CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

8th CNS/ATM Symposium

NextGen: Addressing U.S. Future Needs for Air Transportation

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Program Director, Asia Pacific

21 February 2008

セリア･フ･フレンバーグ女史のプロファイル

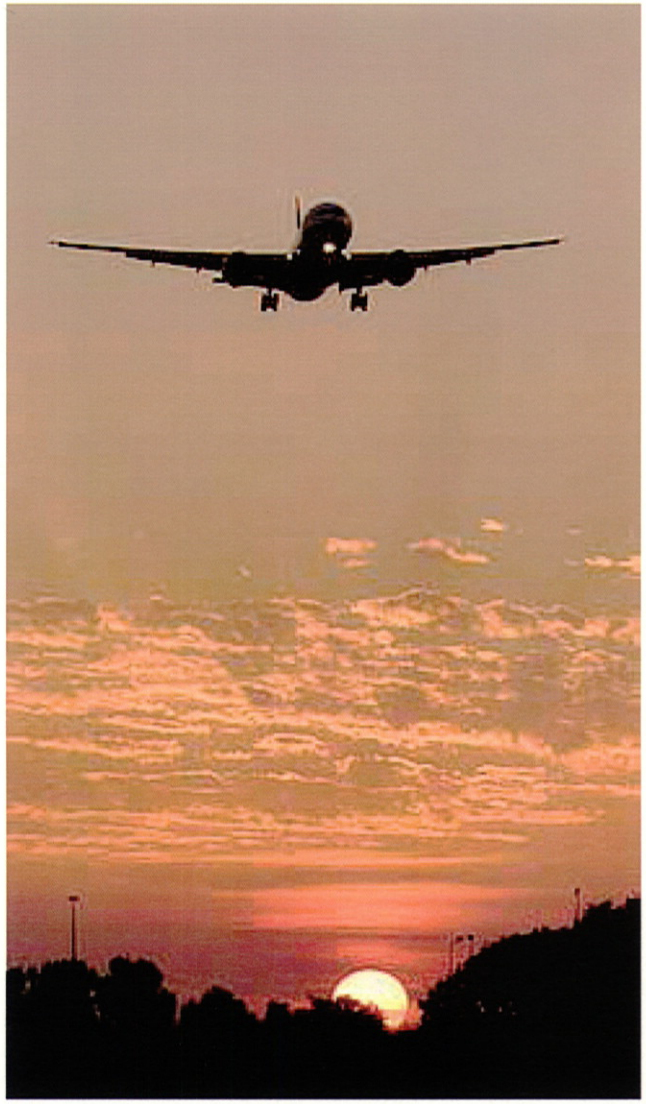
米国マイター（MITRE）社

アジア太平洋国際プログラムセンターにおける先進航空システム開発に関わるプログラムディレクター

- **レンバーグ女史の社内ポスト**
  - マイター社、アジア･太平洋国際プログラムセンターのプログラムディレクター
  - マイター社、先進航空システム開発センター（MITRE／CAAD）におけるアジア･太平洋諸国向けの戦略的計画と企画執行の責任者
  - マイター社、CAADにおける国際的なアジア･太平洋航空プログラムのビジネス計画、開発及びマネージメントを指揮
- **フレンバーグ女史の業務経歴**
  - 米国FAA、JPDOに対する技術的支援、更には世界中の航空分野、即ち、CNS／ATM，ATFM及び空港総合システムにおける国際的プログラムに対する技術的支援の提供
  - 米国FAA並びに国際的な民間航空当局に対する多数のソフトウエア、運用、技術開発の評価並びに分析プログラム等をリード
  - 各種セミナーや会議において、CNS／ATM，ATFM、システムエンジニアリングに関わるトピックスについて数多く講演
  - フレンバーグ女史のプログラムマネジャーとしての活躍例
    1) 日本の航空局のMTSAT／MSASへの技術支援及び羽田空港のRNAV／RNP方式の開発に関わるマイター社プログラムマネジャー
    2) 中国のCNS／ATM基本計画研究，ATFM計画，GNSS研究、並びにアジア太平洋地域に関わる地域的GNSSの研究等についてのプログラムマネジャー
    3)上記の他、タイ、インドネシア、ベトナム、及びフィリピンにおけるCNS／ATM関連の多くのプロジェクトを完了
    4) 日本の中部国際空港、中国の上海プドン国際空港及び広州新バイユン国際空港向け総合通信情報システムに関わるマイター社のプログラムマネジャー
    5) JPDO傘下のグローバルハーモニゼーション･ワーキンググループの活動委員会の共同議長
- **フレンバーグ女史の学位等**
  - メリーランド州、ボルティモーのジョンホプキンス大学のコンピュータサイエンスに関するMS（修士）学位を保持
  - ミズーリ州、セントルイスのワシントン大学の電子エンジニアリング（数学、経済の副専攻科目を含む）に関するBS（学士）学位を保持
  - 電気･電子技術学会（IEEE）、女性技術者協会（SWE）、及びアルファ･ファイ･オメガ（APO）機構に所属

Overview of Presentation

- NextGen
- Related FAA Programs
- Challenges
- Conclusion



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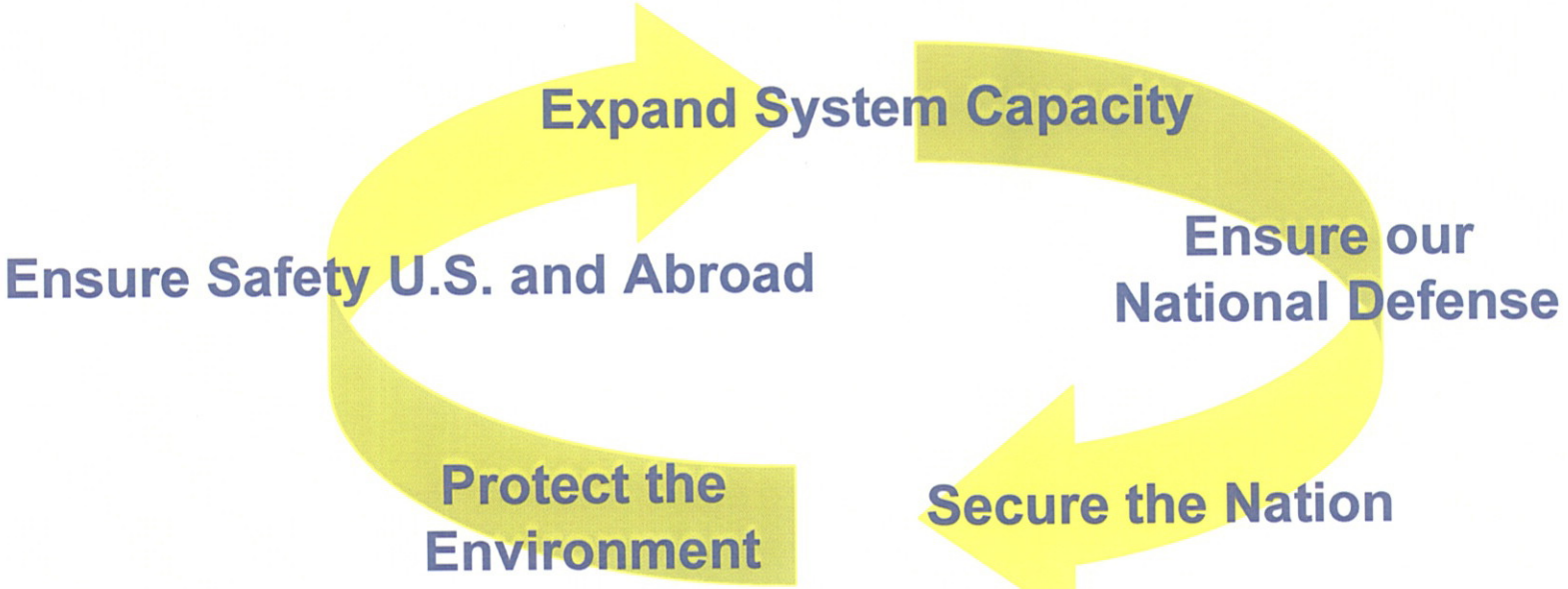
NextGen Goals

A Next Generation Air Transportation System that meets the nation's future air transportation safety, security, mobility, efficiency, and environmental needs



Advance Global Aviation and Harmonization

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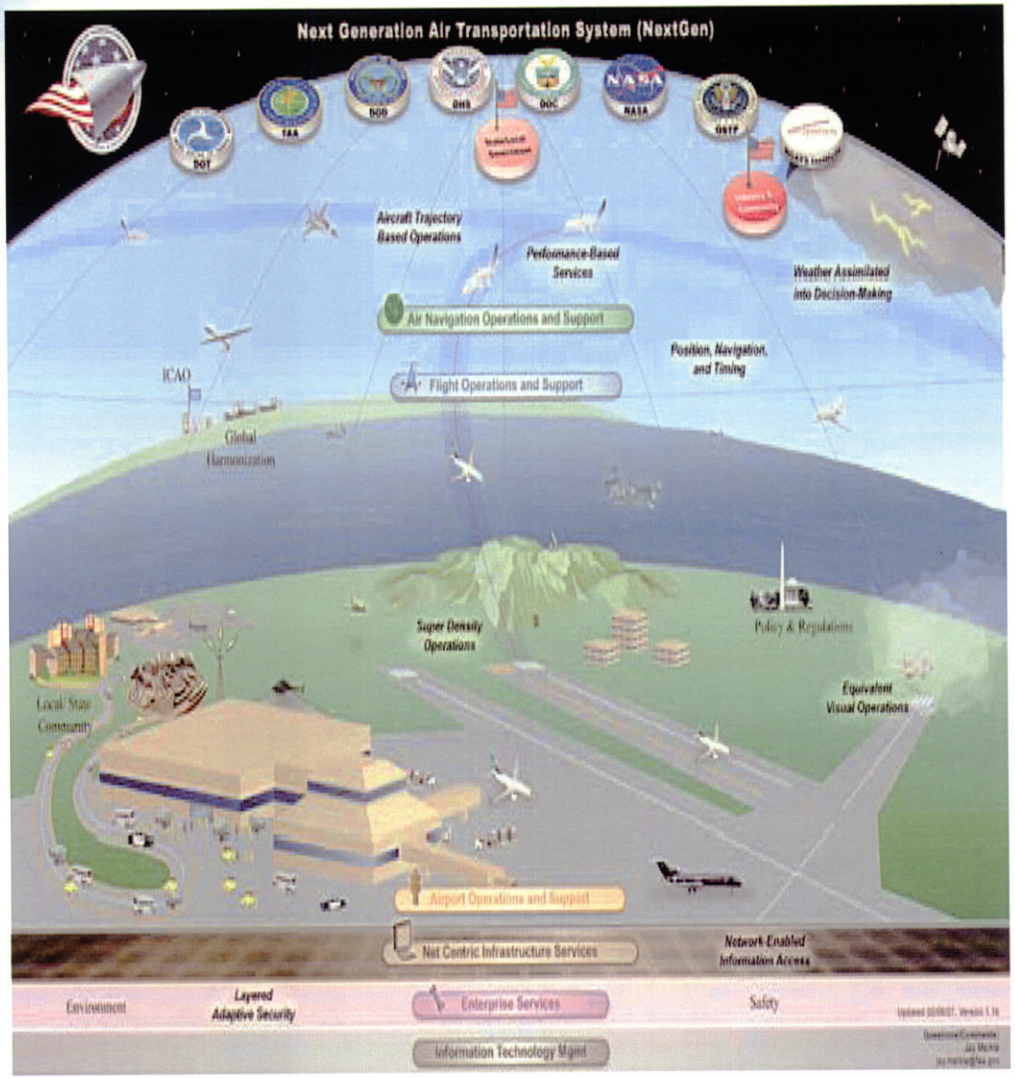
What is NextGen?



Transformation goals:

- "State of the art" in air transportation
- Scalable up to tripling in capacity
- Ensure national defense (readiness and homeland security)
- Enhance environment (noise, air quality)
- Improve safety
- Harmonized globally

Capabilities:

- Network-Enabled Information Access
- Performance Based Operations & Services
- Weather Assimilated into Decision Making
- Layered, Adaptive Security
- Position, Navigation, and Timing Services
- Aircraft Trajectory Based Operations
- Equivalent Visual Operations
- Super Density Arrival/Departure Operations

Led by Joint Planning and Development Office

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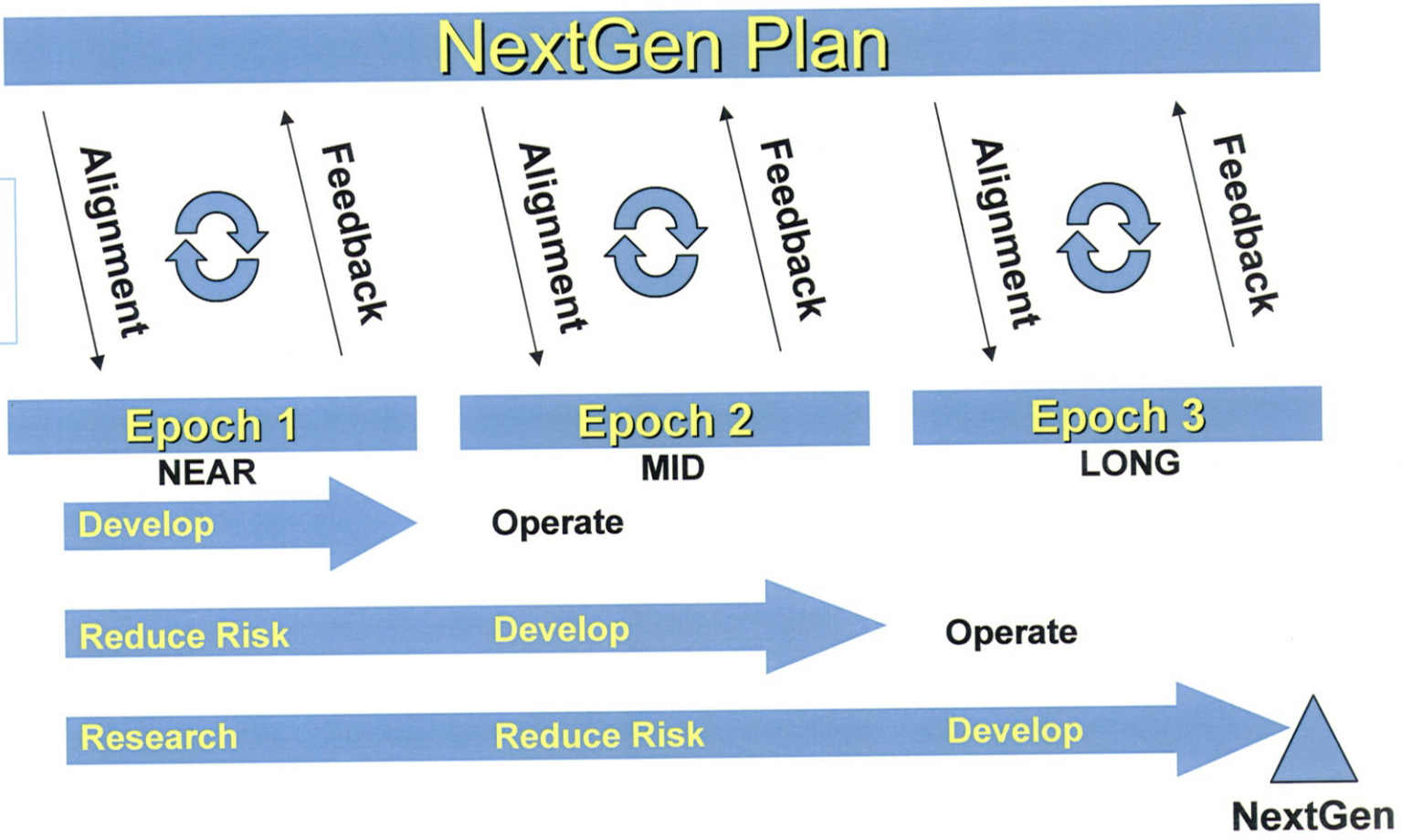
NextGen Evolution

JPDO
Planning & Oversight

NextGen Plan provides mechanism for alignment and oversight

Agencies
Implementation

Phased Implementation to manage risk and ensure intermediate benefits



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Building NextGen Capabilities

Core Technologies, Capabilities & Systems Engineering

Develop: FY06-11 **Implement: FY10-15**

- Emphasize later stages of R&D to support mid-term capabilities (e.g. field trials)
- Field trials minimize risk for achieving integration of multiple NextGen capabilities
- Develop & implement core technologies (DataCom, SWIM, Net-Enabled Weather)
- Develop performance-based standards; avionics standards and development
- Complete infrastruture and systems engineering (TBO, CATM, etc.)
- Develop NextGen systems integration plan for mid-term transition to NextGen
- Implement expanded RNAV/RNP procedures across NAS domains
- Continued implementation of known solutions/infrastructure (ADS-B)
- Complete airspace redesign (OEP airports)
- Design and develop controller training/tools required for mid-term transition to NextGen.

Mid-Term Transition to NextGen

Develop: FY12-17 **Implement: FY14-19**

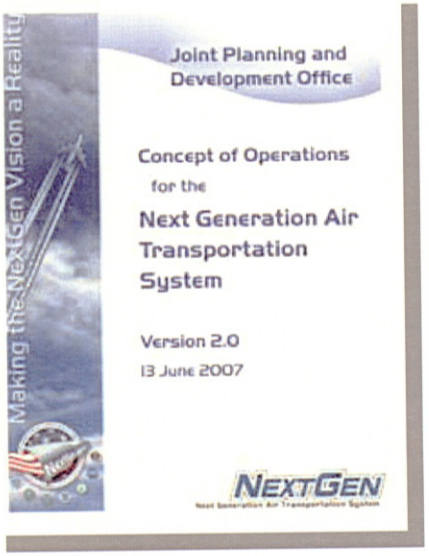
- Aircraft equipped for the mid-term
- Initial delivery of NextGen services and capabilities become available across domains (enroute, terminal automation, surface ops)
  - Trajectories exchanged via data link
  - Implement initial TBO and flexible airspace management
  - Implement integration of flow management with ATC
  - Improved collaboration and decision-making across domains
  - Implement enhanced airborne flow programs to reduce impact of weather
- Complete transfer of services and systems integration for air transportation system-wide NextGen solutions delivery and operations

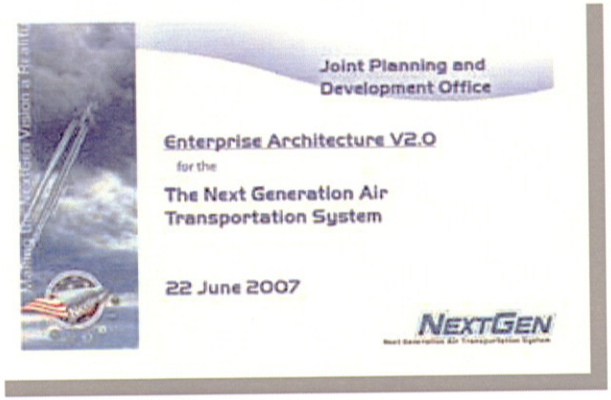
NextGen Solutions Integrated Across NAS

Develop: FY18-21 **Implement: FY20-25**

- Trajectory-Based Operations
- Increase Arrivals/Departures at High-Density Airports
- Flexible Terminals & Airports
- Collaborative Air Traffic Management
- Reduced Weather Impact
- Safety, Security & Environmental Performance
- Transformed Facilities

Foundational NextGen Documents





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Operational Evolution Partnership (OEP)

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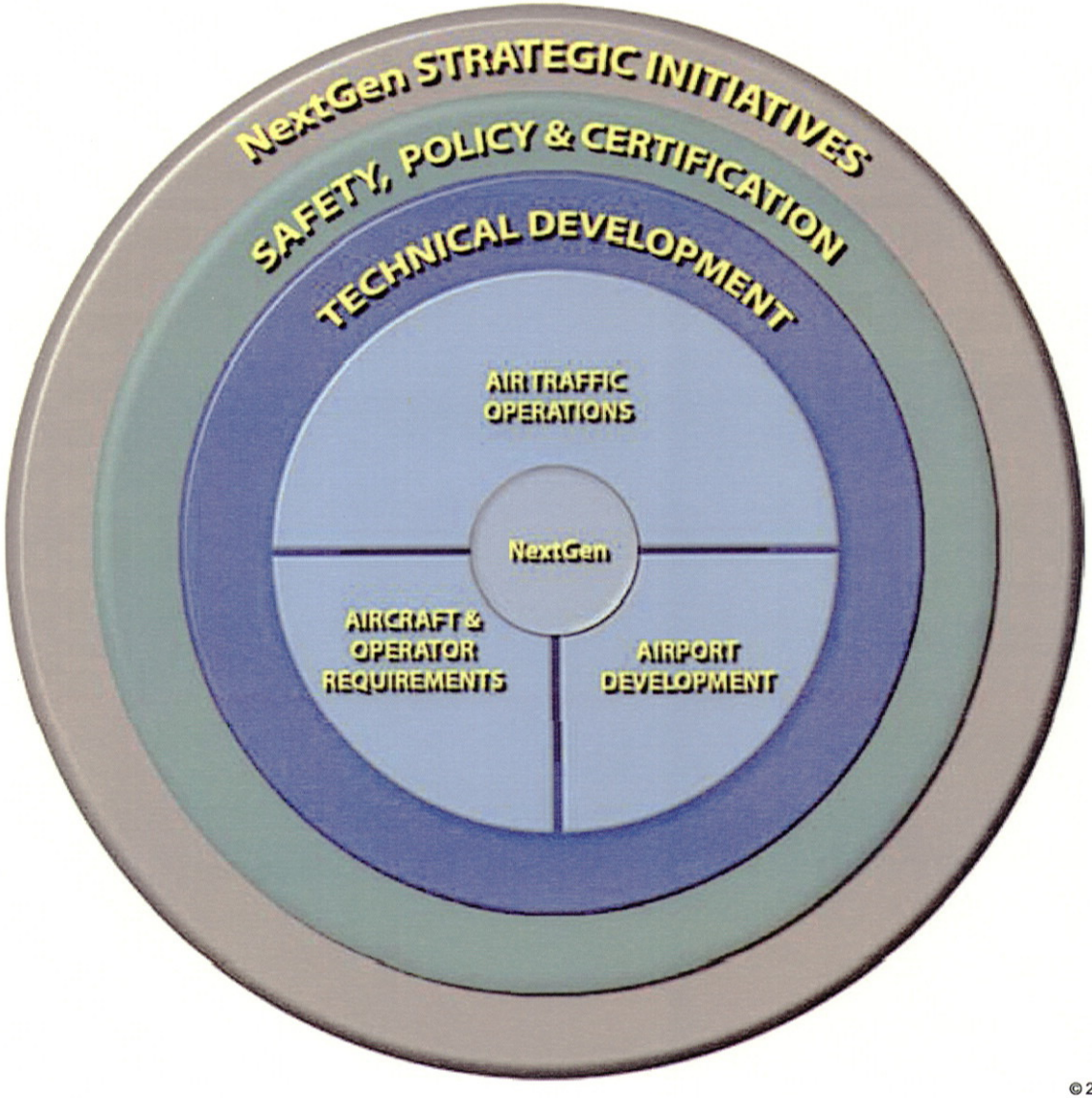
Operational Evolution Partnership



