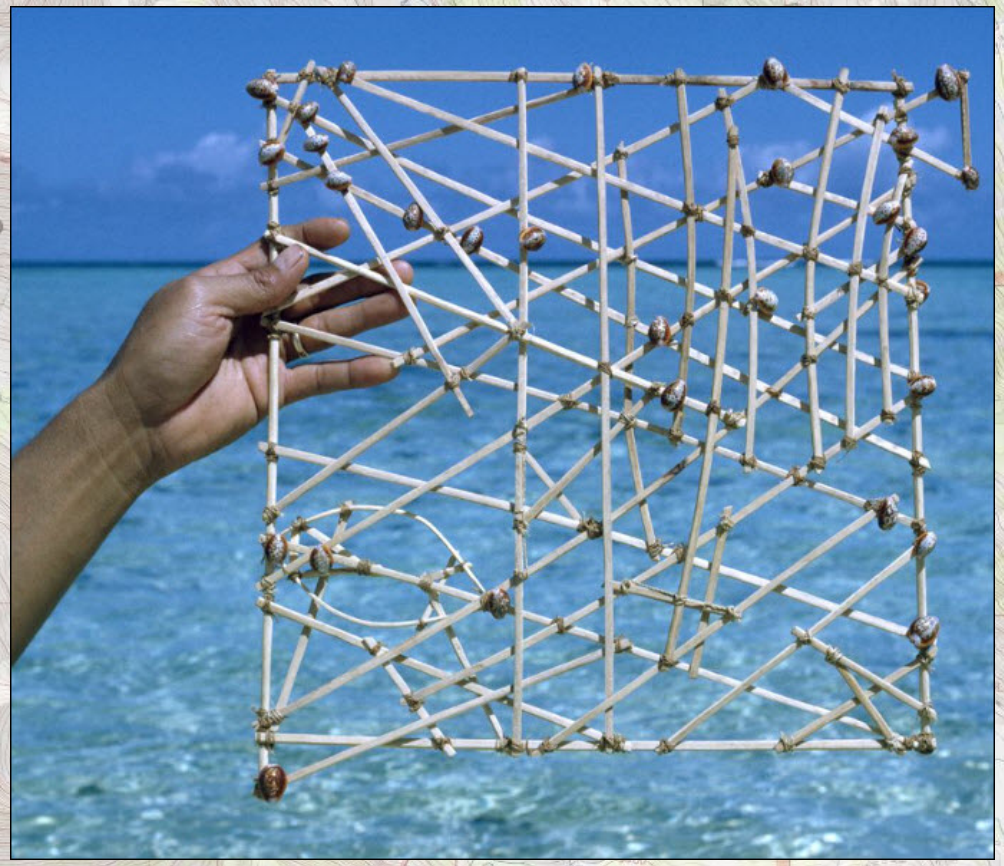
NMCCSC: "This Way. No, This is the Way!"

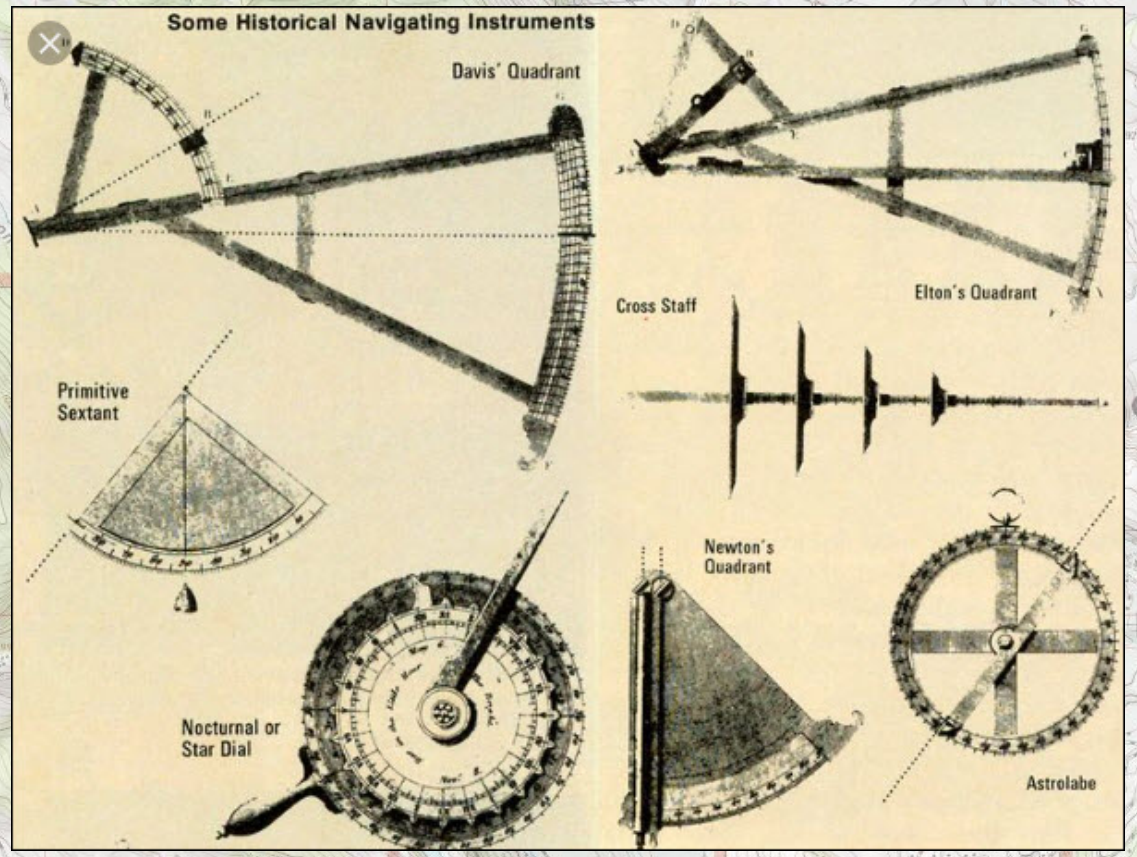
Current Location Technology and Route Planning Resources

Gerry Trujillo
gerttruj@yahoo.com
January 2020

Early Navigation Tools



Polynesian Stick Chart



Sextant, Quadrant, Cross-staff, Astrolabe

Where am I? How to I get to …?

Trilateration

Satellites

App

Latitude

Longitude

Coordinates

Accuracy

GPS

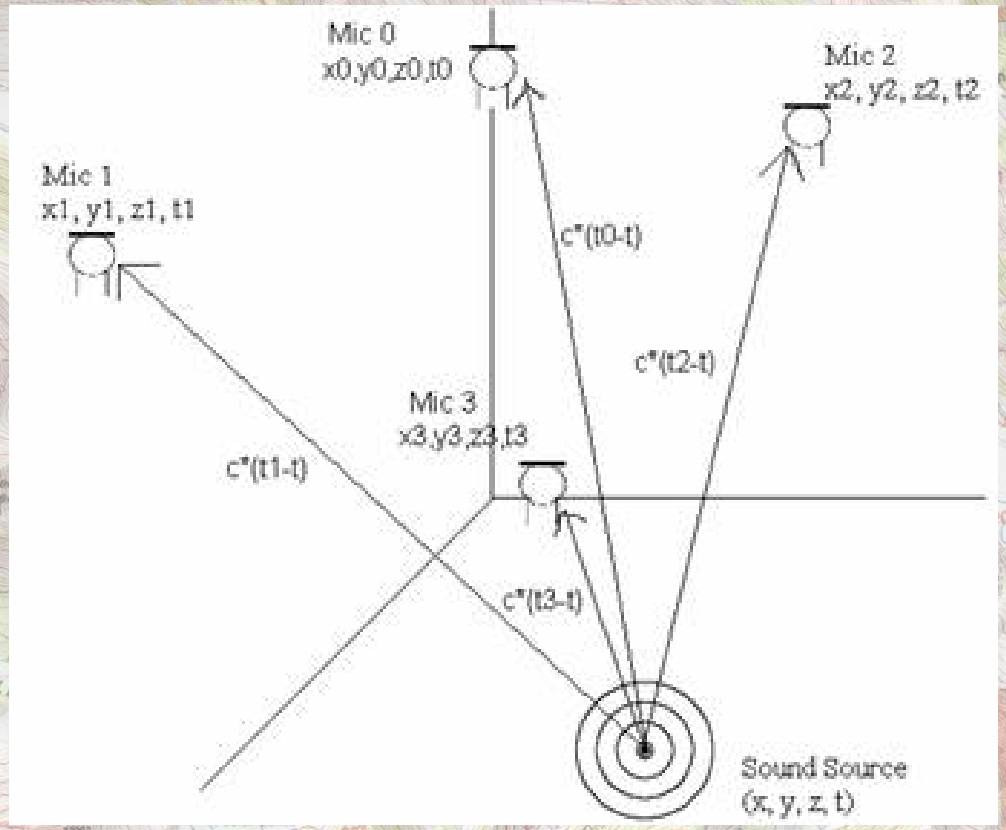
Location

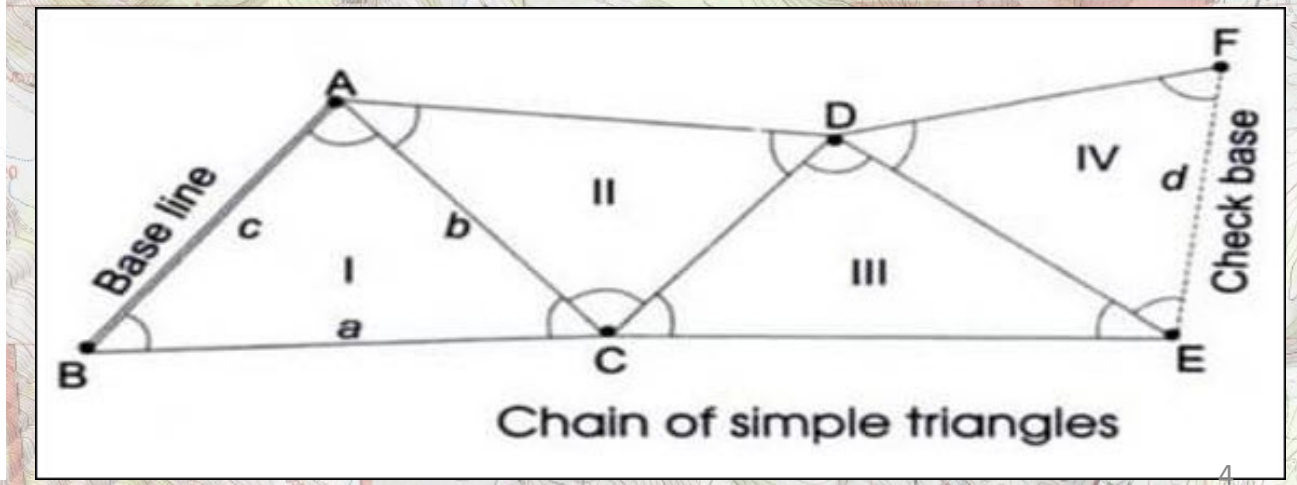
Garmin

Triangulation

Triangulation:

Object location by using angles and distances.





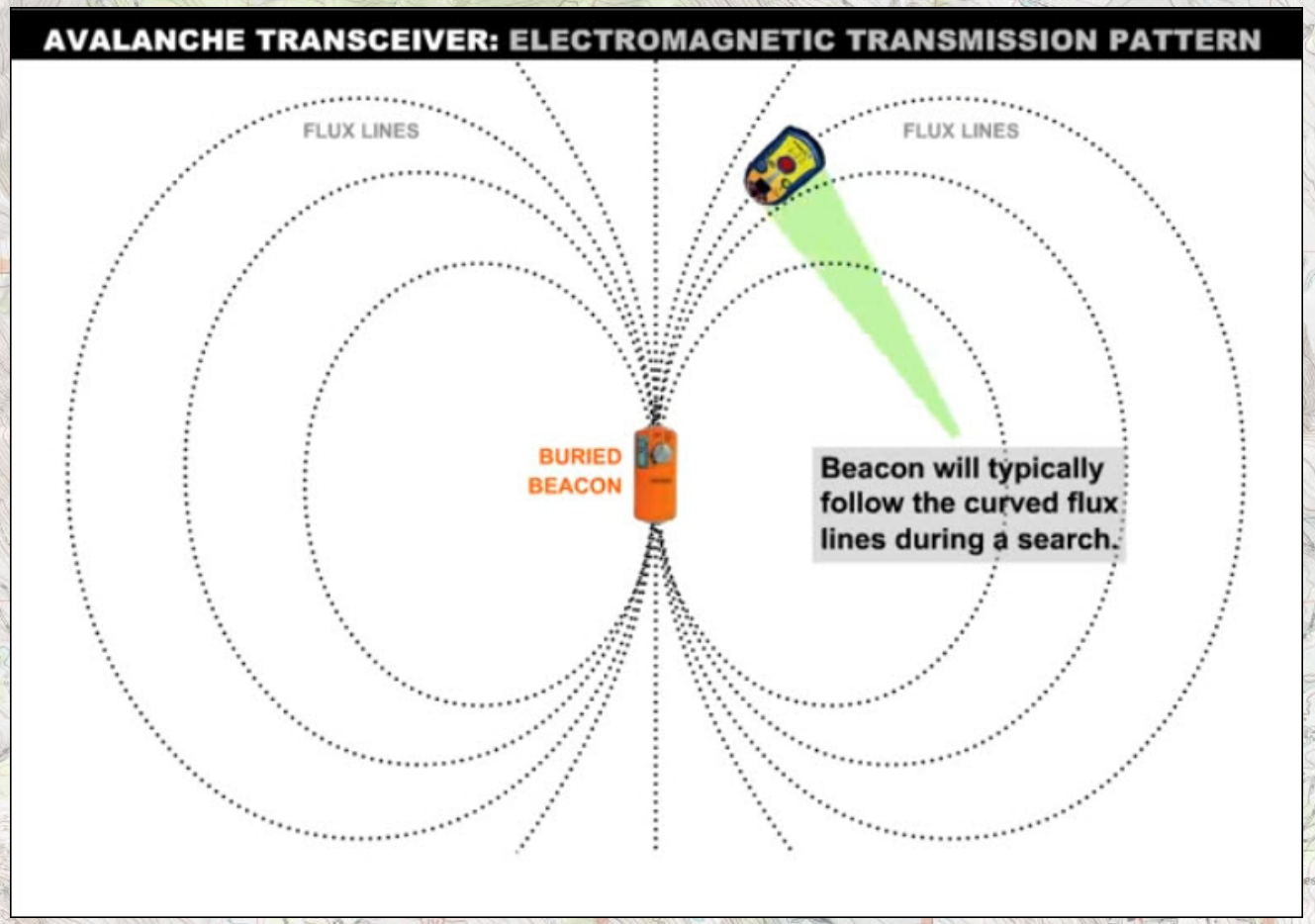
Snoring Boy Scout Dad

Triangulation!

