
# GPS Data Capture With ArcPad

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# Overview

- Essentials of GPS
- GPS Data Capture with ArcPad
- ArcPad and GPS Integration Settings
- Field Mapping System Considerations
- HARDWARE!

# Essentials of GPS

- Evolving as a key component of GIS
- Works on trilateration of satellite radio signals from satellites
- “How Far?” = “How long did it take the radio waves to get from the satellite to the receiver?”
- All signals and positions have error

# GPS Components

- Antenna-receiver
- Processor = The GPS
  - Contain quartz clocks of varying quality
- Data Logger
- Computer Software
- Various Grades of GPS
  - Recreational
  - Resource - Mapping
  - Sub-meter
  - Survey

# GIS-GPS Integration Workflow

- Build an enterprise database
- Determine field data collection methodology
- Collect the field data: geometry and attributes
- Import field data into GIS format
- Analyze and interpret new data in GIS

# GPS Mission Planning

- Objective: Integrate your field data with your enterprise GIS
  - What is the Enterprise?
- Pick a study area and environment
- Plan to update certain features on the ground using GPS
- Plan feature and attribute data models

# Planning for attribute capture

- Design in Attribute fields: Always include a Notes field (text, 256 width)
  - GDB Domains = allowable values for each field: Always include “other”
    - + GDB Subtypes → Default values
  - Geodatabase & ArcPad Studio Build forms
- Maintains data value consistency, saves time
- Other Examples: Trimble Pathfinder Office, Rite in the Rain Notebooks
- Possible but not easy to modify in field

# Planning for feature capture

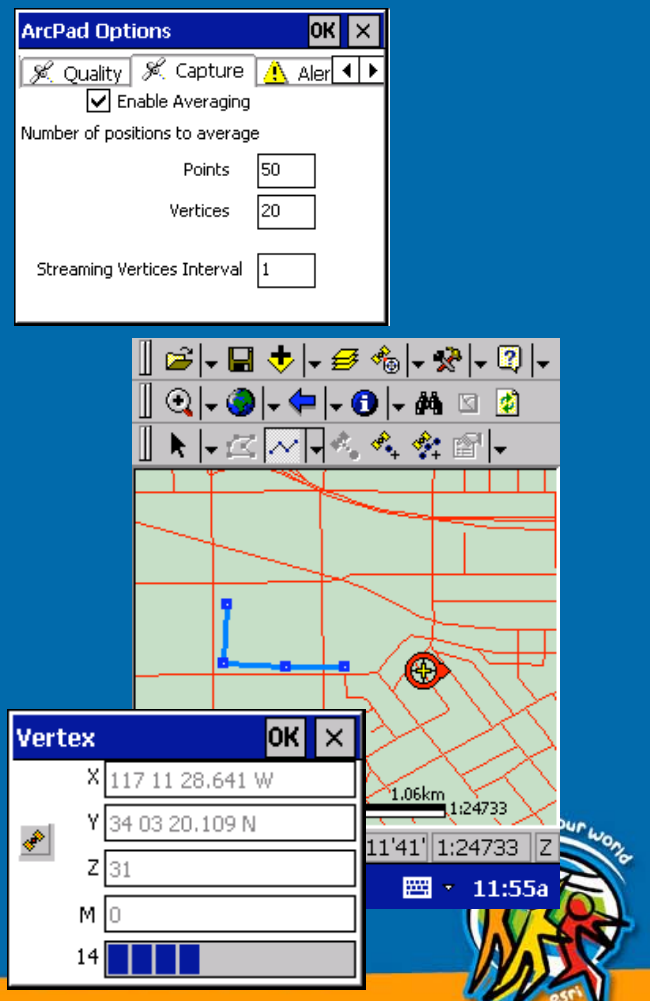
- Feature geometry may depend on scale
- Polygon size: meters, acres, miles?
  - Land cover (“fuzzy”) vs. parking lot (“sharp”)
- Douglas Co. Parks Example
  - Parks as points for locator map
  - Features as points, line, polygons

# Data Life Cycle : ArcPad in ArcGIS 8.3

- Start with GeoDatabase (personal or SDE)
- Make an ArcMap and export to ArcPad
  - GDB → .shp + scripts and forms
- Update/add features to shapefiles
- Upload .shp data to PC and check updated features back into GDB

# GPS data capture in ArcPad

- Capture points, lines, polys
- Point and streaming mode digitizing
- Edit geometry
  - Add, move
  - Features or vertex
  - Append to lines
- Specify streaming vertices interval
- Position averaging for points and vertices
- Quality Thresholds
- Alerts



