GPS Integrity RAIM, WAAS, and LAAS: Concepts and Status

Federal Aviation Administration

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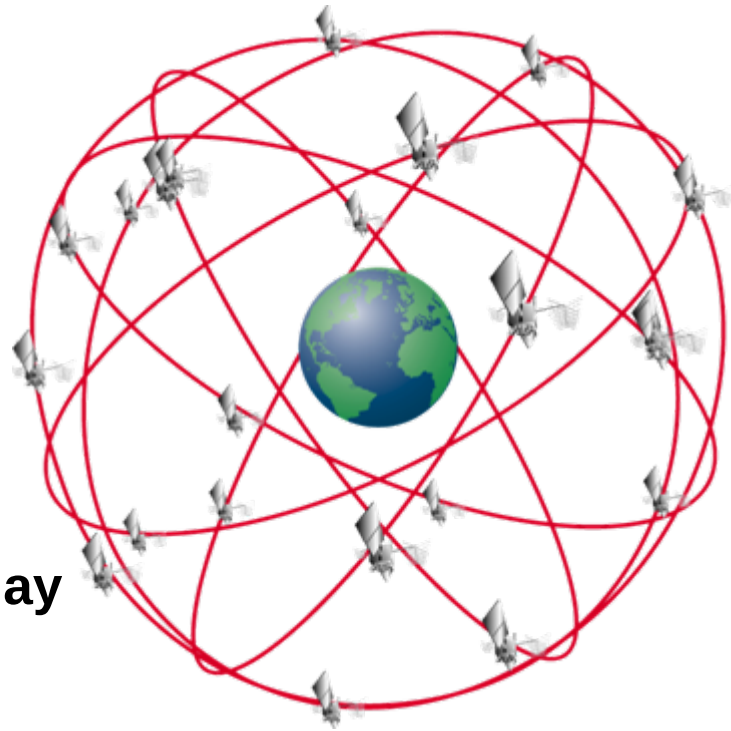
Overview