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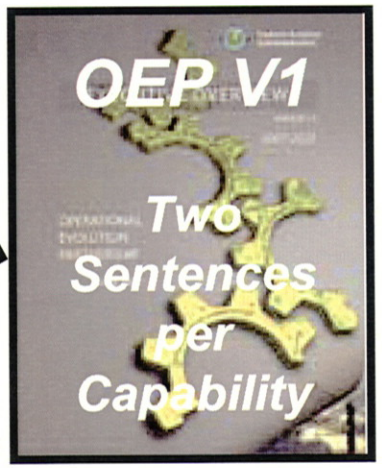
Operational Evolution Partnership

www.faa.gov/programs/oep

JPDO Guidance

Reauthorization Briefing

Solution Sets
Capabilities
RPDs
Resource Planning Documents



One page of structured text; one page timeline of top level activities

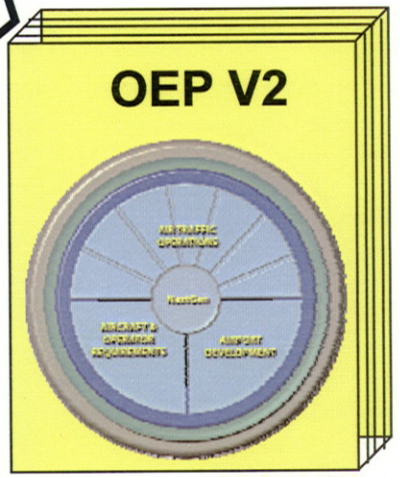
Draft Two Pagers

OEP V1 Title
OEP V1 Description
Needs
Ops Concept
Design/Architecture
Dependencies
Benefits

page 1

Time Line
Programs
Architecture (EA) Decisions
Activities
Schedule

page 2



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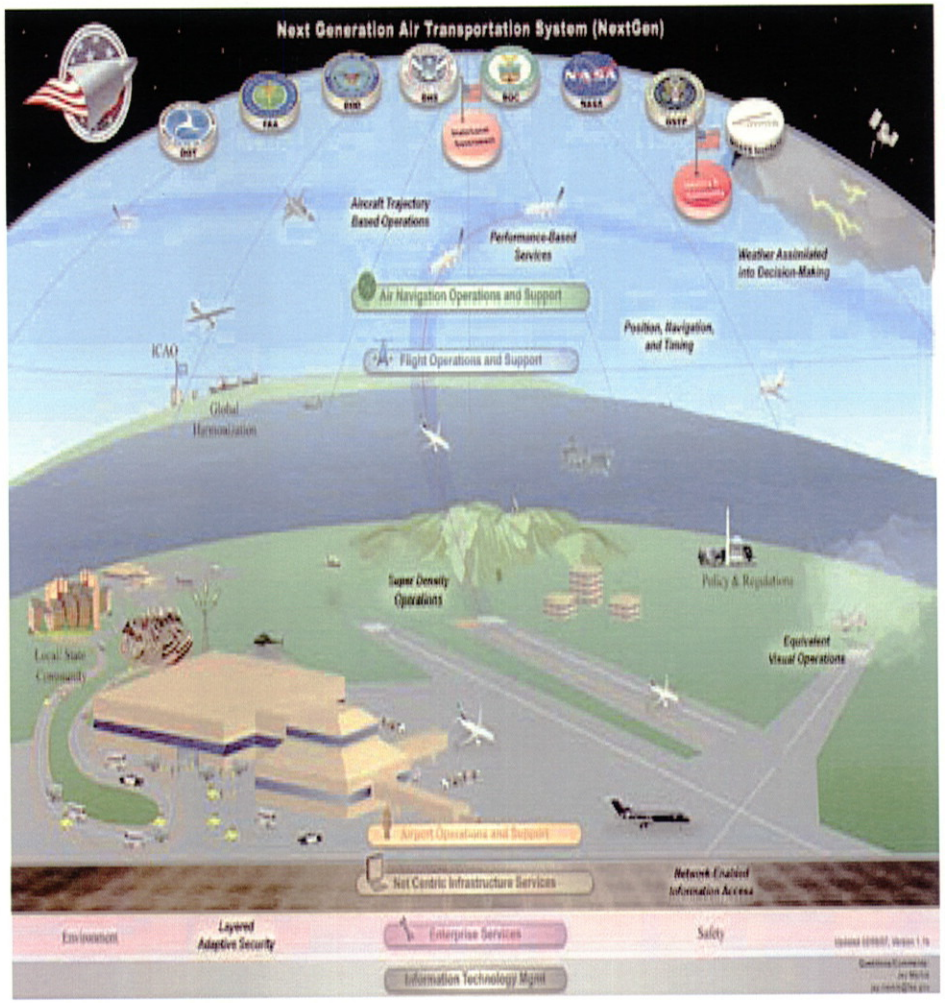
NextGen Capabilities



- Network-Enabled Information Access
  - SWIM
- Performance Based Operations and Services
- Weather Assimilated into Decision Making
- Layered, Adaptive Security
- Position, Navigation, and Timing Services
- Trajectory-Based Aircraft Operations
- Equivalent Visual Operations
- Super Density Arrival/Departure Operations

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System Wide Information Management (SWIM)

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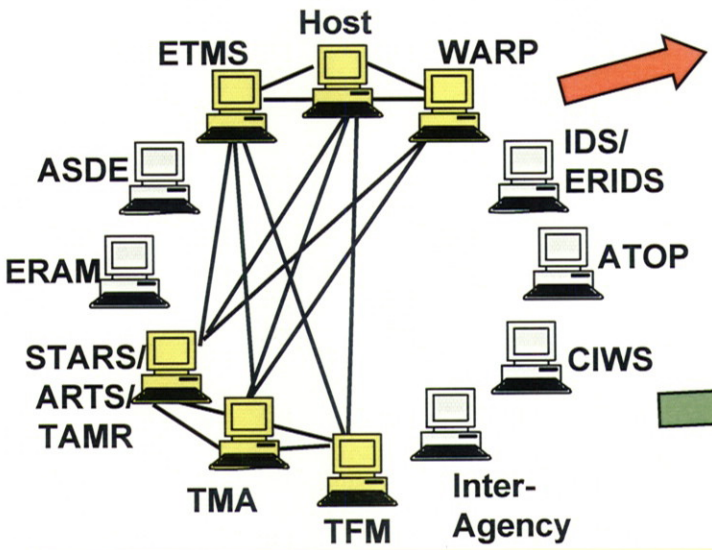
Evolution of the National Airspace System (NAS)

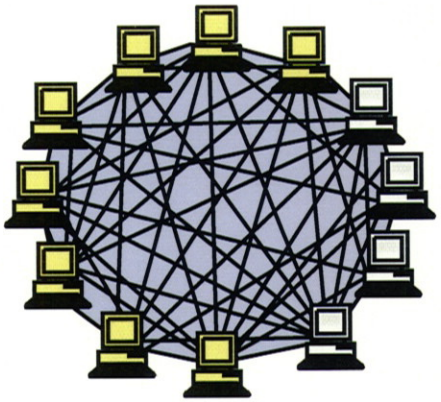
Continuation of present approach - leads to an N^2 scaling problem and a dead end!

Next Generation Air Transportation System

NGATS

Today

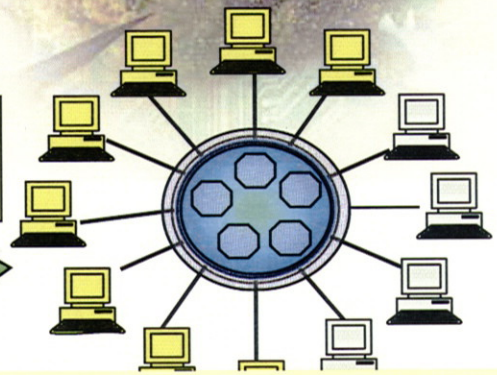




- Existing point-to-point hardwired NAS
- Unique interfaces, custom designs
- Information not available where needed
- New system integration difficult and expensive

Future

NetCentricity Needed for NextGen



- Open, standardized, service interfaces
- Common network infrastructure
- Access control based on policy, not geography or topology

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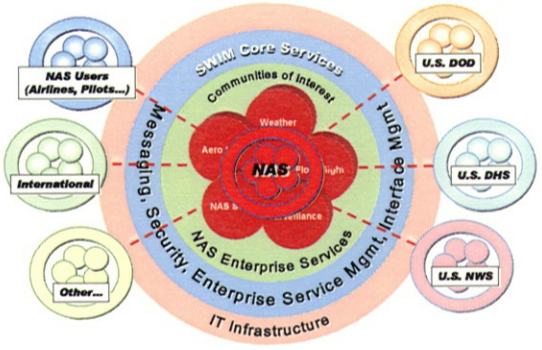
NetCentricity and SWIM

- **"At the heart of the NextGen concept is the information exchange component known as net-centric infrastructure services or net-centricity"**
  - **JPDO CONOPS for NextGen**

- **"The key to enabling net-centric operations in NextGen is information management"**
  - **JPDO Draft Information Management and Exchange Strategy**

- **"System Wide Information Management (SWIM) will provide an open, flexible, and secure information management architecture for sharing NAS data and enabling increased common situational awareness and improved NAS agility"**
  - **FAA SWIM Description**



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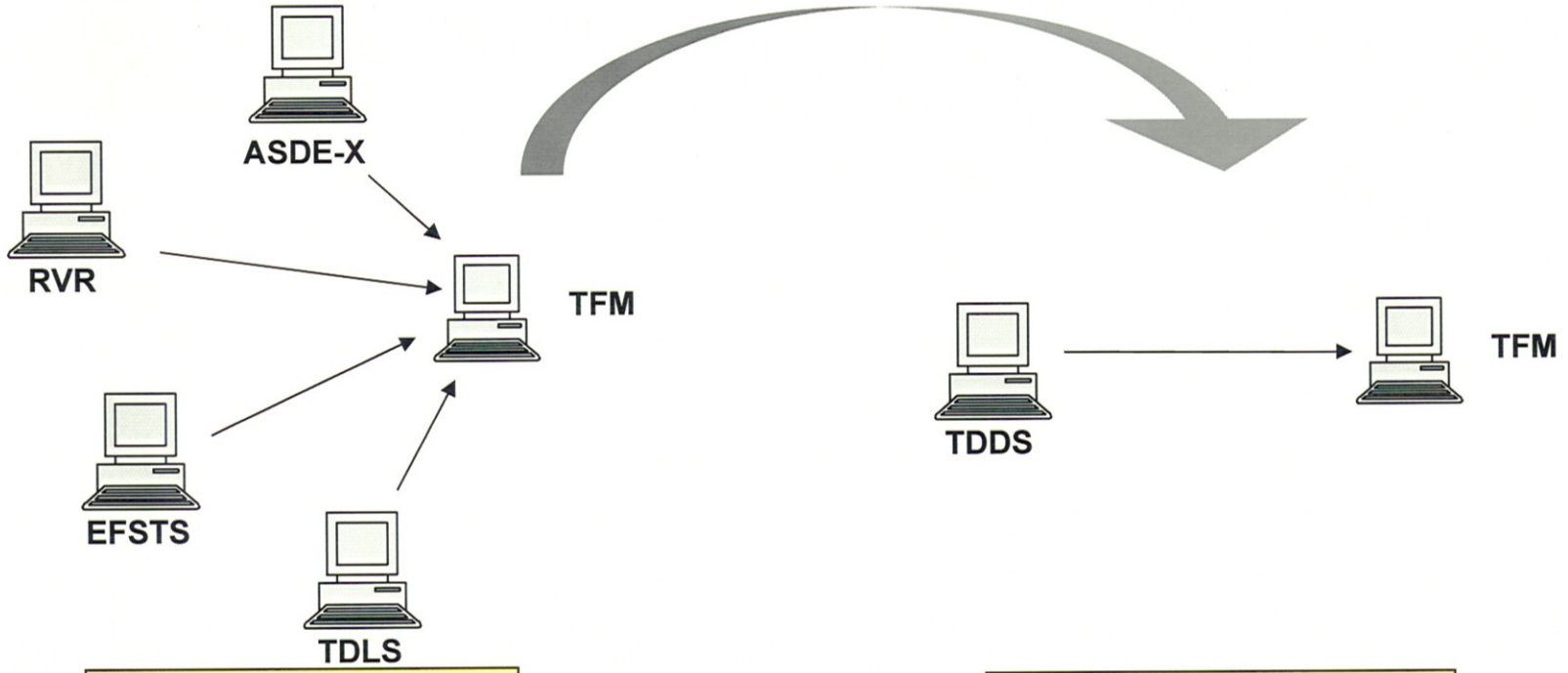
One Example



TFM currently plans to install several unique interfaces to collect surface data

Instead TFM will have one interface to get the same data

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Initial Program Approach

- Employ Communities of Interest (COIs) to develop capabilities and requirements
- Leverage existing contracts with business units
- Define relationships with business units and SWIM Implementing Programs (SIPs) using service level agreements (SLAs)
- Federate the SWIM architecture to manage schedule and cost risk
- Plan on evolutionary development in later segments to meet the future needs of FAA and NextGen

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Program Overview

- **Mission Need and Initial Requirements Document completed in September 2005, Initial Investment Decision (IID) in July 2006**
- **Nine Segment 1 capabilities were derived from Communities of Interest:**
  - **Aeronautical Information Management (AIM)**
  - **Flight & Flow Management (F&FM)**
  - **Weather**
- **SWIM will not implement a separate infrastructure for Segment 1**
  - **SWIM will leverage existing infrastructures, processes, resources, and logistics chains that are part of the program offices "touched" by the 9 SWIM capabilities**

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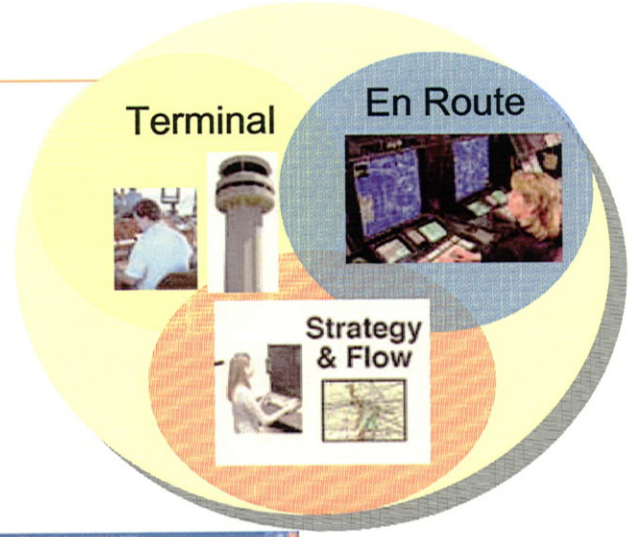
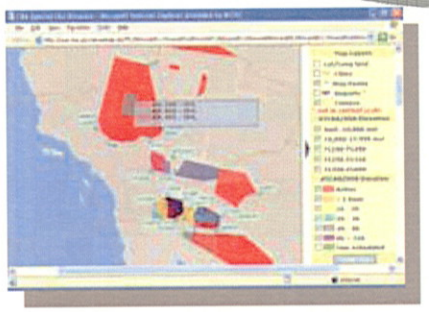
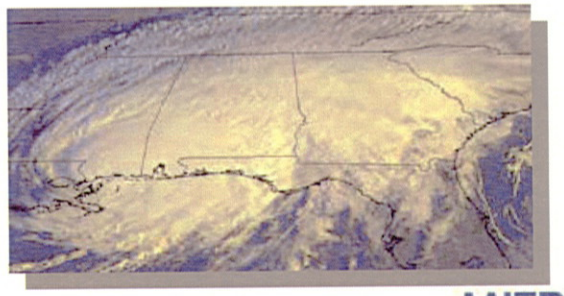
SWIM Segment 1 - Active COIs

- **Flight and Flow Management (F&FM) COI**
  - Improve operations through exchange of flight information between En Route (ERAM), Traffic Flow Management (TFM), and Terminal/tower systems
- **Aeronautical Information Management (AIM) COI**
  - Rapid distribution of Special Use Airspace (SUA) status information
- **Weather COI**
  - More efficient exchange of weather data between FAA, National Weather Service (NWS), and industry. This capability will be demonstrated in 2008/2009







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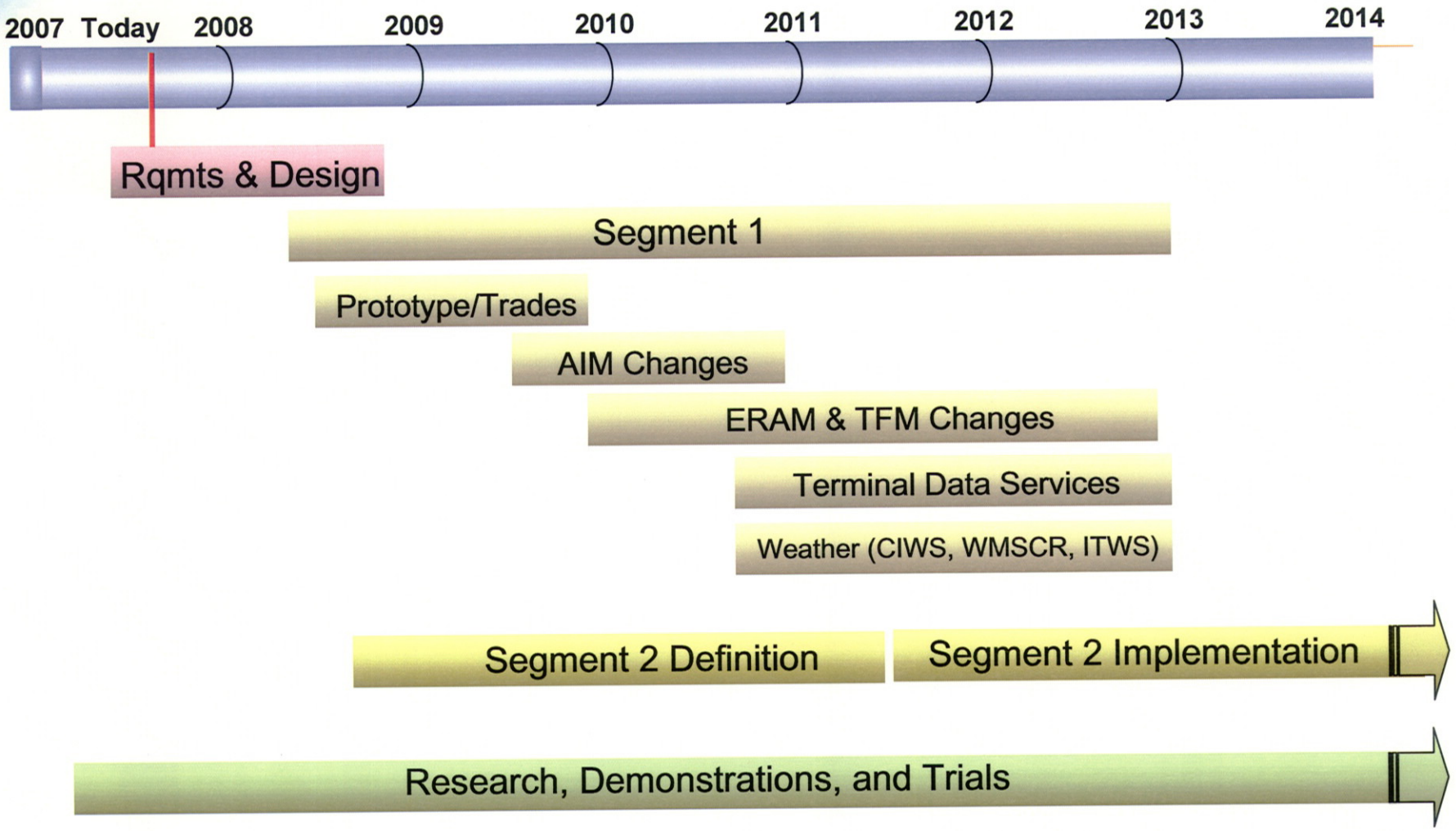
SWIM Program Approach



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Automatic Dependent Surveillance – Broadcast (ADS-B)