Avalanche Beacon: Triangulation

Avalanche beacons work on the principle of triangulation.

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



Yagi Beam Antenna

Triangulation: Ham radio application using signal strength to locate emergency radio transmitters on downed aircraft.

2 Meter Measuring Tape Yagi Beam Antenna

GNSS (Global Navigation Satellite System)

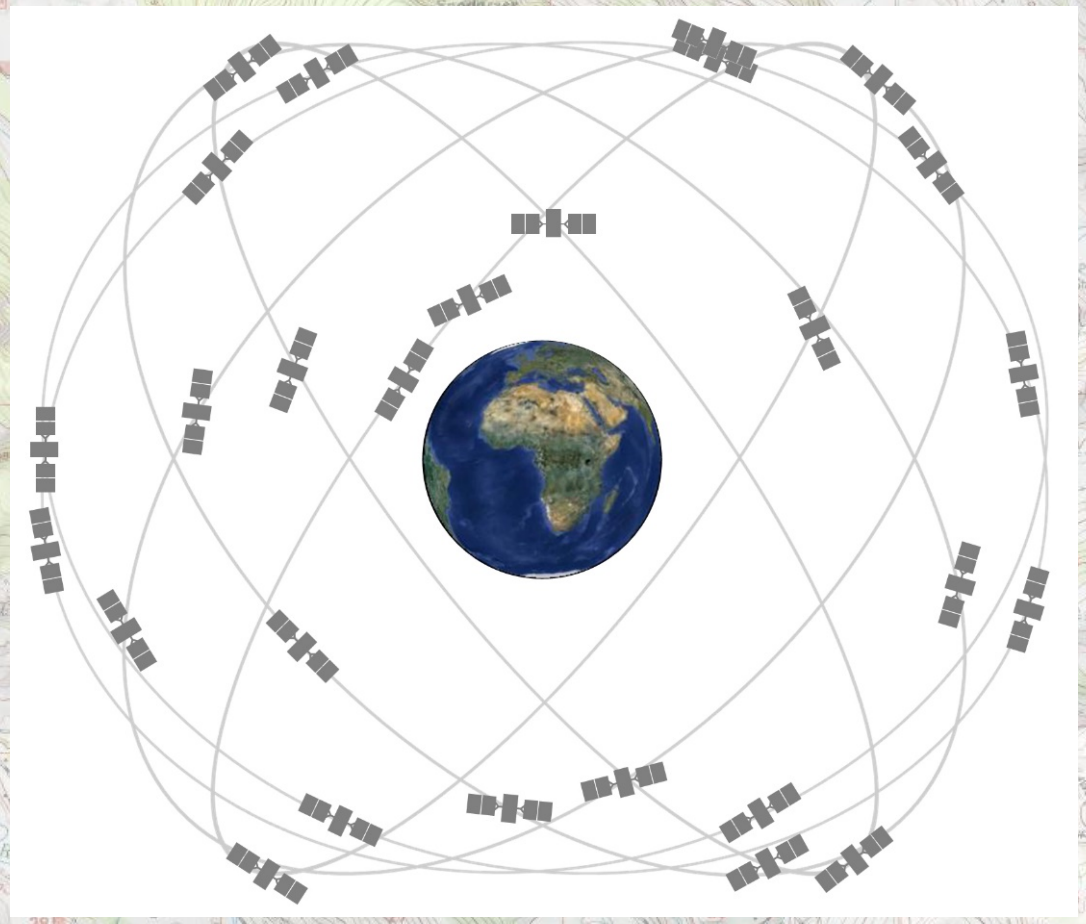
Generic term for Satellite Navigation Systems

GPS (Global Positioning System)

US DoD System (USAF)

30 operational Satellites broadcast radio signals (Precise Satellite position, Atomic Clock Time)

GPS receivers only receive signals.

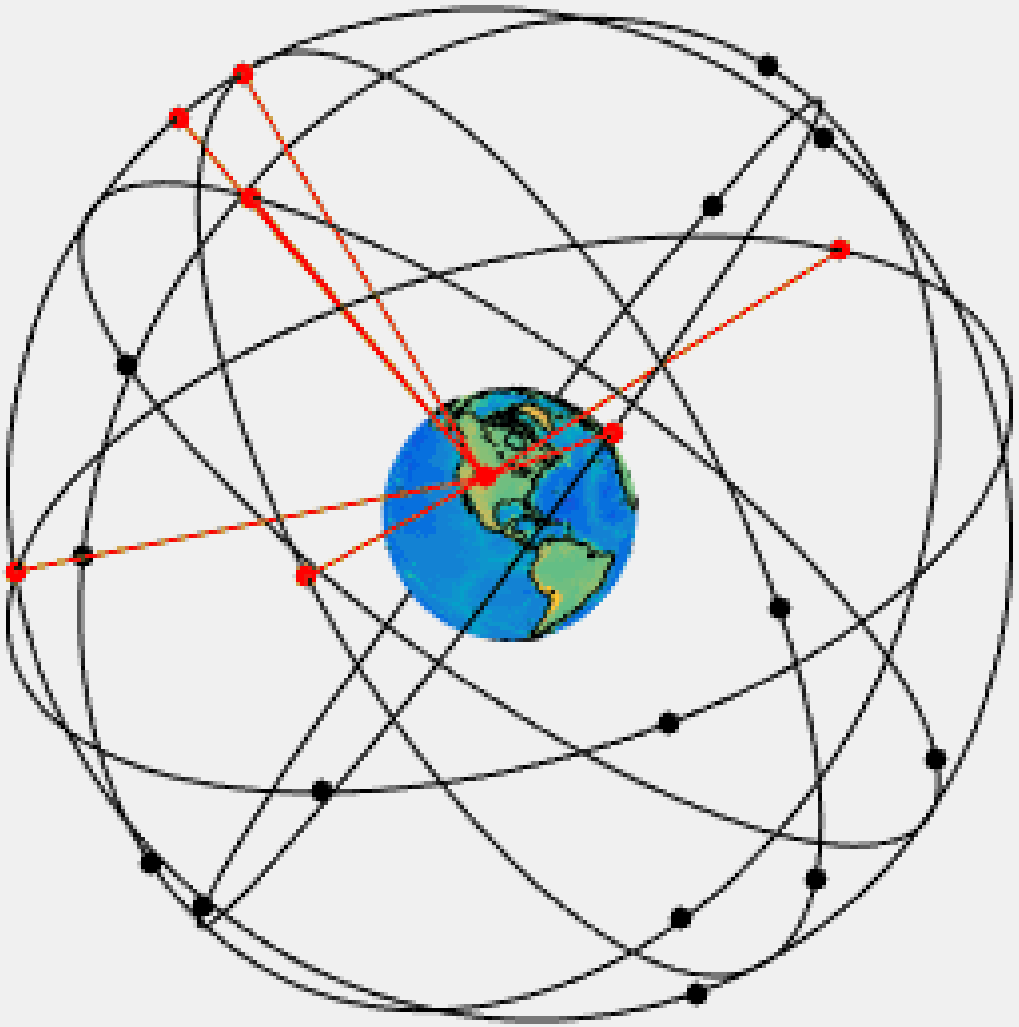


GPS satellites broadcast position and precise time.

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

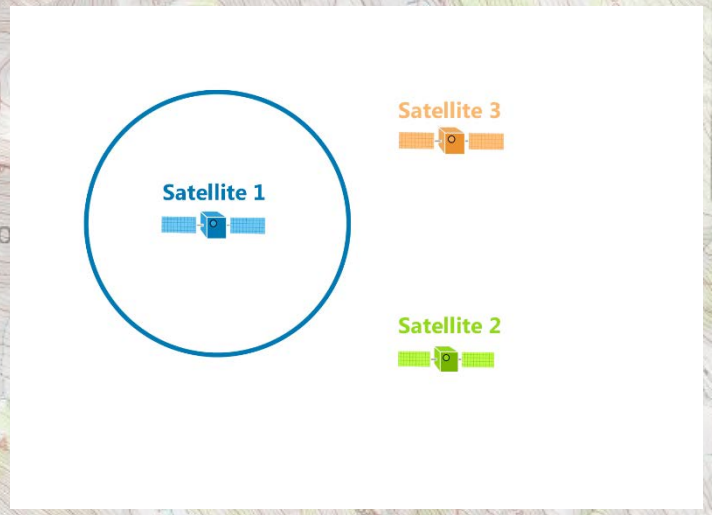
$$D = c \times T = c \times (Ts - Tr)$$

Satellite time: 2 nanosecond drift /year
GPS receiver: 10 nanosecond accuracy/day

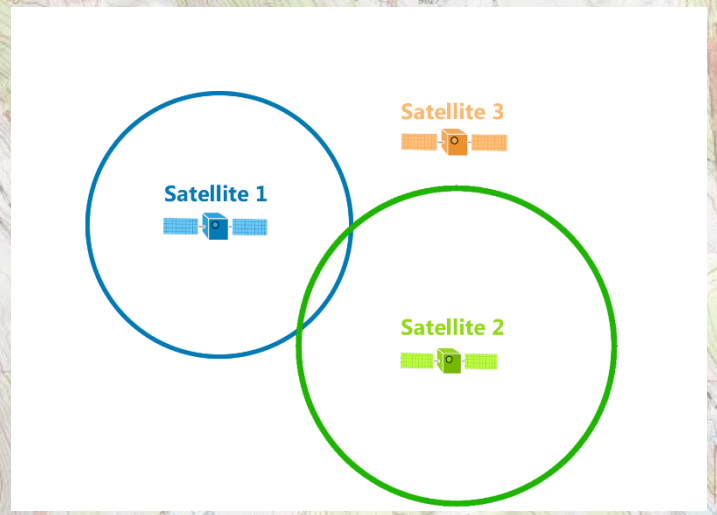


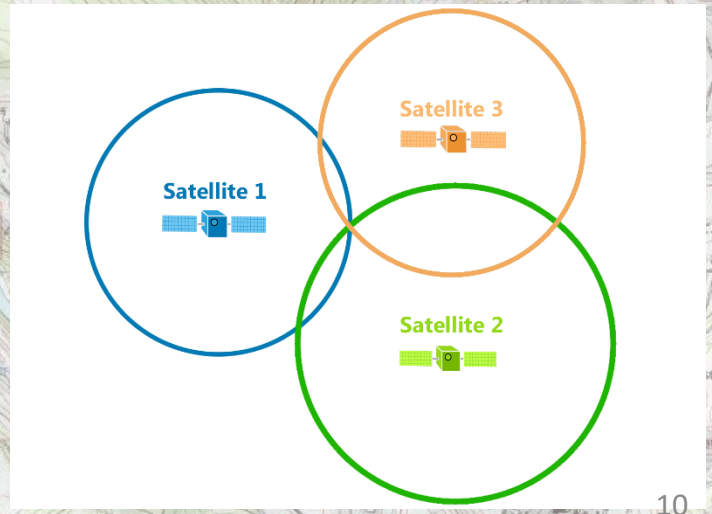
7 visible satellites

2D Trilateration:



Three distances are used to determine location of one intersection point.

