Introduction to Global Positioning System (GPS)

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What is GPS?

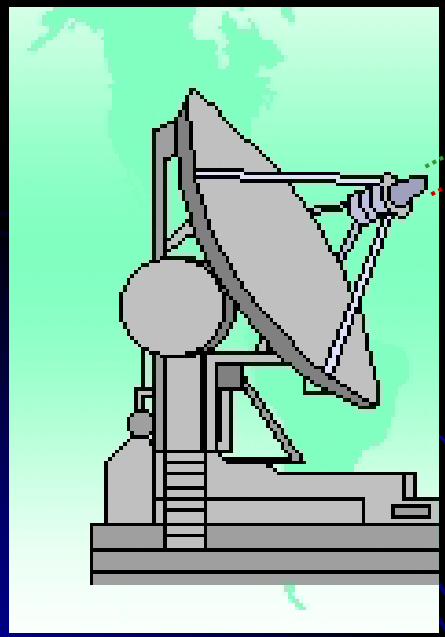
- The GPS is a satellite navigation system designed to provide instantaneous position, velocity and time information
  - The GPS was developed by the U.S. Dept. of Defense for military purposes

What is GPS?

- Now it can be used world-wide by any civilian free of charge
- Entire system is comprised of three segments:

1. Control segment
2. Space segment
3. User segment

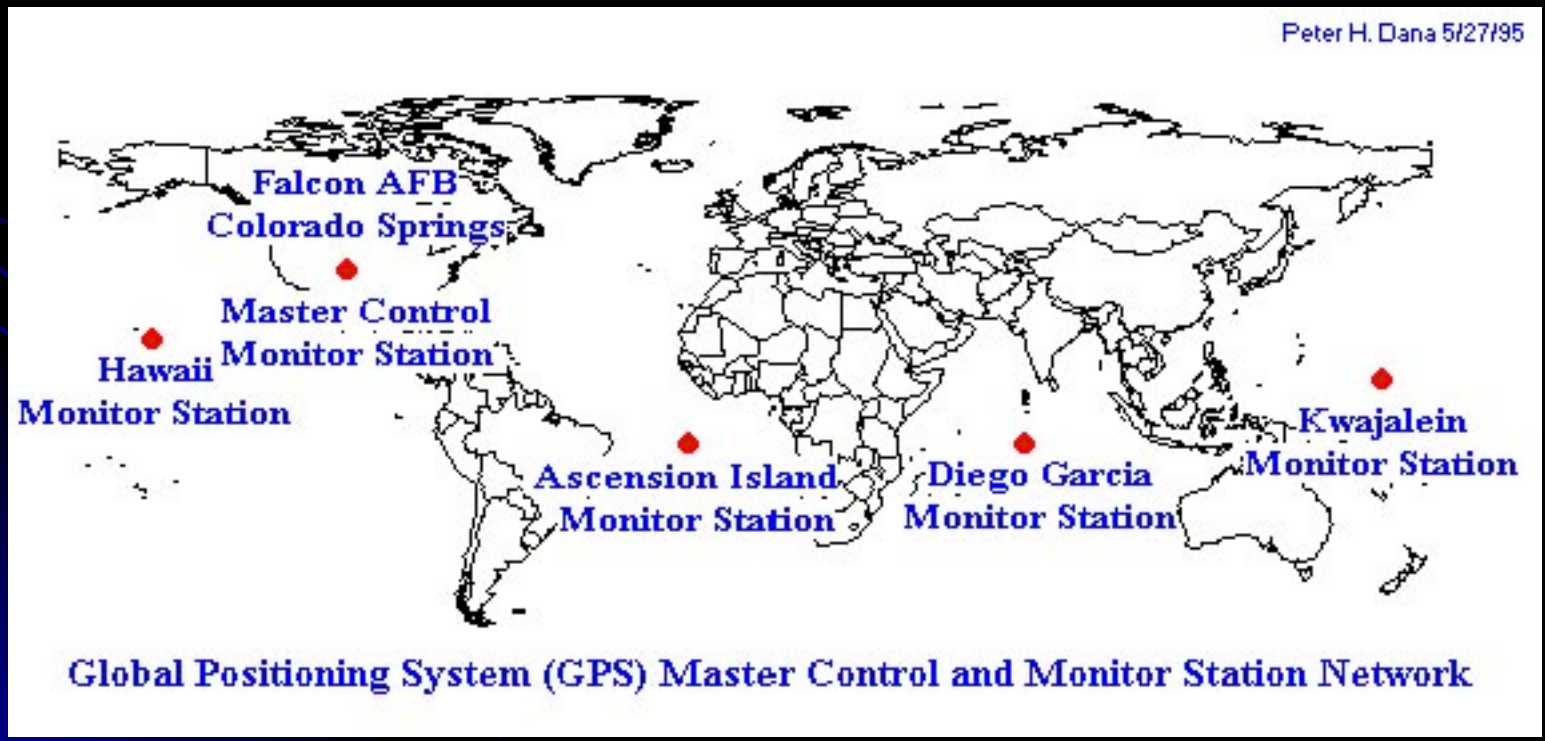
Control Segment



- The “Brain” of the system
- Controlled by the U.S. Government
- Monitors the satellite’s navigation messages and sends adjustments if necessary

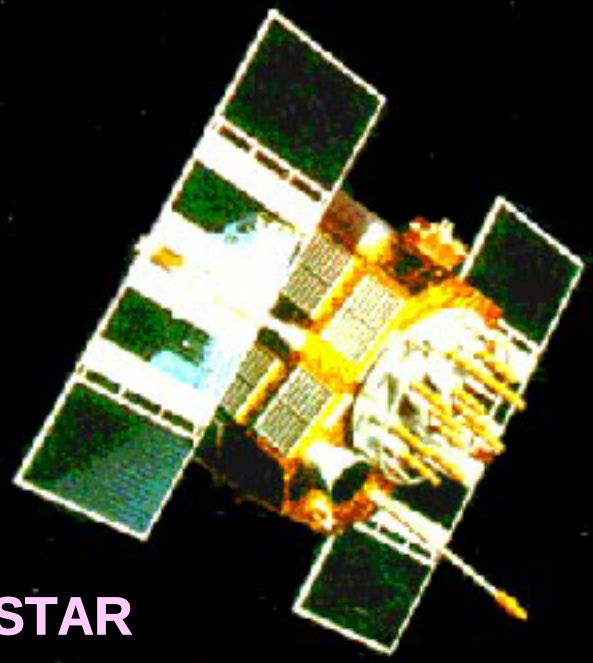
Control Segment

- Contains 1 control station and 4 monitor stations throughout the world
- Each satellite passes over a monitoring station daily



Space Segment

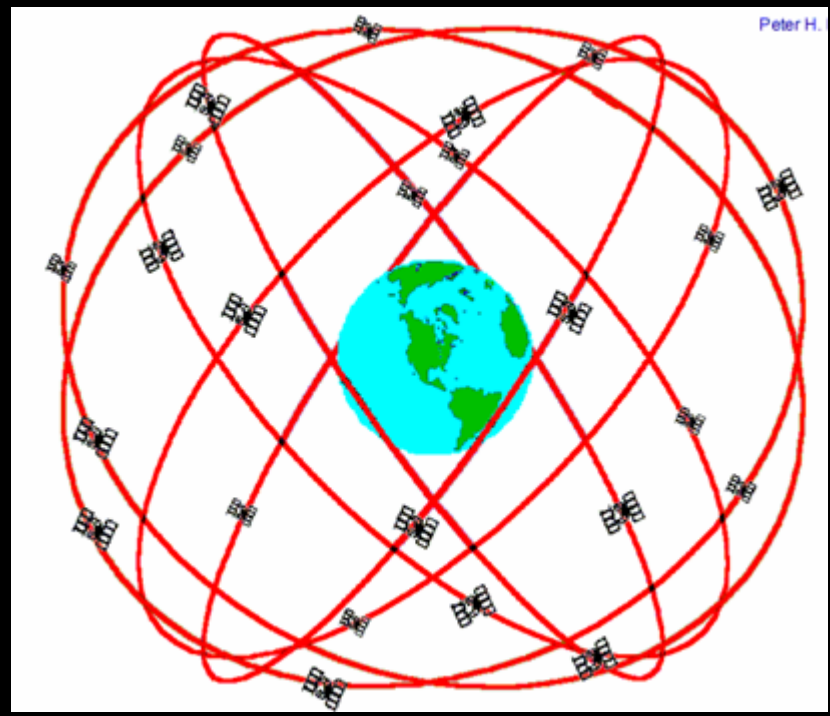
- Comprise of 24 operating satellites needed for system to be fully operational