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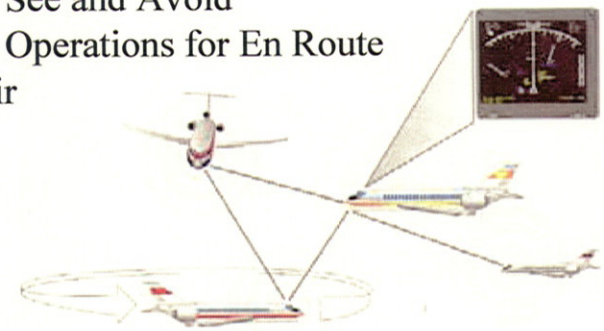
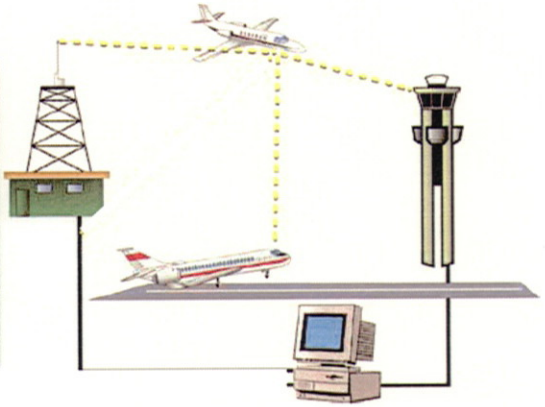
ADS-B – One of the Enablers for NextGen
Nine Operational Enhancements

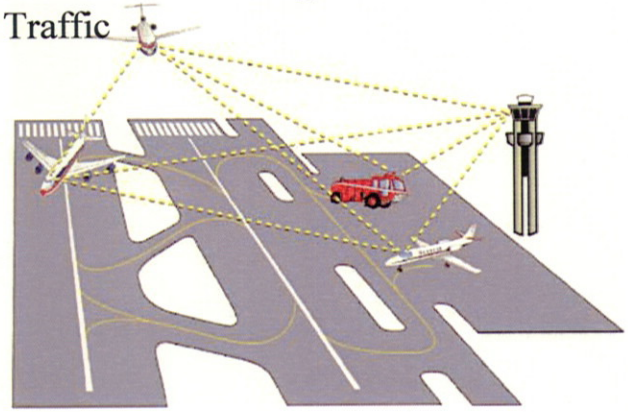
Air-to-Air
- Improved Separation Standards
- Improved Low-Visibility Approaches
- Enhanced See and Avoid
- Enhanced Operations for En Route Air-to-Air



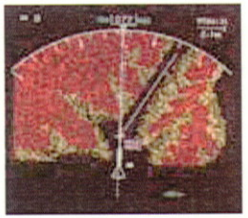
Air-to-Ground
- Surveillance Coverage in Non-Radar Airspace



Ground-to-Ground
- Improved Navigation on Taxiways
- Enhanced Controller Management of Surface Traffic



Ground-to-Air & Self-Contained
- Weather and SSR Traffic to the Cockpit
- Affordable Reduction of Controlled Flight into Terrain (CFIT)



Artwork Credit: FAA Safe Flight 21 Program Office

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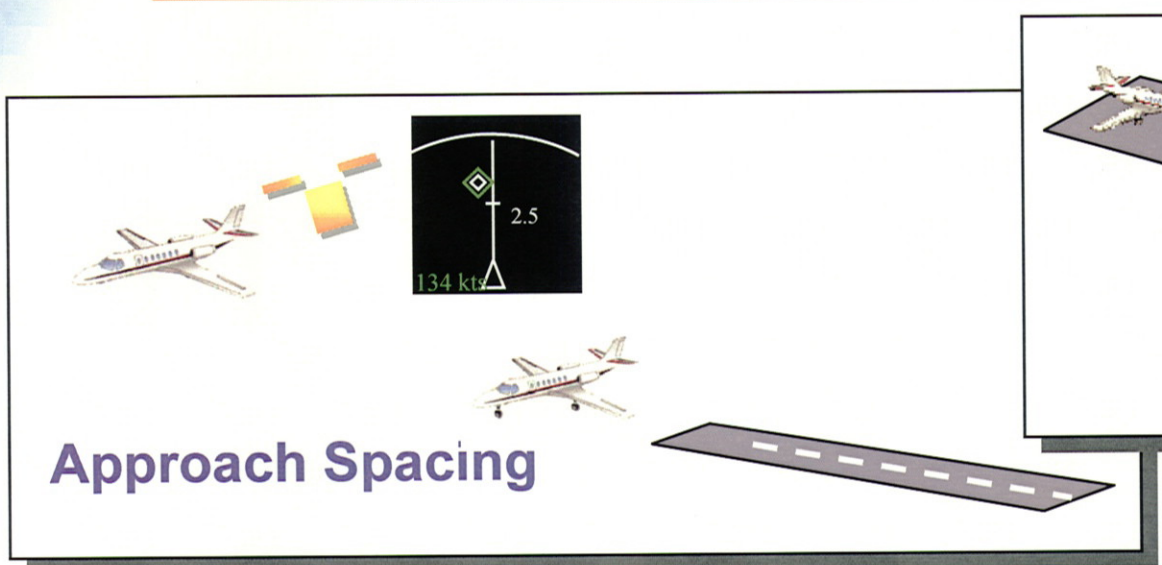
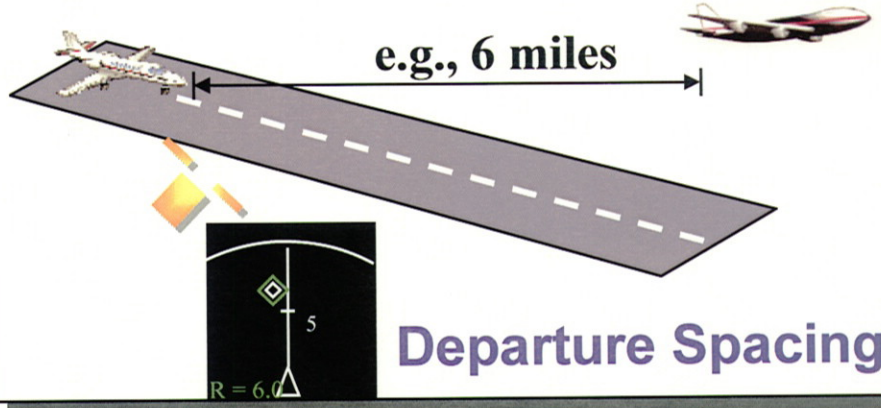
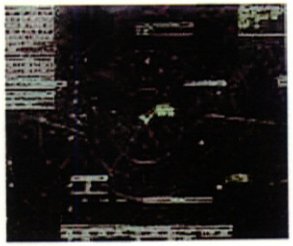
CAA: Operational Evaluation & Applications

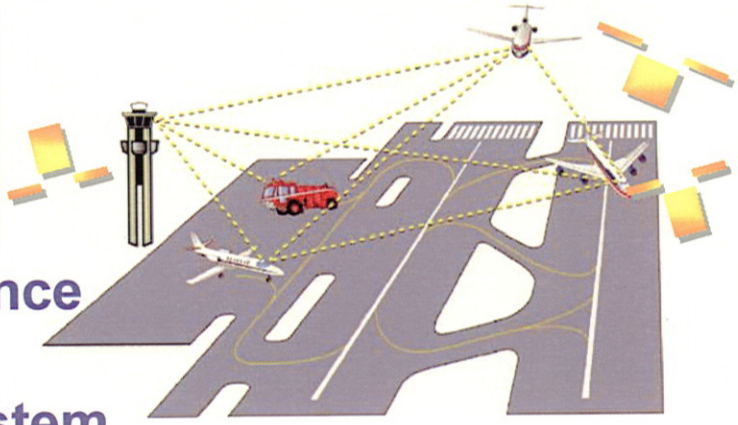


Approach Spacing



Departure Spacing





Airport Surveillance and Surface Management System

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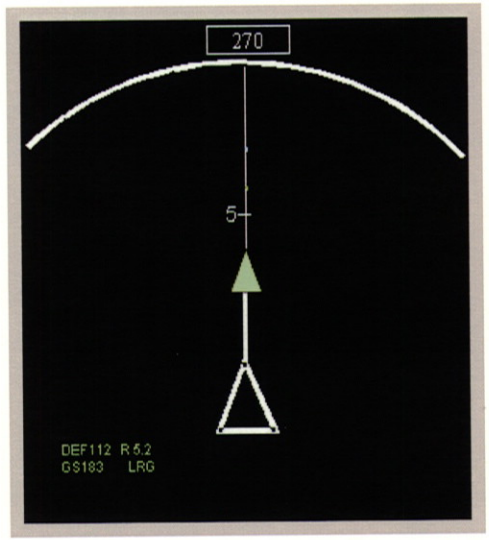
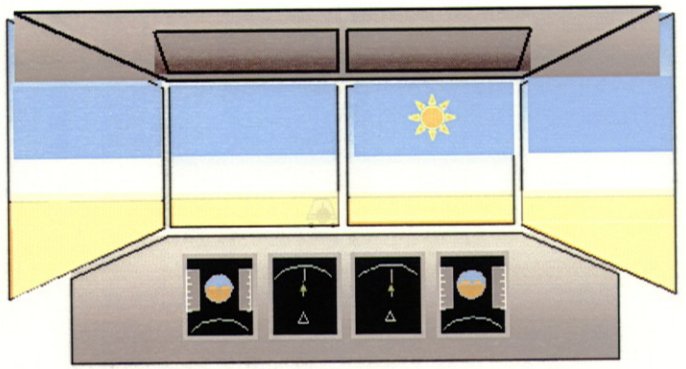
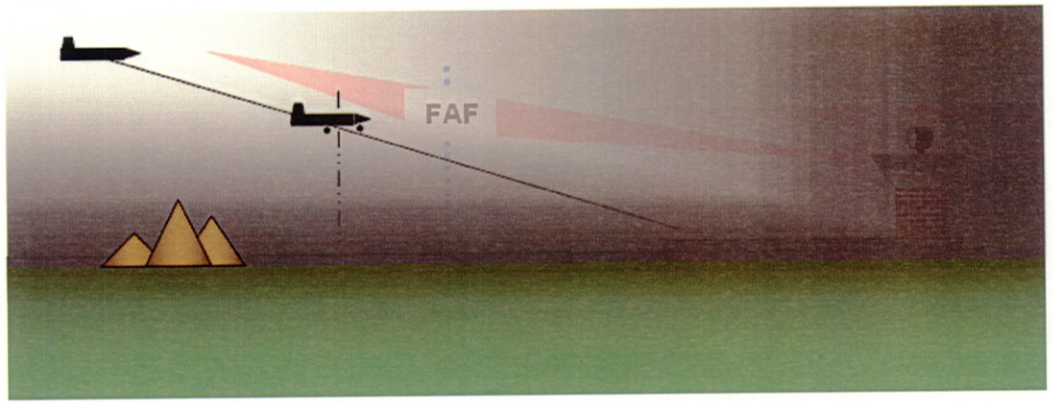
CDTI Assisted Visual Separation (CAVS)

- Air traffic control provides traffic advisory with aircraft call sign
- Pilot flies the approach and uses the CDTI during brief periods of lost visual contact (due to haze, sun, reduced visibility, etc.)
- This is a new procedure







Not to scale

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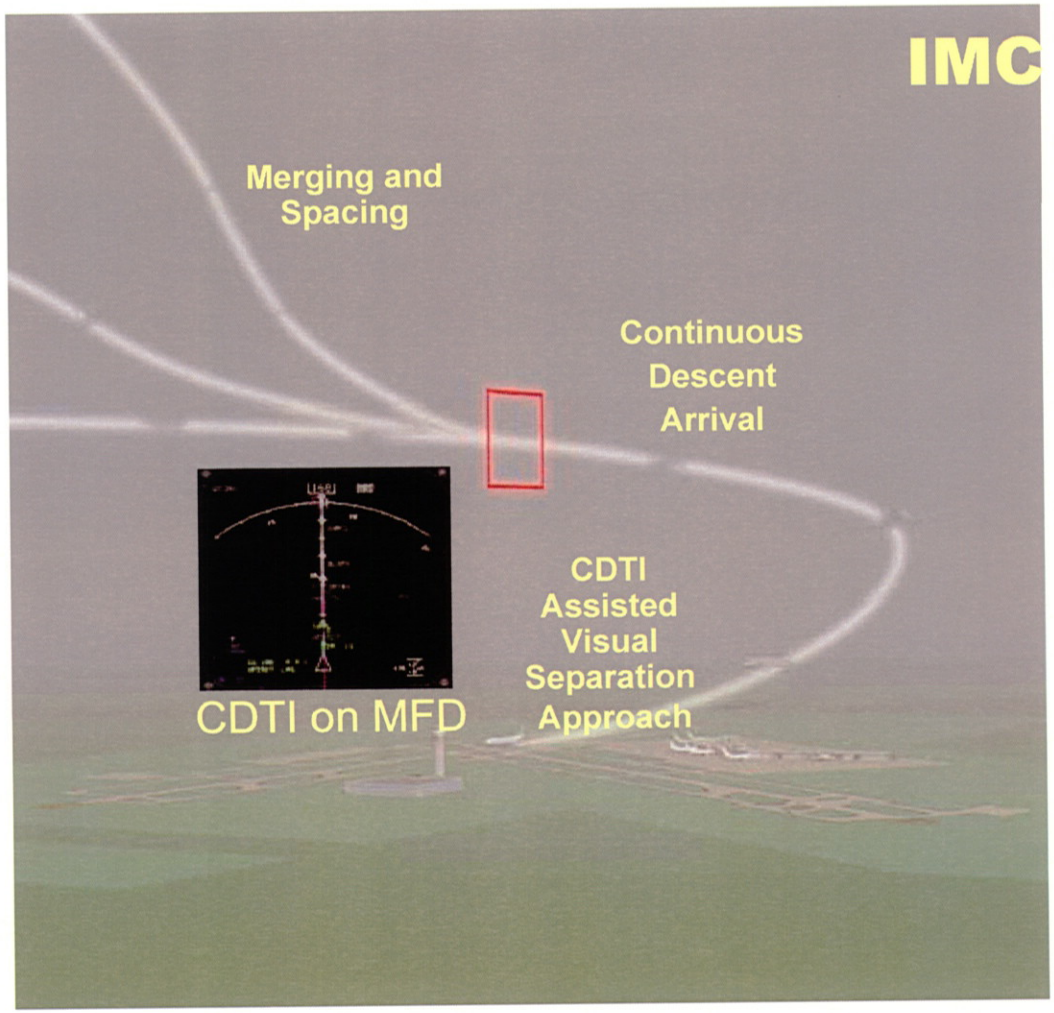
Merging & Spacing Development

- ***Phase One***
  - ~15 west coast Louisville in-bound aircraft
  - UPS Global Operation Center (GOC) provides speed instructions via ACARS based on a sequencing tool
  - Flight crew flies the assigned speed(s) until flying the Continuous descent Arrival (CDA)
- ***Phase Two***
  - Same as Phase One except flight crew flies GOC speed(s) until within ADS-B range of lead aircraft, then flies flight deck-based M&S to FAF
- ***Phase Three***
  - Numerous aircraft from numerous merge points across United States
  - ATC has sequencing tool
  - Flight crew flies flight deck-based M&S when requested by ATC



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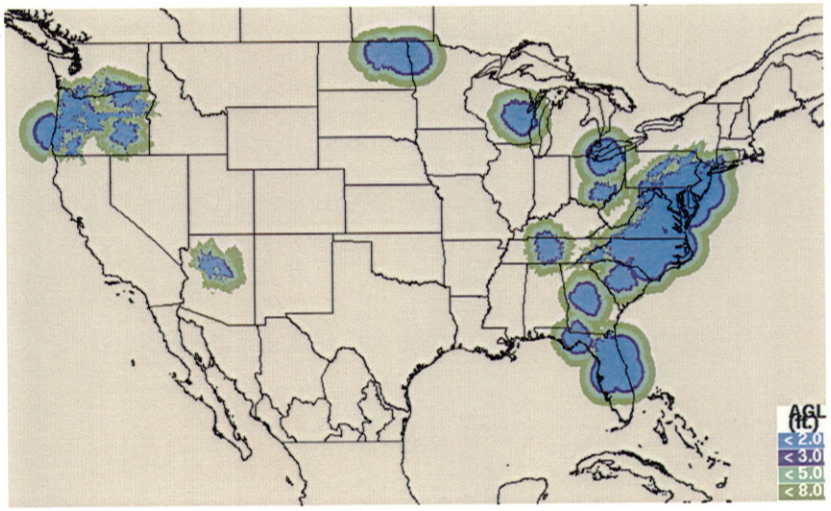
National Deployment

- **Implement a national infrastructure of ADS-B ground stations**
  - Promote FAA's Flight Plan 2008-2012 to reduce GA fatal accidents and provide international leadership
  - Reduce overall cost-of-ownership to the FAA
    - Reduce the cost of ground-based surveillance
    - Decommission about half of the surveillance radars
    - Over time, ADS-B becomes the primary surveillance source and radar is backup
  - Continue to develop ADS-B standards in harmonization with the world
  - Provide a foundation for NexGen applications and benefits

Current GBT Coverage



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National Broadcast Services Status

- Avionics activities
  - Garmin AT delivering fully UAT certified avionics
  - Embry Riddle Aeronautical University equipped their entire fleet (~100 aircraft)
    - Daytona Beach, FL & Prescott, AZ
  - ~400 aircraft UAT equipped in AK
  - ~50 government and private aircraft UAT equipped in lower 48
  - ~4000 1090ES equipped aircraft observed over the US (but most not meeting required standards)
- Partnership agreements in place
  - Embry Riddle
  - Maryland, Virginia, North Carolina, North Dakota, Pennsylvania, Ohio, Oregon
- Contract awarded to ITT in 2007 to build the national ground infrastructure and deliver ADS-B services
  - National infrastructure complete ~2013, with interim services available earlier
- "ADS-B out" equipage rulemaking effective ~2020 in development

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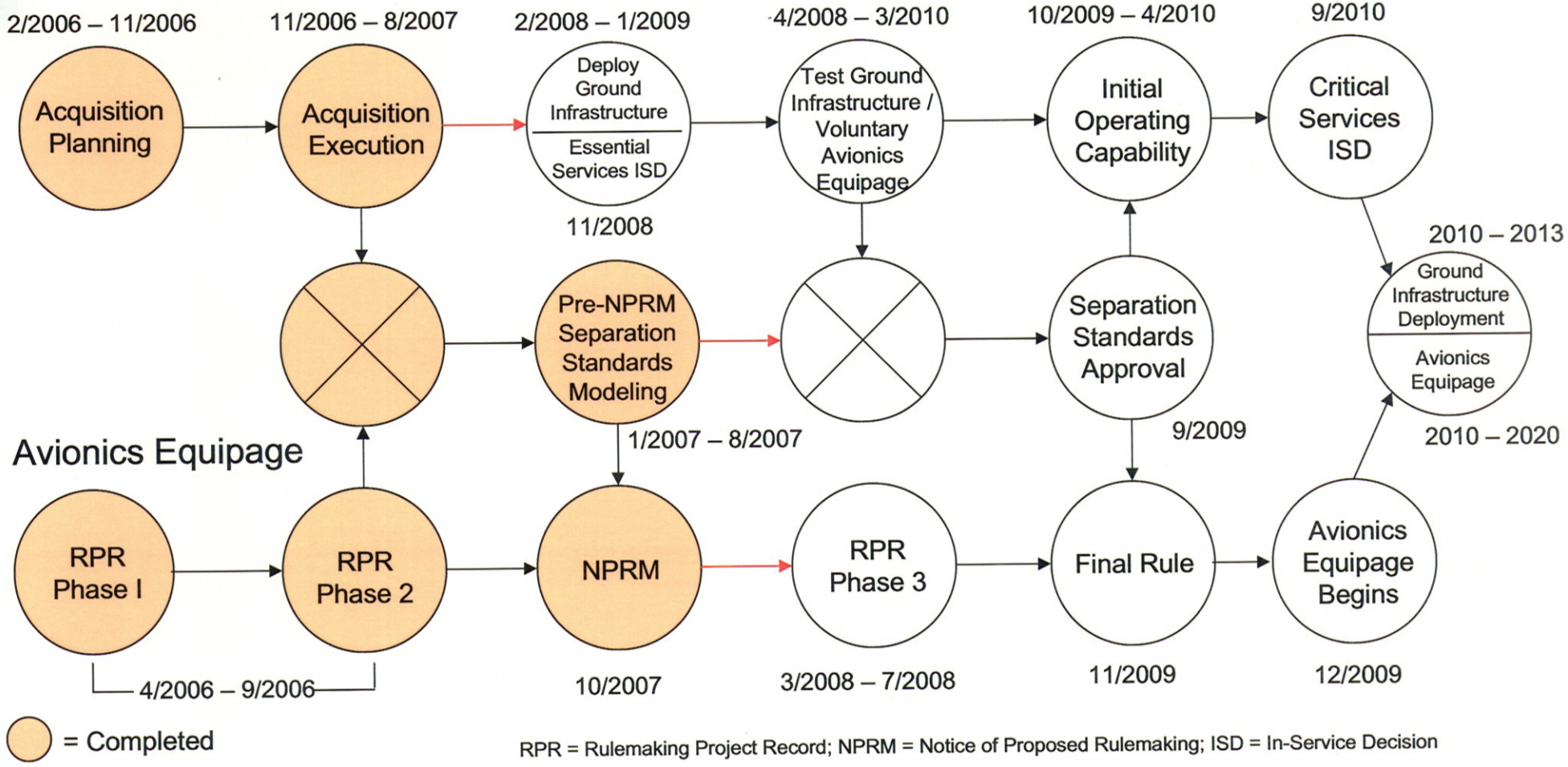
Program Status: Ground Infrastructure Dual Track Strategy



