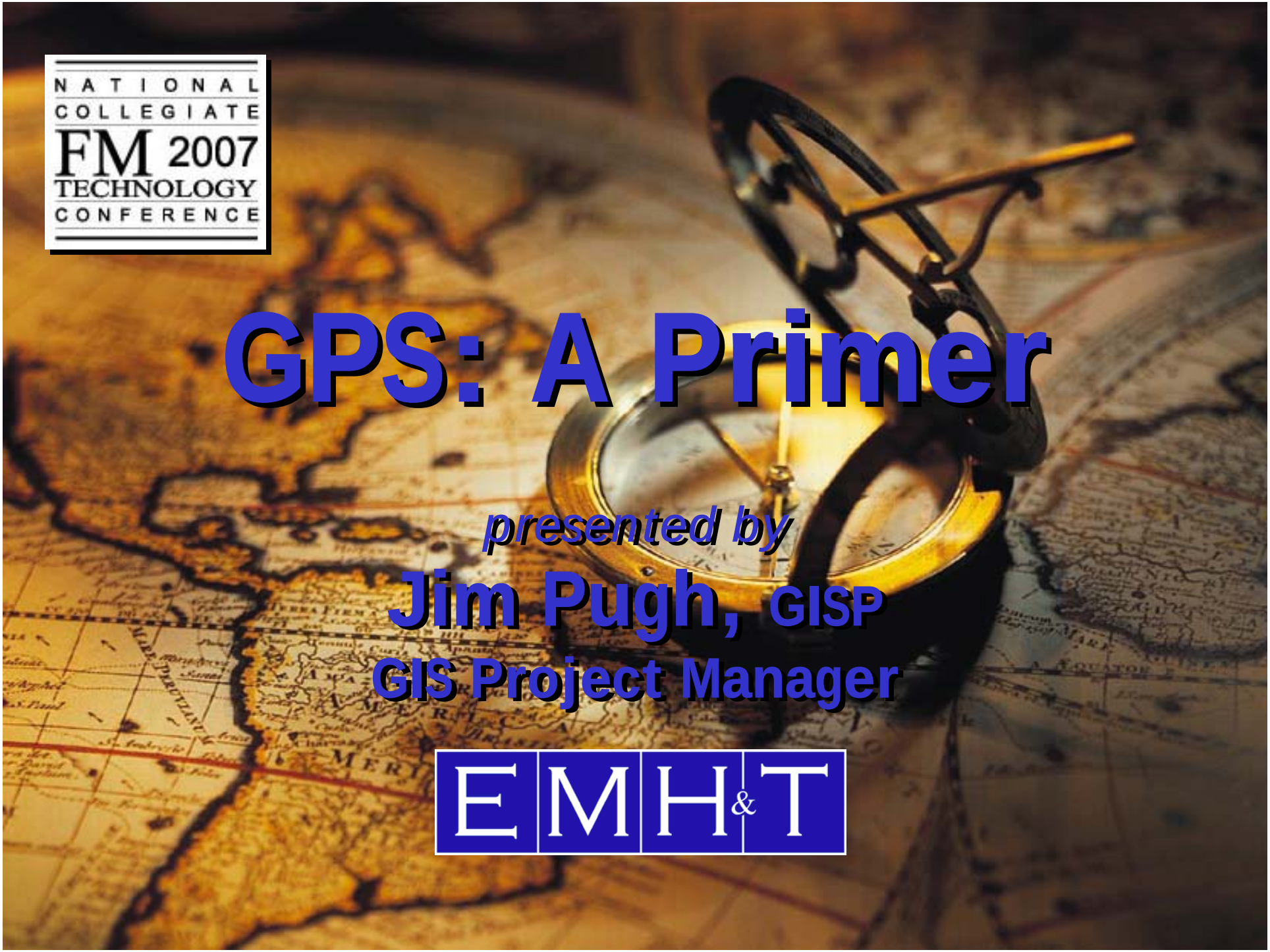
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GPS: A Primer
presented by
Jim Pugh, GISP
GIS Project Manager
EMH&T

GPS: A Primer

- GPS = Global Positioning System
- 24 Satellites in Orbit around Earth
- Each Broadcasts precise time and known location
- Receivers triangulate position

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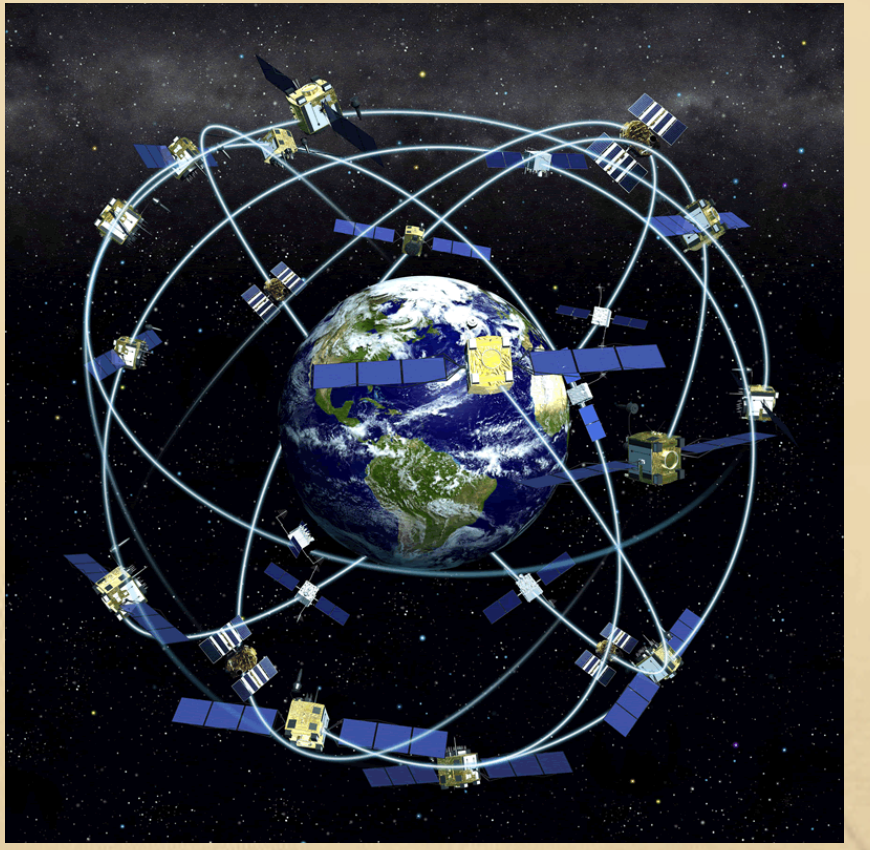
By the way…

- "GPS" is an American system
- "GLONASS" is Russian
- "Galileo" is EU



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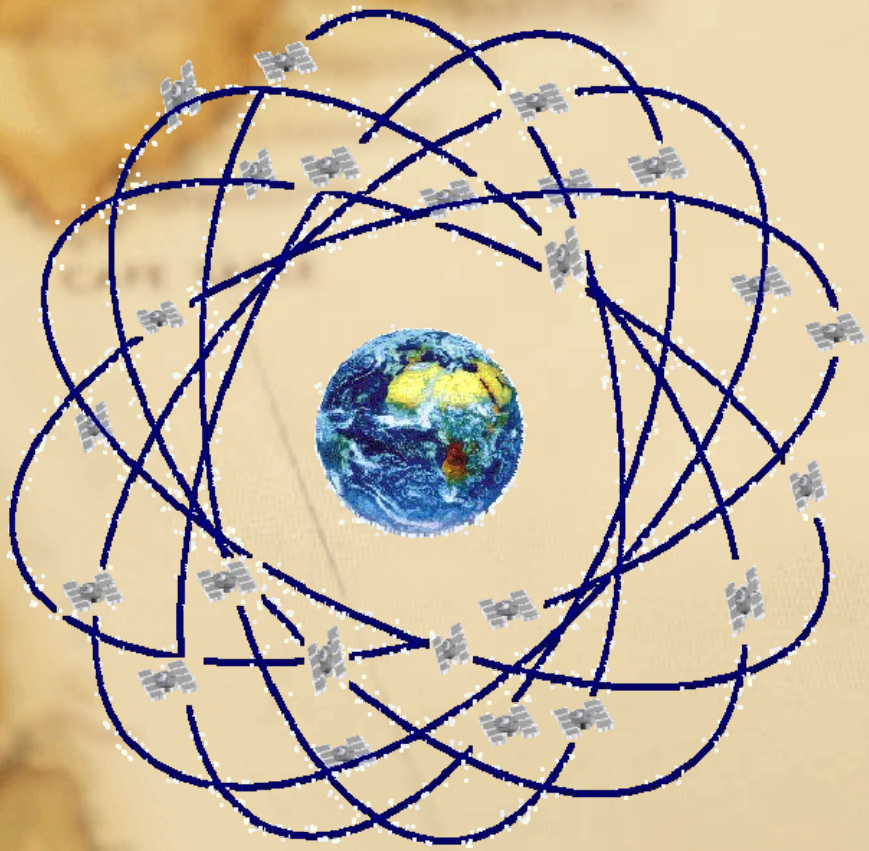
GPS Orbit



