ATS Evaluation and T&E Services Groups

Evolution of Testing to Monitoring

Federal Aviation Administration

Presented to: V&V Summit

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Date: October 22-23, 2008

PURPOSE

- **Describe current and future testing initiatives for NAS subsystems/NextGen enabling programs and the evolvement of operational system/service performance monitoring**

Agenda

- **Background**
- **Concept**
- **Program/Service Examples**
  - SBS, WAAS, FSS, RVSM, ZOA FIR,TCAS, SWIM, NextGen DataComm
- **Issues/Conclusions/Recommendations**

Background

- **Recent acquisition concept moving more towards services (e.g., FSS, SBS, SWIM)**
- **Conduct of testing still required**
- **Have used testing tools/procedures to perform monitoring functions – nothing new here**

Concept

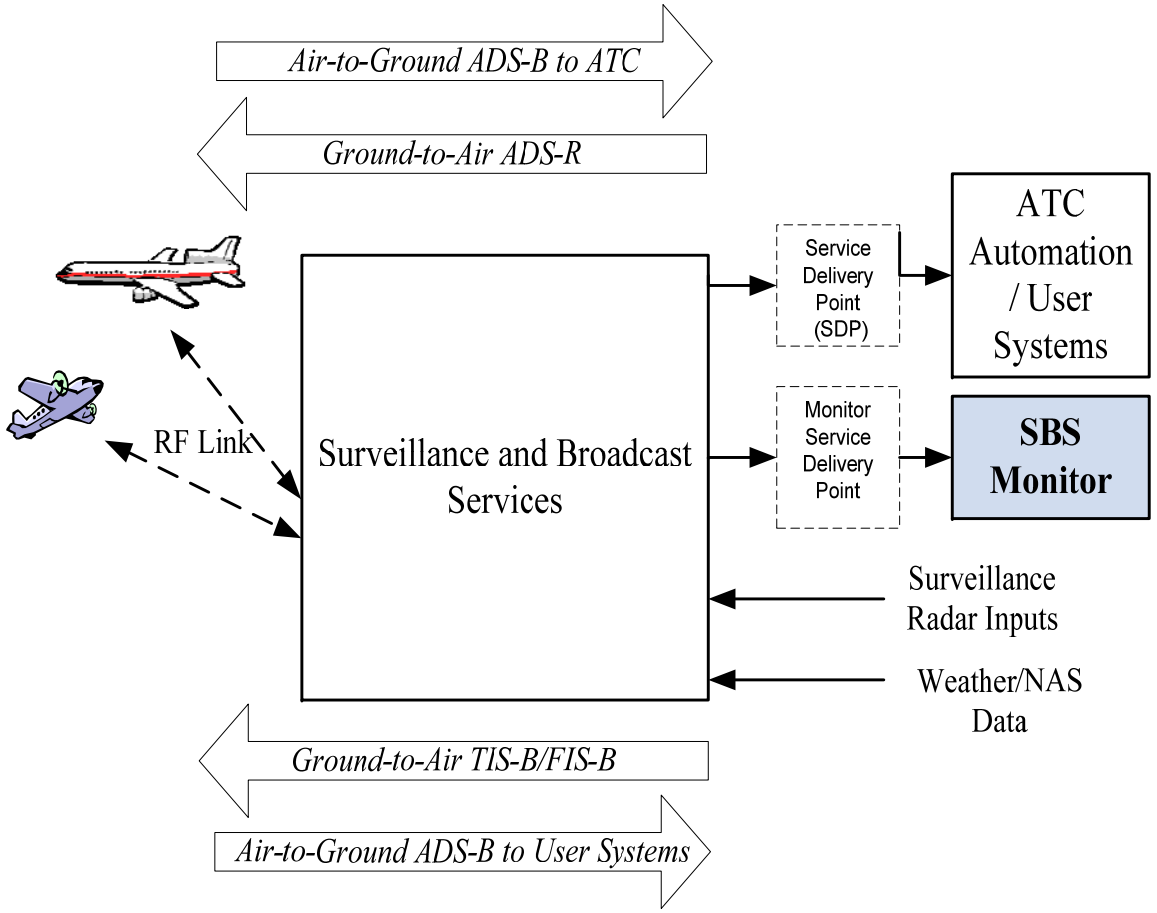
- **As we continue to test acquired services, transform the tools/procedures to perform a monitoring function**
- **Monitoring**
  - Contractor is meeting contractual specification
  - Service/system is supplying correct, accurate and usable data
  - External (FAA, non-FAA) users and systems perform as expected

Surveillance and Broadcast Services

(SBS)

System Overview

- **Independent monitor of the SBS System**
- **Provide an independent assessment of contract TPMs**
- **Real-time alarms and alerts and off-line analysis of metrics are provided to the user.**

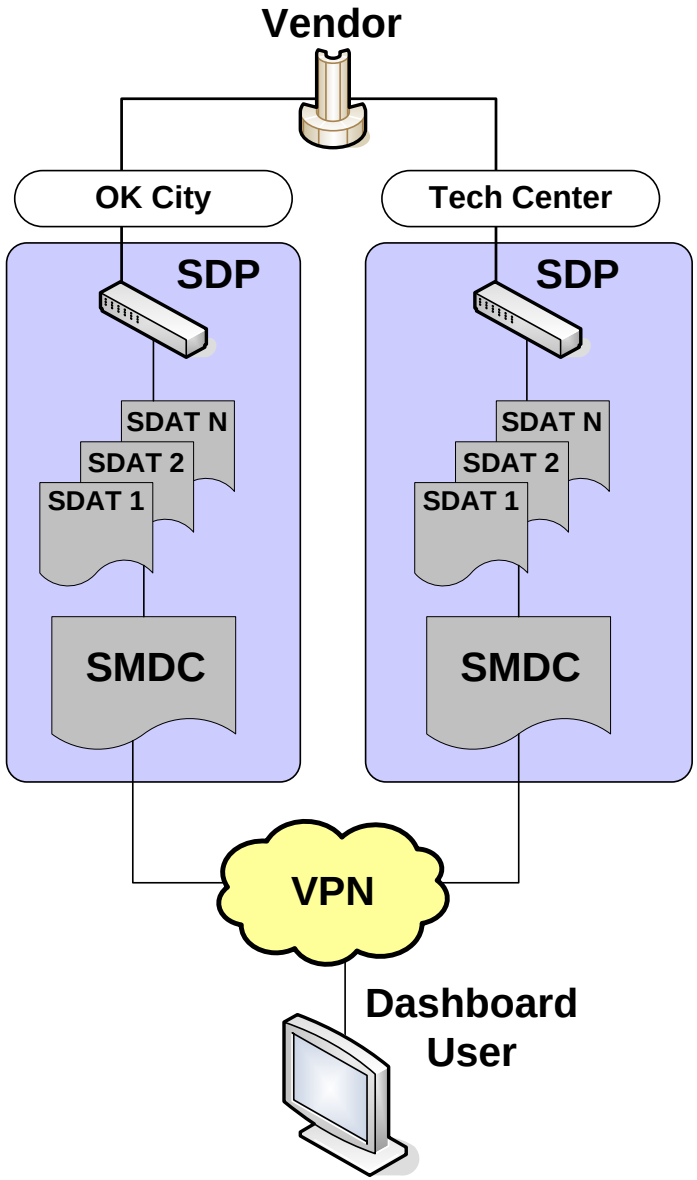


Functions Performed

Contract Technical Performance Monitoring	**Provide an assessment of the Contract Technical Performance Metrics (TPM)**
Service Status Monitoring	**Report the current status of SBS services within each Service Volume**
Operational Performance Assessment	**Collect metrics which have value outside those collected for the TPMs**
Avionics Performance Monitoring	**Monitor received ADS-B reports to measure equipage levels, ADS-B data quality metrics, and state vector continuity**

Architecture

- **Components**
  - SDP
    - One per location
    - Point of delivery
  - Surveillance Data Acquisition Tool
    - Monitoring applications process data and store results
    - Multiple instances
    - Co-located with SMDC
  - Surveillance Monitor Data Center
    - Command and control center
    - Infrastructure Components



Technical Center SBS Monitor

- **Primary Monitor until OK City Monitor is available and then will be Backup Monitor**
- **Support SBS Monitor Software Upgrade Development**
- **Support SAT, OT and Field Familiarization Activities**
- **Support Automation/SBS Interface Development**

RSM + FISB Service

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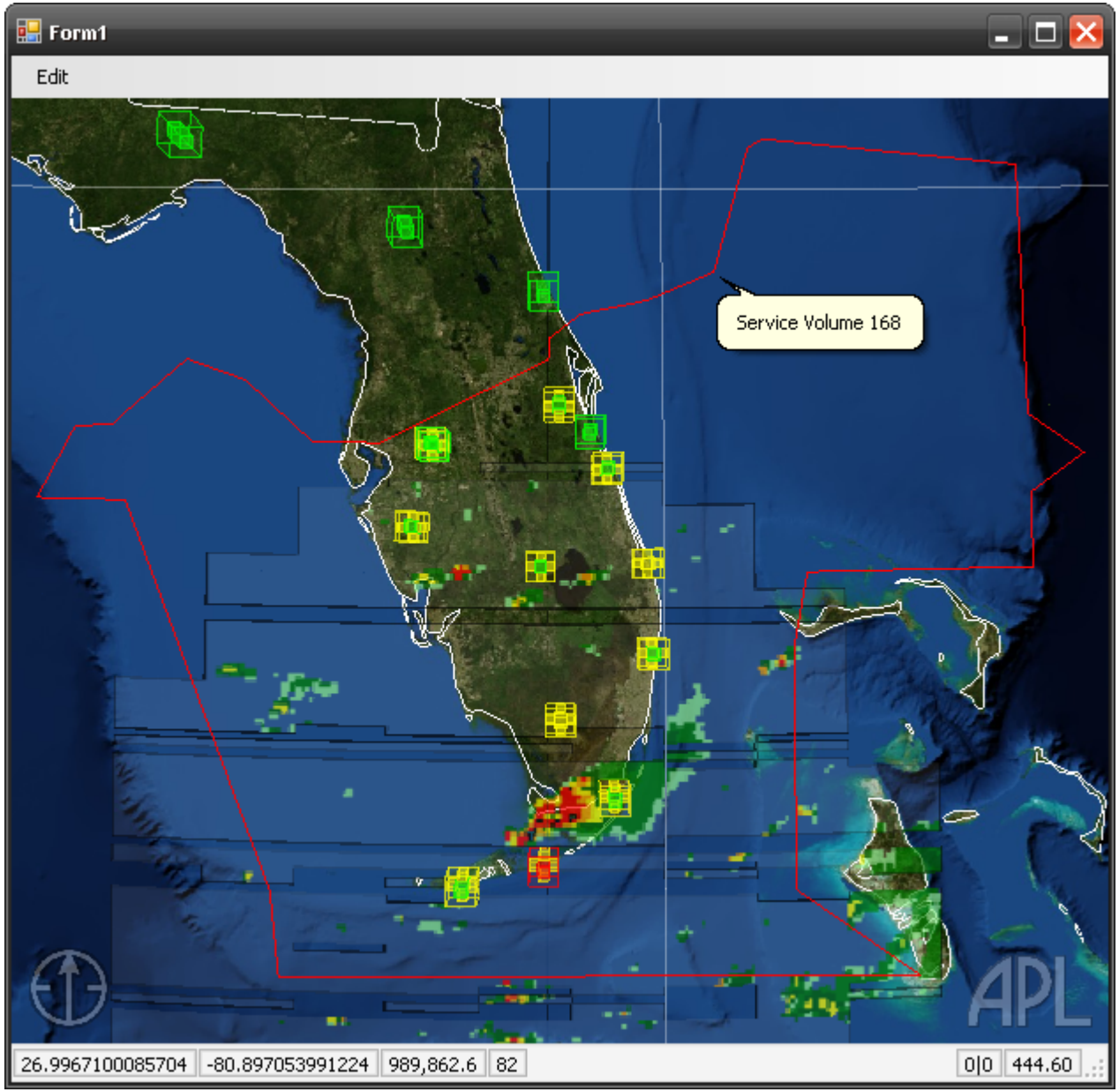

