ADS-B and

WFP Operators

Safety Advantages Security Concerns

Thomas Anthony
Director
U.S.C. Aviation Safety and Security Program

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University of Southern California

ADS-B

- How can ADS-B be useful for Humanitarian Air Operation? Are there security concerns?
- Evolution of ADS-B
- Begin with RADAR

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RADAR

Radio Direction and Range

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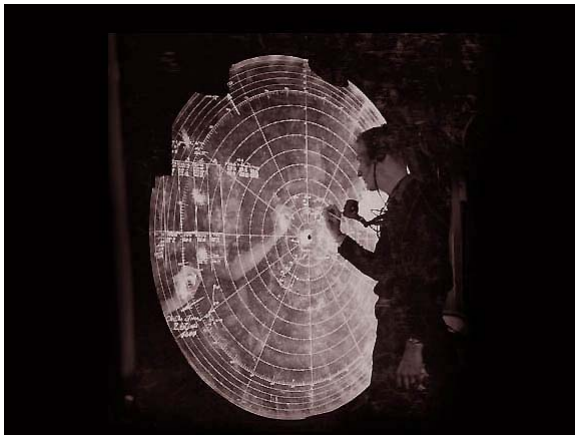

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IFF

- Identification Friend or Foe
- Predecessor to transponder
- Simple response signal when interrogated
- No response meant Foe
- Security innovation
- Led to safety feature
- Mode A identify individual aircraft

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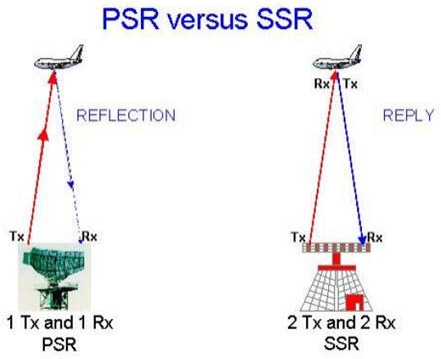
Primary Radar
Secondary Surveillance Radar



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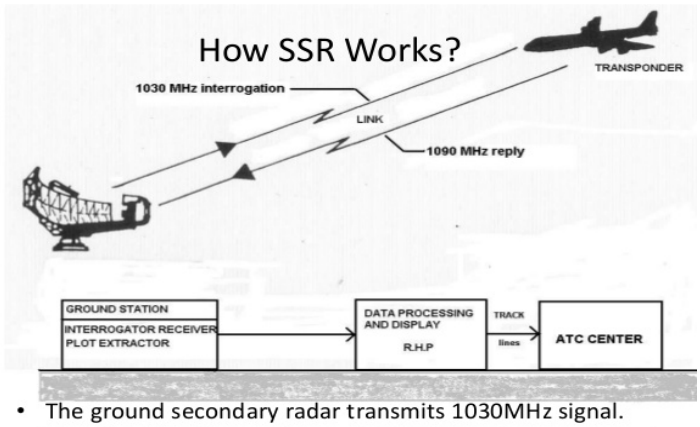

- The ground secondary radar transmits 1030MHz signal.
- The aircraft radar receives on 1030MHz and transmits back 0n 1090MHz.
- The transponder reply is more powerful than the reflected radar signal allowing for far greater range. (250nm).

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Transponder Mode A, Mode C

- Military IFF became civil transponders
- Mode A transponder squawk codes allow discrete aircraft identification
- Requires pilot to dial in the assigned transponder code
- Mode C – Aircraft altitude from altimeter

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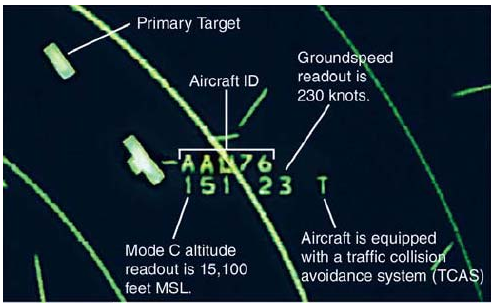
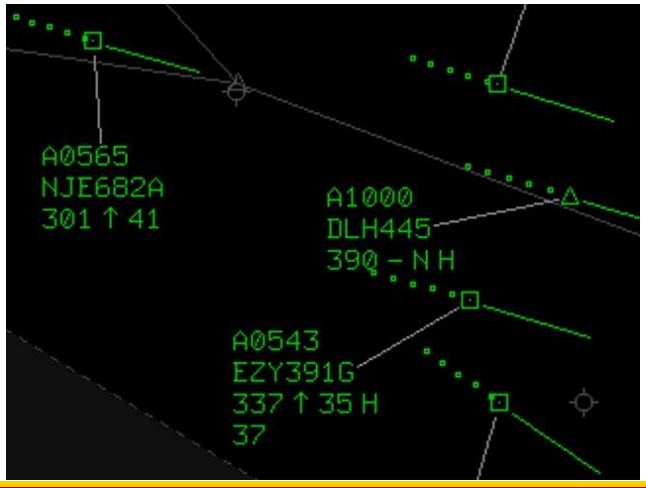
Radar ATC Information Displayed

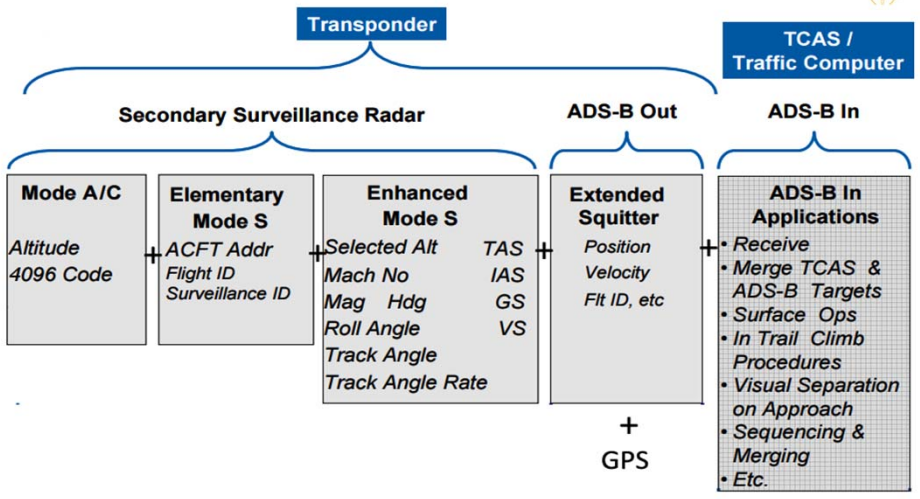


Transponder Mode A, Mode C



Mode S Transponder

- Mode S can **select** a single transponder code to interrogate
- Avoids over-interrogation in busy terminal areas
- Enables airborne collision avoidance systems TCAS
- Message is addressed to 24 bit ICAO hex code permanently assigned to the aircraft
- **Upon interrogation transmits to ATC SSR, other aircraft with TCAS, and ADS-B**