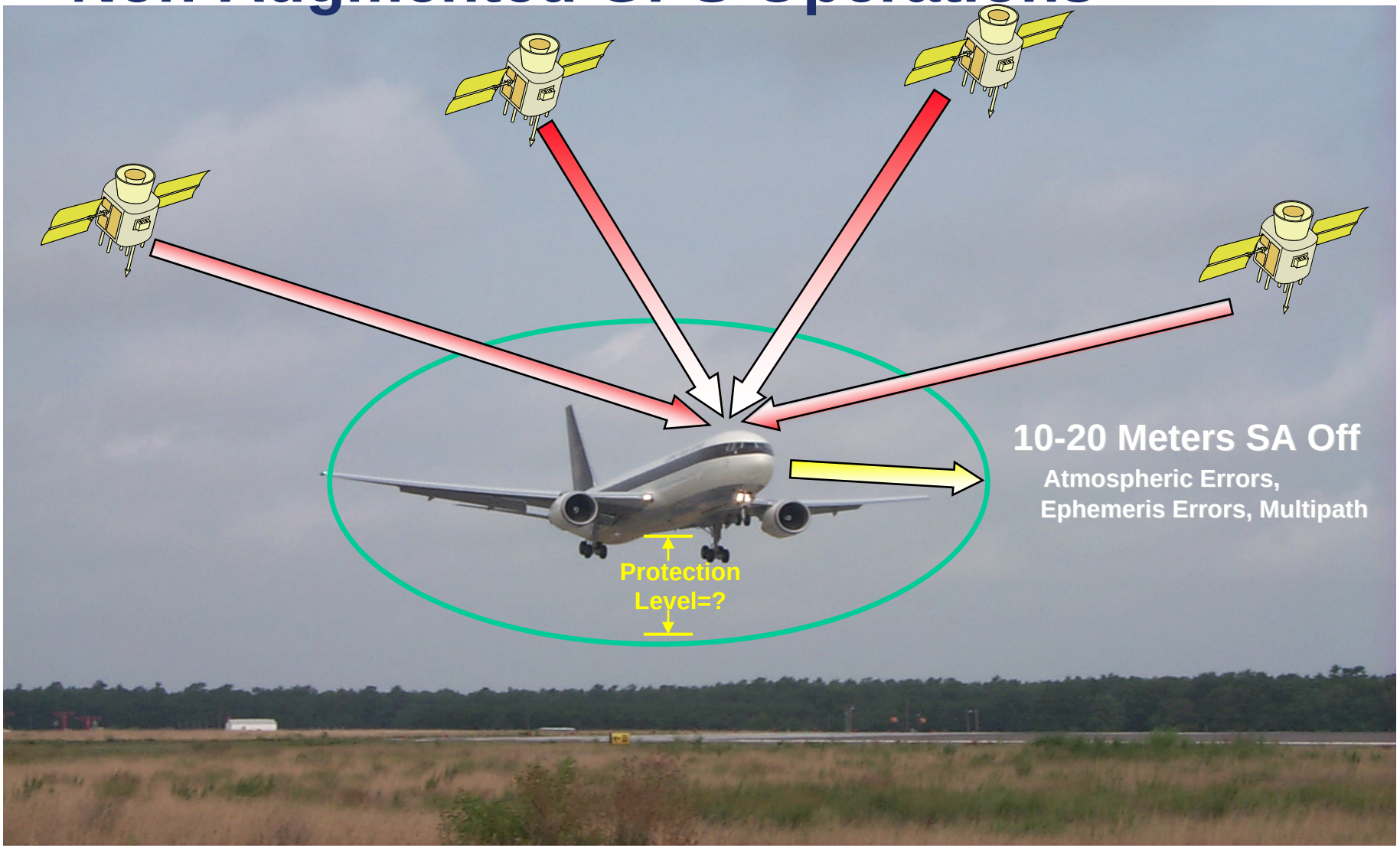
- GPS Basics
- GPS with Receiver Autonomous Integrity Monitoring
- FAA GPS Augmentation Systems
- Wide Area Augmentation System
- Local Area Augmentation System
- Summary