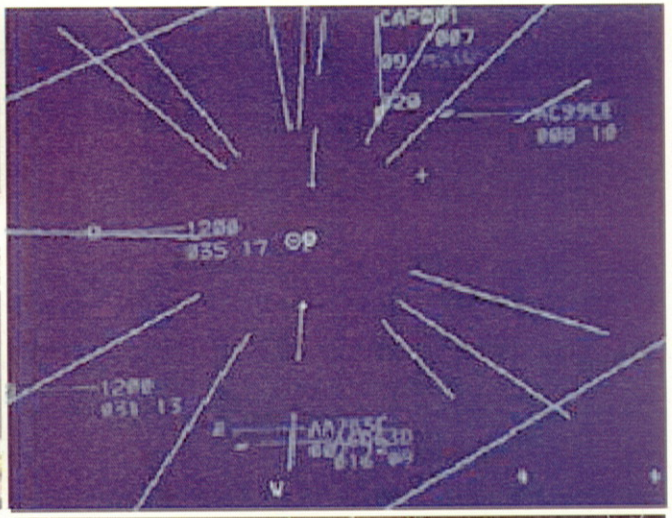
RPR = Rulemaking Project Record; NPRM = Notice of Proposed Rulemaking; ISD = In-Service Decision

Source: FAA

MITRE

Alaskan Aviation: First Operational Use of ADS-B
IFR Services: 1 January 2001/0018Z

- Controller vectoring Capstone-equipped aircraft to Bethel, Alaska ILS Runway 18, below radar coverage
- Maintaining separation from a second Capstone-equipped aircraft using ADS-B
- System certified as part of NAS for routine use



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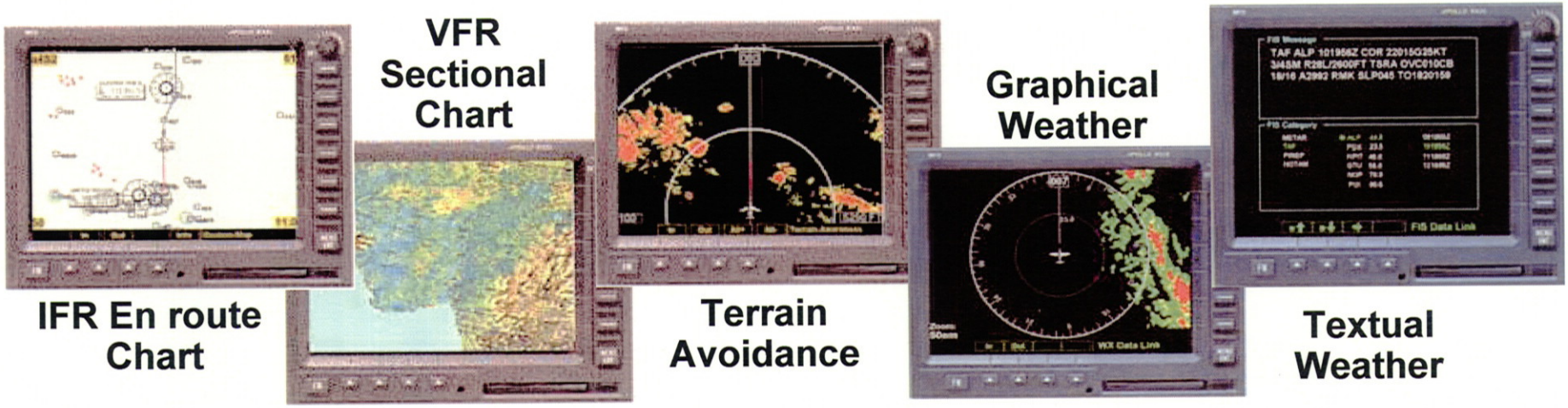
Phase I Operational Experience

- **Overall, a 50% reduction in accidents (2000-2005)**
  - **Reduced number of mid-air collisions**
  - **Reduced number of CFIT incidents**
  - **Reduced number of "mismanagement" type accidents**
  - **Large increase in IFR operations**



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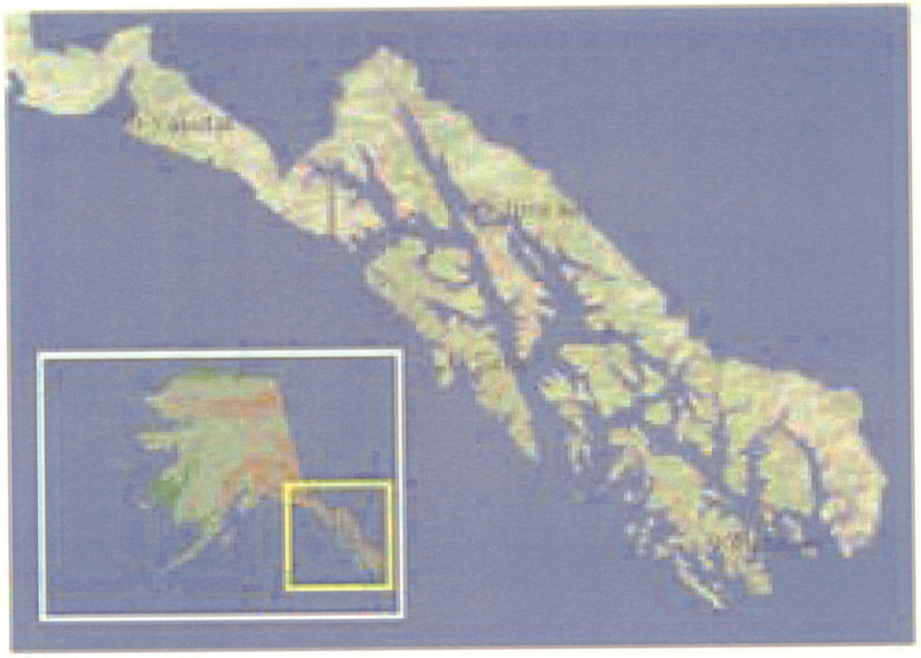
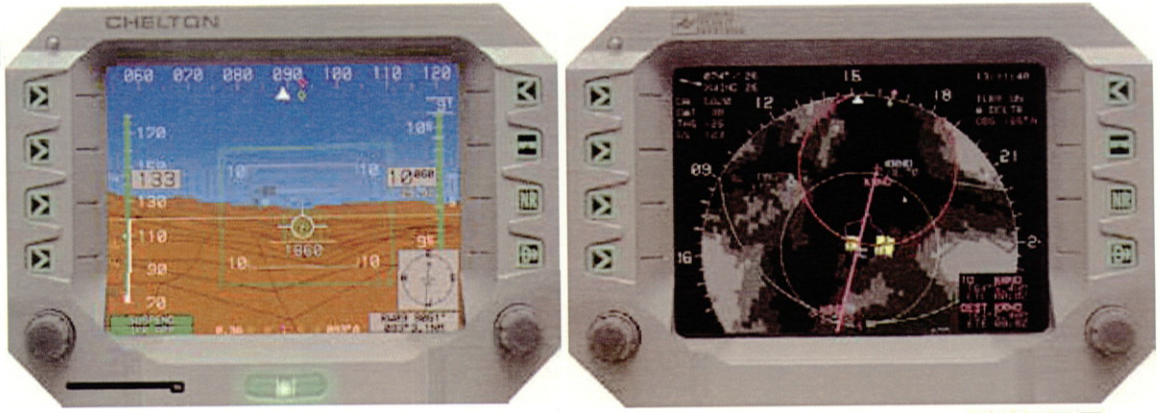
Capstone Phase II--Southeast Alaska

- **Make "useable" the IFR infrastructure in SE Alaska**
  - Provide low-altitude airways
  - Provide en route radar-like services
  - Improve terminal surveillance
  - Improve terrain avoidance
  - 12 GBTs installed
- **Improve communication infrastructure**
- **Improve runway safety**
- **Equipping aircraft with Capstone avionics (~200 now equipped)**





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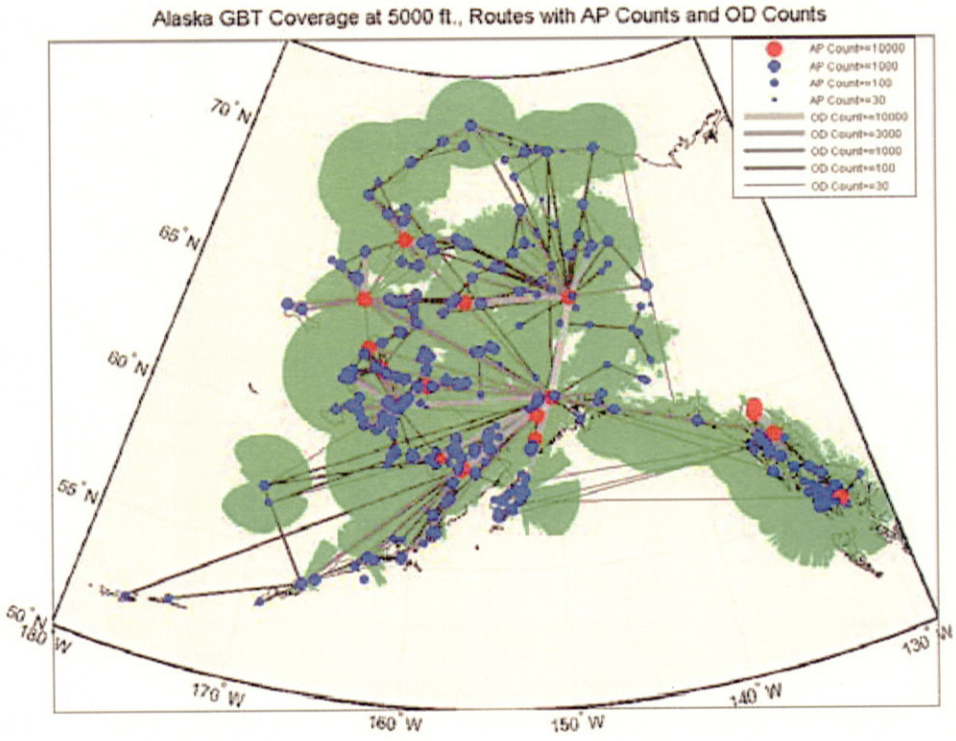
Capstone Phase III

- **Statewide deployment**
  - **Additional GBT's to be installed across the state**
  - **User benefits**
    - » **Safety**
    - » **Efficiency**
    - » **IFR ATC services**
    - » **Flight monitoring**
    - » **Community benefits**
  - **FAA benefits**
    - » **Safety**
    - » **Infrastructure cost of ownership reduction**
    - » **Capacity/efficiency**



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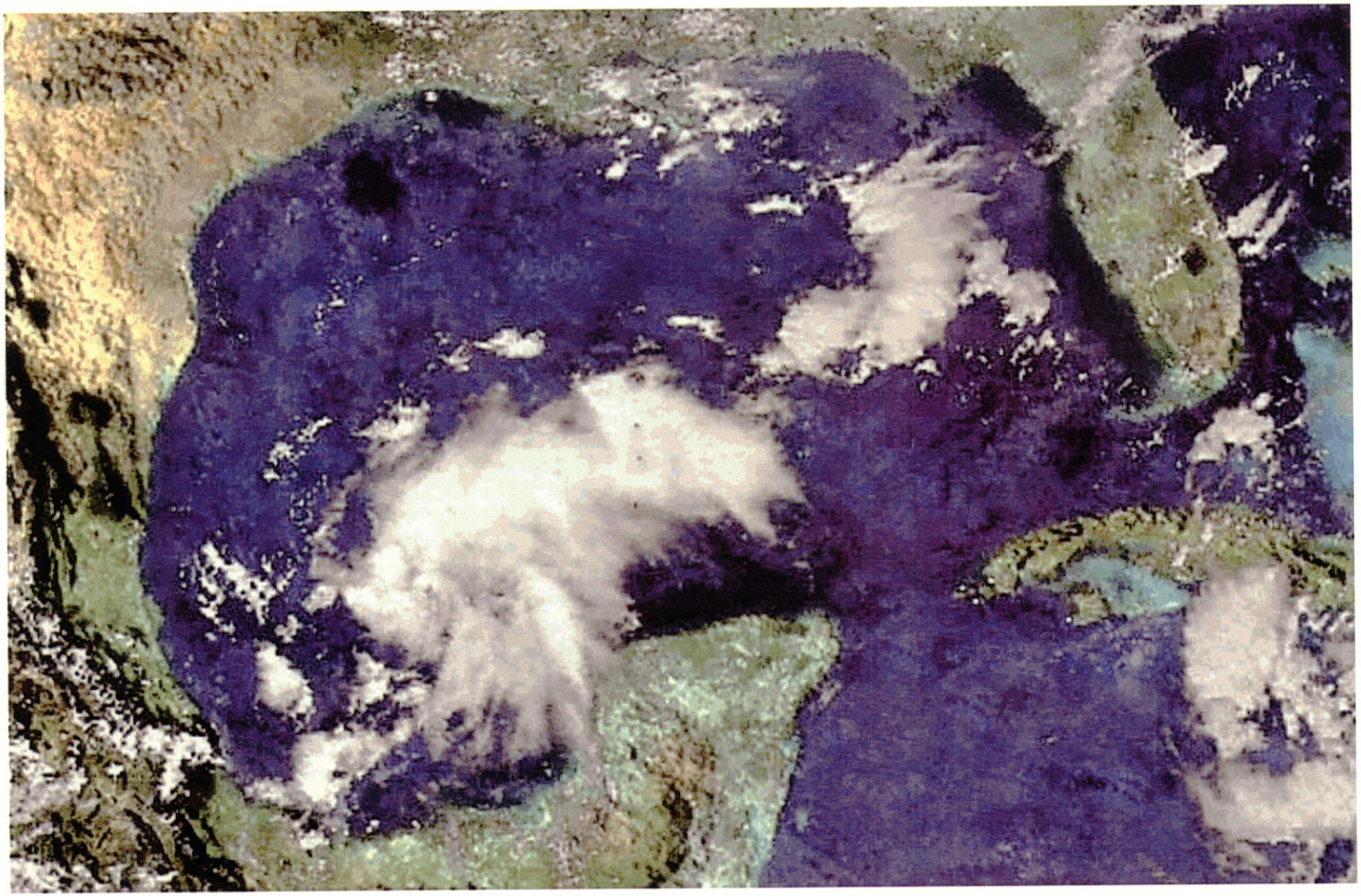
Gulf of Mexico



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High Altitude (Air Transport)

NextGen Solution

- **Near- & Mid-term**
  - **FAA (in cooperation with Mexico) deploys an ADS-B ground infrastructure that completes high altitudes surveillance over the Gulf (by 2010)**
  - **Aircraft overflying the Gulf equip with ADS-B "Out" avionics**
  - **FAA deploys additional communications radios to complete radio coverage (by 2010)**
- **Mid-term**
  - **TFM**— improved weather reroute planning and execution (8% occurrence)
- **Far-term**
  - **Airspace/RNP/routes**—as needed when capacity becomes an issue, start greater use of RNAV/RNP for more direct and more routing options
  - **Advanced conflict detection**—as needed when capacity becomes and issue, improved capacity and more direct routes

Operational Improvement

- **Near-term**
  - **Reduced separations (5NM is the goal)**
  - **Increased capacity**
  - **Fewer Delays**
  - **Direct routing & more routing options**
  - **Increased access to optimal altitudes**
- **Mid-term**
  - **Improved weather re-routing**
- **Far-term**
  - **Additional increased capacity**
  - **Fewer Delays**
  - **Direct routing & more routing options**

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Low Altitude (Helicopters)

NextGen Solution

- **Near- & Mid-term**
  - FAA deploys an ADS-B ground infrastructure that provides low altitude surveillance over the oil-producing portion of the Gulf (by 2010)
  - FAA deploys several more weather stations (AWSS) and communications radios (by 2010)
  - Helos overflying the Gulf equip with ADS-B "Out" avionics
  - Helos equip for IFR operations and train crews accordingly
- **Mid- & Far-term**
  - Addition of CDTI for improved situational awareness and weather

Operational Improvement

- **Near- & Mid-term**
  - Ability to fly during IFR conditions
    - Fleet mix transition to 85% IFR ops
    - Increased capacity
    - Improved safety
    - Guided approaches/departures (laterally and vertically)
    - Regularity of services/ reduced delays
    - Direct routing
  - Improved Search and Rescue Services
  - Ability to request VFR Flight Following
- **Mid- & Far-term**
  - Improved safety

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Continuous Descent Arrival (CDA)

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Current Research & Development (R&D)

- **Continuous Descent Arrivals (CDA)**
  - Clears an aircraft to descend from cruise altitude to final approach
  - For maximum benefit, uses a best-economy power setting at all times
  - Allows level or shallow segments for deceleration (e.g., 250 knots at 10,000 feet)
  - Transitions to a final approach along a standard glideslope
  - Benefits include fuel savings, emissions and noise reduction
- **Impact of CDA at a given airport is based on multiple factors**
  - Application of CDA (% of CDA, time of day, approaches)
  - Traffic characteristics (equipment mix, traffic demand/pattern)
  - Airport configuration (runway dependencies)
  - Airspace constraints

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Initial Findings

- **Based on the early R&D and evaluations:**
  - **Impact of CDA on arrival throughput/delay**
    - **CDA percentage progressively reduces arrival throughput and increases delay**
    - **Impact is seen first in the time periods when the arrival demand stays high. As the percentage of CDAs increases, the impact spreads into other periods when the demand in more isolated**
    - **As the percentage of CDAs exceeds 40%, the impact becomes more prominent**
  - **Impact of CDA in airport capacity**
    - **CDA percentage progressively reduces airport capacity**
    - **As percentage of CDA flights increases from 0% (no CDA) to 86% (all CDA), airport capacity (arrival and departure) decreases from 118/hour to 106/hour**

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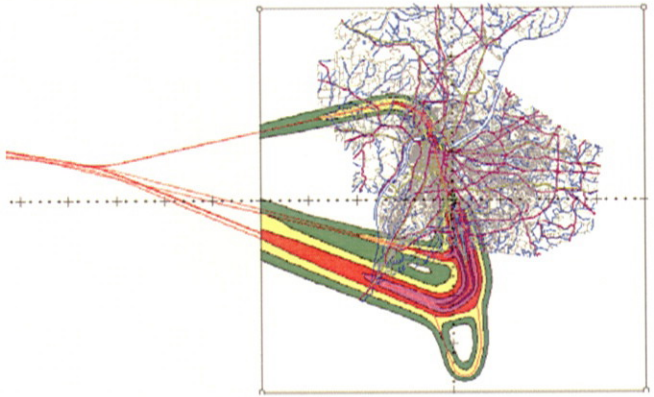
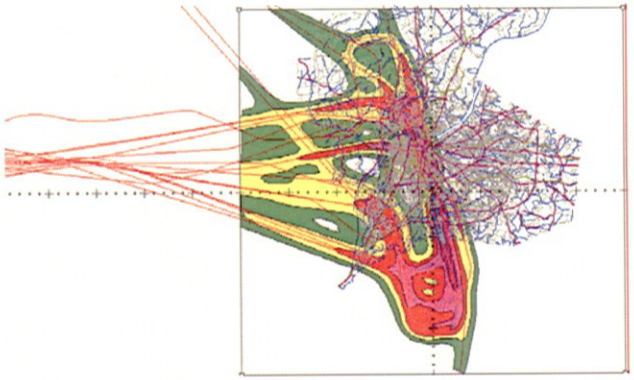
CDA Reducing Environmental Impacts