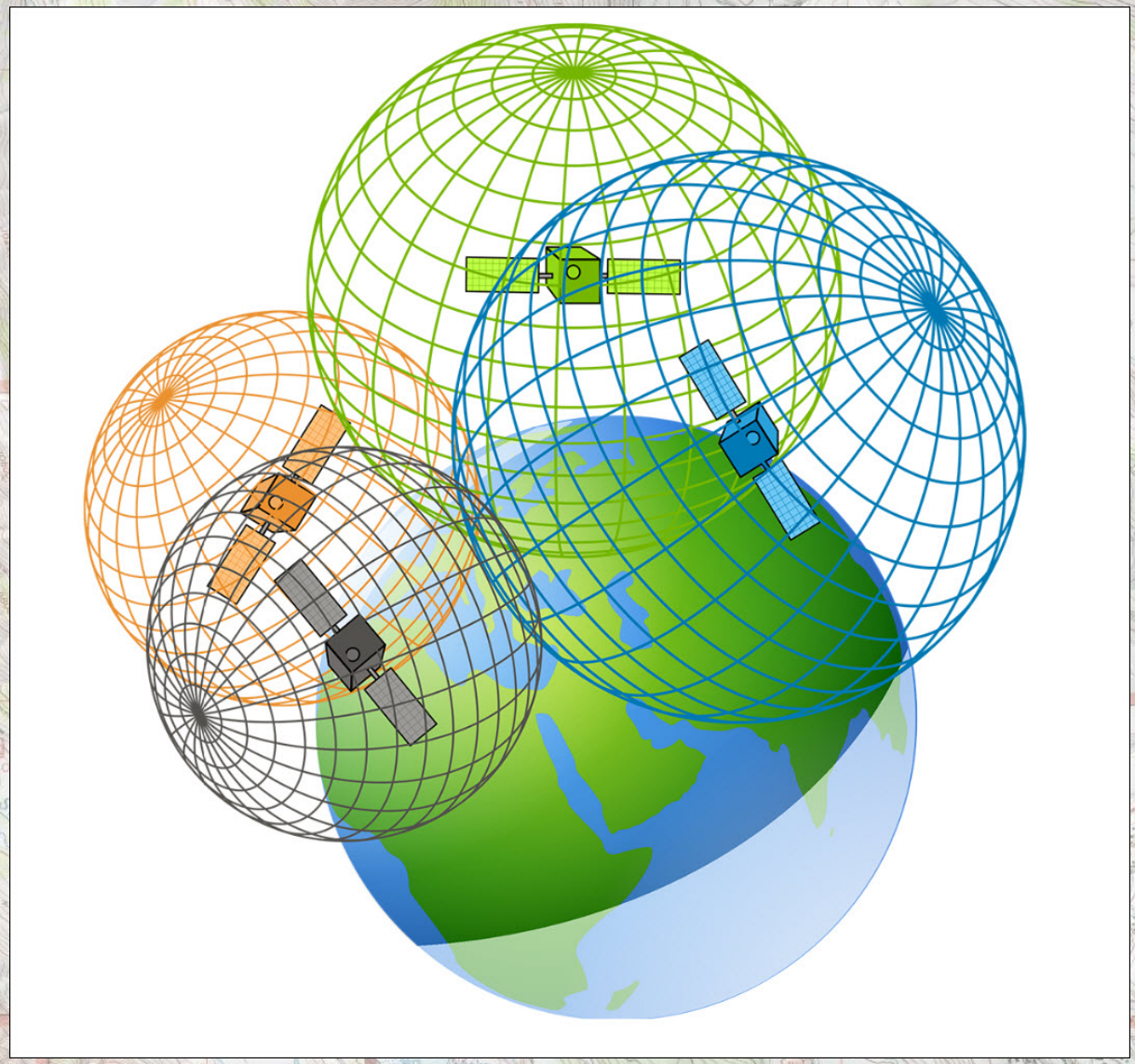




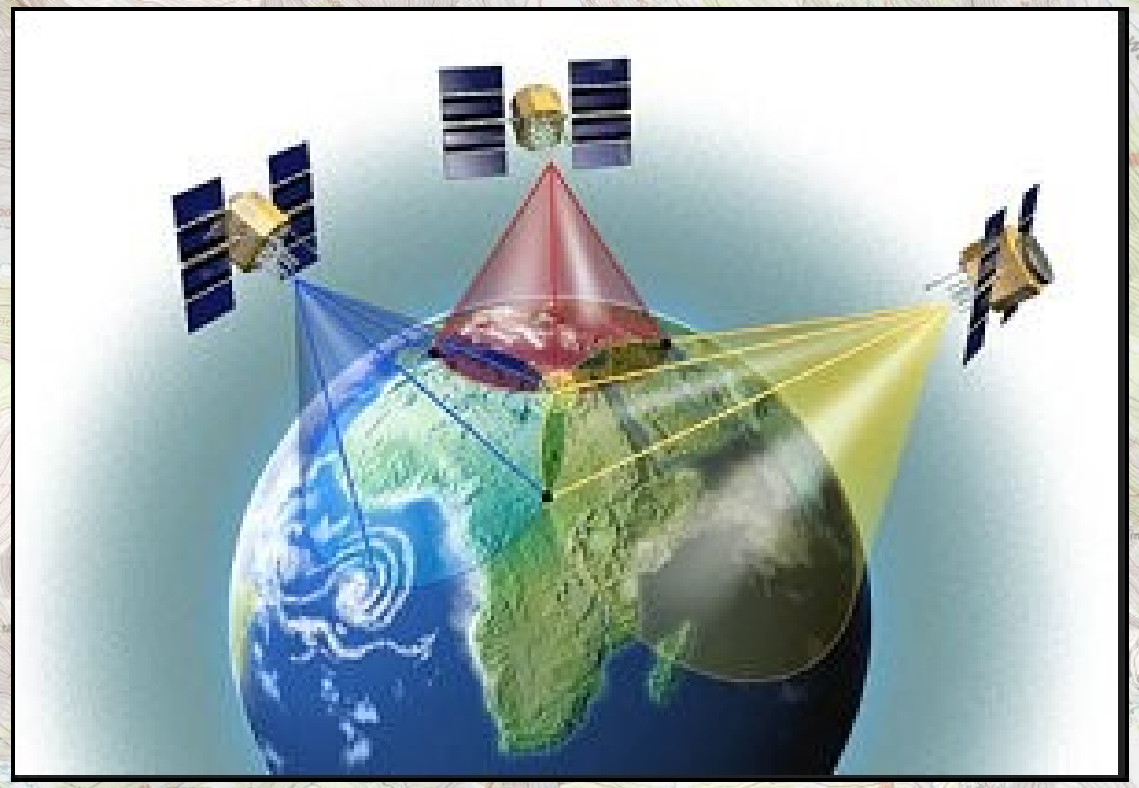
3D Trilateration:

4 Satellites provide 4 spheres to locate GPS receiver more accurately!

5-8 satellites are usually visible from any location



3D Trilateration:

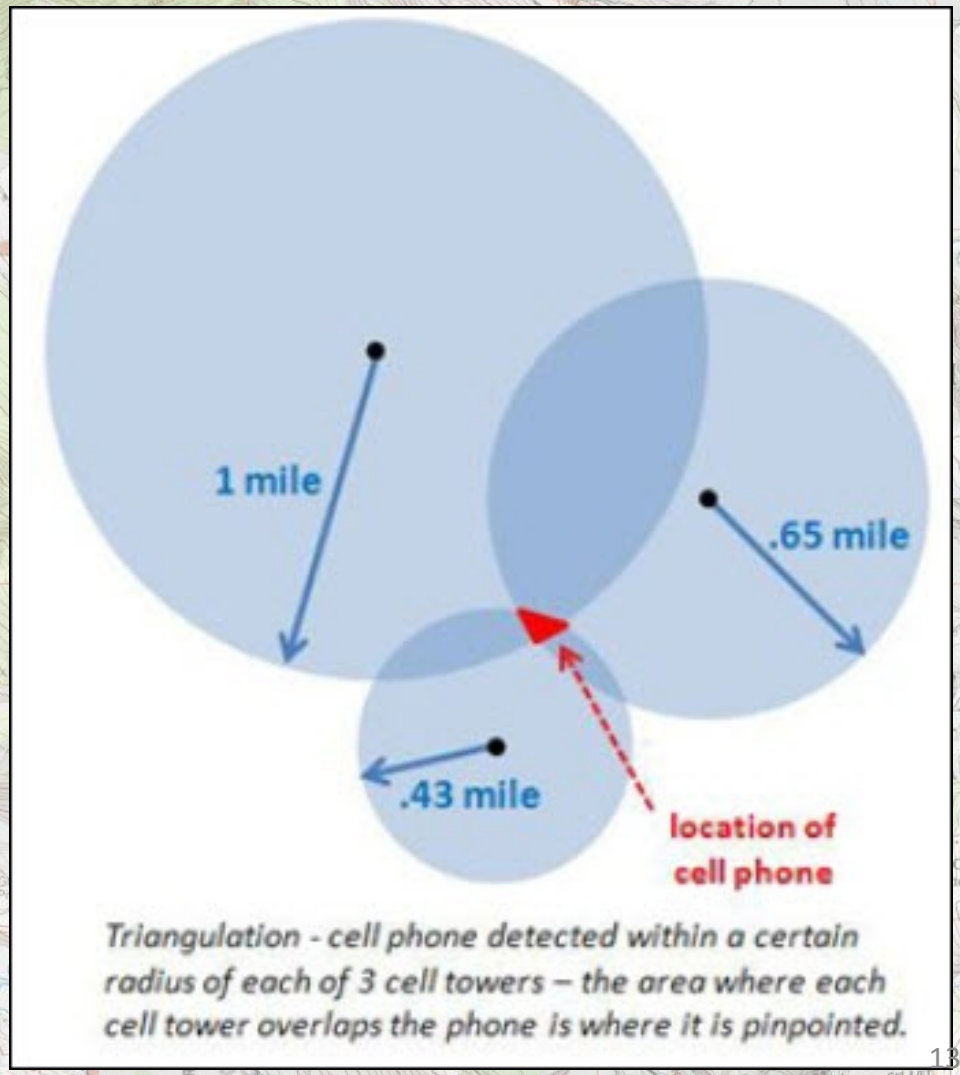


Cell Triangulation vs. Trilateration

Caution:

Interchangeable terminology!

Three towers are used to estimate cell phone location by estimating distance (trialateration) to cell phone or signal strength (triangulation).



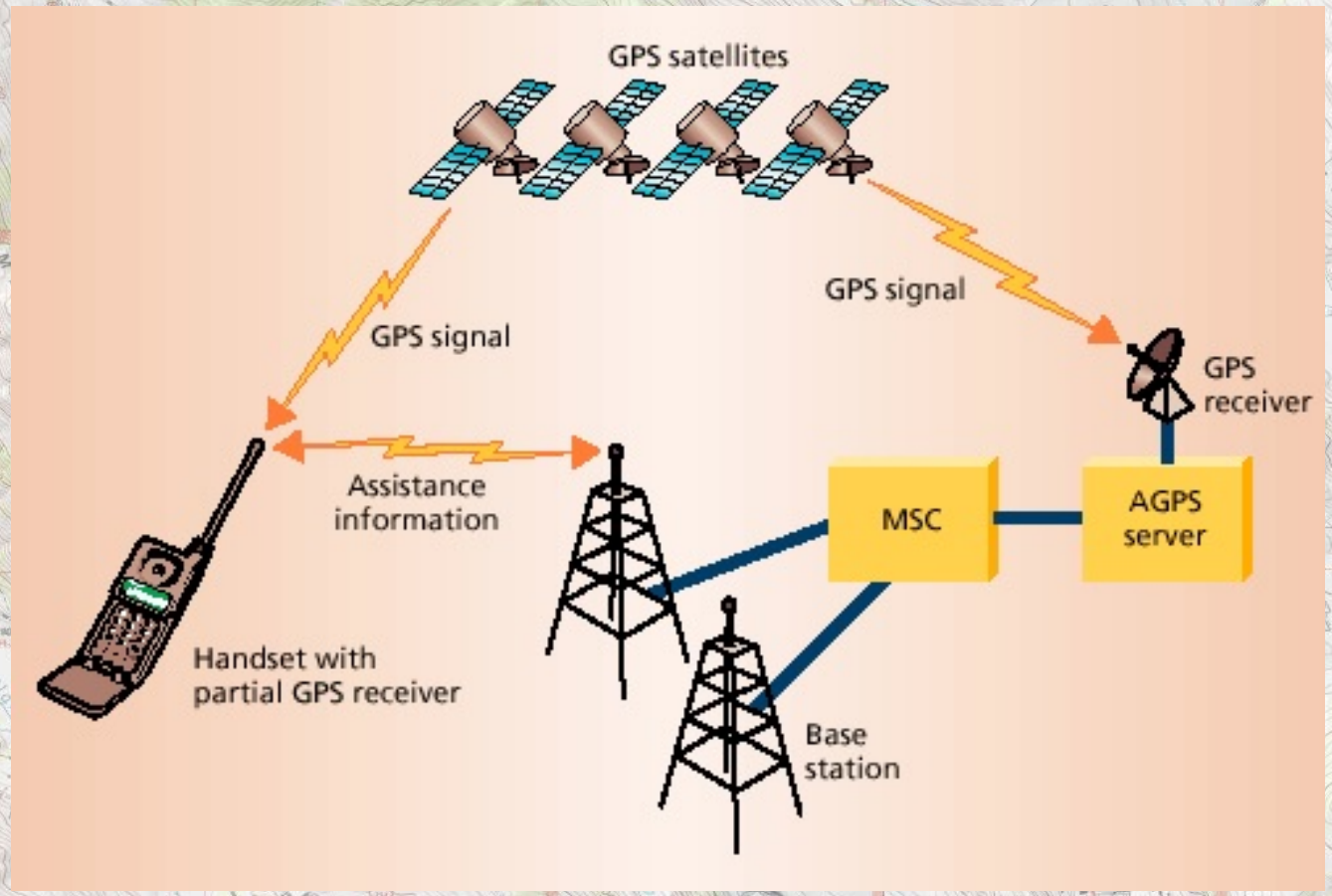
Triangulation - cell phone detected within a certain radius of each of 3 cell towers – the area where each cell tower overlaps the phone is where it is pinpointed.