Global Positioning System Basics



- **Space Segment**
  - **24 Satellites**
  - **6 Orbital Planes**
  - **4 Satellites per Plane**
  - **SVs Orbit at approximately 20 million meters above the earth**
  - **Each SV Orbits the earth twice a day**
- **Ground Control Segment**
  - **Master Control Station, Colorado Springs**
  - **Monitor Stations; Hawaii, Ascension Island, Diego Garcia, and Kwajalein**

Non-Augmented GPS Operations



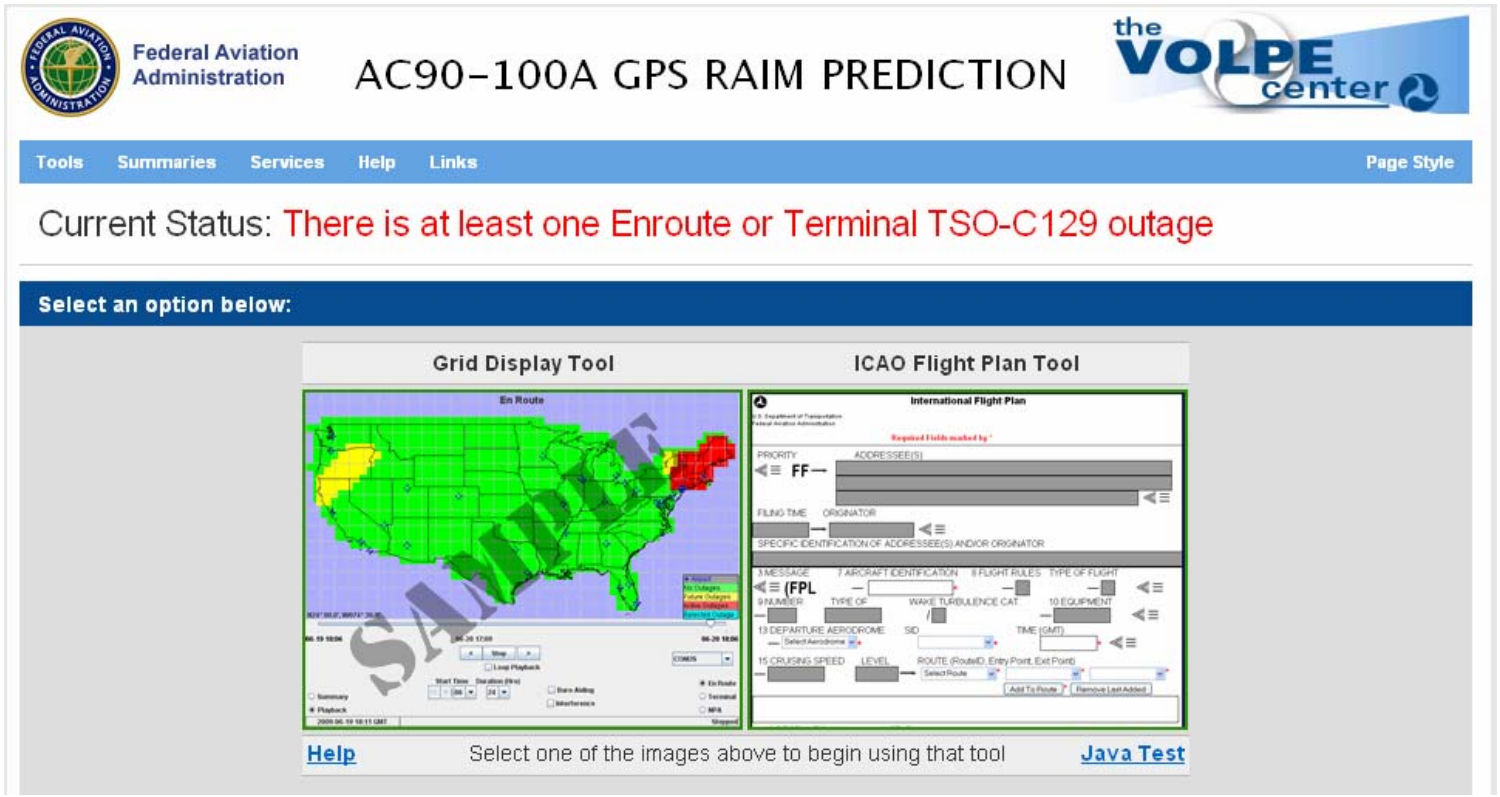
GPS Operations and RAIM

- Receiver Autonomous Integrity Monitoring (RAIM) provides GPS solution integrity without additional augmentation
- RAIM functions include Fault Detection (FD) and Fault Detection and Exclusion (FDE)
  - Fault detection algorithms determine if there is an error in the GPS solution
  - Fault detection and exclusion algorithms determine if there is an error in the solution and can isolate and exclude satellites from the solution

