

# Land Navigation VI

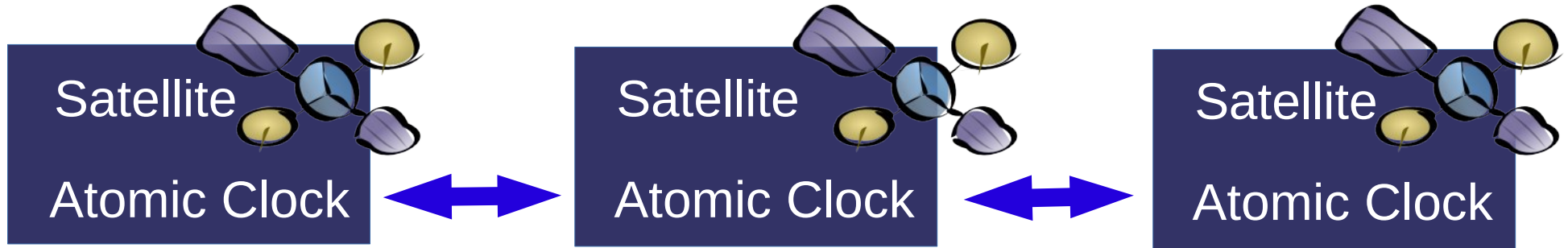
## Basic GPS/GNSS



# GNSS/GPS

- Global Navigation Satellite System
  - GPS (US)
  - GLONAS (Russia)
  - Galileo (EU)
  - BeiDou (China, regional, global by 2020)

# How GPS Works

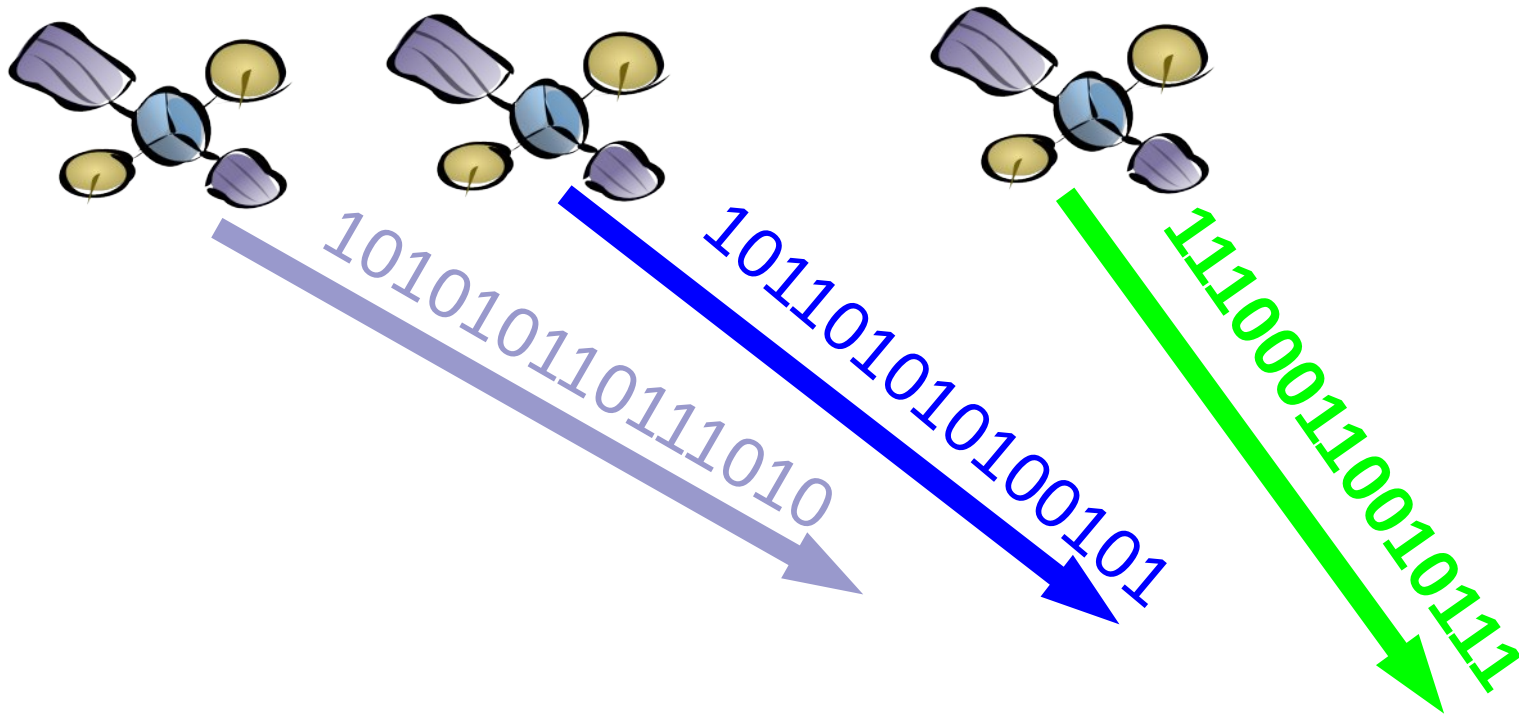


Each satellite carries an atomic clock  
These are synchronized from a master  
atomic clock on Earth.