A-GPS: Assisted GPS (cell phone)

Cell phone towers provide rough estimate of cell phone location, speeding up “first fix.”

GPS receivers take longer for “first fix.”

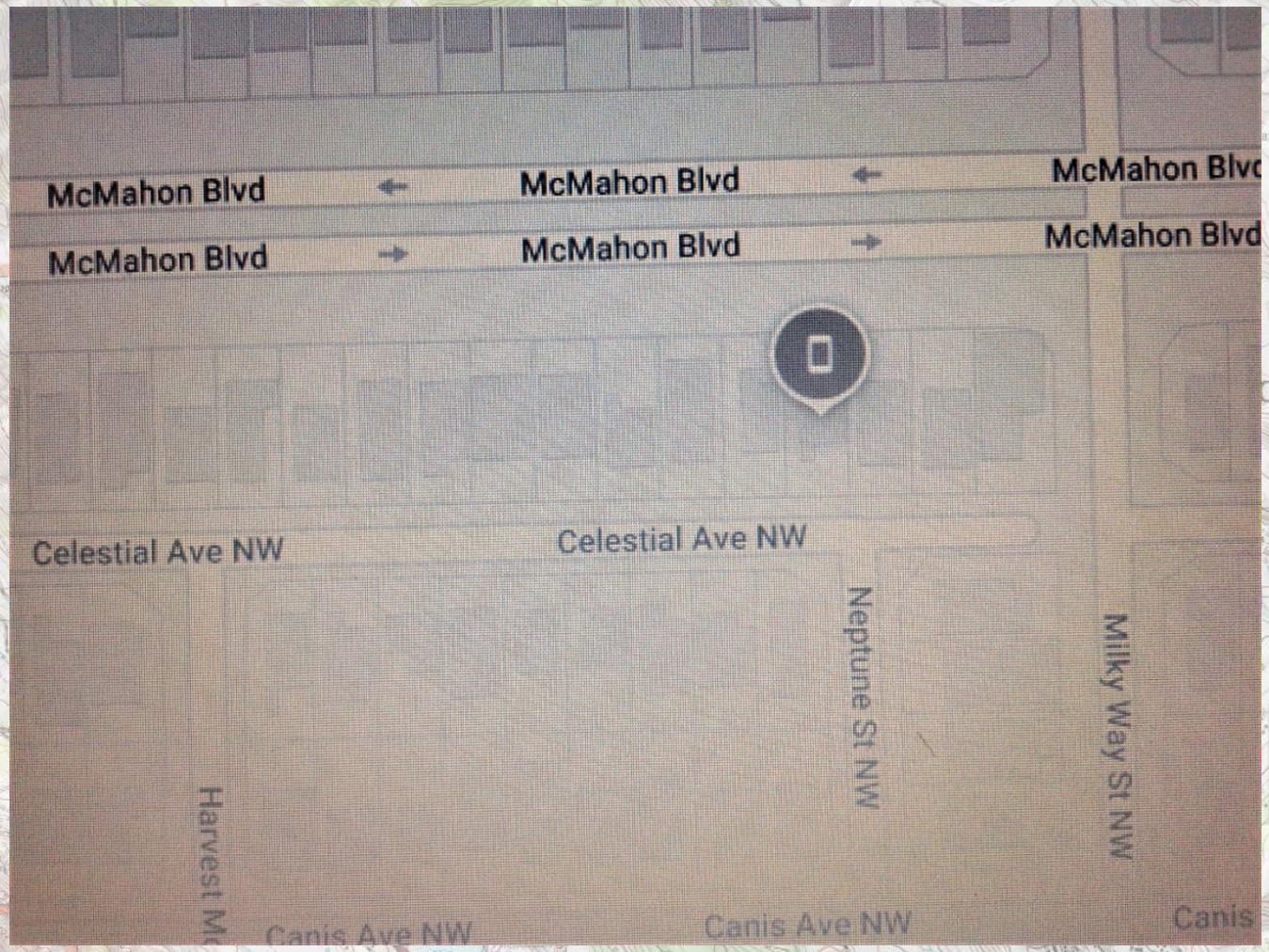
A-GPS has been utilized by first responders and E911 Services.



Cell Phone Ping

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

Google’s “LocateMy Device” may use a “ping” to locate a lost phone.



11 Essentials?

Add communication device to Essentials List?

4 Basic Responsibilities:

- Coordinate w/responsible party
- Carry seasonal essentials for survival
- 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)
- NOTE: Cold disables batteries; keep phone warm in zip-bag.

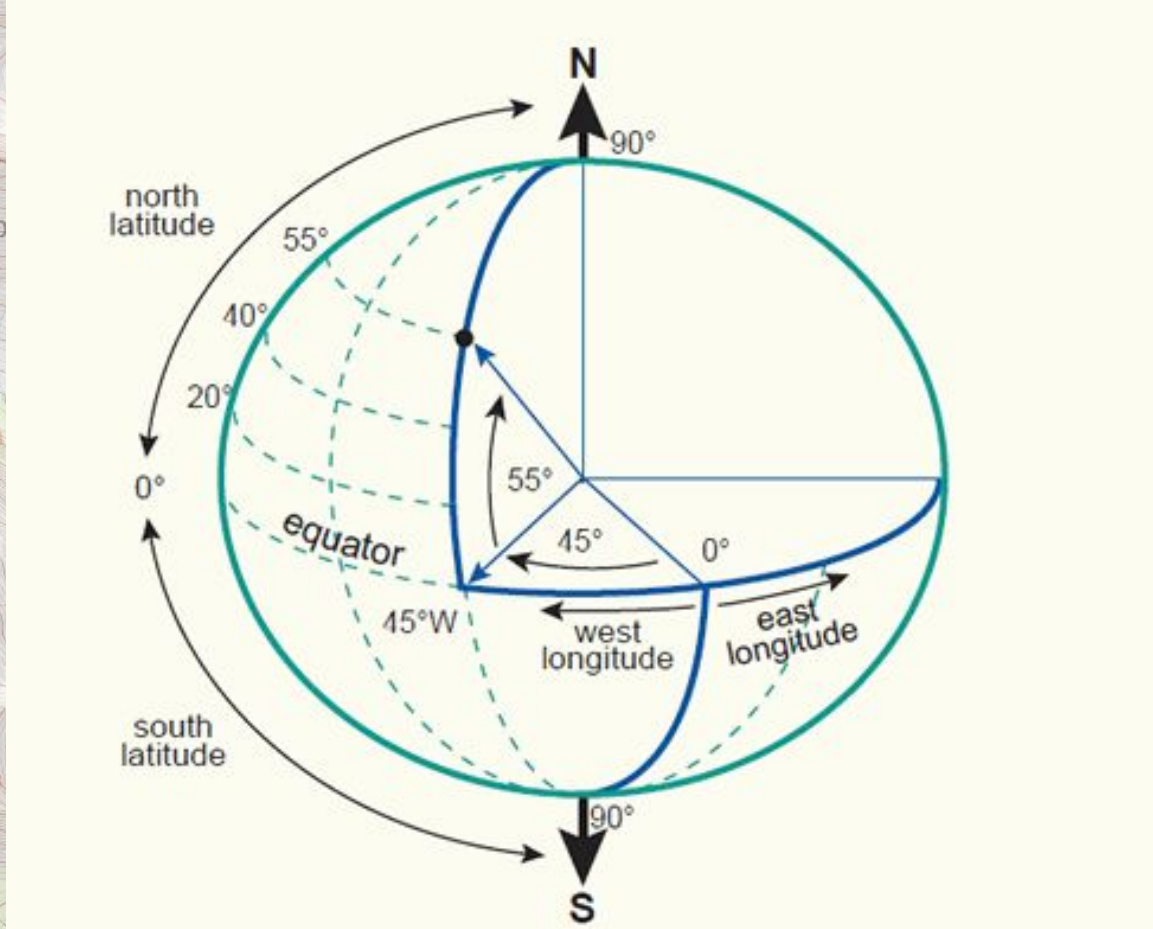
“Death by GPS”

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

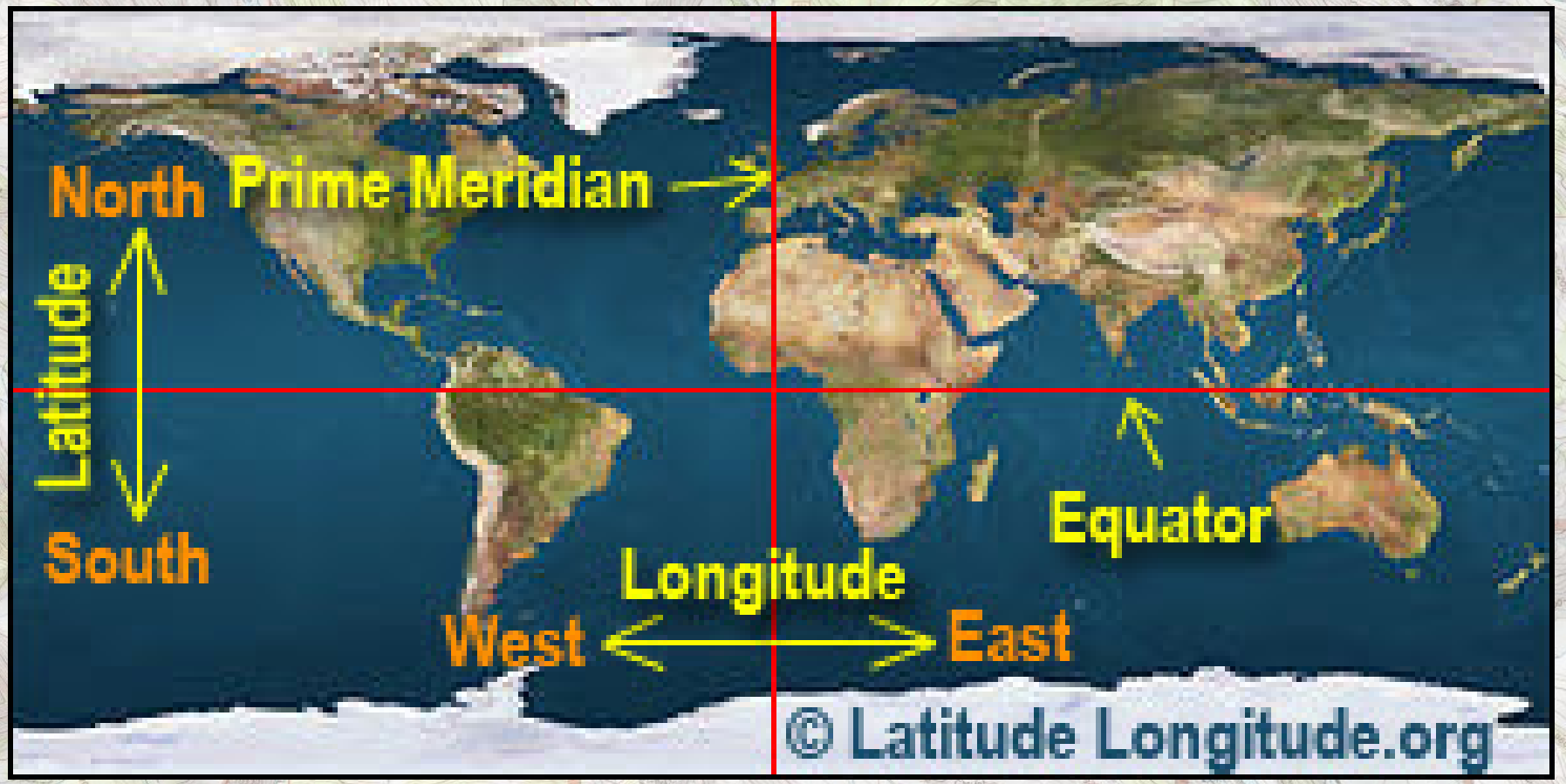
West of P.M.

(W or Negative)

East of P.M.