Track + FISB Service

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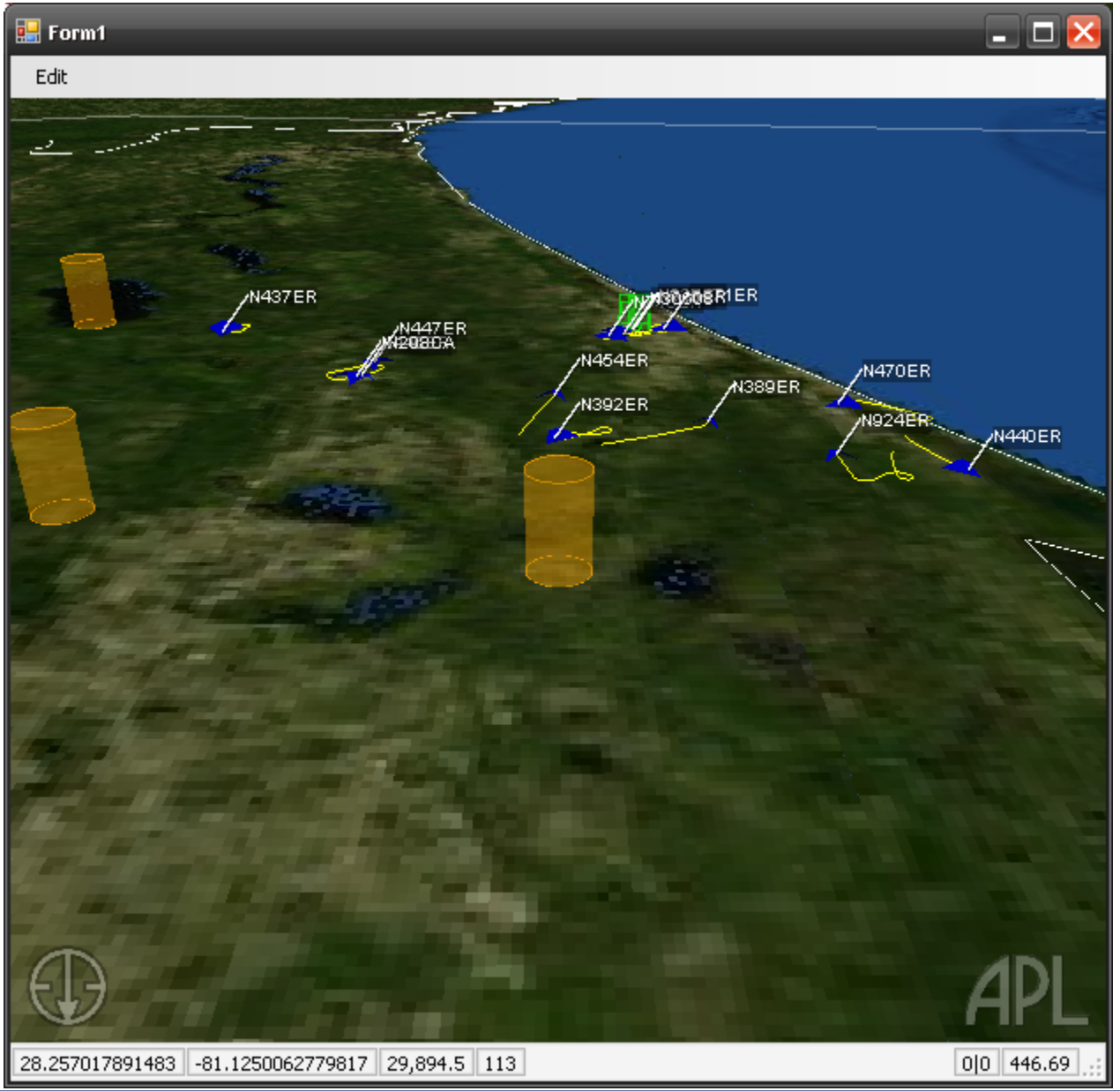
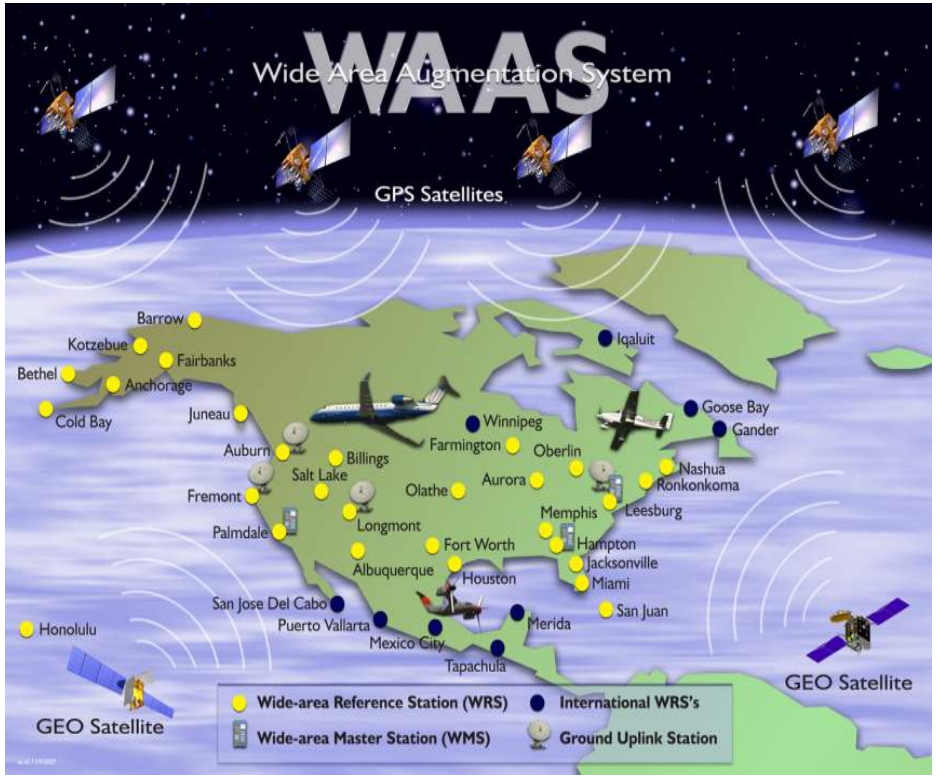


Global Positioning System/ Wide Area Augmentation System (GPS/WAAS)

Wide Area Augmentation System



- GPS alone cannot completely satisfy civilian aviation requirements
- WAAS augments the accuracy, availability, and integrity of GPS
- WAAS-provided service includes:
  - Precision approach capability in much of North America
  - RNP* 0.1 and RNP 0.3 service for all of North America and a portion of South America

*RNP = Required Navigation Performance

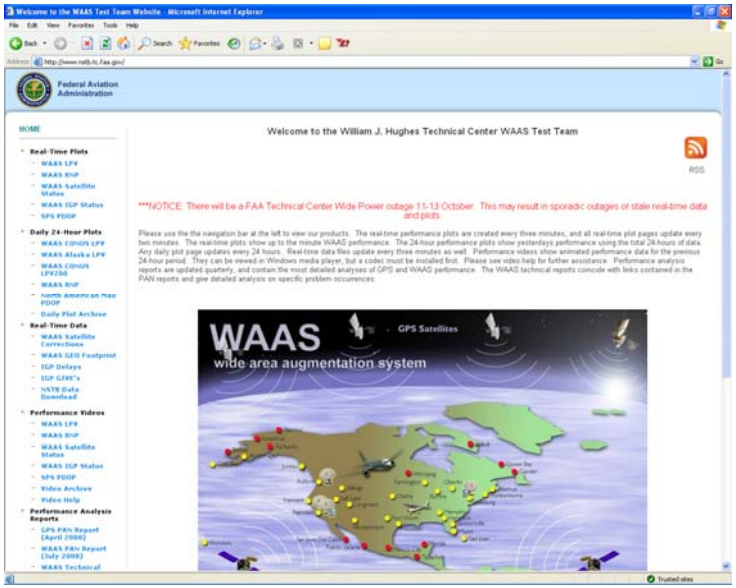
GPS/WAAS Monitoring

- **Performed by WAAS Test Team at WJH Technical Center**
  - Tools developed originally for WAAS T&E (DT and OT)
- **Real Time and other monitoring products available at the WAAS Test Team website**
  - Includes:
    - Real time GPS/WAAS performance information
    - Quarterly GPS and WAAS performance reports
  - Information used by WAAS Operations Specialists, SOS, AVN, AIR, program office, and general public
  - http://www.nstb.tc.faa.gov/