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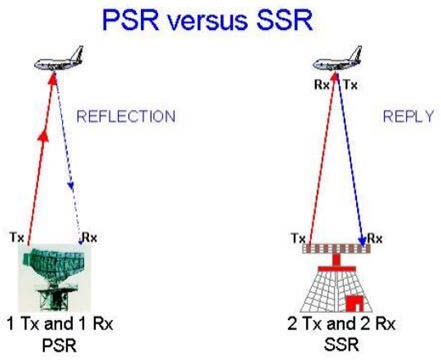
Air Traffic Control Radar Ground-based

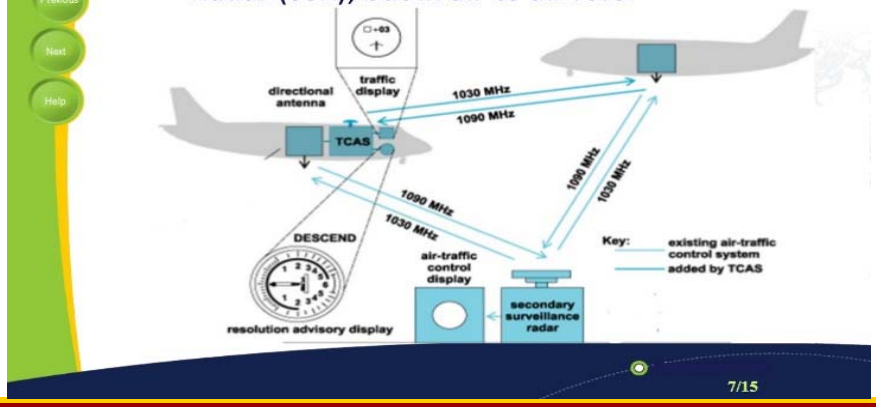


TCAS

- Traffic Collision Avoidance System
- Aircraft to aircraft system
- Next step to a non-ground based system
- Ground-based implies a large, expensive infrastructure

HOW TCAS WORKS

- TCAS operates similar as Secondary Surveillance Radar (SSR), but in air to air role.



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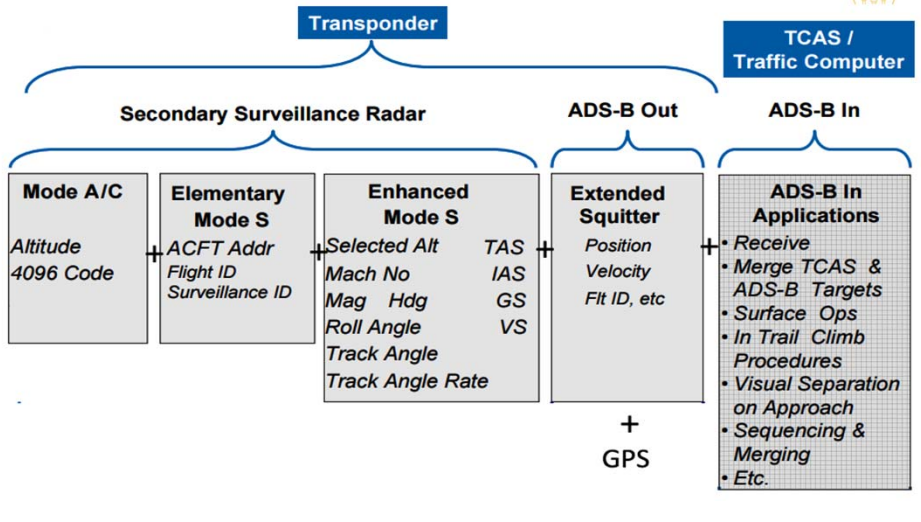

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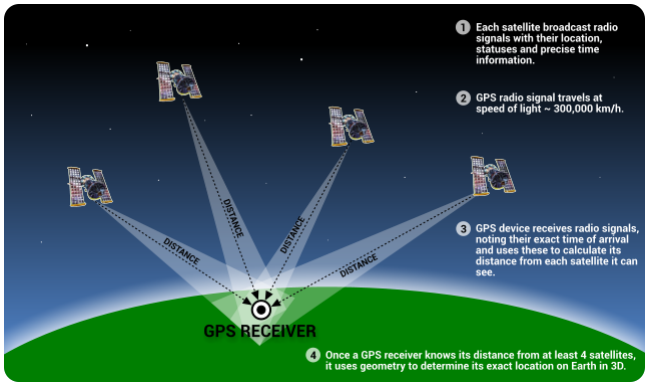
Evolution to ADS-B

- The next step toward ADS-B is GPS

GPS – Global Positioning Satellite System



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GPS

- It is the GPS satellite system that makes ADS-B navigation possible
- It is a space based system that communicates directly with the aircraft
- The information from GPS signal is transmitted out via ADS-B to ATC and other aircraft

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Automatic Dependent Surveillance-Broadcast ADS-B

- **Airplane automatically transmits** accurate position, its velocity (both vertically and horizontally), its altitude, heading and other information to controllers and other ADS-B equipped aircraft.
- It is **dependent upon** the broadcast of information from the **aircraft** not transponder interrogation from ATC
- Aircraft equipped with **ADS-B Out broadcast** the information 1x per second.