- About 12,000 miles above Earth
- 6 Circular Orbital Planes
  - Global Coverage
- Equipped with very precise atomic clocks

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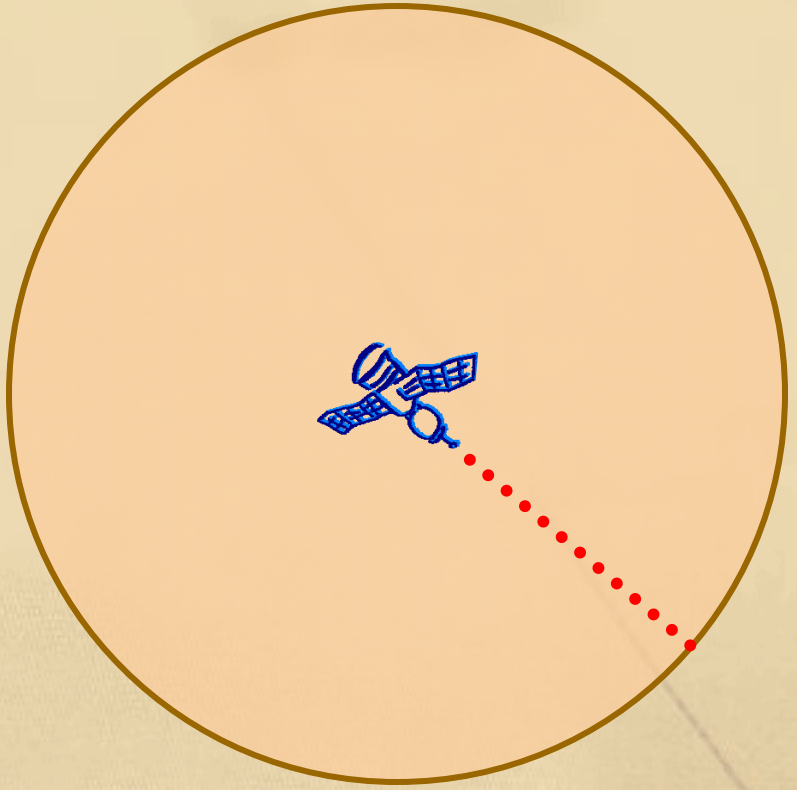
It's about time…

- Distance = Velocity x Time
- Velocity is fixed at the Speed of Light
- Calculate signal travel *time* and distance is solved
- Location is somewhere within a sphere



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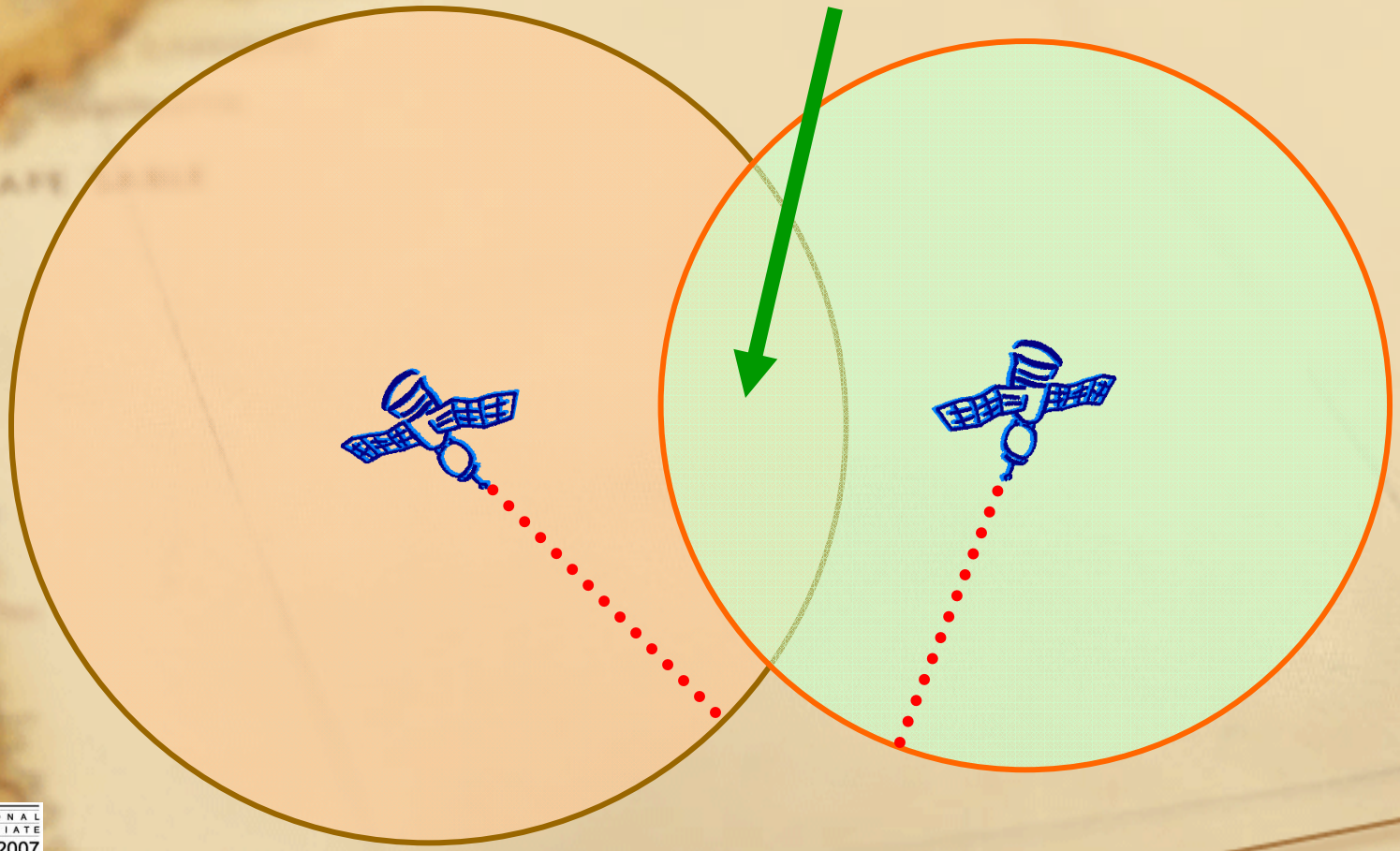
It's about time...

- A second distance can calculate an area...



