"Mobile Technology For Outdoor Activities" (Part 1)

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NMCCSC
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Note: Presentation created for smaller monitor sizes

"QUICK" Review of January 2020 Presentation

"Current Location Technology and Route Planning Resources"

Where am I? How to I get to …?

Trilateration

Compass

Satellite

App

Latitude

Longitude

Coordinates

Accuracy

GPS

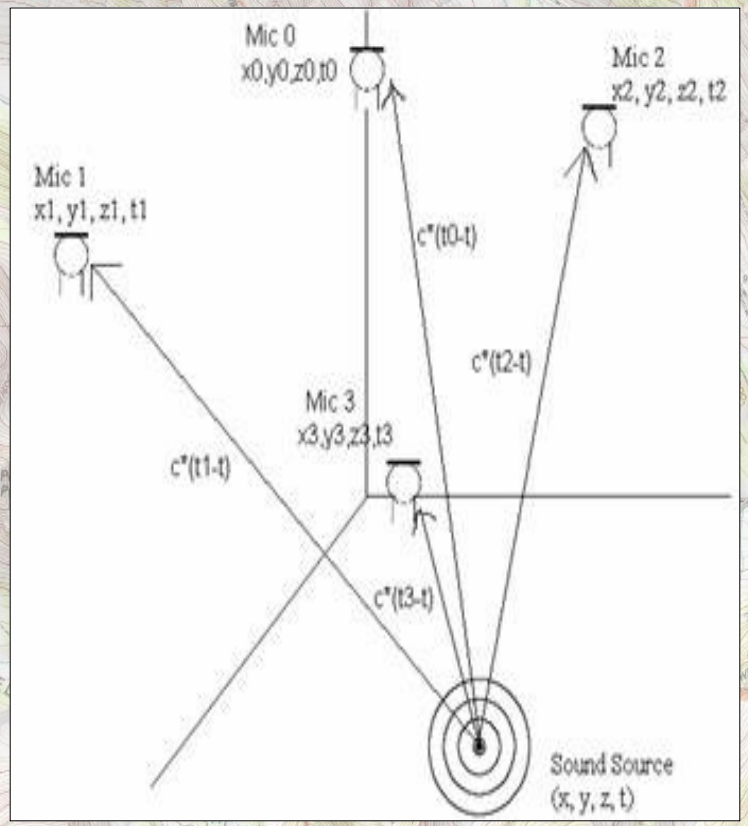
Garmin

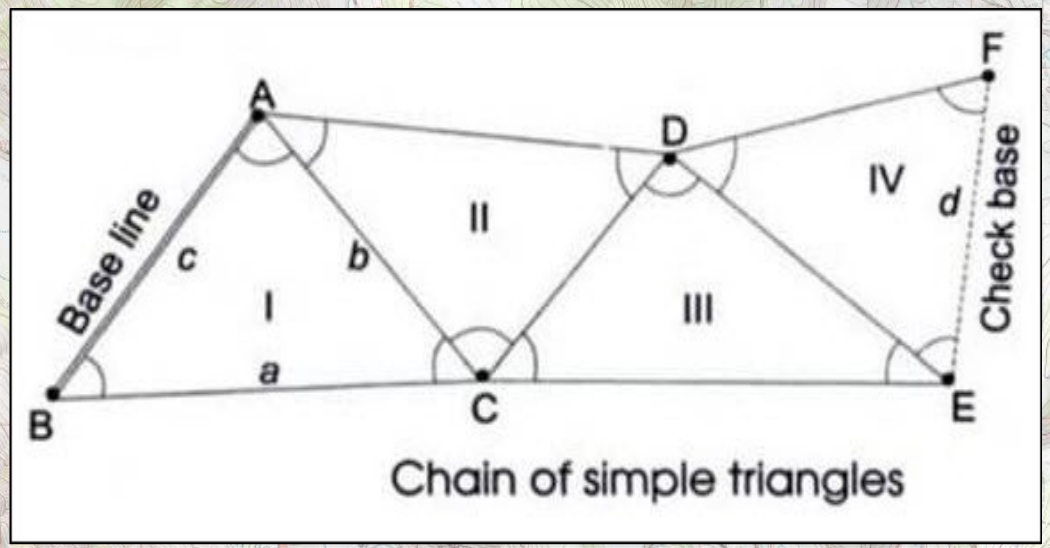
Location

Triangulation

Triangulation:

Object location by using angles and distances from different points.

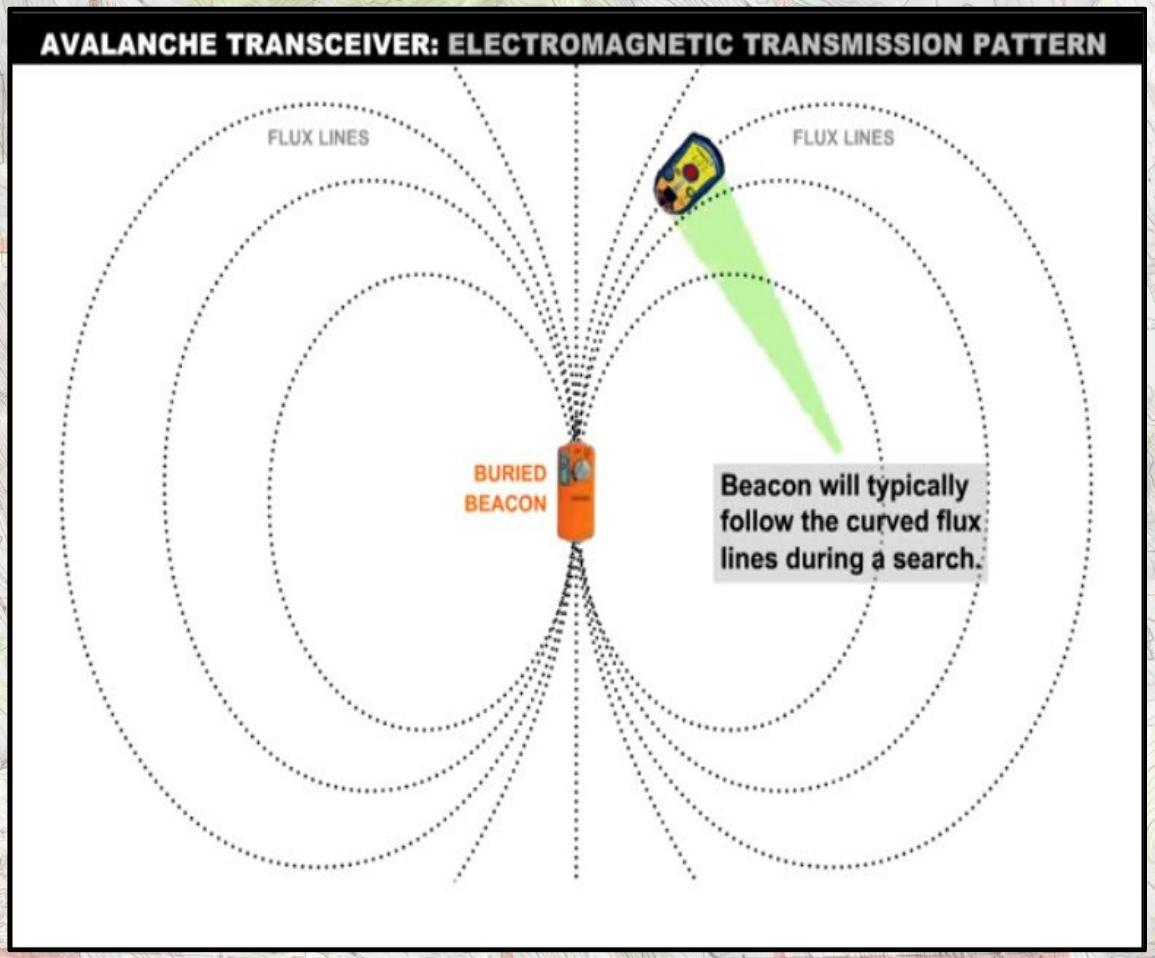




Avalanche Beacon: Triangulation

Beacon works on the principle of triangulation.

