Garmin GNS 430W Workshop

VFR & IFR Operations

Presentation Outline

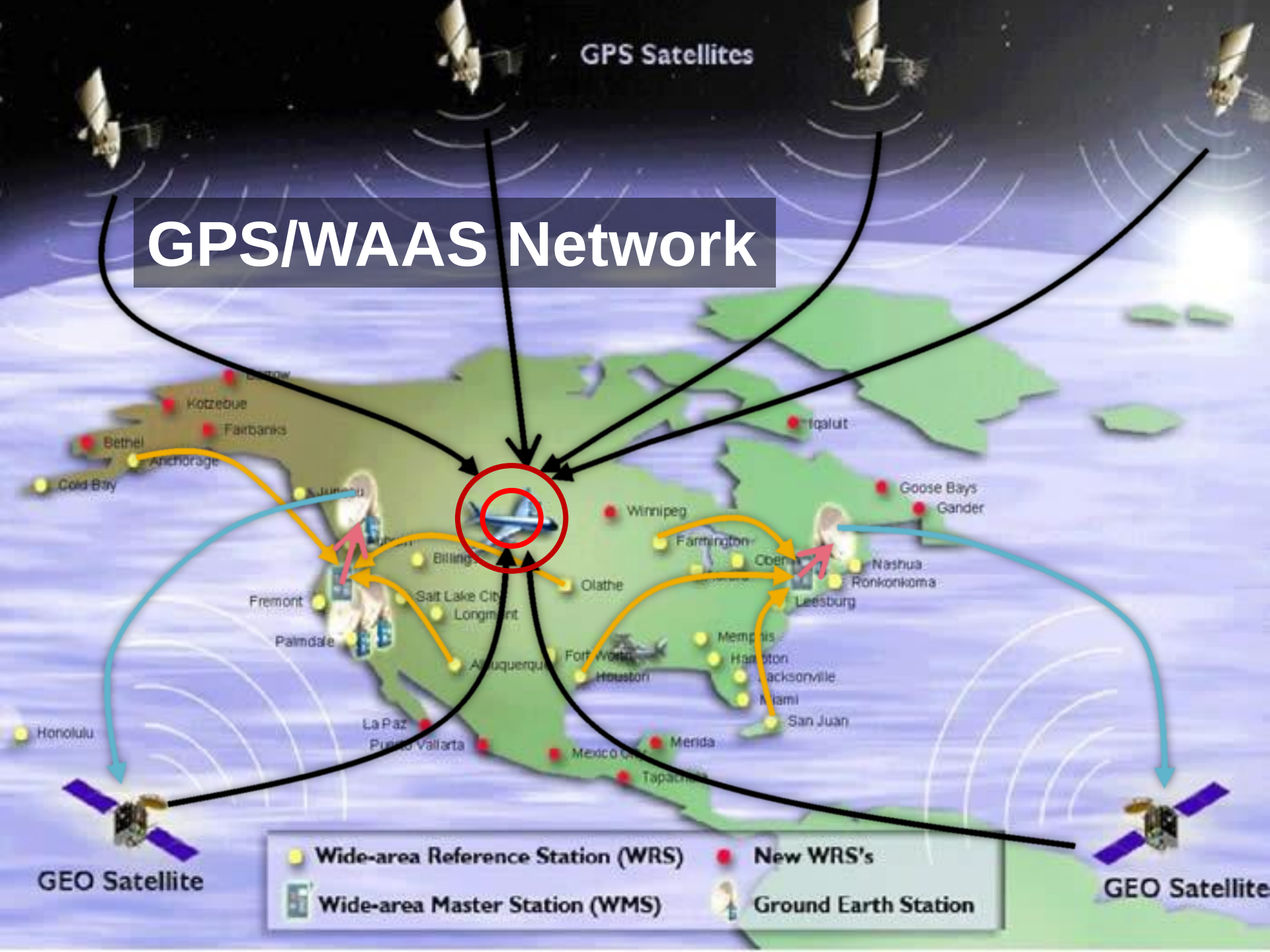
- General GPS/WAAS Concepts
  - GPS/WAAS Overview
  - GPS Navigation Concepts
  - GPS vs VLOC Navigation
- Basic 430W Operations
  - GNS 430 Overview
    - Start-Up Screens
    - "Knobology"
    - Entering Data
  - Terrain Awareness
  - Traffic & Weather Pages
  - Useful Features & Tips
    - Scheduler / Flight Timer
    - Winds Aloft
    - Vertical Navigation
  - GPS Do's and Don'ts
- Garmin PC Simulator
- Break
- IFR Operations
  - Are you IFR legal?
    - Database Updates
  - Flight Plans
    - Intercepting Airways
    - SIDs and STARs
    - Approaches
  - Amended Flight Plans
  - Intro to GPS Approaches
  - GPS Approach Modes
  - Example Flights
    - KDXR -> KGON (GON ILS Rwy 5)
    - OXC RNAV (GPS) Rwy 18
    - MMK GPS Rwy 36
  - IFR Do's and Don'ts
  - Review

GPS/WAAS Overview

A Brief Review

GPS and WAAS Overview

- Global Positioning System (GPS)
  - Satellite-based navigation
    - 24 satellites orbiting 12,000 miles above the earth's surface
    - Satellites orbit twice a day in a precisely-known orbit
  - Full constellation became operational in 1994
  - Receivers use time-based triangulation to calculate the user's location
    - Accurate within 15 meters (~50 feet)
- Wide Area Augmentation System (WAAS)
  - Corrects for GPS signal errors
    - Consists of a network of ground reference stations at precisely-surveyed locations
    - A master station generates a correction signal and transmits it to one of two geostationary satellites
  - Available in the entire Continental US and parts of Canada and Mexico
  - Improved position accuracies
    - 1 meter (~3 feet) horizontal
    - 2 meters (~6 feet) vertical

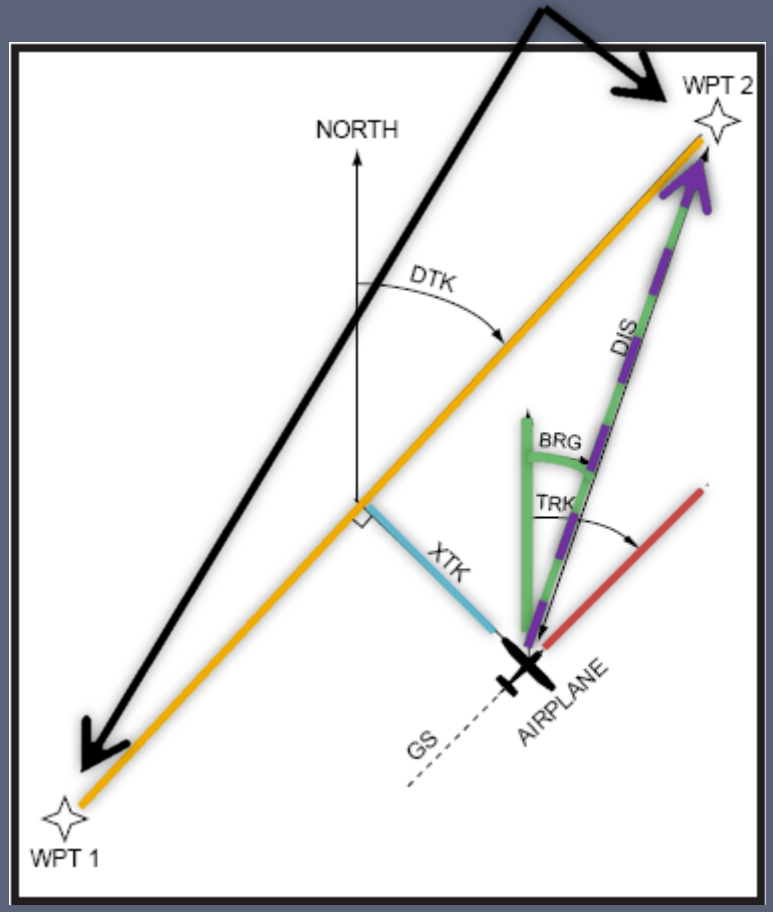

GPS Satellites
GPS/WAAS Network
Kotzebue
Fairbanks
Bethel
Anchorage
Cold Bay
Juneau
Billings
Salt Lake City
Fremont
Palmdale
Albuquerque
Olathe
Winnipeg
Farmington
Oberlin
Goose Bays
Gander
Nashua
Ronkonkoma
Leesburg
Memphis
Hampton
Jacksonville
Miami
San Juan
Houston
Merida
La Paz
Puerto Vallarta
Tapachula
Honolulu
GEO Satellite
GEO Satellite
Wide-area Reference Station (WRS)
New WRS's
Wide-area Master Station (WMS)
Ground Earth Station

GPS Navigation Concepts

GPS Navigation Concepts

A course is always defined by two waypoints!