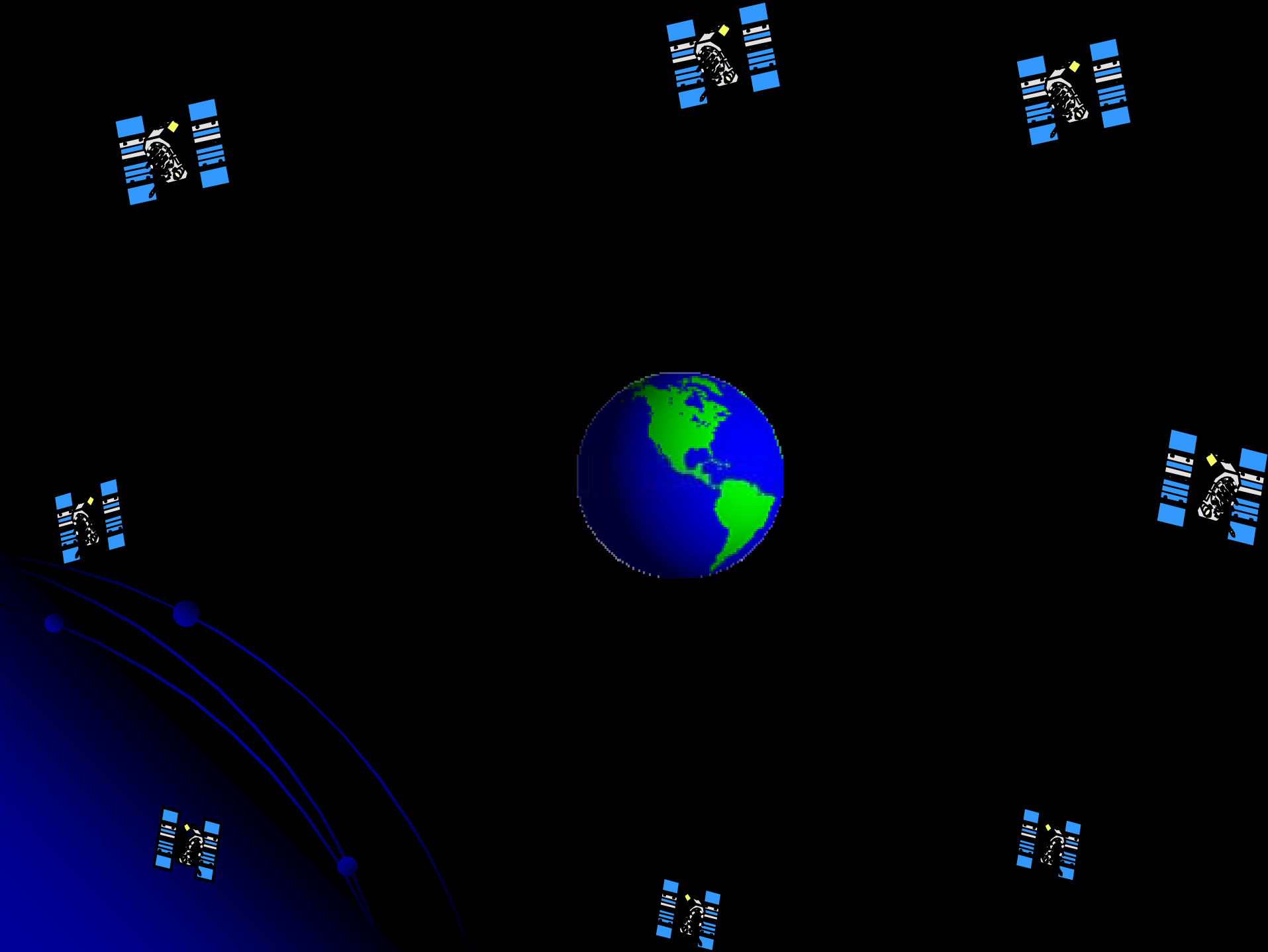


NAVSTAR

Space Segment

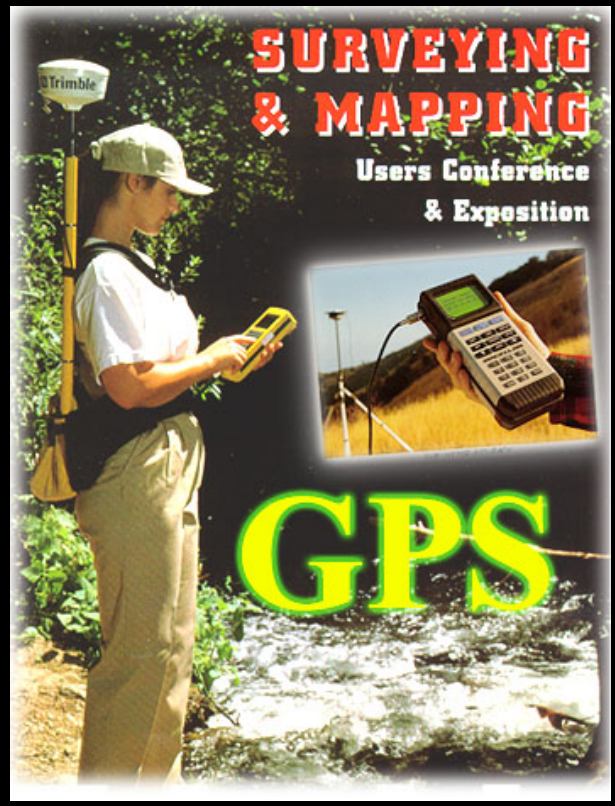
- 6 orbital planes
- each plane has 4 satellites
- 20,200 km orbit
- 1 revolution every 12 hours



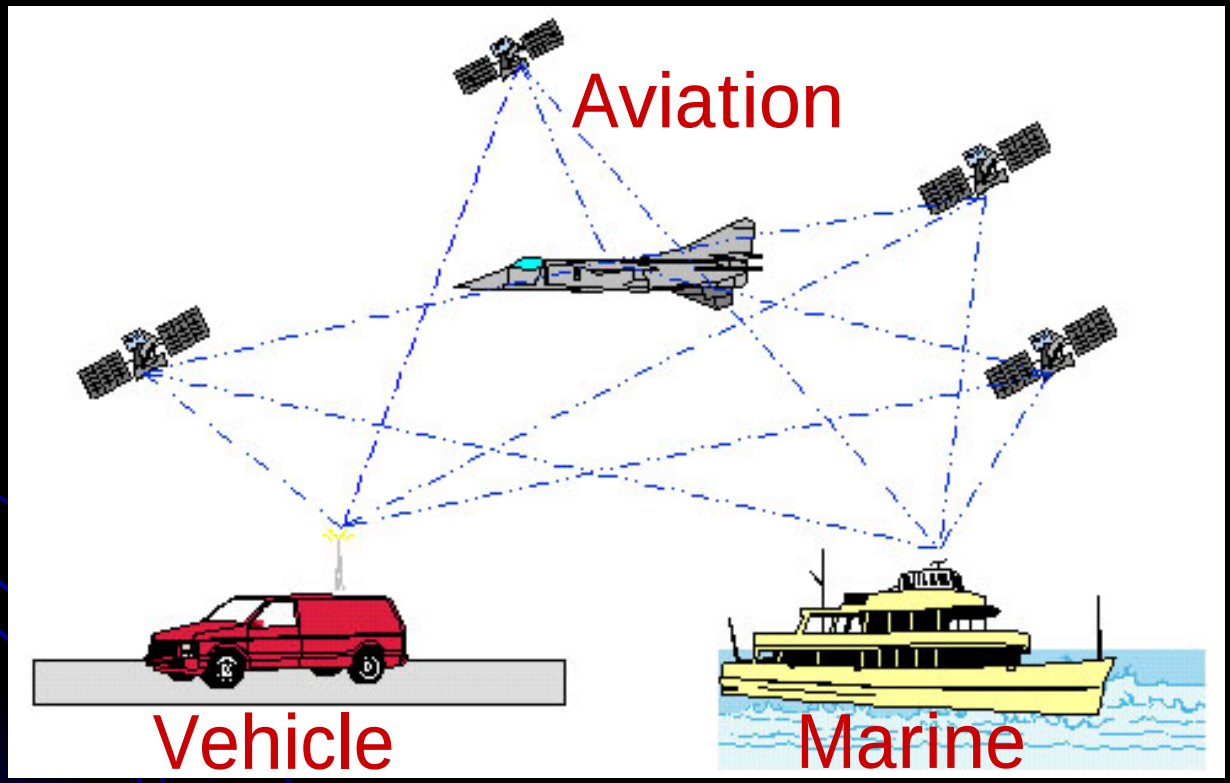


User Segment

- Civilian users
- Military users

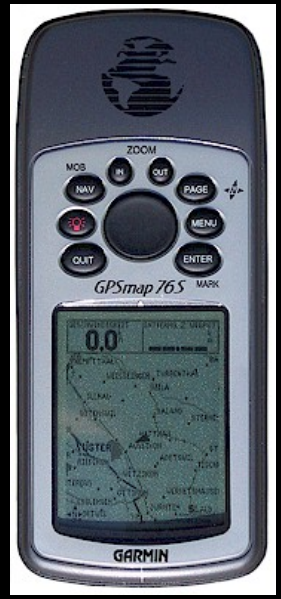


GPS Navigation



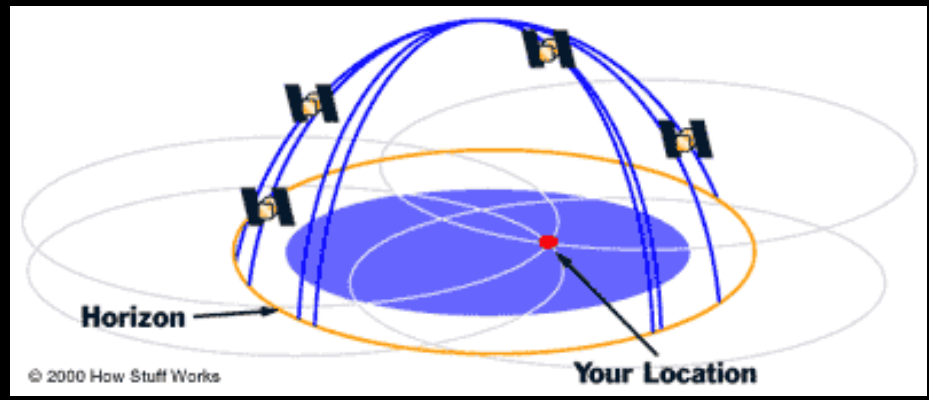
GPS Receiver

- Antenna
- Body
- Battery



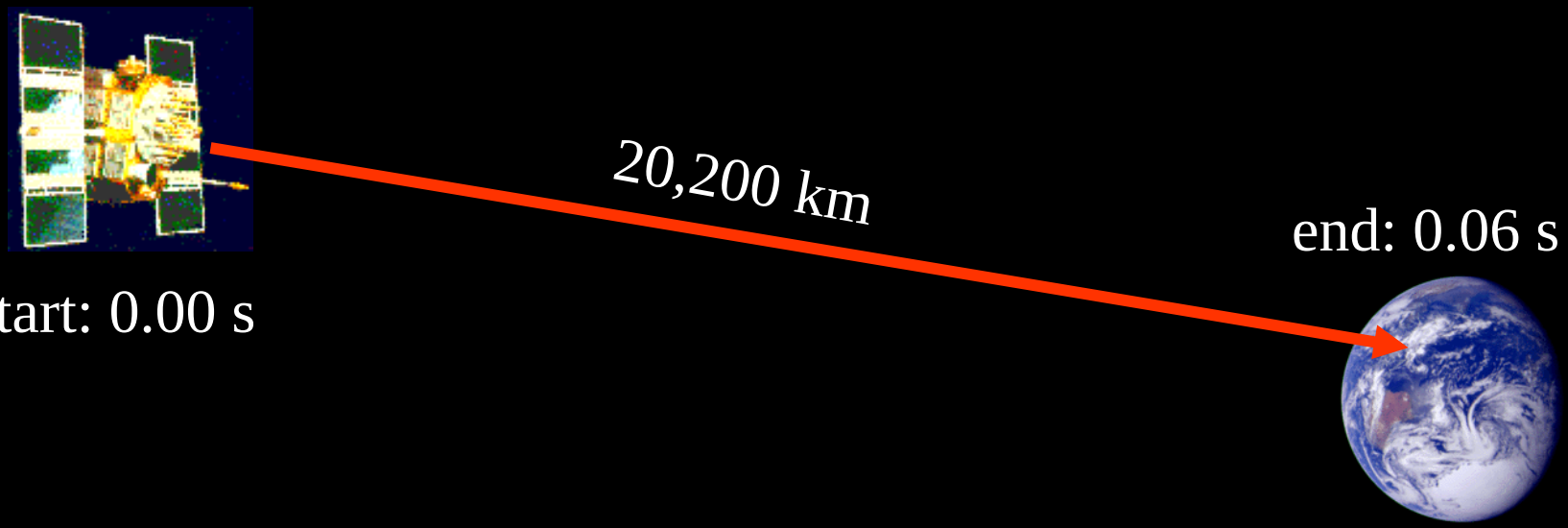
How does it work?