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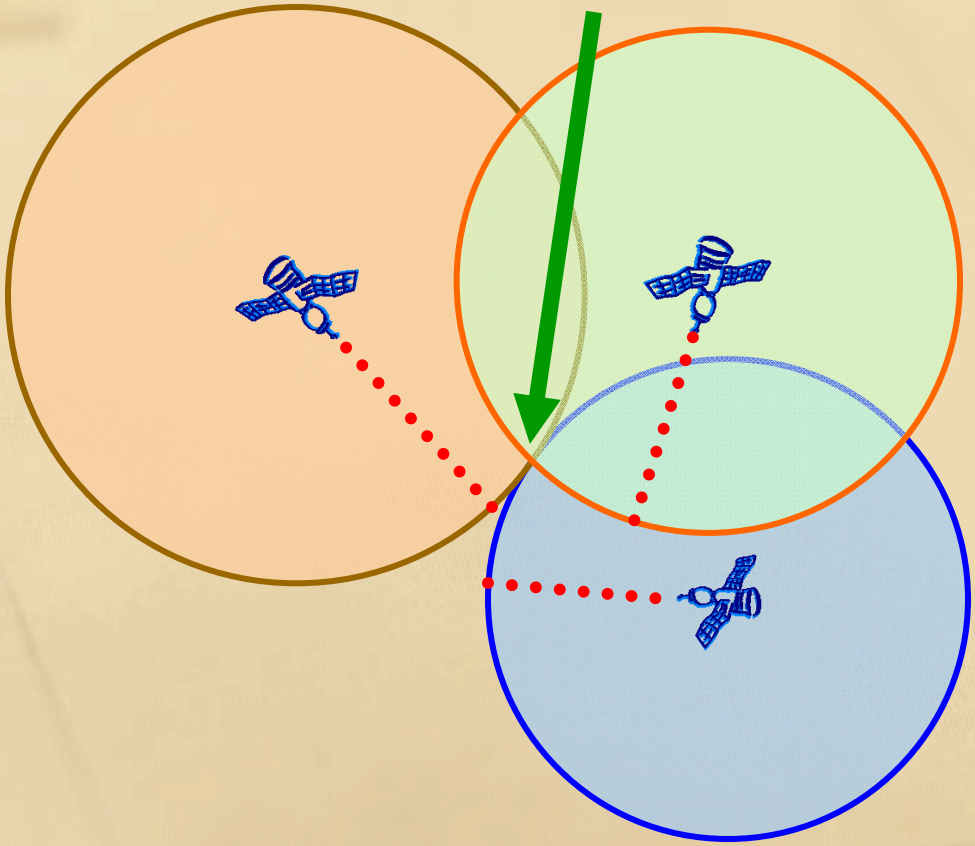
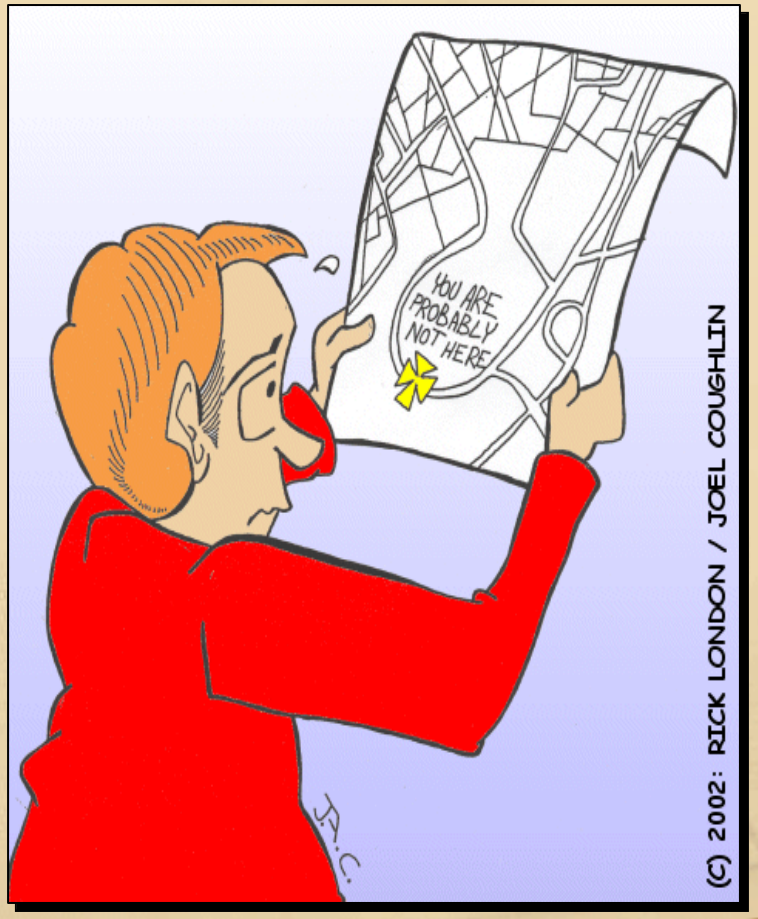
It's about time…

- The third distance can calculate a point…



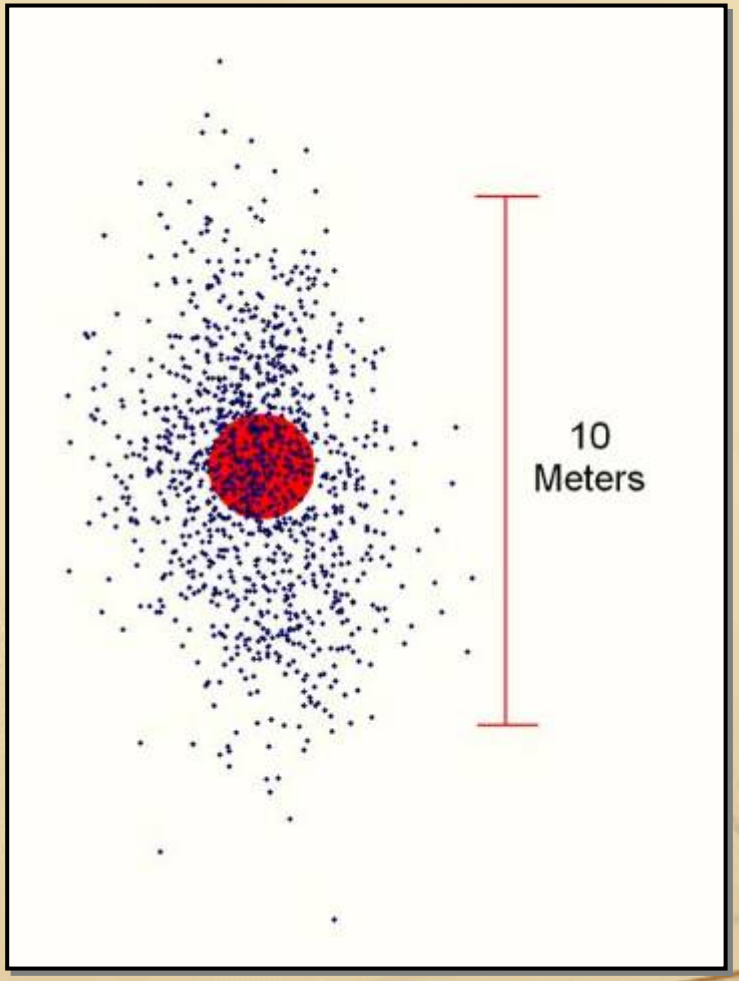
If it were a perfect World…

- Extremely precise clocks required
  - Average time from Satellite <0.06 sec
  - 1ns error = 1 ft
- Speed of Light
  - Not a constant
- Orbits change



If it were a perfect World…

- Each reading is slightly different
- Due to changing
  - Satellite location
  - Satellite DOP's & combinations
  - Varied clock errors
- Points are averaged



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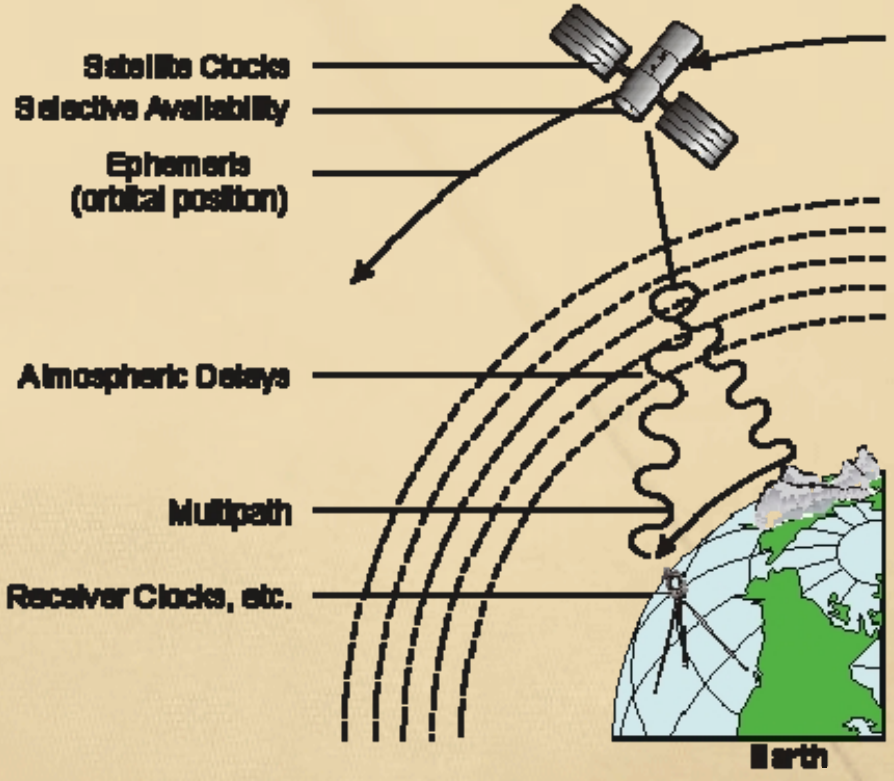
GPS Error