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ADS-B

- Advantages:
  - Does not require an extensive ground based infrastructure of radar transmitters and receivers that must connect with each other
  - Is not limited by line of sight issues between radar antenna and the target

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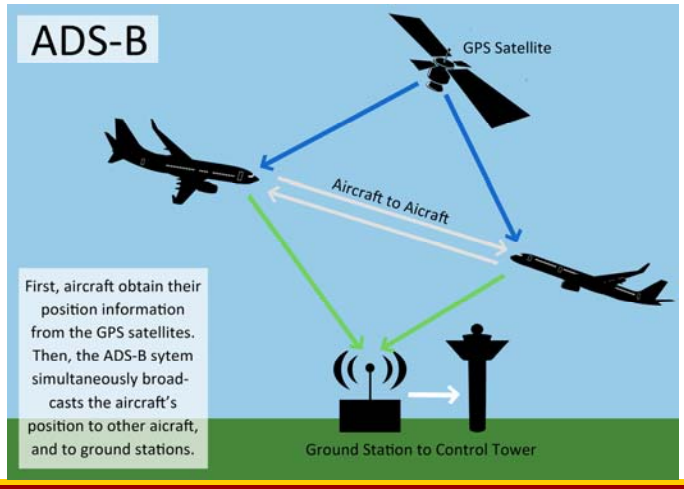

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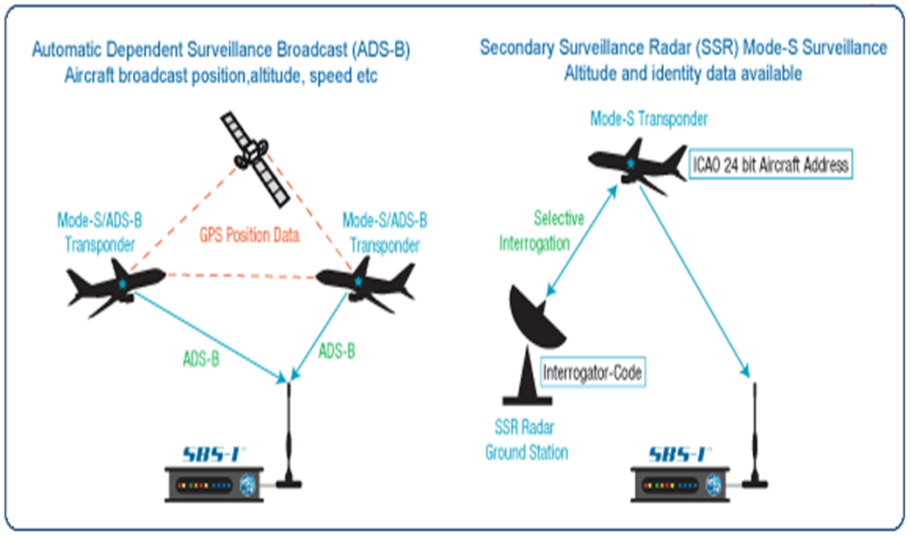

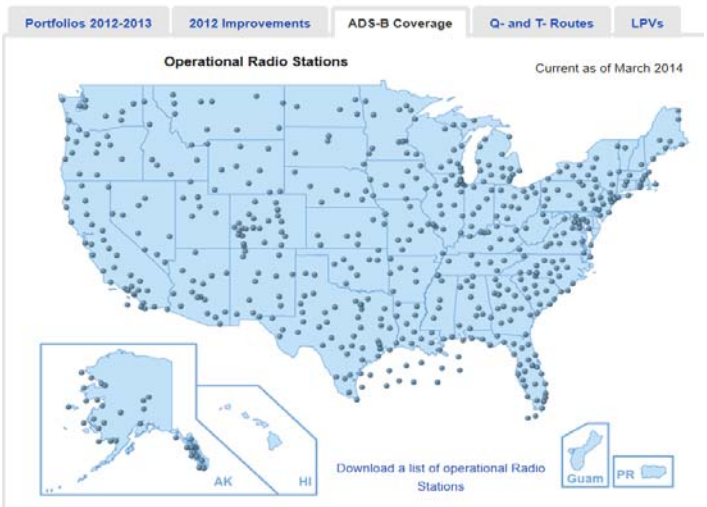

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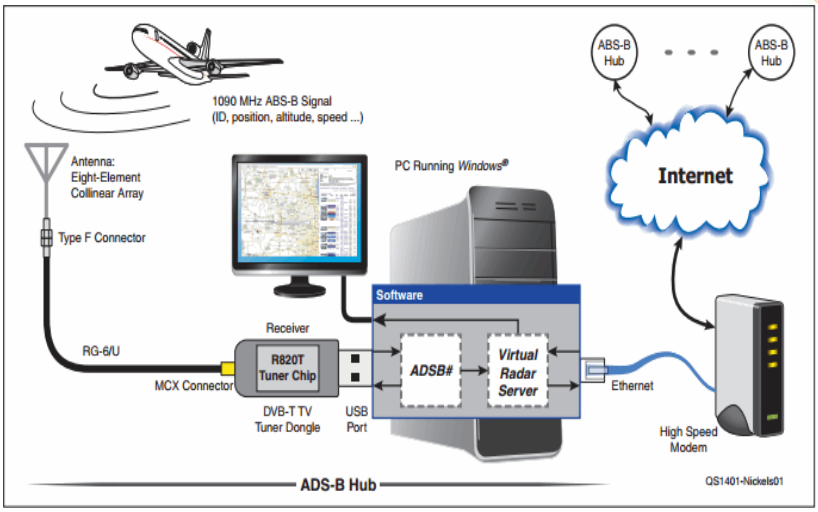