DTK	Desired Track
TRK	Track
BRG	Bearing
CTS	Course To Steer
XTK	Cross-Track
DIS	Distance (nm)
GS	Groundspeed (kts)



What is RAIM?

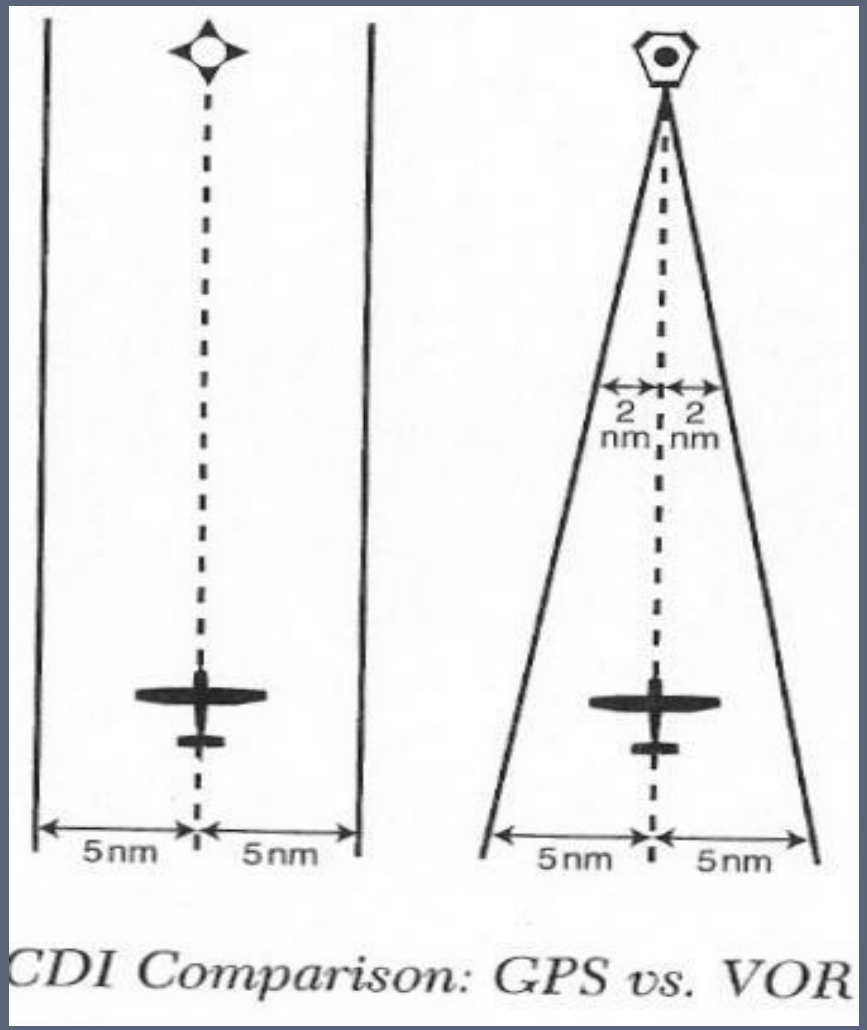
- Receiver Autonomous Integrity Monitoring
  - The "Off" flag – Primary means of ensuring receiver integrity
  - Needs a minimum of 5 satellites in view
    - 6 for FDE (WAAS)
  - Required for IFR operations
    - Handheld GPSes do not normally have RAIM
  - Must be available at the FAF to fly a GPS approach
- "RAIM Prediction" alerts you to RAIM error at destination *before* you fly

RAIM Prediction is required for any IFR flight that uses RNAV procedures

- RAIM not available in flight
  - Enroute/Terminal – Revert to VOR, or cross-check every 15 minutes
  - Prior to FAF – Fly to MAP and execute the Missed Approach procedure
  - After FAF – Expect 5 minutes of GPS guidance
- "INTEG" annunciation
  - Abort approach and execute the Missed Approach procedure

GPS Accuracy vs. VOR

- CDI Comparison
  - GPS: Fixed-width accuracy*
  - VOR: Accuracy varies with distance
    - Becomes more sensitive as you get closer
    - "Cone of confusion"
- GNS 430 – "Resolver-Type" Design
  - Resolver Course Indicator Coupled to CDI
  - OBS Course Selector Must Be Set To DTK



CDI Comparison: GPS vs. VOR

GNS 430 Key Functions

COM Power / Volume / Squelch

Frequency / Annuciator Windows

Map

Function / Data Fields

RANGE Zoom In/Out

Direct-To Navigation

COM Toggle / HOLD 121.5

Context-Sensitive MENU

VLOC Volume / Identification

CLEAR / Default NAV

VLOC Toggle

Enter / Confirm

LARGE KNOB MHz / SMALL KNOB KHz

LARGE KNOB Page Groups

PUSH Toggle COM/VLOC

SMALL KNOB Pages / PUSH Toggle Cursor

CDI - Toggle Nav Source GPS/VLOC

OBS Mode / Waypoint Sequencing

MSG – View System Messages

FPL – Flight Plan

PROC – IFR Procedures

Instrument Panel Self-Test

- Verify CDI / GS displacement is correct
  - CDI half left
  - G/S half up
  - To/From is TO
  - No flags
- Verify OBS course
  - Garmin "OBS" value and selected OBS course should match
    - Within 4 degrees (standard VOR accuracy check) is a good reference point for minimum accuracy

Default Nav Page

- The "home" page
- Press and hold CLR to load from any other page

Active leg of flight plan

Course deviation indicator (CDI)