- Satellite Clocks
- Selective Availability (SA)
- Orbital Errors (Ephemeris)
- Atmospheric
  - Delays & Signal Strength
- Multipath
- Receiver Clock



GPS Error

• Satellite Clocks	Minimal – atomic clocks
• Selective Availability (SA)	Disabled – was upwards of 300 feet
• Orbital Errors (Ephemeris)	7 feet
• Atmospheric	13 feet
– Delays & Signal Strength	
• Multipath	3 feet
• Receiver Clock	13 feet

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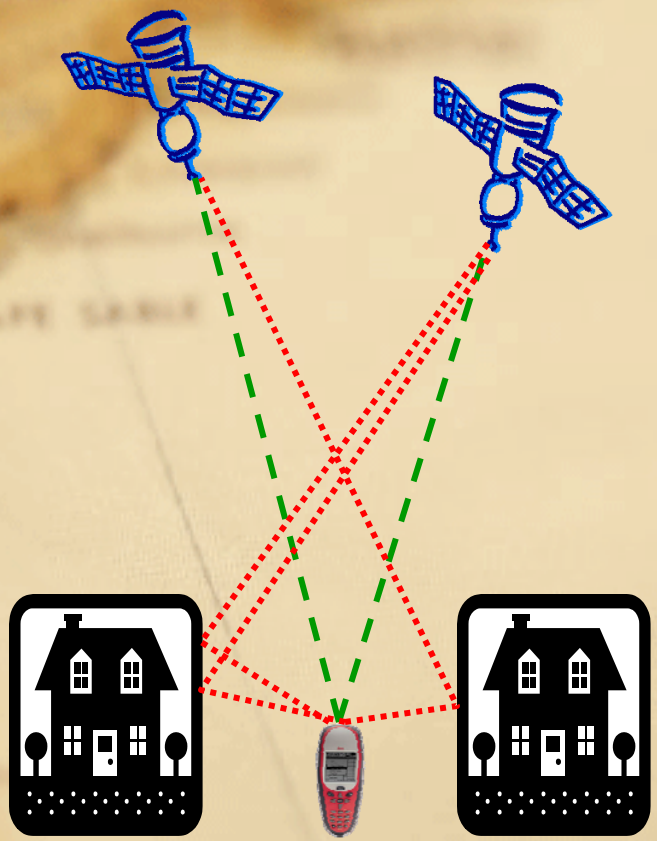
Ephemeris

- Satellite location
- Monitored by DoD
  - Updated Constantly
- Almanac: all SV's
- Adjusted
  - Orbit
  - Altitude
  - Speed

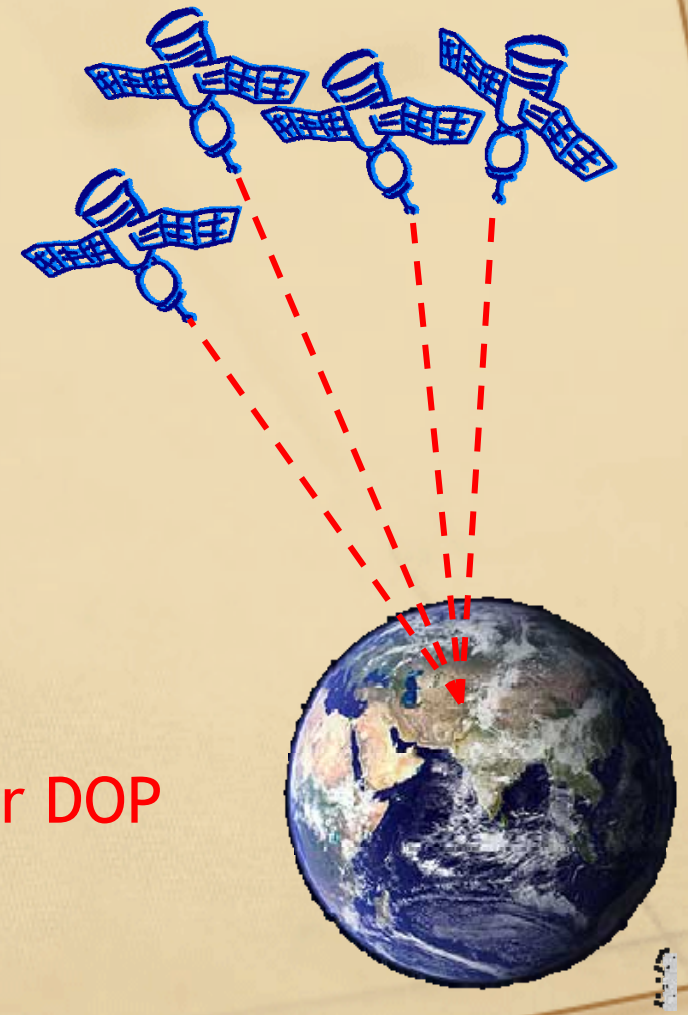
Multipath



- Signal reflects off Objects
- Travels further and delayed
- Corrected with improved antenna and processors
- “First one wins”

Dilution of Precision (DOP)

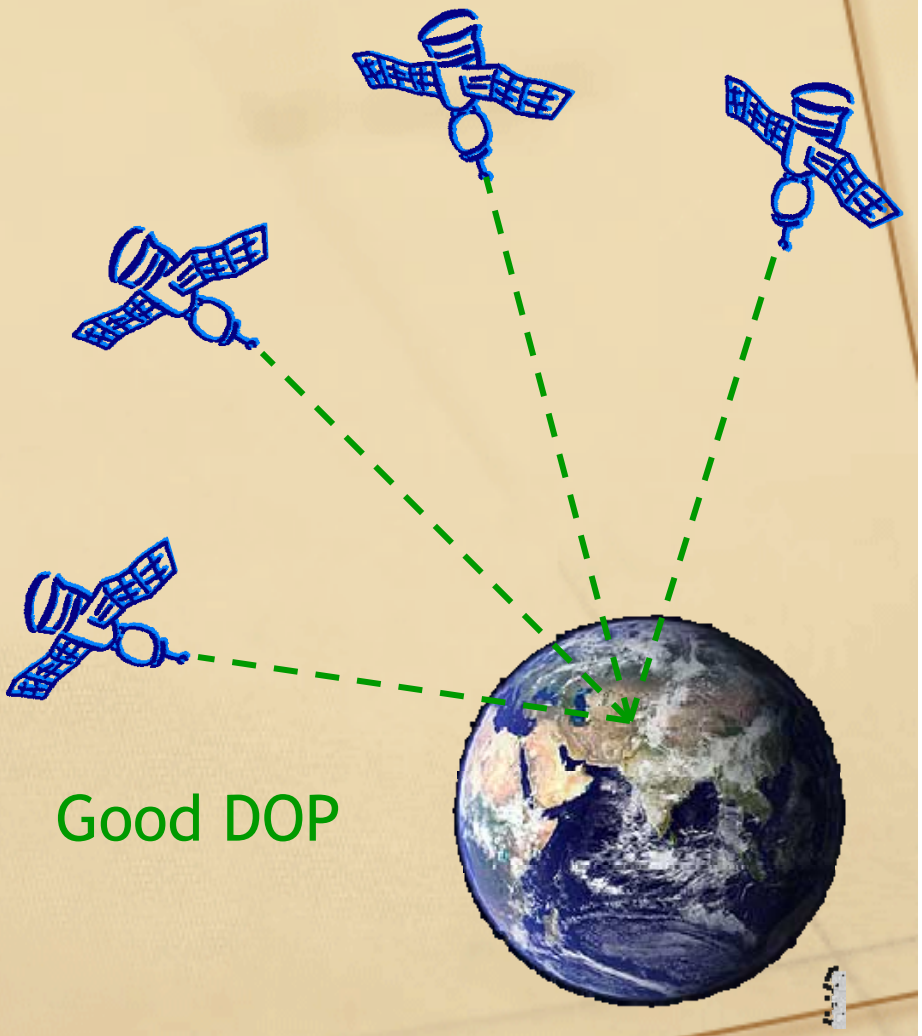
- Includes:
  - Horizontal (HDOP)
  - Vertical (VDOP)
  - Position (PDOP)
    - $\sqrt{HDOP^2 + VDOP^2}$
    - Generally below 6
  - Time (TDOP)
  - Geometry (GDOP)
    - $\sqrt{PDOP^2 + TDOP^2}$