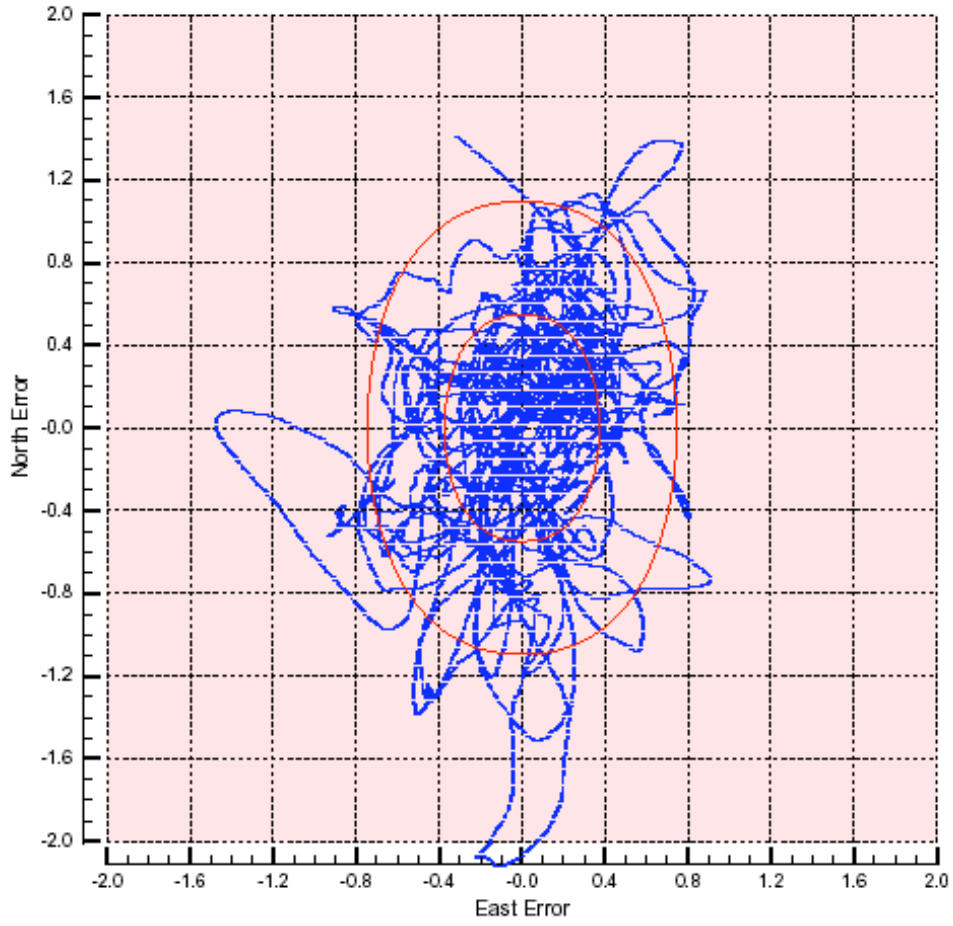
# Accuracy

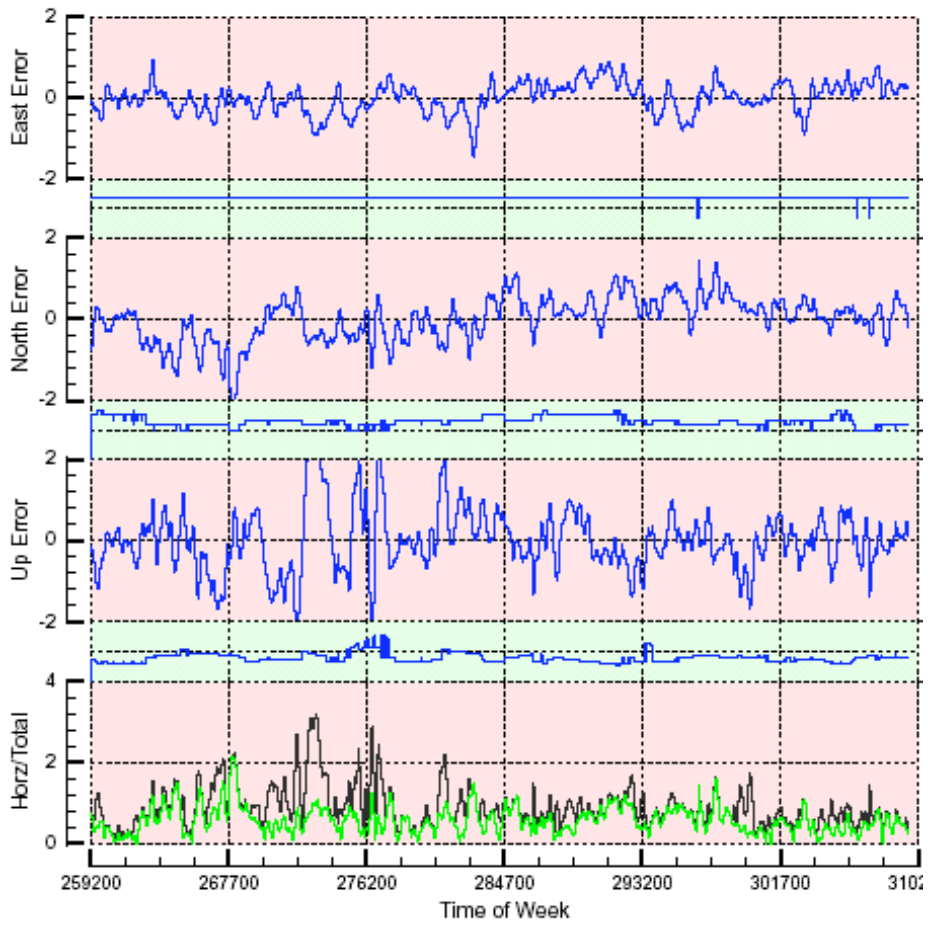
- GPS position accuracy is established by the GPS receiver
  - Autonomous
  - Real-Time differential correction
- Post-processing
  - Supported via Trimble's GPScorrect extension for ArcPad 6
- ArcPad and GPS data capture accuracy
  - Controlled by quality thresholds
  - Enhanced by position averaging