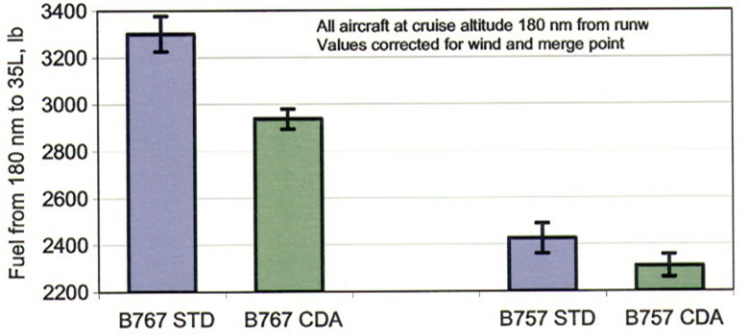
Noise pattern with CDA



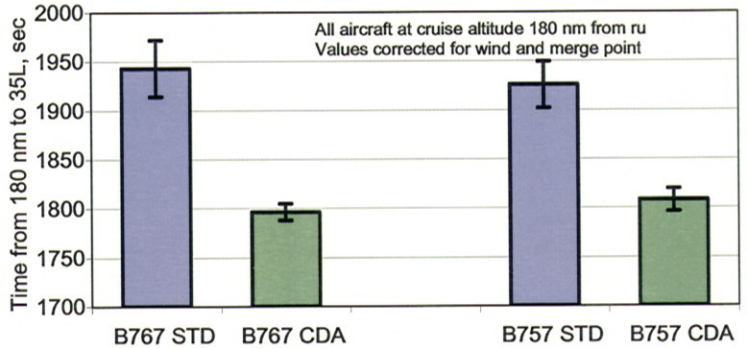
Noise pattern without CDA



Reduced Fuel Burn



Reduced Flight Time



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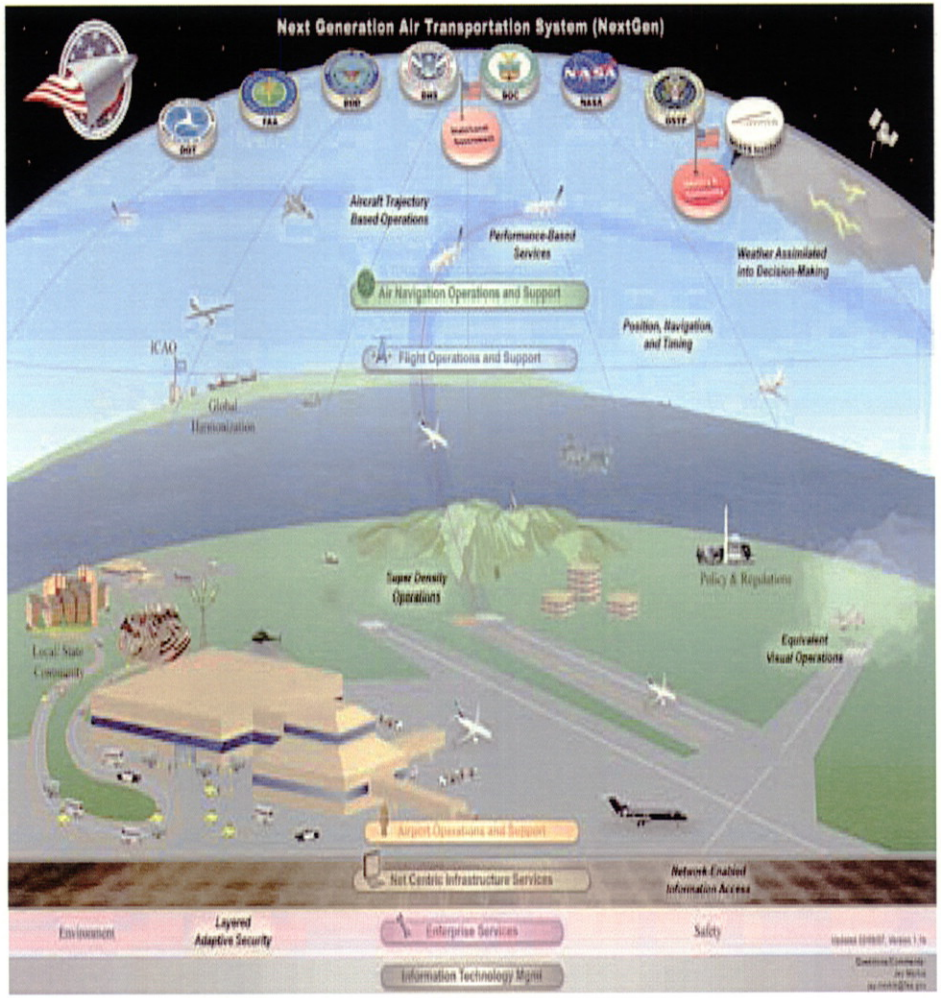
NextGen Capabilities



- Network-Enabled Information Access
- Performance Based Operations and Services
- Weather Assimilated into Decision Making
- **Layered, Adaptive Security**
- Position, Navigation, and Timing Services
- Trajectory-Based Aircraft Operations
- Equivalent Visual Operations
- Super Density Arrival/Departure Operations

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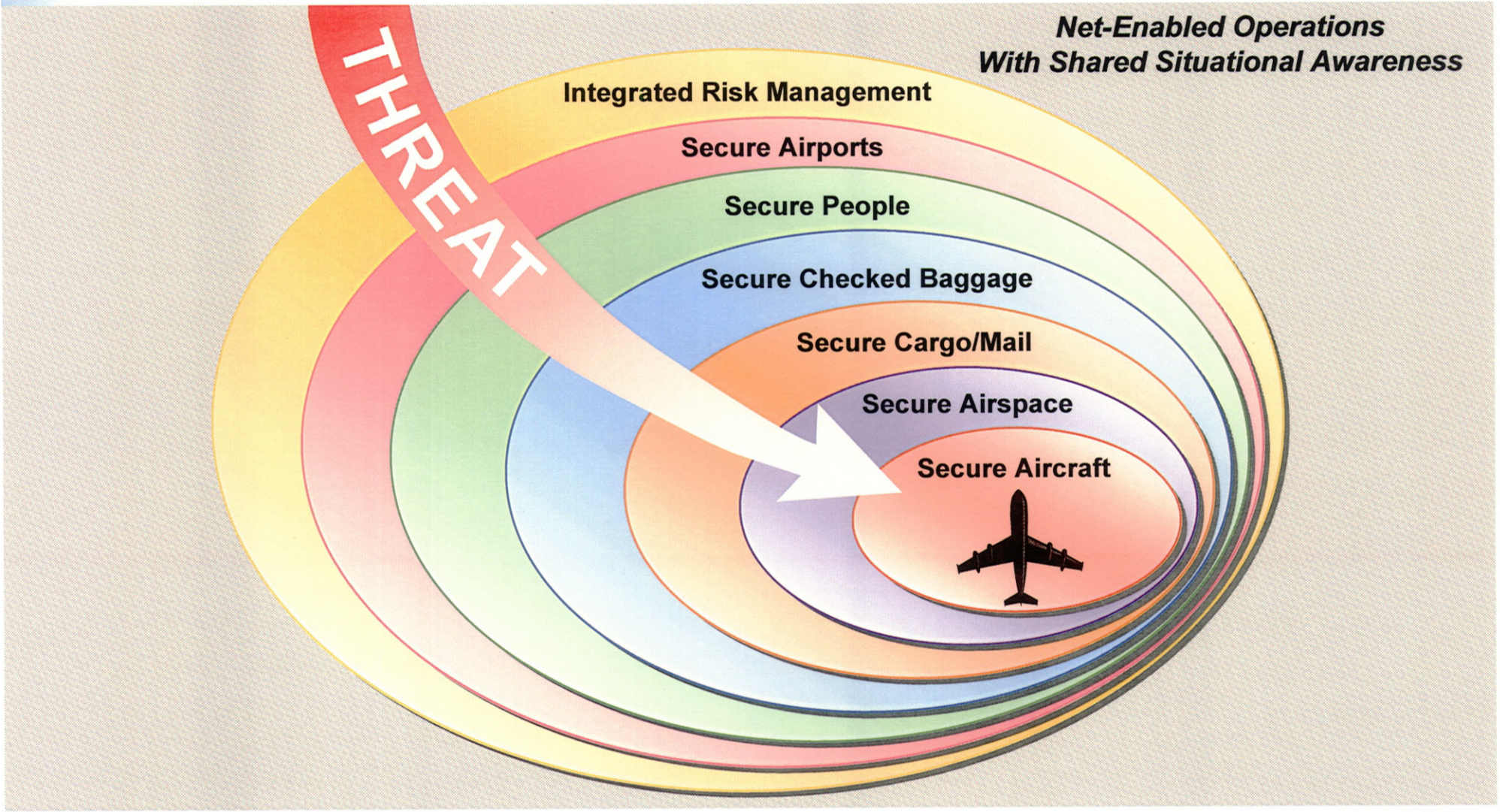
NextGen Layered, Adaptive Security



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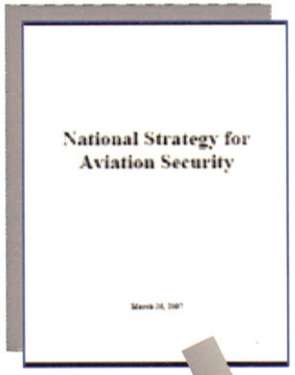
Secure Airspace Concept Context

National Policy on Aviation Security

- Aviation Transportation System Security Plan
- Aviation Operational Threat Response Plan
- Aviation Transportation System Recovery Plan
- Air Domain Surveillance and Intelligence Integration Plan
- International Aviation Threat Reduction Plan
- Domestic Outreach Plan and
- International Outreach Plan



NextGen Concept of Operations

- Collaborative ATM
- Trajectory-Based Operations
- Flight Object
- Shared Situational Awareness
- Net-Enabled Operations
- Airport Operations
- Safety
- Security

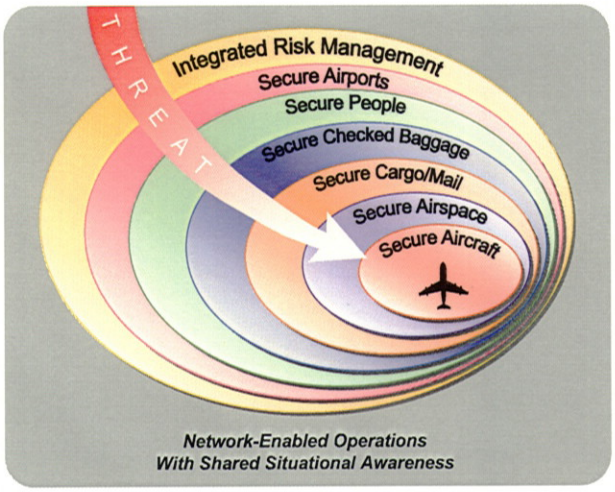
NextGen Security Annex
Layered, Adaptive Security Framework

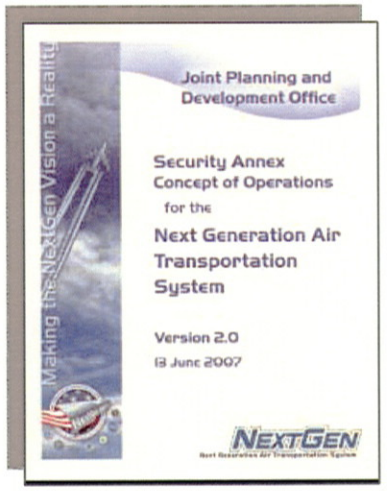
Integrated Risk Management

- Continual risk assessment
- Development and implementation of adaptive security measures.

Secure Airspace

- Security Restricted Airspace
- Flight-specific risk assessment
- Flexible airspace access based on risk





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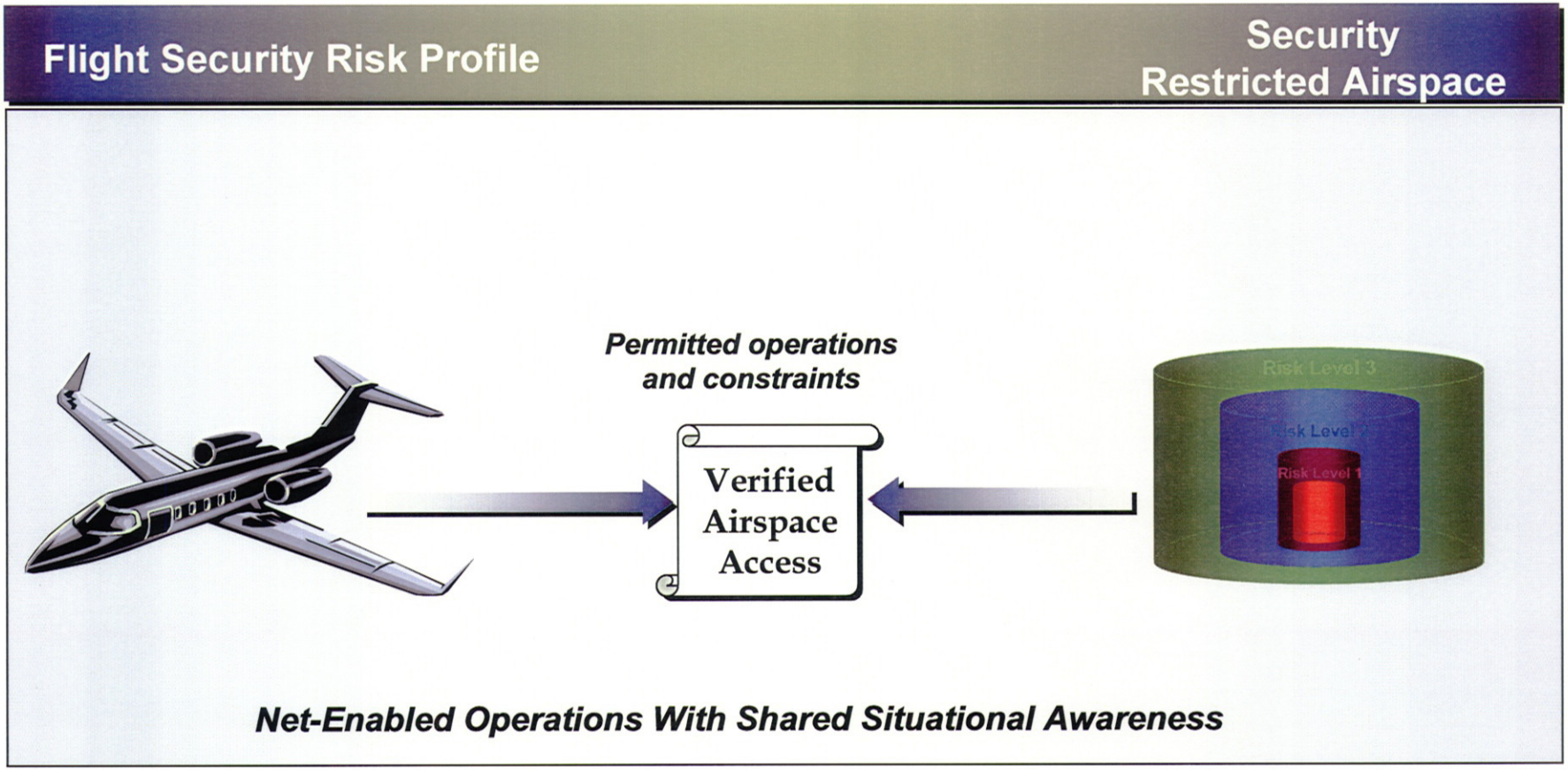
Major Components of NextGen Secure-Airspace Concept



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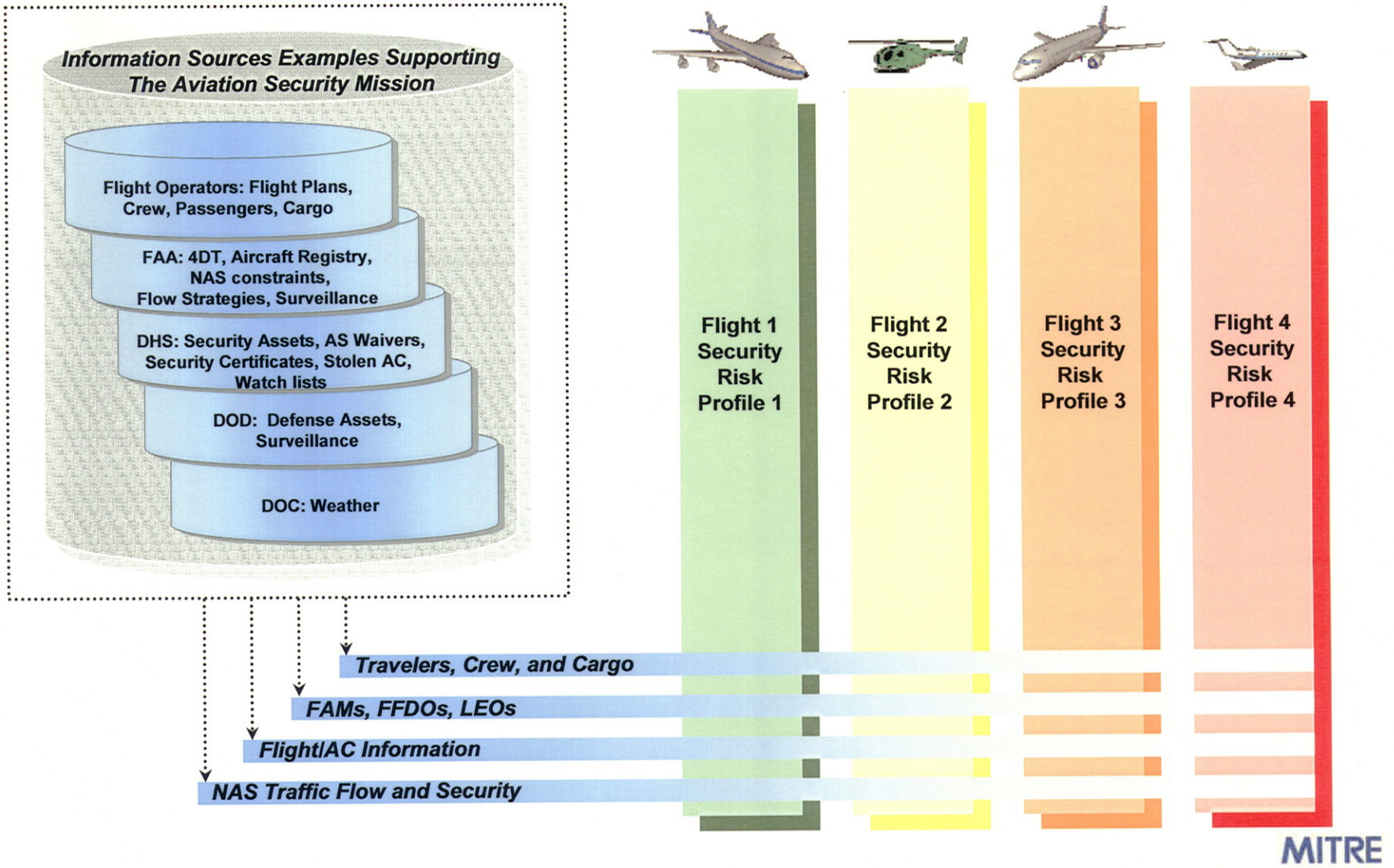
-- A Notional Example --
Flight Risk Profile



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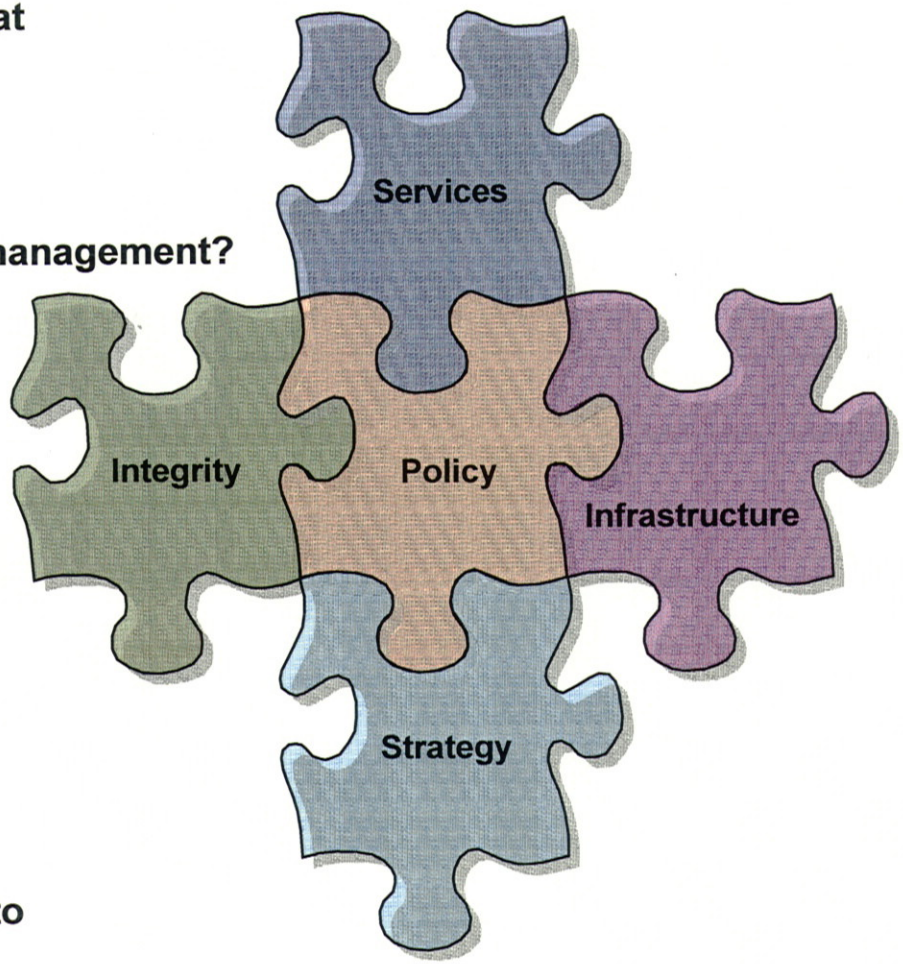
Information Sharing Challenges
- Example Issues -

- **Policy**
  - Who can see what information under what condition?
    - Privacy
    - Clearances
  - Roles and Responsibilities
    - What is ATM's role in security event management?
    - Who pays for what?
    - Who makes what decisions when?
- **Strategy**
  - What are the visions and goals?
  - Do we strive for unified standards?
- **Infrastructure**
  - How do we connect?
  - Do we have enough bandwidth?
- **Integrity**
  - Is the information of high quality for decision making?
- **Services**
  - What information services are available to the Aviation Security stakeholders?