TO/FROM flag*

Position of current page within current page group

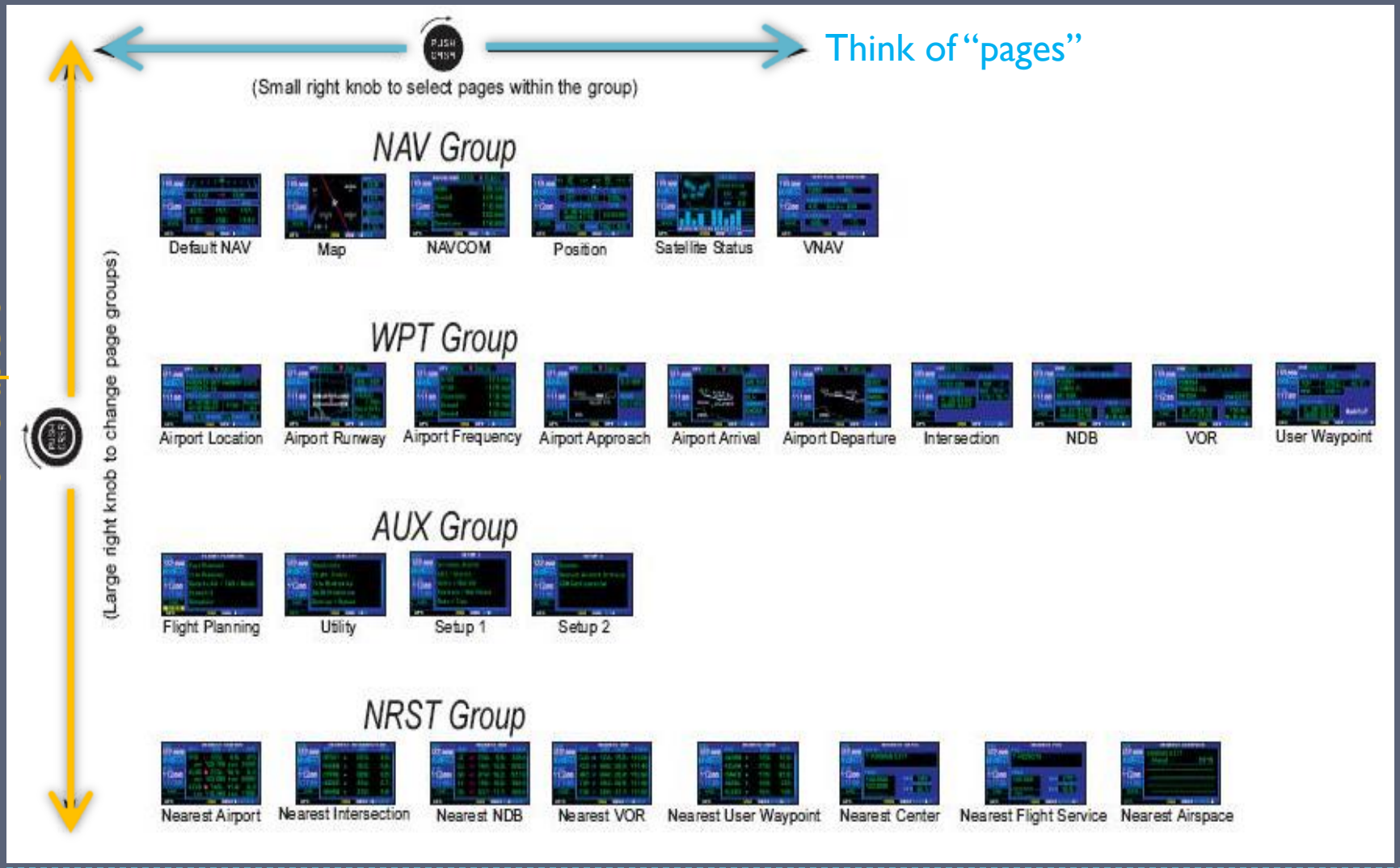
User-selectable data fields

Current page group ("chapter") name

Individual pages in current page group

* Always TO when in GPS mode

GNS 430/530 Page Navigation



GNS 430/530 Page Navigation

- NAV group
  - How do I get to my destination?
  - Are there any hazards on the way (traffic, terrain, weather)?
- WPT group
  - Where am I going, and what is available there?
  - The "AFD" section of the Garmin
- AUX group
  - Flight planning and E6B-like utilities
  - System setup
- NRST group
  - What is nearest to my current location?
  - "Big trouble, big knob"

Map Declutter

- Pressing the "CLR" button cycles through the four modes
  1. Removes all land data except rivers & lakes.
  2. Removes all airspace except Prohibited & Restricted. Also removes NDBs, Intersections, and User waypoints.
  3. Removes all data except the Active Flight Plan, Prohibited airspace, rivers, lakes, traffic, and lightning data.
- While inbound to the FAF, an additional "-A" declutter mode (equivalent to -3 above) is automatically activated

Entering Data

5 PRESS CLR key to cancel entry

1 PRESS once to activate cursor, PRESS again to deactivate

4 PRESS ENT key to confirm entry

3 TURN BIG KNOB to move cursor, or change fields (when cursor is off)

2 TURN SMALL KNOB to select characters

GNS 430/530 Data Fields

- **BRG** – Bearing To Waypoint
- **CTS** – Course To Steer
- **DIS** – Distance To Waypoint
- **DTK** – Desired Track
- **ESA** – En-route Safe Altitude
- **ETA** – Estimated Time of Arrival
- **ETE** – Estimated Time En-route
- **GS** – Groundspeed
- **MSA** – Minimum Safe Altitude
- **TKE** – Track Angle Error
- **VSR** – Vertical Speed Required
- **WPT** – Active Waypoint
- **XTK** – Cross-Track Error

Terrain Awareness

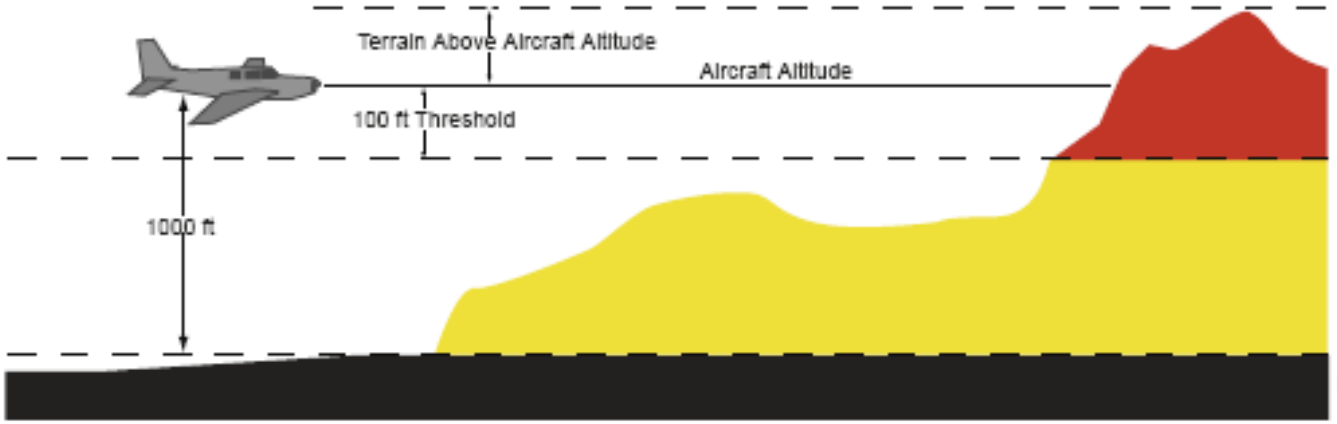
Terrain Awareness

- Portrays a 2D picture of the surrounding terrain and obstacles relative to the position and altitude of the aircraft
- Non-TSO-C151b terrain awareness system
  - *Advisory-only*
- Separate terrain database updates
  - Obstacle and terrain databases are on the same card, but updated at different intervals
- Based off of GPS altitude, converted to MSL

Terrain Awareness Criteria

Obstacle Symbol	Unlighted Obstacle		Lighted Obstacle		Color	TERRAIN/Obstacle Location
	< 1000' AGL	> 1000' AGL	< 1000' AGL	> 1000' AGL		
					Red	Terrain/Obstacle above or within 100 ft below current aircraft altitude
					Yellow	Terrain/Obstacle between 100 ft and 1000 ft below the aircraft altitude
					Black	TERRAIN/Obstacle is more than 1000 ft below the aircraft altitude

Terrain Color Symbology



TERRAIN Altitude/Color Correlation

Terrain Awareness Alerts

Premature Descent Alert

Forward Looking Terrain Avoidance

On-Screen Caution

Flashing Alert = Immediate Evasive Action Required!

Terrain Modes

360-view

120-view

Terrain Inhibit Notification

Traffic & Weather Pages

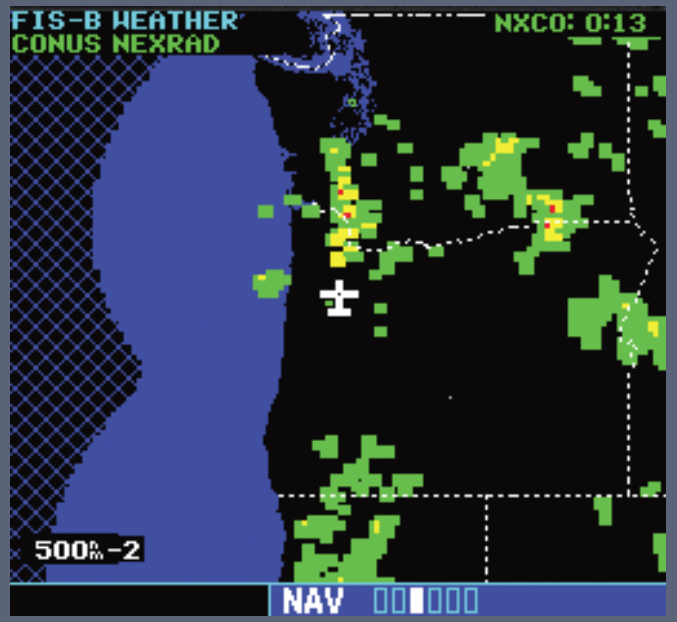
Traffic Page

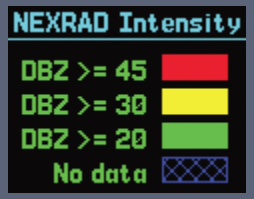
- From the "NAV" group (chapter), use the right little knob to select the dedicated traffic page
- Displays the 8 nearest targets within a specified filter range
- Traffic data can also optionally be shown on the moving map page