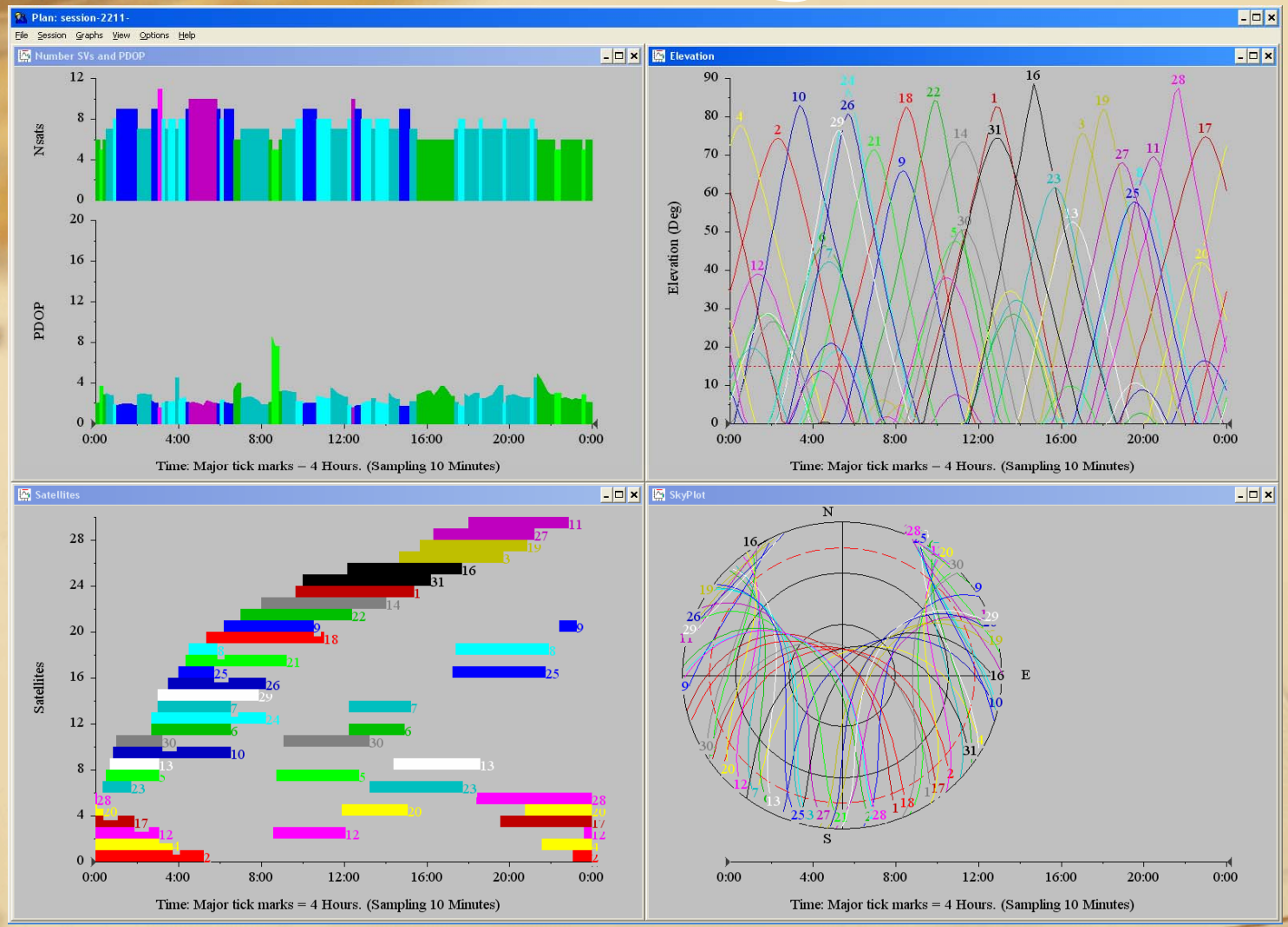
Poor DOP

Dilution of Precision (DOP)

- Includes:
  - Horizontal (HDOP)
  - Vertical (VDOP)
  - Position (PDOP)
    - $\sqrt{HDOP^2 + VDOP^2}$
    - Generally below 6
  - Time (TDOP)
  - Geometry (GDOP)
    - $\sqrt{PDOP^2 + TDOP^2}$



When to go?



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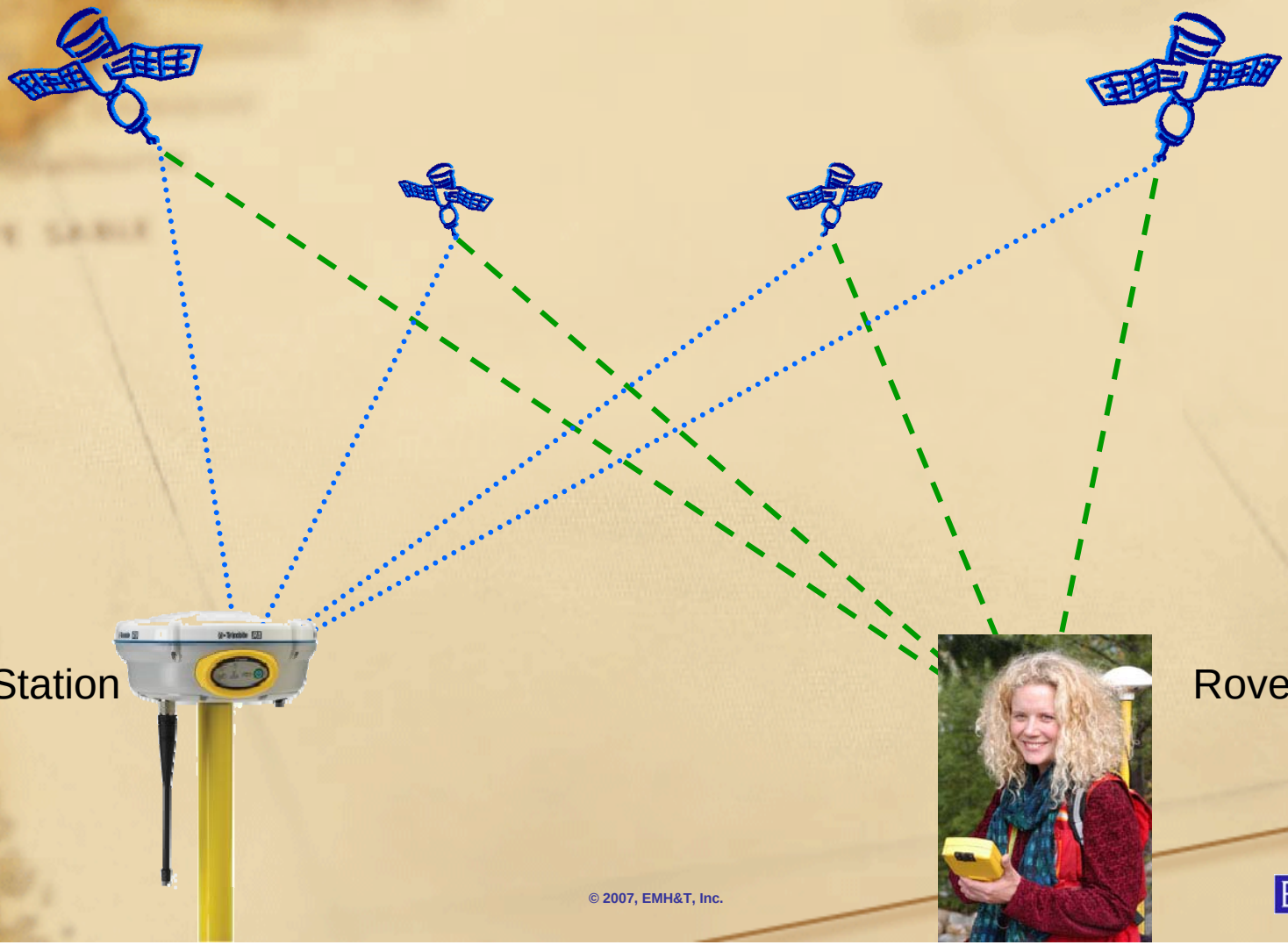
Differential Correction