# How is GPS accuracy measured

- Static accuracy
  - Characterized at known positions (truth)
  - Data logged for 12+ hours
  - Data logged in the open and under canopy
- Dynamic accuracy
  - Walk/drive between two known positions
  - Measure perpendicular error from straight line
  - Often referred to as pass-to-pass accuracy

# How is GPS accuracy measured



# How is GPS accuracy measured

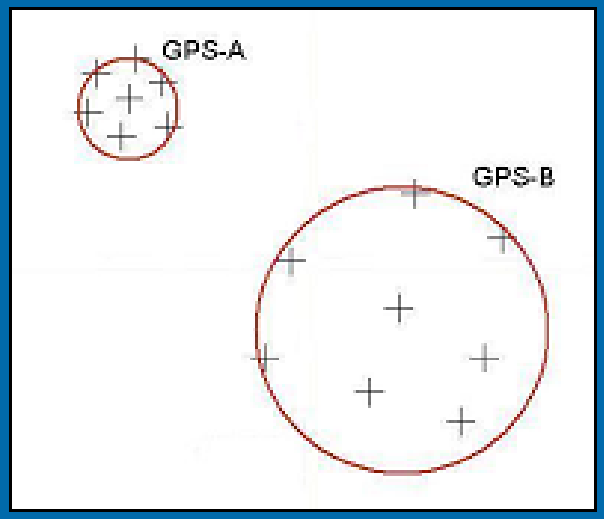
- Comparing two receivers
  - Data must be logged at the same time
  - Antennas must be <1m apart
  - Settings must be identical
  - Turn off automatic features
  - Log in typical environment
  - Log close to where equipment will be used
  - Be sure of WGS84 coordinates of truth points
  - Log as much data as possible and repeat tests

# How is GPS accuracy measured

- Accuracy versus Precision
  - Accuracy is an absolute measure against truth
  - Precision is a relative measure of variability
  - Need accuracy for
    - Collecting data for a GIS
    - Relocating assets
  - Need precision for
    - Measuring lengths and areas
    - Vehicle guidance