Satellites transmit on 15475.42 MHz  
Navigation signal and C/A signal

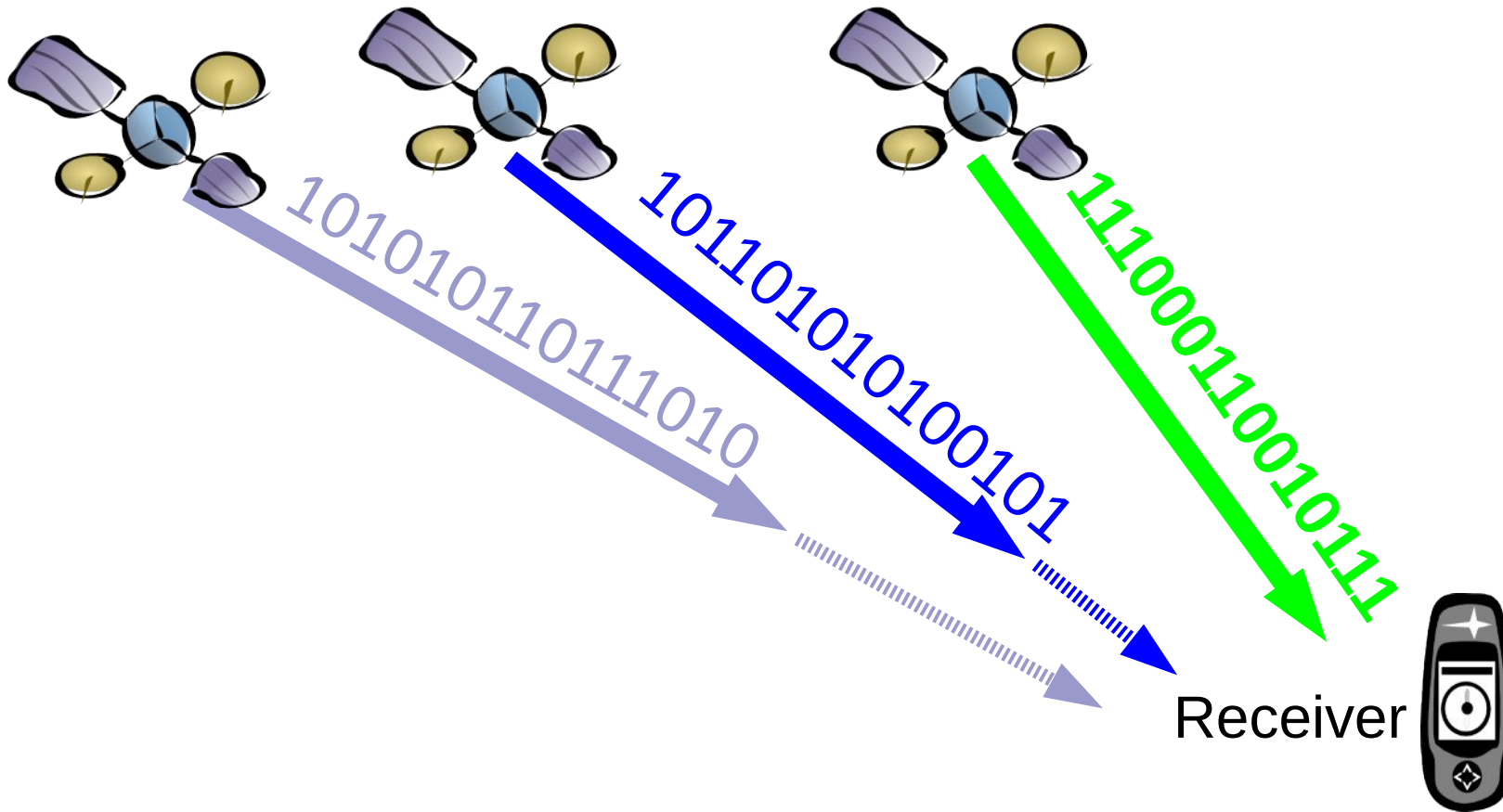
Ground Station  
Master Atomic Clock

# The C/A Signal



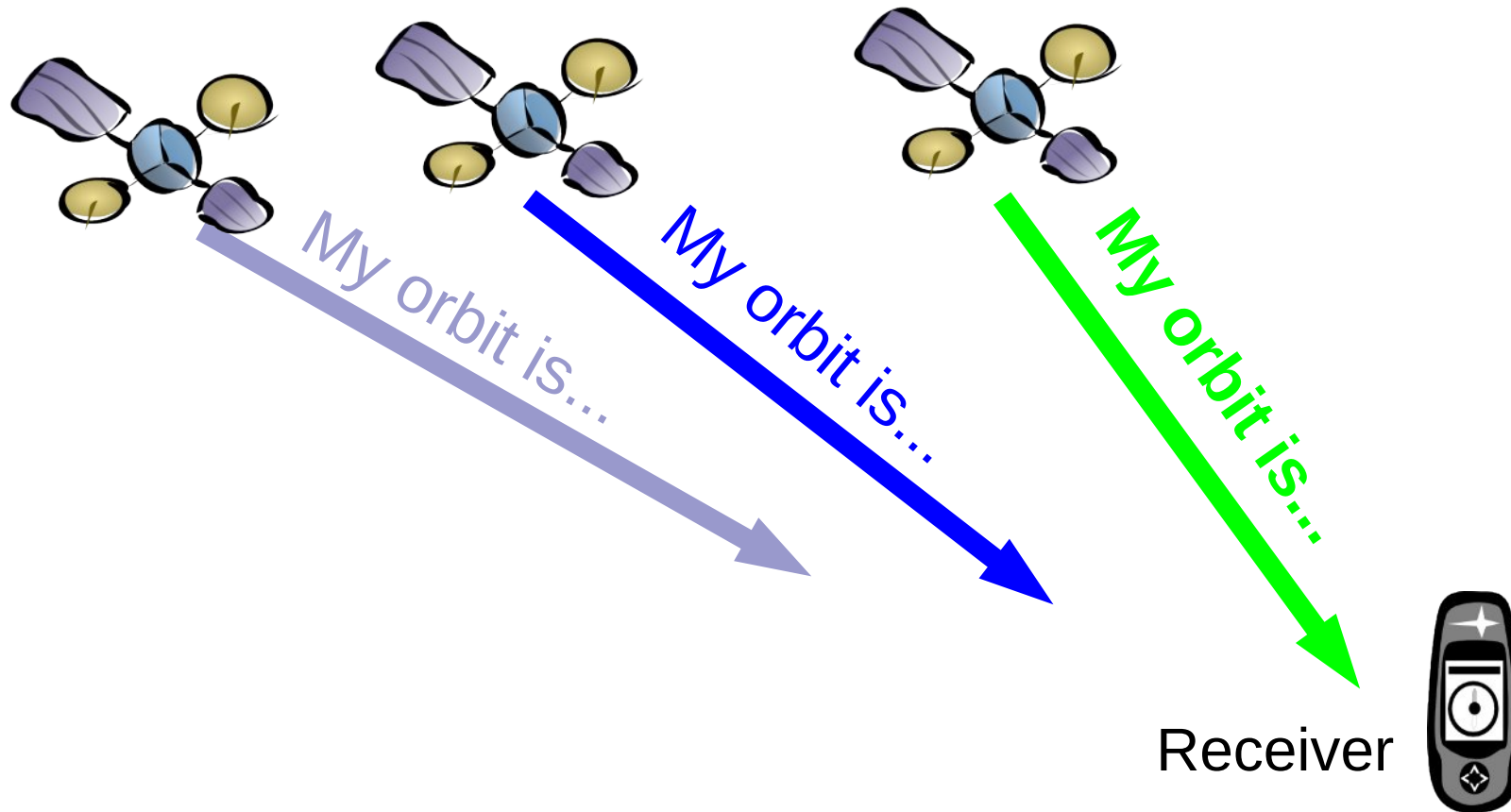
Each satellite transmits its own unique “name” a 1023 bit Pseudo Random Noise word. All satellites start to send this signal at known times.

# The C/A Signal



Since each satellite transmits its “name” at a known time, a receiver can identify a “letter” in each name, know exactly when that “letter” left the satellite, and thus from the time lag among them tell the relative distance to each satellite.

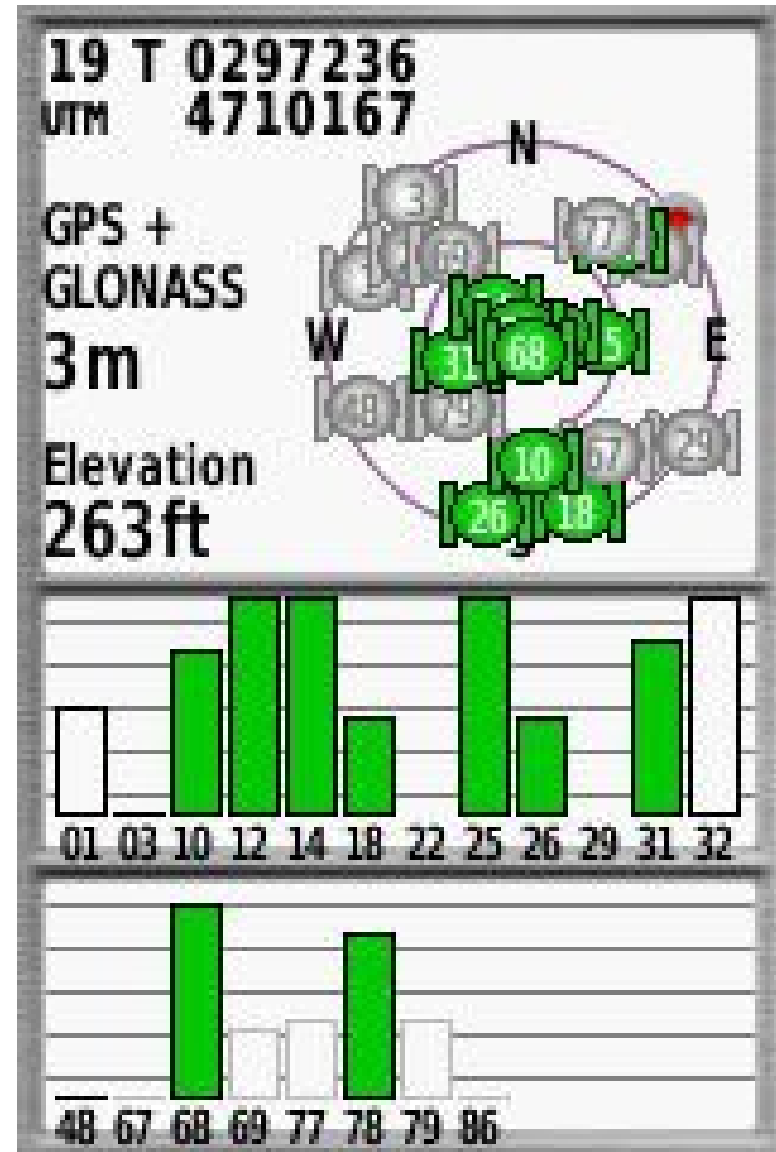
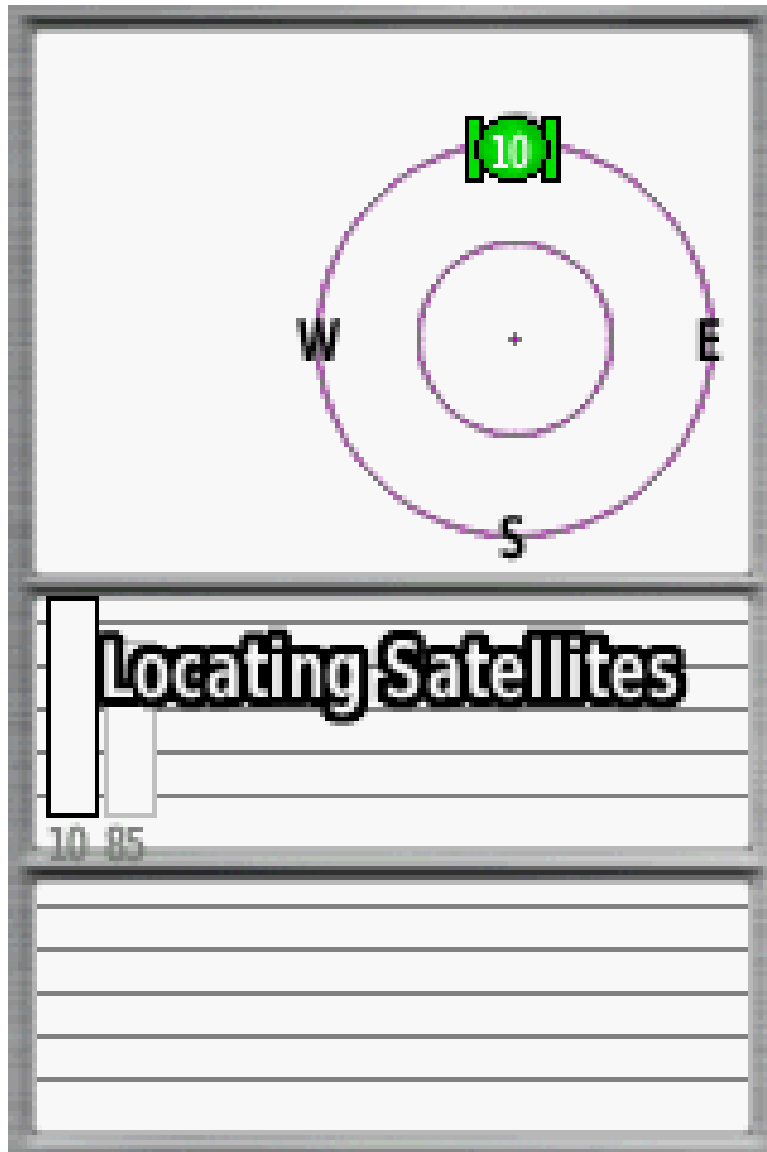
# The Navigation Message



The Navigation message includes the orbital parameters and the time the C/A signal was sent.  
(I'm here, I started sending my name at...)



