**Topic**

- ☐ Scans
  - ☐ Hieght's page 32 (2.8)
  - ☐ Multipath interference 280 (6.8)
- ☐ Availability
  - ☐ figure 337 (7.10)
  - ☐ 339 (7.13)
  - ☐ 340 (7.14)
  - ☐ 341 (7.15)
- ☐ 383 (8.2)
- ☐ 494 (9.21)
- ☐ 495 (9.22)
- ☐ 525 (9.35)

- ☐ Up to speed
  - ☐ latitude and longitude
  - ☐ Geoid
    - ☐ Oblate Spheroid
      - ☐ draw shape
    - ☐ Datum
      - ☐ WGS 84
        - ☐ 6378km
      - ☐ Different datums will give rise to different lat/long, heights
  - ☐ Four heights
    - ☐ Ellipsoid
    - ☐ Geoid (sea-level)
      - ☐ feature of the earth
      - ☐ In the U.S. the Geoid is below the Ellipsoid
    - ☐ Topography
    - ☐ User (height to ellipsoid)
- ☐ GPS is beacon-based
  - ☐ intersecting spheres
  - ☐ TOA concept
    - ☐ GPS gives time, position, velocity
    - ☐ velocity may be integrated or based on doppler shift
  - ☐ timing error adjustment
    - ☐ System Time
    - ☐ Satellite Time
    - ☐ Receiver Time
  - ☐ 3-D fix requires 4 satellites or assumptions
  - ☐ Satellite provides two types of data
Topic

- □ Ephemeris data
  - □ Where is the satellite, what is its path
  - □ ranging data
- □ Question:
  - □ What is a single-frequency SPS GPS User?
- □ Augmentations
  - □ Ground-based and Space-based
  - □ Differential Systems or Sensor-based Systems
  - □ Differential Systems
    - □ Concept: Reference station
  - □ Additional Information
    - □ Corrections to range measurements
    - □ Corrections to satellite clock or position data
    - □ Raw reference stations measurements
    - □ Integrity data (use, don't use)
    - □ auxiliary data about the reference station
- □ How does that additional information arrive
  - □ broadcast radio
  - □ dedicate wire
  - □ Internet
  - □ Satellite feed
  - □ Maybe not real-time
- □ Absolute or Relative
  - □ Absolute
    - □ Flight Path of an airplane at airport
    - □ Ship entering a harbor
  - □ Relative
    - □ Plane landing on a carrier
- □ code-based vs carrier based
- □ local, regional, or wide-area
- □ Draw Local DGPS concept
- □ Sources of error
  - □ correlated in time and space?
  - □ satellite clock error
    - □ same for all satellite observers
  - □ ephemeris errors
    - □ Show scan
    - □ ephemeris error of 5m, user-reference separation of 100km, correction error of 2.5 cm
Augmentations

Differential Systems

Sources of error
- Ephemeris errors
  - Ephemeris error of 5m, user-reference separation of 100km, correction error of 2.5 cm
- Tropospheric effects
  - Environmental effects
    - Basically path based
- Weather front -> 40 cm error

Ionospheric effects
- Angle of path

Code based techniques
- Local Area DGPS
  - First obvious idea - transmit different positions
    - Problems
      - Satellite combos
      - Algorithmic differences
    - Second idea - transmit different ranges
- Regional Area DGPS
  - Multiple reference stations
  - Calculate positions
  - Weight based on range.
- Wide-Area DGPS
  - Broadcast separate estimates of error components
  - Lots of ground stations combining information centrally then broadcasting analysis
- Space-based systems
  - WAAS (!)
  - EGNOS
  - MSAS (Southeast Asia)
  - GAGAN (India)
- Precise Point Positioning (beyond WADGPS) (< 10 cm accuracy)
  - These systems don't use any of the position or clock information from the satellite
    - Get that info from separate feed
    - Satellite antenna lever arm
    - Phase wind-up
    - Solid tides
- Dual-frequency receiver
- Starfire
- CORS
  - Offline corrections
- Carrier based techniques
Topic

- Changes in doppler shift of carrier wave
- Sensor augmentation
  - Kalman filter
  - Dead Reckoning
  - Deals with Signal loss
  - Dynamic environment between updates
  - Two scans
- Mobile systems
  - Mobile-assist
  - Mobile-based
  - Show scan