- You need at least 4 satellites to determine your location!
  - 4 dimensions
    - Latitude (Y)
    - Longitude (X)
    - Elevation (Z)
    - Time (T)

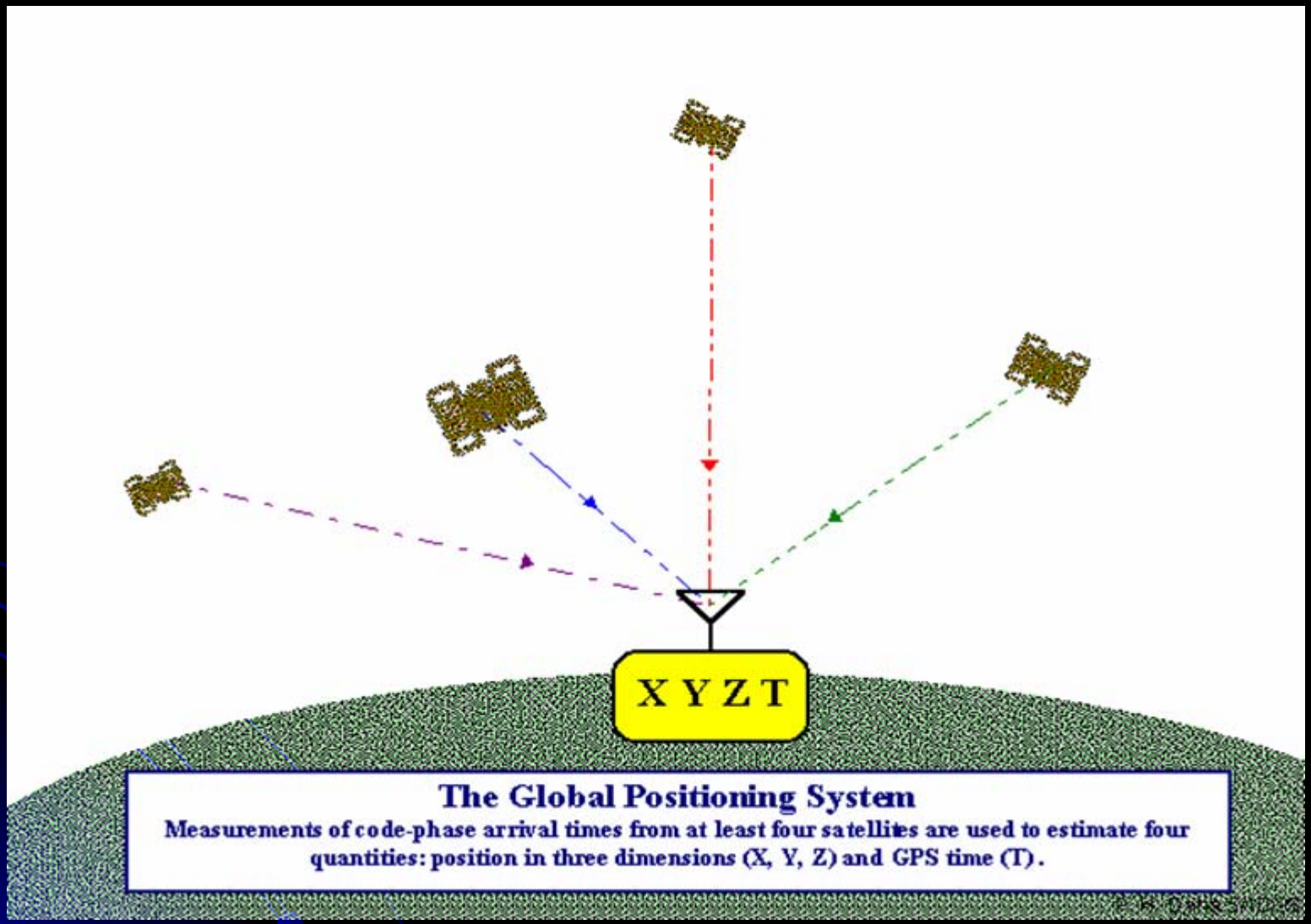


- Therefore, you need information from four satellites!

- Distance measurement

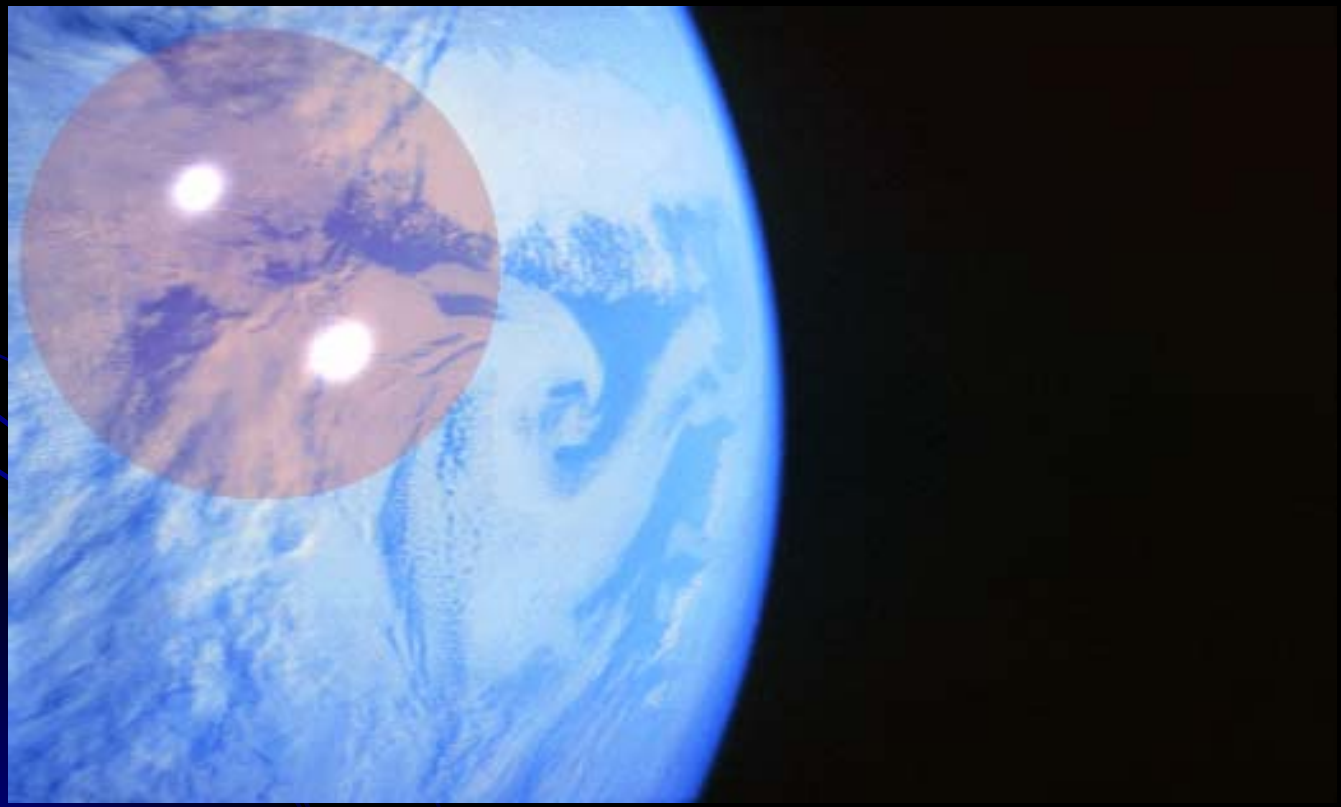


- Information from these four satellites are used to solve:
  - Distance = Velocity x Time
- Velocity = speed of light
- If you have 3 satellites, the receiver will guess at your elevation and give you latitude and longitude

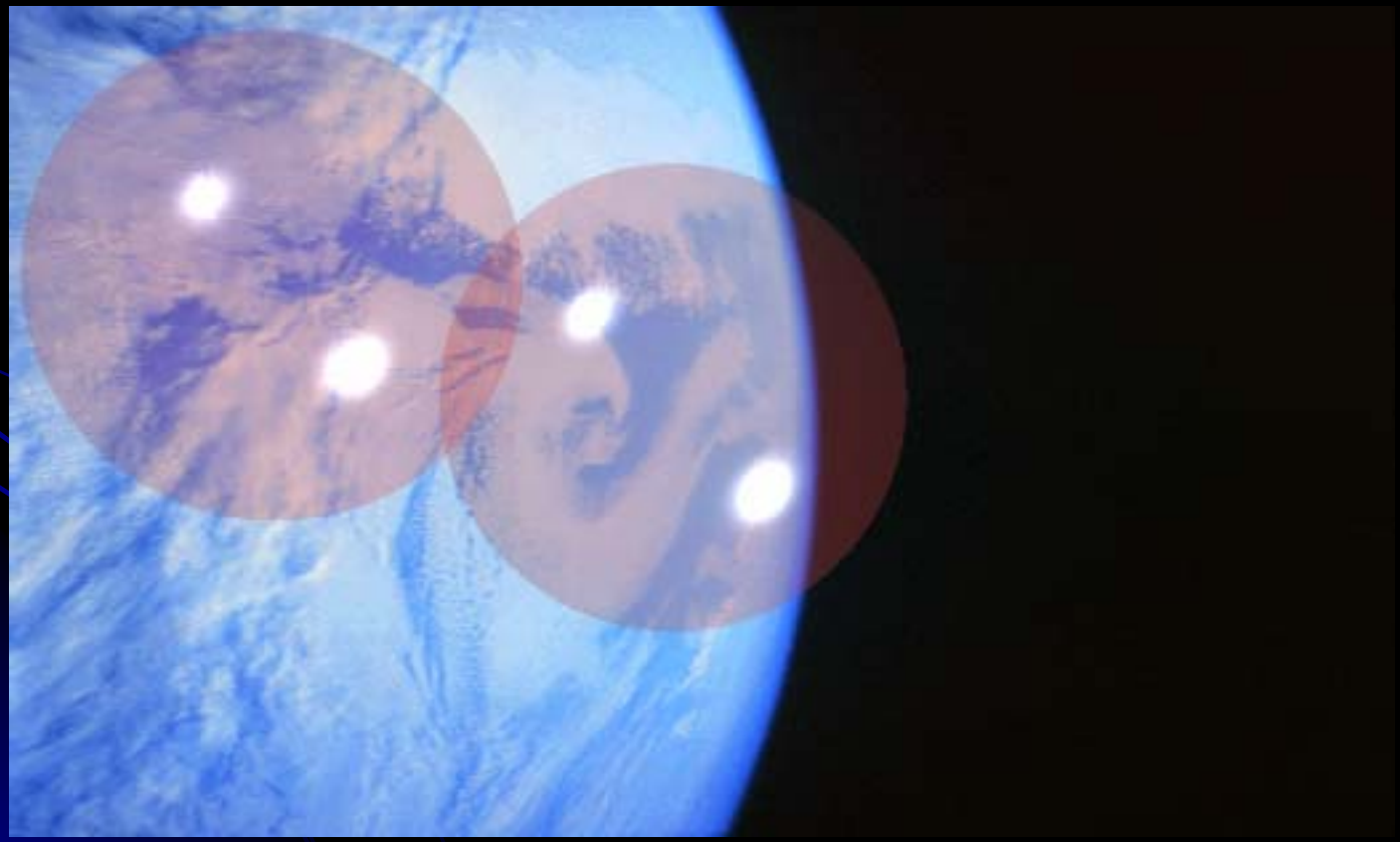

X Y Z T
The Global Positioning System
Measurements of code-phase arrival times from at least four satellites are used to estimate four quantities: position in three dimensions (X, Y, Z) and GPS time (T).

