

Global Positioning Systems, Opinions and Approaches

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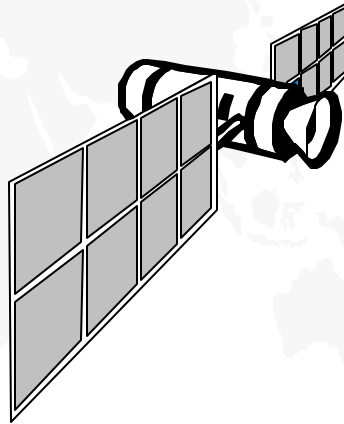
GLOBAL POSITIONING SYSTEM

- Renaissance in navigation, surveying and mapping professions
- May completely replace conventional methods of transportation navigation
- New applications continually emerging:
 - Natural resource management
 - fleet management
 - agriculture
 - public safety
 - disaster mitigation

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GPS SATELLITES

- Orbit around 20,200 km in 6 orbital planes
- Orbital period about 12 hr
- Travel about 4 km per second
- Weigh about 900 kilograms
- 5 m wide with solar panels



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TYPES OF GPS SATELLITES

- Block I
 - Original experimental satellites
 - 11 launched between 1978-85
- Block II
 - Operational satellites
- Block IIR
 - Replacement satellites
- Block IIF
 - Follow-on satellites

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GPS CODE

- Codes used to communicate with receivers
- Codes carried by 2 carrier waves
- Carrier waves part of L-band
 - L1 -- 1575.42 MHz
 - L2 -- 1227.60 MHz
- 3 Basic codes: P code, C/A code, Navigation code

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DUAL-FREQUENCY RECEIVERS

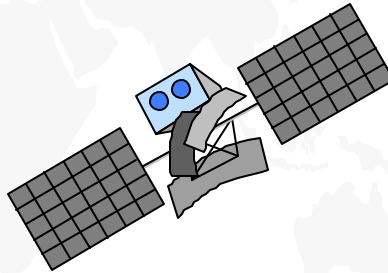
- Simultaneously receive L1 & L2
- Can compensate for ionospheric effect
- Can increase reliability on long lines
- Increases scope of possible procedures
- Now, use codeless technology

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GPS OBSERVABLES

- PSEUDORANGE
 - Used for instantaneous point positioning or applications with lower accuracy

- CARRIER PHASE
 - Also called carrier beat phase
 - Used for high precision GPS surveys



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PSEUDORANGE VS PHASE KEY ADVANTAGES AND DISADVANTAGES OF OBSERVABLES

	<i>PSEUDORANGE</i>	<i>PHASE</i>
<i>ADVANTAGES</i>	<i>NON-AMBIGUOUS</i> <i>SIMPLE</i>	<i>HIGH ACCURACY</i> <i>POTENTIAL</i>
<i>DISADVANTAGES</i>	<i>LOW ACCURACY</i>	<i>MORE COMPLEX</i>

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SELECTIVE AVAILABILITY VS ANTI-SPOOFING

- SA - Selective Availability
 - Degrade broadcast orbit & dithering of satellite clock
 - Accuracies degraded to 100 m horizontally and 156 m vertically
- AS - Anti-Spoofing
 - Denial of access to P-code
 - P-code replaced with Y-code
 - Y-code similar to P-code, but is unknown to unauthorized users

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DILUTION OF PRECISION

- DOP
 - Concerned with geometric strength of figure described by the positions of the satellites with respect to one another
 - Unfavorable geometry when satellites lie on straight line or when bundled up together
 - Uncertainty of position = $DOP \times UERE$
 - ex: $DOP = 2$, $UERE = +/- 5 \text{ m}$
uncertainty = $2 \times 5 \text{ m} = +/- 10 \text{ m}$

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DILUTION OF PRECISION

- GDOP (Geometric Dilution of Precision)
 - Uncertainty expected in X, Y, Z and clock offset
 - Ideal arrangement, one satellite overhead & others 120° apart near horizon
- HDOP - Horizontal Dilution of Precision
- VDOP - Vertical Dilution of Precision
- PDOP - Position Dilution of Precision
- TDOP - Time Dilution of Precision
- RDOP - Relative Dilution of Precision

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SINGLE POINT VS RELATIVE POSITIONING

- Single point
 - Coordinates of receiver at “unknown” point determined w.r.t. earth’s reference
- Relative positioning
 - Coordinates of receiver at “unknown” point determined w.r.t. receiver at “known” point
 - Advantages -- higher accuracies achieved

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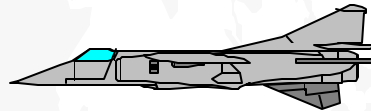
REAL-TIME VS. POST PROCESSING

- Real Time
 - Positions computed instantaneously on site
 - Requires data link to transmit corrections from base to rover
 - Very low accuracy pseudorange single point positioning
- Post Processing
 - Data are combined & reduced after all data collection completed
 - Used mostly for very high accuracy phase relative positioning

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STATIC VS. KINEMATIC

- Static
 - Conventional Static
 - GPS receiver stationary at point at least 1 hour
- Kinematic
 - Receiver collects data while moving
 - Originally -- need to maintain lock



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HYBRID POSITIONING SYSTEMS

- Stop-and-Go (Semi-kinematic)
 - Similar to kinematic except rover stops at a point and then goes on to other
 - Rover integer ambiguities need to be found
 - Must maintain lock
- Pseudo-Kinematic
 - Rover occupies unknown point for a few minutes twice, at least an hour apart
 - Does not need to maintain lock

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HYBRID POSITIONING SYSTEMS

- Rapid Static (Fast Static)
 - Static positioning requiring only minutes of observations
 - Relies on successfully resolving integer ambiguities over very short time period

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HARN

- High Accuracy Reference Networks
 - State-by-State supernetworks comprised of GPS observations
 - Extremely accurate, vehicle-accessible, regularly spaced control points with good overhead visibility

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CORS

- Continuously Operating Reference Stations
 - Store GPS observations 24 hours a day
 - Data made available at no cost for on-line downloading

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SOURCES OF DGPS ERROR

- Errors common to base & rover can be reduced, errors not common cannot
- Orbital errors can be corrected if distance between base and rover is less than 100 km
- S/A can be removed
- Most errors due to ionospheric & tropospheric delay can be removed

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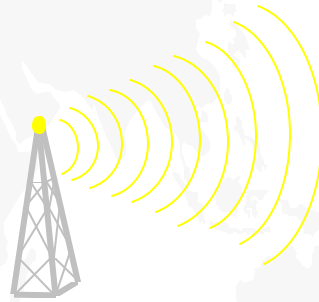
COMMERCIAL DIFFERENTIAL GPS PROVIDERS

- Racal LandStar
 - Utilizes wide area differential GPS network
- OmniStar
 - Uses wide area differential GPS system
- Accqpoint
 - FM based differential GPS connected through local FM stations
- DCI
 - FM based corrections through local FM stations

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REAL-TIME KINEMATIC

- Form of Differential GPS
- -2 cm + 2 ppm, with 1 ppm equating to 1 mm per 1 km



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AIRBORNE GPS

- GPS in photogrammetric aircraft used during photography
- Reduces the amount of ground control necessary for aerial triangulation
- Increases accuracy
- With inertial system -- no ground control needed

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