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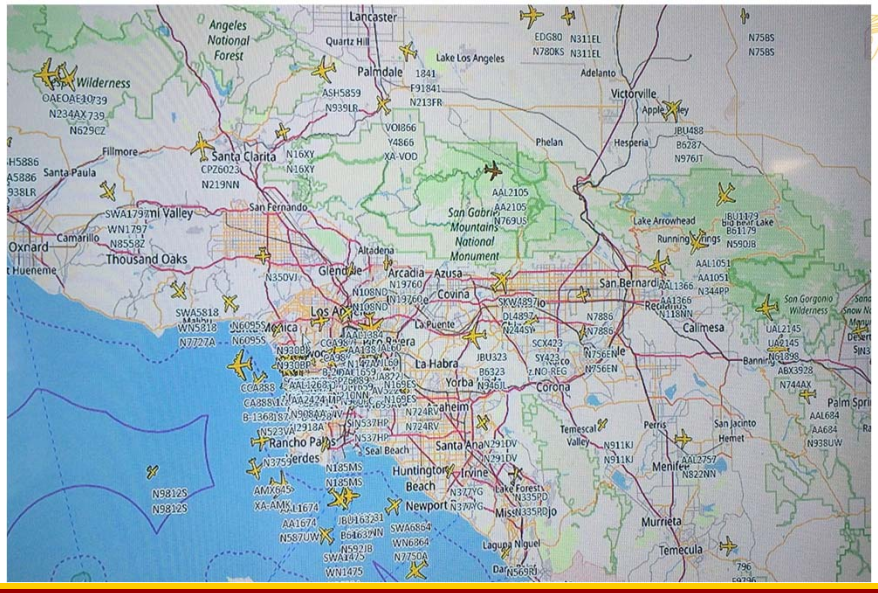

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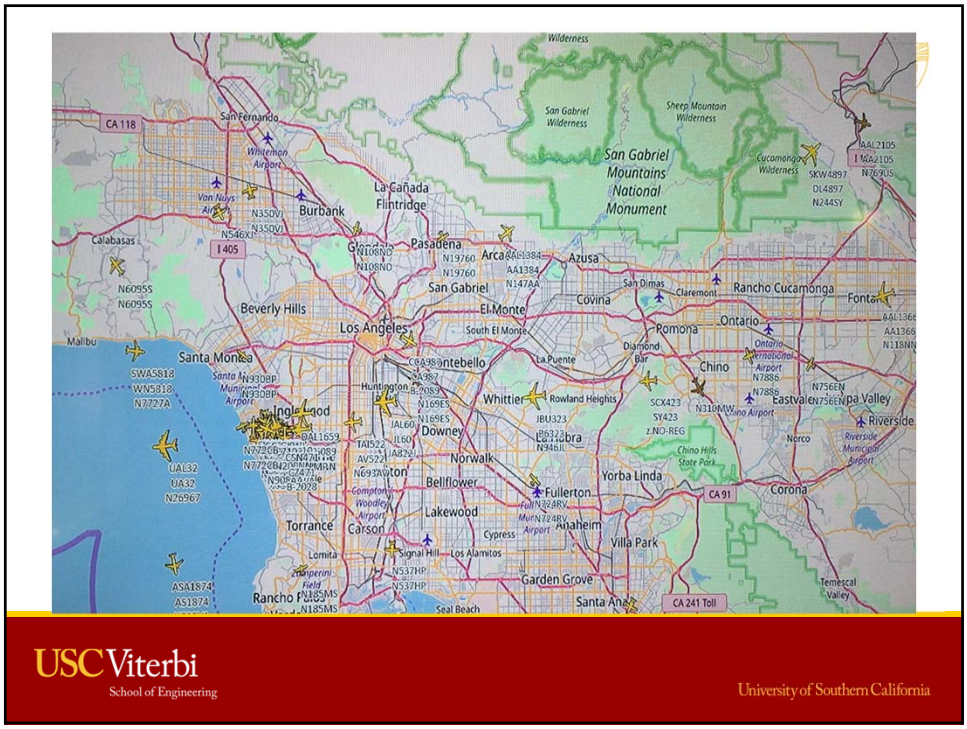
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Whittier
Downey
Norwalk
Bellflower
Fullerton
Anaheim
Torrance
Carson
Lakewood
Long Beach
Santa Ana
Garden Grove
Yorba Linda
Corona
Riverside
Malibu
Calabasas
San Fernando
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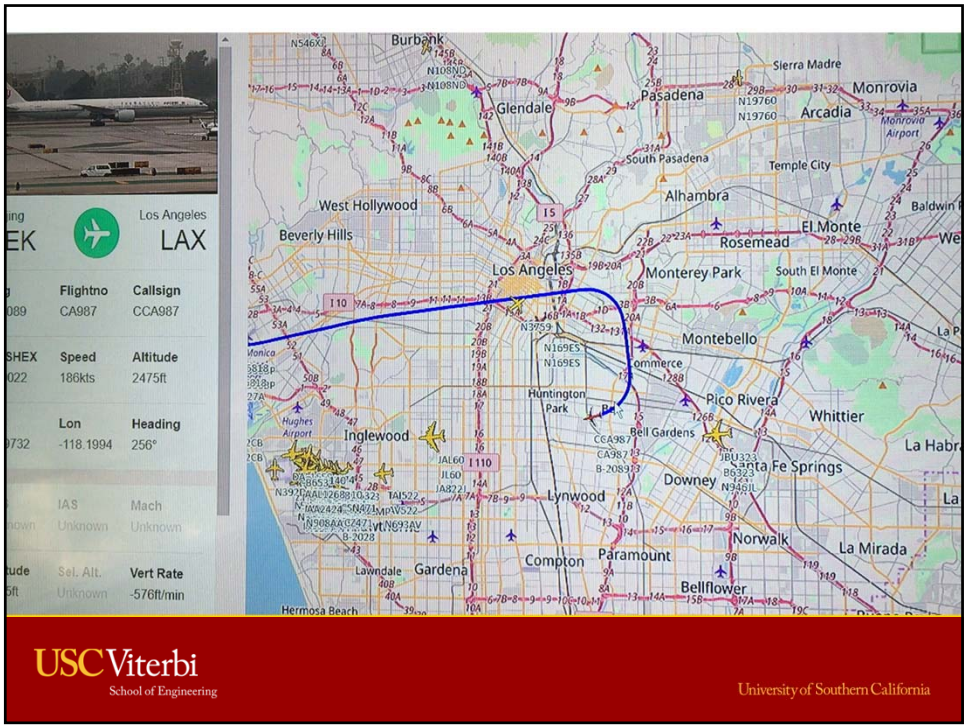
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Montebello
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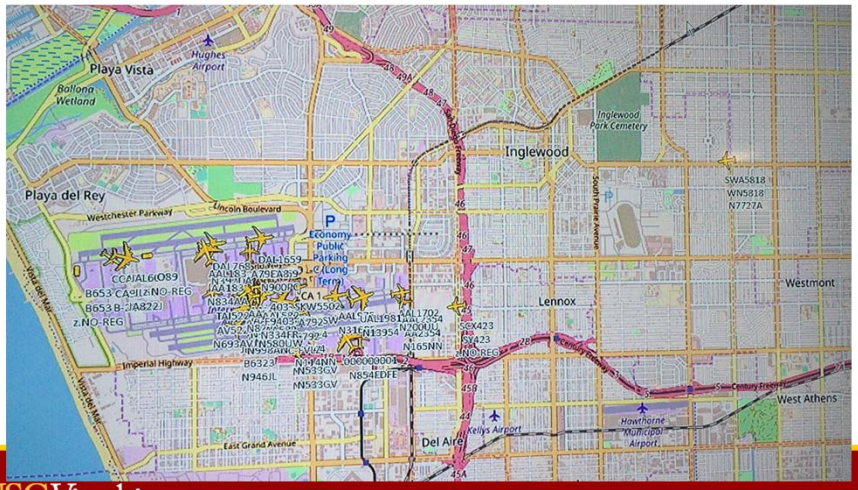