Triangulation

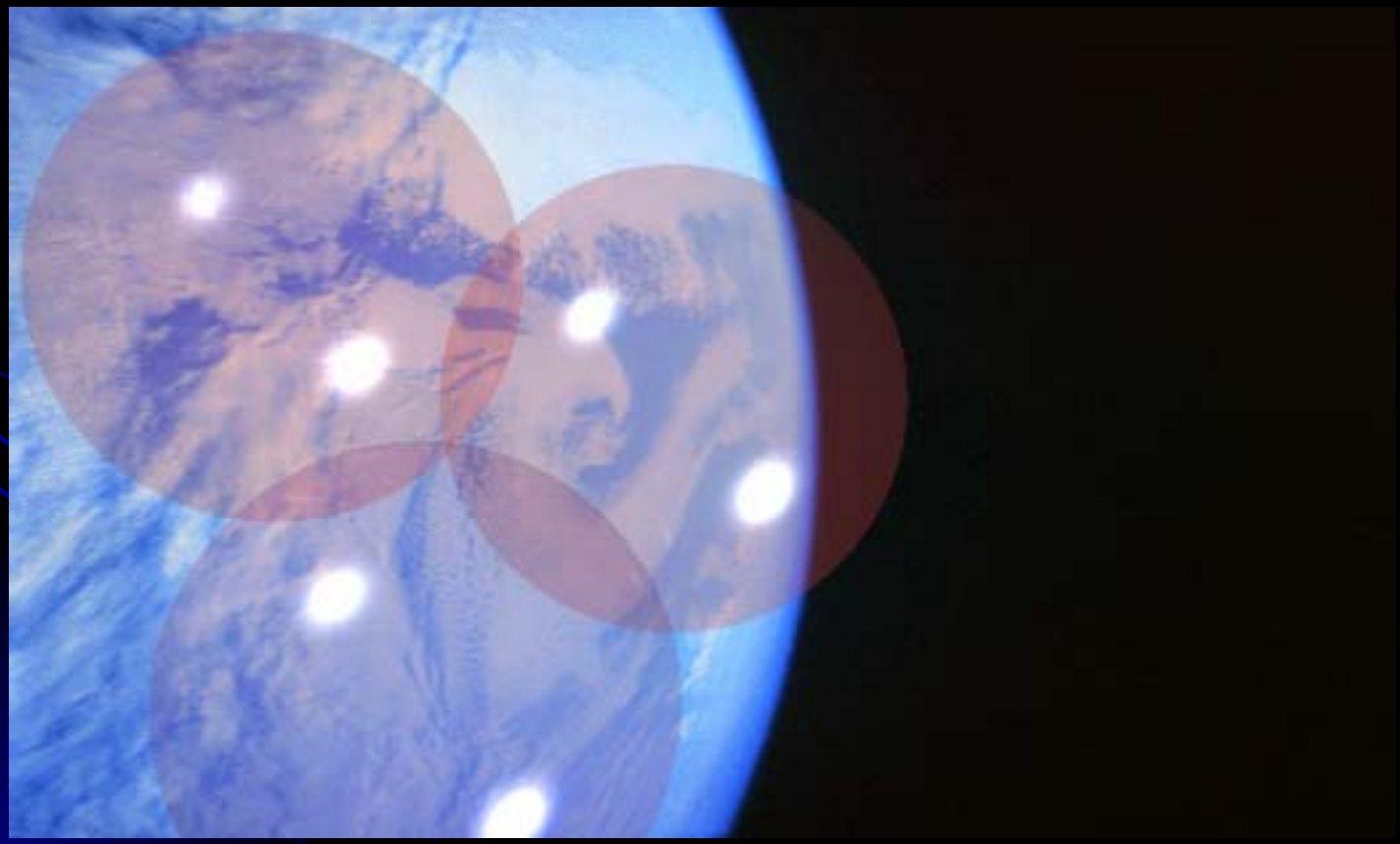
- 1 satellite



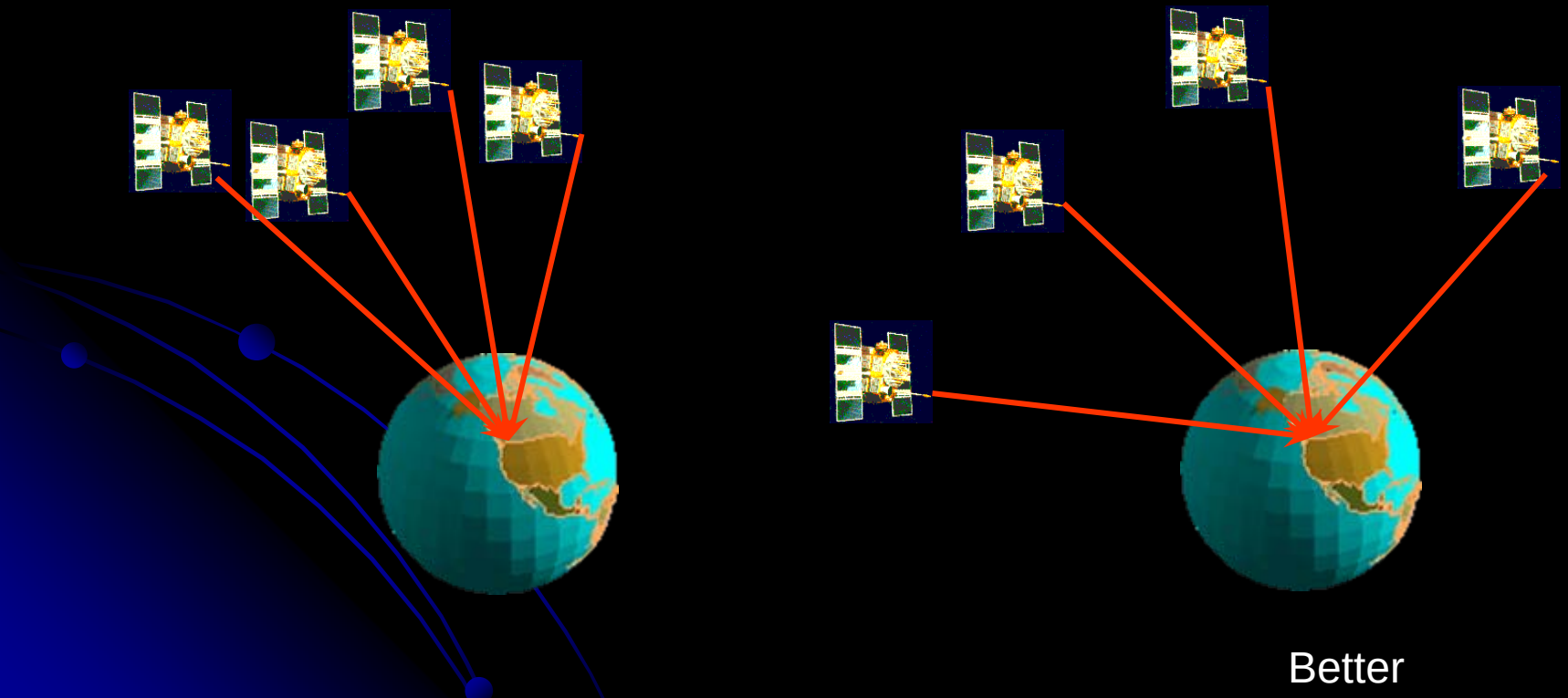
- 2 satellites



- 3 satellites



- Wider spread gives better precision



Better

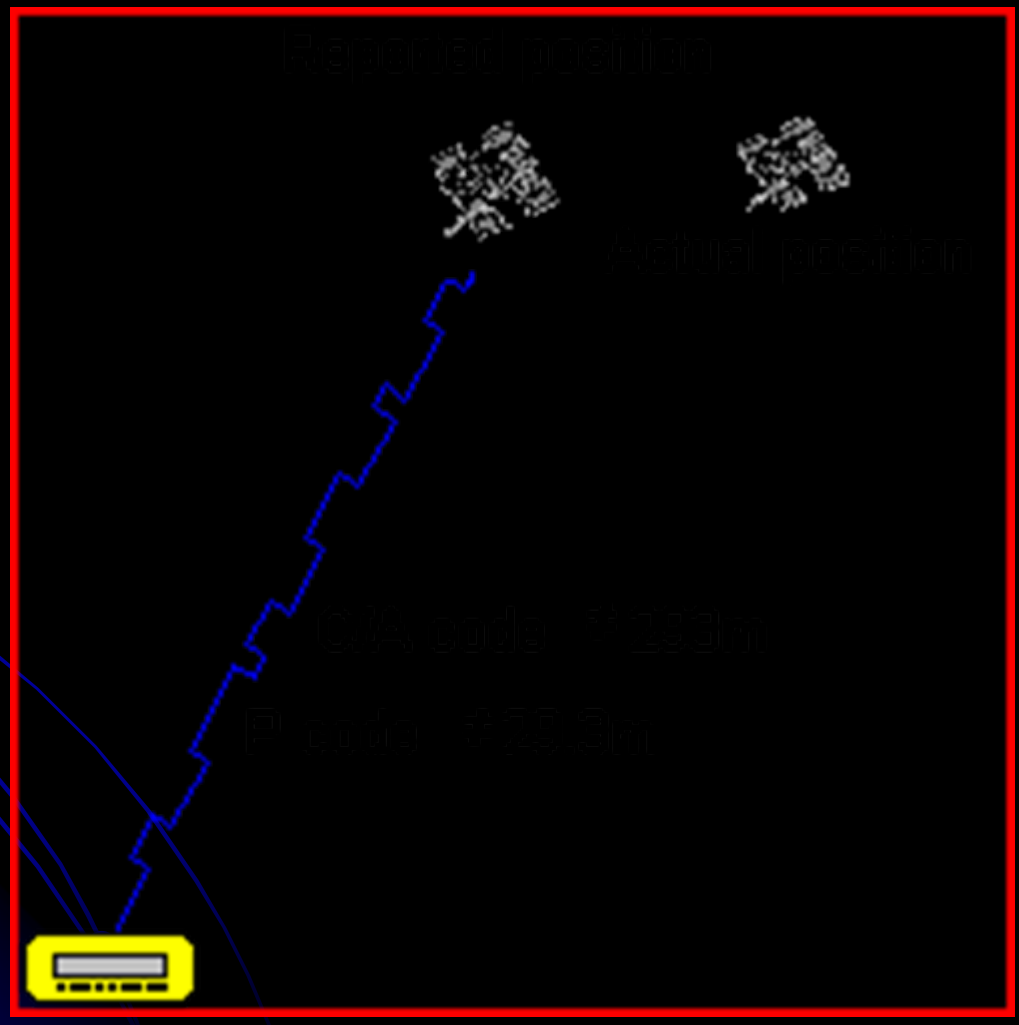
Source of error

- Selective availability
- Atmospheric delay
- Multipath error

Selective Availability (S/A)

- To discourage enemy forces from using GPS
- US government induced artificial errors to reduce GPS position accuracy
- Sometimes S/A is ON and sometimes it is OFF.

No more S/A since May 1, 2000



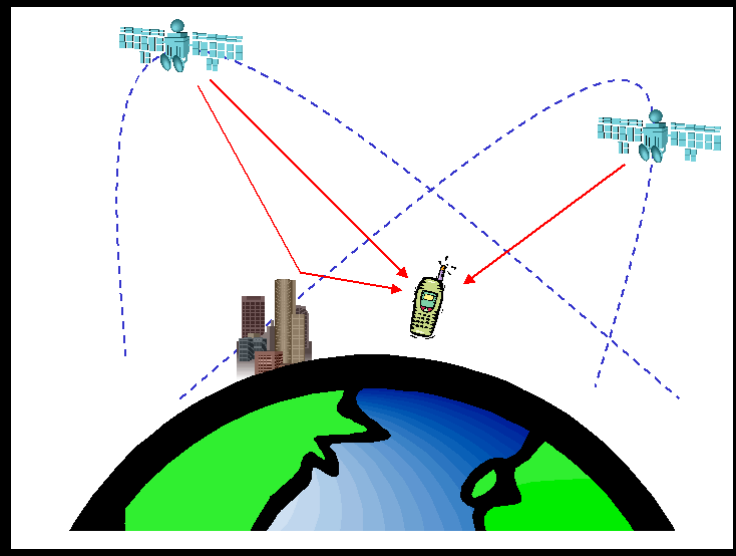
Atmospheric Delay

- GPS signals are slightly delayed while they pass through the atmosphere
- For best results, don’t use GPS receiver during lightning, storm or heavy rain.