- Traffic Advisory (TA) – Traffic may pose a collision threat.
- Proximity Advisory (PA) – Traffic Is within 6nm and +/- 1,200'
- Other detected traffic

Weather Page

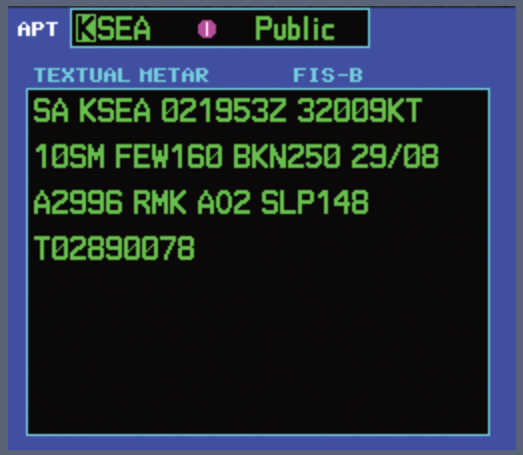
- From the "NAV" group (chapter), use the right little knob to select the dedicated weather page
- Displays NEXRAD radar and graphical METARs
- Weather data can also optionally be shown on the moving map page





Textual Weather Pages

- From the "WPT" ("AFD") group, use the right little knob to select either the METAR or TAF page (if available)
- If there is more text than will fit on the screen, press the **small right knob** to activate the cursor and turn the **large right knob** to scroll the page



Useful Features & Tips

“Nearest” Pages

- Provides
  - Airports
  - Waypoints
    - Intersections
    - NDBs
    - VORs
    - User Waypoints
  - Airspace & Services
    - ARTCC
    - FSS
    - Airspace
- Can load information about each waypoint/airspace

Scheduler & Flight Timers

Scheduler

Flight Timer

Computing Winds Aloft

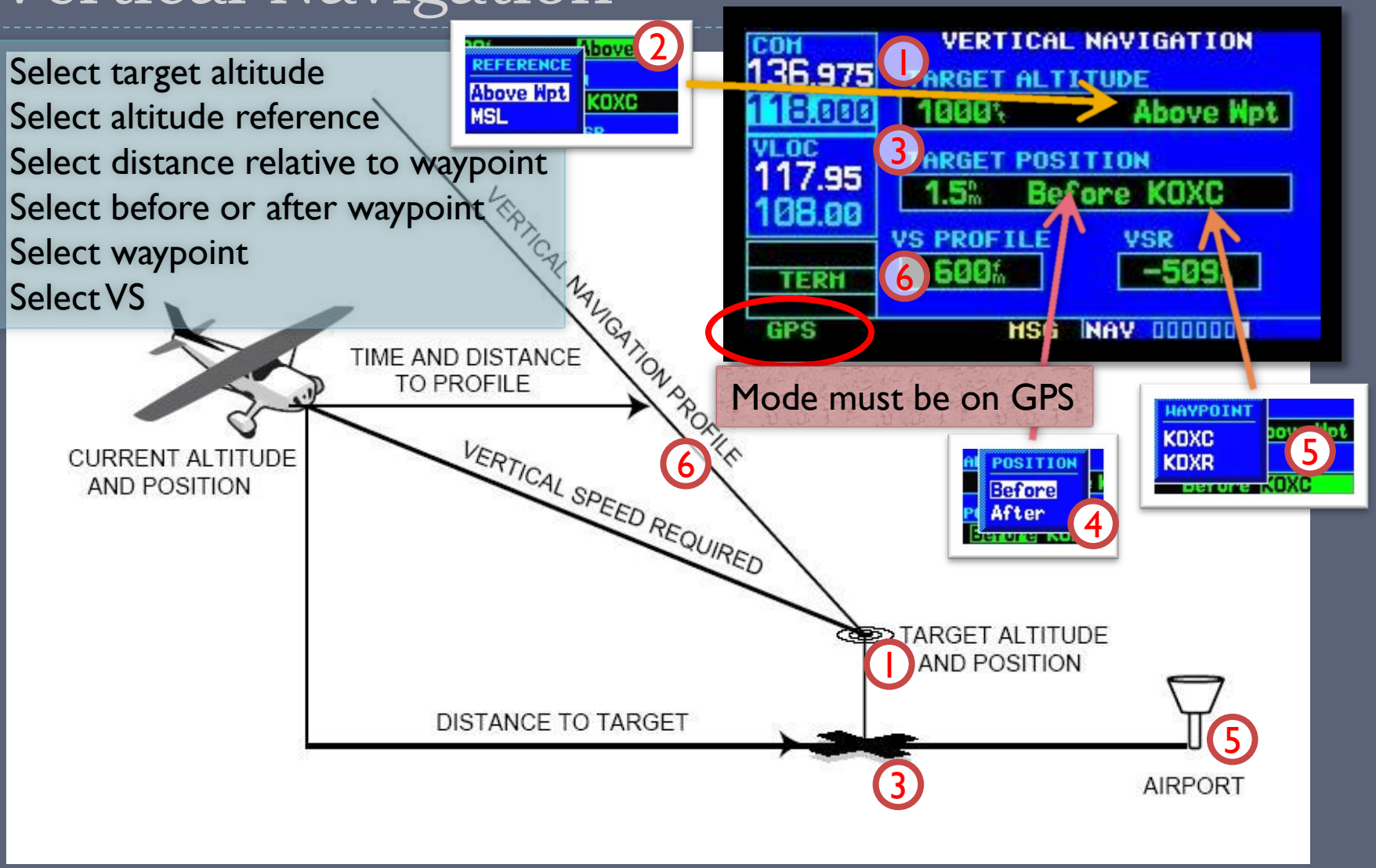
- Great tool to use when submitting a PIREP
- "Ind Alt" will initially show your GPS altitude
  - Will likely need fine tuning, but not by much
- "CAS" will initially show your GPS ground speed
- "BARO" will show the last entered value
- "HDG" will show your GPS ground track heading
  - This should be set to your magnetic heading

Map Orientation

- Three modes of map orientation
  - DTK up
    - Desired track (course) is straight up
  - **North up**
    - Orientation of paper charts
  - **Track up**
    - Current heading is straight up
- From the "NAV" page, press MENU, select the "Map" group, then "ORIEN"

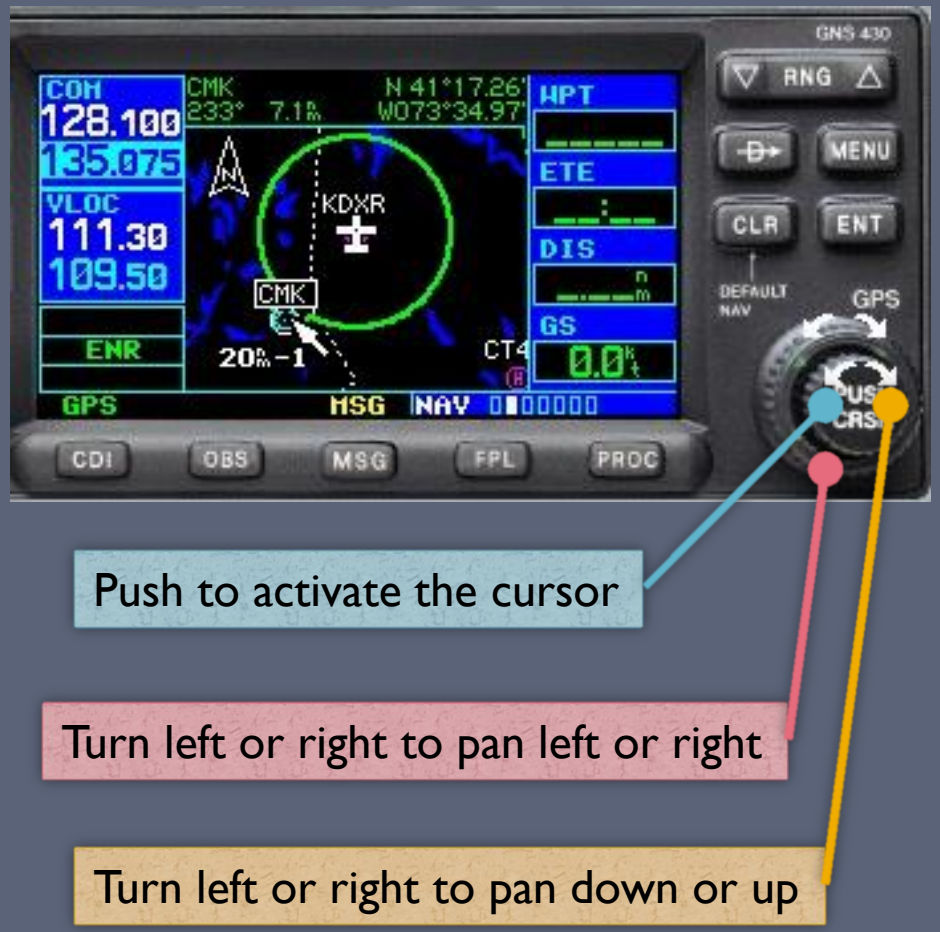
Vertical Navigation

1) Select target altitude
2) Select altitude reference
3) Select distance relative to waypoint
4) Select before or after waypoint
5) Select waypoint
6) Select VS