# Does My GPS know where it is?



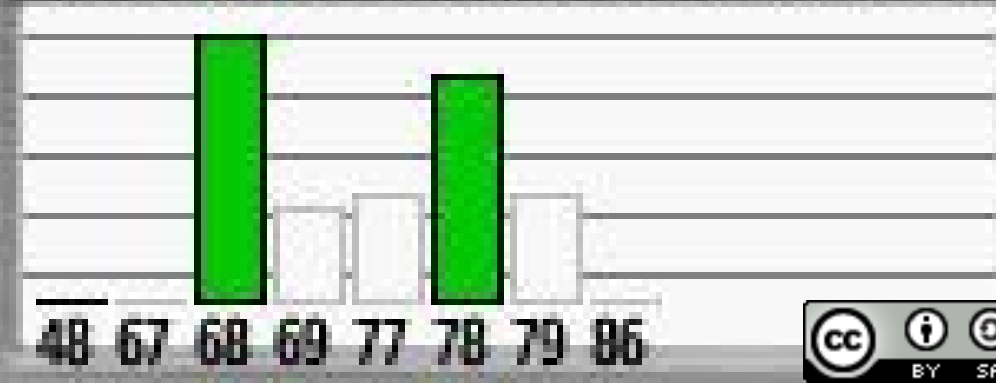
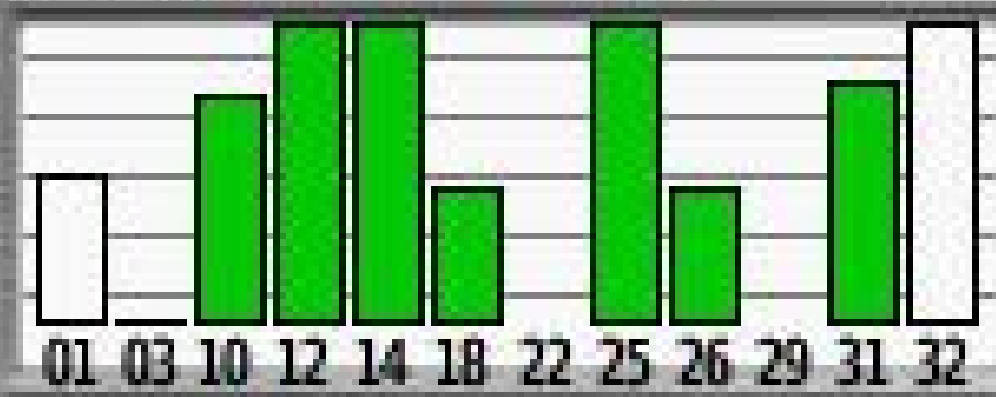




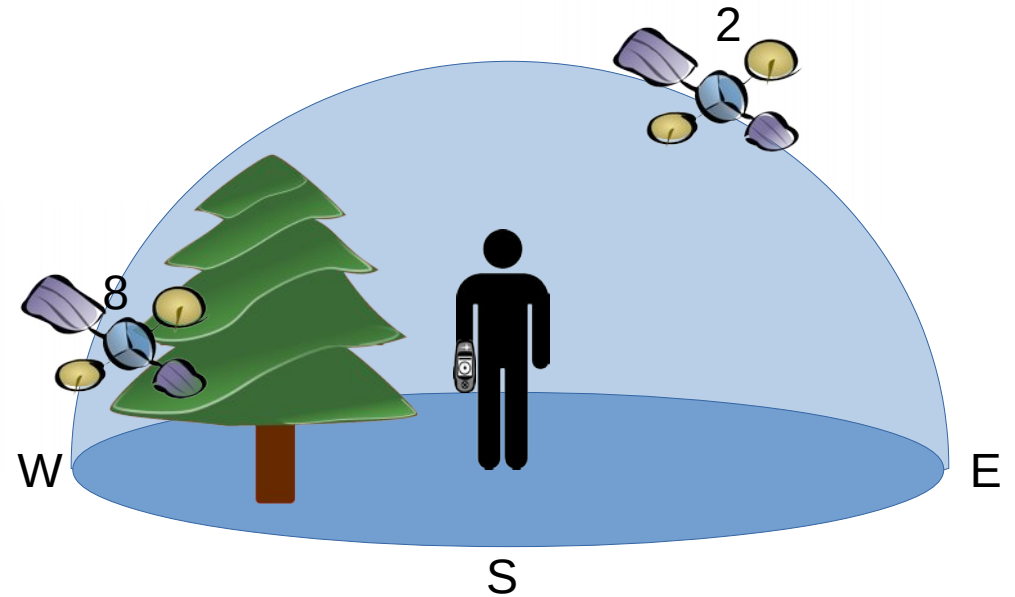
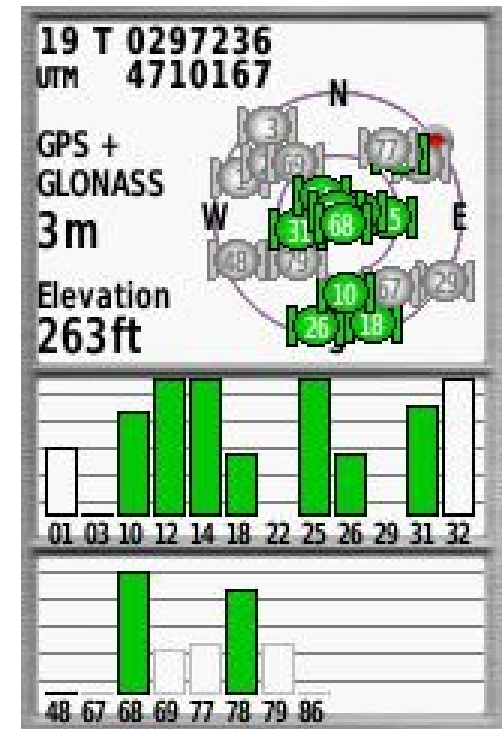
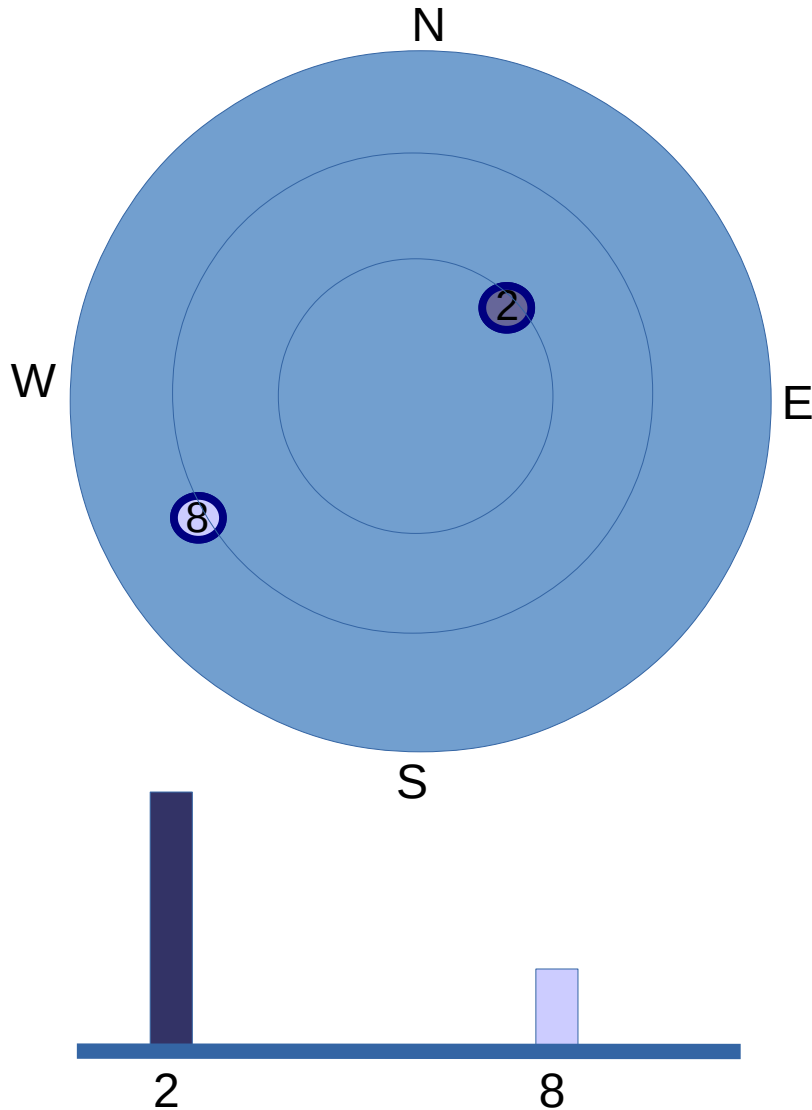
19 T 0297236  
 UTM 4710167