GPS/WAAS Monitoring

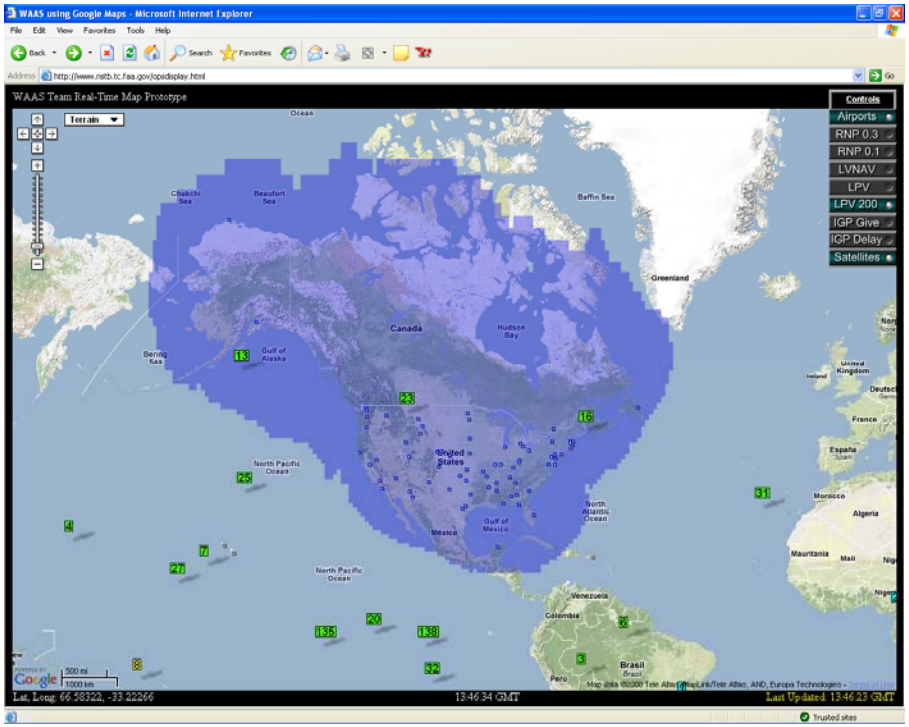
- **Data received at WJH Technical Center via dedicated one-way terrestrial communications circuits**
  - These circuits connect directly to WAAS equipment
  - Process ~10 GB of data daily
- **Software developed in-house by WAAS Test Team**
  - Primary tool based on RTCA WAAS MOPS
    - Emulates a GPS/WAAS user

GPS/WAAS Monitoring Website



WAAS Test Team Homepage

Screenshot showing WAAS coverage and GPS/WAAS satellite locations/status



Flight Service Systems (FSS)

Direct User Access Terminal Service

Direct User Access Terminal (DUAT) Service is an Internet-based weather information and flight plan processing service provided by the Federal Aviation Administration through designated Service Providers for United States civil aviation pilots and other authorized users.

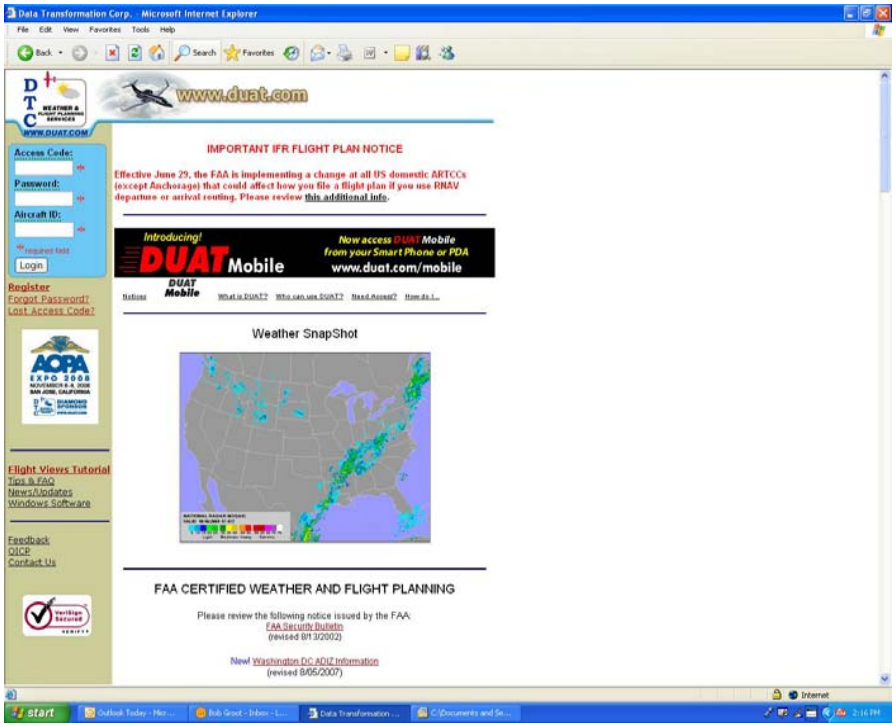
Major DUAT Service functions include the capabilities to:

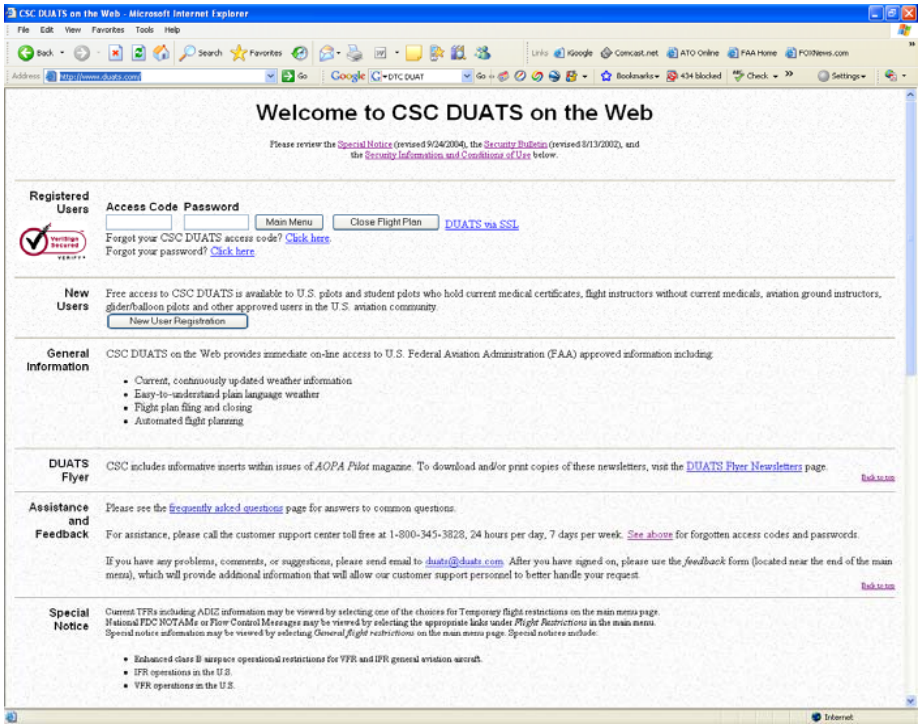
- Provide a selection of weather information formats (standard, abbreviated or outlook) for routes of flight or defined areas
- Process flight plans and associated messages
- Encode/decode location names and location identifiers (LOCIDs)
- Provide select weather graphic products
- Provide information services to FAA offices
- Ensure that the security of the NAS is not compromised by delivery of the DUAT Service

DUAT Service Providers: "DTC" & "CSC"

Data Transformation Corporation (DTC)
Turnersville, NJ 08012
800-245-3838
http://www.duat.com/

Computer Sciences Corporation (CSC)
Chantilly, VA 20151-3819
800-345-3828
http://www.duats.com/