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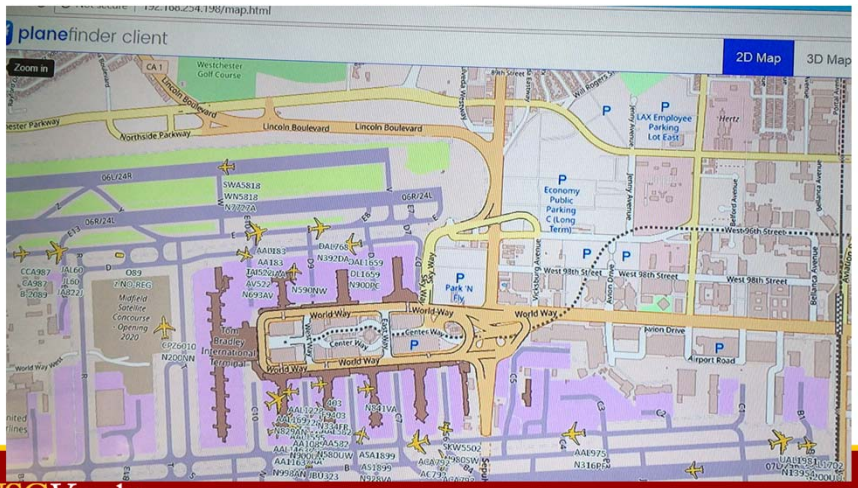

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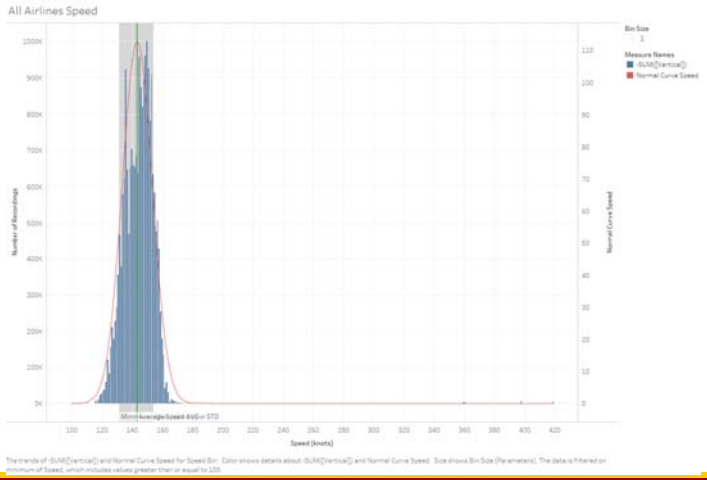
Five days of ADS-B Data B737 only LAX



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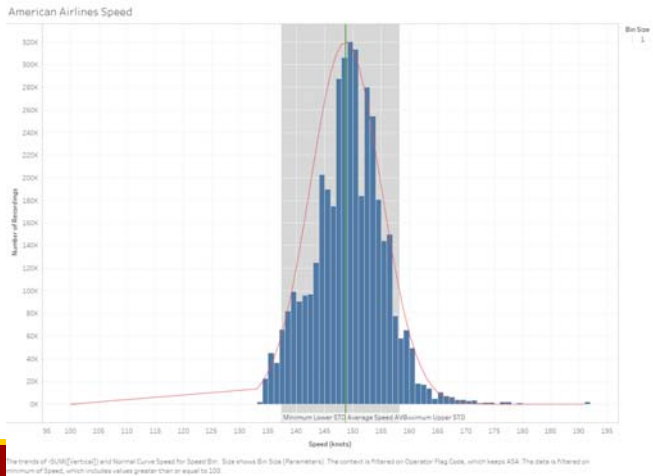
American Airlines



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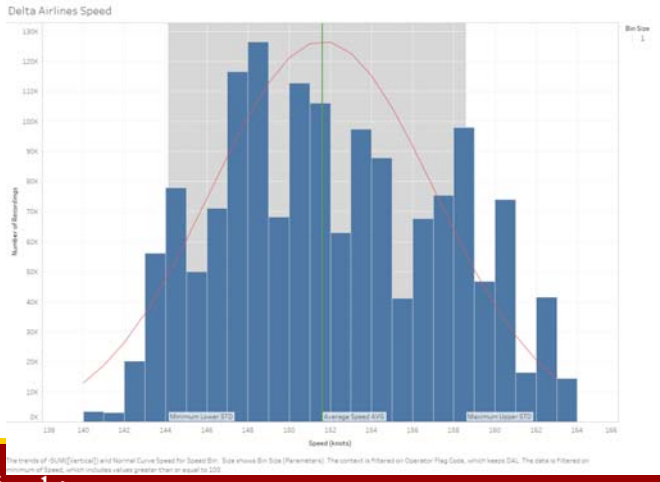
Delta Airlines