GPS +  
 GLONASS  
 3 m

Elevation  
 263 ft

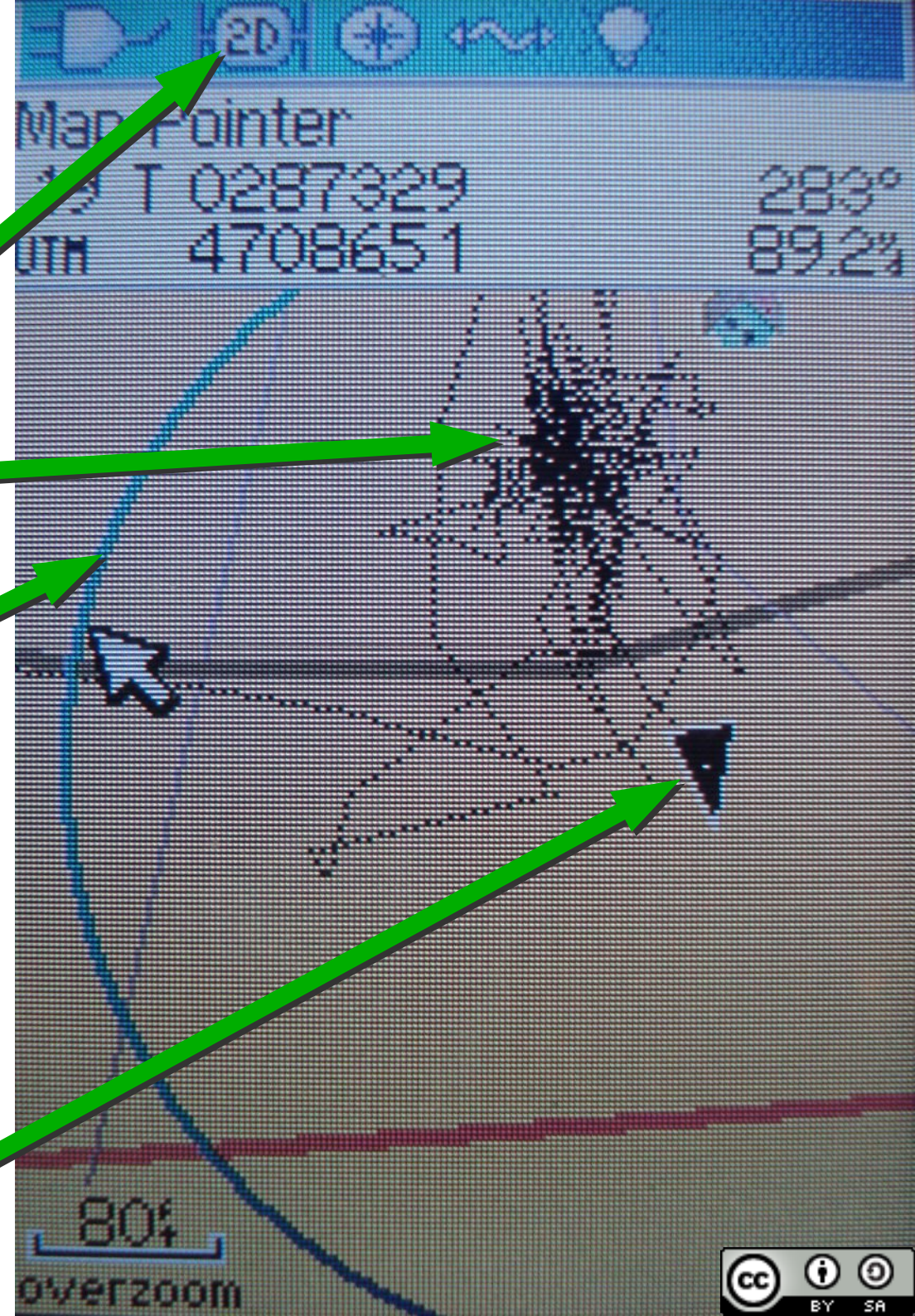


# Acquiring Satellites

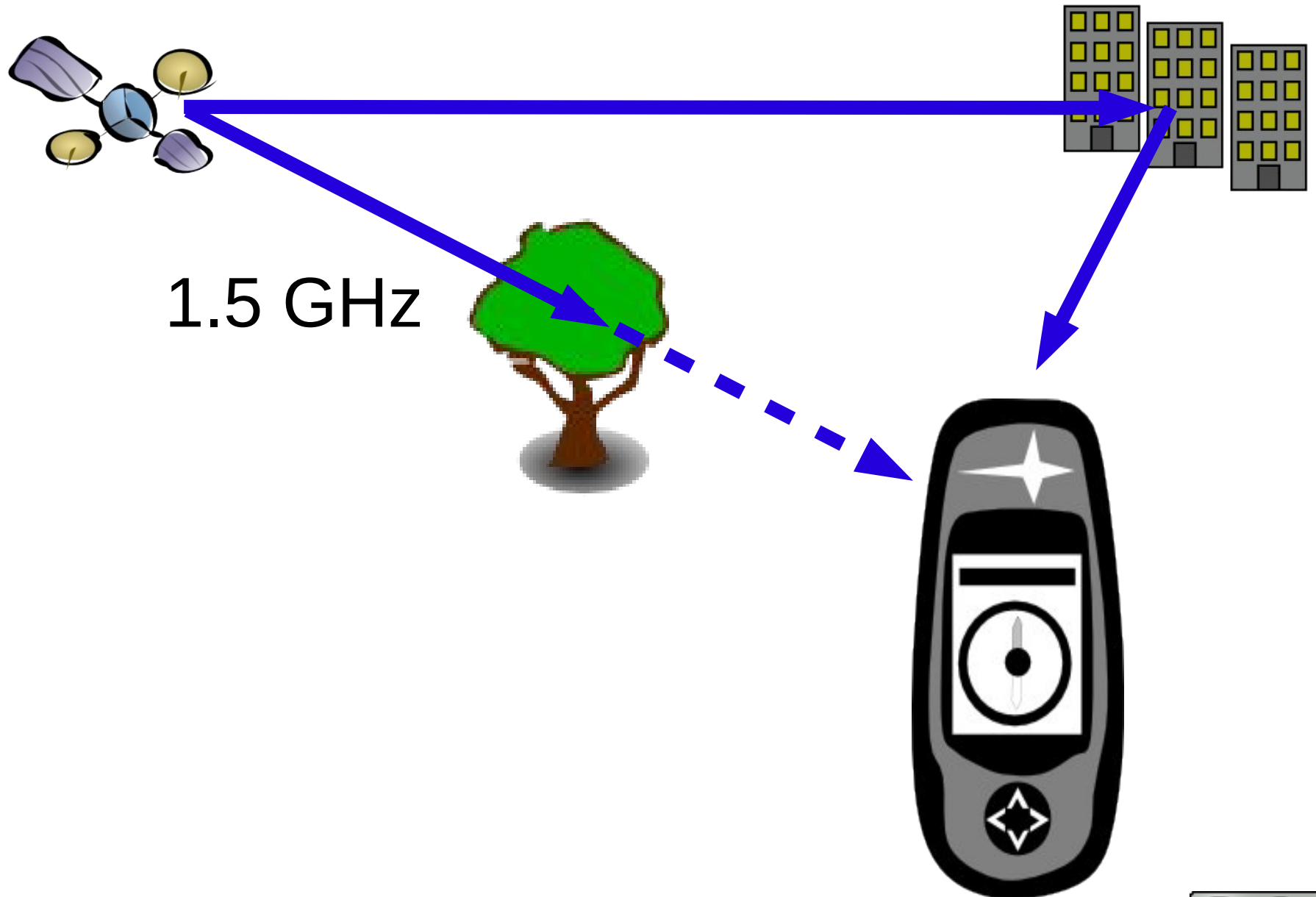


# Poor Lock

- 2D position only
- Random walk Track (mostly from position errors)
- Large circle of current position error (95% probability) (here, within about 90 meter radius)
- Current position and direction of travel



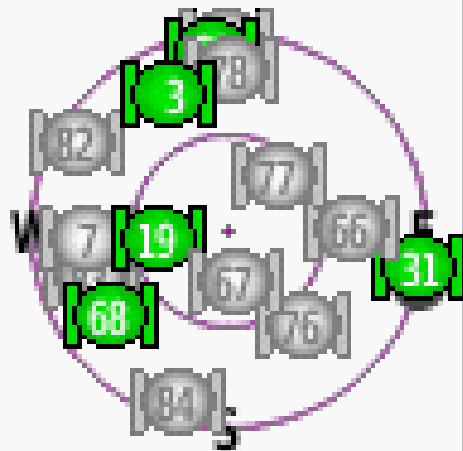
# Microwave Signal



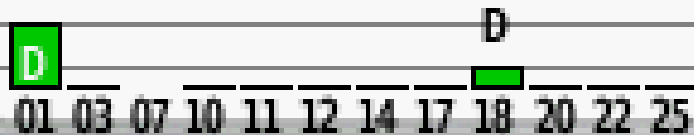
1.5 GHz



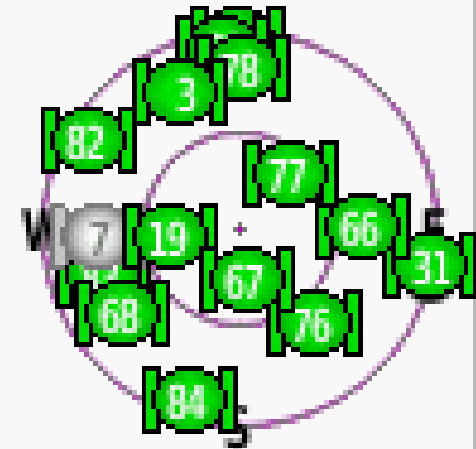
Public Domain image from NASA: Aurora Australis seen from the Space Shuttle Discovery