DUAT Services

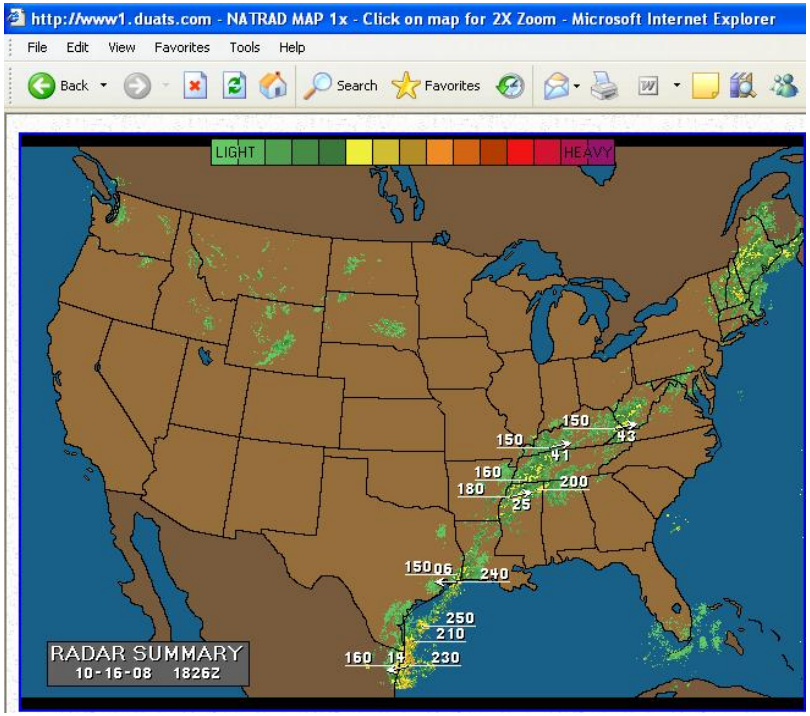
Current weather information

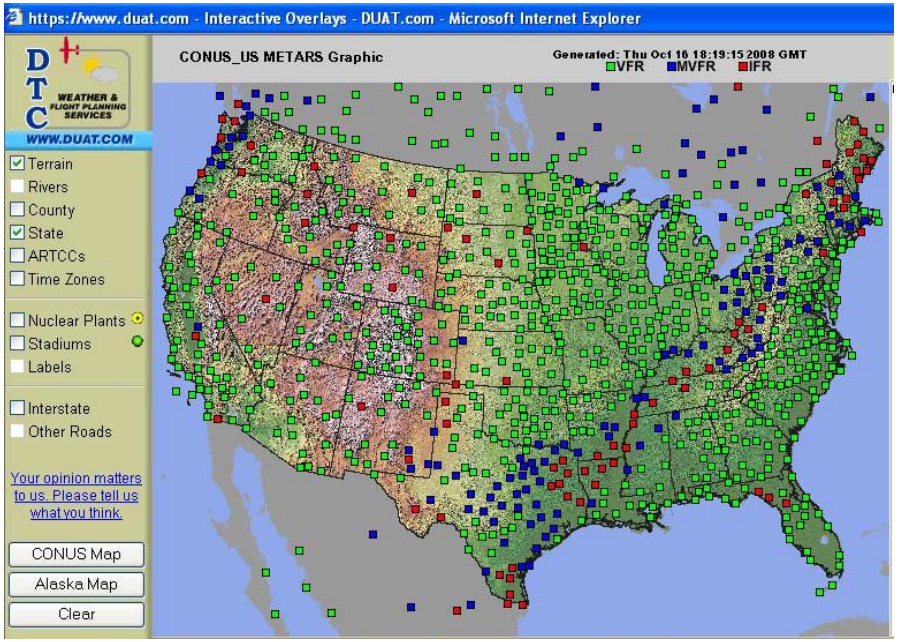
Forecast weather information

Notice to Airmen (NOTAM) information

Flight planning service to authorized users

Event reconstruction data to authorized FAA offices





DUAT Service is available 24 hours a day, 7 days a week

An online help function is provided

Access via toll free telephone numbers or popular Internet web-browsers

DUAT Services Testing

- **Pre-Contract Award**
  - Operational Capability Assessments/Demos/Tests
  - Every 2 – 5 Years (typical)

- **Operational Tests**
  - Post Contract Award
  - As required for FAA mandated changes
  - FAA approval of provider service enhancements
  - Regression tests

DUAT Services Monitoring

- **FSS Team Quality Monitors DUAT Services**
  - 3 to 4 business days per week
  - Live monitoring of both providers services
  - Assessments include planned and Ad Hoc tests
  - No pre-coordination with service providers
  - Review service provider's transaction reports
  - Promptly identify service deficiencies to the Flight Service Program Office (FSPO)
  - Assist FSPO and provider to resolve deficiencies
  - Provides monthly reports and recommendations to FSPO

REDUCED VERTICAL SEPARATION MINIMUM (RVSM)

Introduction of RVSM in North America

- **Implemented using ICAO guidance material – Doc 9574**
- **Over 2 Years in the making**
  - Know Your Airspace – empirical evidence
  - Seminars and internal FAA training
  - Fleet preparation – user education
  - Establish *North American Approvals Registry and Monitoring Organization*
    - Altimetry system error monitoring and monitoring systems development - *Aircraft Geometric Height Measurement Element (AGHME)*
- **Pre-implementation safety assessment – identify areas for action**
- **Implementation – January 20, 2005 0901 UTC**
- **Post-implementation safety assessment – review of performance**
- **On-going Regional Monitoring Agency activities**
  - Biannual safety assessment
  - Aircraft performance per Doc 9574
  - Full participation with global Regional Monitoring Agency partners

MONITORING HEIGHT-KEEPING PERFORMANCE

FL 350 = Constant Pressure Altitude

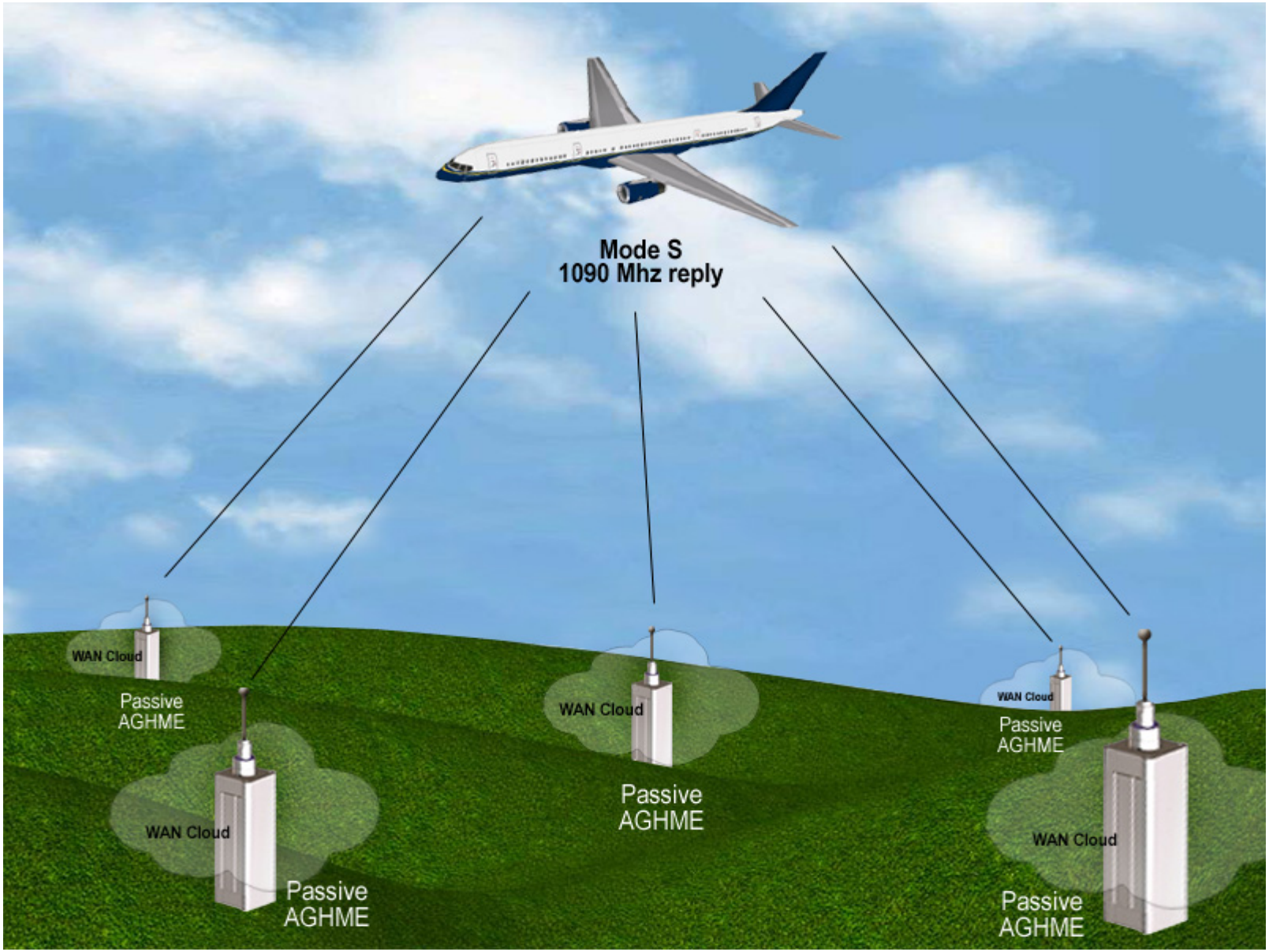
FL 350 Geometric Height

Total Vertical Error (TVE)

= Altimetry System Error + Assigned Altitude Deviation

= ASE +AAD

Aircraft Ground Height Monitoring Equipment (AGHME)