Receiver detects the transmitter's signal direction/strength on a standardized radio frequency (457 kHz)

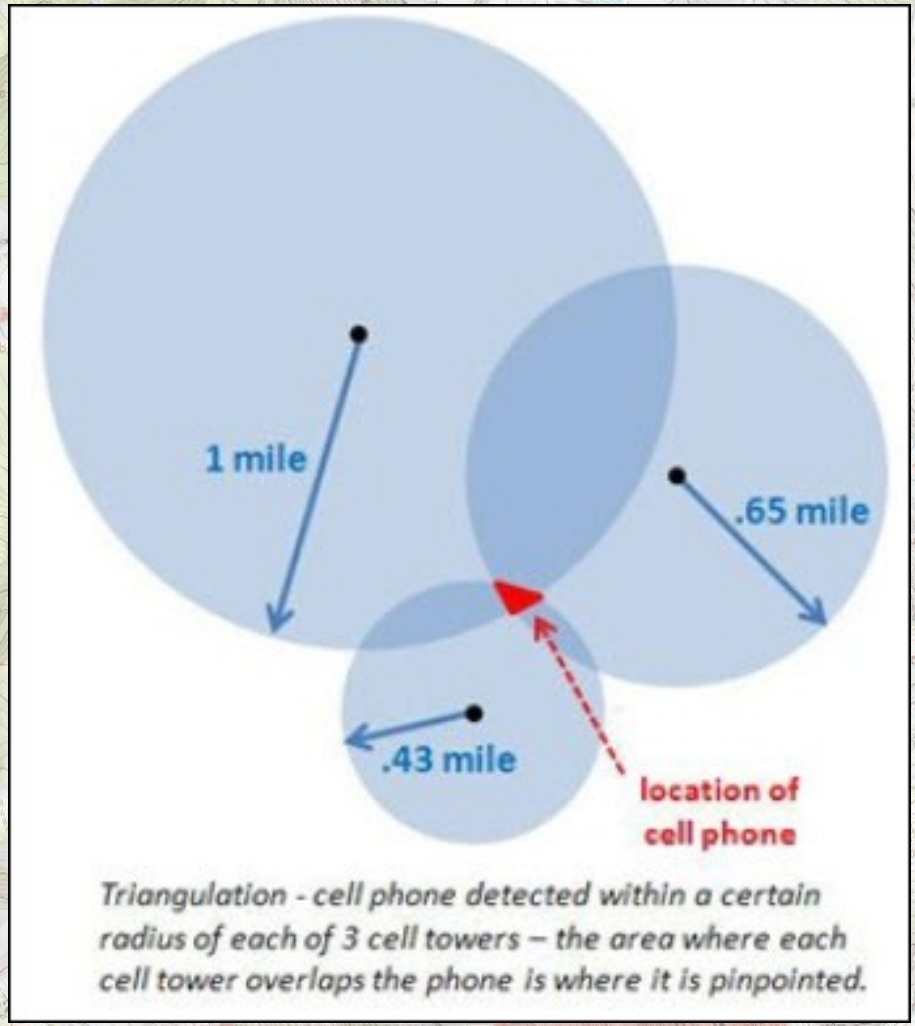


Mobile Phone Triangulation

Three towers are used to **estimate** cell phone location by estimating distance from each tower to cell phone via the antenna pattern. Signal strength may provide angular measure for triangulation.

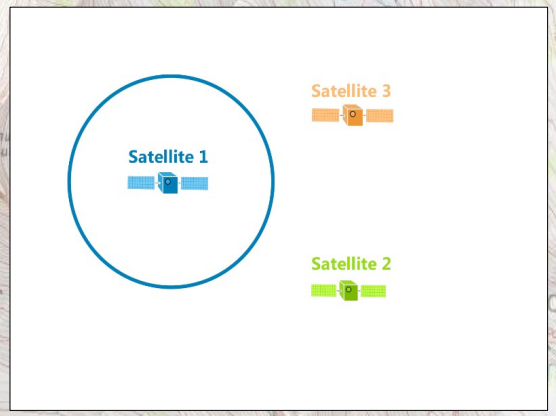
Various methods may also be used in combination.

Due to load on one tower, system may switch to other tower which is more distant, reducing accuracy.



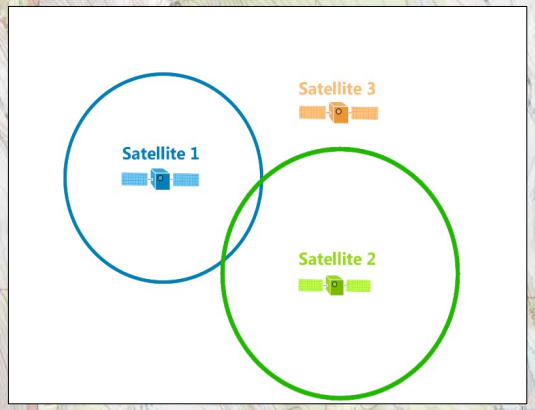
Triangulation - cell phone detected within a certain radius of each of 3 cell towers – the area where each cell tower overlaps the phone is where it is pinpointed.

2D Trilateration:



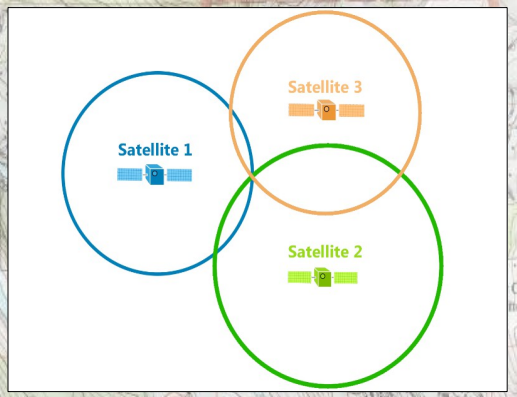
Relies on **DISTANCE** measurements from a known point, not angular measure. Satellite positions are known and receiver distance to multiple satellites is known. Multiple intersection points provide accurate location of receiver.

Receiver is somewhere on radius curve from Satellite 1.



Receiver distance from Satellite 2 provides 2 possible locations.

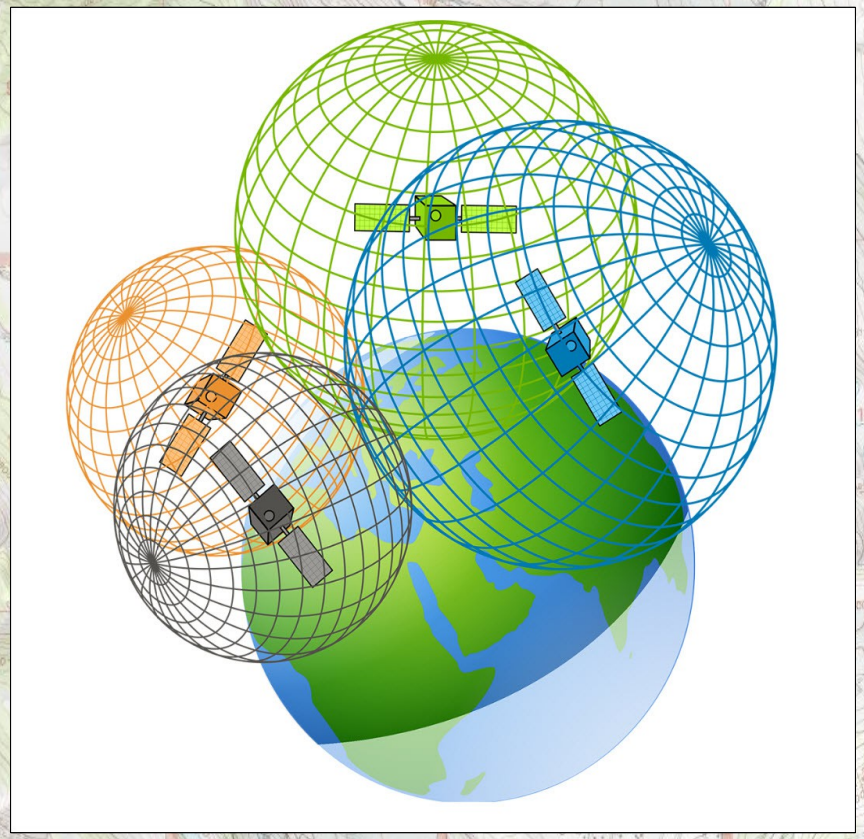
Receiver distance from Satellite 3 determines which of the two possibilities is receiver location.



3D Trilateration:

4th satellite provides altitude in 3D space, thus your location on the Earth. More satellites provide higher accuracy.