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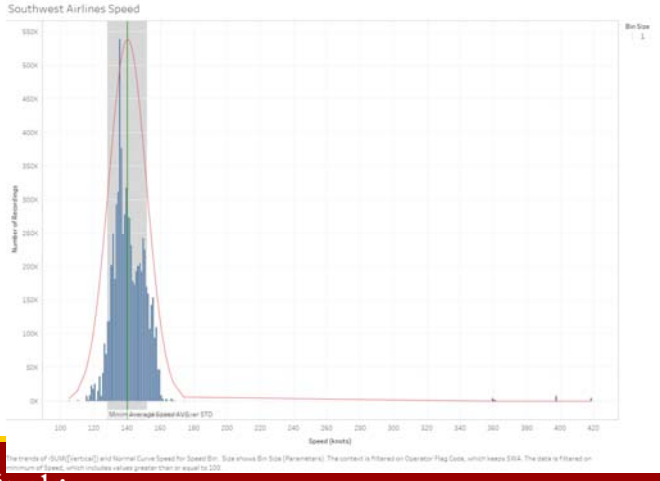
Southwest Airlines



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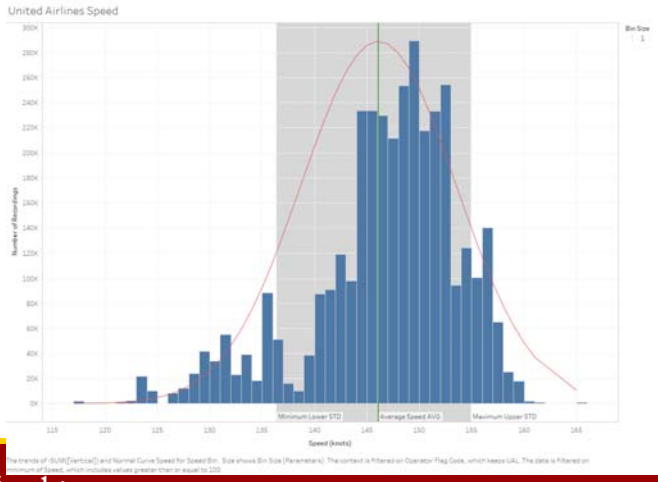
United Airlines



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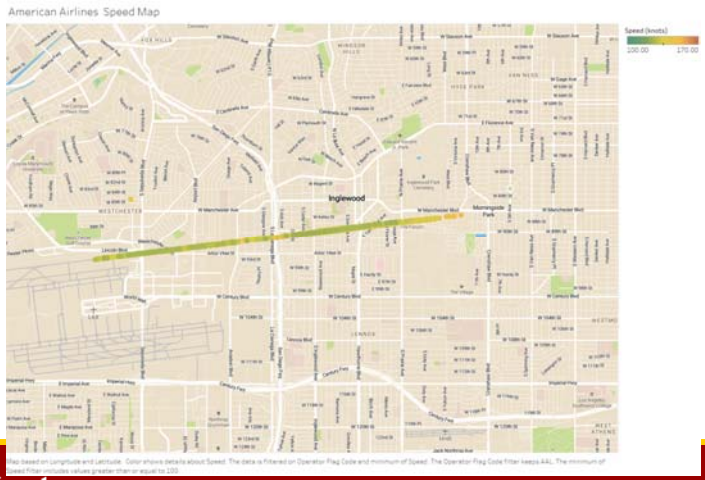

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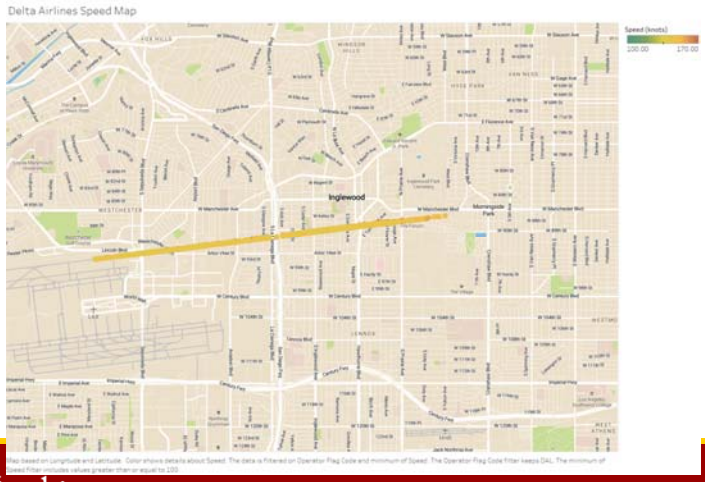

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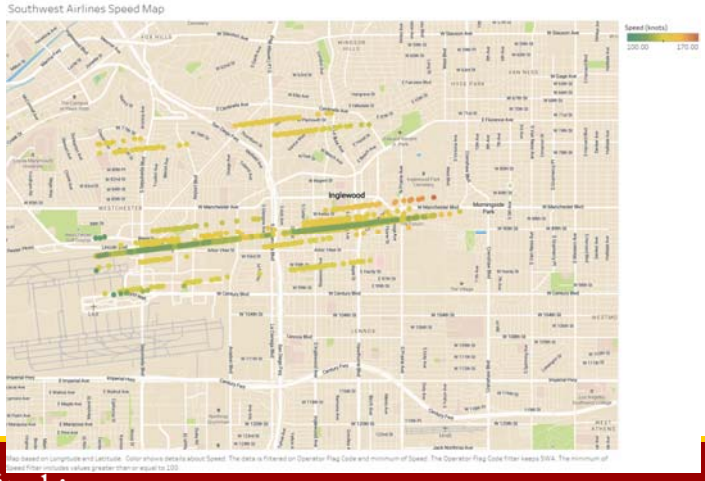
Southwest Airlines