Map Cursor

- Can be used to move the map beyond its current limits without adjusting the zoom level
- Can also be used to select a point on the map to get bearing and distance information, as well as the name of the selected point
  - Press Direct-To to navigate direct to a highlighted point
  - Press ENT to load more information on the point

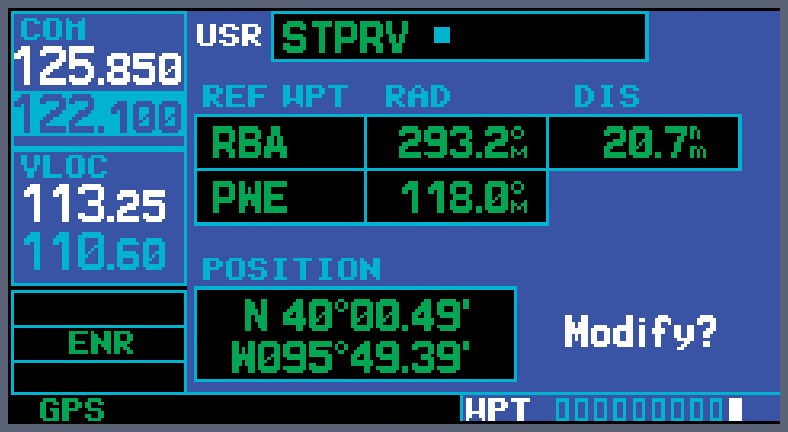


User-Defined Waypoints

- Up to 1000 user-defined waypoints can be stored
- Can be created from the User Waypoint page or from the Map page
- User waypoints are referenced by name only

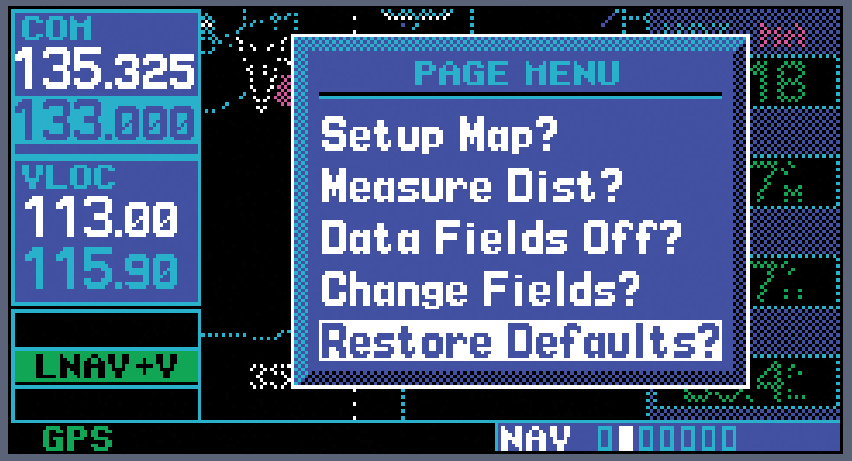
- ***Do not create a user waypoint with the same name as a real waypoint!***

- User waypoints are best used for ground references (houses, etc) or common reporting points (e.g. "the prison" at KDXR)



Restoring Default Settings

- Resetting the four user-selectable data fields
  - Press the MENU button, use the big knob on the right to select "Restore Defaults?", and press ENT



- Resetting AUX page settings
  - From the setting page to reset, press the MENU button and press ENT

Garmin PC Simulator

VFR GPS Demonstrations

1. Start-up screen: Database currency
2. Start-up screen: CDI check
3. Big knob: Page groups
4. Small knob: Individual pages
5. Changing data fields on the map page
6. Map setup
7. Terrain awareness
8. Looking up waypoint/airport information
    - Entering data
9. "Nearest" demonstration
10. Scheduler and flight timers
11. Computing winds aloft
12. Vertical navigation

GPS Do's and Don'ts

DO

- Develop skills in stages
- Practice with PC simulators
- Program *on the ground*
- Delegate GPS operations to copilot
- Fly the airplane first!

DON'T

- Exceed VFR or personal minimums
- Focus inside the cockpit
- Rely solely on GPS map display for navigation
- Fiddle with it while close to an airport or in a high workload situation
- Try new features for the first time in the air

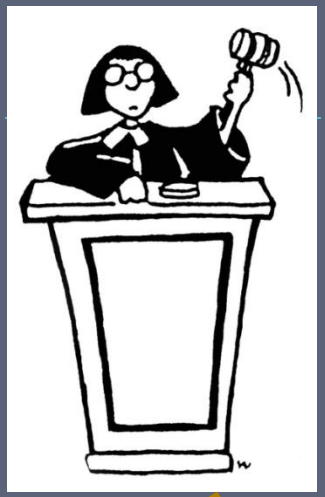
GPS is Not a Substitute for Sound ADM!!
"Proper Prior Planning Prevents Poor Performance!"

Wake Up – It's Quiz Time!

What is the difference between HDG and TRK?	*HDG is the magnetic heading the aircraft is pointed, while TRK is the aircraft's ground track.*
What is the CDI key used for?	*To toggle between navigation sources (GPS or VLOC) output to an external HSI or CDI.*
What is the OBS key used for?	*It allows the pilot to select a desired course to/from a waypoint (entering the traffic pattern, or holds).*
How do you cancel a Direct-To course?	*Direct-To, Menu, "Cancel Direct-To NAV?", Enter.*
How do you display the default nav page from any screen?	*Press and hold the "CLR" button.*
How do you active the cursor?	*Press the right small knob.*

IFR GPS Operations

Are You IFR Legal?



- IFR-Certified GPS Unit
  - Garmin 430/530
    - TSO C-129a Certified for IFR Enroute and Approach
  - Garmin 430W/530W
    - WAAS TSO C-146a Certified for *sole source of navigation*
- IFR-Certified Installation
  - Installation must also be certified! (AC20-138)
  - AFM Supplement must be in the aircraft
  - Database current (Updated every 28 days)?*
- IFR Usage
  - May be used in lieu of ADF and DME*
  - Review GPS/WAAS NOTAMs and "All available information" – FAR 91.103

- ~~Alternate means of navigation required – FAR 91.205~~
- ~~A non-GPS approach must be available at alternate airport (or VFR)~~
- No longer required with WAAS (TSO C-146a)

- File /G – IFR RNAV-Capable Aircraft
  - ICAO: B2 (RNAV 5 GNSS), C2 (RNAV 2 GNSS), D2 (RNAV 1 GNSS)

* = More details provided on a later slide

When Your Database is Not Current

- VFR
  - No legal requirements to have a current database
- IFR
  - Legal for en-route and terminal navigation
    - Each waypoint must be verified with an alternate source of *current* data (e.g. paper chart, electronic chart)
  - Per the Garmin 430W STC, "GPS", "or GPS", and "RNAV (GPS)" approaches are *not* allowed
    - Example: Danbury's "GPS RWY 08" approach is not allowed, but the "VOR or GPS-A" approach is allowed *if flown using VOR guidance*.
    - Danbury's "LOC RWY 08" is also allowed