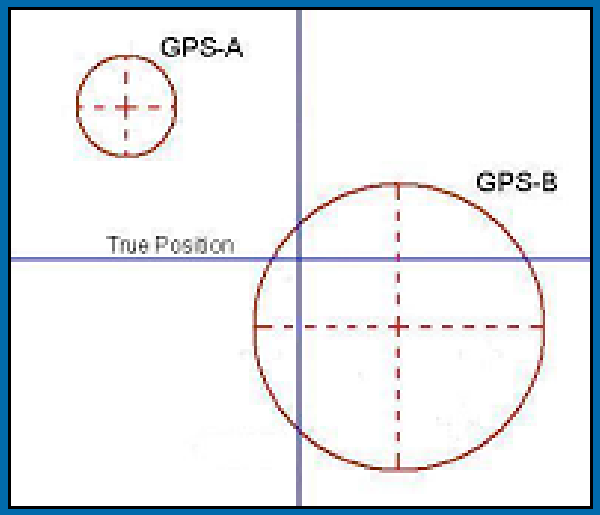
# How is GPS accuracy measured

- GPS-A is more precise than GPS-B



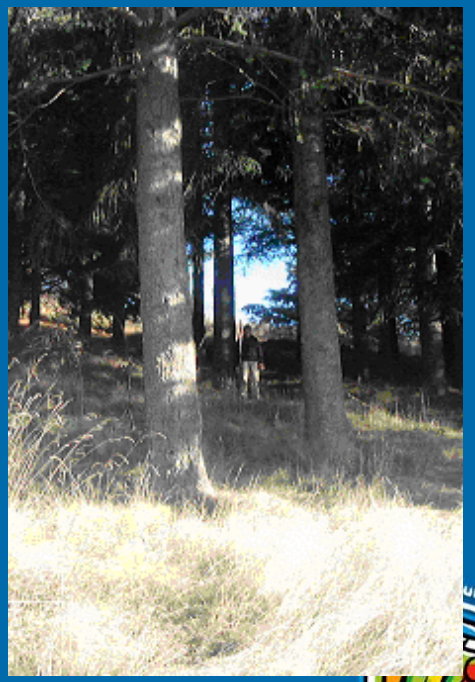
# How is GPS accuracy measured

- After averaging, GPS-B is more accurate than GPS-A



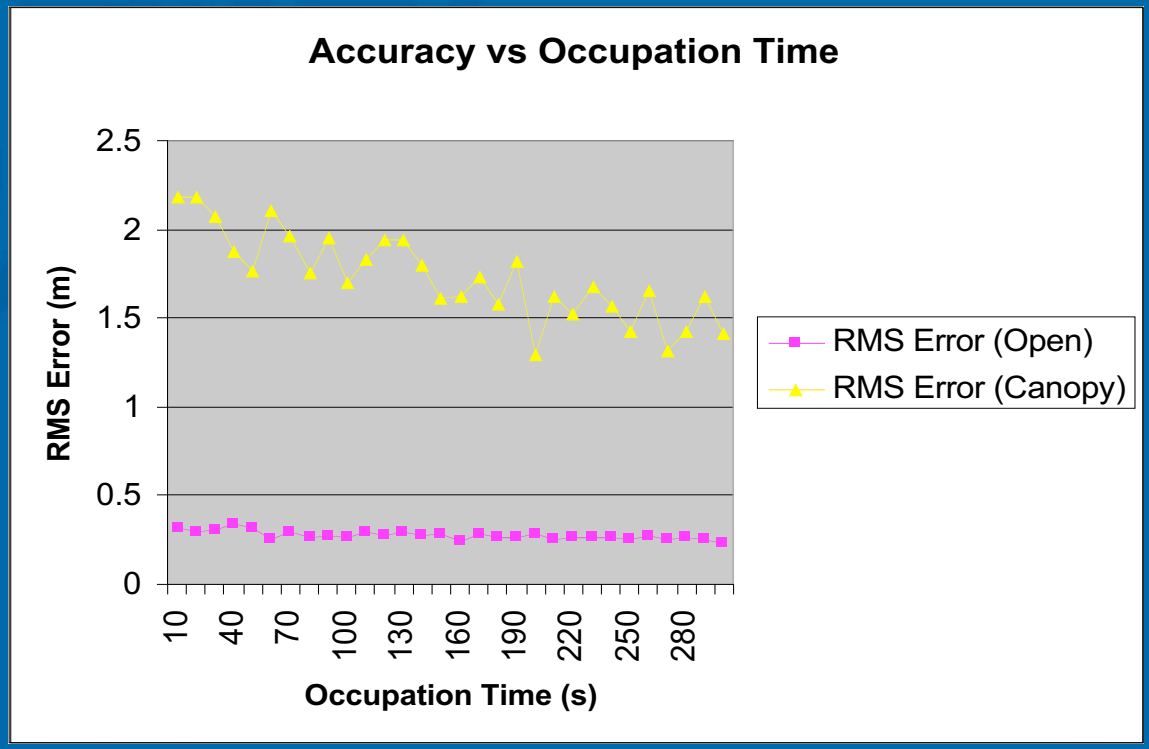
# What factors affect GPS accuracy

- Receiver and antenna type
- Data collection and processing techniques
  - Occupation time, settings
  - Differential correction
- Satellite geometry – DOP
  - Varies over time, but predictable
  - In-field mission planning
- Environment
  - Ionospheric conditions
  - Obstructions and multipath
  - EVEREST multipath rejection



