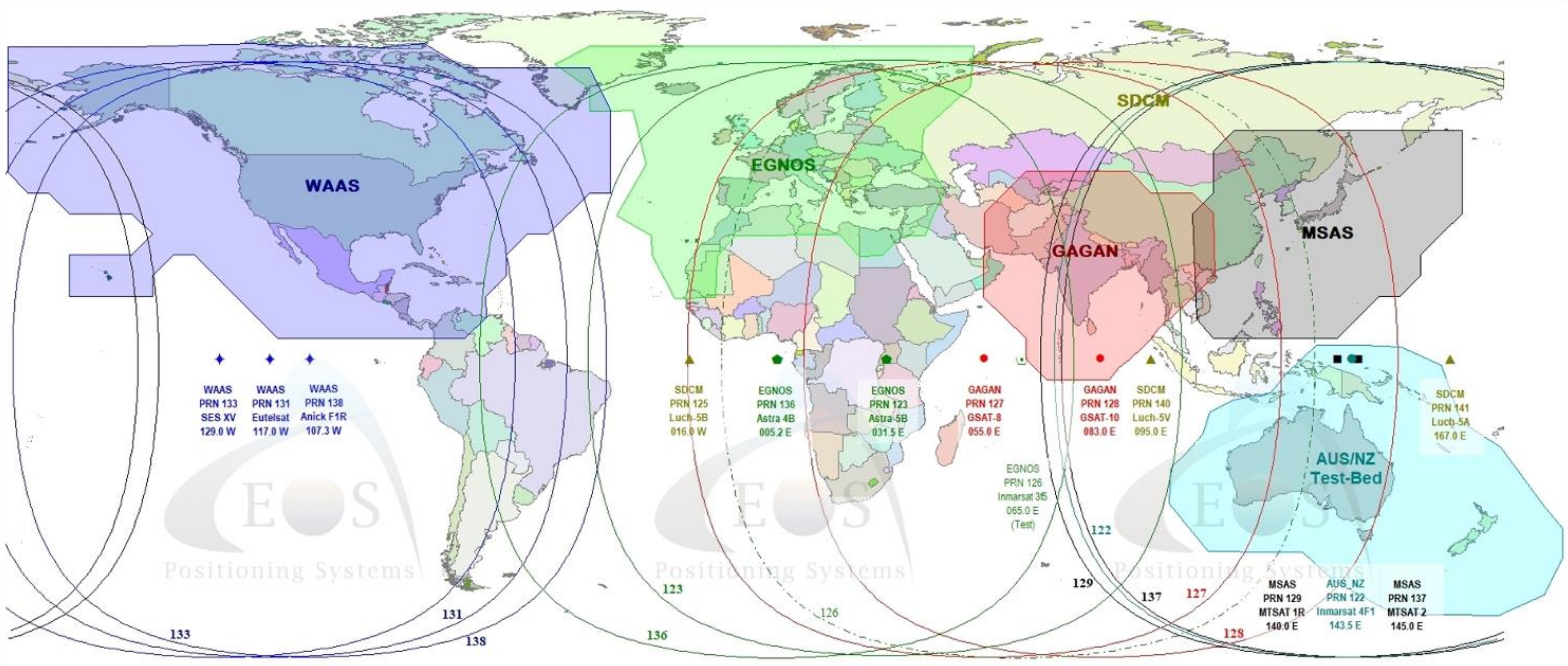
- **SBAS** (Real-time)
- **RTK** (Real-time)
- **Post-Processing**

SBAS

- Satellite Based Augmentation System (WAAS in the U.S.)
- Capable of providing **sub-meter accuracy** with a high-performance receiver
- Nearly all consumer devices use this technology to some extent, but don't exploit its accuracy
- Network of base stations throughout the U.S., Canada, and Mexico piping corrections through 2 geosynchronous satellites