Mode S
1090 Mhz reply
WAN Cloud
Passive
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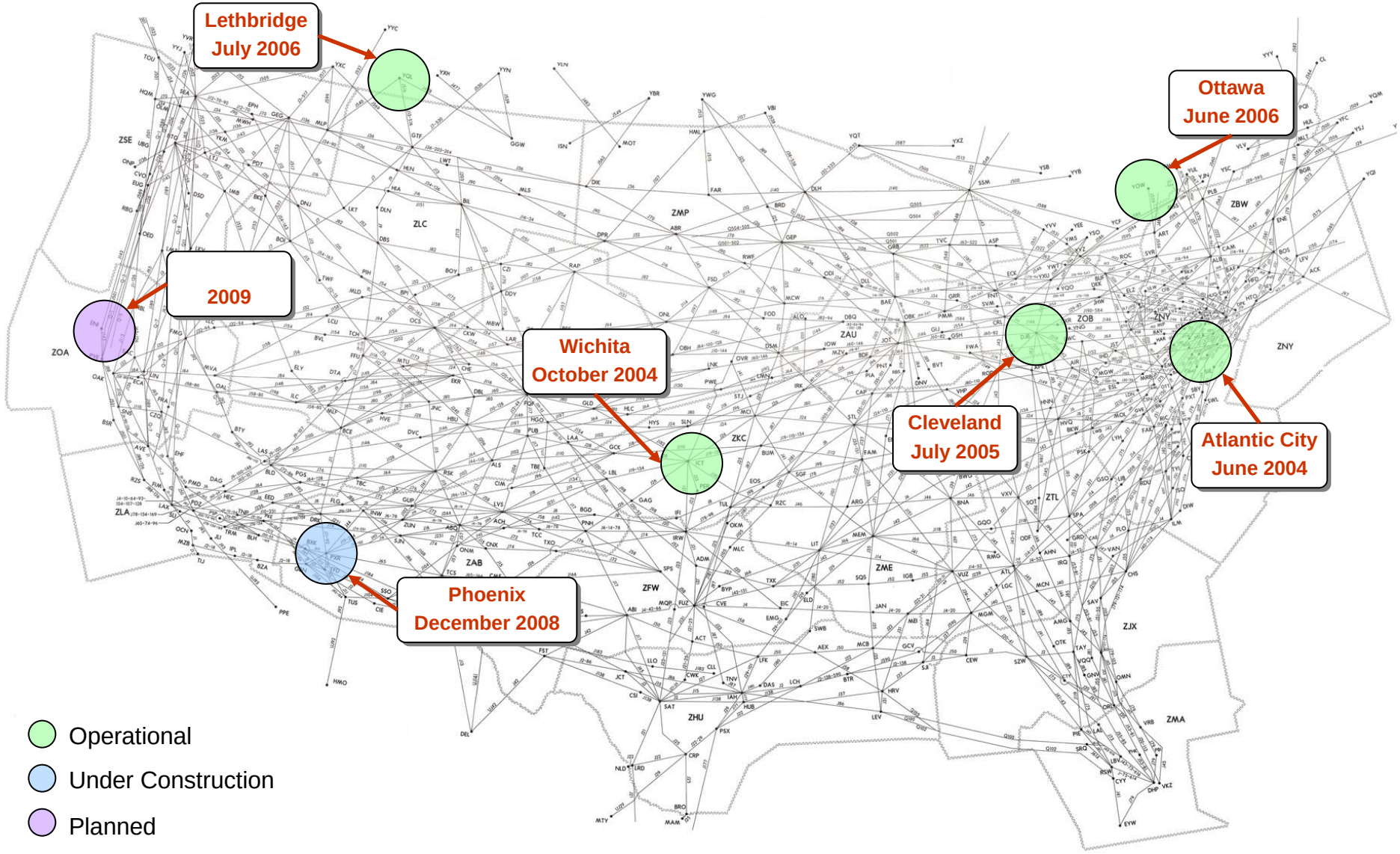
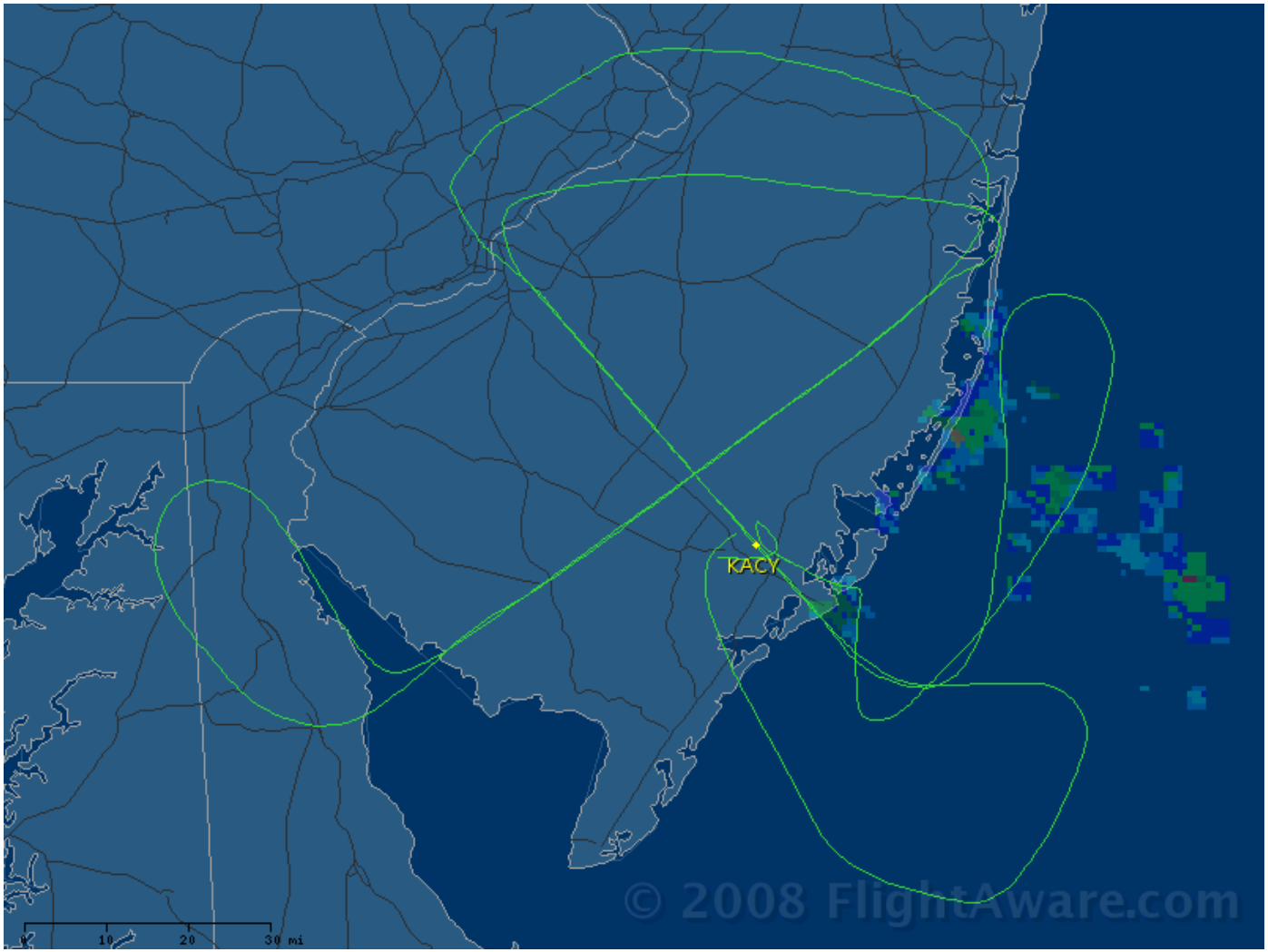

Lethbridge
July 2006
Ottawa
June 2006
2009
Wichita
October 2004
Cleveland
July 2005
Atlantic City
June 2004
Phoenix
December 2008
Operational
Under Construction
Planned

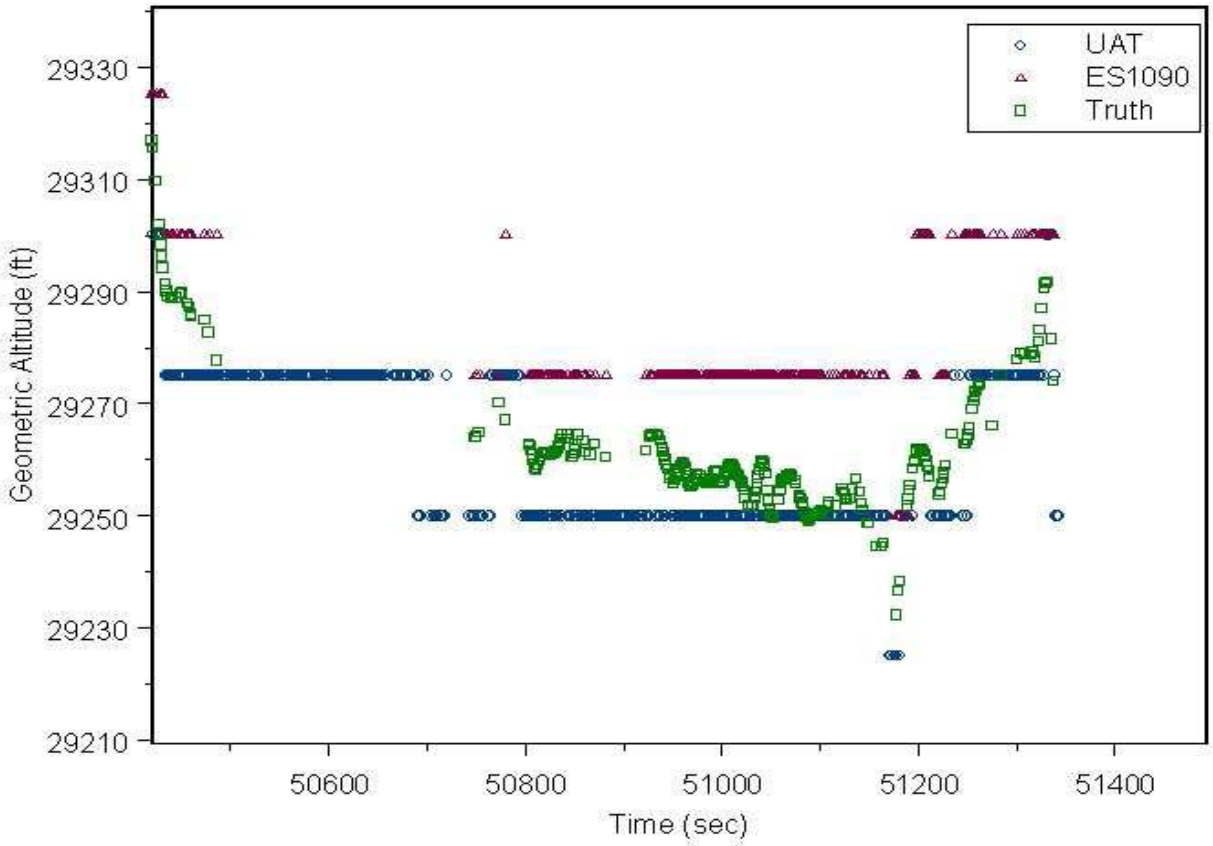
Combined Flight Tests on N47

- **Satisfy several simultaneous tests**
  - RVSM AGHME Improvements
  - Shakedown new ADS-B 1090 MHz Extended-Squitter Rack
  - ADS-B UAT on-board equipment – ground receivers
  - Exercise new TCAS unit
- **Evaluate the suitability of ADS-B geometric height data to satisfy RVSM monitoring requirements**
  - Initial results presented at AIAA Navigation and Control Conference – August 2008
  - Follow-on results to be presented at ICAO Separation and Airspace Safety Panel – Late October 2008

Flight Path



Data Comparison



Segment and Flight Level	Data Source	ASE	Number of Observations
June 27 FL 410	EGMU	73	188
	1090 ES	95	176
	1090 ES – 25 ft bias	70	176
	UAT	73	310
June 27 FL 410	EGMU	111	137
	1090 ES	149	65
	1090 ES – 25 ft bias	124	65
	UAT	118	173
June 27 FL 410	EGMU	78	155
	1090 ES	Insufficient Data	5
	UAT	76	155
July 2 FL 410	EGMU	57	647
	UAT	58	58
July 2 FL 410	EGMU	55	468
	UAT	50	46