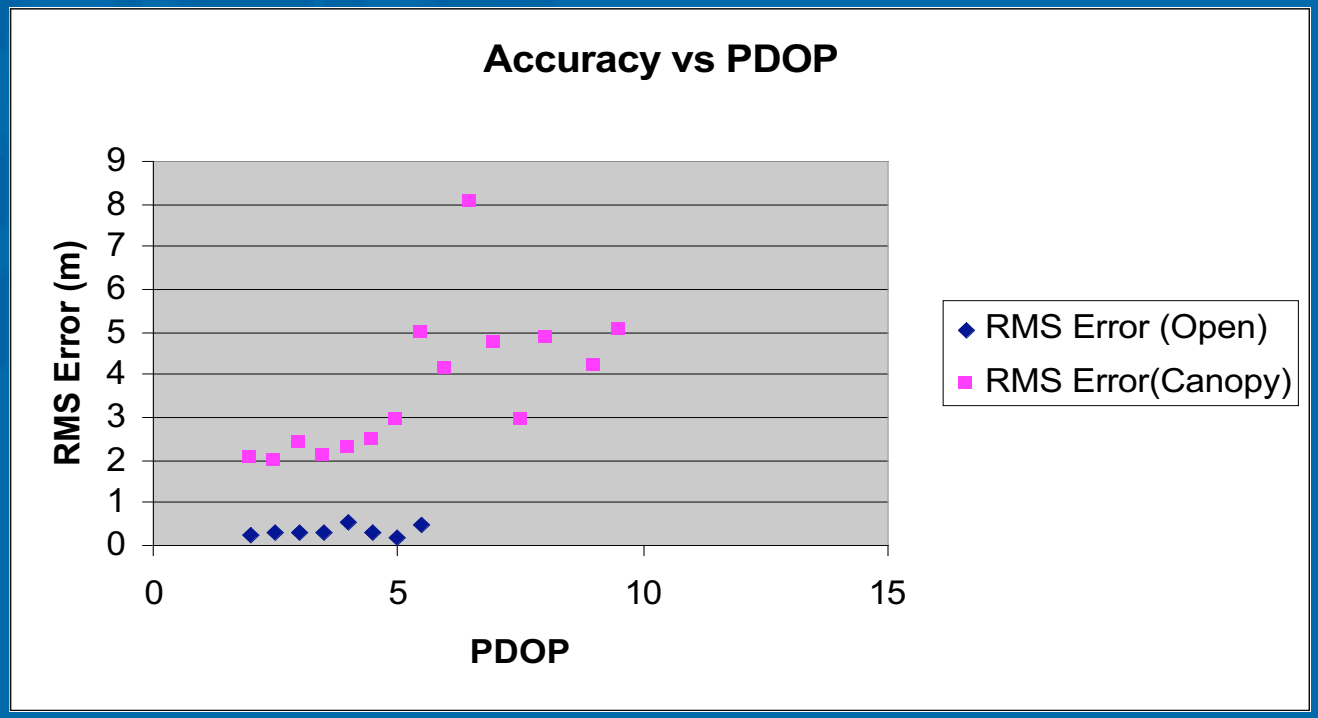
# What factors affect GPS accuracy

- Accuracy improves marginally with occupation time
- Improvement more significant in tough environments



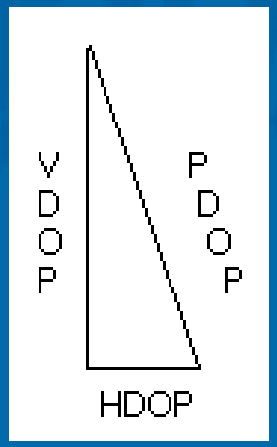
# What factors affect GPS accuracy

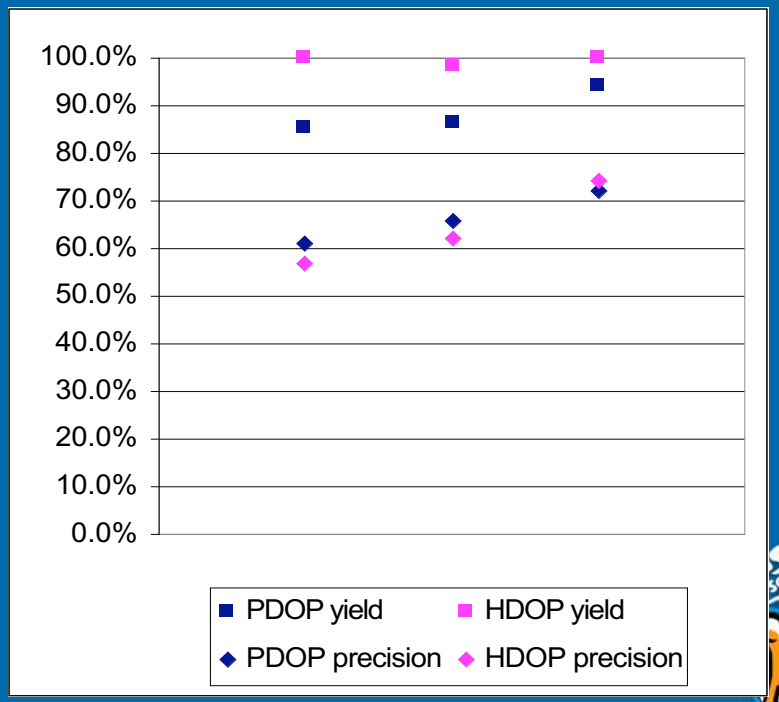
- Error increases with DOP, linearly for higher DOPs
- Impact is more significant in tough environments