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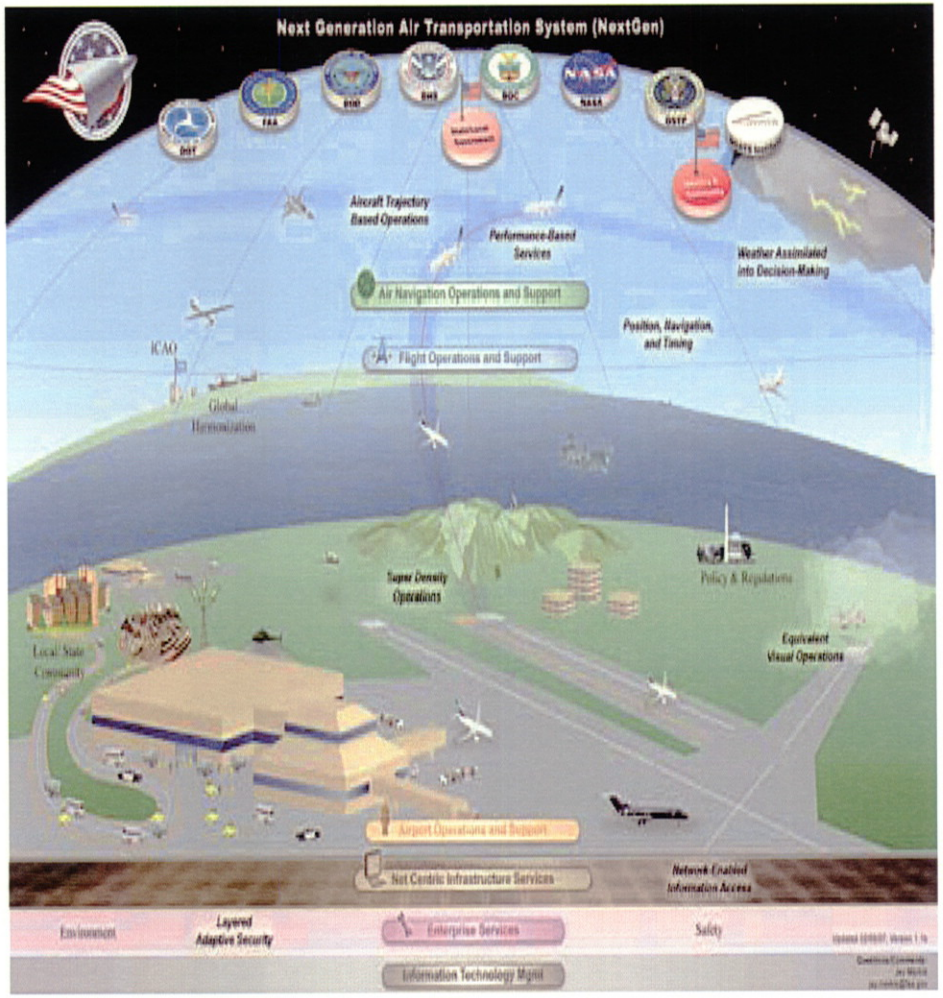
NextGen Capabilities



- Network-Enabled Information Access
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- Position, Navigation, and Timing Services
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- Equivalent Visual Operations
- Super Density Arrival/Departure Operations

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En Route Automation Modernization (ERAM)

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ERAM
Infrastructure Acquisition

Modernizes en route automation and infrastructure to provide an open-standards based system that will be the basis for future capabilities and enhancements

- **Replaces:**
  - **Host computer system software/hardware**
  - **Direct Access Radar Channel (DARC) software/hardware**
  - **Other associated interfaces, communications and support infrastructure**
- **Provides:**
  - **New automation architecture allows future growth and capabilities**
  - **New capabilities to support flexible routing, new surveillance types and sensors, full capability including safety alerts on backup system**
- **Attributes:**
  - **Leverages recent and ongoing developments and deployments – product line evolution**
  - **Initial size est. 1.1 to 1.3 MSLOC with 45 to 55% from NDI/Reuse opportunities**

Source: Briefing "Refining Software Development Estimation Techniques for the Federal Aviation Administration En Route Systems Acquisition" by Jeffrey O'Leary En Route Software Acquisition and Development Manager, AUA200, 1/28/03

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Context Diagram

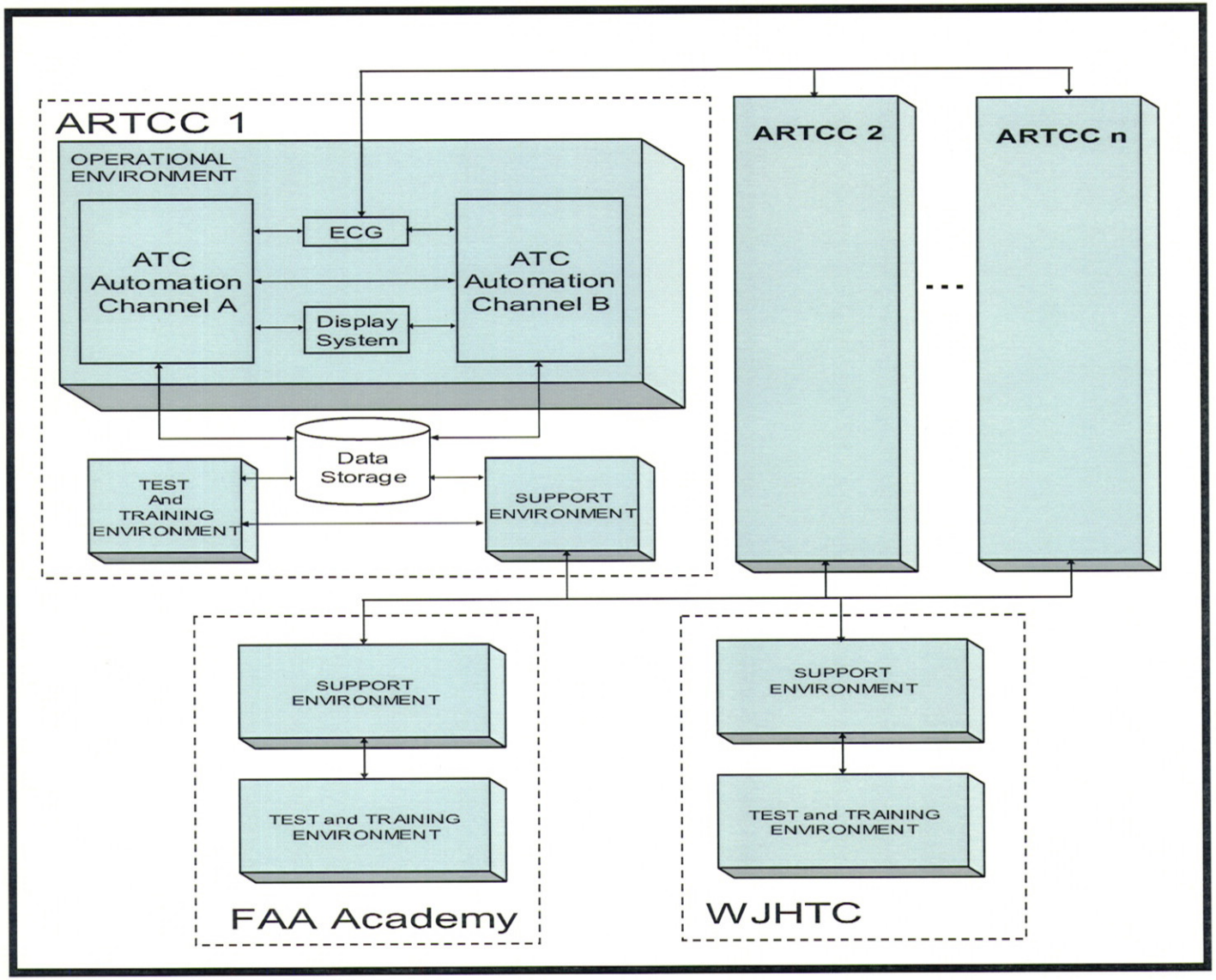

Diagram provided by Lockheed Martin Transportation and Security Solutions

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ARTCC Operational Physical Architecture

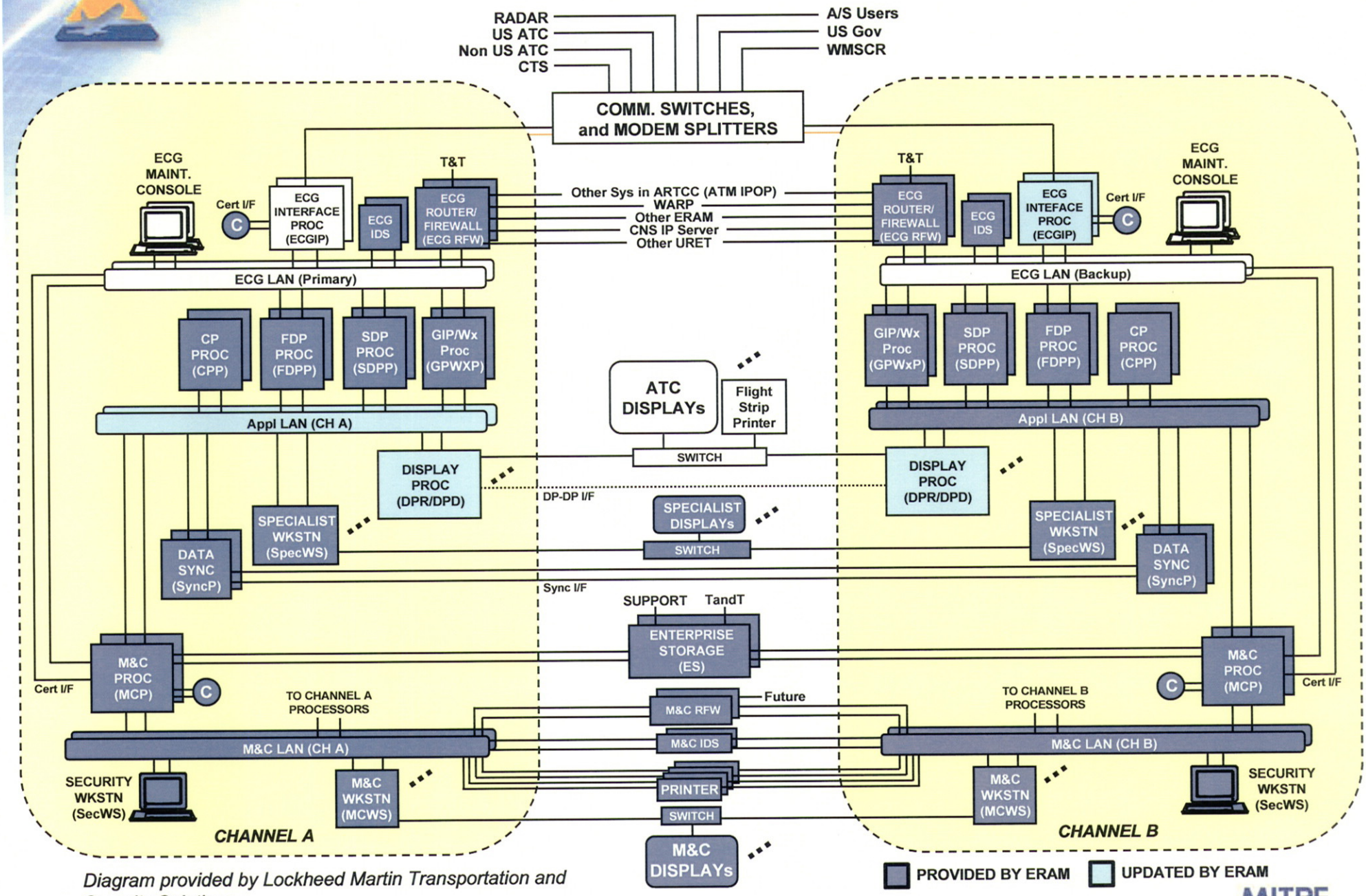

Diagram provided by Lockheed Martin Transportation and Security Solutions

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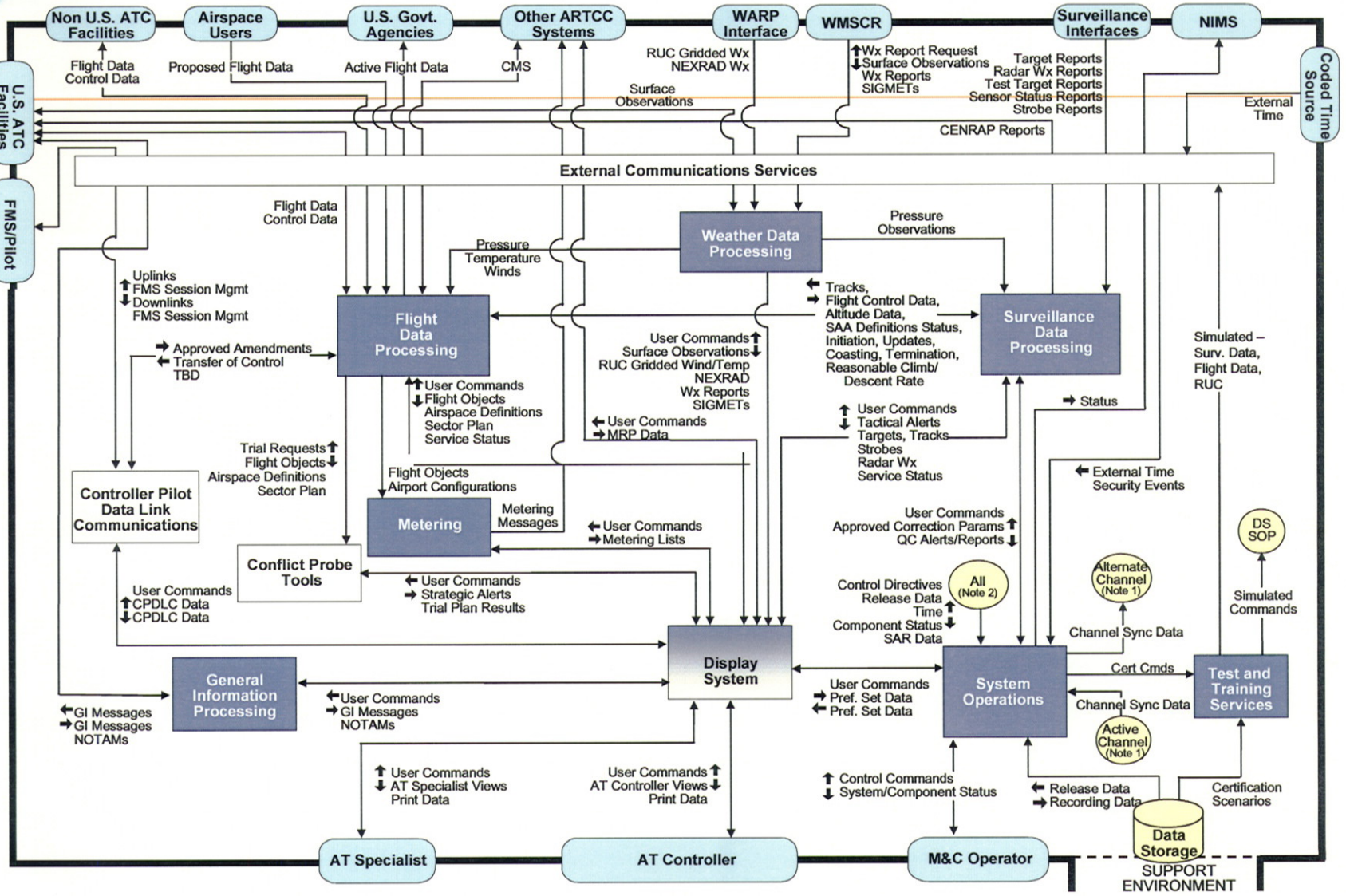
ARTCC En Route Automation System
Operational Functional Architecture



Product of Lockheed Martin

ERAM Subsystem

Note 1: FDP, SDP, DS, SOP, WDP, GIP, MET, CPDLC produce and receive channel synchronization data
Note 2: FDP, TTS, SDP, DS, CPT, WDP, GIP, MET produce and receive data from SOP

Source: Briefing "Refining Software Development Estimation Techniques for the Federal Aviation Administration En Route Systems Acquisition" by Jeffrey O'Leary En Route Software Acquisition and Development Manager, AUA200

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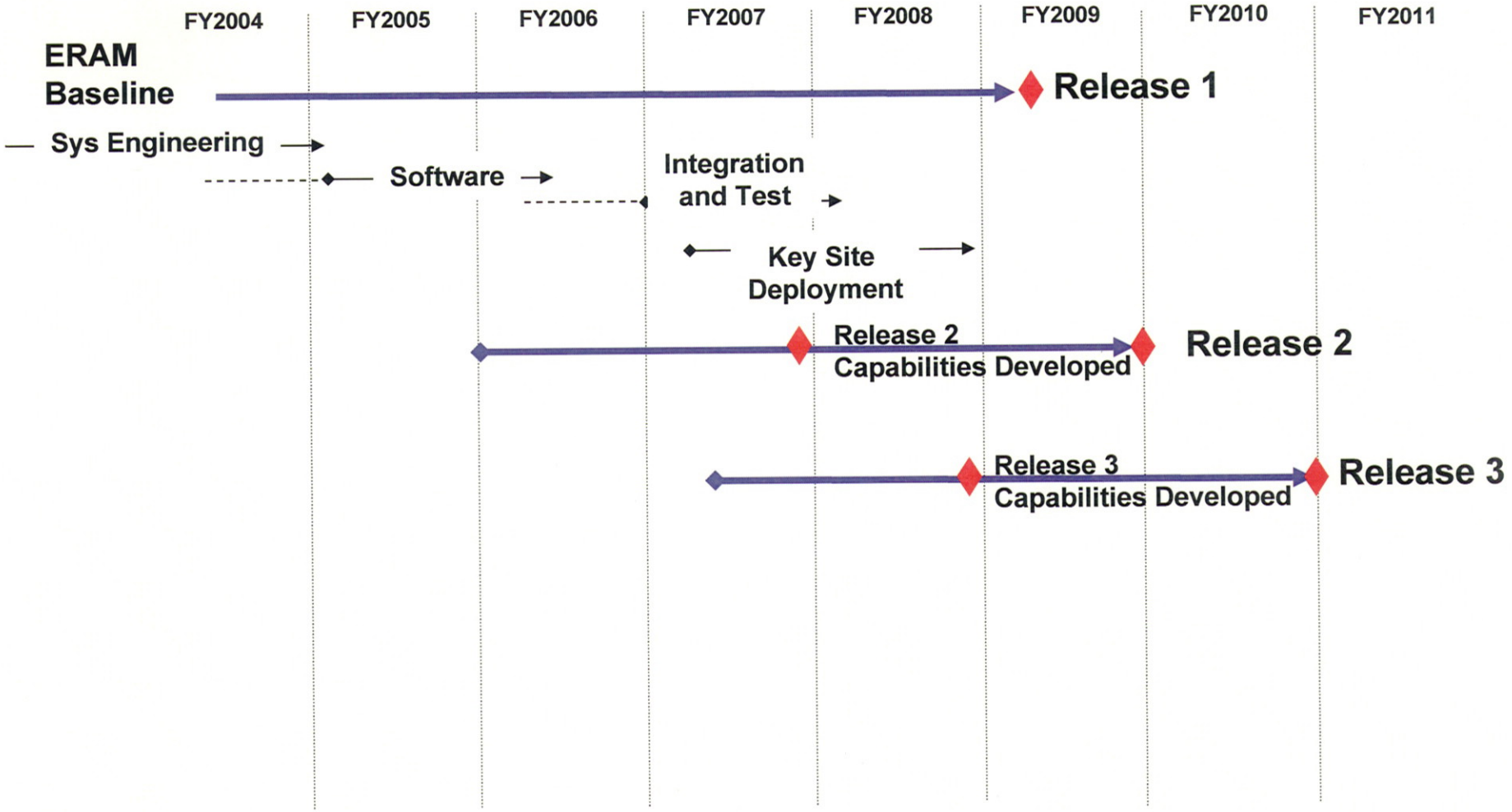
ERAM Timeline

http://nas-architecture.faa.gov/nas/mechanism/mech_data.cfm?mid=6685



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Air Traffic Flow Management (ATFM)

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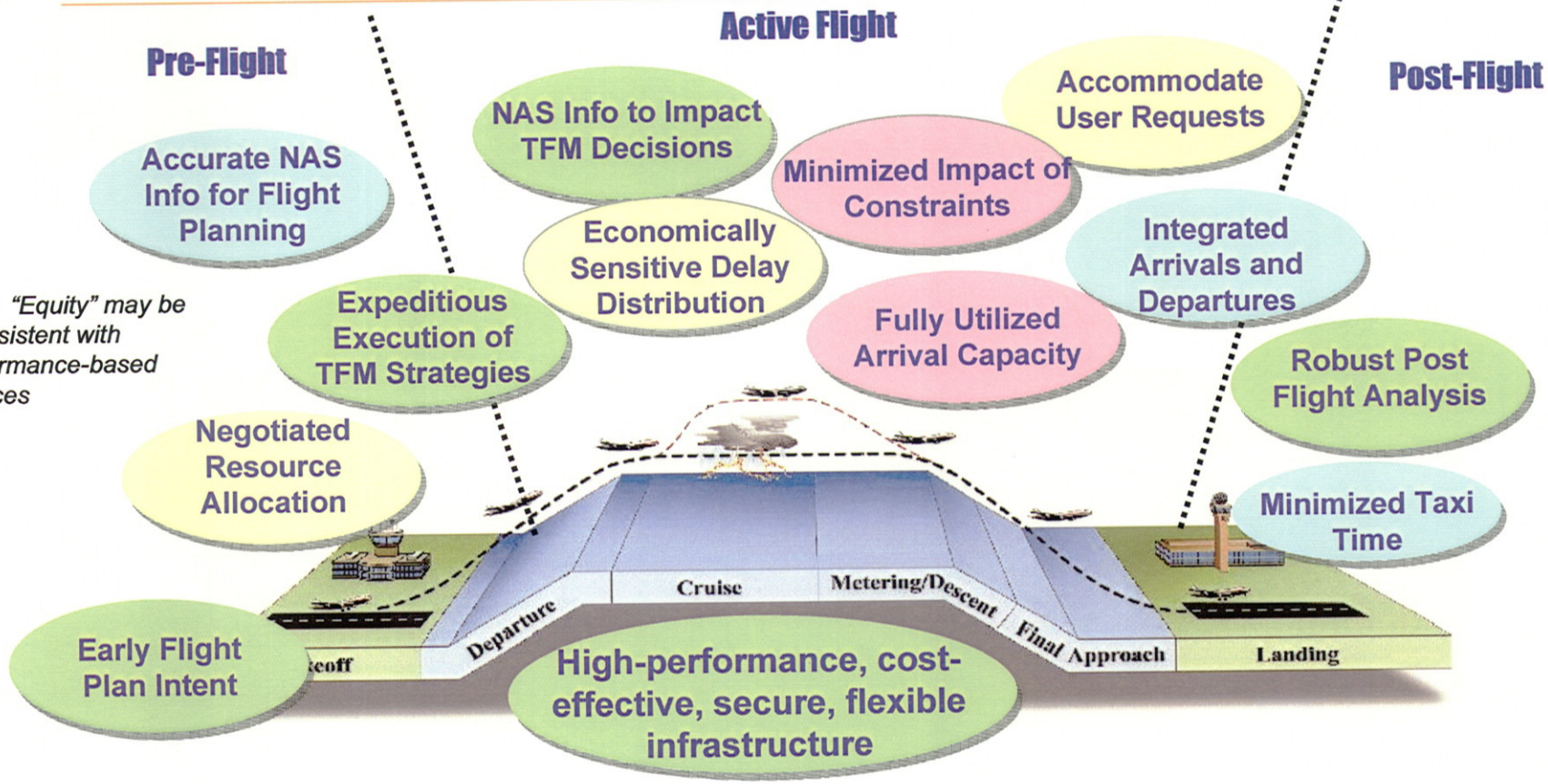
ATFM and the NextGen Concept:
Collaborative, Economically Sensitive, Managing Uncertainty, working Across ATM Domains