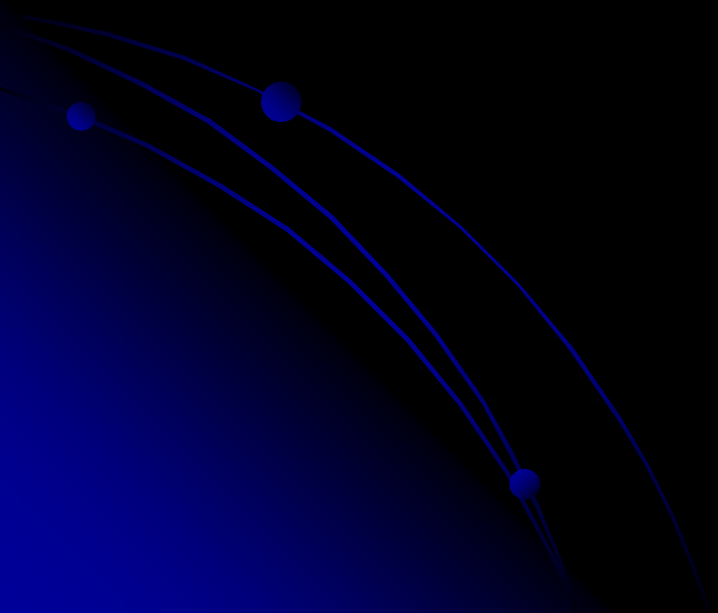
Multipath Error

- Occurs when the GPS signal is reflected off an object before it reaches your GPS receiver