5-8 satellites are usually visible from any location



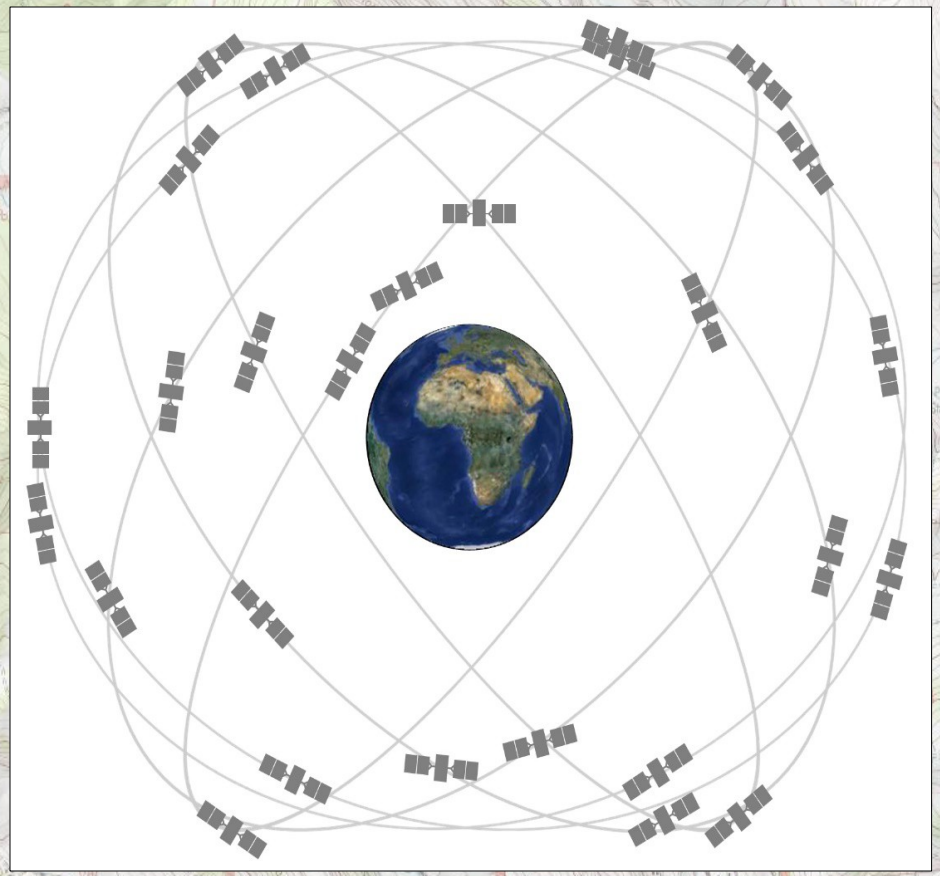
NOTE: "Trilateration" is sometime called "triangulation."

GNSS (Global Navigation Satellite System)

Generic term for Satellite Navigation Systems

GPS (Global Positioning System) (US DoD - USAF)

30 operational Satellites broadcast Precise Satellite Position, Atomic Clock Time of Transmission, Ephemeris & Almanac Data, Health Info, & Clock Corrections via the "GPS Message."



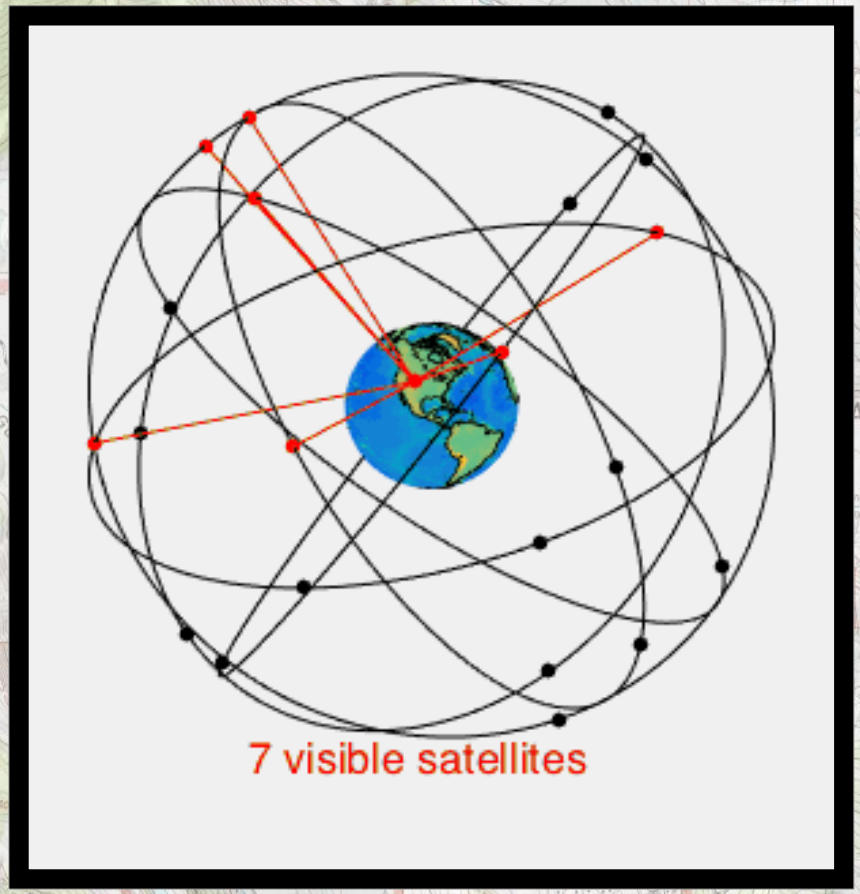
Other Satellite Systems

Galileo (EU)
GLONASS (Russian)
BeiDou (China)
QZSS (Japan)
SBAS (Satellite-based Augmentation System;
Geo-stationary satellite & ground based differential corrections

GPS units only receive line of sight signals.

GPS (US Global Positioning System)

6 satellite orbits are designed to provide at least 4 satellites in view. (One spare satellite per orbit).
4 satellites are used to calculate a Time Bias.
Most GPS units require 5 satellites before they provide location. 5-10 hour availability per satellite. 12 hour period each. Accuracy improves with more signals.



GPS receiver calculates **DISTANCE** to satellite by the time it takes for signal to reach receiver.

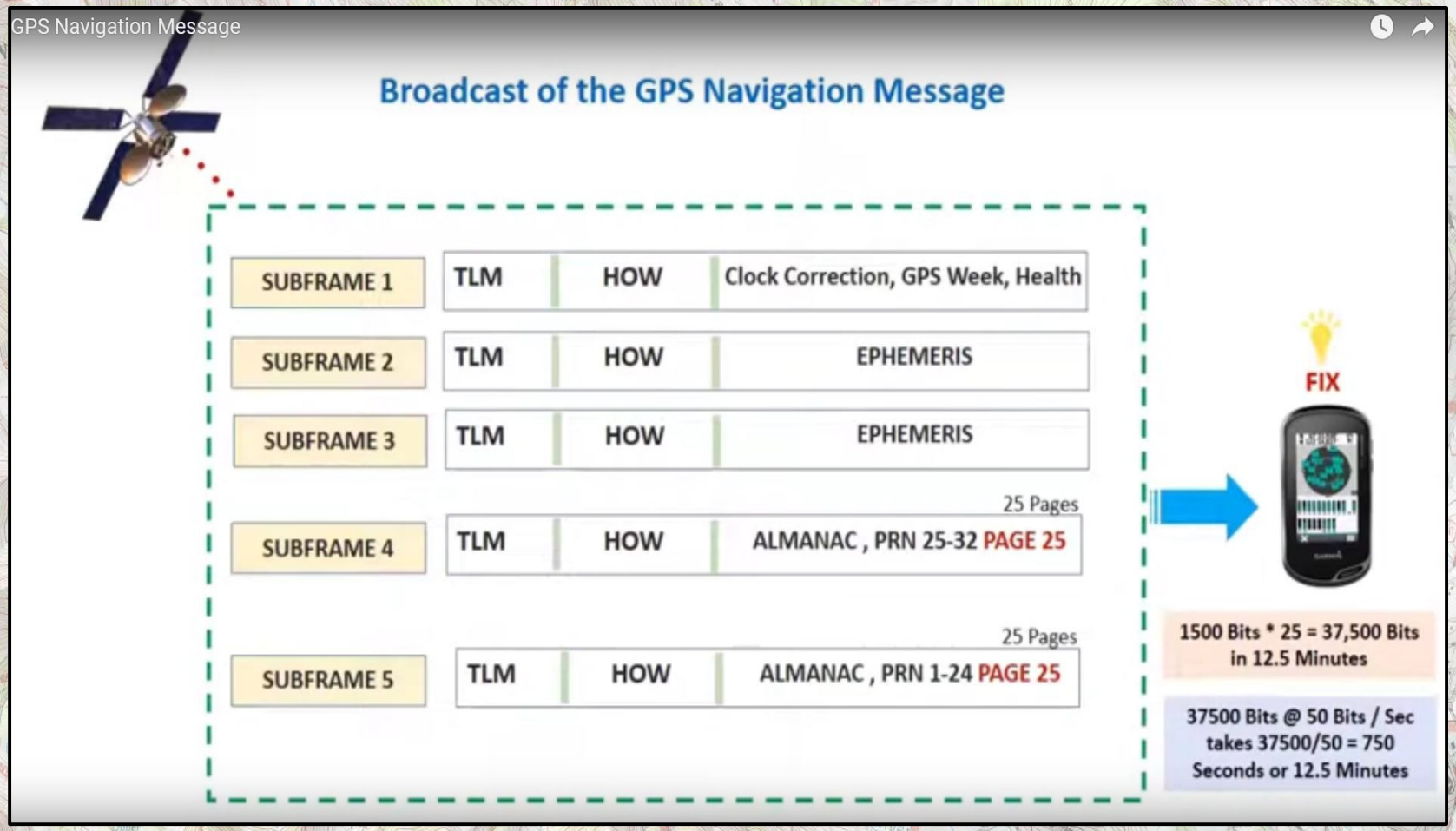
D = S x T = S x (Ts – Tr)

S = Speed of light
Ts = Satellite time
Tr = GPS receiver time

Ex: Velocity (60 mph) x Time (2 hours) = Distance (120 miles)

GPS Navigation Message (NAV)

25 pages (frames) of data, each taking 30 seconds to transmit, and low power (low data rate) result in 12.5 minute delay to transmit entire NAV. NAV is transmitted repeatedly. GPS units that have been off for a period on time require longer time for “first fix.”