# What factors affect GPS accuracy

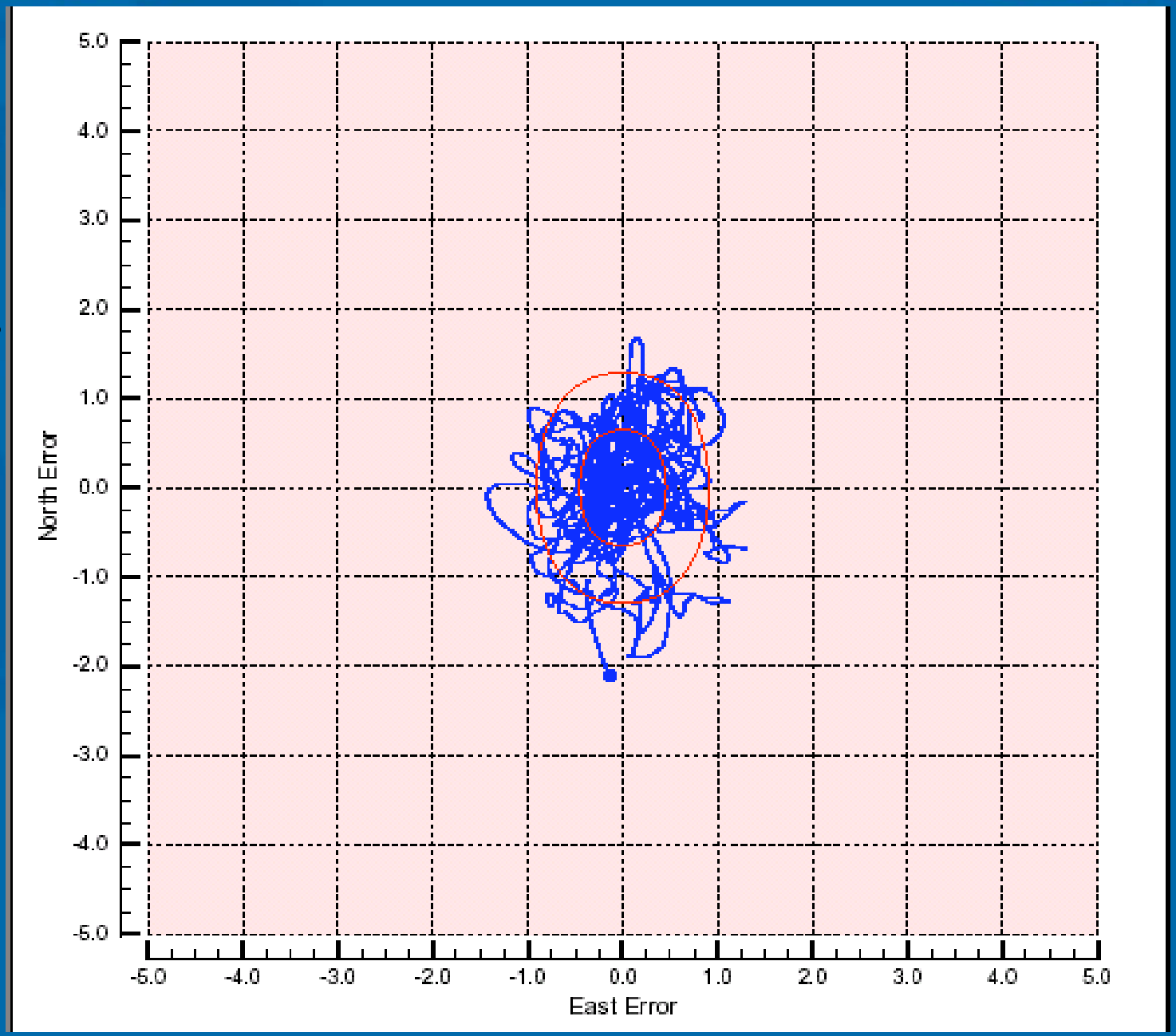
- Use PDOP mask (6) for 3D
- Use HDOP mask (4) for 2D (i.e. no need for heights) – gives better yield for similar horizontal precision
- $PDOP^2 = HDOP^2 + VDOP^2$



# How accurate is real-time differential GPS

- Depends on receiver type
  - Submeter
  - 2-5m
  - 3-15m
- And correction source
  - Satellite differential
  - Beacon
  - WAAS
  - Other RTCM source
- RTCM age limit is a yield / accuracy trade-off
- Velocity filtering helps in tough environments


5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
North Error
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
East Error