RAIM Information

- RAIM Prediction Link

  http://www.raimprediction.net/ac90-100/

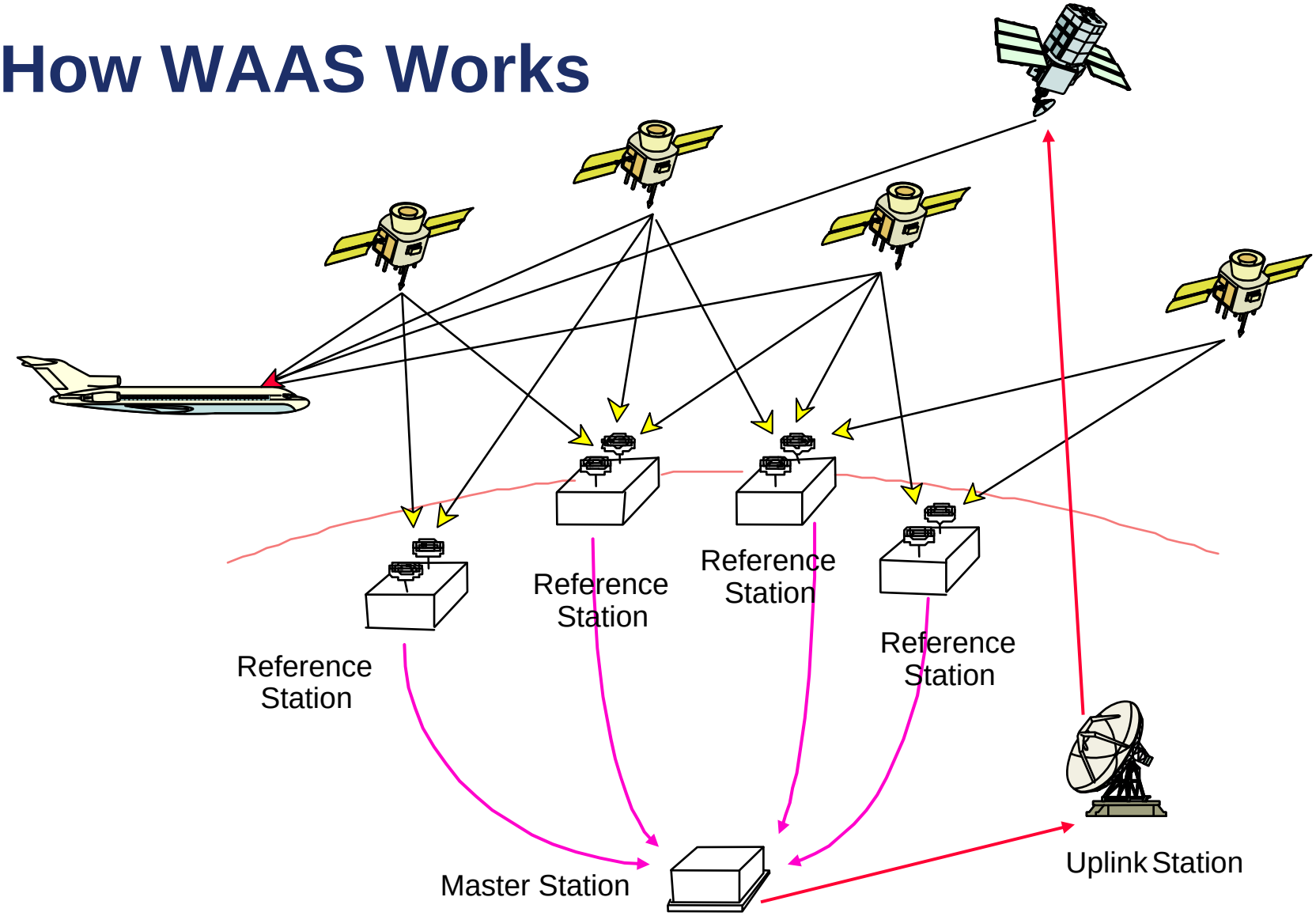


Satellite Navigation

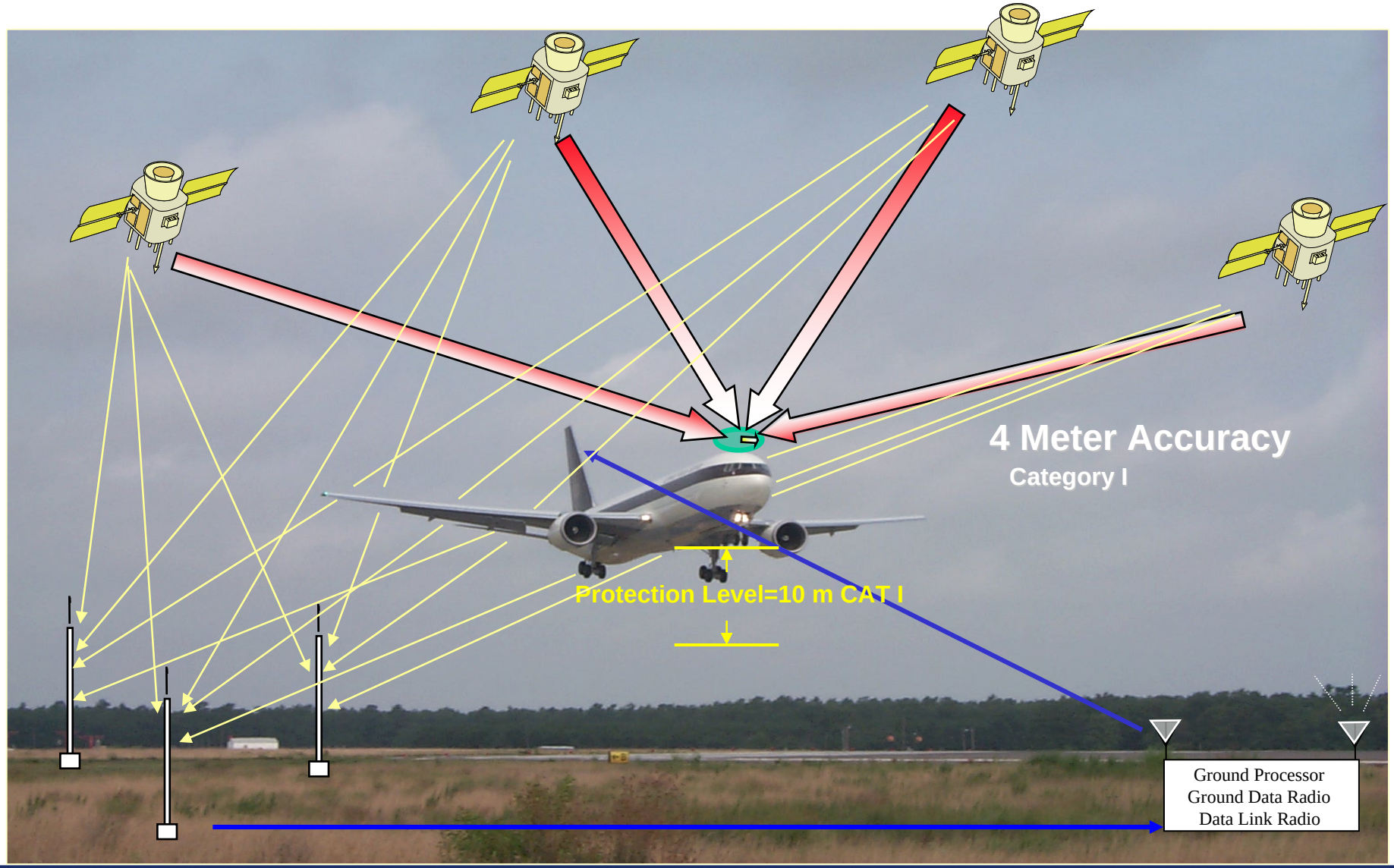
WAAS / LAAS Implementation

Space-Based Augmentation System (SBAS)
Ground-Based Augmentation System (GBAS)

How WAAS Works



How LAAS Works



Local Area Augmentation System (LAAS) Service

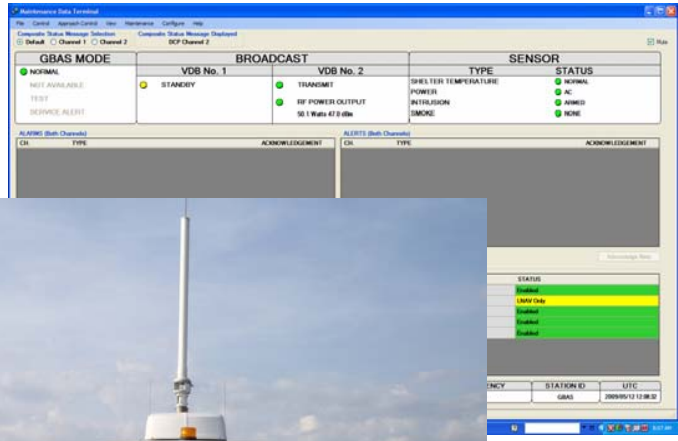
- **Provides Precision Approach Capability, CAT I/II/III Service.**
  - **Performance equivalent to existing Instrument Flight Rules (IFR) radionavigation landing aids.**
  - **Complements the Wide Area Augmentation System (WAAS)**
    - **Provides CAT I where WAAS is not available.**
    - **Uses WAAS integrity information when in coverage of a WAAS GEO.**
  - **Requirements were coordinated internationally to support harmonization efforts.**
- **CAT I/II/III Architectures Have Common Baseline Configuration and are fully interoperable.**

LAAS CAT I Approval Status

- SLS-4000 was installed at the FAA Technical Center in September 2008
  - Being used as a platform to support FAA review of Honeywell design artifacts, Integrity Monitor Verification, and a CAT III development system
- Hazardously Misleading Information (HMI) Report was completed December 2008
  - Fully describes the integrity safety case for the SLS-4000
- CAT I System Design Approval
  - NonFed Approval Completed! September 3, 2009
- SLS-4000 was installed at Newark Liberty International Airport (EWR) in November 2009
  - FAA is working to resolve environmental interference at EWR