“Thank you!” Neil McCasland, for more detail on GPS Message

GPS Skyplot

The satellite “Skyplot” provides a visual aid to explain how a satellite's position relative to the reciever impacts the accuracy of the location data. It's better for satellites to be dispersed than clustered. Signal quality from satellites close to horizon are not as good as others above a “mask angle” of 10 degrees. “Line of Sight” impacts signal quality.

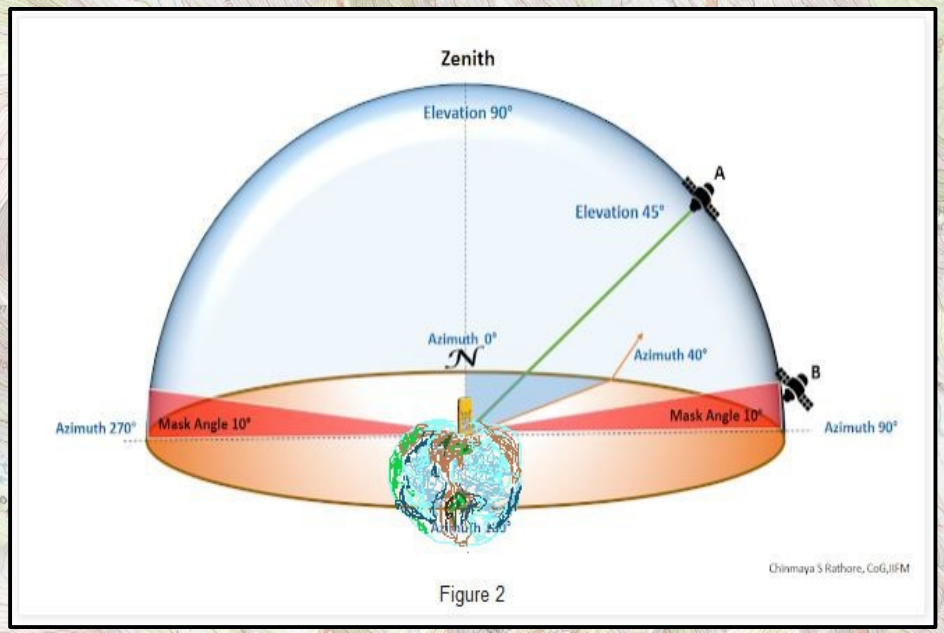


Figure 2

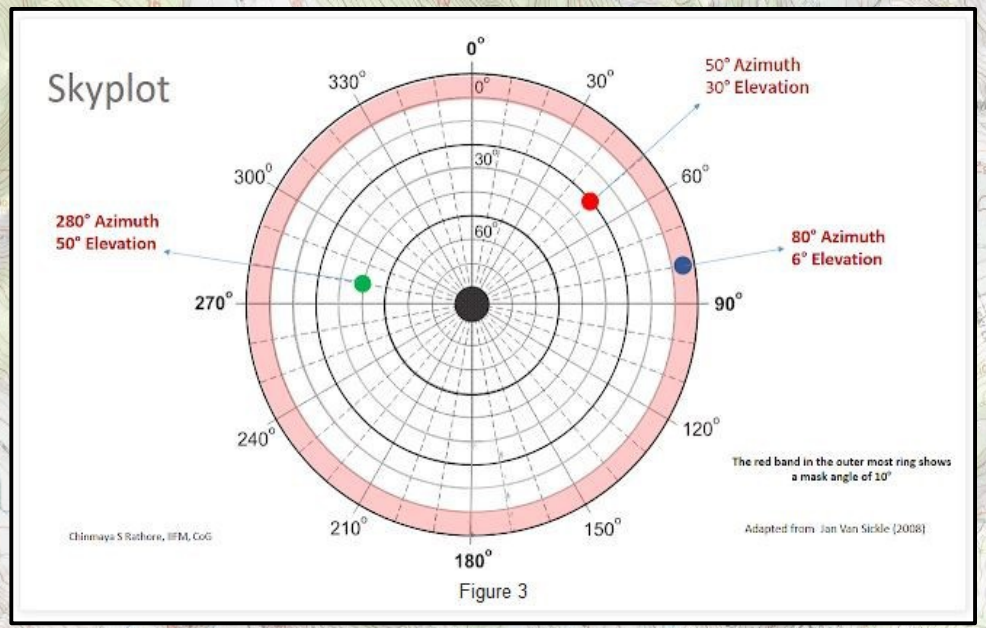


Figure 3

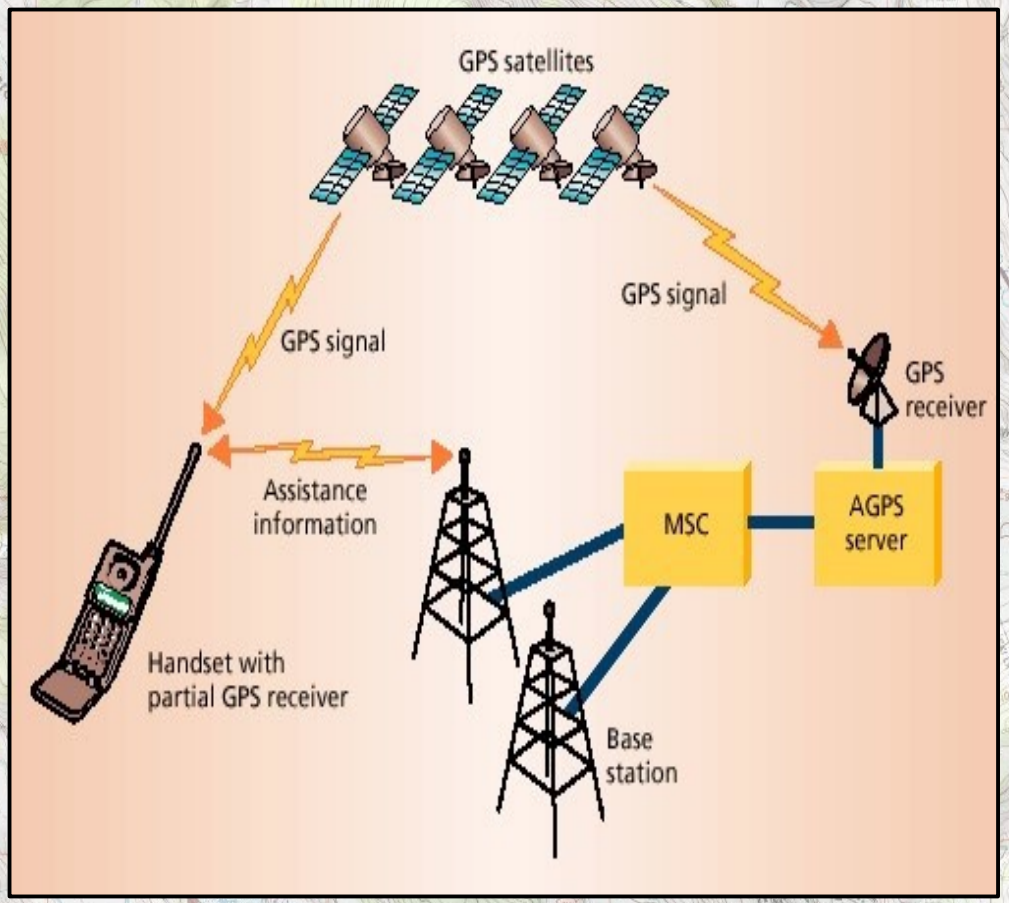
A-GPS: Assisted GPS (Mobile Device)

Cell phone towers provide rough estimate of cell phone location, speeding up "first fix." Many cell phone GPS chips utilize GPS and GLONASS.

GPS receivers take longer for "first fix."

Airplane mode disables A-GPS and reverts to standalone GPS. Consider rescue implications.