Mountain, building

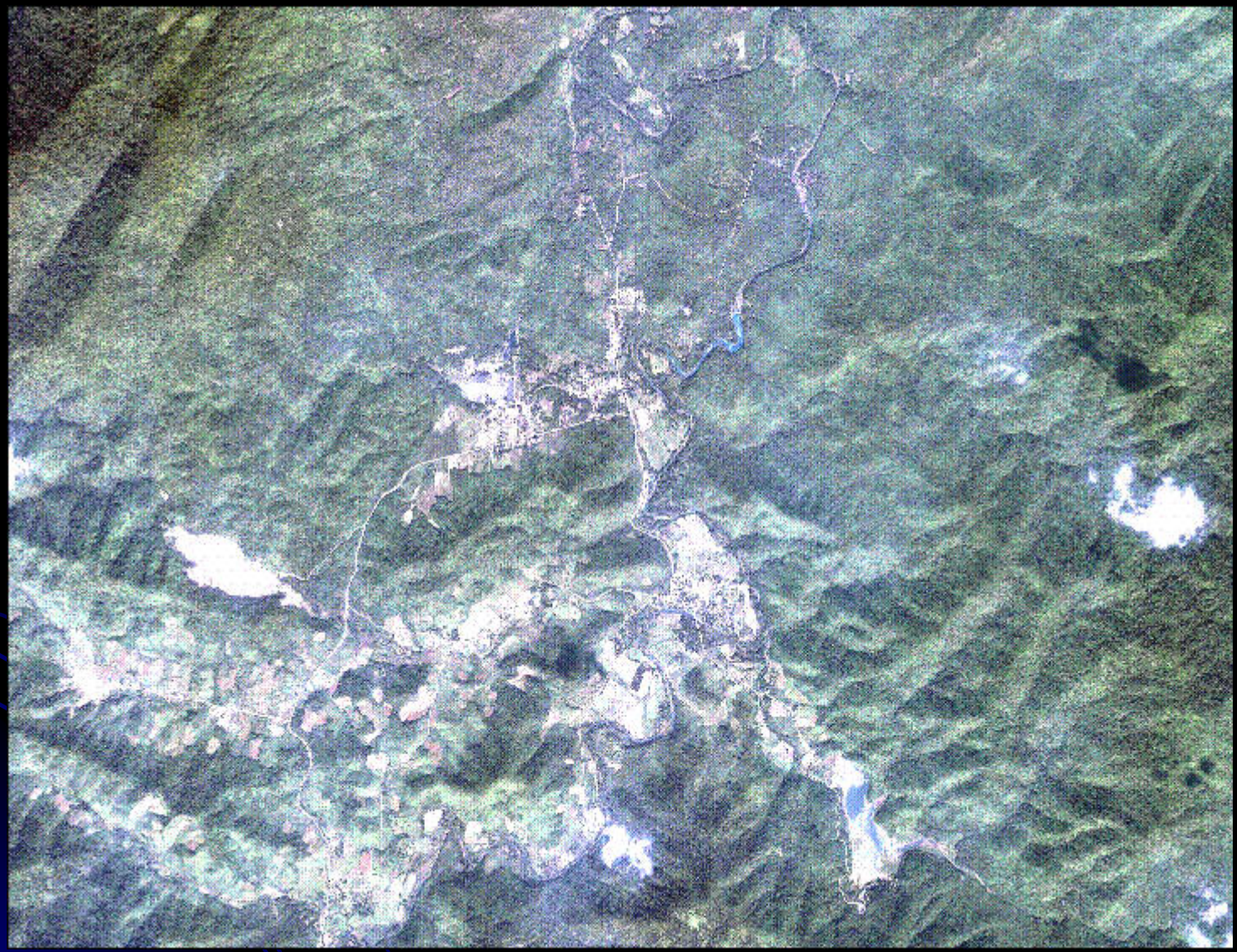


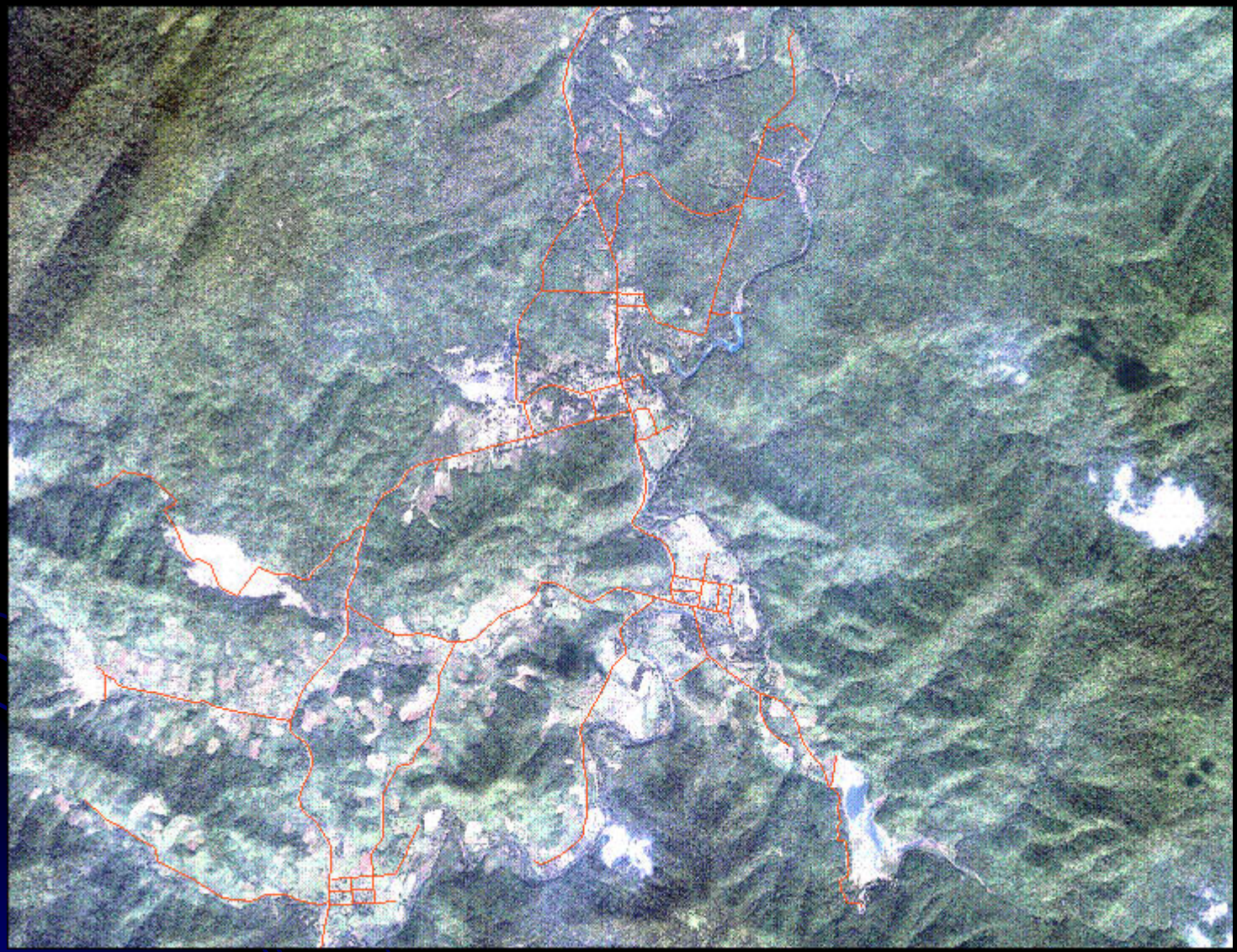
Applications

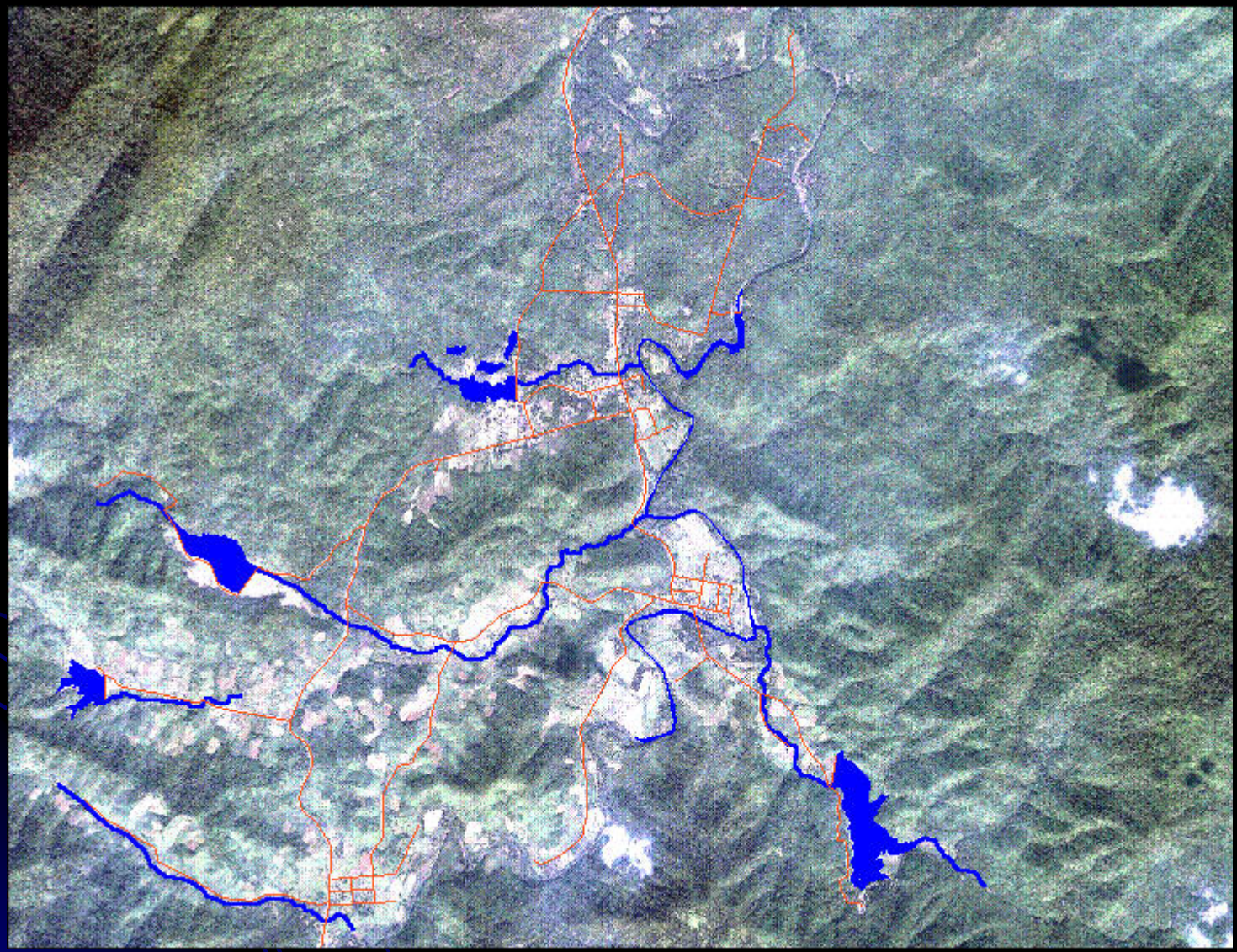


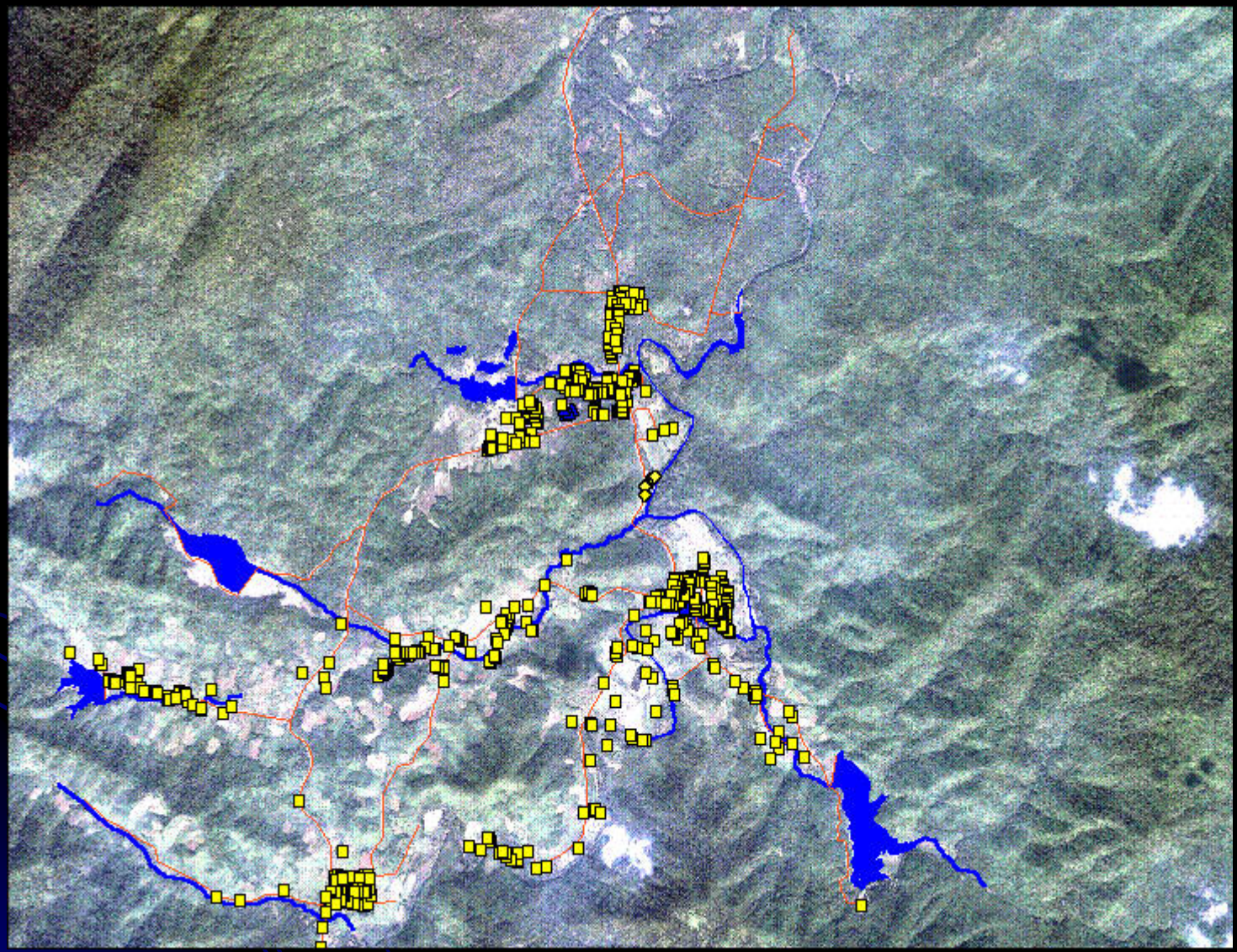
- Multiple applications include:
  - *GIS data capture*
  - *Vehicle tracking*
  - *marine/vehicle navigation*
  - *surveying*
  - *aviation*
  - *agriculture*
  - *recreation*
  - *much more...*