Key Curb-to-Curb Capabilities Supported by TFM

Aircraft Trajectory-Based Operations
Weather Assimilated into Decisions
Network-Enabled Information Access
Performance-Based Services

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TFM Evolution Vision:
Now – 2018

Collaborative, automated, and probabilistic traffic management

Operations shift from

- Verbal transmission of data
- Inconsistent data quality
- Manual identification and evaluation of congestion problems
- Manual development of resolution strategies
- Manual application of flow initiatives

- Limited accounting for prediction uncertainty
- Resolutions focus excessively on high-volume flows

To

- Automated collaboration & data transfer
- High quality and enhanced data
- Automated identification and evaluation of congestion problems
- Automated generation and assessment of problem resolution strategies
- Automated application aircraft-specific flow initiatives
- Explicit uncertainty management via probabilistic techniques
- Resolutions based on overall system performance

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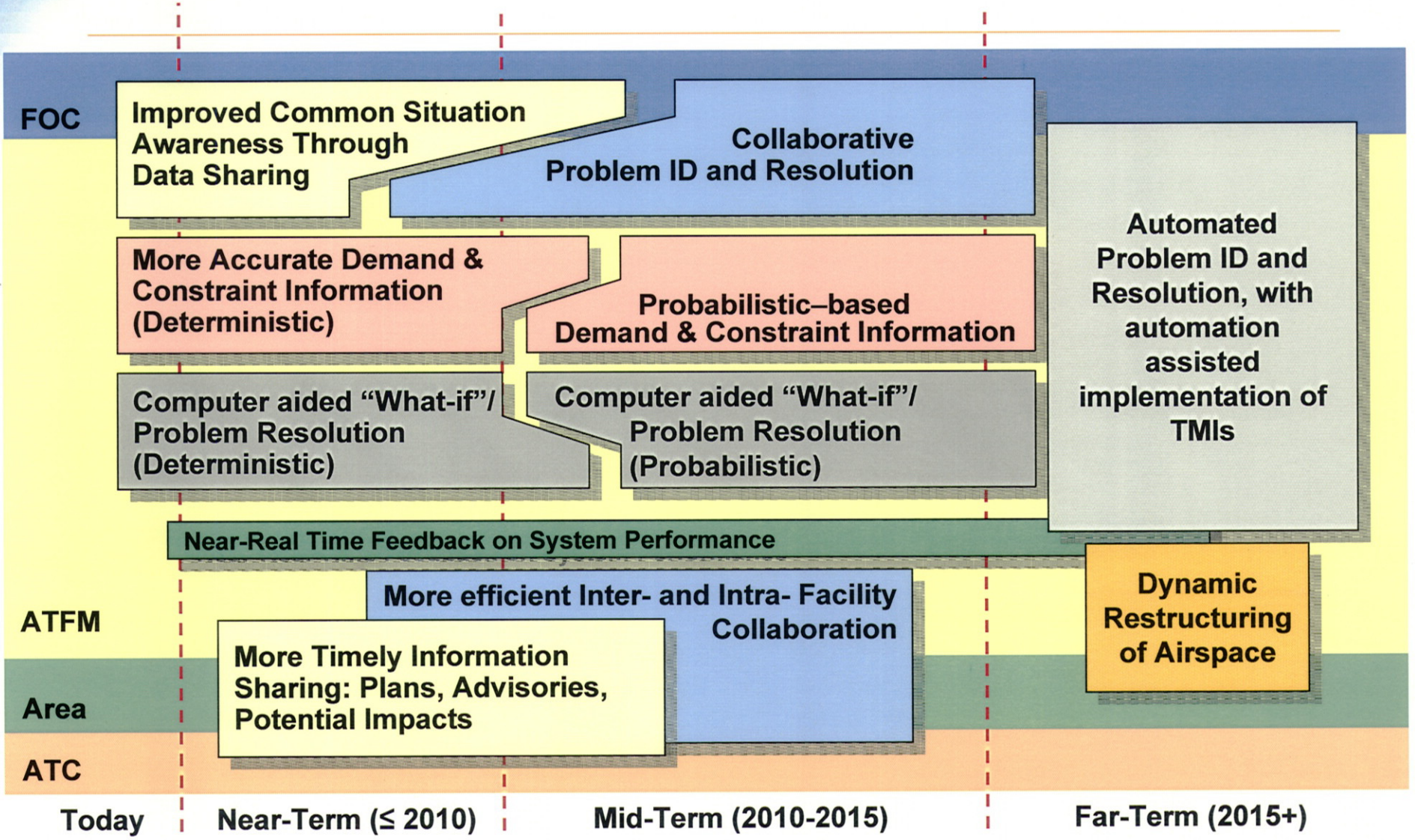
TFM Evolution Beyond the Near-term



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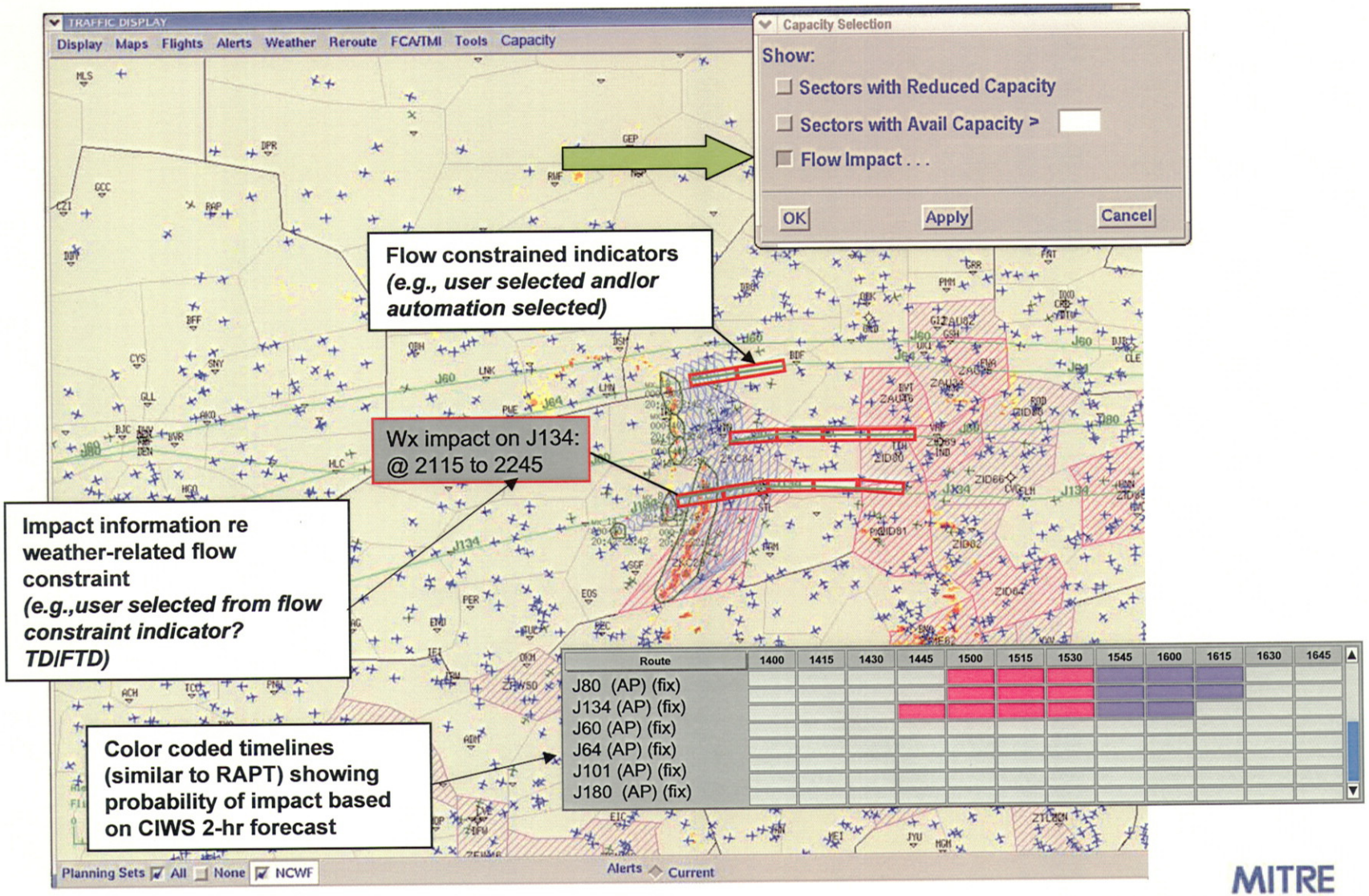
Weather Product Integrated into Flow Management Tools



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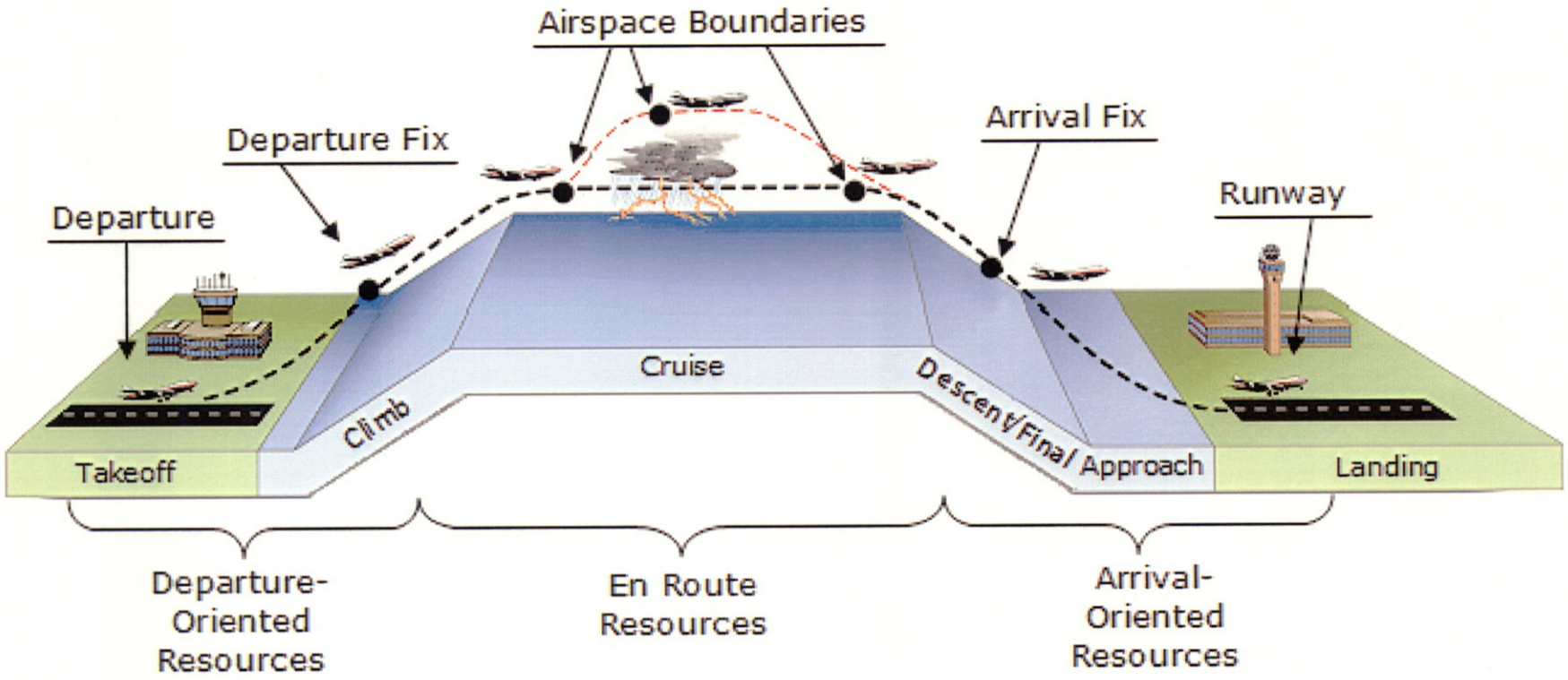
Integrated Time Based-Flow Management (ITBFM) Managed Resources



- **Flow Management Point (FMP)**
- **Flow Management Time (FMT)**

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Status of U.S. ATFM Modernization Program

- Preliminary design and hardware technical refresh plan approved by FAA, May 2003
- FAA awarded the Modernization Contract to CSC, June 2004
- Initial release of ETMS replacement scheduled for May 2008

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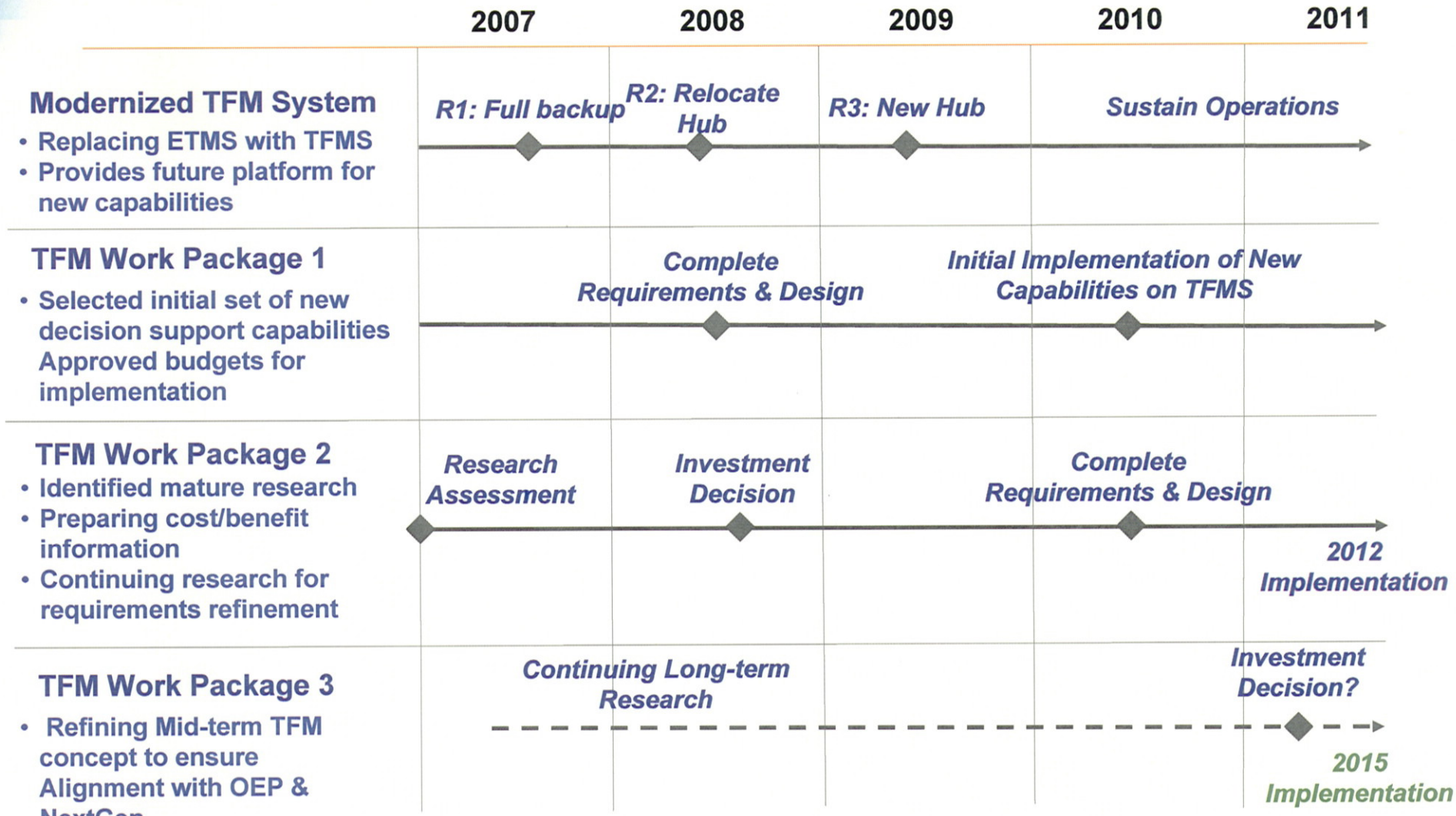
TFM System Evolution



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*EnRoute*Trainer -- Intelligent Tutoring Systems (ITS)

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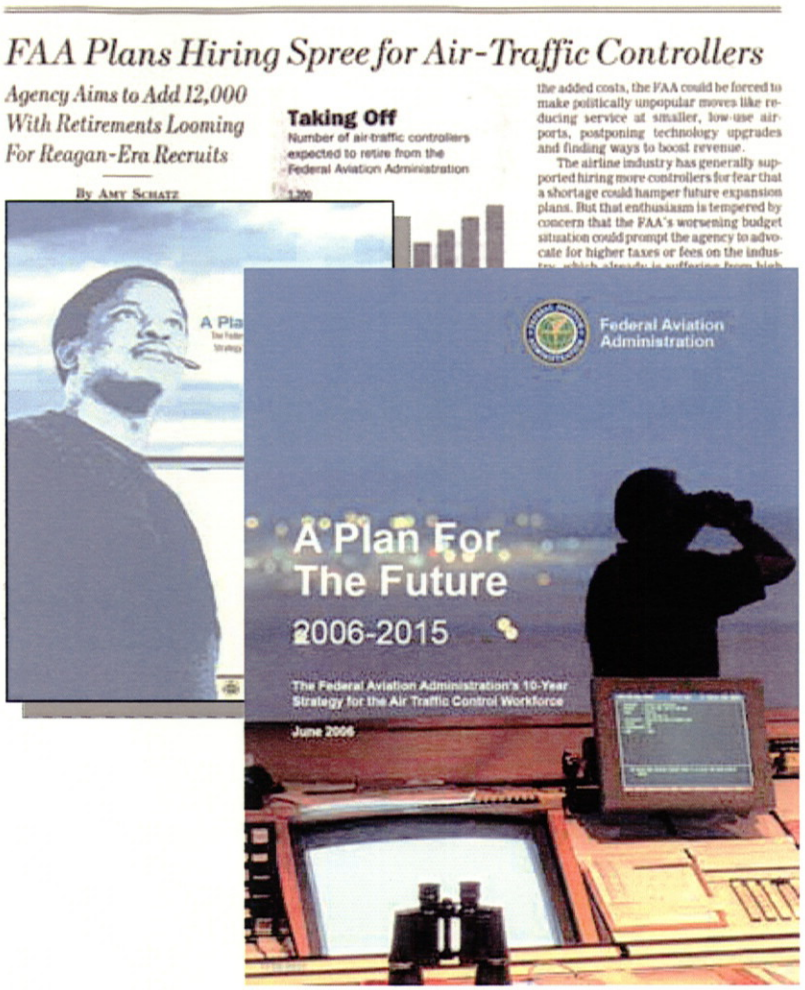
The Challenge for Controller Training

Wall Street Journal, 21 Dec 2004



FAA Plans Hiring Spree for Air-Traffic Controllers

Agency Aims to Add 12,000 With Retirements Looming For Reagan-Era Recruits

By Amy Schatz

Taking Off

Number of air-traffic controllers expected to retire from the Federal Aviation Administration

the added costs, the FAA could be forced to make politically unpopular moves like reducing service at smaller, low-use airports, postponing technology upgrades and finding ways to boost revenue.