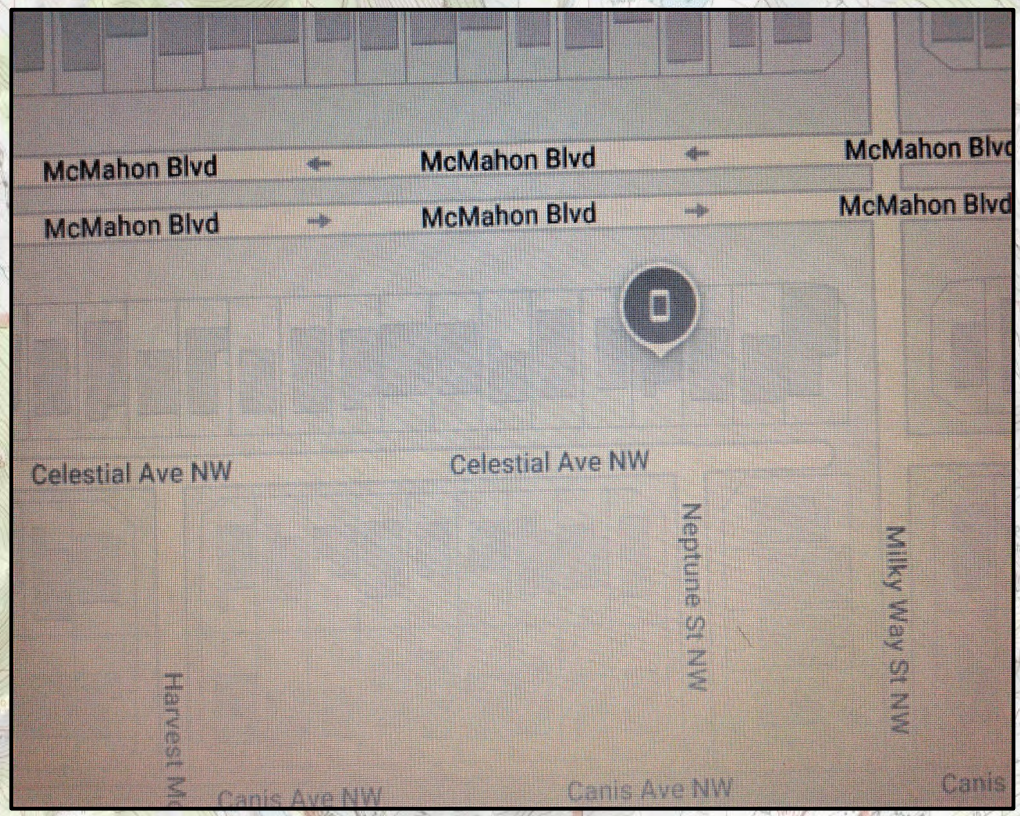
A-GPS has been utilized by First Responders and E911 Services.



Cell Phone Ping

A “ping” request returns the cell phone GPS location; a more precise location.

Google’s “Locate My Device” uses a “ping” to access GPS location on a lost phone.



NOTE: I lost my mobile phone, which was subsequently run over. Resident of this home found it. I stopped by and resident was glad I knew where it was located.

11 Essentials?

Add communication device to Essentials List?

4 Basic Responsibilities:

- Coordinate w/responsible party
- Carry topo map, base plate compass, & GPS receiver
- Carry cell phone & turn on periodically and note signal access. This also provides carrier with “ping” data in case rescue is needed. (Optional: Satellite communicator – Personal Locator Beacon)
- Carry seasonal essentials for survival

NOTE: Cold disables batteries; keep phone warm in zip-bag.

http://www.traditionalmountaineering.org

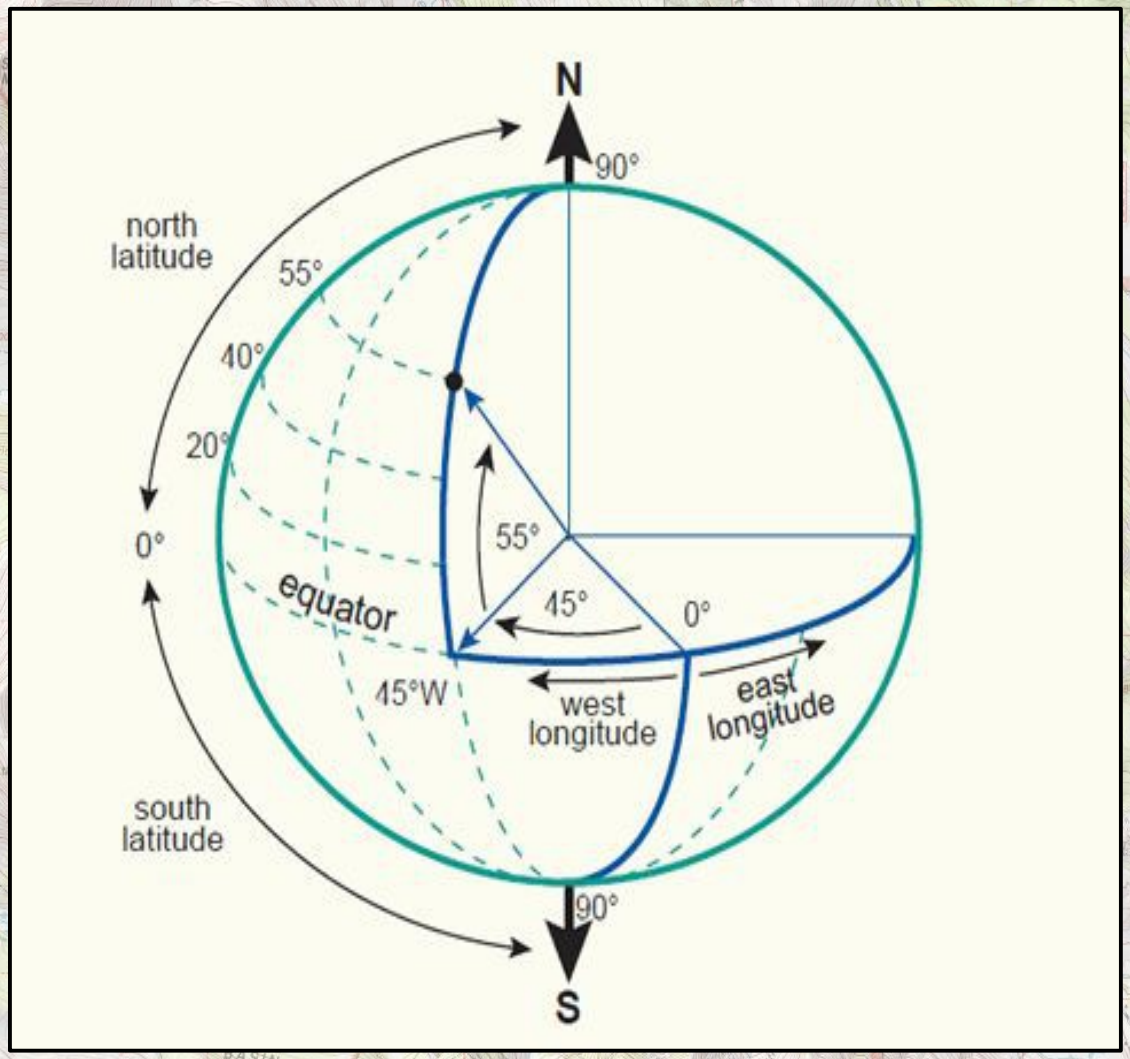
“Death by GPS” (Grey Matters!)

Our trust in GPS technology has taken common sense out of the equation. People became lost, injured or died, because they trusted GSP over obvious factors.

This was the cause of various deaths attributed to following GPS directions or GPS maps.

https://listverse.com/2018/11/27/10-times-gps-failed-with-terrible-consequences/

Geographic Coordinate System



Latitude: Horizontal

North of Equator

(N or Positive)

South of Equator

(S or Negative)

Longitude: Vertical

West of P.M.

(W or Negative)

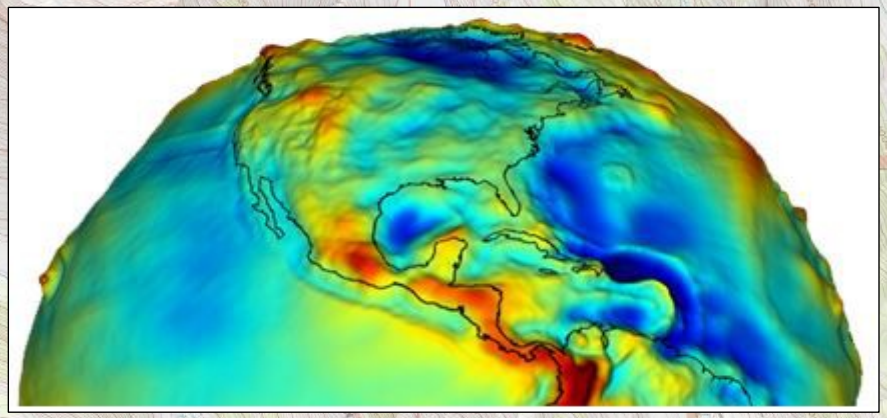
East of P.M.