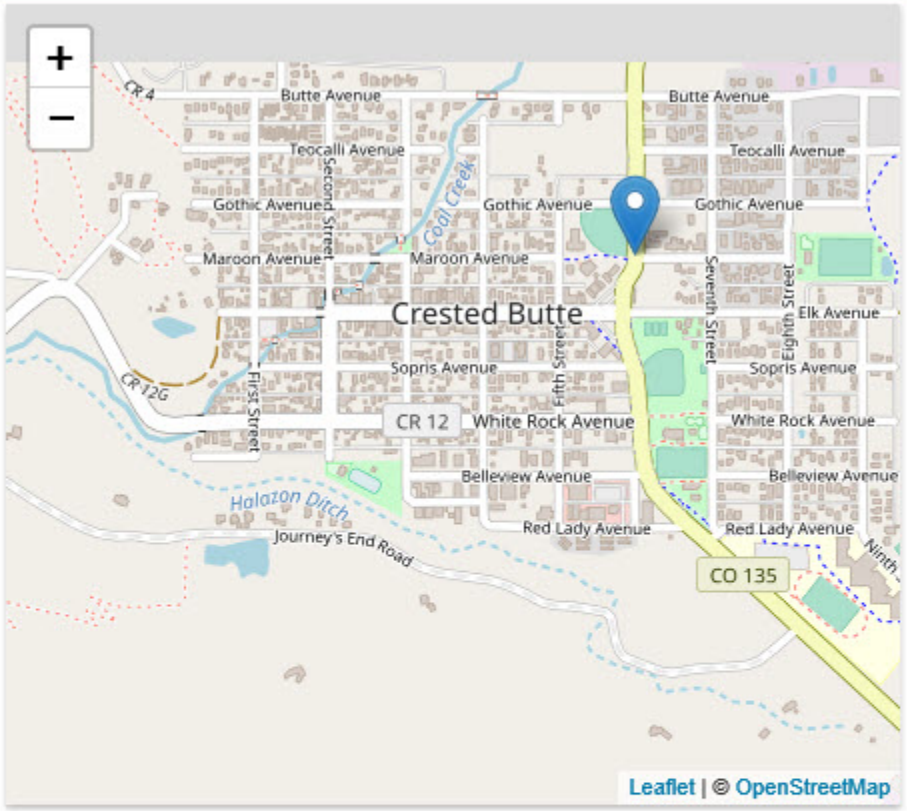
(E or Positive)

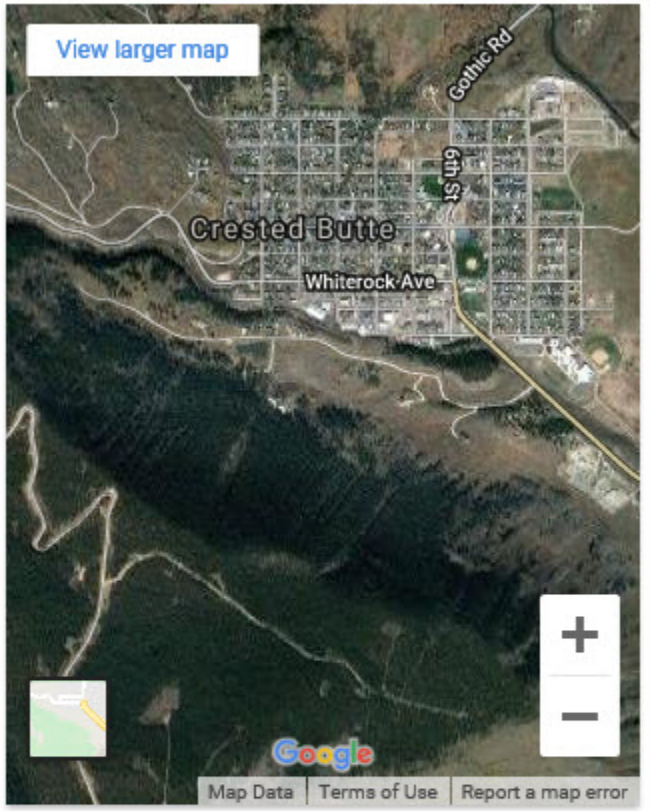
Projected Coordinate System



Latitude

Longitude

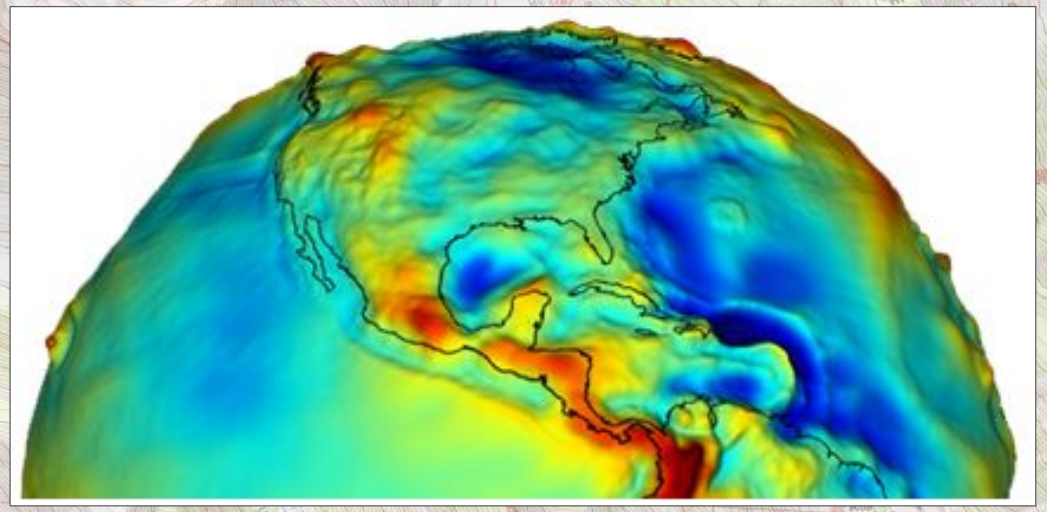


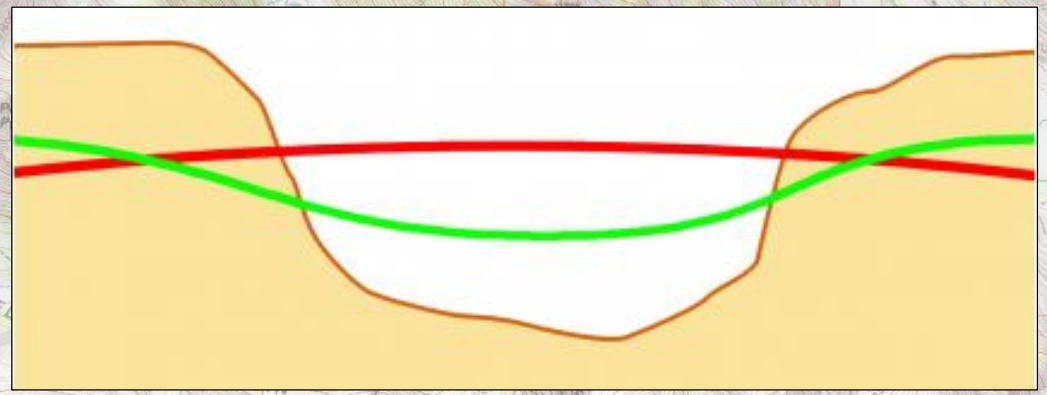


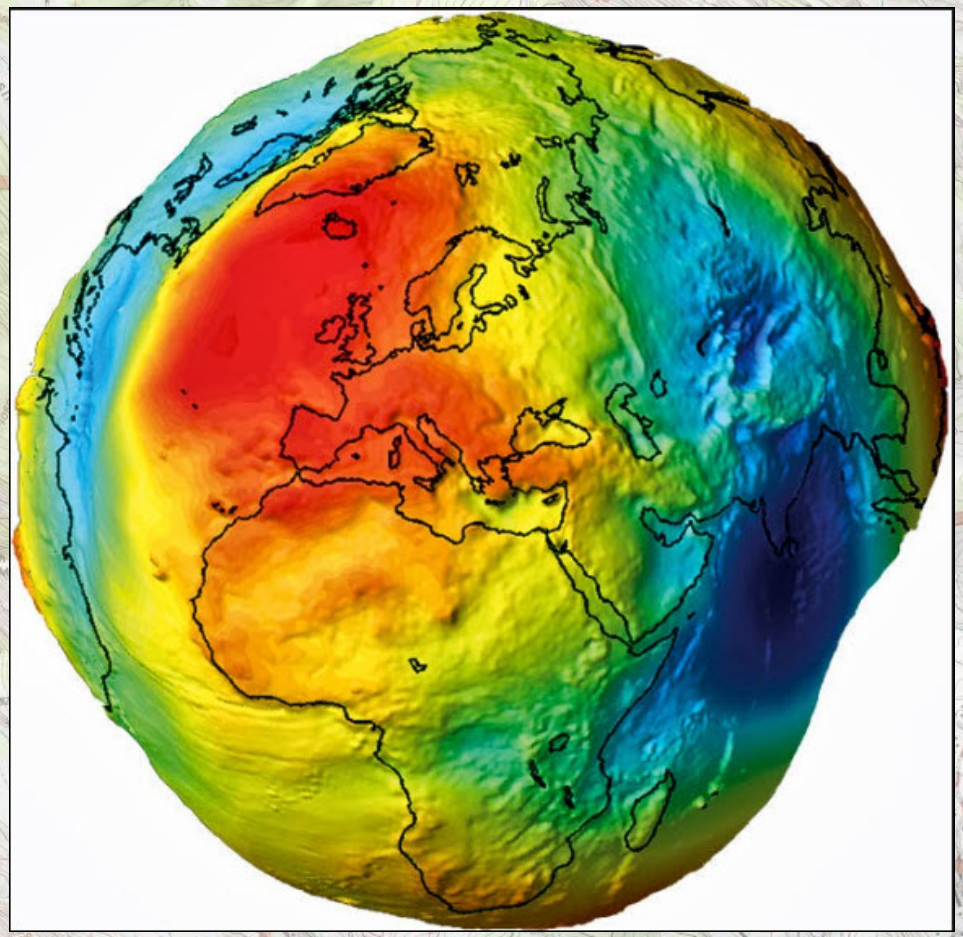
Lat Long	GPS Coordinates
(38.870682, -106.980942)	38° 52' 14.4552" N 106° 58' 51.3912" W

World Geodetic System (WGS84)

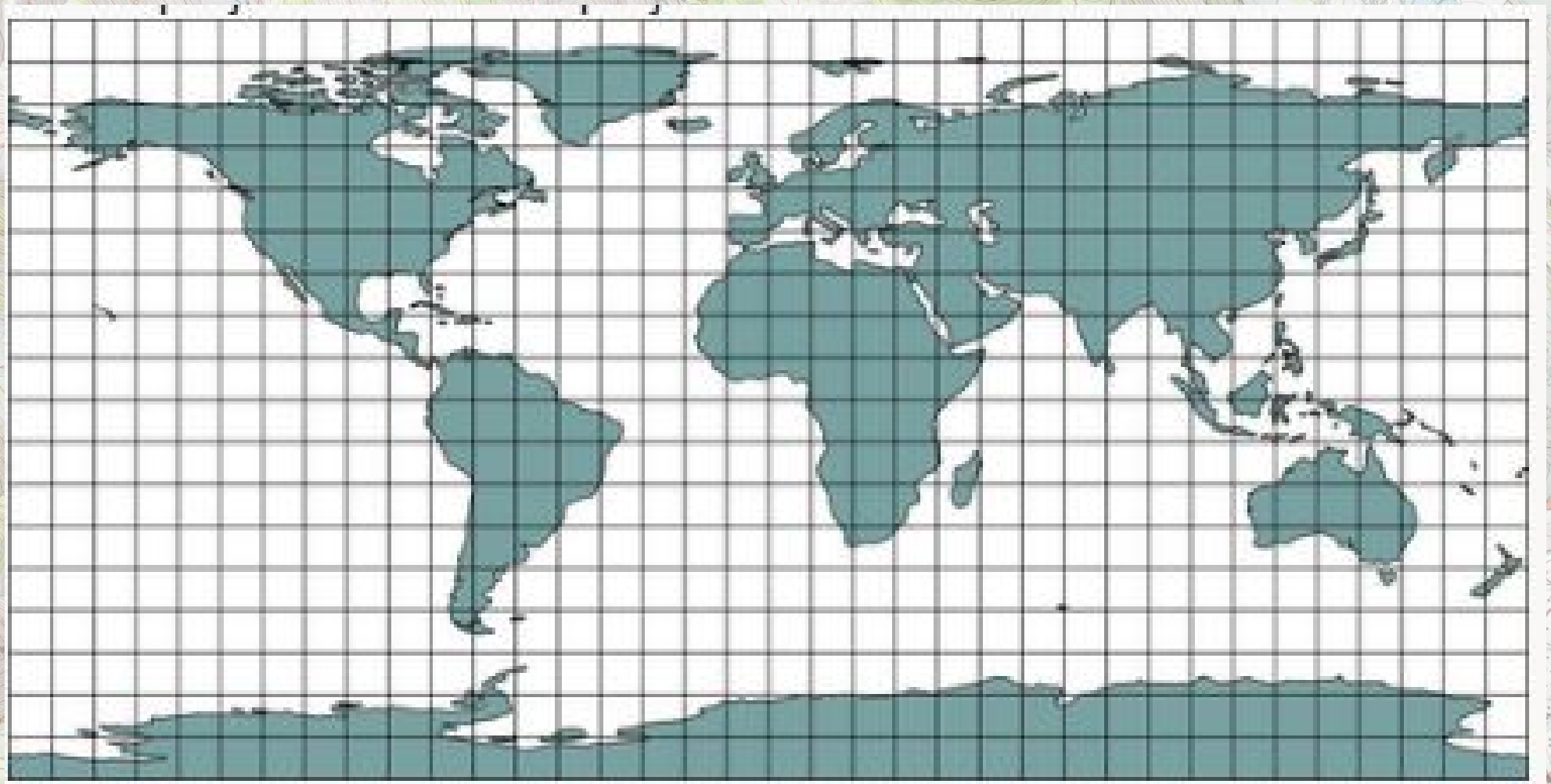
Spheroid/Ellipsoid, Geoid, Topography Elevation