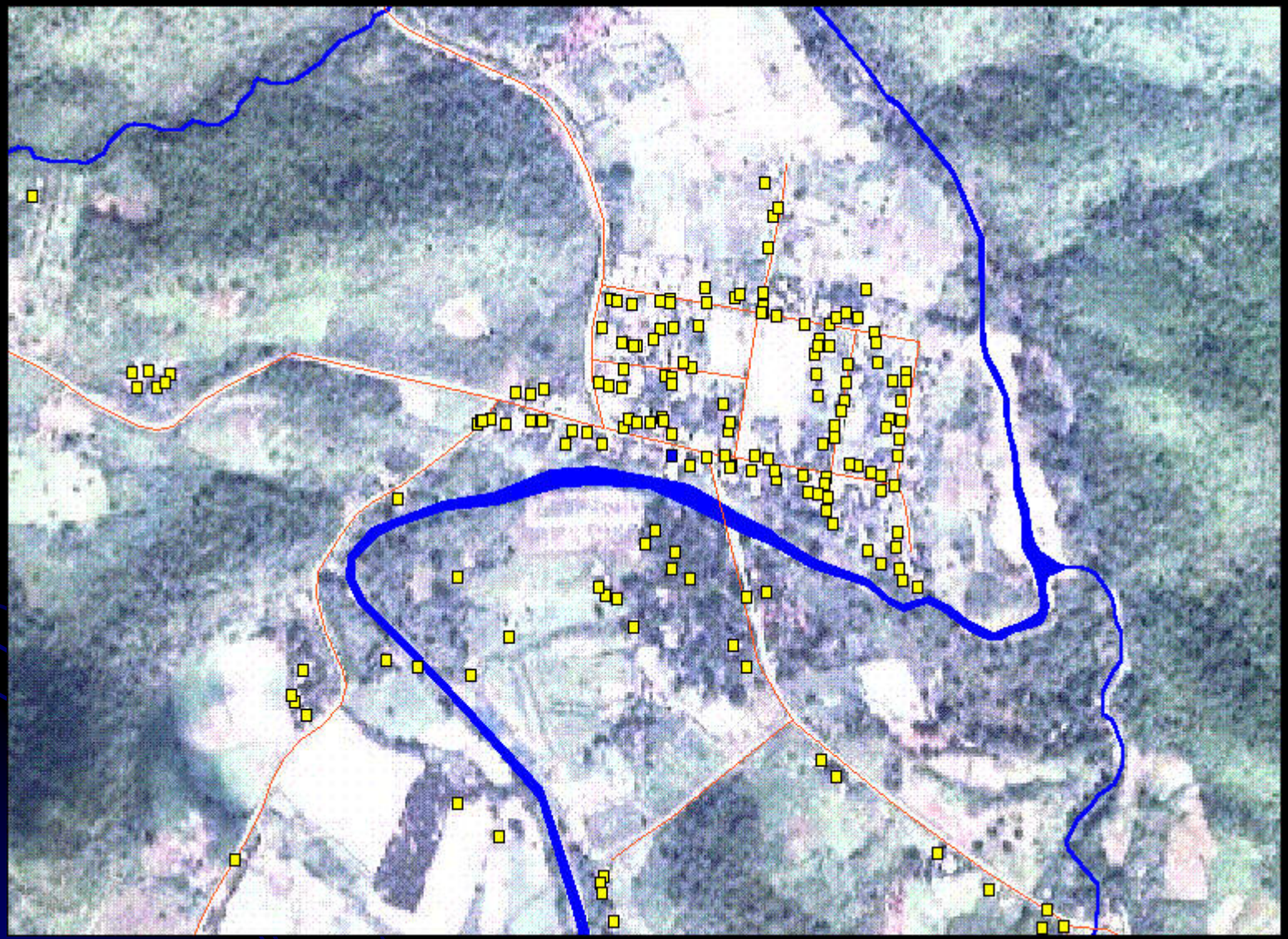
GIS Data Capture

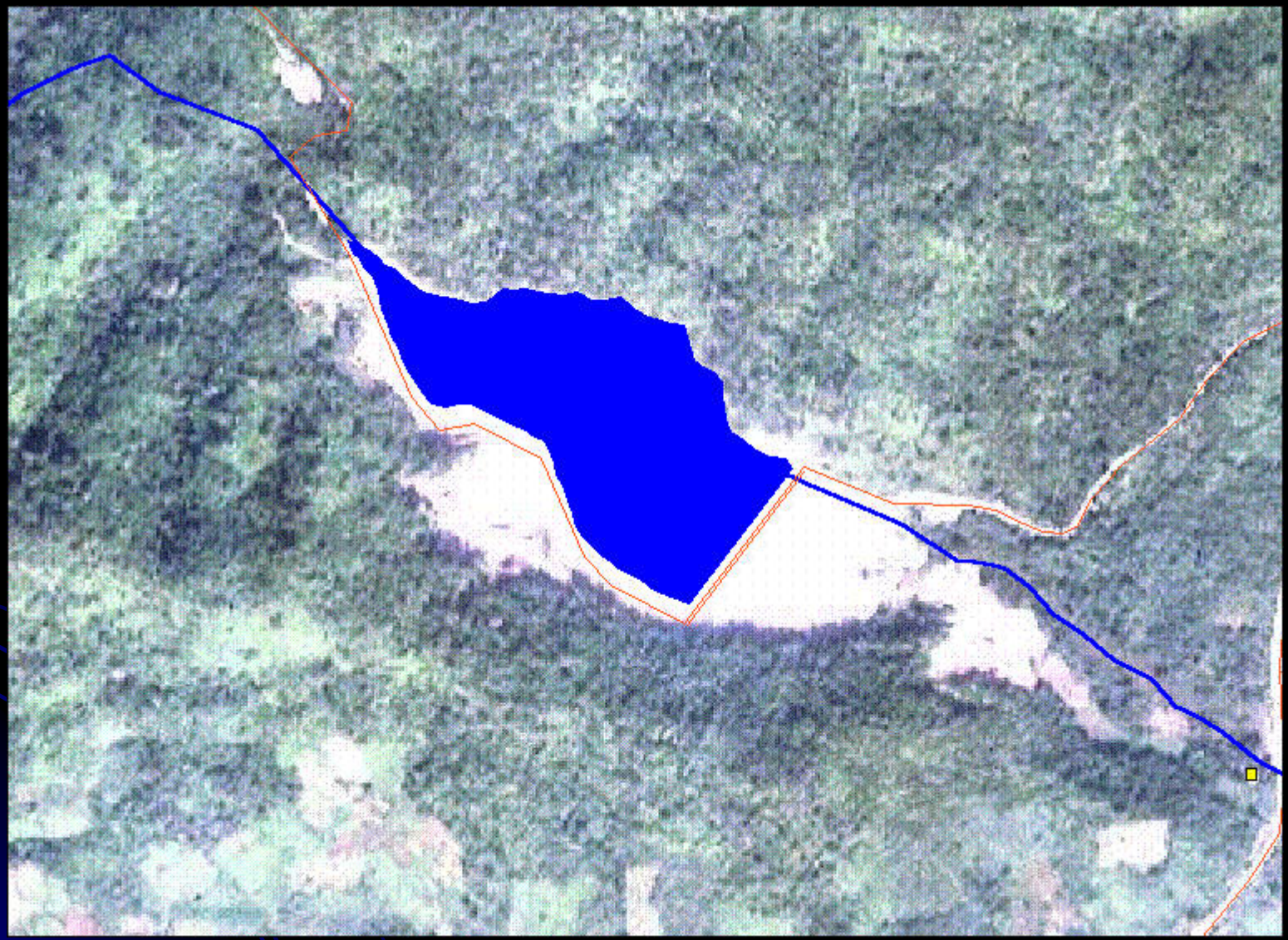






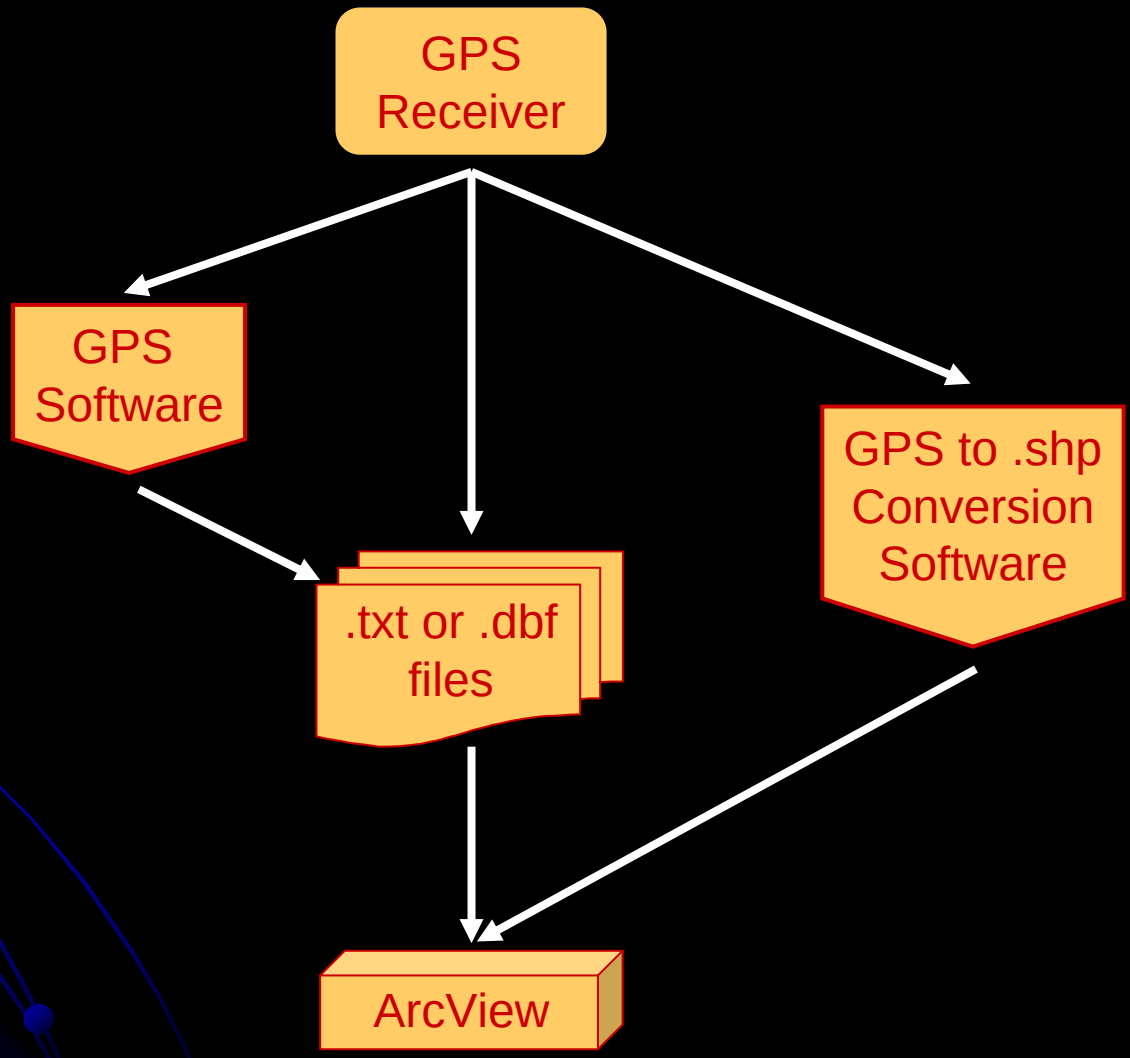






Mapping the water reservoir

Import GPS data to ArcView 3.x

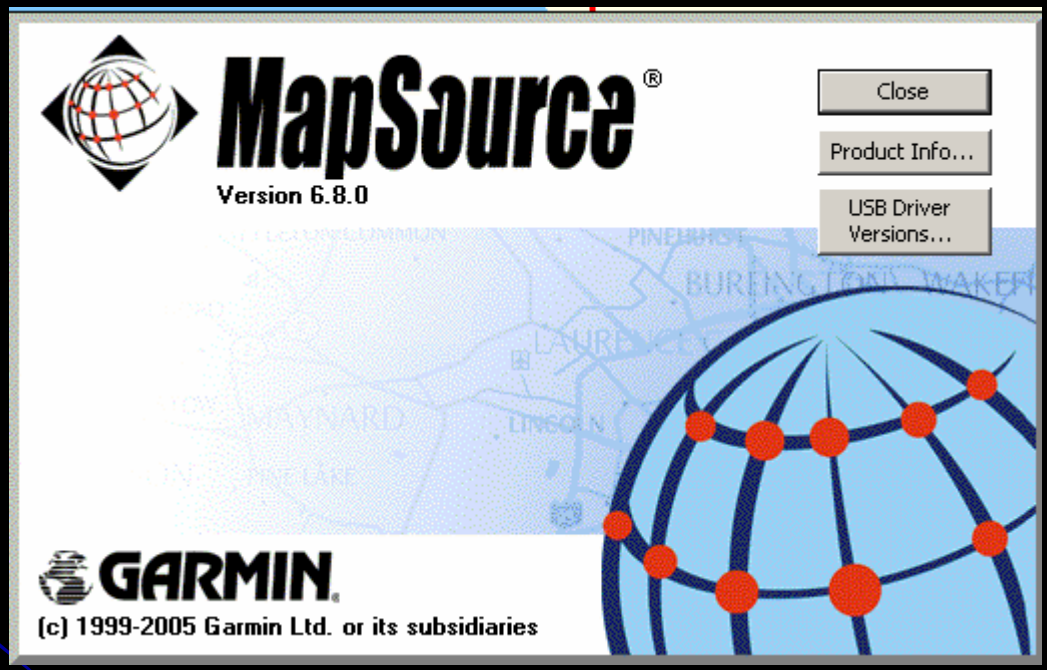


- GPS Softwares
  - MapSource® -- Garmin
  - GPS TrackMaker -- freeware
  - EasyGPS – freeware
  - etc
- Conversion software
  - DNR Garmin -- ArcView extension

(http://www.dnr.state.mn.us/mis/gis/tools/arcview/index.html)

Import GPS data to Google Earth

- Connect GPS receiver to computer
- Run program MapSource® or EasyGPS®
- Read data from the GPS receiver
- Save file (file type = .gpx)
- Run GoogleEarth
- Open your .gpx file