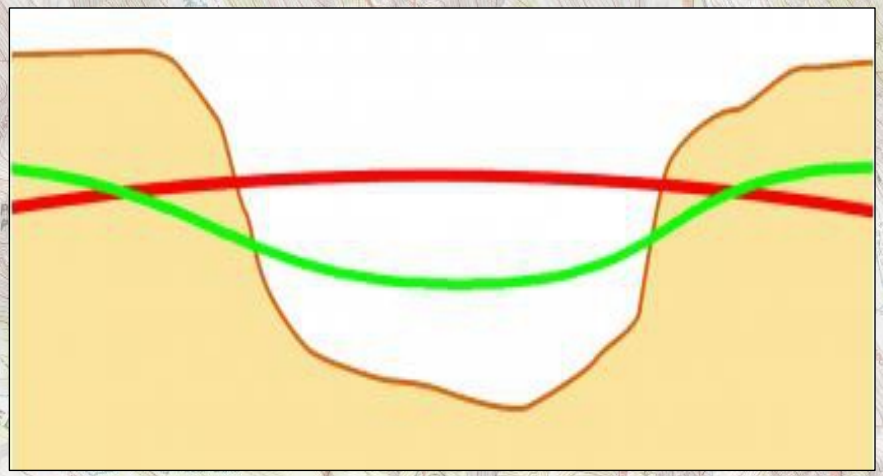
(E or Positive)

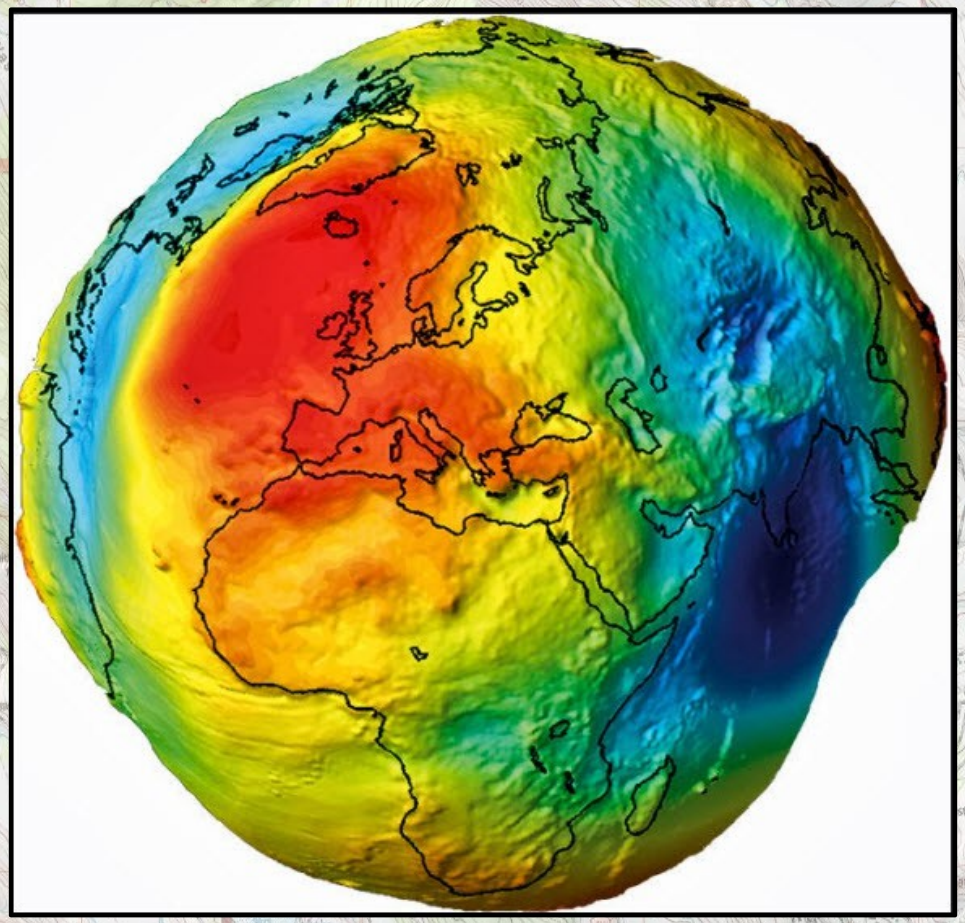
Projected Coordinate System

World Geodetic System (WGS84)

WGS84 is considered to be the Global Ellipsoid model for the Earth. GPS uses WGS84 as its reference coordinate system to estimate a position (LAT, LON, ELEV) on the ellipsoid



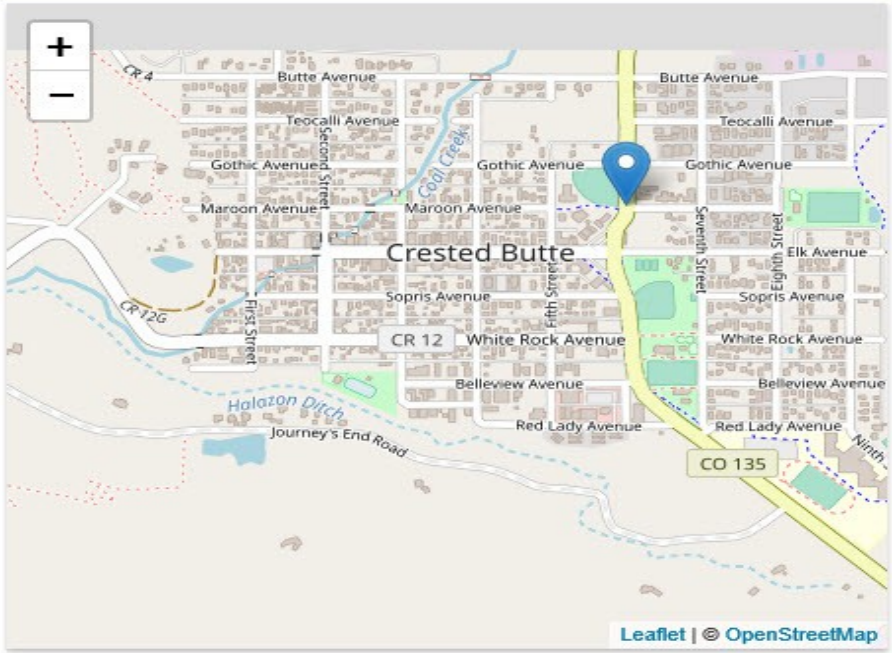


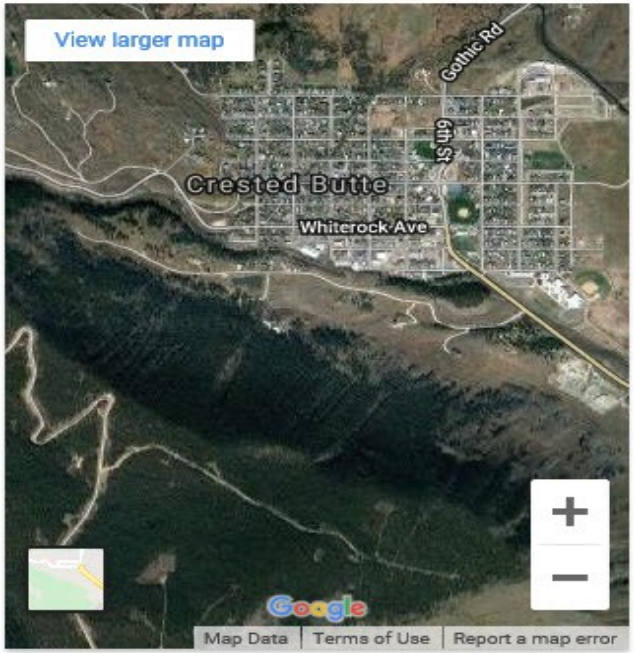


Spheroid/Ellipsoid; Geoid; Topography Elevation

Latitude/Longitude Representations

Degrees; Degree Minute & Seconds; Degree Minutes; UTM





Lat Long	GPS Coordinates
(38.870682, -106.980942)	38° 52' 14.4552'' N 106° 58' 51.3912'' W

Emergency Services Requests: Be very clear when you communicate with Emergency Services, what coordinate system you're providing. **Decimal Degrees (WGS84)** is easier to deal with than Degrees/Min/Sec. Almost all GPS apps allow you to select format used to display locations. That said, many SAR groups are switching to US National Grid (based on UTM) system. (I'm not going there!) Research and standardize your apps!

GPS Precision vs. Accuracy

Gaia (5 dec)

Sandia_Crest__RockyPoint_(1_1_20 9_19_41_AM).gpx - Not...