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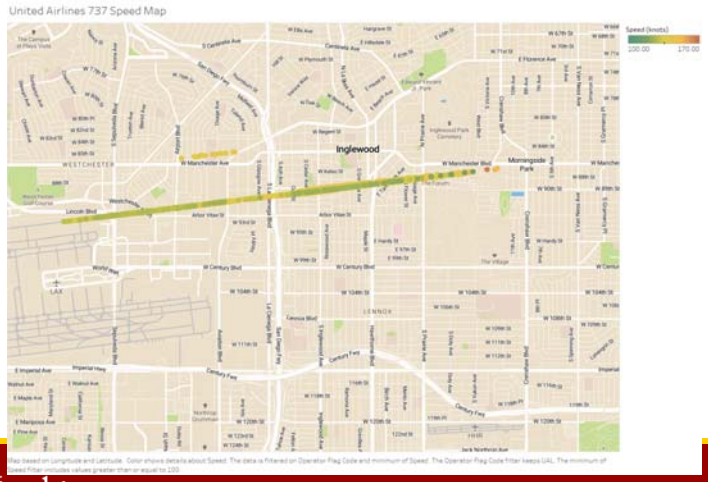
United Airlines



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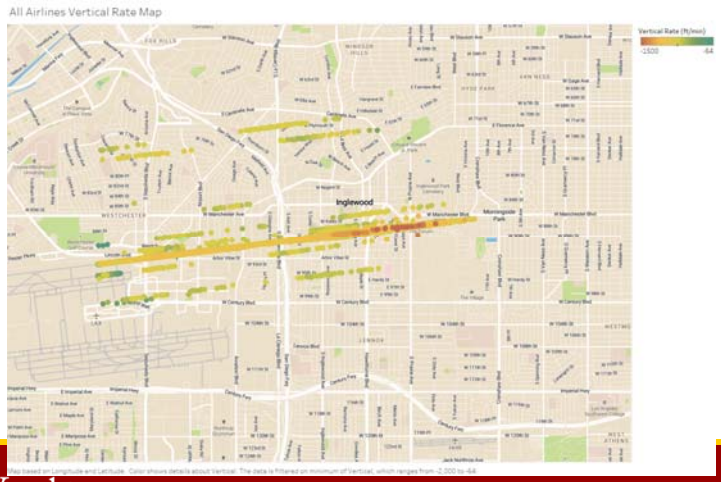
All Airlines Vertical Rate



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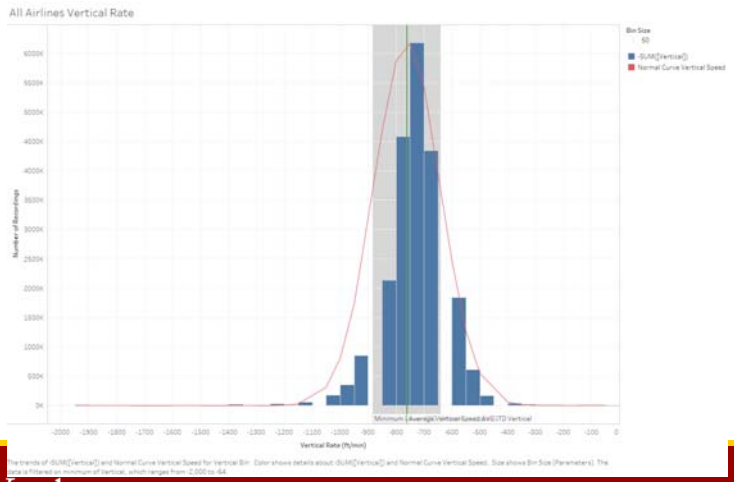
All Airlines Vertical Rate



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1090MHz ADS-B Antenna - 66cm / 26in

by FlightAware

105 customer reviews | 29 answered questions

Amazon's Choice for "ads-b"

Price: $39.95 prime

Get $70 off instantly: Pay $0.00 upon approval for the Amazon Prime Rewards Visa Card.

- Indoor/Outdoor (waterproof) 1090 MHz antenna
- 5.5 dBi gain
- N Type Termination
- 2.5 cm to 4 cm diameter mounting bracket included
- FlightAware-compatible

New (1) from $39.95 prime

Report incorrect product information.

Love it?
Add it to your registry.

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FlightAware Pro Stick Plus ADS-B USB Receiver Built-in Filter

by FlightAware

1 customer review

#1 New Release in Radio Scanners

Price: $19.75 prime | FREE One-Day

Pay ~~$19.75~~ $0.00 after using available Discover Cashback Bonus®.

- Builds on the popular Pro Stick by adding a built-in 1090 MHz bandpass filter
- Increases range 10-20% over a Pro Stick in environments where filtering is beneficial
- Over 40% less expensive then buying a Pro Stick v1.1 and an external filter

New (1) from $19.75 prime

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Equipment needed to collect and record ADS-B data:

- Antenna tuned for 1090 mHz, purchased or homemade
- Coaxial cable to recording computer
- Software Defined Radio USB stick
- Decoding software; options include (all free)
  - Modesdeco2
  - Dump1090
  - ADSB Spy
  - RTL 1090
  - Plane Plotter
  - Many more
  - All free, most open source (open source = anyone can inspect how software works = can't hind malicious code)
- Lines of data created by decoding software
  - Hexadecimal Data
  - Comma Separated Data
- Data can then be saved into database; options include
  - SQL (Structured Query Language, pronounced sequel)
  - Text Files
  - Comma Separated Variable (CSV) files
  - Any other database format
- Collection range depends on line-of-sight and sensitivity of receiver
  - USC can reach cruise-altitude aircraft 250 miles away
  - Multiple receivers can be connected via internet to expand range
    - All data is timestamped – networking delays do not corrupt data
- The following organizations will provide professional-grade ADS-B receivers if you have a good location that they want more coverage in (non-exhaustive list)
  - Planefinder (ours)
  - FlightAware
  - Flightrader24 (used by Andrew Walton at Liberty University)
- Harder to find software that will automatically record data into local database
  - Will require at least a basic understanding of programming
  - But ADS-B is popular with amateur radio and programming communities
    - Would likely accept opportunity to put their hobby towards official aviation use
  - But of course ask USC Aviation Safety and Security any questions you may have

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The Final Take-Aways

- Investment of $500
- Ground-based system
- Observe ADS-B equipped aircraft
- Range line of sight
- Initiate an initial flight data system

- Anyone with $500 and computer capability can see the information as well.