LAAS CAT I Approval/Test Activities

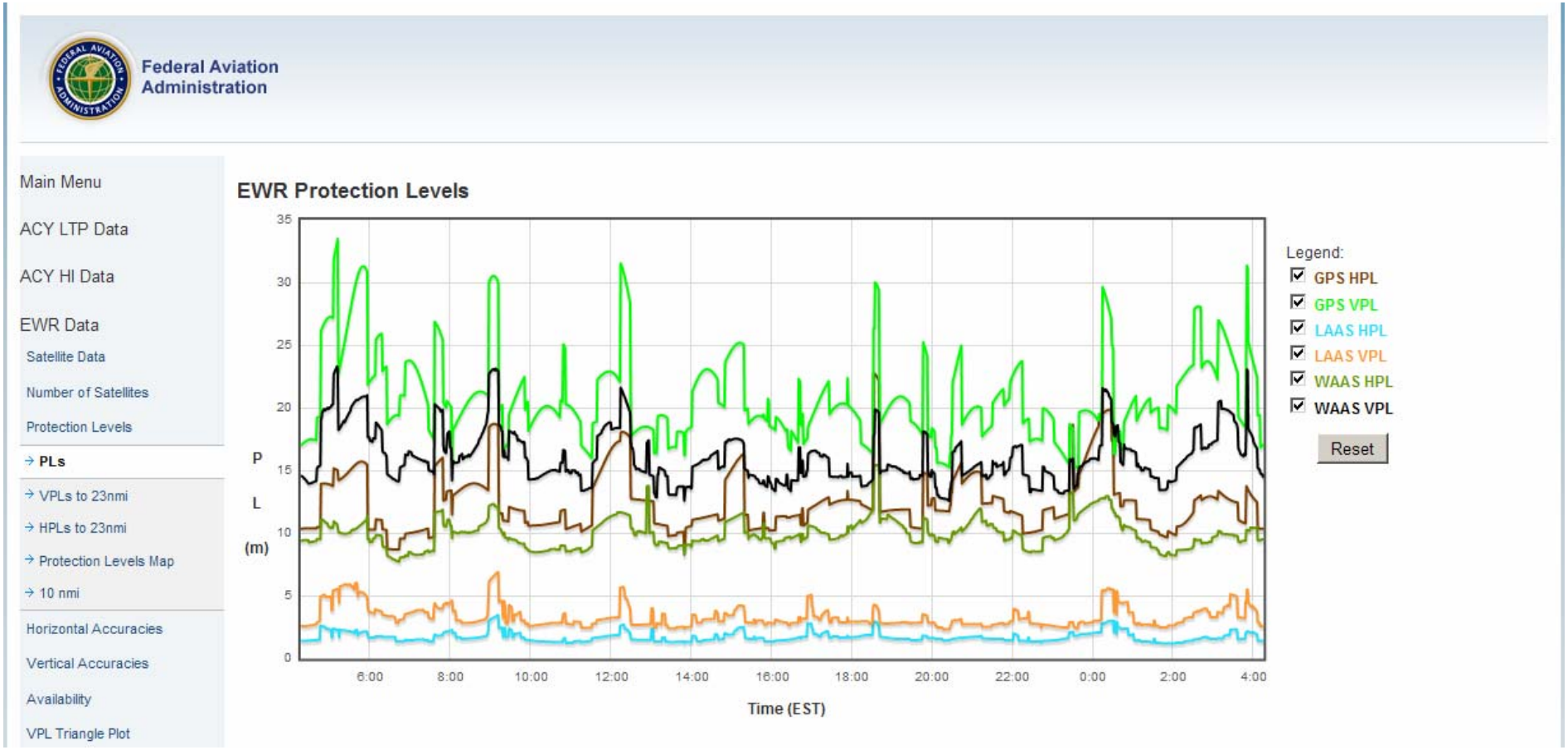
- Install / Siting Process Review
- Training and Documentation Review
- Test Case and Procedures Review
- 24/7 Signal in Space (SIS) monitoring
- Stability and Integrity Monitor Testing



LAAS Information

- LAAS Team Web page

  http://laas.tc.faa.gov/



Summary

- Discussion of GPS, RAIM, WAAS, and LAAS
  - High-level concepts and overview
- Provided links for additional information
- Contact Information at the FAA Technical Center
  - Navigation Engineering Development Services

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