Base Station

Rover

Differential Correction

Known Position
All Satellites
Calculate Error

Unknown Error
Compare to Base
Apply offset Error

Base Station

“Post Processing”

Rover

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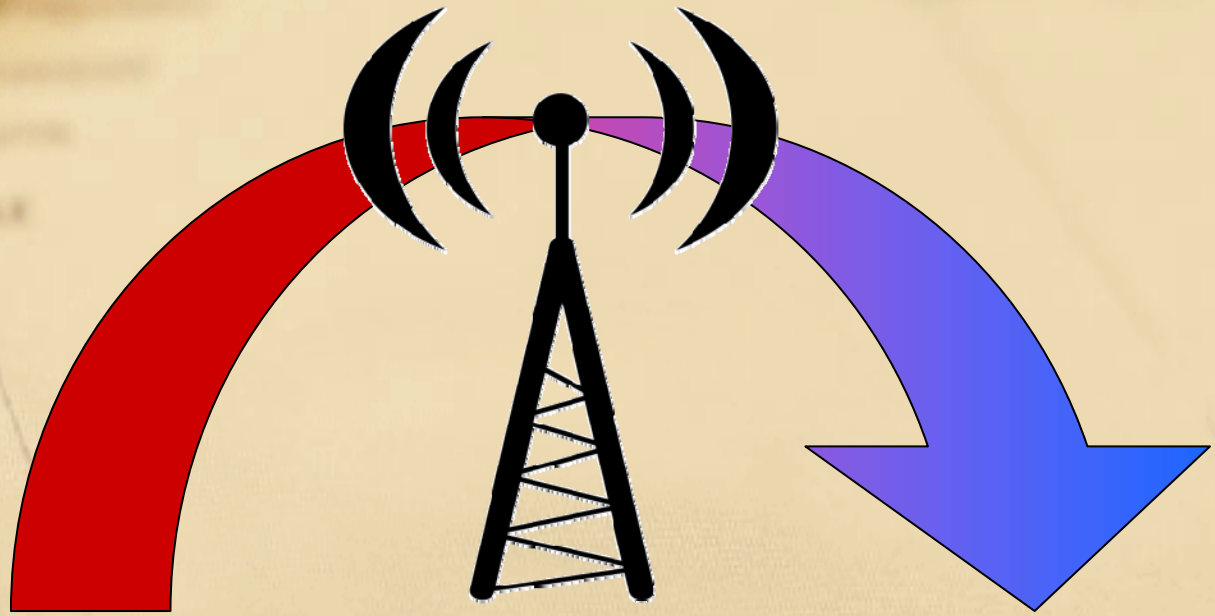
Differential Correction



Base Station

"DGPS"
"RTK"

Rover

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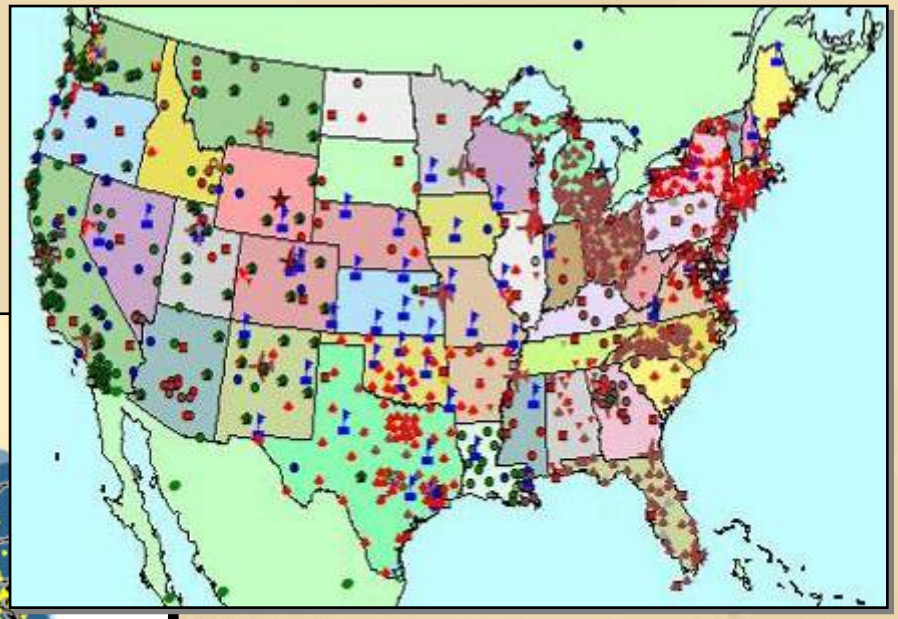
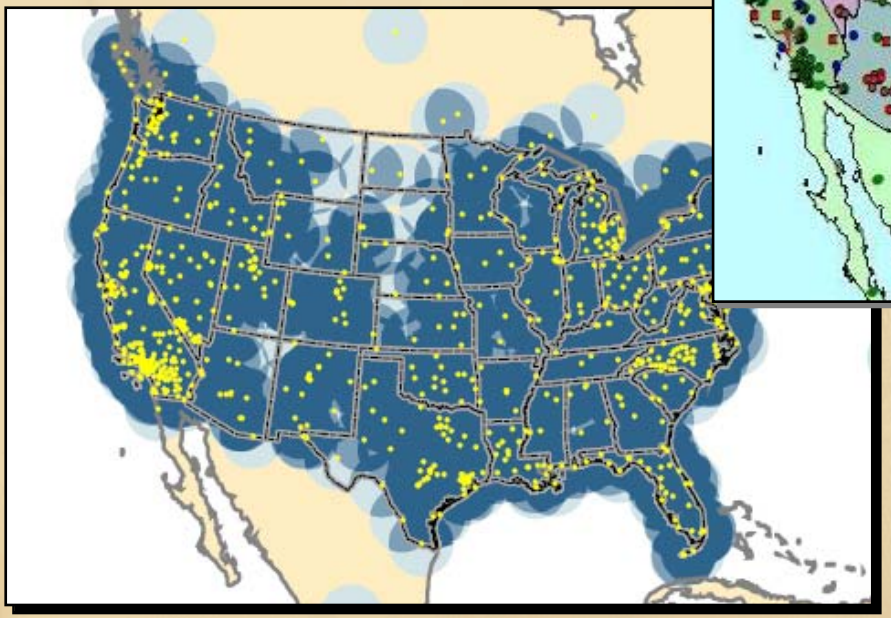
Differential Correction

- National Public Base Station Network





Types of GPS

- Recreational Grade
  ± 30 - 100 feet
- Mapping Grade
  ± 1 – 3 feet
- Survey Grade
  < 0.04 feet (1 cm)

Vertical 2-5 times horizontal accuracy

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Types of GPS

- Recreational Grade
  - ± 30 - 100 feet
- Mapping Grade
  - ± 1 – 3 feet
- Survey Grade
  - < 0.04 feet (1 cm)

Purchased for
$100-800

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Types of GPS

- Recreational Grade
  - ± 30 - 100 feet
- Mapping Grade
  - ± 1 – 3 feet
- Survey Grade
  - < 0.04 feet (1 cm)

Purchased for
$3,000-5,000+

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Types of GPS

- Recreational Grade
  - ± 30 - 100 feet
- Mapping Grade
  - ± 1 – 3 feet
- Survey Grade
  - < 0.04 feet (1 cm)

Purchased for
$15,000-50,000++

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Types of GPS

- Recreational Grade
  - ± 30 - 100 feet
- Mapping Grade
  - ± 1 – 3 feet
- Survey Grade
  - < 0.04 feet (1 cm)

What do you get?