SBAS

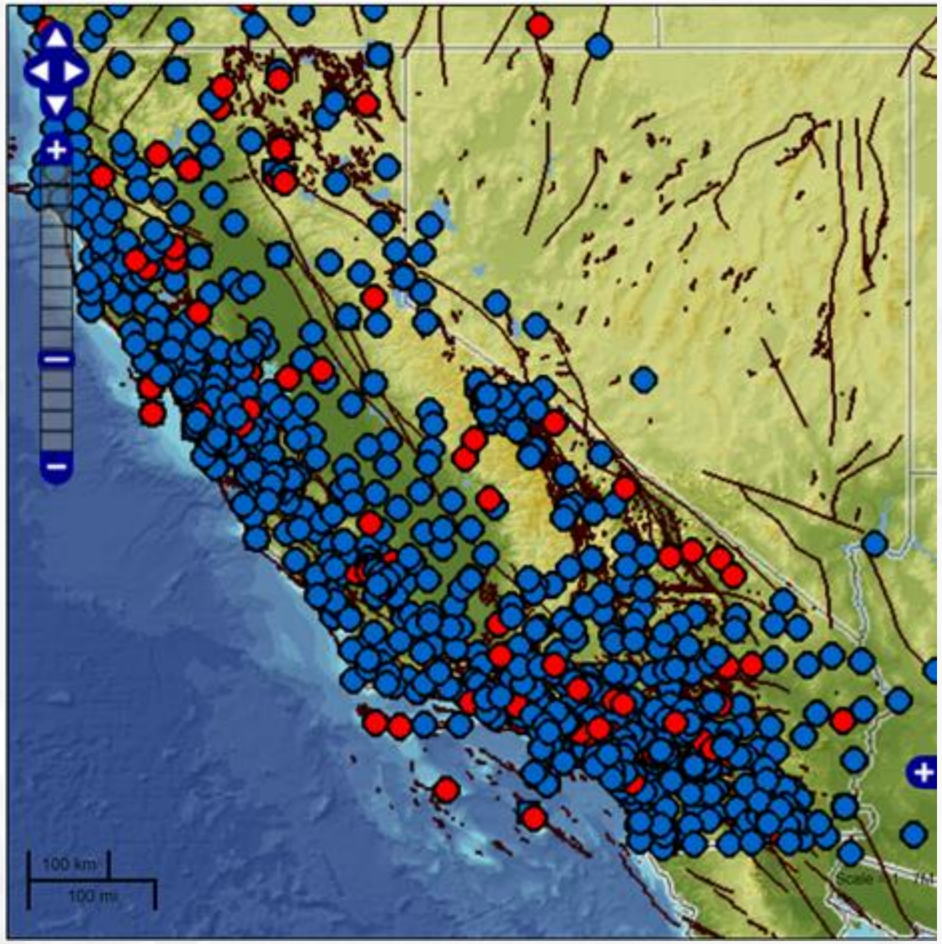

WAAS
EGNOS
SDCM
GAGAN
MSAS
AUS/NZ Test-Bed
WAAS PRN 133 SES XV 129.0 W
WAAS PRN 131 Eutelsat 117.0 W
WAAS PRN 138 Anick F1R 107.3 W
SDCM PRN 125 Luch-5B 016.0 W
EGNOS PRN 136 Astra 4B 005.2 E
EGNOS PRN 123 Astra-5B 031.5 E
GAGAN PRN 127 GSAT-8 055.0 E
EGNOS PRN 126 Inmarsat 3F5 065.0 E (Test)
GAGAN PRN 128 GSAT-10 083.0 E
SDCM PRN 140 Luch-5V 095.0 E
MSAS PRN 129 MTSAT 1R 140.0 E
AUS_NZ PRN 122 Inmarsat 4F1 143.5 E
MSAS PRN 137 MTSAT 2 145.0 E
SDCM PRN 141 Luch-5A 167.0 E
133
131
138
123
136
126
122
129
137
127
128

RTK

- Real Time Kinematic
- Capable of providing **centimeter accuracy** in real-time
- High accuracy GNSS receivers/Survey grade receivers
- Local RTK base station or RTK Network required
- Precision limited by baseline distance

RTK (Continued)

- Many states and regional governmental bodies have free/paid RTK networks (inquire with Eos)
- Rovers use the datum that the RTK base/network is referenced to
- Base station satellite support (eg. 2 constellations) can limit rover performance
- More organizations are opting to setup and operate in-house base station to take advantage of all satellite constellations