Flight Plans

- Dedicated button 

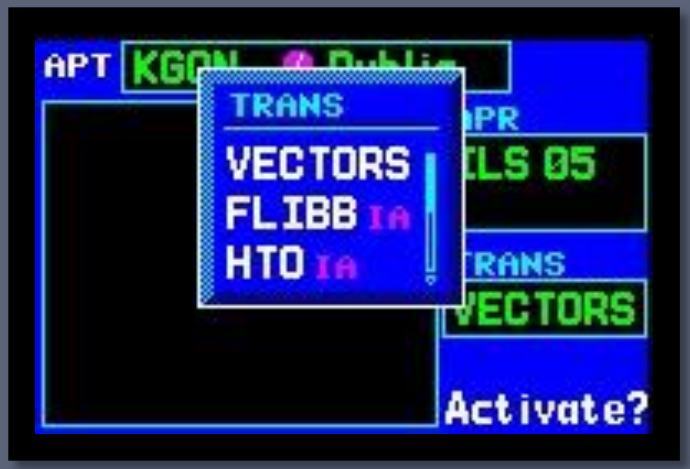
- Up to 20 stored flight plans
  - Up to 31 waypoints per flight plan
  - Custom names of up to 18 alpha/numeric characters
- Must manually enter each waypoint along a Victor airway

Activating a Leg

- Two ways to activate a leg
  - Using Direct-To
    1. Select the first waypoint along the leg
    2. Direct-Direct
    3. Enter
  - Using Menu
    1. Select the first waypoint along the leg
    2. Menu, highlight "Activate Leg?" (should be highlighted by default), Enter
    3. Enter

Loading an Approach

1. "PROC" button
2. "Select Approach?"
3. Select the desired approach
4. Select the desired transition
    1. "Vectors" draws a reference line to the FAF
5. "Load" vs "Activate"
    - "Load" adds the approach waypoints to the flight plan, but doesn't activate it.
    - "Activate" also loads the waypoints, but then provides Direct-To for the initial fix



Flight Plans with Multiple Destinations

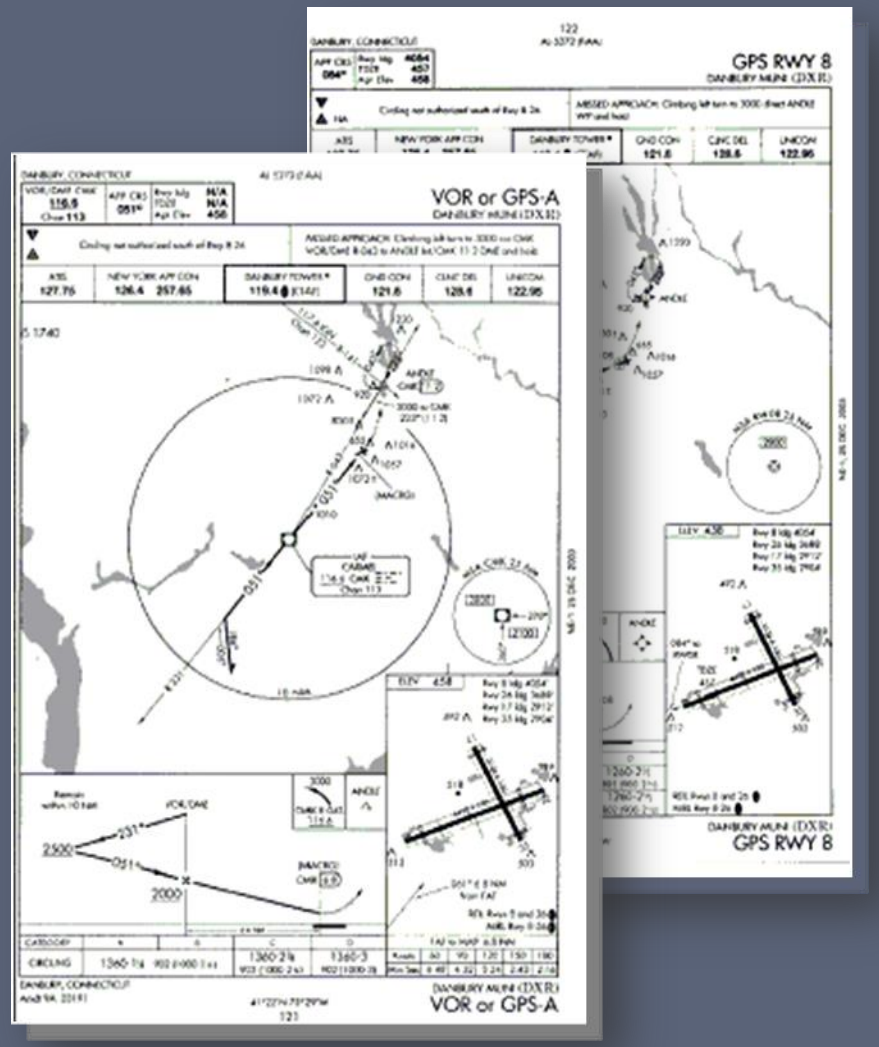
- Switching approaches
  1. Press "PROC", select "Select Approach?", "ENT"
  2. Press "MENU", "MENU"
  3. Scroll to "Select Next FPL Apt?" and press "ENT"
- Reasons
  - Easily load an approach for the departure or alternate airport
  - Simplify IFR training / proficiency

Loading SIDs and STARs

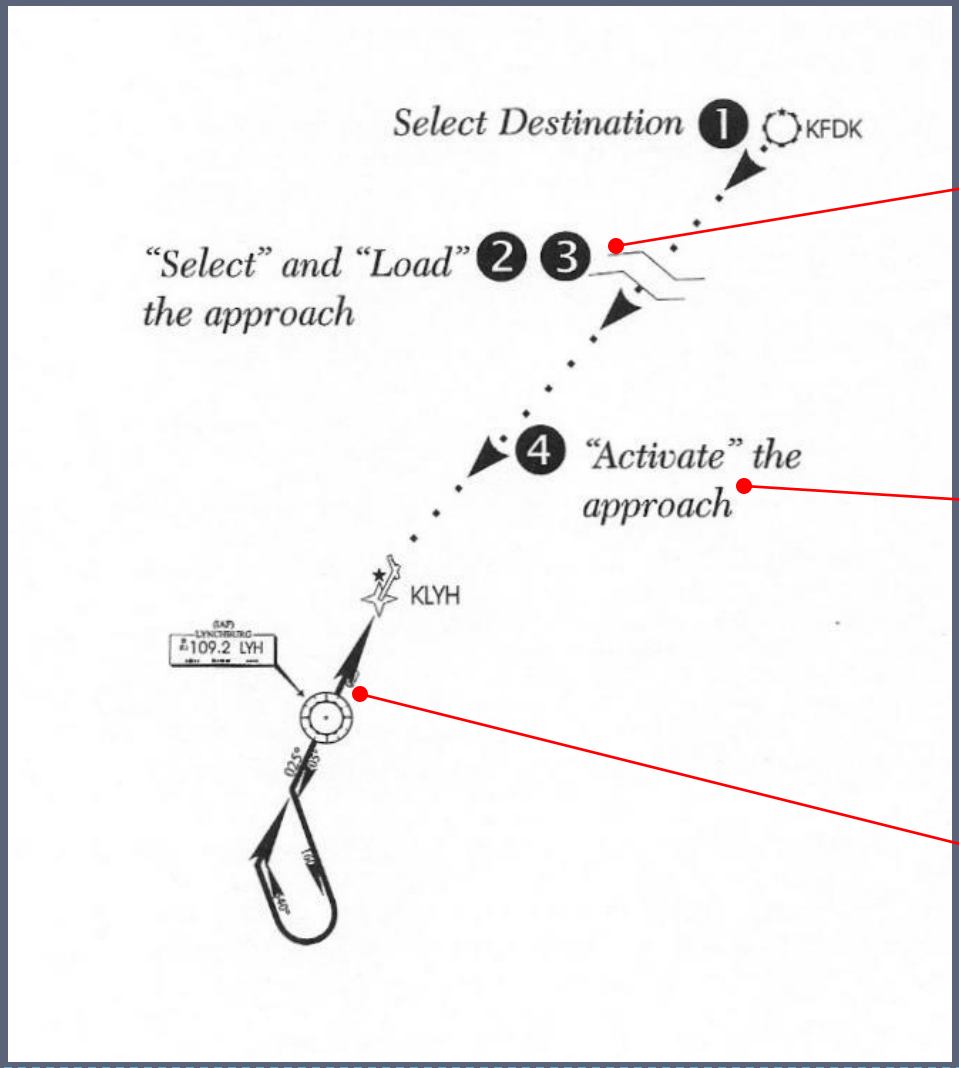
- Similar method to loading an approach
  1. "PROC" button
  2. "Select Departure?" / "Select Approach?"
  3. Select the desired departure / approach
  4. Select the desired departure runway / transition
  5. "Load"