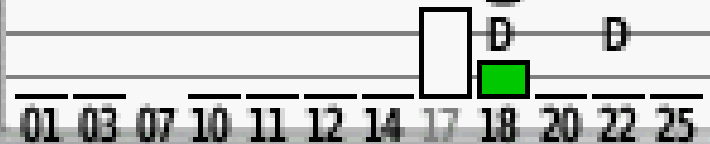
## Weak GPS Signal



31 32 66 67 68 76 77 78 82 83 84 193



## Weak GPS Signal



31 32 66 67 68 76 77 78 82 83 84 193

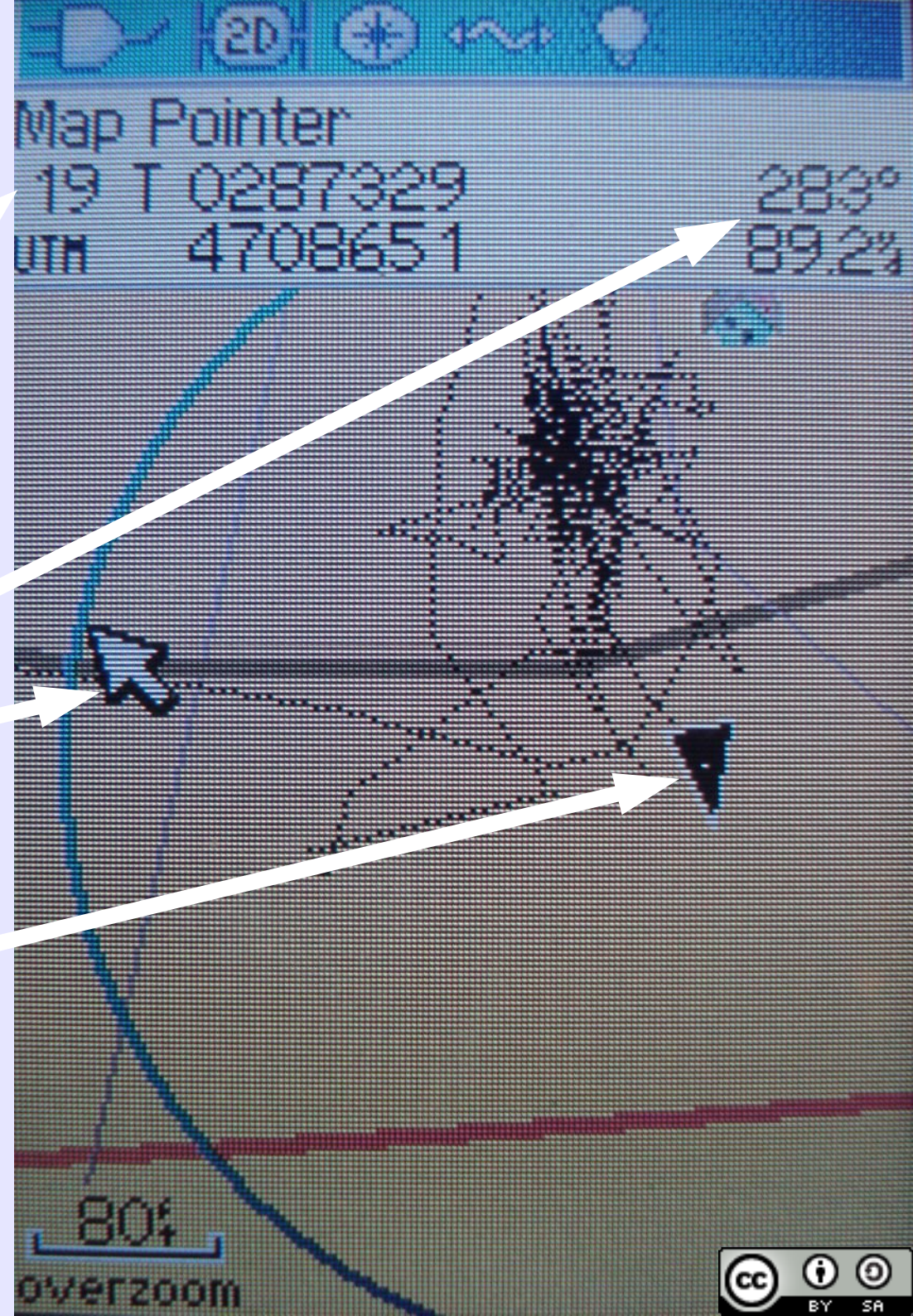
# Some Limitations of GNSS Receivers

- Need Batteries
- Altitude is lower accuracy than position
- Need Line of sight to 3+ satellites
  - Accuracy can be reduced under tree canopy
  - Accuracy can be reduced by multi-path in urban areas or canyons
  - Accuracy can be reduced by solar weather
- Many opportunities for human error





- Coordinates at pointer
- Distance and bearing from current location to pointer
- Pointer
- Current Location and direction of travel



# Displays Vary (Learn Yours)

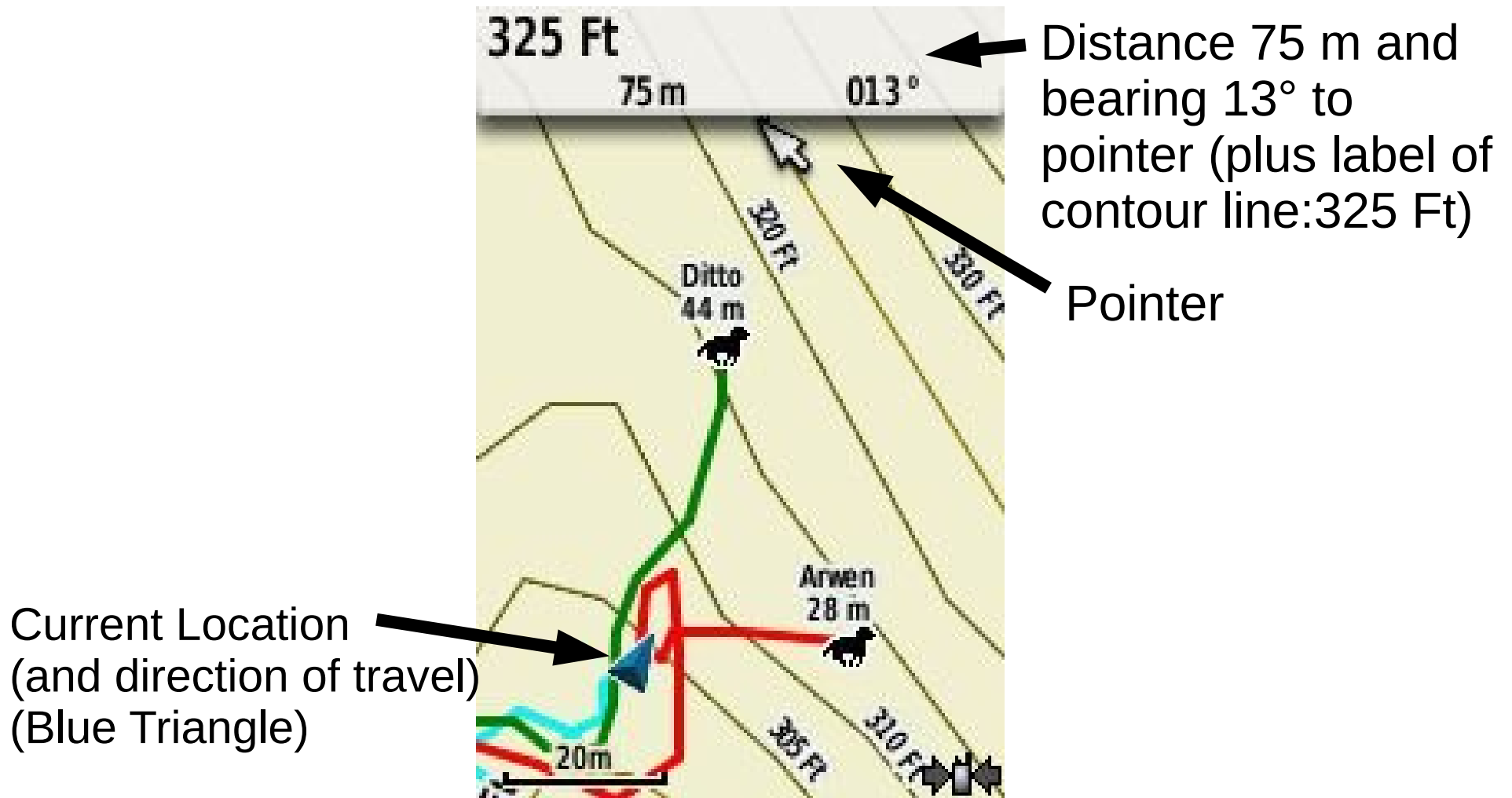


Current Location (Blue Triangle)