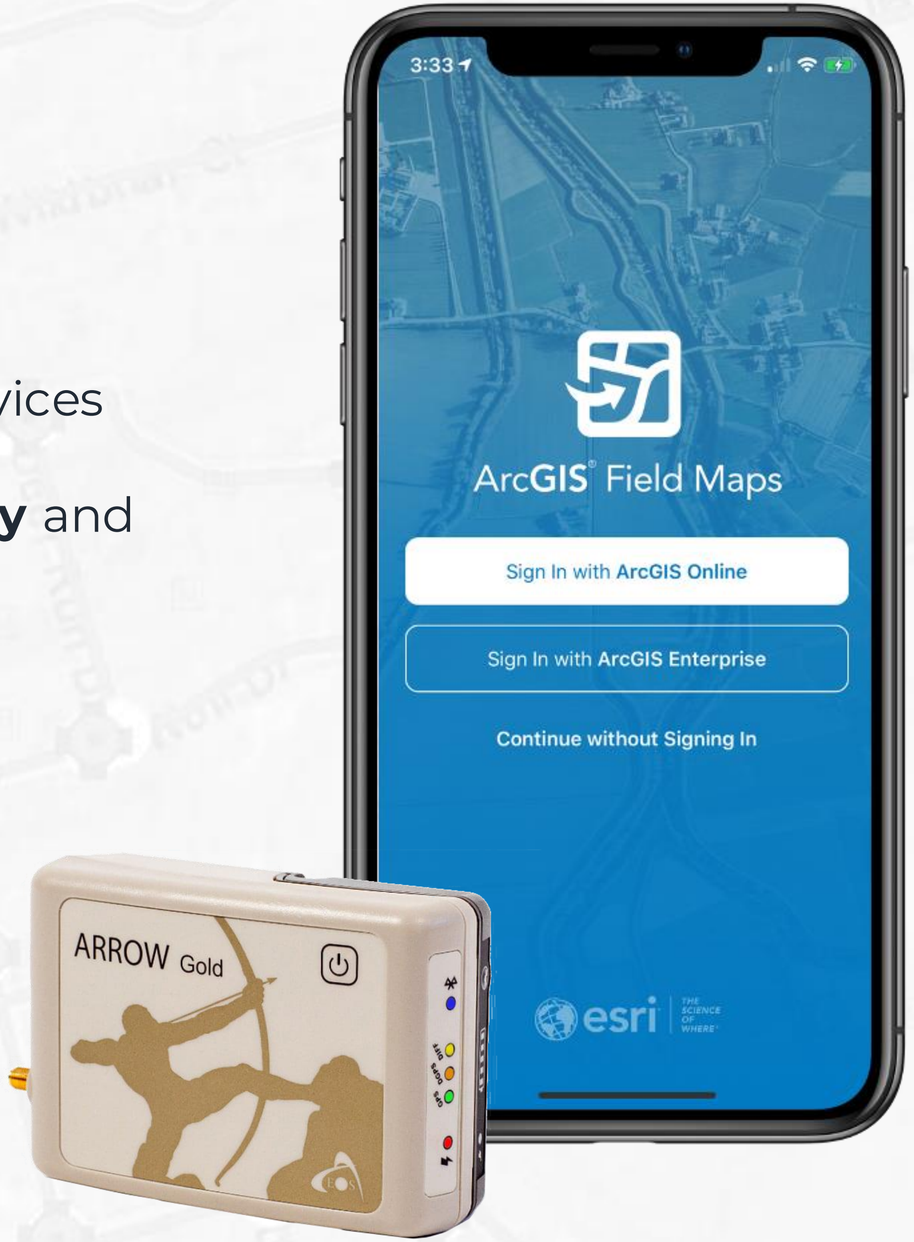


Post Processing

- Not real-time
- Capable of providing centimeter accuracy
- Any device capable of capturing raw data
- Local CORS base station required
- Precision limited by baseline depending on technique used (static vs. fast-static)

Devices Utilizing GNSS

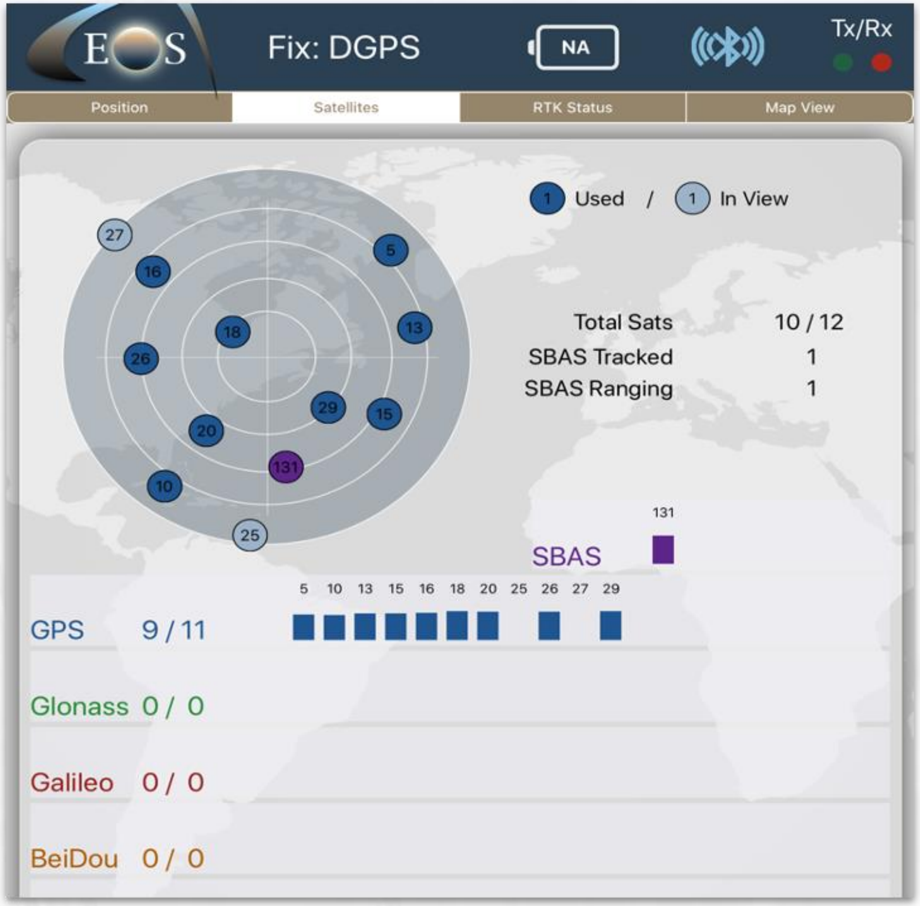
- GPS technology highly integrated into mobile devices
- External GNSS Receivers provide greater **reliability** and **accuracy**
    - Access to a larger **number of satellites**
    - Ability to utilize **correction sources**
    - Hardware & software designed for high accuracy
        - Antennas
        - Receiver algorithms