MapSource®
Version 6.8.0
Close
Product Info...
USB Driver Versions...
GARMIN
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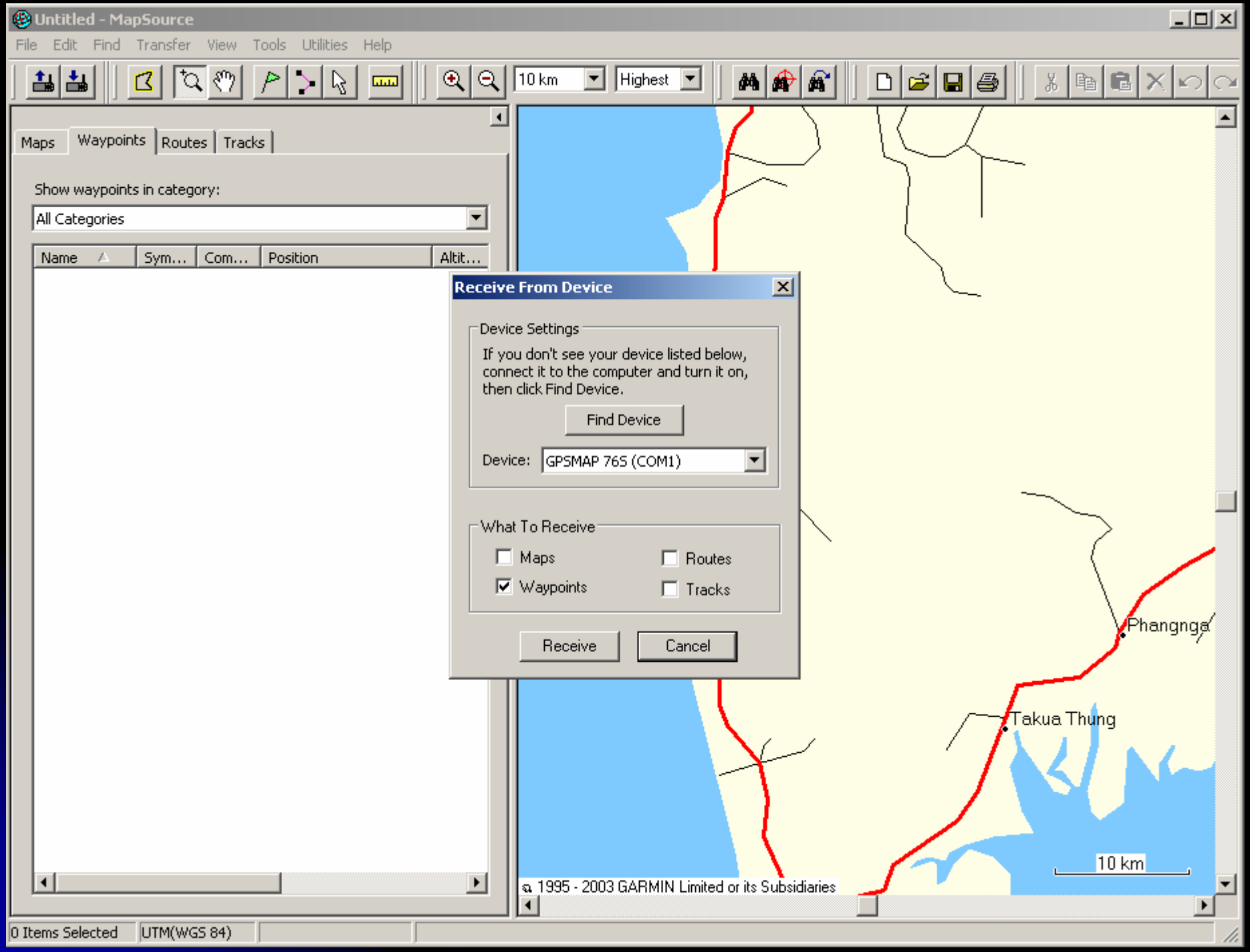
Untitled - MapSource
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10 km
Highest
Maps Waypoints Routes Tracks
Show waypoints in category:
All Categories
Name Sym... Com... Position Altit...
Receive From Device
Device Settings
If you don't see your device listed below, connect it to the computer and turn it on, then click Find Device.
Find Device
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What To Receive
Maps
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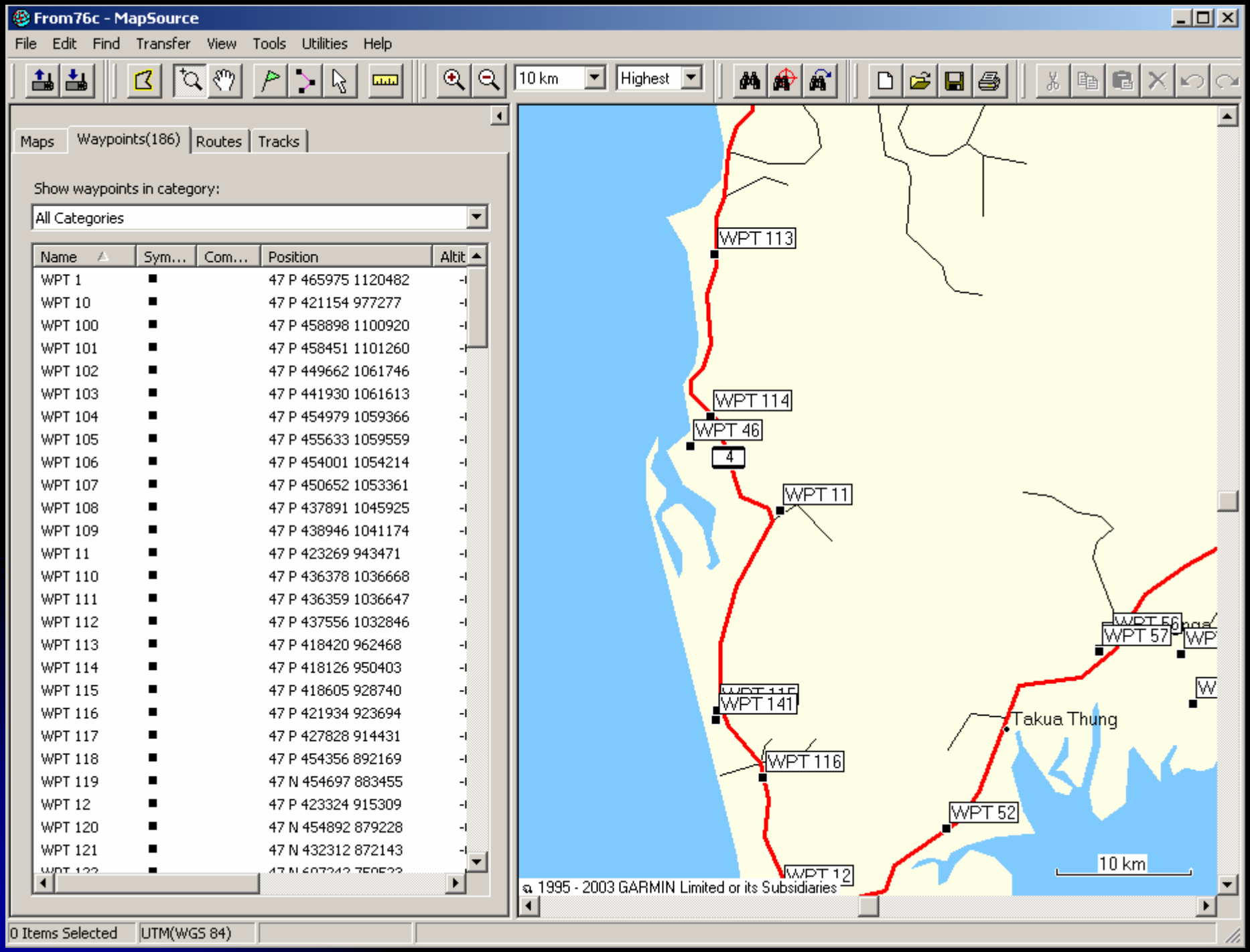
10 km
1995 - 2003 GARMIN Limited or its Subsidiaries
0 Items Selected
UTM(WGS 84)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WPT 10 47 P 421154 977277
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WPT 11
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WPT 52
WPT 12
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1995 - 2003 GARMIN Limited or its Subsidiaries
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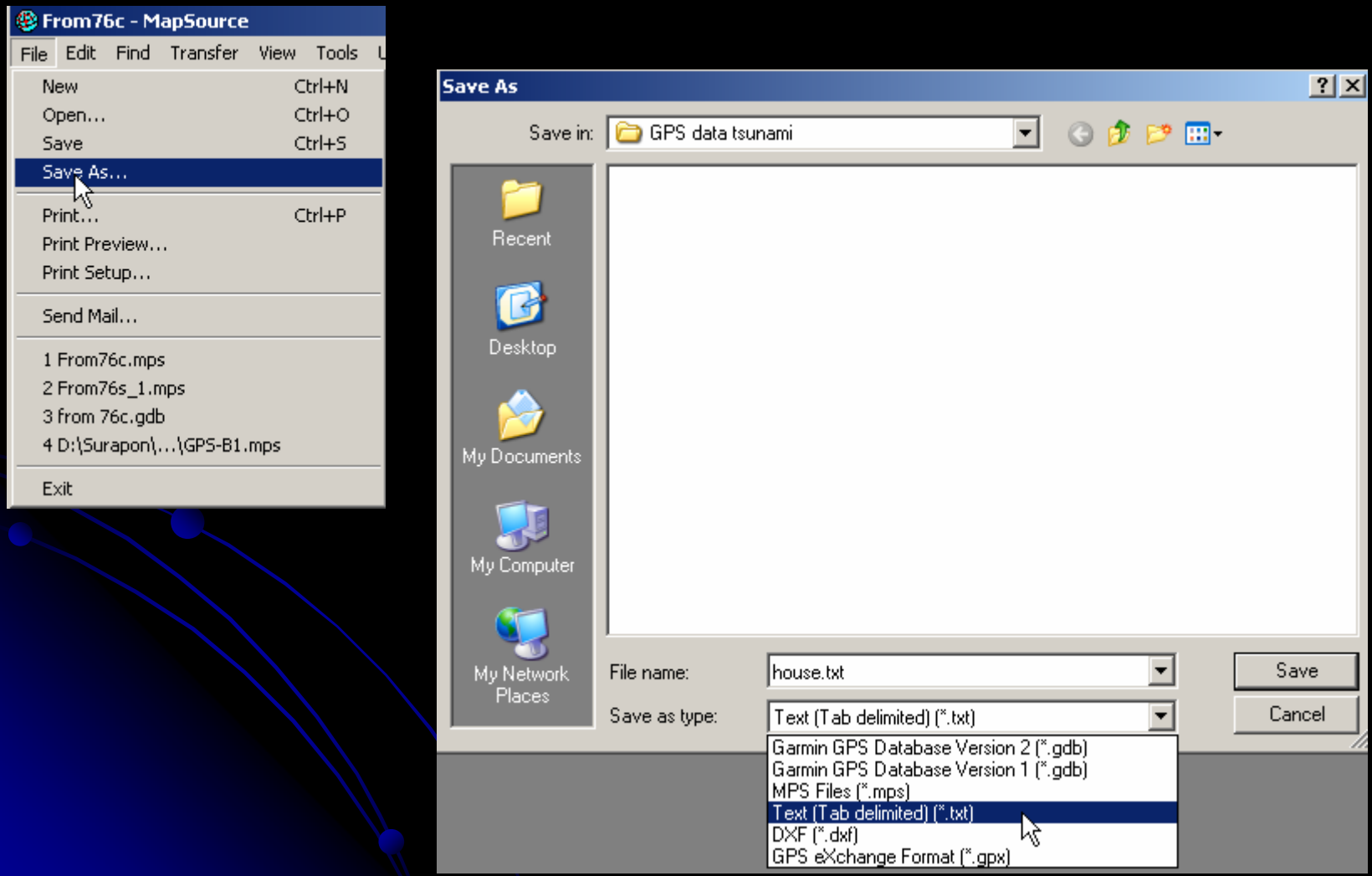
UTM(WGS 84)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2 From76s_1.mps
3 from 76c.gdb
4 D:\Surapon\...\GPS-B1.mps
Exit
Save As
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GPS data tsunami
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Desktop
My Documents
My Computer
My Network Places
File name:
house.txt
Save as type:
Text (Tab delimited) (*.txt)
Save
Cancel
Garmin GPS Database Version 2 (*.gdb)
Garmin GPS Database Version 1 (*.gdb)
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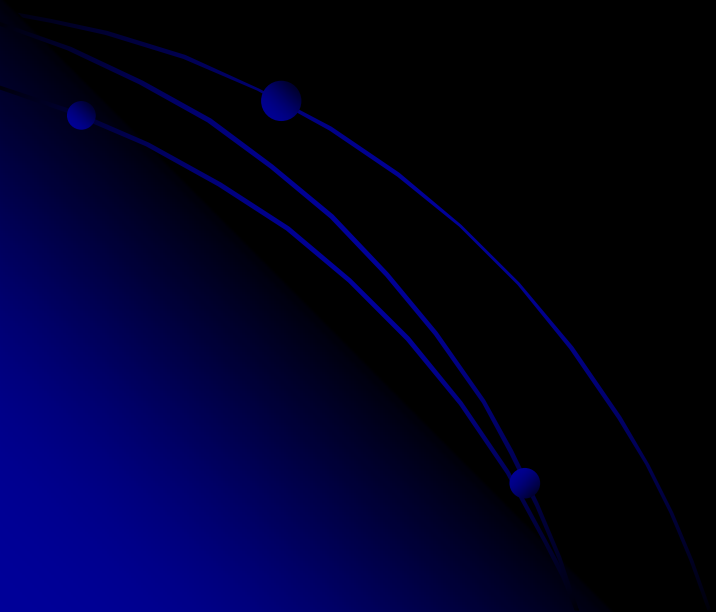
DXF (*.dxf)
GPS eXchange Format (*.gpx)

Any question?