File Edit Format View Help

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<trk>
<name><![CDATA[New Track 1/1/20 9:19:41 AM]]></name>
<desc></desc>
<number>19</number>
<extensions><topografix:color>c0c0c0</topografix:colo
<trkseg>
<trkpt lat="35.19511" lon="-106.432594">
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</trkpt>
<trkpt lat="35.195445" lon="-106.433743">
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</trkpt>
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<ele>3082</ele>
```

Garmin (10 dec)

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8T12:24:31Z</time></trkpt><trkpt lat="35.1441670675" lon="-106.5104873758"><ele
8T12:24:36Z</time></trkpt><trkpt lat="35.1444621105" lon="-106.5093051922"><ele
8T12:24:43Z</time></trkpt><trkpt lat="35.1446240488" lon="-106.5086498111"><ele
8T12:24:47Z</time></trkpt><trkpt lat="35.1447777729" lon="-106.5080023091"><ele
8T12:24:51Z</time></trkpt><trkpt lat="35.1449662820" lon="-106.5071797092"><ele
8T12:24:56Z</time></trkpt><trkpt lat="35.1450562198" lon="-106.5061365813"><ele
8T12:25:02Z</time></trkpt><trkpt lat="35.1450590696" lon="-106.5059584659"><ele
```

ViewRanger (8 dec)

1:52 92%

```
{"header":{"colour":-16777216,"name":"Track
Jan 1, 2020 9:19:24 AM","lastModTime":
1577901732253,"gridPositionCoordType":17},"points":[{"lat":
3                                    ":-892821314,"map_y":
3                                    54436,"from_
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35.1956829,"lon":-106.43391766,"map_x":-892832413,"map_y":
```

View Copy Web Search Share Select all

These examples show the contents of a GPX file. The file can be edited with any text editor. Mapping devices/apps provide functionality using the contents, or they may add to the file, such as when recording a track.

https://gis.stackexchange.com/questions/8650/measuring-accuracy-of-latitude-and-longitude/8674#8674

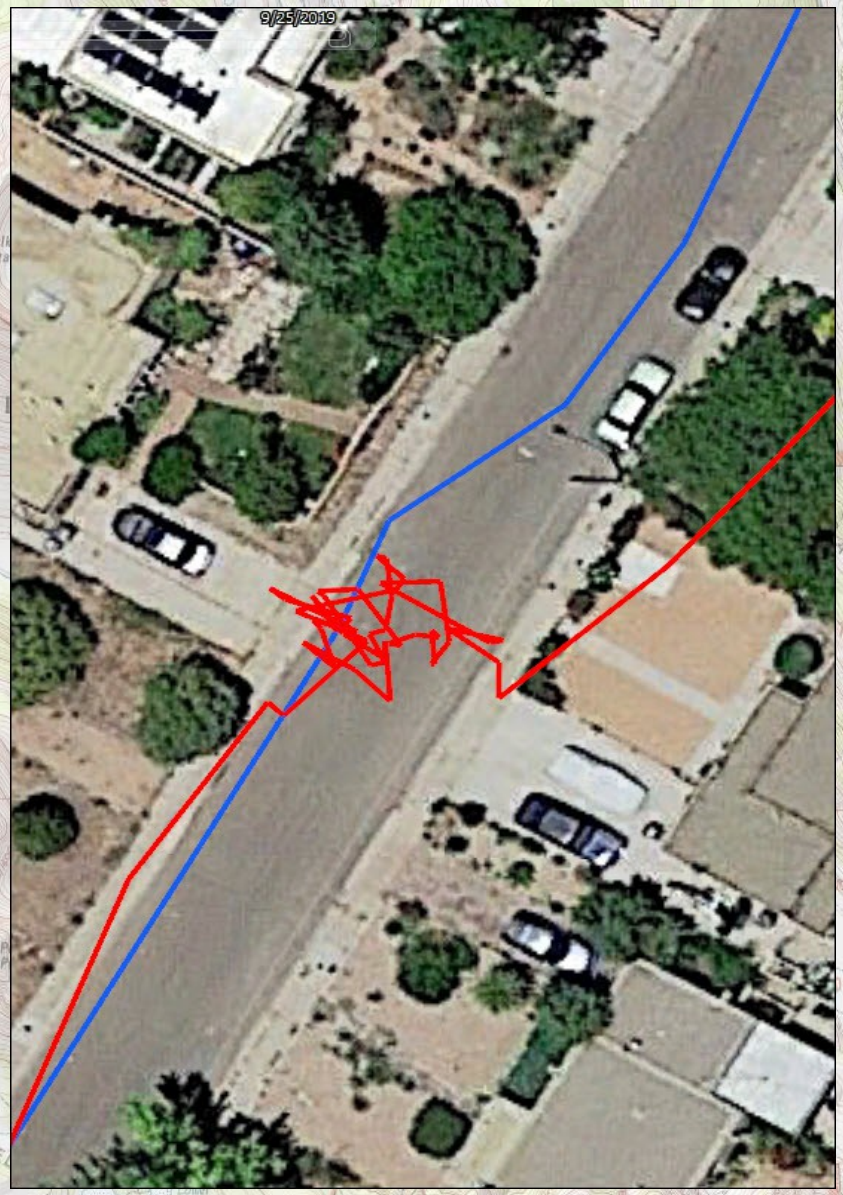
GPS Precision vs. Accuracy

Comparison of mobile phone App and a Garmin

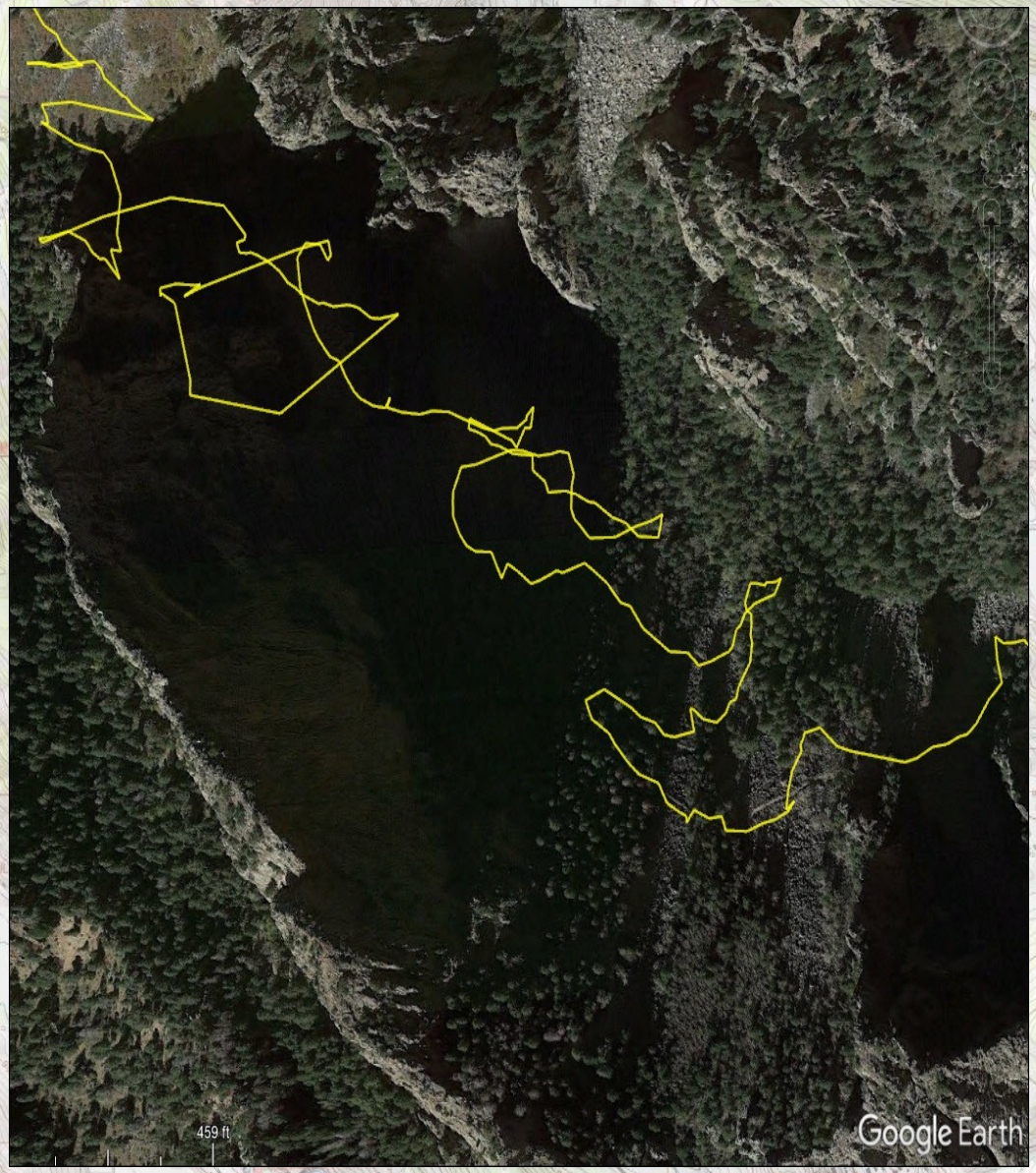
The red track reflects A-GPS on a phone app.