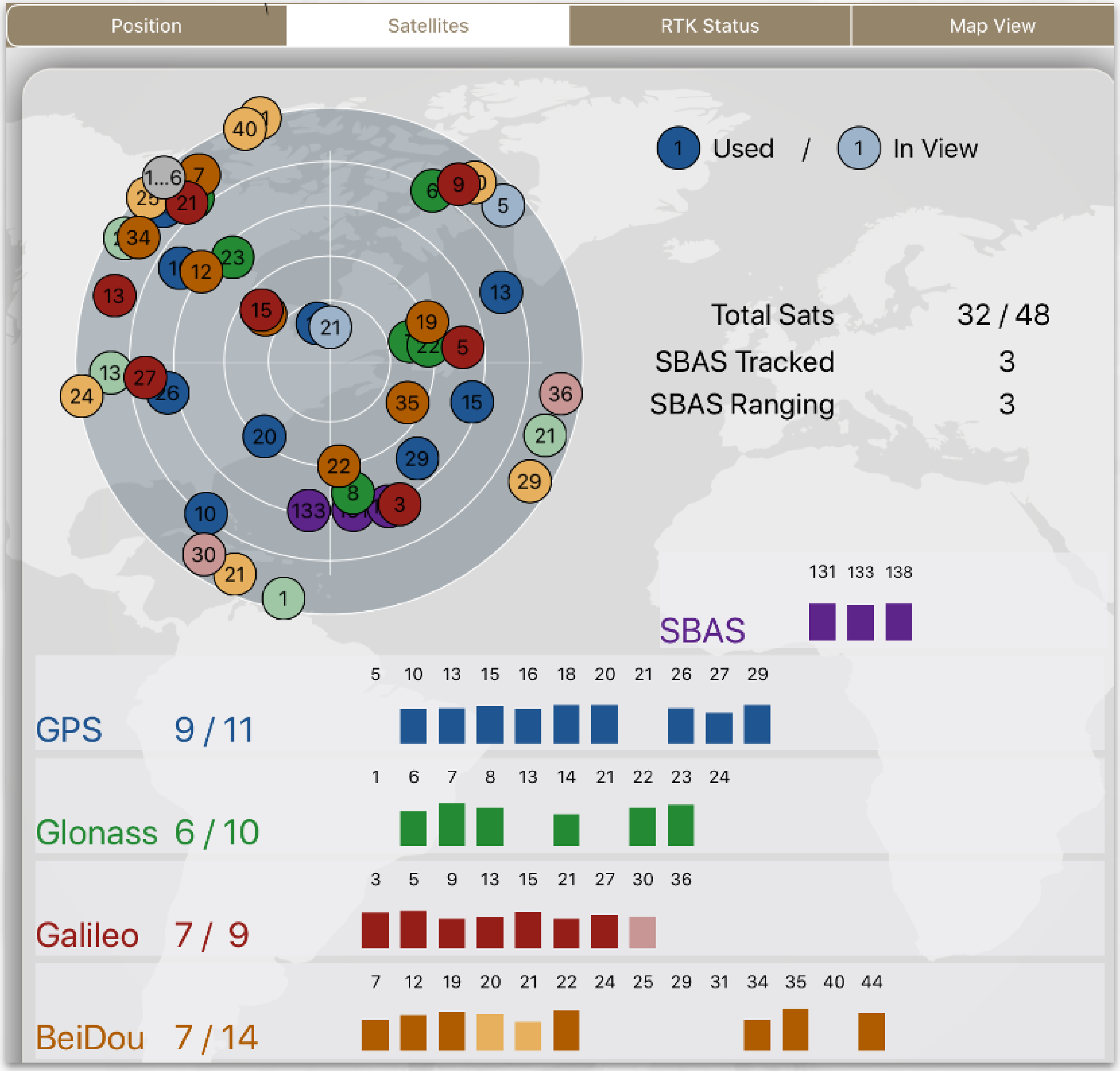


GNSS Challenges

- Tree canopy
- Buildings
- Bridges
- Other infrastructure
- Indoors
- Not weather