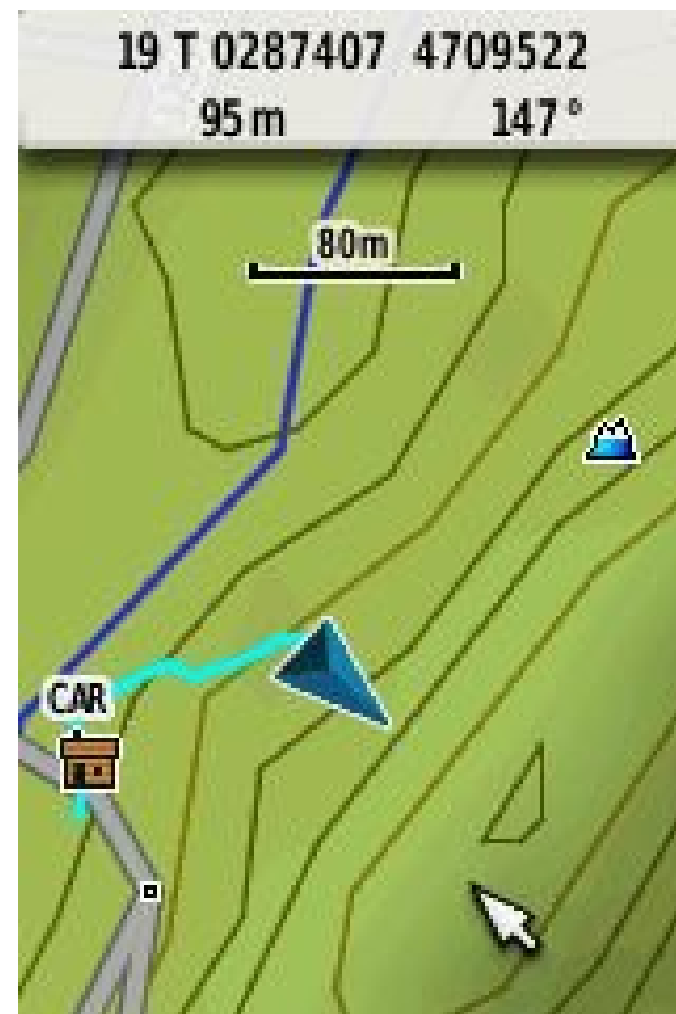
Distance and bearing to pointer  
(and label at pointer (Stream))

# Displays Vary (Learn Yours)

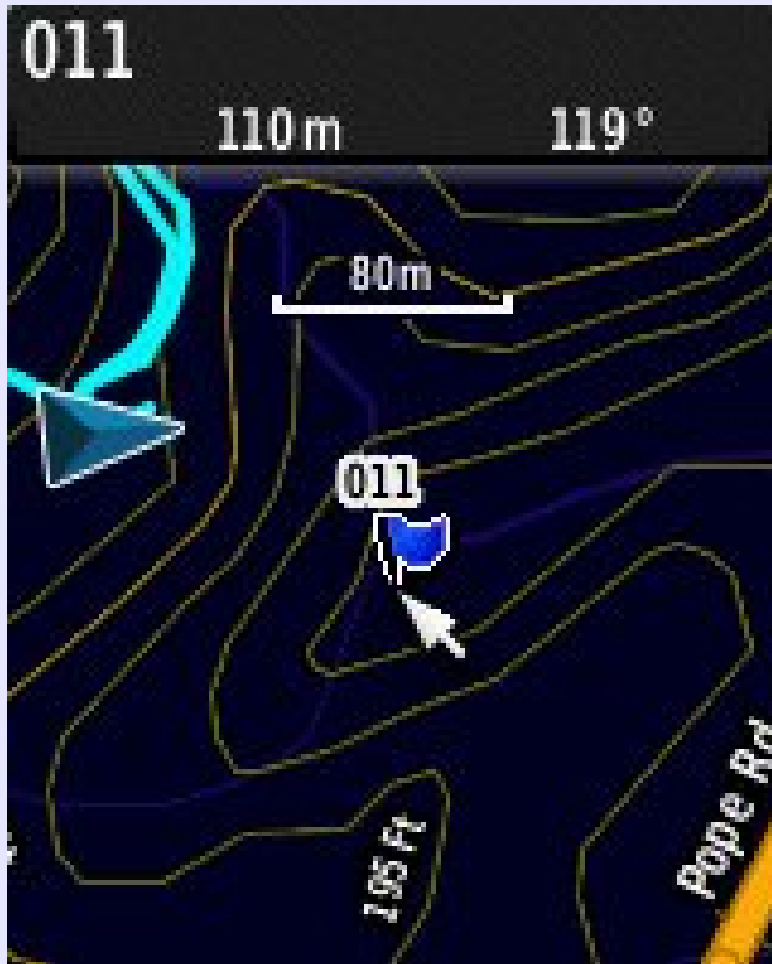


# Simple Navigation

- Bearing and distance to a point
- Track
- Waypoints
- Go To a Waypoint



# Waypoints



011

Note

Location  
19T CH 03571  
USNG 08245

Elevation  
810 <sup>f</sup><sub>t</sub>

Depth  
\_\_\_\_\_ <sup>f</sup><sub>t</sub>

000 <sup>f</sup>      0 <sub>m</sub>

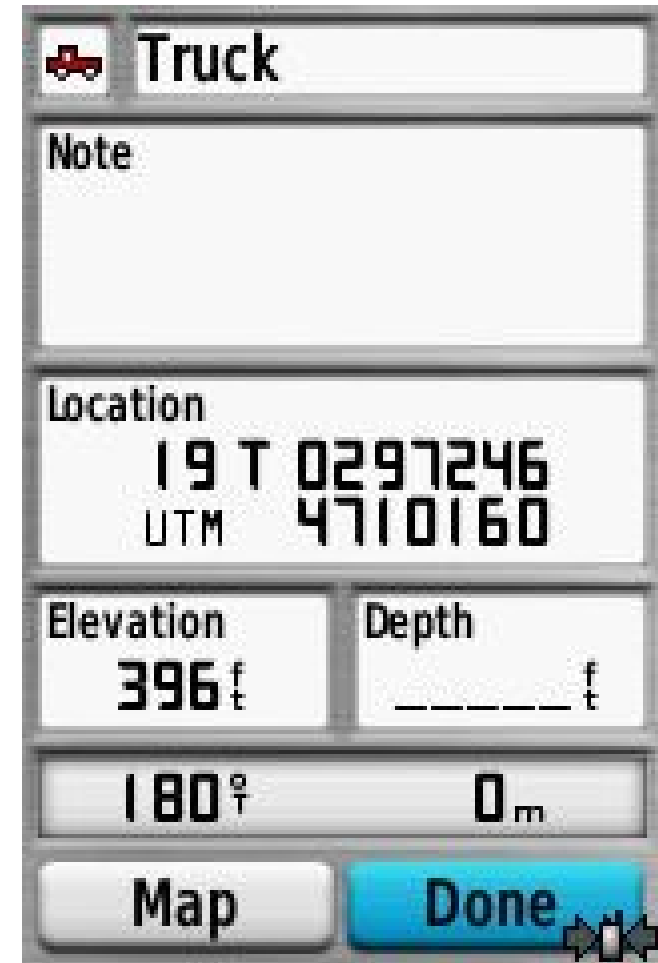
Map Done

# Go To Waypoint



[Find]