The blue track is from a Garmin with freshly charged batteries. Collection was started without calibration and no wait time for "first-fix". Are the 10 decimal places providing me with better accuracy?

GPS Data Collection Quality



Garmin kept collecting data while I paused for about 10 minutes



GPS signal scatter and fewer satellites visibile on the La Luz “Rock Slide”

Radio Communications

Consider adding radio communications capabilities.

- **FRS**
  - No license required
  - Low power
  - Short signal range
- **GMRS**
  - No test for license ($)
  - Higher power
  - Longer signal range
- **Ham (VHF/UHF)**
  - FCC test req. ($15/Life)
  - Highest power
  - Repeater usage
  - Longest range

Personal Locator Beacon (PLB)

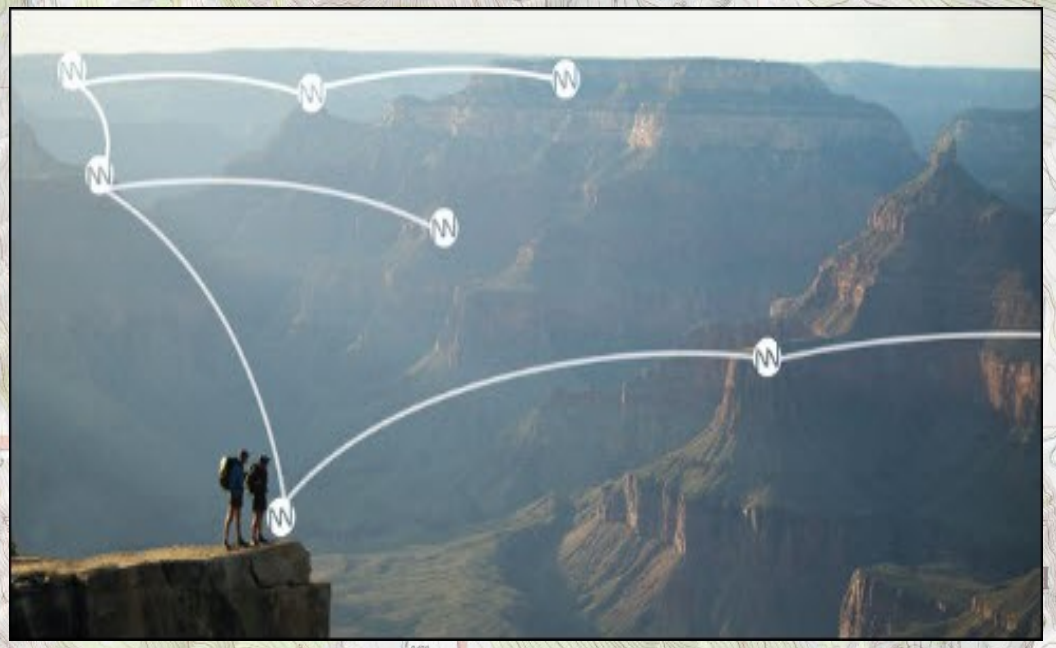
Garmin
Spot
Bivy
Somewear

https://www.theverge.com/2019/4/12/18306207/best-gps-communicator-hiking-trails-garmin-spot-somewear-bivy

https://www.greenbelly.co/pages/best-personal-locator-beacons-satellite-messengers

goTenna

MESH technology allows users to link two or more smartphones into a local, secure network (UHF Frequency) providing location data sharing and text capabilities.



Extend network with other **goTenna** users or drop off Stationary Relays in key areas.

Device Power Considerations

- Determine what devices/batteries you really need
- Keep batteries warm
- Specify battery type in use on GPS receiver
- Shorten backlight timeout period
- Conserve battery power - “Battery save” mode
- No WiFi, Bluetooth, Lowest display level, Airplane mode
- Carry spare batteries and/or USB battery charger
- Consider solar charger for devices/batteries
- Group: Consider coordinating device usage
- Phone (Emergency): Turn on periodically or as needed

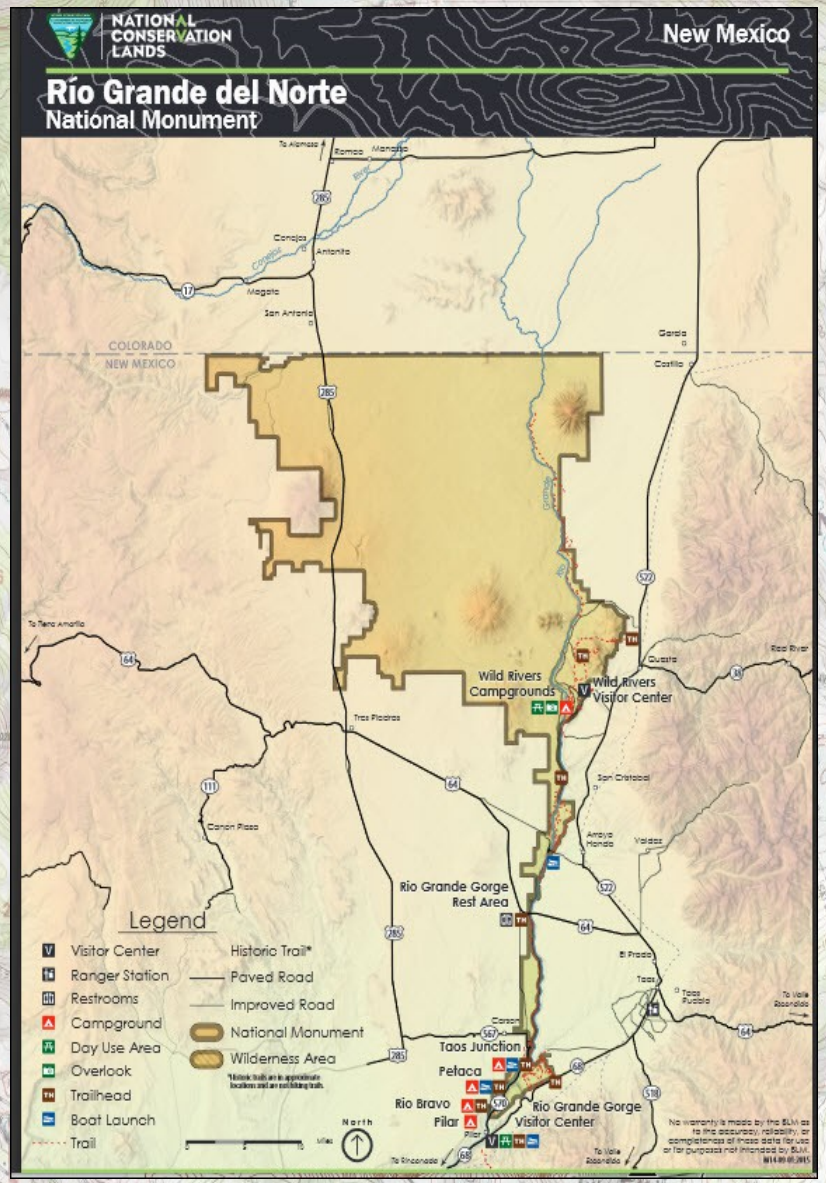
Geo-Referenced Map (geoPDF)

Georeferenced PDF maps are related to a ground system of geographic coordinates. They can be displayed on your GPS-enabled mobile device. When viewed with a mobile map application, your location may be viewed on that map, without the need for cell reception.

BLM and US Forest Service developed georeferenced maps for use with various apps. Forest Service maps may be purchased for the Avenza app.

https://www.fs.usda.gov/visit/maps

https://www.blm.gov/maps/georeferenced-PDFs



Offline Maps

Offline maps allow you to download an area (tiles) to access map location information where you don't have cell phone service or if mobile device is on “airplane mode.”

There's a broad mix of features that are supported, or NOT, with offline maps. You may plan a route by using the “snap” feature as you trace a potential route. You may be able to upload GPX track data. Most apps offer basic tracking.

Some apps provide this feature for a “premuim” plan. ($)

iOS and Android platforms may not both be supported.

- TrekMe
- OsmAnd Offline Maps (Android)
- MapOut (iOS)
- Galileo Pro (iOS/Android)
- Locus Map Pro (Android)
- OruxMaps Offline Maps (Android)
- Alpine Quest GPS (Android)
- Google Maps (iOS/Android)
- Komoot (iOS/Android)
- MotionX GPS HD (iOS)
- Backcountry Navigator Topo GPS (Android)
- Gaia GPS (iOS/Android)
- Ride With GPS (iOS/Android)
- Avenza Maps iOS/Android)

https://www.cyclingabout.com/best-offline-gps-apps-smartphone-navigation-apps/

https://support.google.com/maps/answer/6291838?co=GENIE.Platform%3DAndroid&hl=en

"Mobile Technology For Outdoor Activities" (End Part 1)

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Note: Presentation created for smaller monitor sizes