GPS vs. GNSS


Fix: DGPS
NA
Tx/Rx
Position
Satellites
RTK Status
Map View
Used / In View
Total Sats 10 / 12
SBAS Tracked 1
SBAS Ranging 1
SBAS
GPS 9 / 11
Glonass 0 / 0
Galileo 0 / 0
BeiDou 0 / 0

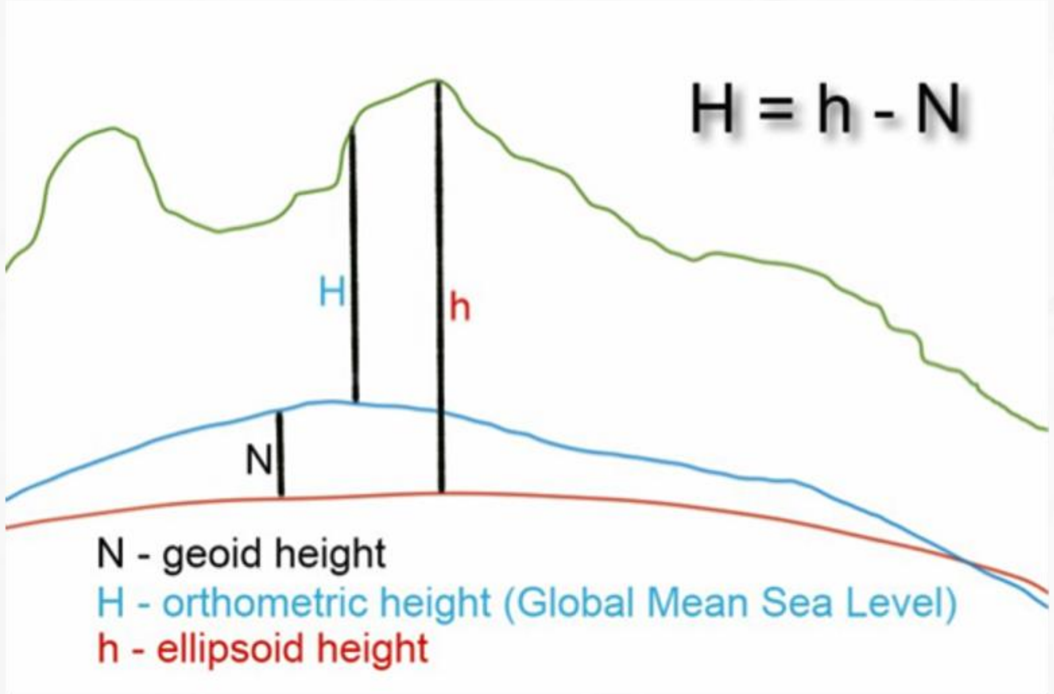

Position
Satellites
RTK Status
Map View
Used / In View
Total Sats 32 / 48
SBAS Tracked 3
SBAS Ranging 3
SBAS
GPS 9 / 11
Glonass 6 / 10
Galileo 7 / 9
BeiDou 7 / 14

GPS vs. GNSS: Accuracy & Productivity

	Accuracy	Productivity	Cost
GPS	☆☆☆☆☆	☆☆	☆
GPS GLONASS	☆☆☆☆☆	☆☆☆	☆☆☆
GPS GLONASS Galileo BeiDou	☆☆☆☆☆	☆☆☆☆☆	☆☆☆☆☆