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For Advice

- daniel.scalese@usc.edu
- aviation@usc.edu
- thomasa@usc.edu

- Daniel can be reached at 310-342-1345
- Website: https://aviationsafety.usc.edu

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Thank You from USC

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GPWS - EGPWS

- Aircraft based
- Not an ATC system
- Aircraft to aircraft

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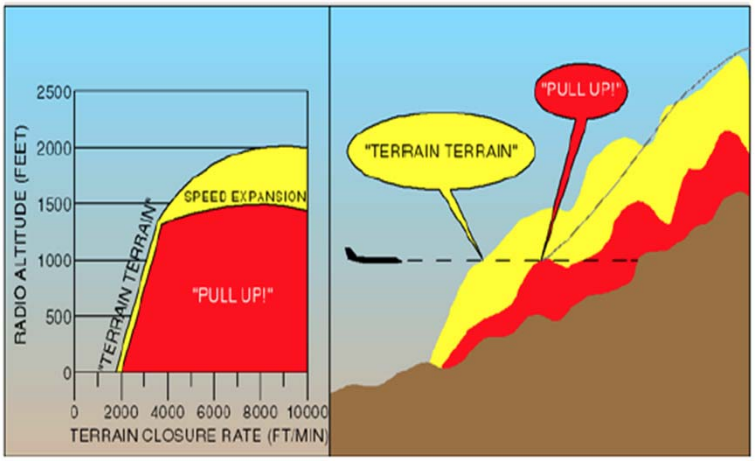
GPWS – EGPWS
Enhanced Ground Proximity Warning System



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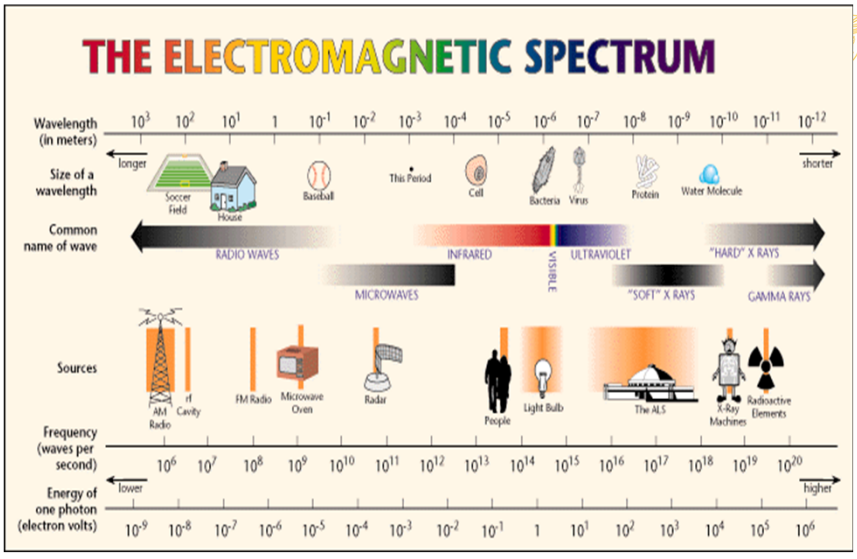
GPWS - EGPWS

- GPWS works on radar altimeter information; it looks down.
- EGPWS compares radar altimeter data with GPS location and terrain elevation data base. Via the software it looks forward as well as down.
- 4300 MHz civil radar altimeter frequency



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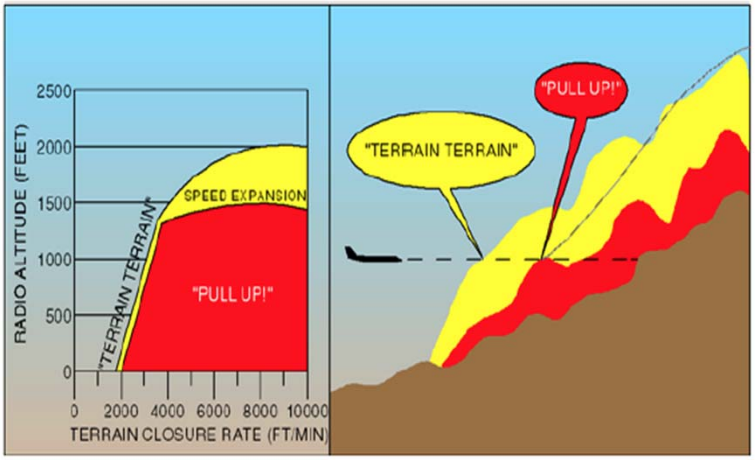
GPWS – EGPWS
Enhanced Ground Proximity Warning System



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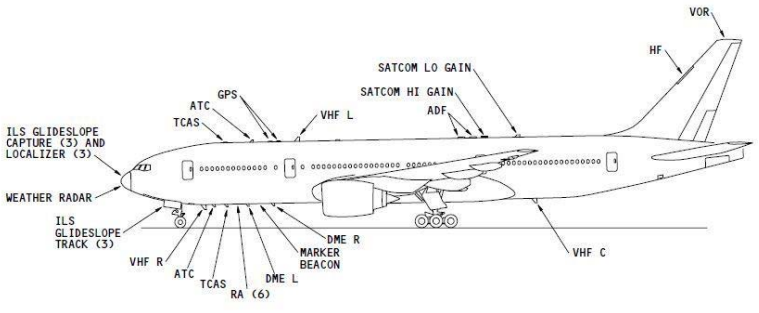
B777 Antenna Locations



777 GENERAL – ANTENNA LOCATIONS

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