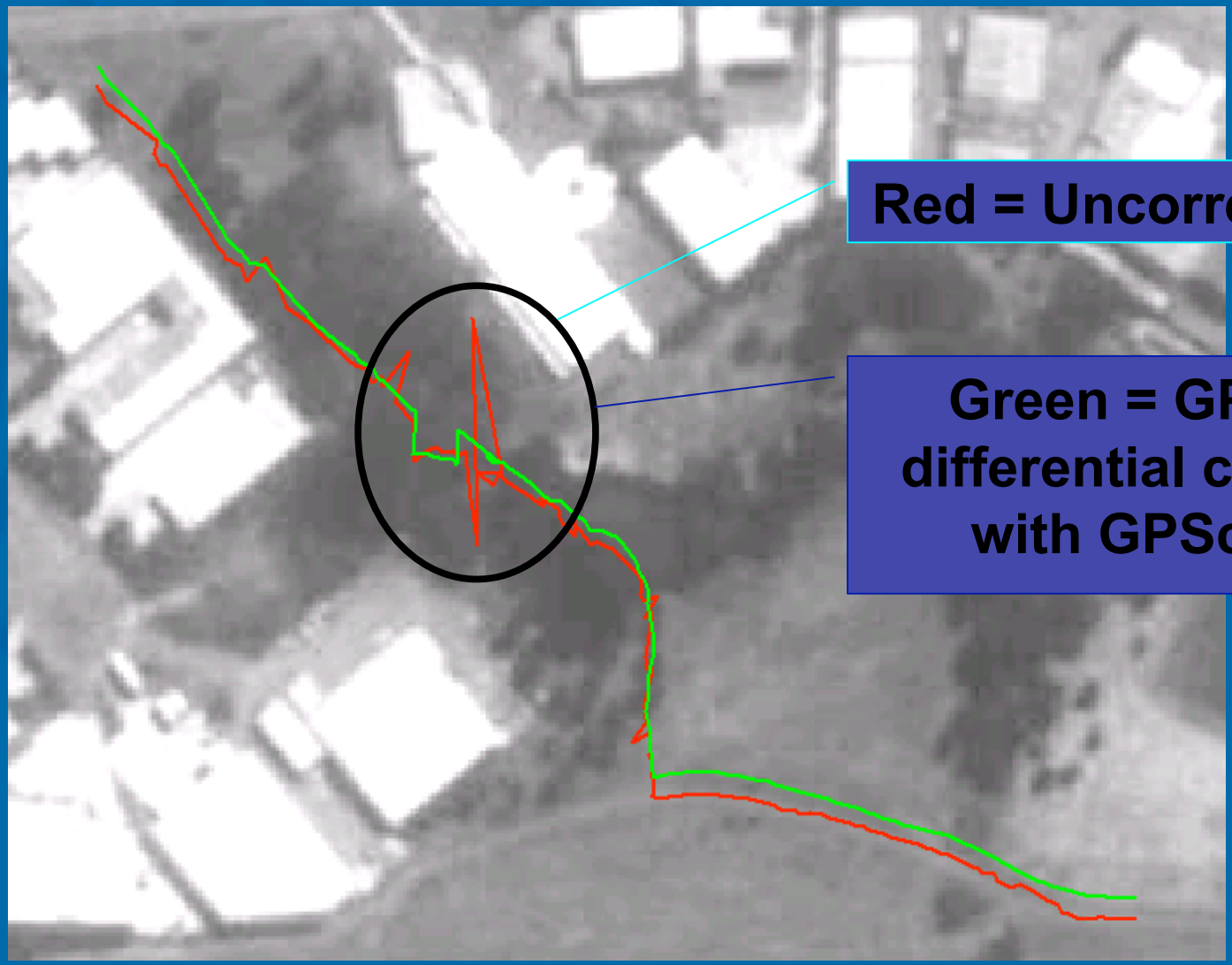
# What is WAAS

- Wide Area Augmentation System
- Created by US Federal Aviation Administration to improve efficiency of aviation operations
- Augments GPS with correction signal from geostationary satellite on GPS frequency
- Initial Operation Capability not yet declared
- Free to use
- 7m vertical / horizontal

# Is accuracy improved by postprocessing???

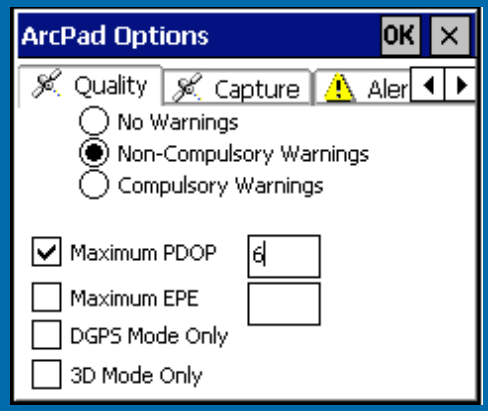
- Real-time DGPS can be postprocessed to further improve accuracy by
  - GPS Pathfinder Office
  - GPS Pathfinder Express
  - Using closer base stations
  - Filling in any real-time gaps
- Log velocity records for line / area smoothing

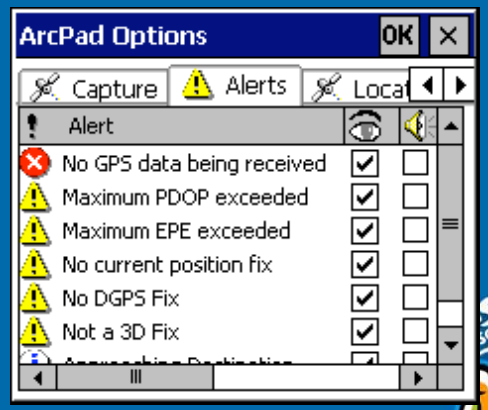
# Differential Correction – Better GPS



# Quality Thresholds

- Quality controls
- Warnings
  - Non-compulsory
  - Compulsory
- Alerts
  - Message box
  - Sound alarm



# Accuracy vs. Yield vs. Storage

- It may be more important to get ANY GPS position…
- Than to get a good position
- Most accurate settings =/= most receptive
- Adjustable as situation dictates: Bad reception, “canyon conditions,”
- Speed of travel→point interval time
- Run stats on precision

# Real-time correction

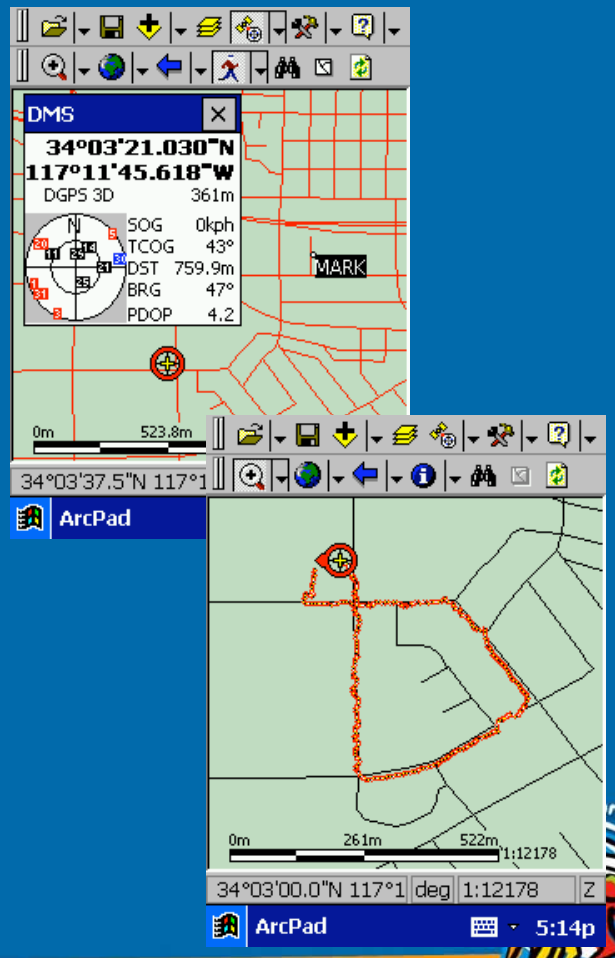
- Corrects positions before they are collected
- Broadcast from three sources
  - Beacon– USCG Navigation beacon, free
  - Commercial Satellite– By subscription
  - WAAS– Free, line of site, avaiation
- GPS unit must be enabled– each source is a separate feature