Better clocks, receivers, filters, processors.

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Types of GPS

- Recreational Grade
  - ± 30 - 100 feet
- Mapping Grade
  - ± 1 – 3 feet
- Survey Grade
  - < 0.04 feet (1 cm)

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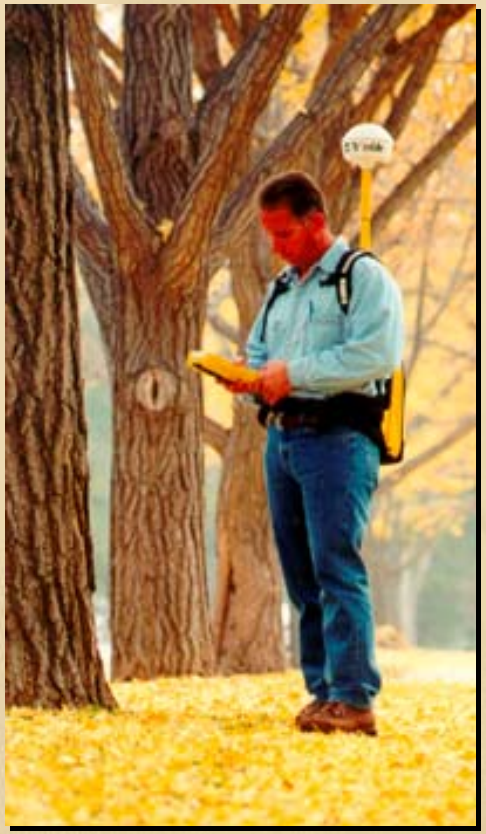
So what can you do with it?

- Tree – Horticulture Inventory
- Ponds – Streams
- Historical - Archeological



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Utilities

- Manholes
- Storm Drains
- Sprinkler Heads
- Power / Light Poles
  - Not to “locate” underground utilities!

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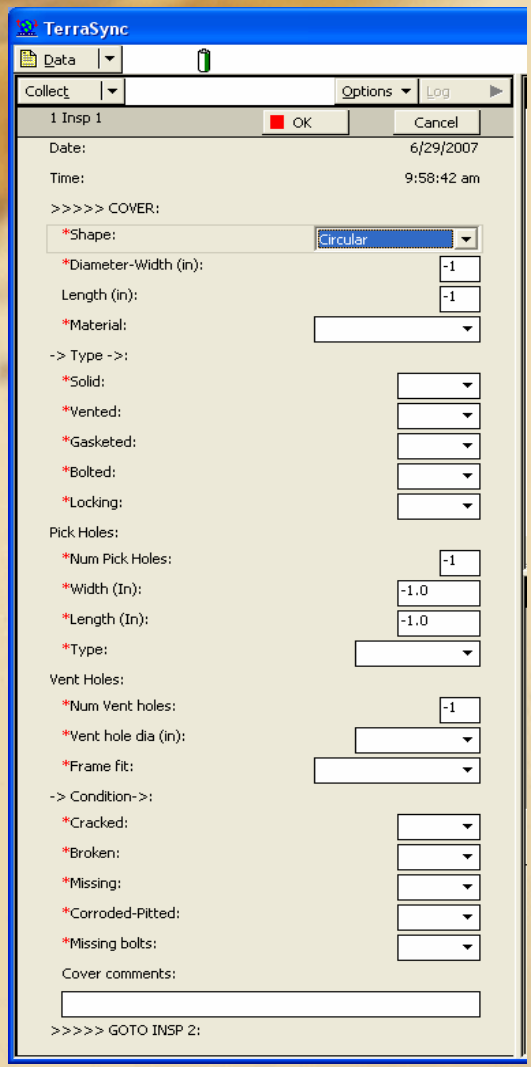
Planimetric

- Building Corners
- Walls
- Trails – Footpaths
- Bike Racks
- Benches – Bus Stops
- Signage

Emergency Management

- GPS is also for Navigation
- Hydrants
- Emergency Call Boxes
- Valves

Attributes



- While you're collecting location, collect data!
- Pull-down menus
- Valid Values – Ranges
- Required Fields

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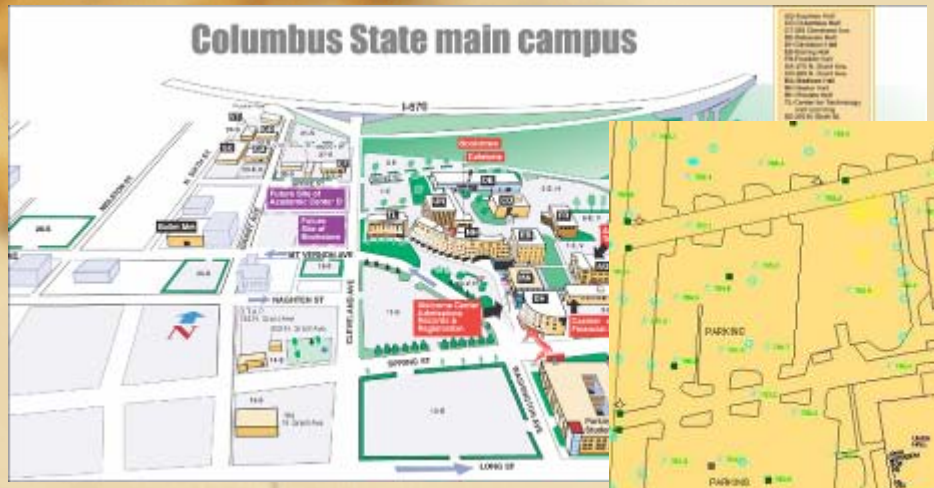
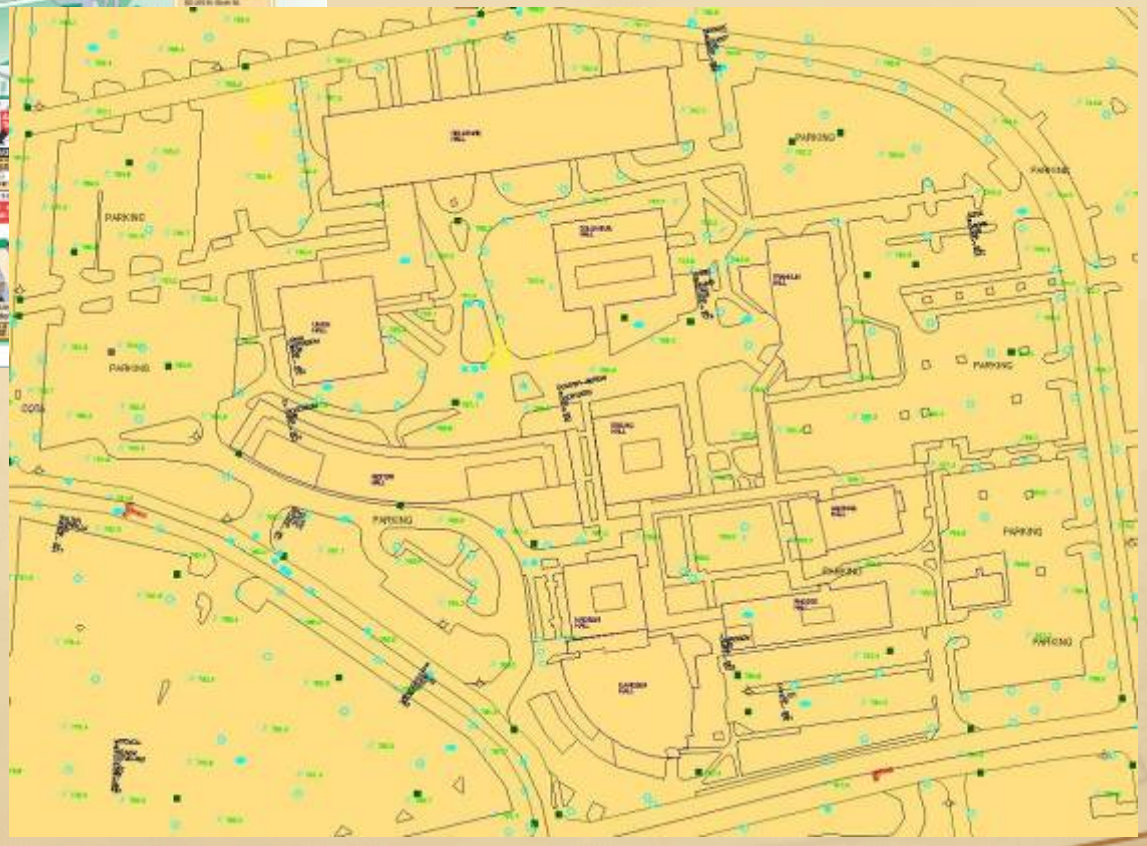
Base Map