Projected Coordinate System

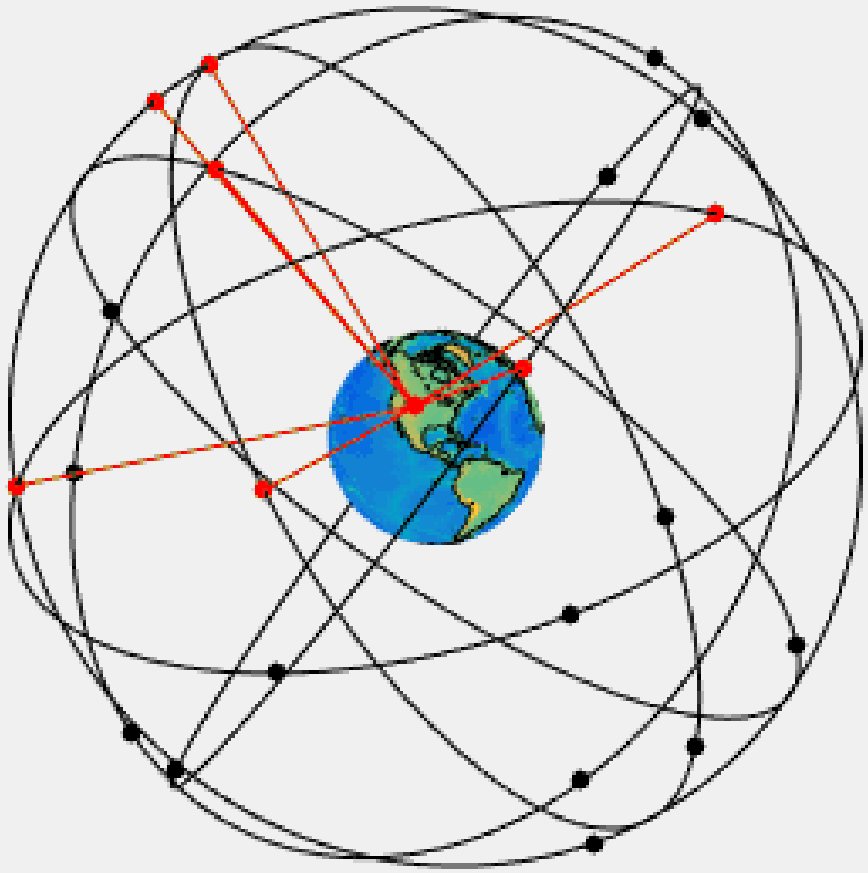


GPS receiver's algorithm utilizes "Distance and Time" to determine a receivers location.

Standard Positioning Accuracy:

25 m horizontal (95% time)

43 m vertical (95% time)



7 visible satellites

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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Garmin (10 dec)

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ViewRanger (8 dec)

1:52 92%

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View Copy Web Search Share Select all

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

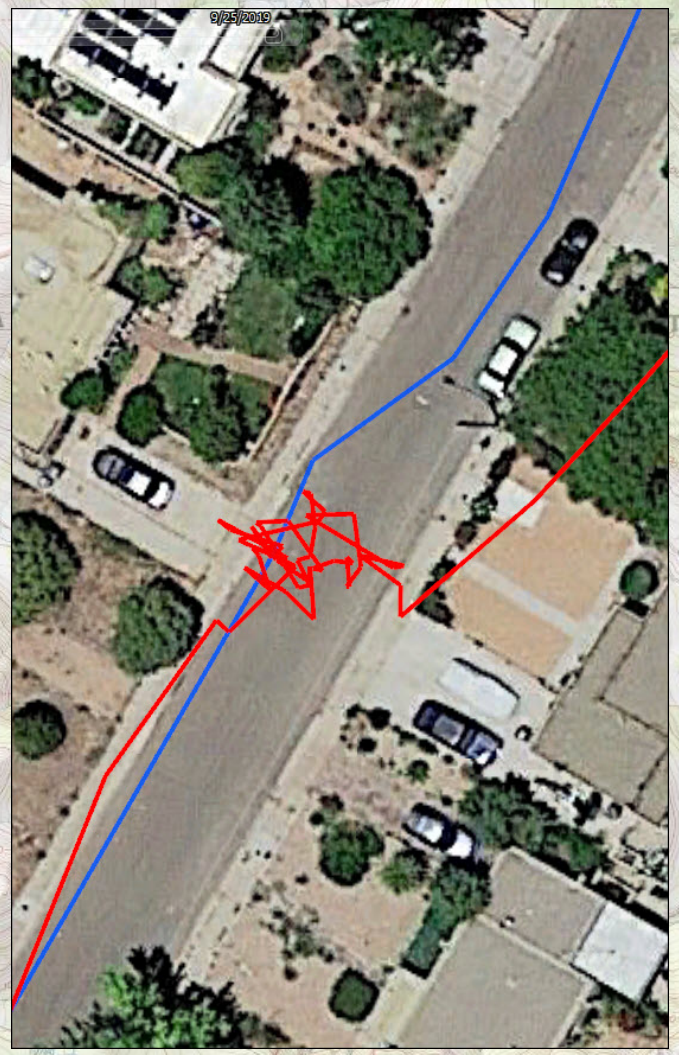
GPS Precision vs. Accuracy

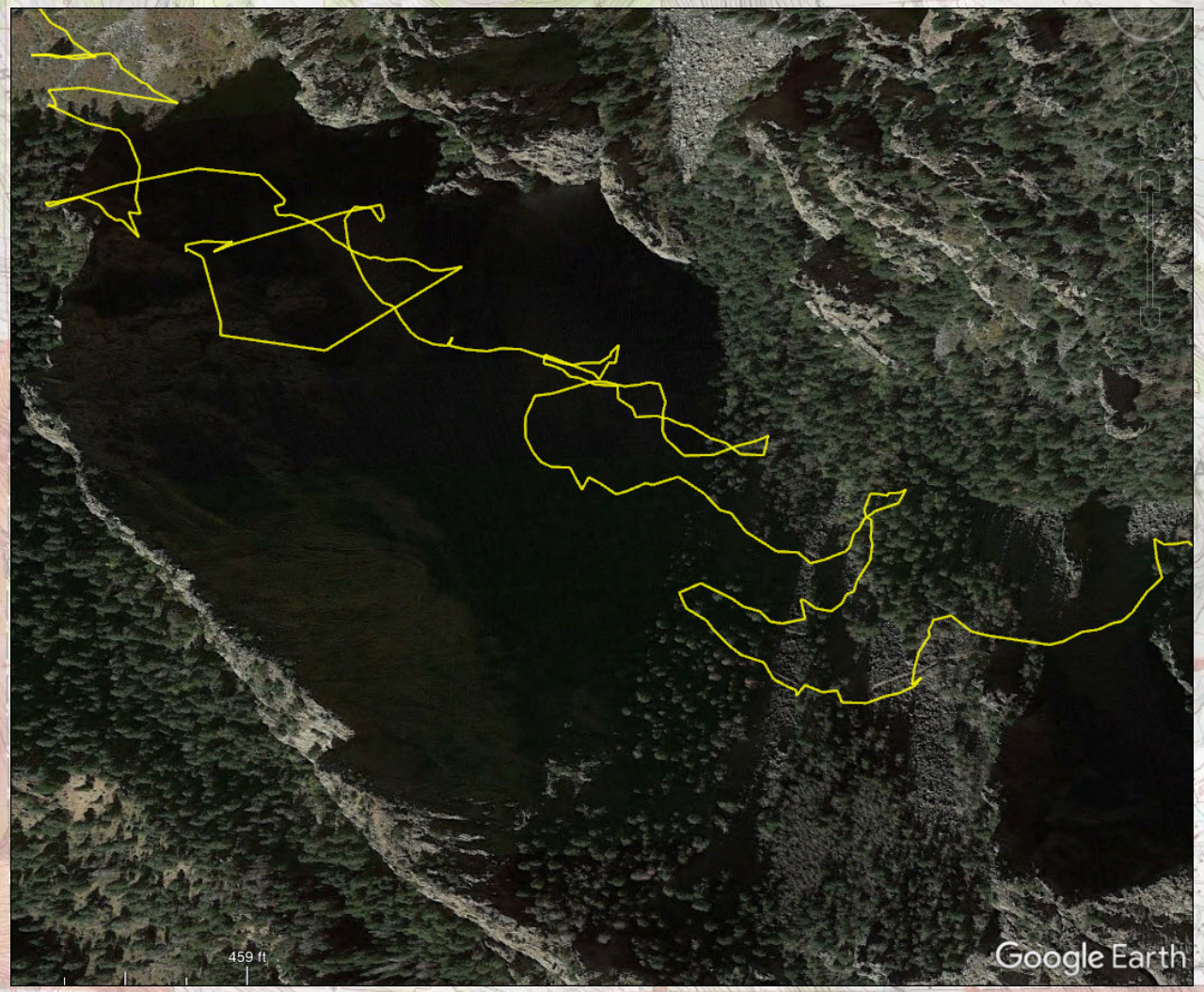
Comparison of mobile phone App and a Garmin

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





Devices/Batteries vs. Outing Type

- 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 charger
- Consider solar charger for devices/batteries
- Group: Consider coordinating device usage
- Emergency: Turn GPS/phone on as needed

Batteries

"Traditional Mountaineering"

Made a recommendation for Lithium batteries

http://www.traditionalmountaineering.org/FAQ_LithiumBatteries.htm

REI "Expert Advice"

Lithium for high drain devices such as digital cameras and GPS receivers and NiMH & Li-ion rechargeable batteries.

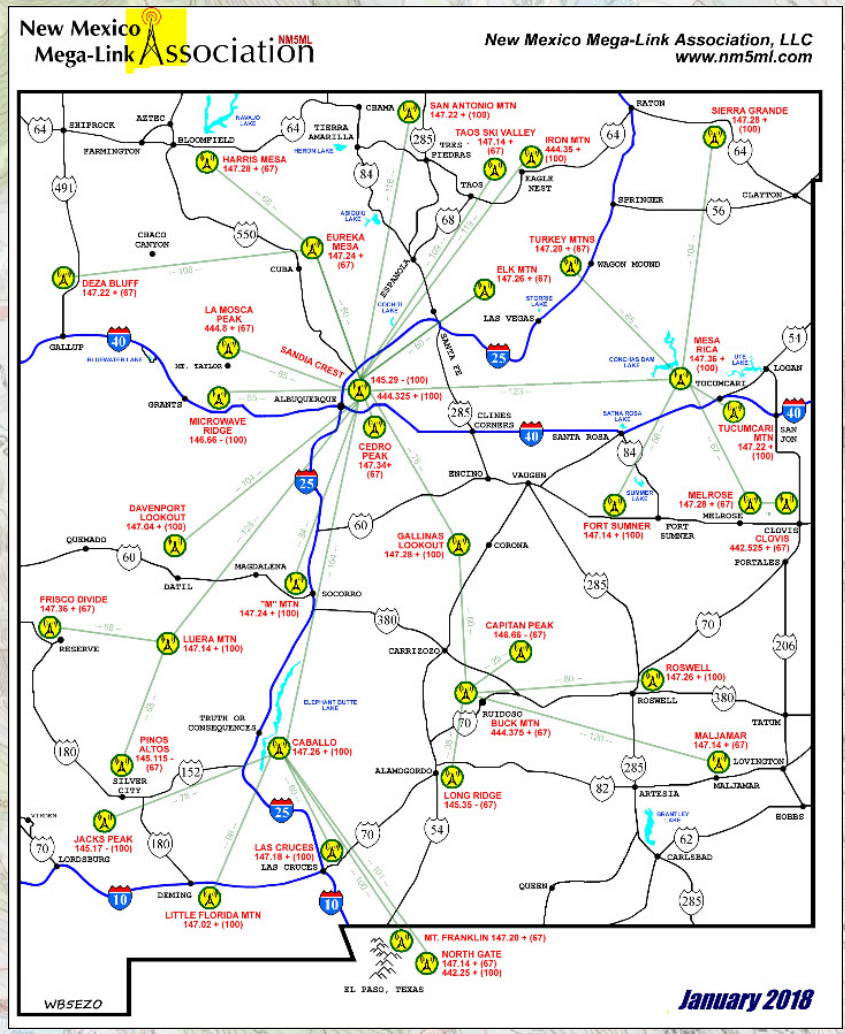
https://www.rei.com/learn/expert-advice/batteries.html#right-type