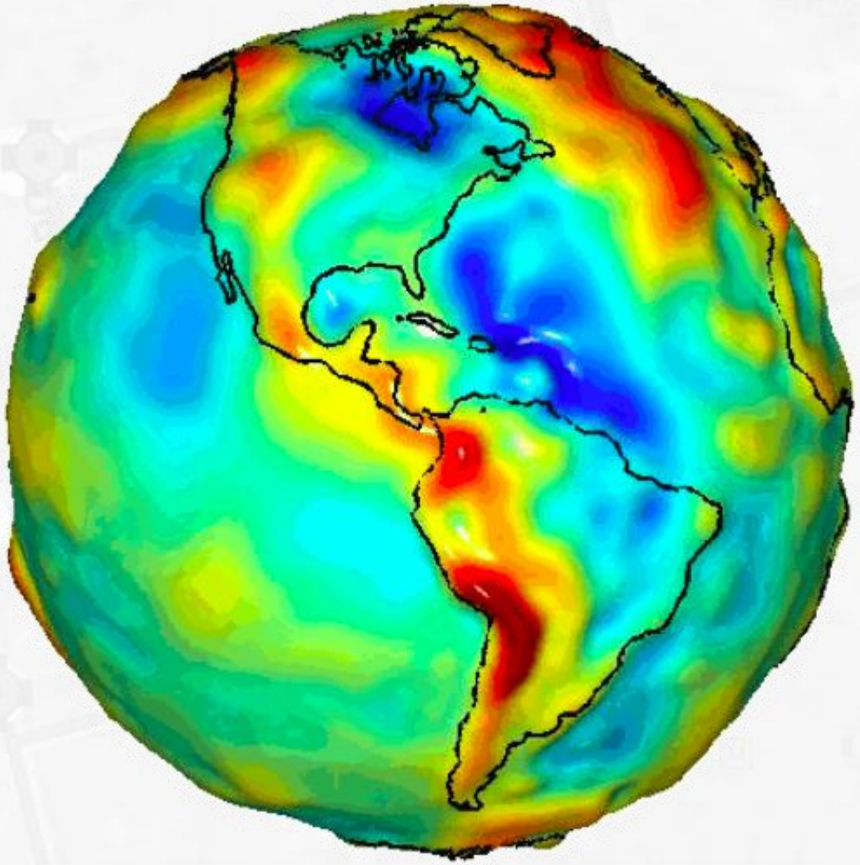
GNSS Elevations

- Ellipsoidal (GPS Height) - Often confuses users with a negative value.
- Mean-sea level – Closer representation of the earth's surface than ellipsoid. Default output on GNSS receivers.
- Orthometric (Geoid18) - Uses a Geoid model to adjust GPS height to a defined vertical datum.



GNSS Receiver Datum

- Defined by the correction source
- SBAS ITRF 2014
- RTK bases/networks in USA use NAD 1983 (2011)
- WGS1984 -> NAD 1983 (2011) can be a significant shift
  ~1.4 meters



Storing **High Accuracy GNSS Data** in **ArcGIS**

1. Datum Transformations & coordinate System Projections

2. Elevations

3. GNSS Metadata

Datum Transformations & Coordinate System Projections

Datum Transformations & Coordinate System Projections

GNSS Receiver -> **Location Profile** -> WebMap -> **Feature Layer**

CS Defined by Correction Source

User defined

3 parameters

(1) GNSS Coordinate System

(2). Map Coordinate System

(3). Datum Transformation

Defined by basemap

Esri Basemaps

WGS 1984 Web Mercator Auxiliary Sphere

WKID: 3857

CS Defined by layer

Examples

SBAS = ITRF

RTK = NAD83 (2011)

CS = Coordinate System

Example Scenarios

1. **SBAS GNSS & Esri Basemaps**
2. **RTK GNSS & Esri Basemaps**
3. **RTK GNSS & Custom Basemap**

1. SBAS GNSS & Esri Basemaps

GNSS Receiver	->	**Location Profile**	->	WebMap	->	**Feature Layer**
ITRF2014		[Default] or [ITRF2014]		WGS84 Web Mercator		NAD 1983 (2011) Oregon North State Plane

2. RTK GNSS & Esri Basemaps

GNSS Receiver	->	**Location Profile**	->	WebMap	->	**Feature Layer**
NAD 1983 (2011)		1. NAD 1983 (2011) 2. WGS84 Web Mercator Aux 3. USA – CONUS And Alaska		WGS84 Web Mercator Aux Sphere		NAD 1983 (2011) StatePlane Oregon North

3. RTK GNSS & Custom Basemap

GNSS Receiver	->	**Location Profile**	->	WebMap	->	**Feature Layer**
NAD 1983 (2011)		1. NAD 1983 (2011) 2. WGS84 Web 3. [Depends]		**Defined by custom basemap**		NAD 1983 (2011) StatePlane Oregon North

*Can differ from the basemap coordinate system

Datum Transformations & Coordinate System Transformation – Take aways

1. **Feature Layer –** Publish the feature layer in your preferred coordinate system.
2. **Location Profile** - Set the correct location profile determined by the GNSS correction source and WebMap basemap.

   Changing from SBAS to RTK(or other way) requires a location profile change.
3. **Map –** The map "operates" in the coordinate system of the basemap. The data is stored in the coordinate system defined by the layer.