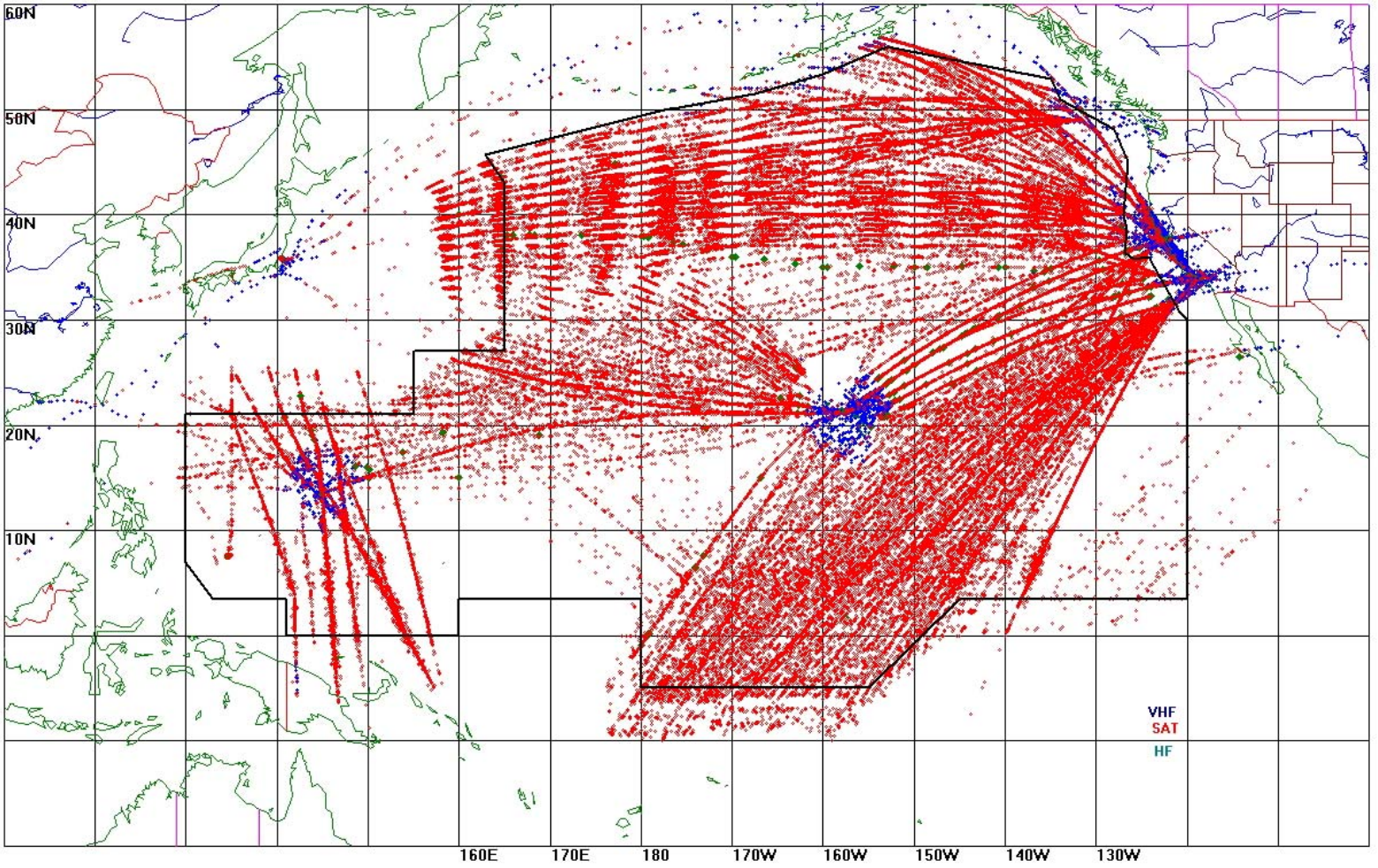
REDUCED SEPARATION
in the
OAKLAND CENTER
FLIGHT INFORMATION REGION

30 NM Lateral /30 NM Longitudinal Separation Reduction (30/30) in Oakland Center FIR

First wide-scale implementation of reduced lateral and longitudinal separation

- Dependent on ground-based controller decision support system (ATOP) and satellite datalink for supporting communication and surveillance (Automated Dependant Surveillance – Contract, ADS-C)
- Organized as an operational trial December 2005
- Performance verification required by Annex 11 – comm, nav, surveillance
- **Datalink services are still being proven**
- **Deficiencies in the datalink system are being remediated**
  - U.S. proposed Oceanic Safety Performance Requirement (per RTCA DO-306) & 0.9999 comm system availability

December 2006 – ADS SAT,VHF & HF/DL Locations



Traffic Collision Avoidance System (TCAS)

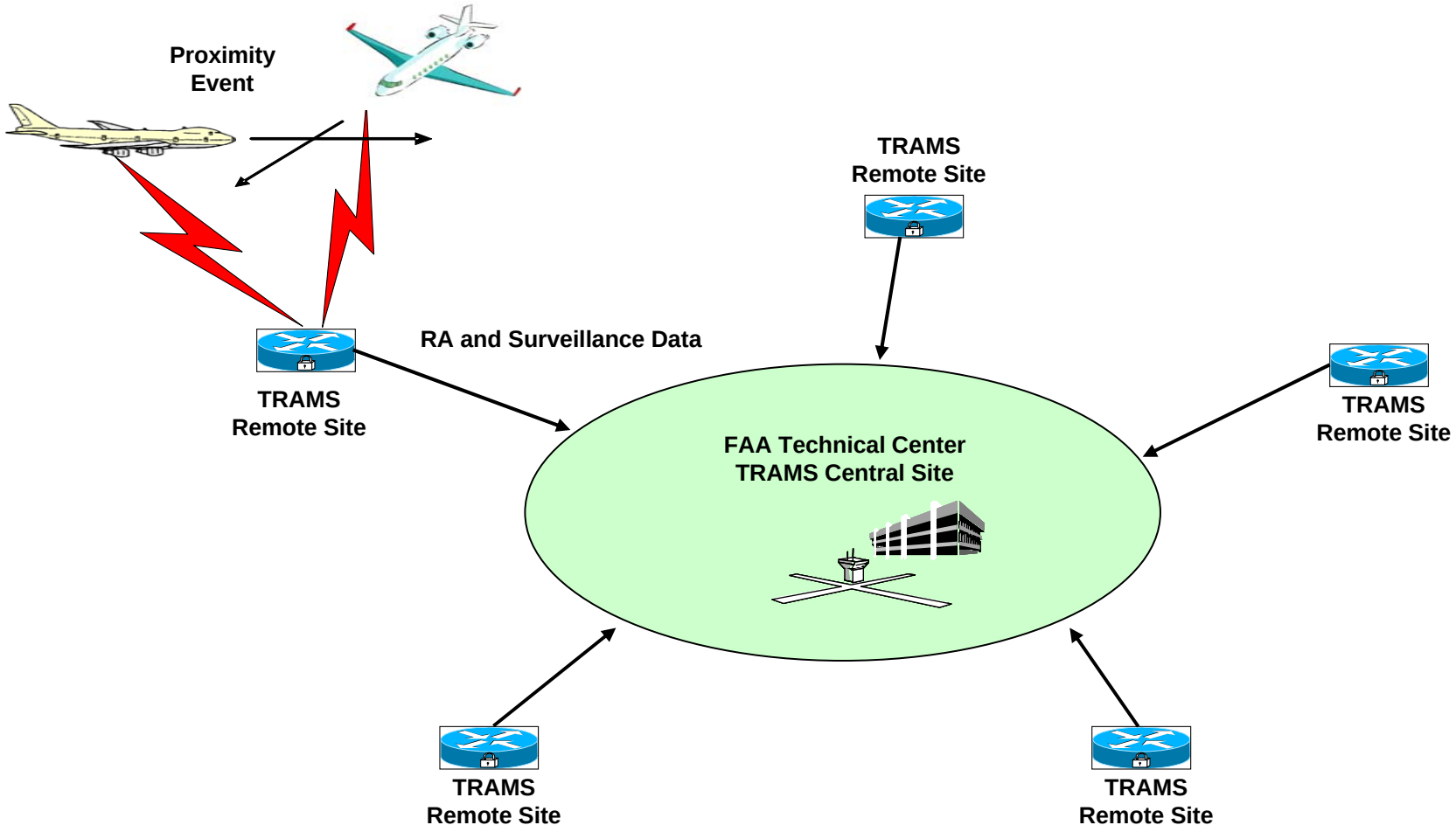
Recent TCAS Events

- **Logic Changes**
  - **RA Reversal**
  - **“Adjust Vertical Speed Adjust”**
  - **Hybrid Surveillance**
- ***Safety Management System* requirement to monitor new systems to protect against NAS performance degradation**
- **TCAS Resolution Advisory Monitoring System**
- **RTCA SC-218 (ADS-B/TCAS Relationships)**
  - **System engineering analysis plan – September 2008**
  - **Complete system engineering analysis – July 2009**
- **UAS applications**

TCAS RA Monitoring System (TRAMS)

- **Distributed ground-based system**
- **Real-time capture of airborne Resolution Advisories (RA) communications, related surveillance**
- **Daily transmission to central facility for analysis/ archive**
- **Database of actual RAs and associated surveillance data for post analysis of TCAS operational performance**
- **Database of selected surveillance data for research**

TRAMS Architecture



TRAMS Data Collection and Processing

- **Remote Site Data Collection**
  - Equippage (transponder & TCAS types)
  - For tracks declaring an RA and tracks not declaring an RA but would otherwise be reasonably expected
    - The RA message
    - Surveillance data
    - 3rd party surveillance data
  - Surveillance data for tracks exhibiting altimetry anomalies
- **Remote Site Processing (Daily Summaries)**
  - Flight operations by equipage
  - Environmental density by equipage & altitude bands
  - Estimates of TA/RA rates for collision risk assessments

TRAMS Deployment

- **Three test sites**
  - **PHL (April 2008)**
  - **JFK (July 2008)**
  - **LAX (November 2008)**
- **Begins Mar 2008 at DFW**
- **New site about every 3 weeks thereafter**
- **Continuous data collection, analysis through FY 2011**
- **Data collection, daily summaries post FY 2011**

TRAMS Sites

Sensor	Airport	# Ops/Install	
BUR	Bob Hope	344	5
HPN	Westchester County	461	12
NUQ	San Jose Intl	504	8
STB	St. Louis Intl	714	9
PDX	Portland	722	13
FLL	Ft. Lauderdale	830	14
OAK	Oakland Intl	921	7
STC	Seattle-Tacoma	950	19
LGB	Long Beach	1107	6
EWR	Newark Liberty Intl	1268	11

Sensor	Airport	# Ops/Install	
JFK	John F Kennedy Intl	1318	2
DTWA	Detroit Metro	1319	17
LAXN	Los Angeles	1388	3
DFW	Dallas-Ft. Worth	1405	4
PHX	Sky Harbor Intl	1476	18
DEN	Denver Intl	1605	15
LAS	McCarren Intl	1696	20
PHL	Philadelphia Intl	1875	1
QXM	O'Hare	2625	16
ATL	Hartsfield Intl	2959	10