New Mexico Ham Radio

Mega-Link

- FCC Amateur Radio Operator License
- 37 **“Open”** repeaters on 35 mountains
- Networked to act as on repeater
- need line to sight
- Good statewide coverage
- Some coverage to adjoining states

www.nm5ml.com



Personal Locator Beacon (PLB)

- Garmin
- Spot
- Bivy
- Somewear

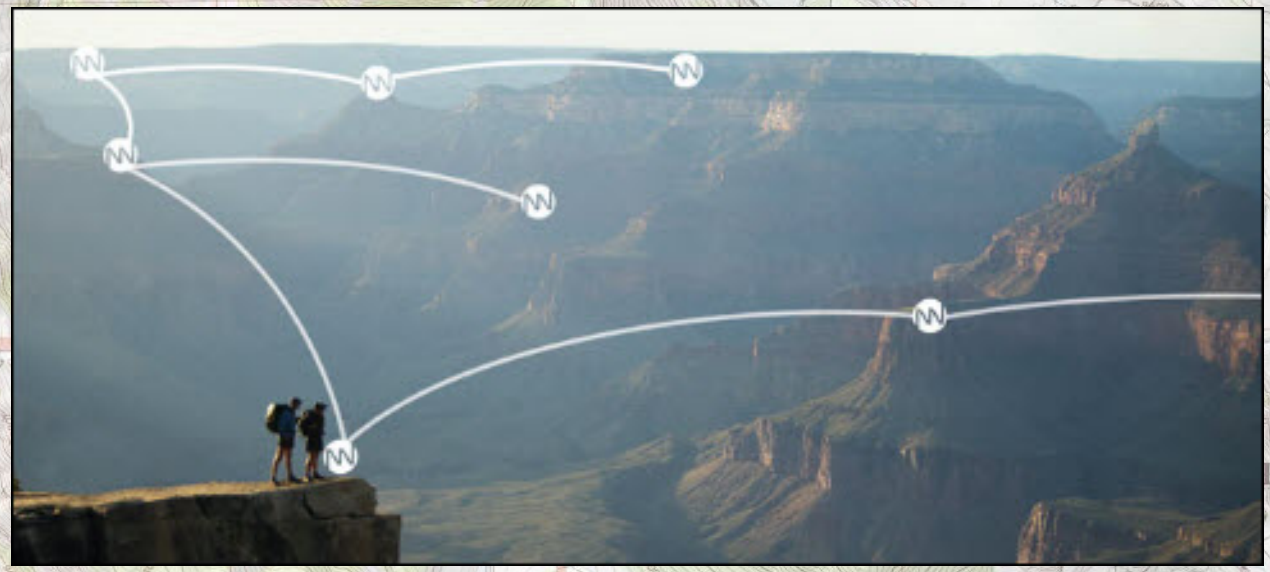
https://www.theverge.com/2019/4/12/18306207/best-gps-communicator-hiking-trails-garmin-spot-somewear-bivy

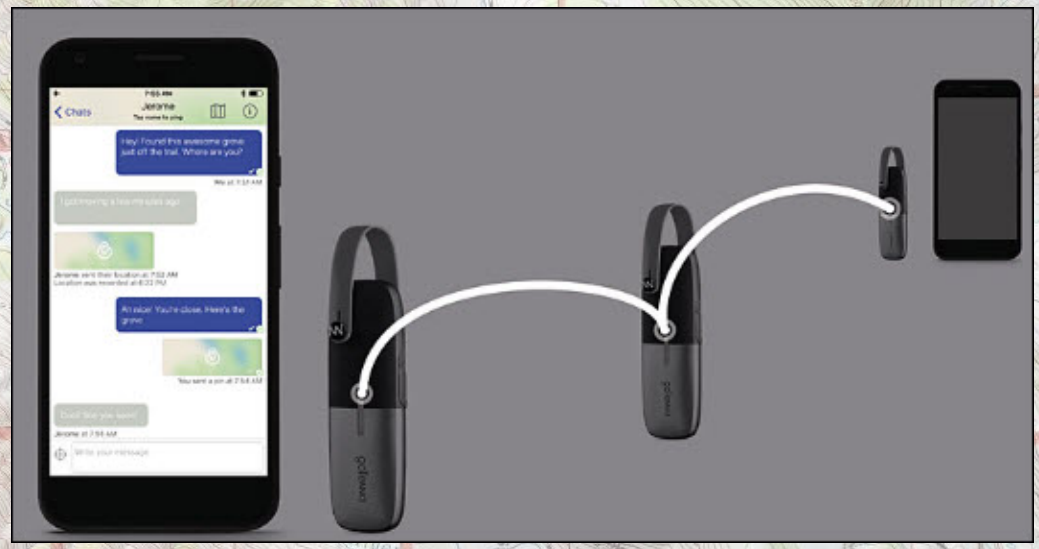
https://www.greenbelly.co/pages/best-personal-locator-beacons-satellite-messengers

goTenna

MESH technology allows users to link two or more smartphones into a local, secure network (UHF Frequency).

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

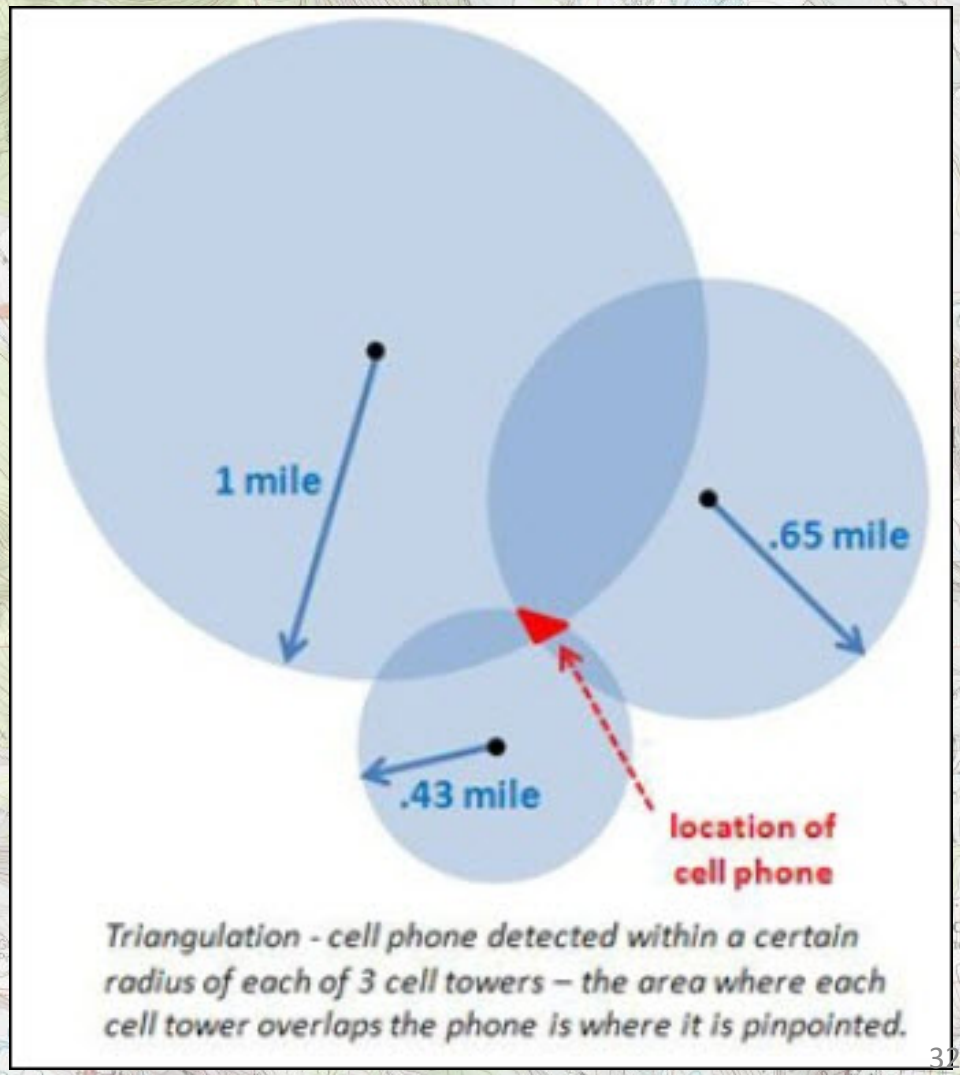




Cell Phone Triangulation vs. Pinging

Supreme Court Decision (June 2018)

Cell phone location data is protected by Fourth Amendment of the US Constitution.



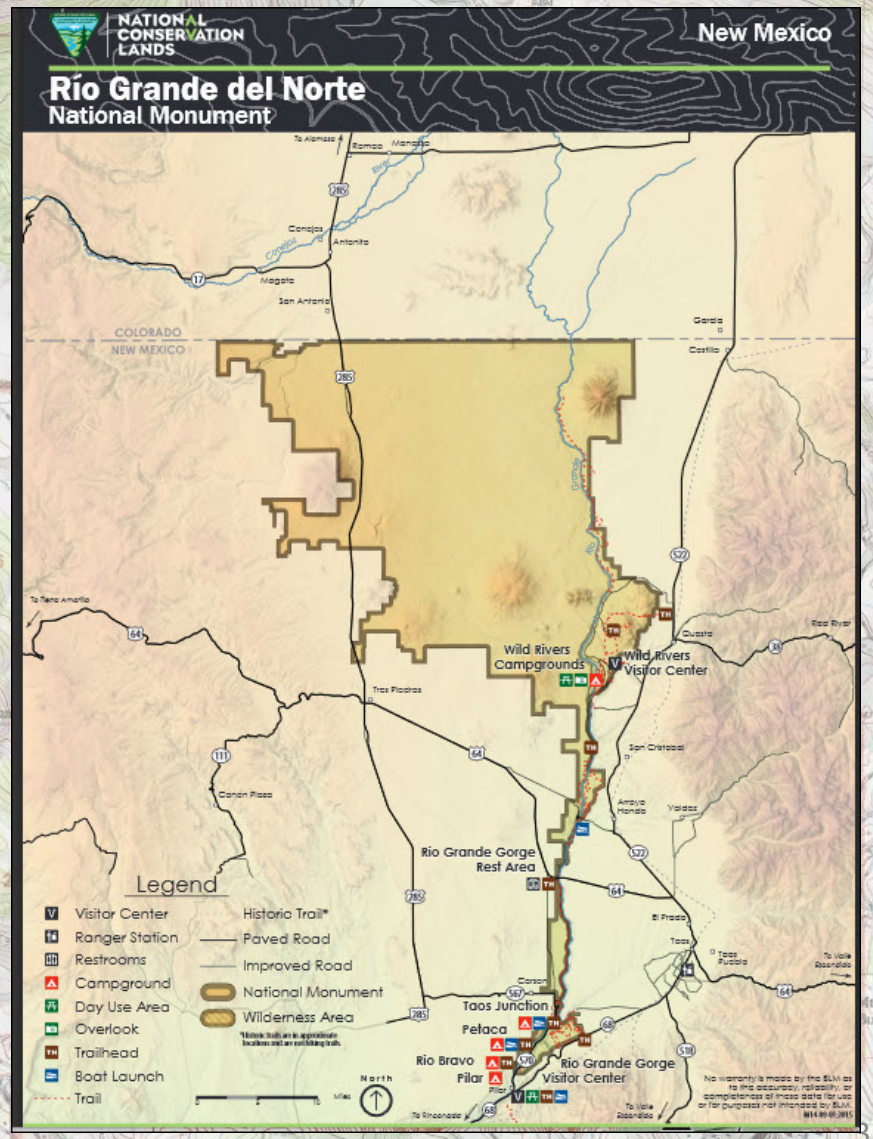
Triangulation - cell phone detected within a certain radius of each of 3 cell towers – the area where each cell tower overlaps the phone is where it is pinpointed.