Intro to GPS Approaches

- 1st Generation – Non-precision VOR/NDB overlay approaches (RNAV)
- 2nd Generation – Stand-alone non-precision GPS approaches (RNAV)
- 3rd Generation – WAAS approach with vertical guidance



GPS Approach Modes



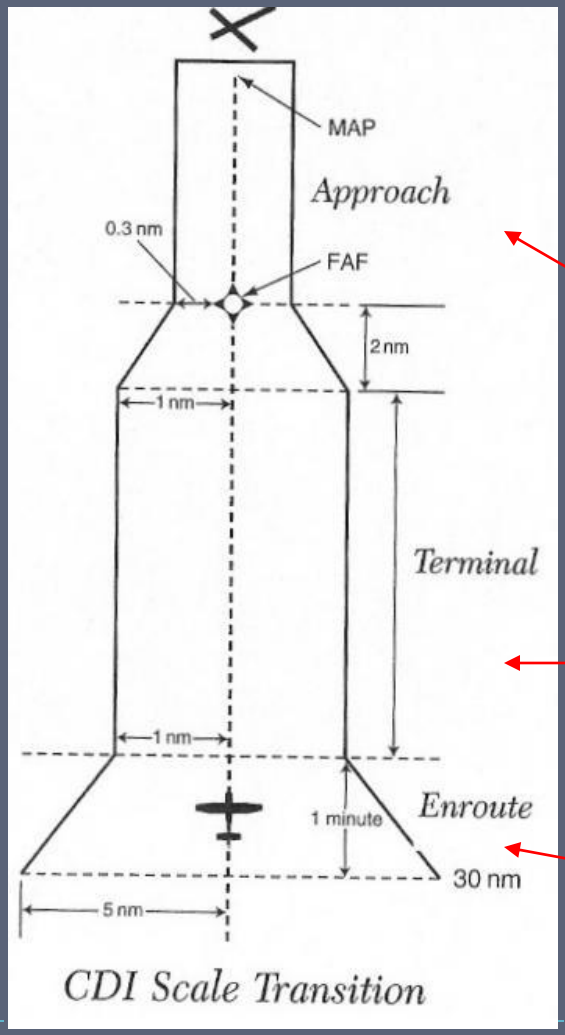
ENROUTE

TERMINAL

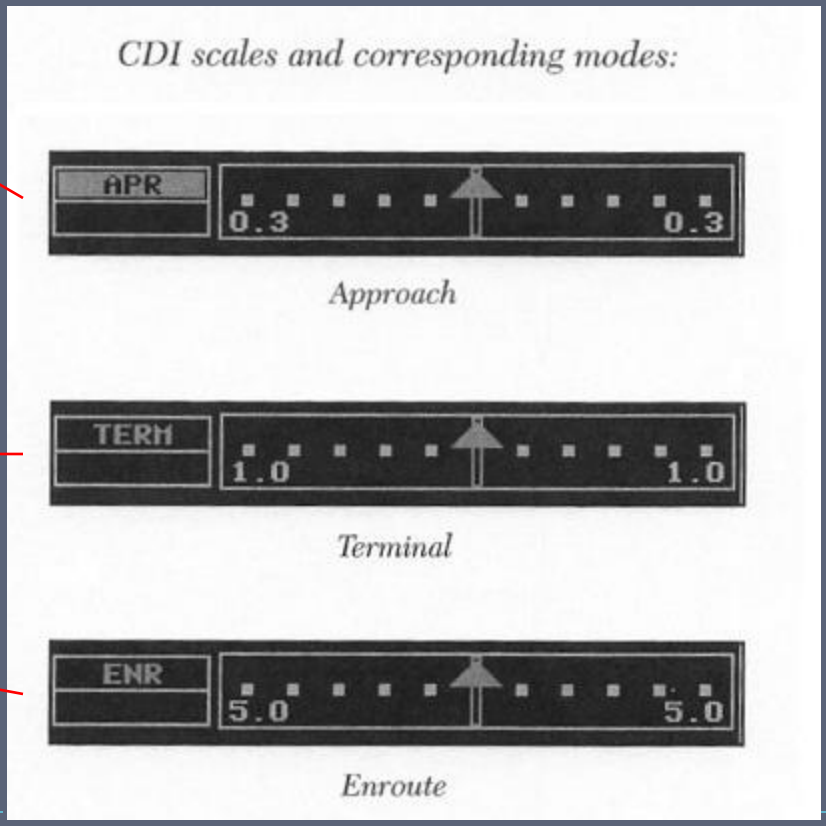
APPROACH

CDI Scale Transitions

During the transition phases, the CDI may give the impression that you are off course, even though you may be on a perfectly good intercept angle.



CDI Scale Transition



430W GPS Approach Mode Summary

Annunciation	Approach	Description
LPV	LPV	Localizer Performance with Vertical guidance
~~**L/VNAV**~~	~~LNAV/VNAV~~	~~Lateral navigation with baro-aided Vertical Navigation.~~ *Not used by GA.*
LNAV+V	LNAV	Non-precision Lateral Navigation with *advisory* vertical guidance
LP	LP	Non-precision Localizer Performance – allows for lower minimums than LNAV
LNAV	LNAV	Non-precision Lateral Navigation

Additional 430W GPS Modes

Annunciation	Approach	Description
MAPR		Missed Approach CDI full scale deflection = 0.3 NM
ENR		En-route navigation CDI full scale deflection = 5.0 NM
TERM		Terminal area navigation CDI full scale deflection = 1.0 NM

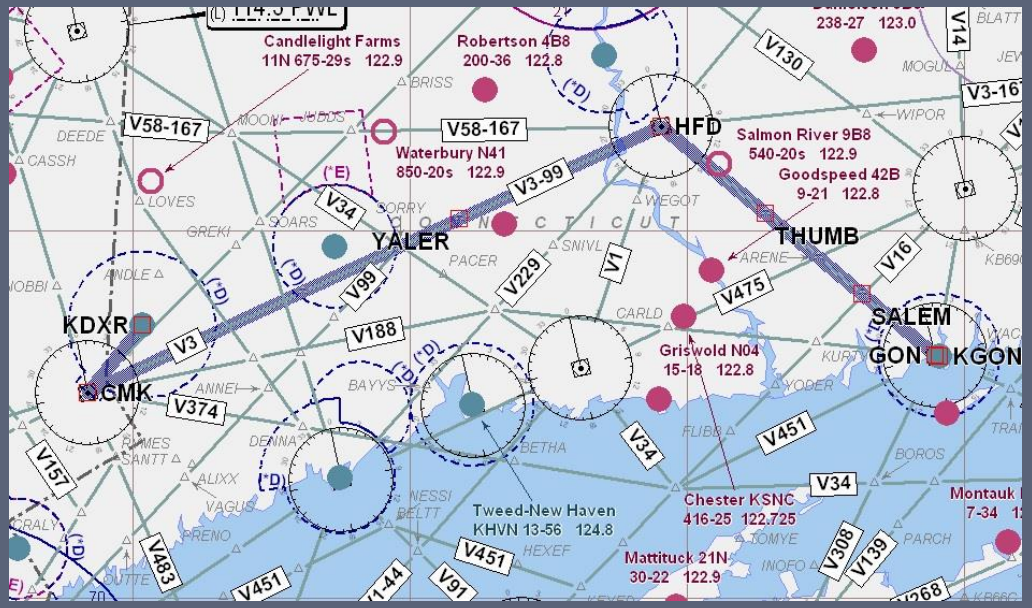
GPS Substitutions

- AC90-108 – Operational & Airworthiness Guidance
  - Suitable RNAV system as an alternate means of navigation