# If You Remembered To Store It

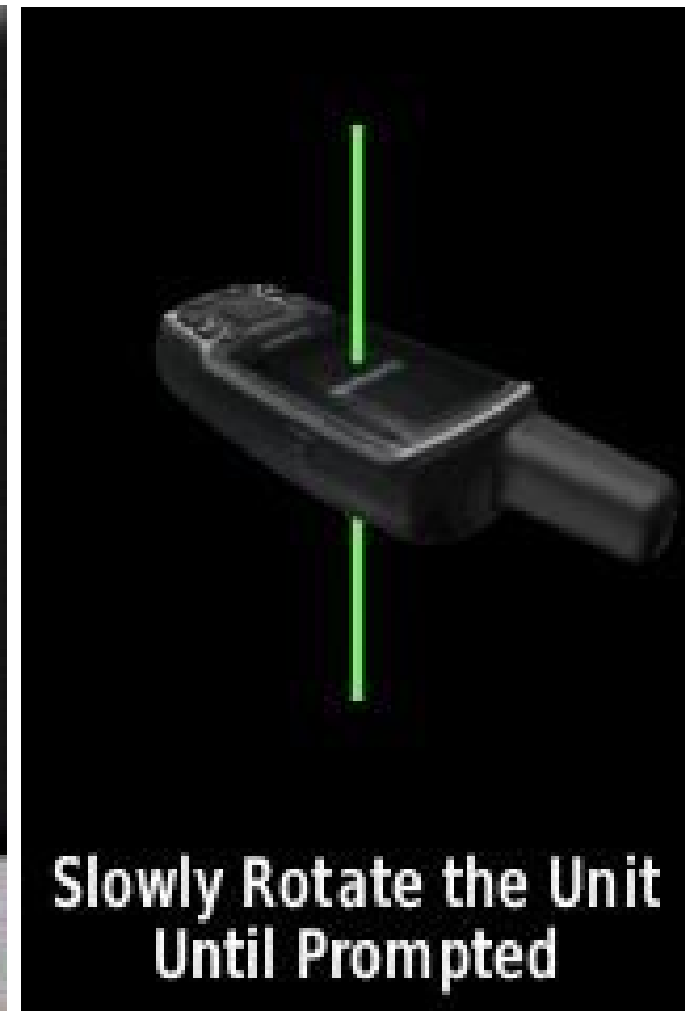
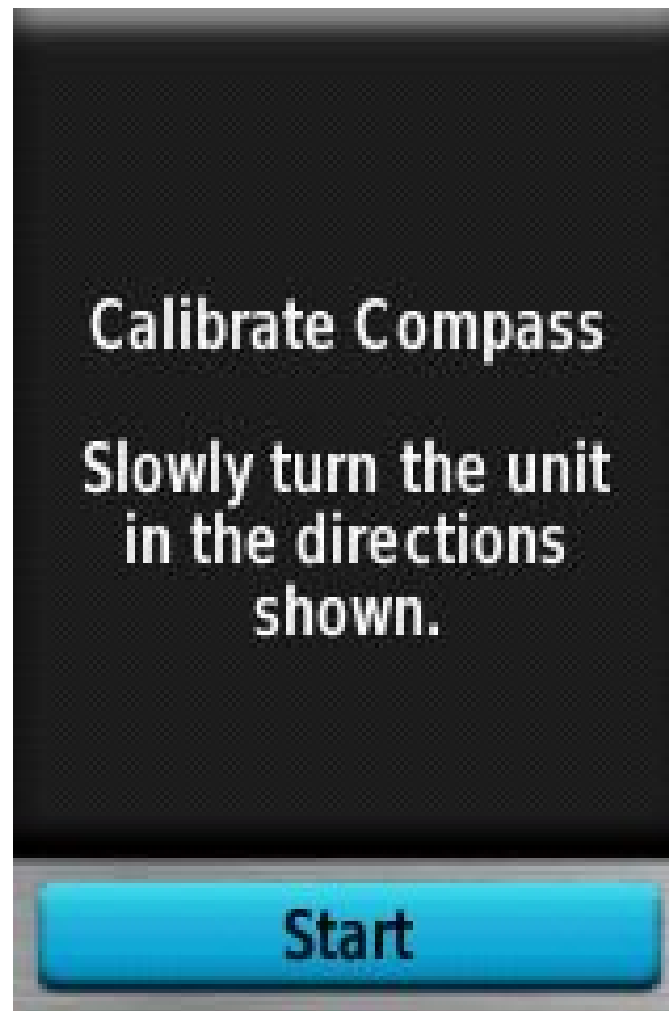


# Practice Good Habits:

- Before you start: Check your batteries.
- When you get out at the drop off point
  - Make sure your GPS has an accurate position.
  - Mark a waypoint with your GPS.
  - Save and clear the current track (dog's too).
  - Make sure that your GPS is recording the track.
- When you start your assignment
  - Mark a waypoint
- When you complete your assignment
  - Save the track for the assignment.



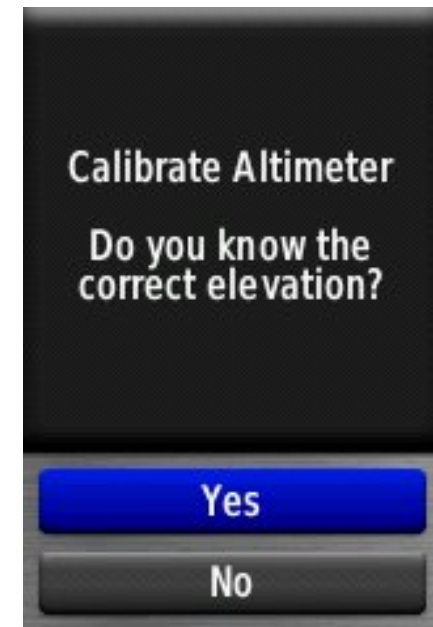
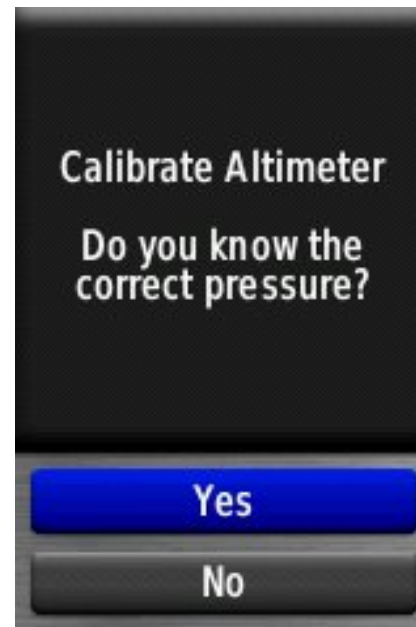
# And Calibrate the Compass (often)



# Practical: Startup Sequence

# Altimeter Calibration

- Known Elevation
- Known Barometric Pressure

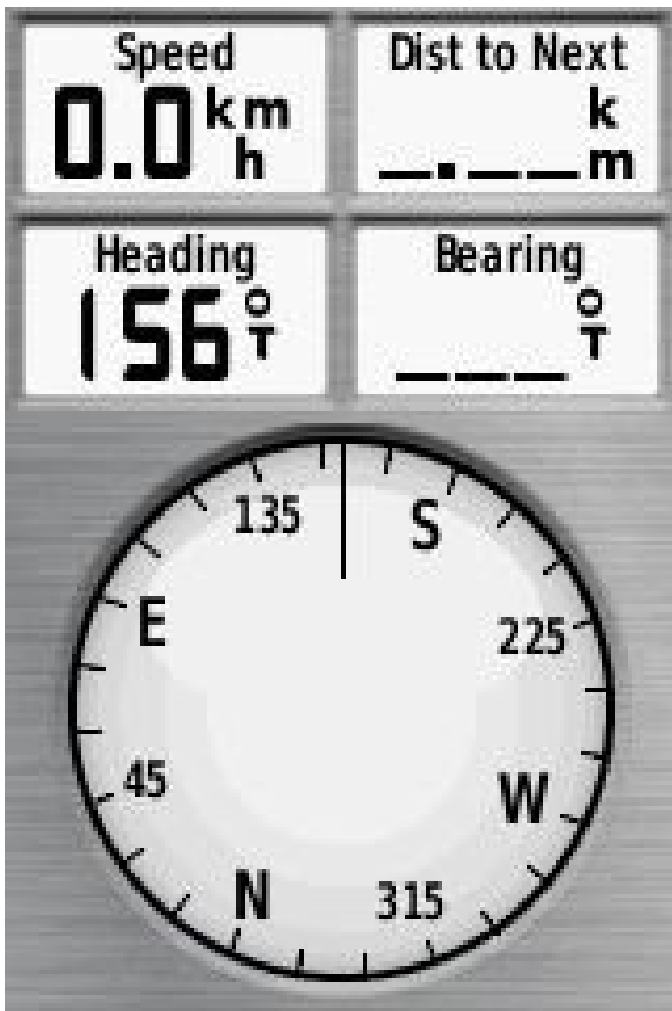


- Location of Waypoint
- Bearing and distance to pointer
- Waypoint
- Track
- Pointer
- GoTo Waypoint
- Current location