Geo-Referenced Map (PDF)

Georeferenced PDF maps are designed to 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 developed georeferenced maps for various

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



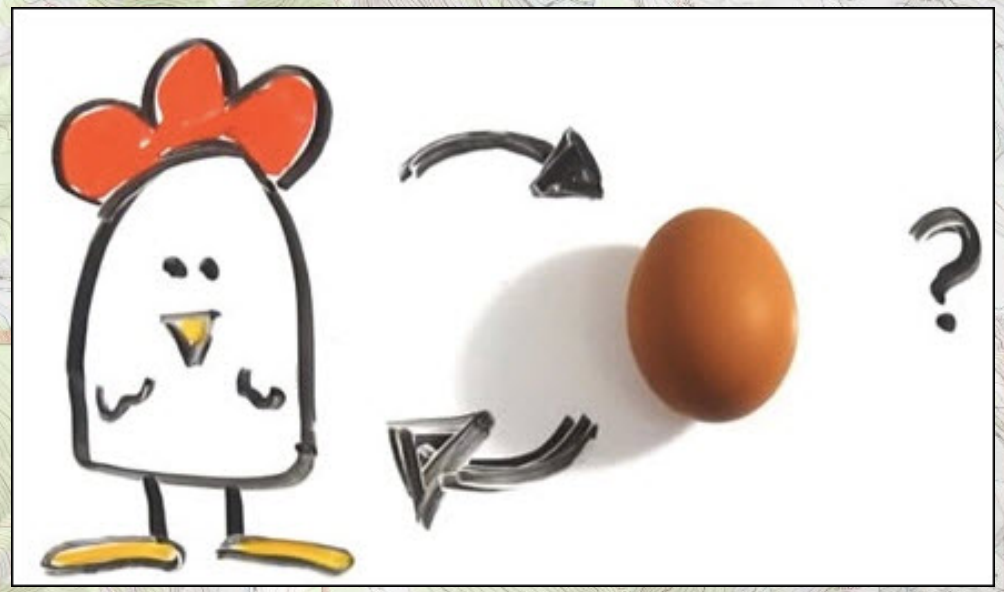
That’s a lot of information!

We’ve learned about:

- Triangulation (Angles/Distance)
- Trilateration (Distance)
- GNSS / GPS (Satellite)
- Latitude/Longitude/Elevation
- A-GPS (Cell Phone)
- Ping (Cell Phone)
- PLB / Communicators
- Amateur Radio - Mega-Link
- “Essentials List +”
- goTenna
- Georeferenced Map
- Batteries

Apps vs. Applications

Some cell phone “Apps” have corresponding “Web Applications”, making it difficult to organize this part of the presentation.



Due to screen size, some features are best suited on a computer than a cell phone.

Computer’s higher resolution is best tool for route planning and research. Cell phone’s small footprint and light weight make it the ideal tool for the field.

Applications

- Gaia GPS
- ViewRanger
- Strava
- CalTopo
- ShowMeHills
- CBGTrails – Gunnison-Crested Butte Tourism Association
- COTREX – Colorado Parks & Wildlife
- EasyGPS – transfer data to various GPS receivers
- Daily Roads Voyager – use mobile phone camera to record video (Carbam-like)
- Google Earth Pro
- GPS Track Editor
- onX (Hunting app shows property ownership
- OsmAnd - Open Source, offline Travel maps

Data Resources

- Albuquerque Senior Center's Hiking Group
- Gaia GPS
- New Mexico Meanders
- Powder Project
- ViewRanger
- Avenza
- CalTopo
- Strava
- Hiking Project
- Map My Run
- GPS Visualizer

Albuq. Senior Center Hiking Group

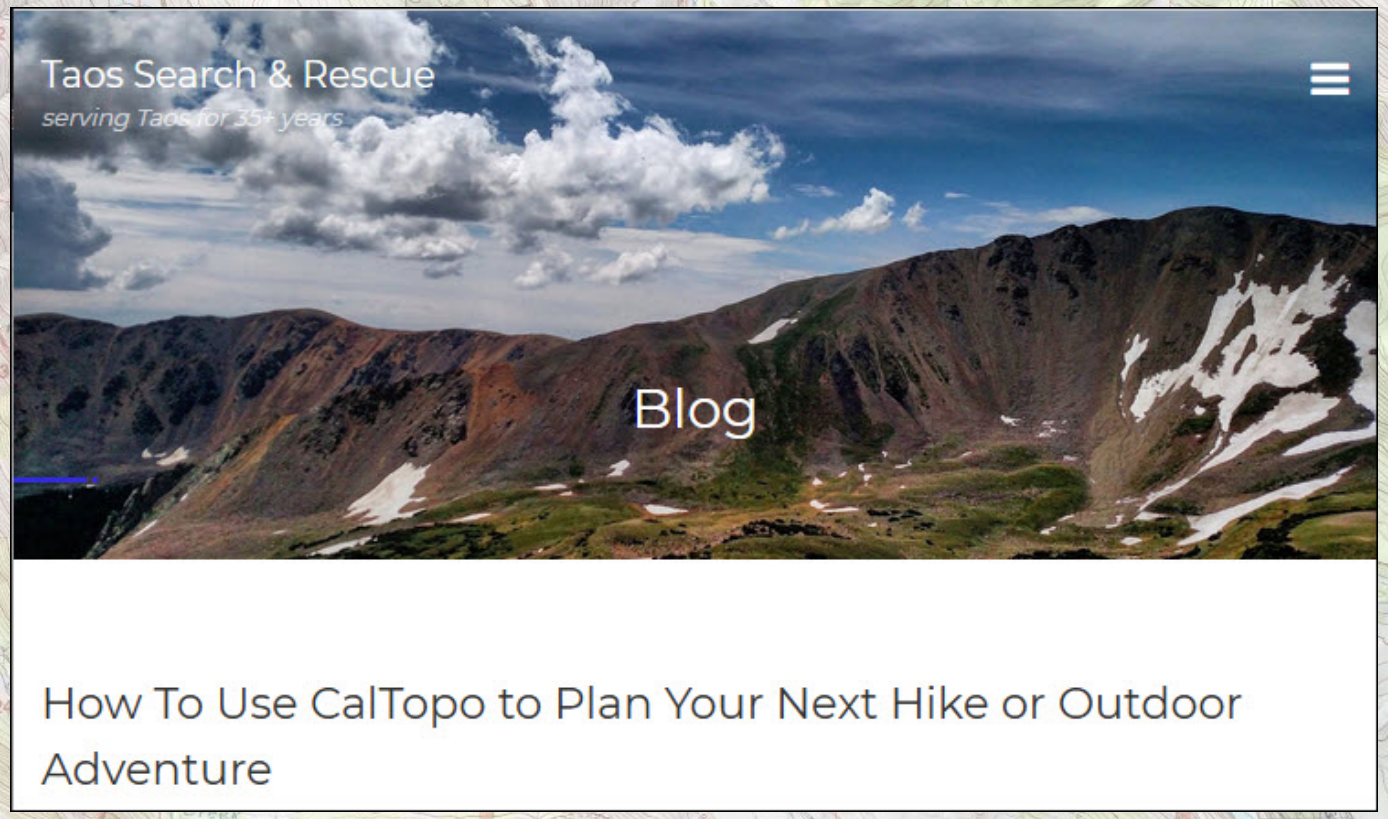
Day	Hike Date	Group	Signups Begin	Meet Time	Hike Name	Region	Hk Cls	Hk Mi	Ttl Up	Rte Typ	All on Trl	GPS Rec'd	Dr Mi	Dr Tm
				AM	South to Los Ranchos									
Fri	01/10/20	LVSC	12/27/19	10 AM	Rio Grande Nature Center To Tingley Beach Meet at trailhead	Albuquerque	B	8.1	35	Loop	Yes	No	10	0:15
Sat	01/11/20	PDSCS	12/28/19	8:45 AM	Sandstone Bluffs Long Loop	El Malpais	B	5.0	380	CCW Loop	No	Yes	160	1:20
Tue	01/14/20	HSC	12/17/19	8:00 AM	Nature Center North Bosque and Ditch Bank	Albuquerque	C	7.8	20	CW Loop	Yes	No	10	0:15
Thu	01/16/20	BCSC	12/19/19	8:00 AM	Faulty Loop Hiker limit 10.	Sandia Mountain South	C	5.2	1090	Loop	Yes	Yes	40	0:35
Fri	01/17/20	NDBMC	01/03/20	7:45 AM	Manzano Open Space	Albuquerque	C	4.1	858	Messy	Yes	Yes	14	0:30
Tue	01/21/20	PDSCT	12/24/19	8:00	Paseo De Las	Albuquerque	B	6.9	325	In/Out	Yes	No	10	0:15

http://www.aschg.org/jsp/home.jsp

http://www.aschg.org/jsp/gpsToolHelp.jsp "Tools for GPS Data" by Marylin Warrant

Tutorials

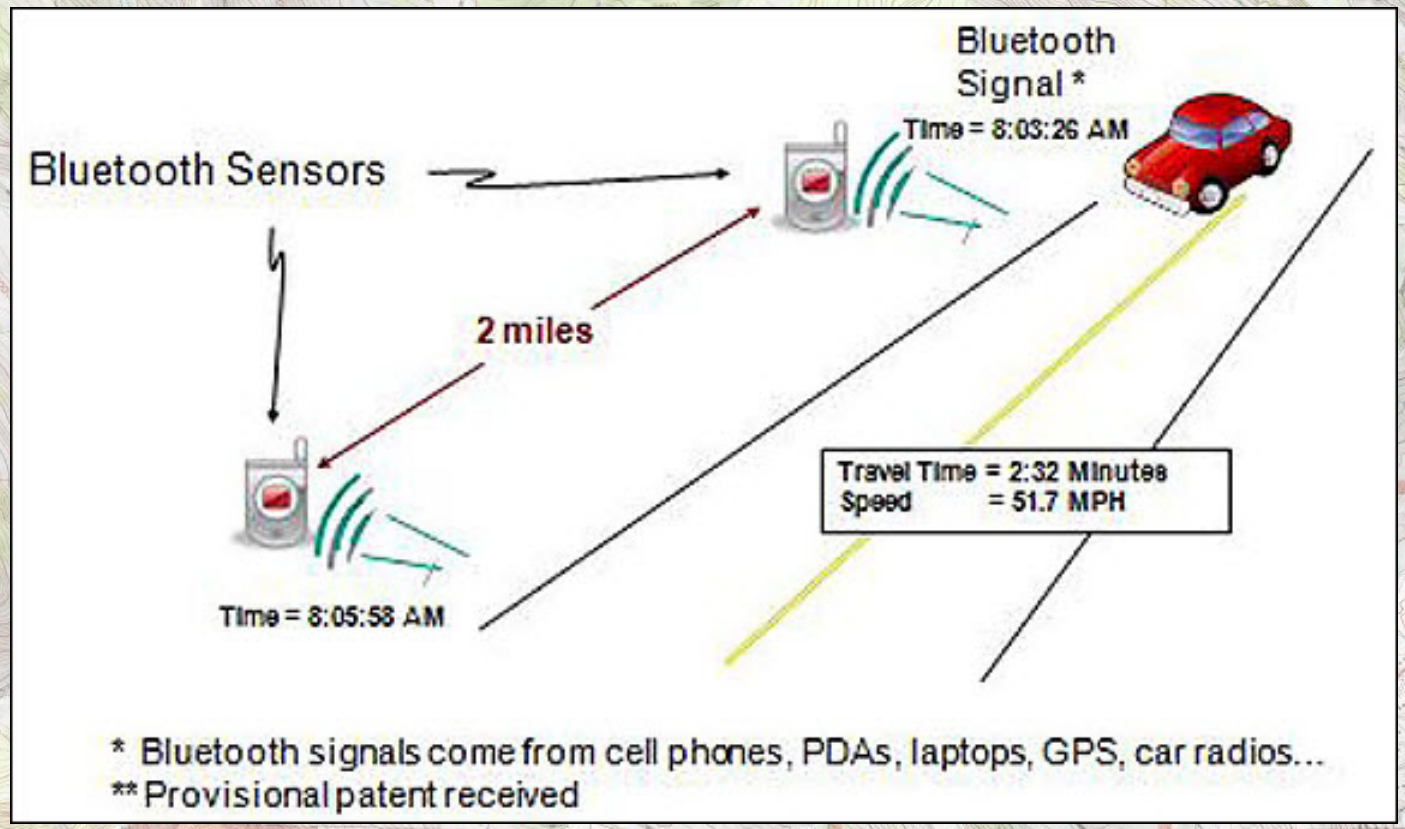
Taos Search & Rescue (CalTopo)



https://sar-taos.org/how-to-use-caltopo-to-plan-hike/

Intelligent Transportation Systems (ITS)

Bluetooth and Wi-Fi Sensors



https://www.pcb.its.dot.gov/eprimer/module9.aspx#detection

Factors you "may want to consider: (1)

- Assumptions: You're prepared physically, did your your research, have the "11 Essentials", have a reliable contact that knows your plan, etc.
- Determine what type of outings you plan to go out on.
- Will you be in areas that don't have cell phone coverage?
- Will you be in well-traveled areas or remote areas?
- Will you be solo or part of a group? Group: Consider coordinating device use to conserve battery power.
- Are there health/terrain risks that would justify an Emergency Communicator ?

Factors you "may want to consider: (2)

- Do you plan to travel internationally? Map availability?
- Do you have the patience to research and test various applications and hardware? Settle on the mix you like. Practice, practice, practice…
- Learning map navigation (compass & paper maps).
- Can you reading the terrain that you find yourself in?
- Analyze risks before you encounter and plan any adjustments or cancel outing in interest of safety?
- Carry spare power source or solar recharger for devices proportional to expected excursion time.

What happens in Tunis stays in Tunis!

Questions?

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