Elevations

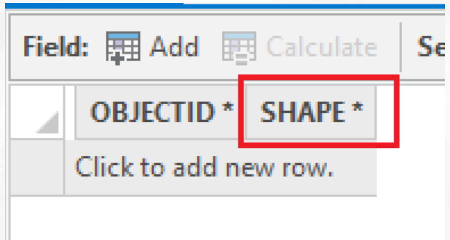
Poll Question

How important is it to collect accurate elevations to you or your organization?

Elevations - Z value vs. Attribute Table

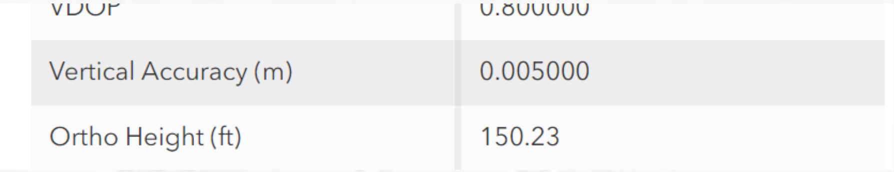
Z Value

- Z-enabled layers can store the elevation of a feature in the geometry of the point or vertex
- Populated automatically by FieldMaps. Units are in meters regardless of the spatial reference.
- Not displayed by FieldMaps by default
- Stored in the same place as X & Y. Source of the coordinates displayed on the map.



Attribute Table

- User defined attribute used to store elevation data.
- Not populated by Field maps automatically by default
- *New* Use FieldMaps field calculations to populate a field of your choice with the elevation data.



Elevations - Types of Elevations Stored

Z Value

- MSL or Orthometric height reported by the receiver in meters
- Changing the spatial reference of the layer has no impact on the value stored.

Attribute Table

- User defined attribute used to store elevation data.
- Not populated by Field maps automatically by default.
- *New* FieldMaps can use field calculations to populate a field of your choice with the elevation data.
- Units can be changed by converting meters to feet within the Arcade script.

ESRIGNSS_Altitude

- Stored in the attribute table as part of a set of special GNSS metadata fields.
- Automatically populated by FieldMaps if field exists.
- Value stored is the ellipsoid height in meters. Also known as GPS height.
- Units cannot be changed.
- This value is obtained by adding the geoid separation value to the MSL elevation.

Elevations - Z value vs. Attribute Table

Z Value

- Z-enabled layers can store the elevation of a feature in the geometry of the point or vertex
- Populated automatically by FieldMaps. Units are in meters regardless of the spatial reference.
- Not displayed by FieldMaps by default
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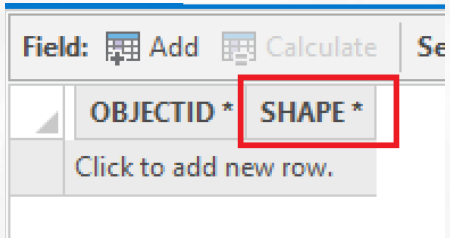


Attribute Table

- User defined attribute used to store elevation data.
- Not populated by Field maps automatically by default
- *New* Use FieldMaps field calculations to populate a field of your choice with the elevation data.

VDOP	0.800000
Vertical Accuracy (m)	0.005000
Ortho Height (ft)	150.23

Elevations – Take aways

1. **Elevations** can be stored in different places and represented in different ways(MSL/Orhto/Ellipsoid).

2. Multiple versions of an elevation can be stored in a single feature.

3. The new FieldMaps field calculation tool can be used to manipulate and populate elevations into a user defined field in real-time.

GNSS Metadata

What is GNSS Metadata?

Detailed information reported by the GNSS receiver used during data collection.

- Common information includes:
  Source of position data
  Estimated accuracy reported
  Satellites used
  Averaging statistics
  Etc.

- Usually stored as a collection of attribute fields

GNSS Metadata – Points

1. A set of 20+ pre-defined attribute fields dedicated to storing GNSS metadata.

2. If these fields exist in a point layer during data collection FieldMaps will automatically populate them.

3. The purpose of these fields is to store the original data from the GNSS receiver before the data is manipulated.

4. Note that the latitude, longitude, and altitude information stored will differ from the point geometry.

Position source type	External GNSS Receiver
Receiver Name	Eos Positioning Systems #21600984
Latitude	45.406765
Longitude	-122.748925
Altitude	24.728000
Horizontal Accuracy (m)	0.012042
Vertical Accuracy (m)	0.015000
Fix Time	10/17/2022, 10:57 AM
Fix Type	RTK Fixed
Correction Age	2.000000
Station ID	1
Number of Satellites	21
PDOP	1.100000
HDOP	0.600000
VDOP	1.000000
Direction of travel (°)	346.220000
Speed (km/h)	0.537080
Compass reading (°)	

GNSS Attributes – Lines & Polygons *New*

1. Overall GNSS statistics stored in a set of attribute fields.

2. Vertex information stored in an attached file in JSON format.

3. Enable this feature by creating the layer in ArcGIS Online and toggling the **Add GPS metadata fields**
   or
   Use a python notebook to enable GNSS attributes on existing line & polygon feature layers.