- 20 TRAMS Remote Sites
- Denver is the only TRAMS Remote Site based at an enroute radar

SYSTEM WIDE INFORMATION MANAGEMENT (SWIM)

System Wide Information Management (SWIM)

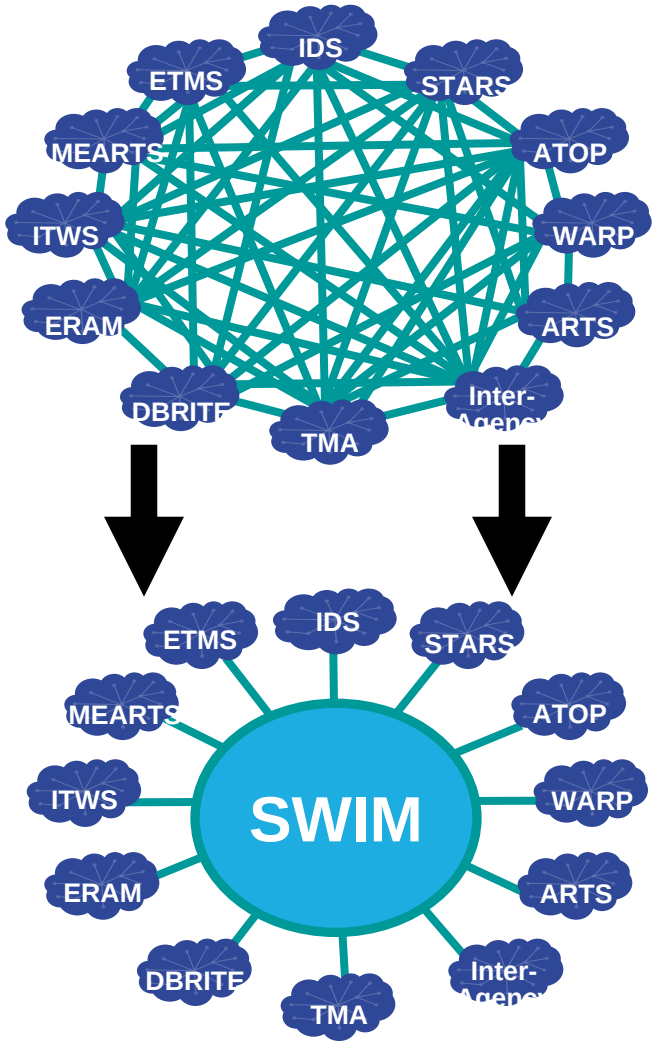
Purpose:

Migrate NAS applications toward a loosely coupled, open-distributed processing environment (Service Oriented Architecture)

Expose data to both new and legacy applications

Support NAS interoperability

Reduce unique interfaces



Method:

Program Office provides common commercial software

SWIM Implementing Programs **(SIPs)** develop / procure software that meets SWIM Program Office mandated standards

SWIM Test team monitors SIP T&E activities

System Wide Information Management (SWIM)

Core Services:

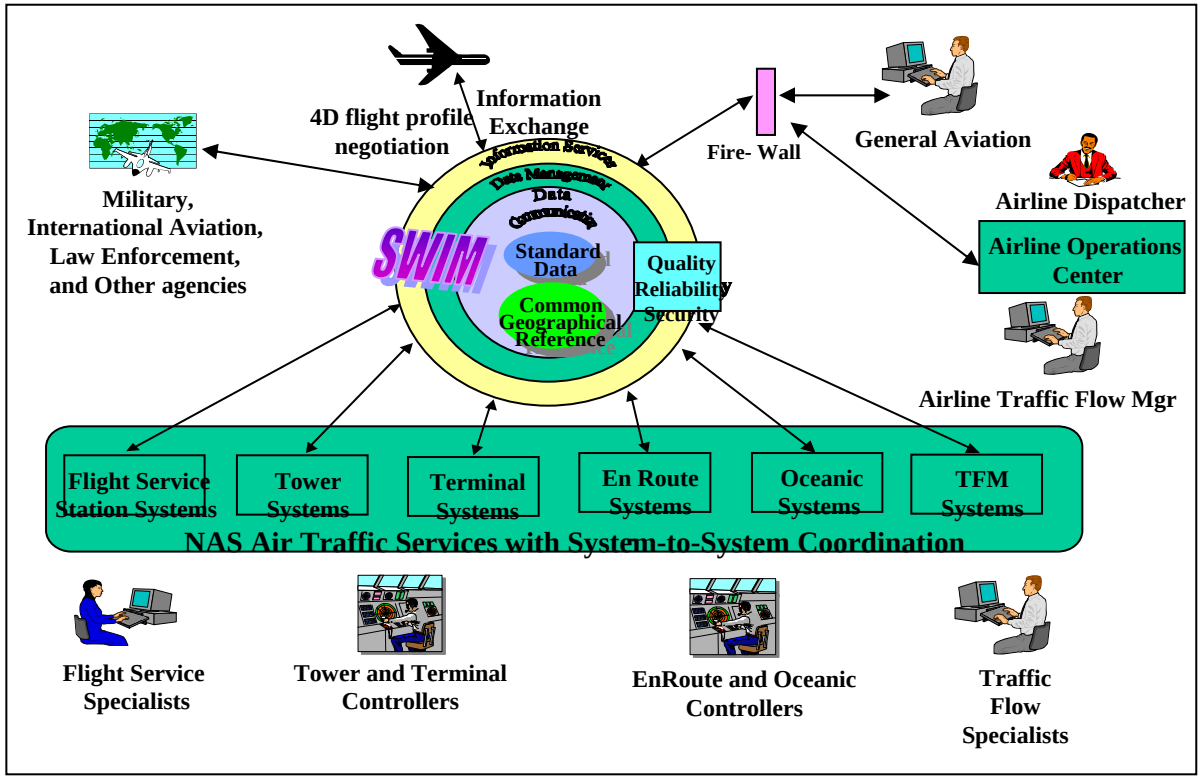
SIPs Will Implement Core Services for Selected Systems