About 0.7 miles off screen

# Customize Your Screen For Your Task



# May need to change Heading Settings to see Bearing in Degrees

E

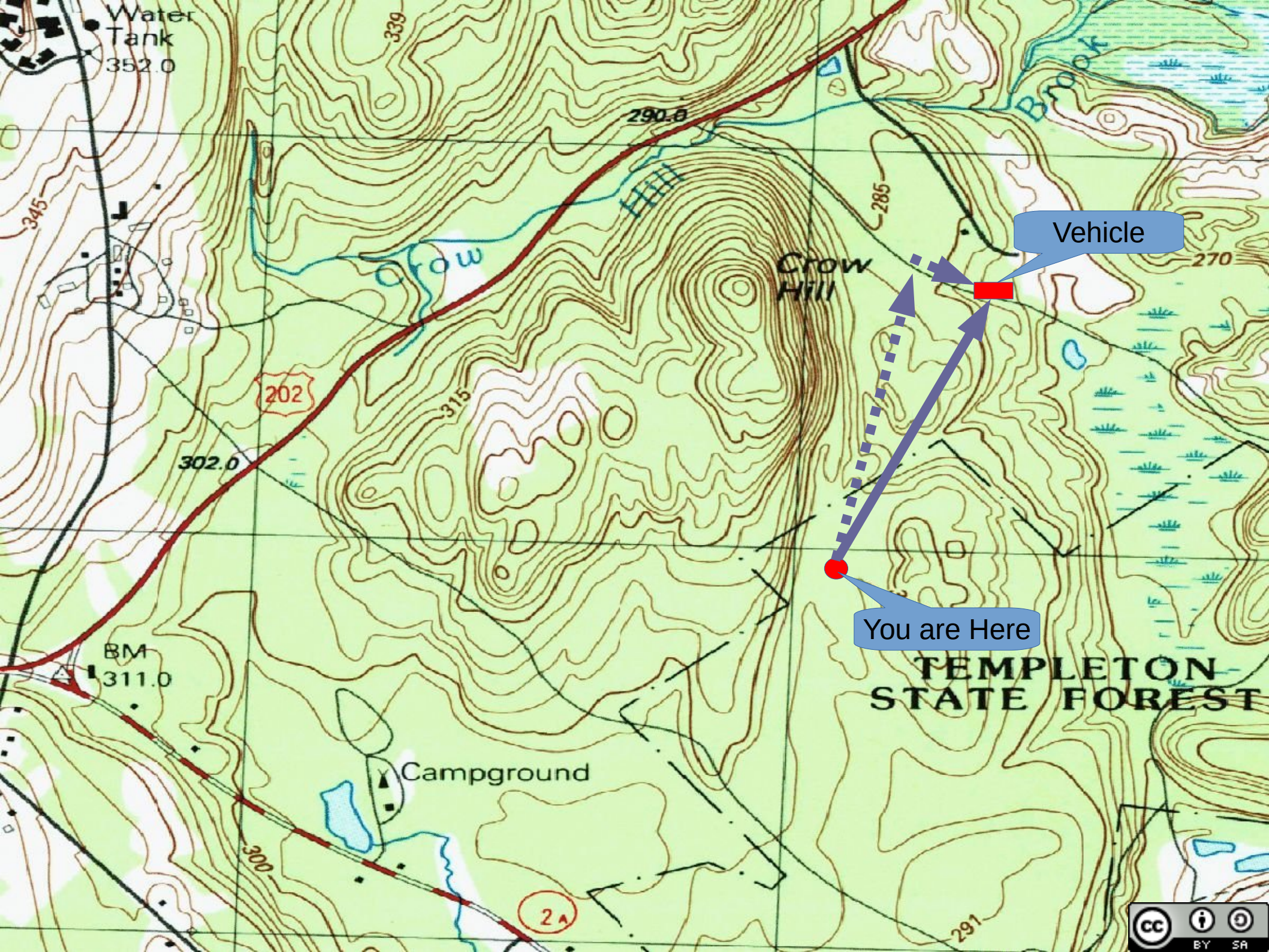


109°



# Fields on Map View





Vehicle

You are Here

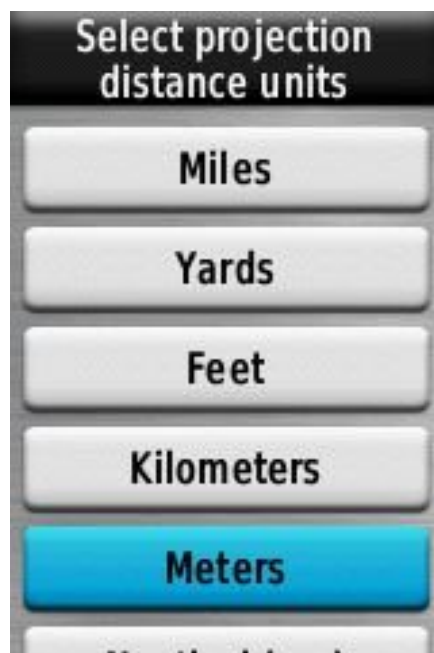
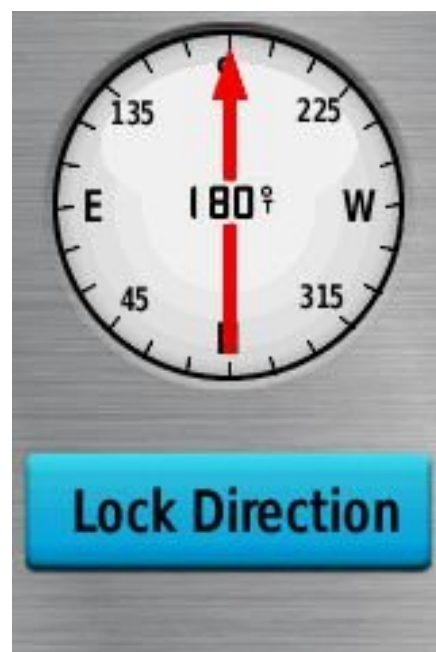
TEMPLETON STATE FOREST



# Ways to Create a Waypoint

- At your current location (Mark)
- At your current location, then edited to a given location (Mark/Edit).
- At your current location, then moved with the map pointer (Mark/Menu/Drag)
- Projected from your current location (Sight & Go).
- Projected from another waypoint. (Waypoint Manager/Waypoint/Menu/Project Waypoint)

# Project a Waypoint from current location




# Project a Waypoint from another Waypoint

The screenshot shows a handheld GPS device interface with the following elements:

- Top Panel:** A text field containing "CHURCH" and a "Note" field below it.
- Waypoint Information:** Location "19T BH 66345 USNG" and Elevation "820 ft".
- Menu:** A list of actions including "Delete", "Change Photo", "Average Location", "Project Waypoint" (highlighted in blue), "Move Waypoint", "Find Near Here", "Set Proximity", "Add to Route", and "Reposition Here".
- Map:** A topographic map showing contour lines and a red dashed line representing a projection path. A blue arrow points from the source waypoint towards the target area.
- Projected Waypoint Panel:** Displays the name "011", the projection parameters "60 degrees" and "300.00 meters", and buttons for "Save" and "Save and Edit".
- Navigation:** A numeric keypad and a "Done" button are visible at the bottom.

# Practical: Waypoints

 <b>011</b>	
Note	
Location	
<b>19T BH 66346</b> <b>USNG 10921</b>	
Elevation	Depth
_____ f _____ t	_____ f _____ t
<b>274</b> <sup>f</sup>	<b>21.16</b> <sup>k</sup> <sub>m</sub>
Map	Go



# Building Your Own Map

- Waypoints
- Routes
- Tracks
- Finding your way back to a pickup point
- Documenting where you have searched
- Documenting a flagline segment boundary
- Documenting a clue

# Finding Your Way Back to a Pickup Point

- Create a waypoint at the place you are dropped off for a search segment.
- Create a waypoint at the point you enter a search segment.

# Documenting Where You Have Searched

- If your GPS can store tracks:
  - Record your track with your GPS.
  - Start recording the track when you start a search segment
  - Stop and save the track when you finish a segment.
- If your GPS can't store tracks:
  - Carry a GPS logger.
  - Record Waypoints at extreme points in your search segment (e.g. when your grid hits a segment boundary).



# Tracks, Waypoints and Routes

The image displays the Quantum GIS (QGIS) interface with a satellite map. A green line represents a track, a cyan line with dots represents a route, and a magenta line with dots represents a route. Three arrows point to these features: a green arrow to the track, a cyan arrow to a waypoint, and a magenta arrow to a route. An inset window shows a detailed view of a route with labels like 'PrHill Y-B' and 'Hill Y-B 1a'. The main window has a layers panel on the left and a coordinate/status bar at the bottom.

Quantum GIS - 1.3.0-Mimas qgis\_layers\_from\_gps

File Edit View Layer Plugins Tools Help Click-fu

Layers

- tracks
- waypoints
- routes
- 24136147\_geo

Track

Waypoint

Route

PrHill Y-B  
19 T 0286690 297°  
UTM 4709478 256.2°

Hill Y-B 1a  
Hill Y-B a  
Pr Hi-F  
Hill Y-B 1  
PrHill Y-B  
PrHill Y-Slv

300%  
overzoom

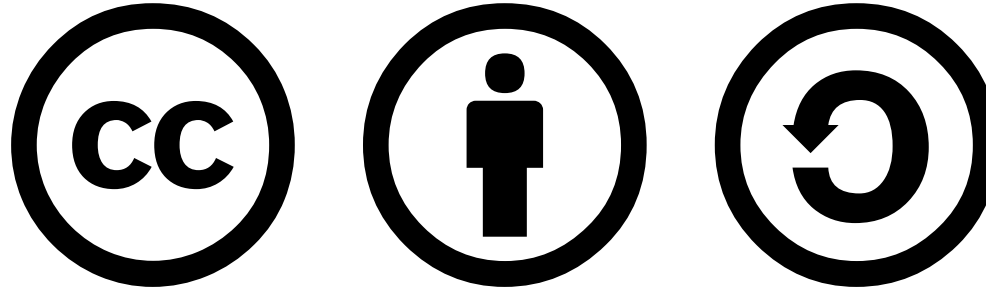
Coordinate: -71.597074,42.515310 Scale 1:2

CC BY SA

# Tracks



Track Log
<b>Do Not Record</b>
<b>Record, Do Not Show</b>
<b>Record, Show On Map</b>
Record Method
<b>Auto</b>
Recording Interval
<b>Normal</b>
Auto Archive
<b>When Full</b>



This presentation Copyright © 2020 Paul J. Morris Some Rights Reserved.

This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License. This material may be freely reproduced and used under the terms of the Creative Commons Attribution-ShareAlike License.

This presentation includes images that have been made available under CC-BY and CC-BY-SA licenses, and material from the public domain. Attributions are noted on individual slides. These contributions to the commons are very gratefully acknowledged.