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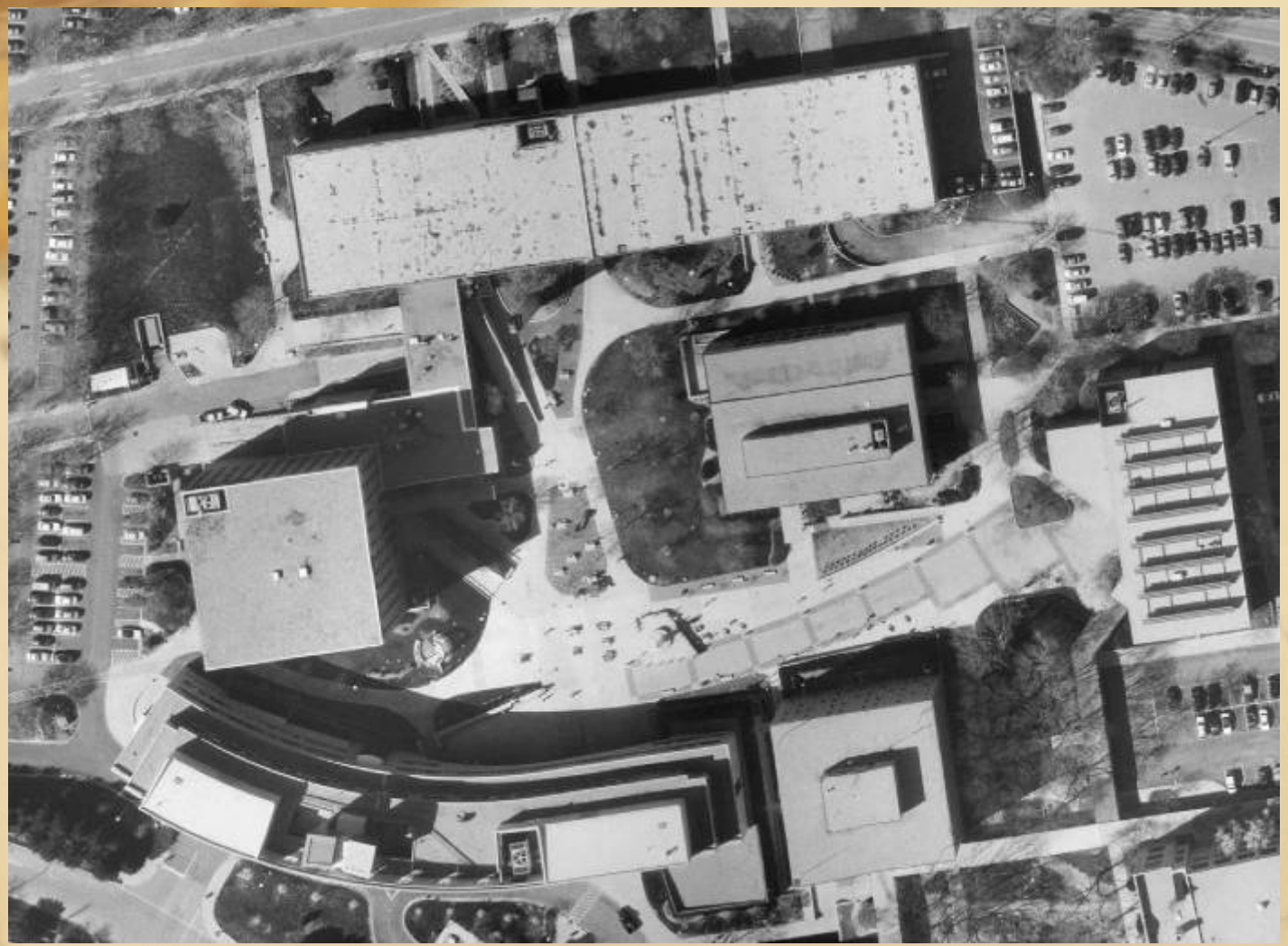
Ground Control



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Cool Tools you can Use!

July 21, 5:43 pm: The nerds meet the geeks

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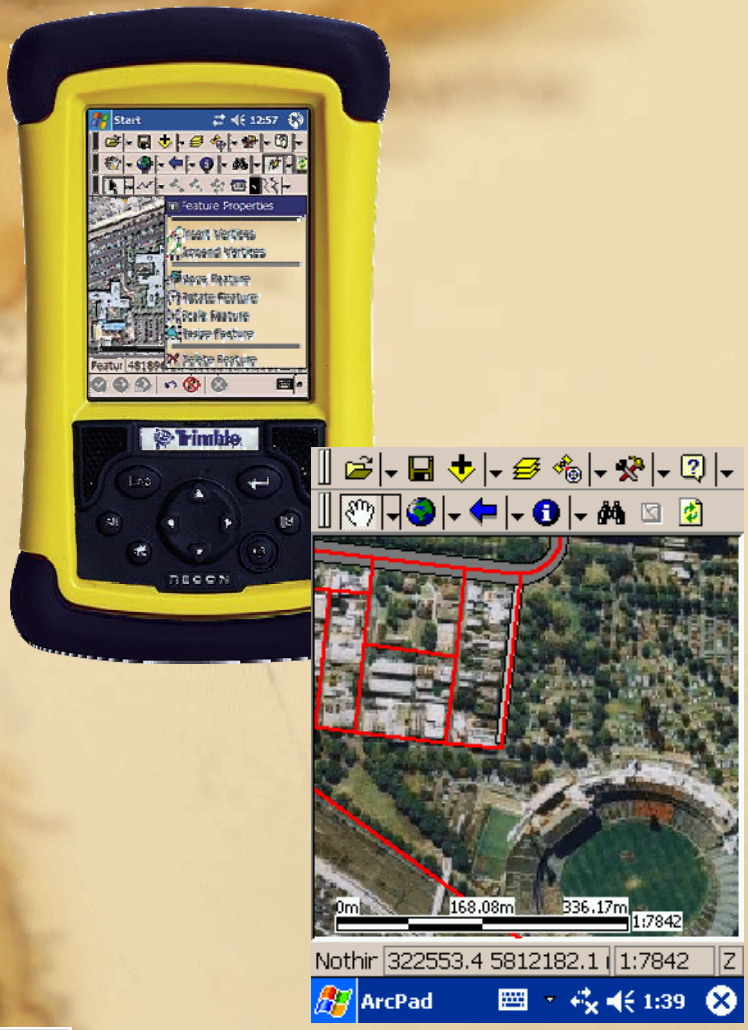
ESRI ArcPad™



- Mini-GIS Integrates with GPS
- Draw, edit
- Enhanced menus, attribute collection
- Works with many Systems
- Customizable

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Laser Rangefinder

- Remote Positions
  - Under Canopy or Overhang
  - In Trees

LaserCraft™ Rangefinder

- Remote Positions
  - Under Canopy or Overhang
  - In Trees

- Remote Measurements
  - Horizontal
  - Vertical

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Ricoh GPS Camera

- GPS Ready
- Data Embedded in Digital Image
- “Talks” with Bluetooth enabled GPS and Rangefinders

GPS: A Primer

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Thank you! Questions?

For more information or a copy of this presentation, please email JPugh@EMHT.com

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