- Allowed substitutions
  - *Determine aircraft position* relative to/distance from a VOR, TACAN, NDB, compass locator, DME fix, fix defined by a VOR radial/TACAN course/NDB bearing/compass locator bearing intersecting a VOR or LOC course
  - *Navigate to/from* a VOR, TACAN, NDB, or compass locator
  - *Hold* over a VOR, TACAN, NDB, compass locator, or DME fix
  - *Fly an arc* based upon DME
  - All of the above is allowed even when a facility is identified as required on a procedure (e.g. "ADF required")
- **Non-allowed substitutions**
  - When a procedure is NOTAMed as "not authorized" ("NA")
    - Example: A procedure is based upon a recently decommissioned NAVAID
  - Substitution on a Final Approach Segment
  - Lateral Navigation on LOC-Based Courses

IFR GPS Demonstrations

1. Flight plans
    1. Creation
    2. Saving
    3. Loading
2. Activating a leg
3. Loading and activating an approach
4. Loading a SID and STAR
    - KJFK.JFK1.RW04L, VCN8.BRIGS.KPHL



KDXR CMK V3 HFD V58 GON KGON

IFR Do's and Don'ts

DO

- Practice in VFR with a safety pilot before using in actual IFR conditions
- Set higher personal minimums until comfortable with its use
- Check GPS/VLOC CDI indicator often
- Check and ID the active VLOC frequency for ILS/LOC
- Always set OBS (and heading bug) to DTK
- Pay attention to suspended waypoint sequencing and active waypoint

DON'T

- Don't rely solely on one nav source
  - DO "shadow" GPS with other systems
- Program during high workload situations
- Forget to check for RAIM INTEG and sequencing to appropriate approach mode prior to FAF

Wake Up – It's Quiz Time!

Is a non-GPS approach required for an alternate when using the GNS430W?

No longer required with TSO 146a certified GPS/WAAS (sole source navigation)

The alternate has an LPV approach – what alternate minimums apply?

Non-precision approach minimums (800-2) apply unless otherwise stated

What are some common Mistakes when setting up for an ILS?

Failure to Set CDI VLOC Mode, Switch and IDENT VLOC Freq

True or False: INTEG indication in flight = OK to proceed to destination via IFR

True – Monitor VOR Enroute. Destination Must Have Non-GPS Approach

What is the difference between charted and GPS distance?

Charted distance is DME slant-range distance, GPS is great-circle ground distance

More Information

- Garmin Website – http://www.garmin.com
  - GNS 430 manual
  - GNS 430 PC Simulator
    - http://tinyurl.com/kytjvqe
  - Training Syllabus
- Avweb – http://www.avweb.com
- YouTube (IFR Magazine, Garmin)
  - http://www.youtube.com/watch?v=zofn3skychQ
  - http://www.youtube.come/watch?v=d1P0RliayIQ
- AOPA Air Safety Foundation – http://www.aopa.org/asf
  - ASF Safety Advisor – GPS Technology

Special thanks to Brad Freeman for the original course material

Open Sky Aviation, LLC.
http://openskyaviation.biz
gbaluha@openskyaviation.biz

GPS Timeline

- 1995: GPS Selective Availability (SA)
  - 330 – 990 feet
- 2000: SA Turned Off
  - 100 – 330 feet
- 2003: Wide Area Augmentation System (WAAS) Enabled
  - < 23 feet
  - Provides Vertical Guidance
  - WAAS Approaches Slightly Higher Minimums than Cat I ILS

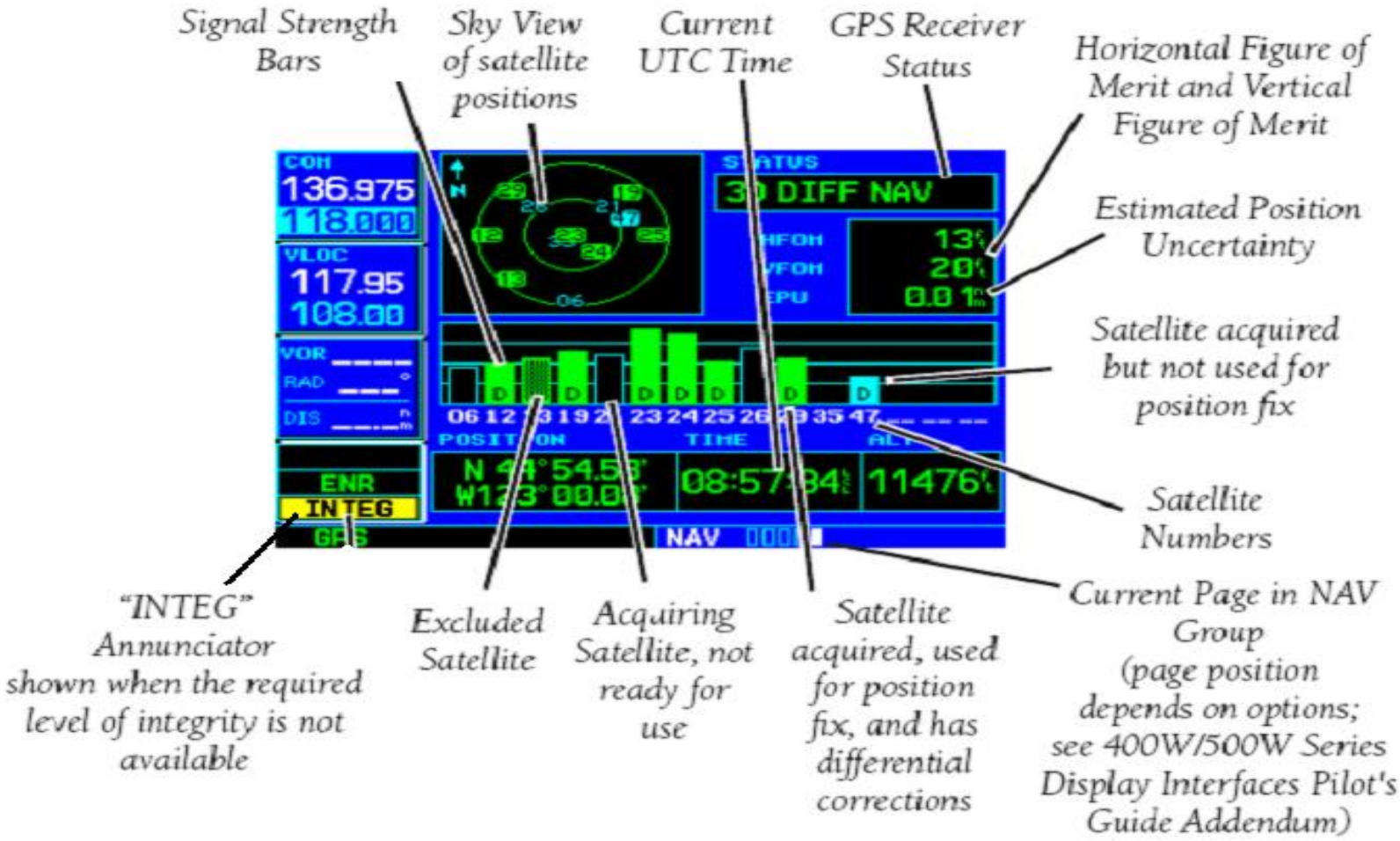
The Global Positioning System (GPS)

- Satellite-based navigation system
  - 24 satellites
  - 12,000 miles above the earth's surface
- Built by the U.S. Department of Defense
- The first GPS satellite was launched in 1978
  - Full constellation of 24 satellites was achieved in 1994
  - Replacements are constantly being built and launched
- GPS satellites orbit twice a day in a precisely-known orbit, and transmit this orbital position data (ephemeris) to the receiver
- GPS receivers take the transmitted information and use time-based triangulation to calculate the user's location
  - Accurate to within 15 meters

What is WAAS?

- Wide Area Augmentation System
  - Corrects for GPS signal errors caused by ionospheric disturbances and satellite orbit errors
- A network of ground reference stations at precisely-surveyed locations
  - Compare GPS distance measurements to known values
  - Each ground reference station is linked to a master station, which generates a correction signal and transmits it to one of two geostationary satellites
  - Correction signal is then broadcast to WAAS-capable receivers
- Covers entire USA (and some of Canada and Mexico)
- WAAS position accuracies
  - 1 meter horizontal
  - 2 meters vertical
  - Up to 5x better than standard GPS

Satellite Status Page



Basic Navigation

- Provides basic navigation information, derived from GPS data
  - GPS ground track
  - GPS ground speed
  - GPS altitude
- Compass tape (based on ground track) can be used to supplement the magnetic compass when making compass turns.