Interface Management – Expose / find services

Messaging – Publish / subscribe, request / reply

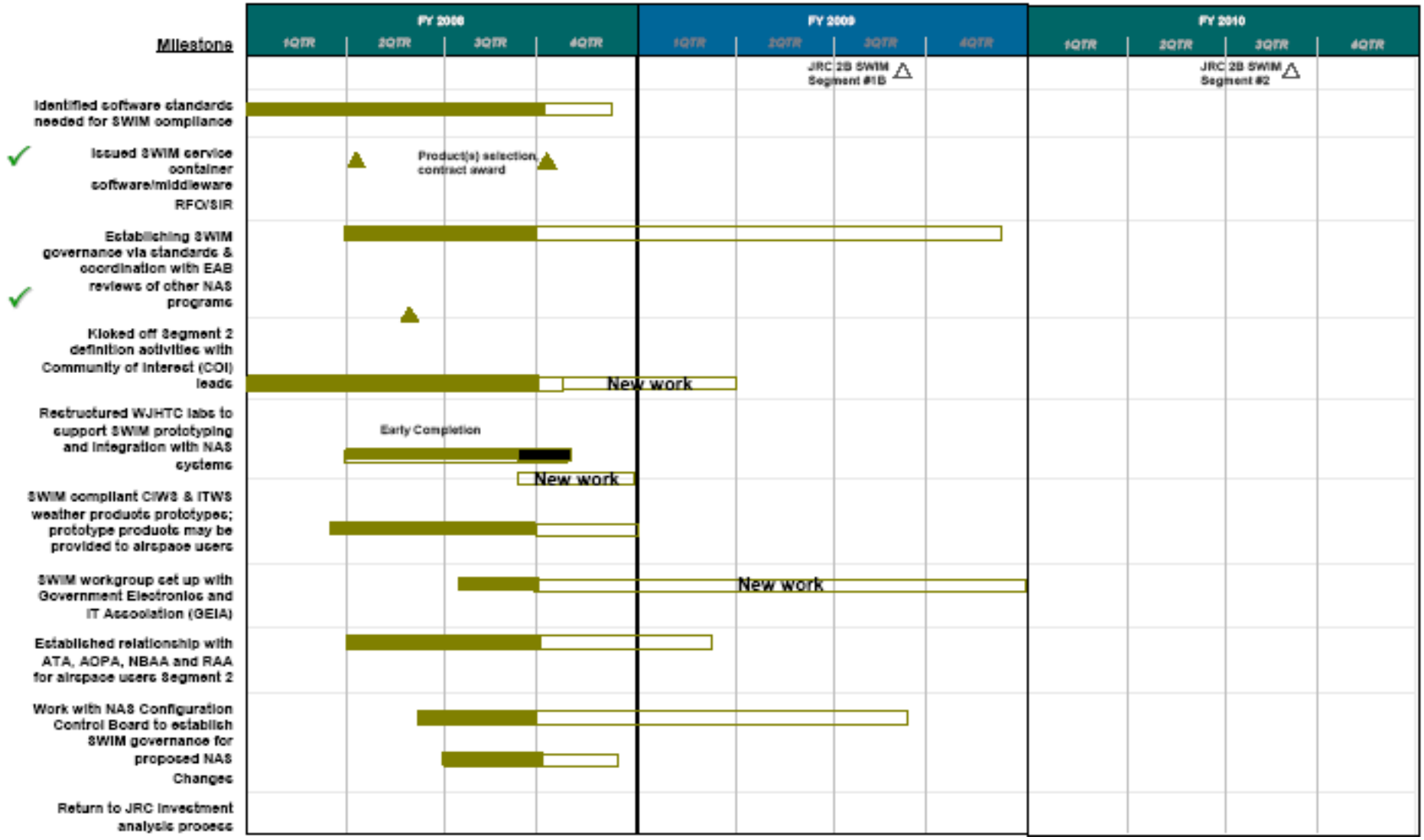
Security – Authorization levels

Enterprise Service Management – **Performance, usage monitoring**



SWIM

FY2008 – FY2010 Activities

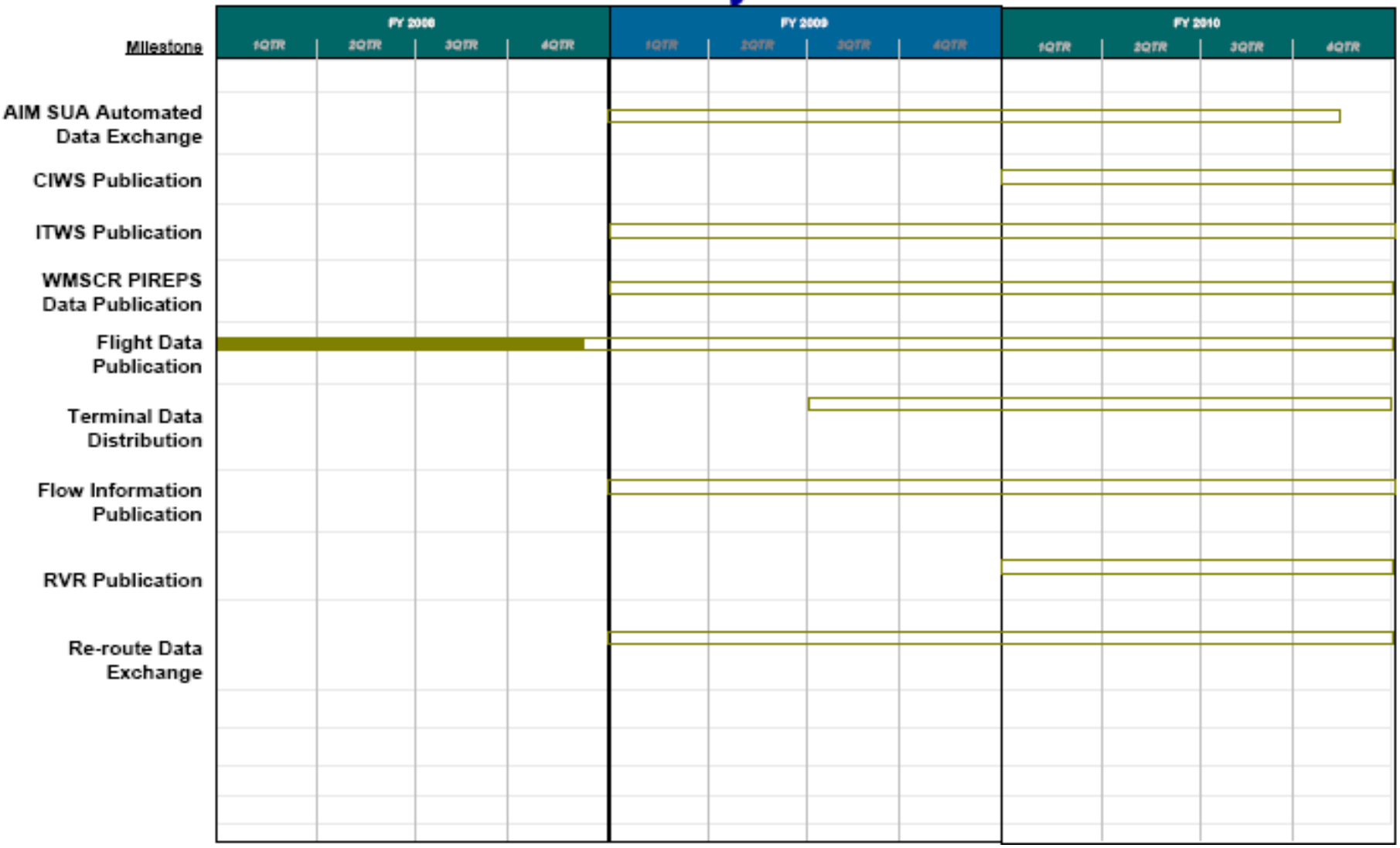


Technical Center Role in SWIM T&E

Agent of Program Office Implementation Team

- Participate in System Engineering SWIM Test Bed Activities
- Develop SWIM Test and Evaluation Master Plan
- Monitor SIP T&E activities to ensure compliance with acceptable standards and requirements

FY2008 – FY2010 Service Delivery Schedule



NextGen DATA COMMUNICATIONS (DataComm)

NextGen Data Communications (DataComm)

Purpose: Transition from voice to data communication

- ATC clearances, instructions, advisories, flight crew requests, reports and traffic flow management, etc
- Data exchange for 4D trajectory-based operations

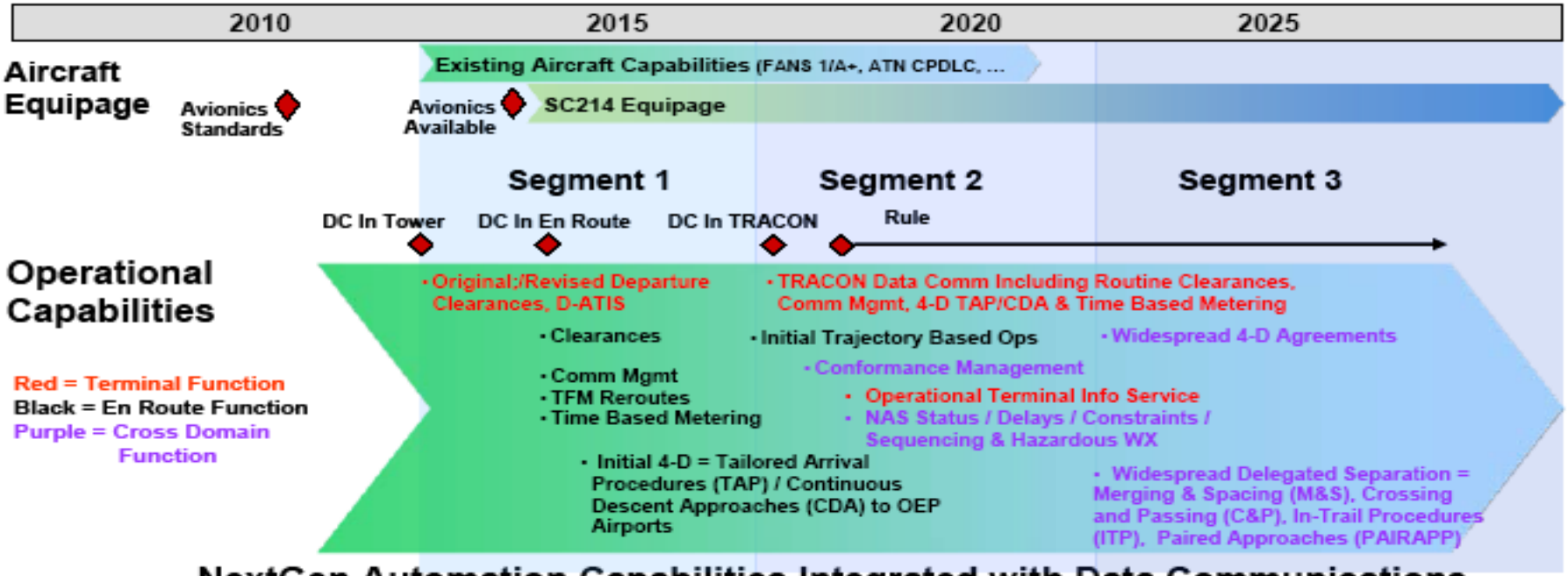
Includes:

- Ground automation system(s)
- Message generation and receipt
- Message routing and transmission
- Ground Wide Area Network
- Air/Ground subnetwork
- Aircraft avionics

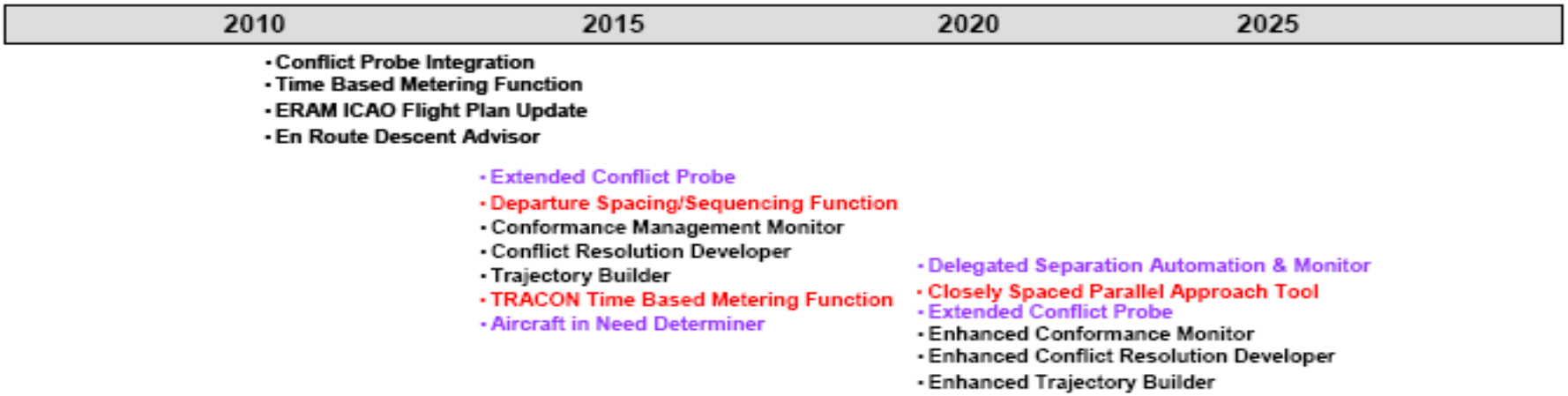
Current Role:

- Support DataComm specification development
- Develop Test and Evaluation Master Plan
- Develop Testbed

Data Communications Services



NextGen Automation Capabilities Integrated with Data Communications



Data Communications

Sandra Anderson, Program Manager

ISSUES, CONCLUSIONS, RECOMMENDATIONS

Issues, Conclusions, Recommendations

- **Initial Target Environment of "Basic" System adds complexity to the already difficult and exacting tasks of DT&E and OT&E –** avionics, pilot interface, external nodes, FAA service providers, etc.
- **Requirements and "System Design" must accommodate enhancements, extensions and uncertainty**
- **Integration of Systems to provide NextGen Capabilities requires "creative" approaches to DT&E and OT&E**

Issues, Conclusions, Recommendations

- **Cooperatively develop T&E tools to facilitate operational system performance monitoring and problem determination and resolution** (possibly extensible to training, incident investigation)

- **The FAA should begin an effort on the feasibility of domain-specific monitoring tools**
  - Signal-in-space (RVSM, WAAS, LAAS, navigation, surveillance, TCAS)
  - Communications/Networks
  - Air Traffic Management (4D trajectory modeling, strategic problem detection/resolution, ETMS…)