# ArcPad GPS connectivity

- Support GPS protocols
  - NMEA 0183
  - TSIP
  - Delorme Earthmate
  - Federal PLGR
- Works with almost all GPS receivers that output these protocols
- Key to success: understanding the relationship between GPS Setting and ArcPad Settings

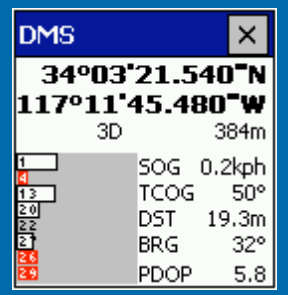
# GPS navigation

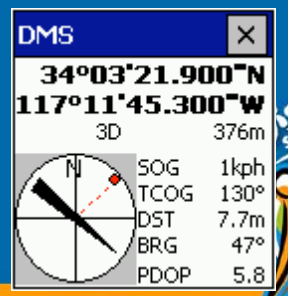
- Basic navigation
  - Shows current GPS location and direction of travel
  - Automatically centers map on GPS position
  - Shows distance and bearing to destination
- GPS Tracklog
  - “bread crumb” trail
  - Captures GPS Tracklog as shapefile with no attributes



# GPS Position Window

- Displays info from GPS receiver
- Current X, Y, Z Position in different coordinate systems
- GPS Mode
  - 2D, 3D, DGPS, RTK
- Navigation information
- Satellite Skyplot
- Satellite signal strengths

# I can't see the GPS on my ArcPad Map!

1. Check the GPS receiver
   - Power on? set to output NMEA messages? Make sure all messages that can be sent are turned on.
2. Check Connections:
   - Make sure a NULL modem adaptor is used when attaching the GPS receiver to the CE device if necessary.
   - Put ArcPad in GPS Debug mode to verify that something is being sent to the CE device from the GPS receiver.
   - Check the GPS manual to determine the COM port settings (port number, baud rate, data bits, stop bits, parity) ;make sure the ArcPad Options are set accordingly.
3. Check Satellites
   - If you are getting a signal in GPS Debug, open the skyplot and look at satellite signals
4. Check Coordinate System
   - Make sure your map has a coordinate system
   - GPS Output Datum set correctly?

# GPS Setting vs. ArcPad Settings

| Setting | Master Unit | Matching Unit |
|---|---|---|
| Baud Rate | GPS | ArcPad |
| GPS Datum | GPS – WGS is usually default | ArcPad |
| GPS Protocol | GPS – NMEA is usually default | ArcPad |
| Streaming Interval | ArcPad | GPS – Usually Default of 1 second |
| Positions per feature | ArcPad | GPS – Usually Default of 1 |
| Port | ArcPad - Device | N/A |
| Data Bits, Stop Bits | GPS -- Defaults | ArcPad |
| Projection | ArcPad - Data | N/A |
| Real-time correction | GPS – must be enabled | ArcPad – Quality Options & Warnings |

# Building a Field GIS System

- GPS Receiver
- ArcPad Software
- ArcPad Hardware
- ArcGIS
- GIS Data
- Auxiliary devices and software

# A Field Mapping System Must Enable You to…

- Navigate:
  - to the site, back to base, then back to the features at a later date
- Record:
  - Capture new and/or Update existing data:
  - location and/or attributes
- Display:
  - Data you are recording + other map layers

# Choosing a Field Mapping System: Hardware

| Requirement | Determining Factors |
|---|---|
| Size, morphology | Proximity to infrastructure, vehicles. Carrying capability. |
| Weight | Physical carrying restrictions. |
| Battery type/life | Operating time frame, cost, added weight. |
| Processor and data storage | Amount and type of background data to be used, and amount of data to be captured. |
| GPS Accuracy | Scale of mapping project. |
| Connectivity | Number of peripheral devices to be used (GPS, laser rangefinder, etc.). |
| Display | Readability in low-light and bright light conditions, available screen display size. |
| Ruggedness | Environment (tropics/desert). |
| Cost | Budget. |

# Other Hardware and Gear

- Auxiliary devices
  - Transit -- Laser range finder
  - Bar code scanner -- Hydrolab
  - Digital camera – voice recorder
  - 802.11
  - CDPD/GPRS Wireless Internet
- Map and Compass

# Other ESRI GPS Solutions

- ArcMap GPS Extension
- ArcGIS Tracking Analyst
- ArcIMS Tracking Server
- Map Objects

# HARDWARE!

- Look at the toys

# Demo

- Arcpad Interface
- GPS Tools
- GPS Editing
- Hooking up a GPS
- Collecting data!

# Questions?