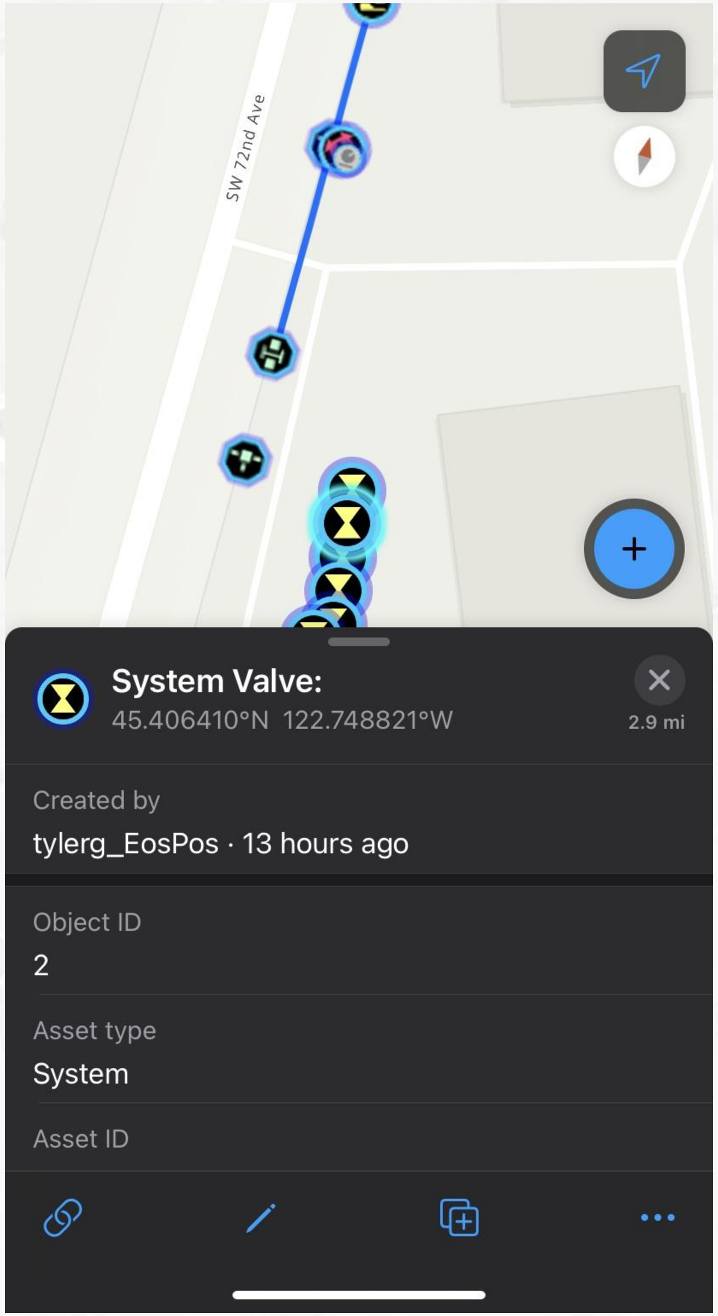
4. Next release of ArcGIS Pro will have a tool available.

Water Main:

Notes	
Number of manual locations	0
Object ID	4
Owned By	Our Agency
Retired Date	
Spatial Confidence	Unknown
Spatial Source	Unknown
Tracer Wire	Unknown
Updated by	tylerg_EosPos
Water Type	Potable
Worst fix type	
Worst horizontal accuracy (m)	4.82
Worst vertical accuracy (m)	3.31

_gnss_metadata.json

Map & Layer Setup



Map & Layer Setup

Basic Steps

1. Create a feature class
2. Add the Esri GNSS attribute fields
3. Add the layer to a WebMap.
4. Setup the WebMap to display/store the elevations.

Demonstrate in ArcGIS Pro & ArcGIS Online

INTERMISSION:

Enjoy this 10-minute break while we get set up for the outdoor demonstration!

Thank you for joining!

- Download the Handouts
- Subscribe to the Eos monthly newsletter: https://eos-gnss.com/subscribe
- Request an advanced data-collection workshop recording: https://eos-gnss.com/request-workshop-access
- On to Q&A …