The airline industry has generally supported hiring more controllers for fear that a shortage could hamper future expansion plans. But that enthusiasm is tempered by concern that the FAA's worsening budget situation could prompt the agency to advocate for higher taxes or fees on the indus-

- **Certification of new controllers is costly and time-consuming**
  - **Terminal: 2-3 years**
  - **En Route: 3-5 years**
- **Total expected losses 2006-2015**
  - **10,291 Controllers**
  - **73% of current workforce**
- **Total hires projected over the next 10 years: 11,851**
- **Sufficient training capacity does not currently exist in the FAA**
- **Numbers from March 2007 FAA Workforce Plan for 2007-2016 even higher**

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Improved Training Process

- Promotion of accelerated learning
- Minimal non-productive time with opportunities to practice and master skills
- Standardized instruction and performance assessment
- Early acquisition of basic ATC knowledge and skills targeted at specific facility operations

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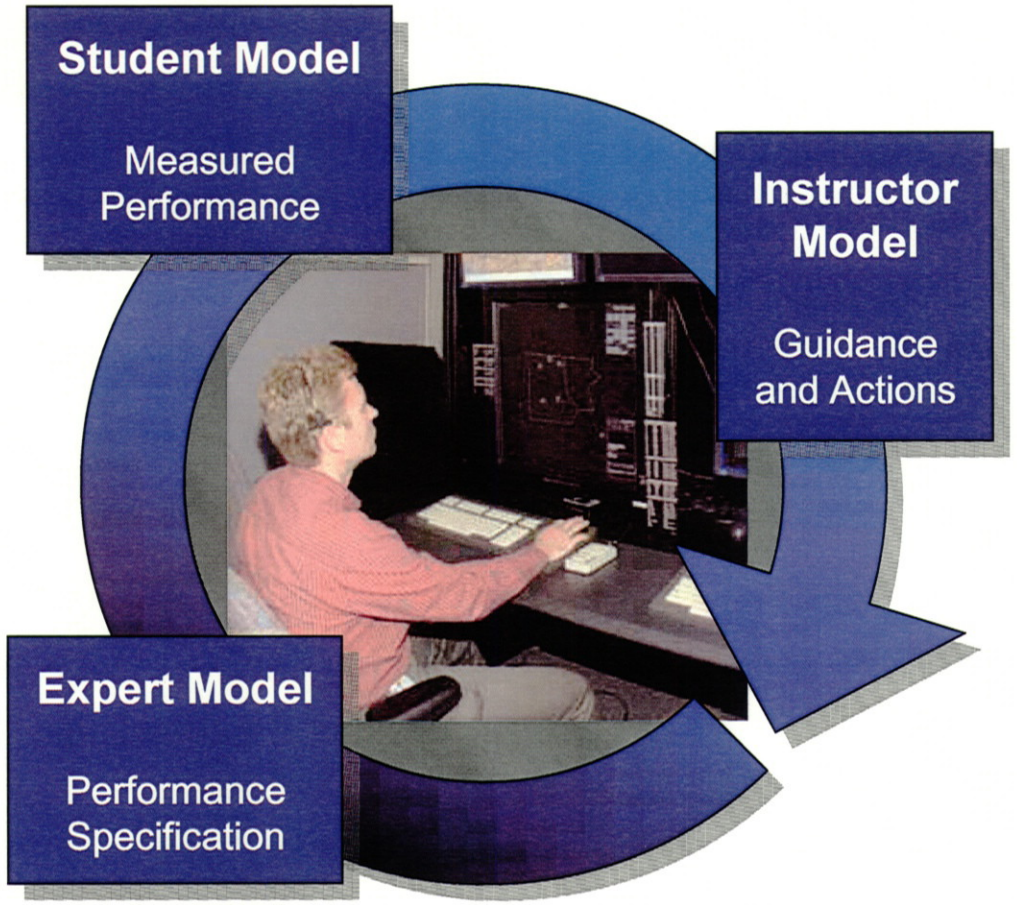
Intelligent Tutoring Systems (ITS)



- **Objectively assess learned skills**
- **Deduces strengths and weaknesses of trainee**
- **Enables self-paced, tailored instruction**
- **Enforces desire to master skills**

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Training Accomplishments
2006

Developmental Controller at Indianapolis using *enroute*Trainer for Radar Training

- **Stand-alone, prototype trial at Indianapolis ATCC**
  - **Radar training curriculum**
  - **High fidelity ATC operations**
  - **Recording, playback, pause**
  - **Voice recognition and speech synthesis for pseudo-pilot role**
  - **New skill-based air traffic scenarios**
- **Students were validated on all sectors**
  - **What would have taken 1080 hours of OJT, took ~524 hours to complete**

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Training Accomplishments
2007

- ***enroute*Trainer used exclusively for radar training**
- **All students completed training and passed evaluation scenarios**
- **MITRE evaluated performance measures, voice and functional enhancements**

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Training Plans
2008 – 2010

- **Transfer technology for inclusion in FAA terminal and en route automation systems**
  - Automated (voice) sim-pilot
  - Skill scenarios
  - Performance metrics
  - Processes and procedures for using new capabilities

- **Continue development of training capabilities**
  - Assess capabilities and benefits with continued field trials for more students and more sectors
  - Evaluate and validate performance measures and real-time feedback
  - Automate ghost controller capability
  - Expand use of skill scenarios and recorded live operations scenarios

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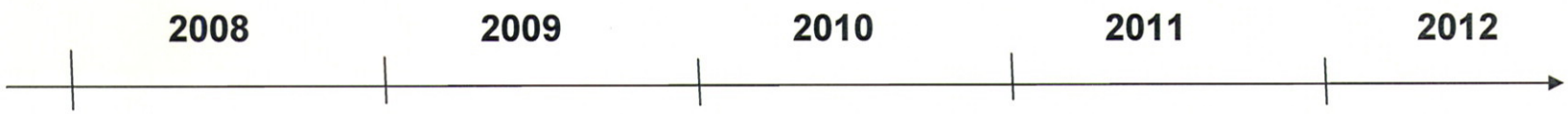
Enroute and Terminal Training 5 Year Overview



2008

Initial enroute ITS development and test at ZID

Terminal Airspace and Procedures Training Prototype evaluation at Miami

Tech transfer enroute controller/controller Voice Technology

Tech transfer initial ITS and skill scenario design

2009

Advanced enroute ITS development and test at ZID

Use enroute trainer to support/evaluate facility training process changes (Functional Training)

Terminal Airspace and Procedures Training Prototype evaluation at 2nd facility (ARTS)

Tech transfer terminal airspace and procedures training materials

Tech transfer enroute ITS design

2010

Continue evaluation of enroute facility training process changes

Tech transfer training materials and training design to support training process changes

2011

Apply training technology/curriculum design innovations to support the evolution to PATM/NextGen

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Mid-Term Research & Development (R&D)

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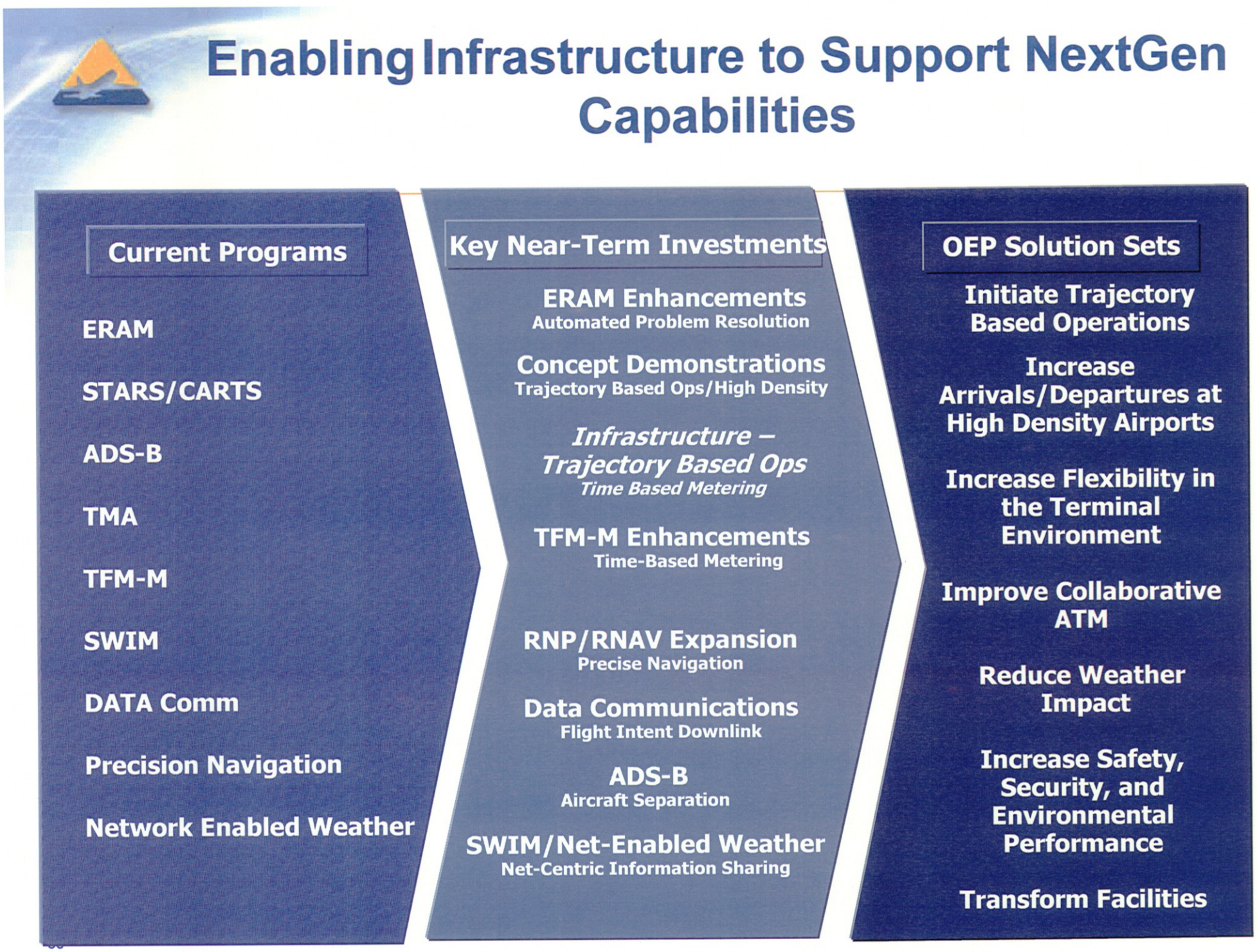
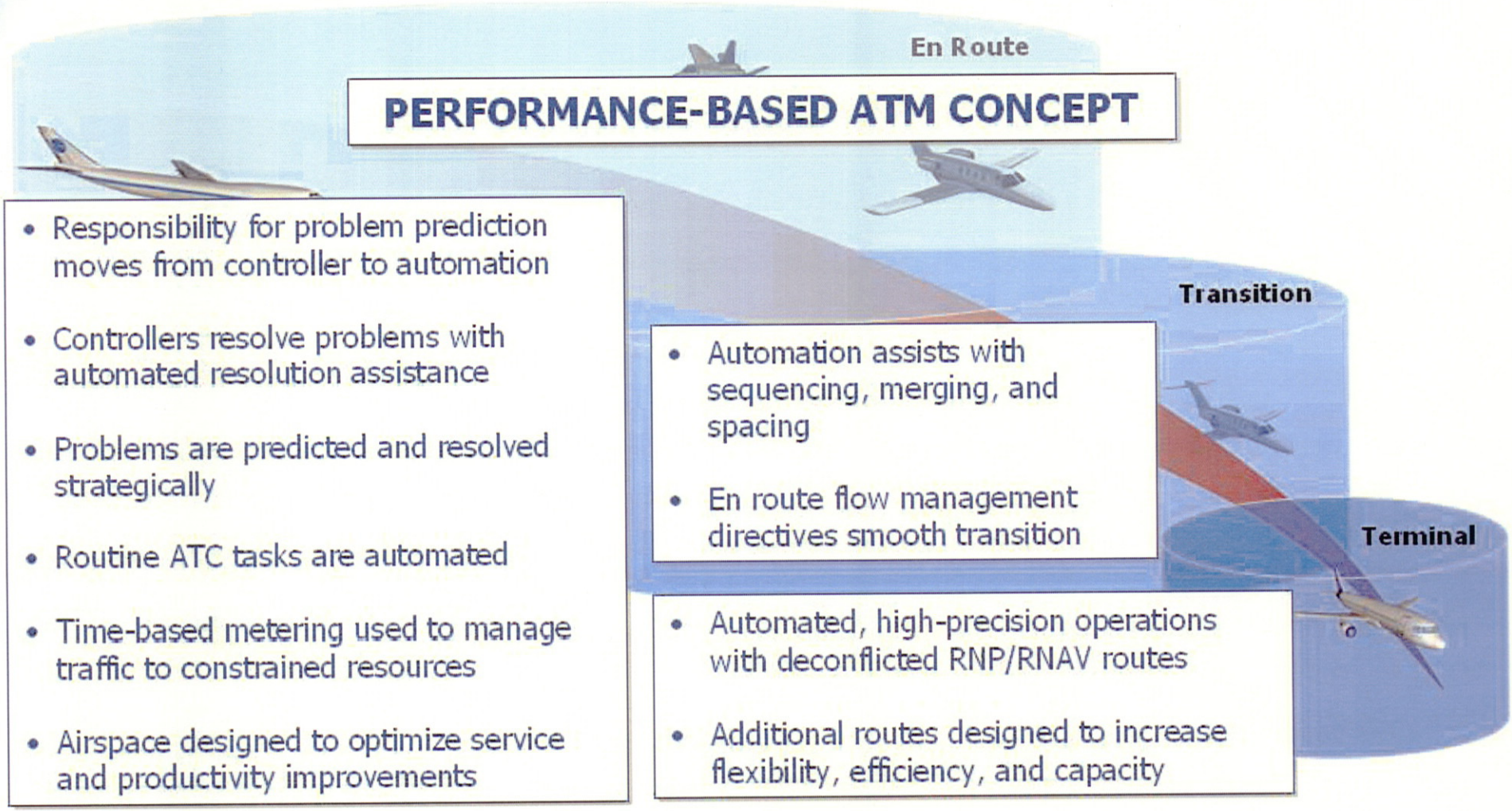
Enabling Infrastructure to Support NextGen Capabilities



Responding to the Challenges

An Outlook for the Next Decade



- Responsibility for problem prediction moves from controller to automation
- Controllers resolve problems with automated resolution assistance
- Problems are predicted and resolved strategically
- Routine ATC tasks are automated
- Time-based metering used to manage traffic to constrained resources
- Airspace designed to optimize service and productivity improvements

- Automation assists with sequencing, merging, and spacing
- En route flow management directives smooth transition

- Automated, high-precision operations with deconflicted RNP/RNAV routes
- Additional routes designed to increase flexibility, efficiency, and capacity

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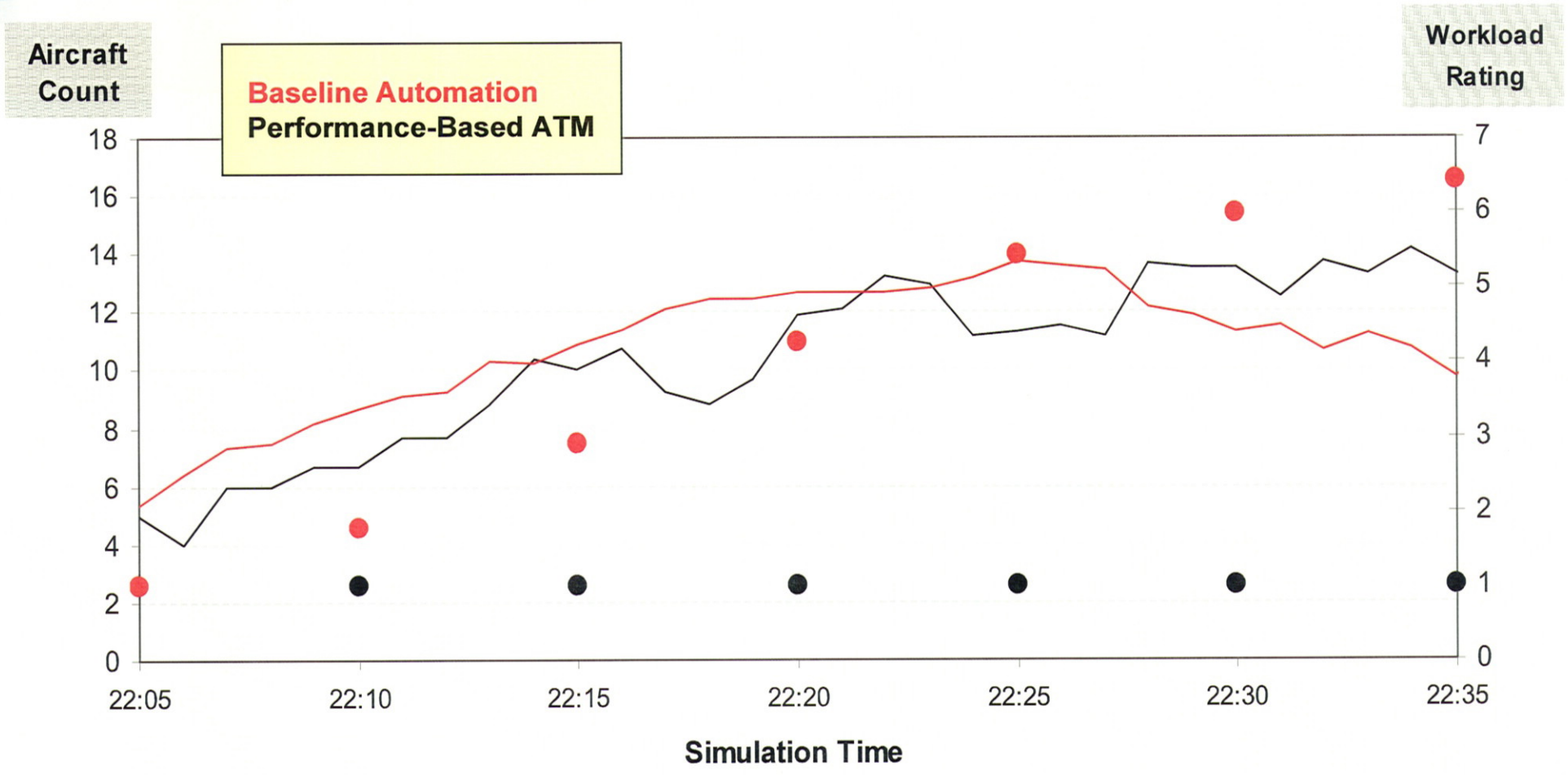
Preliminary R&D Results, in-depth analysis are still being conducted

En Route Experiment Results
Controller Workload



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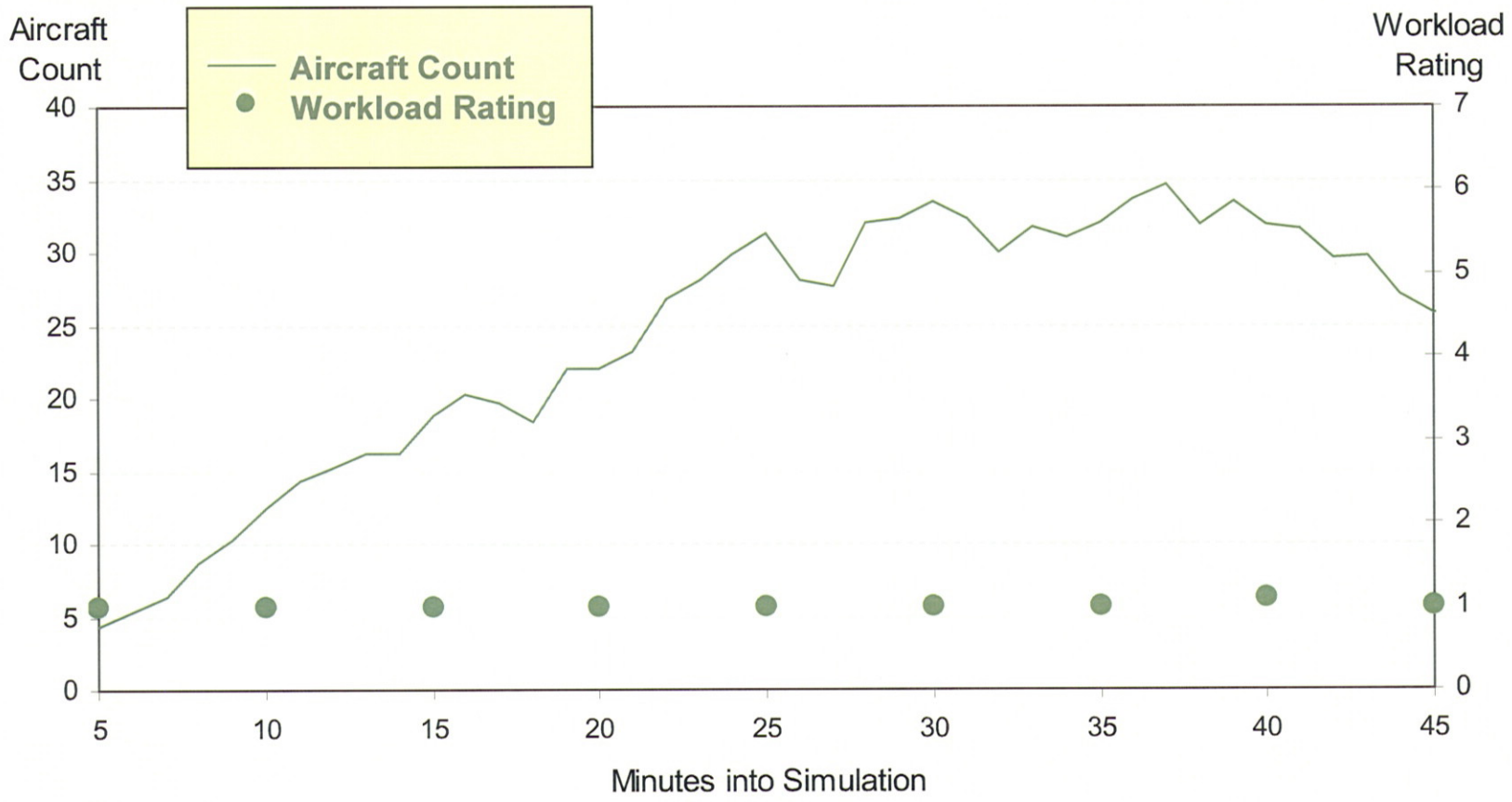
Preliminary R&D Results, in-depth analysis are still being conducted

En Route Experiment Results
Controller Workload (concluded)

P-ATM Operations with Expanded Volume



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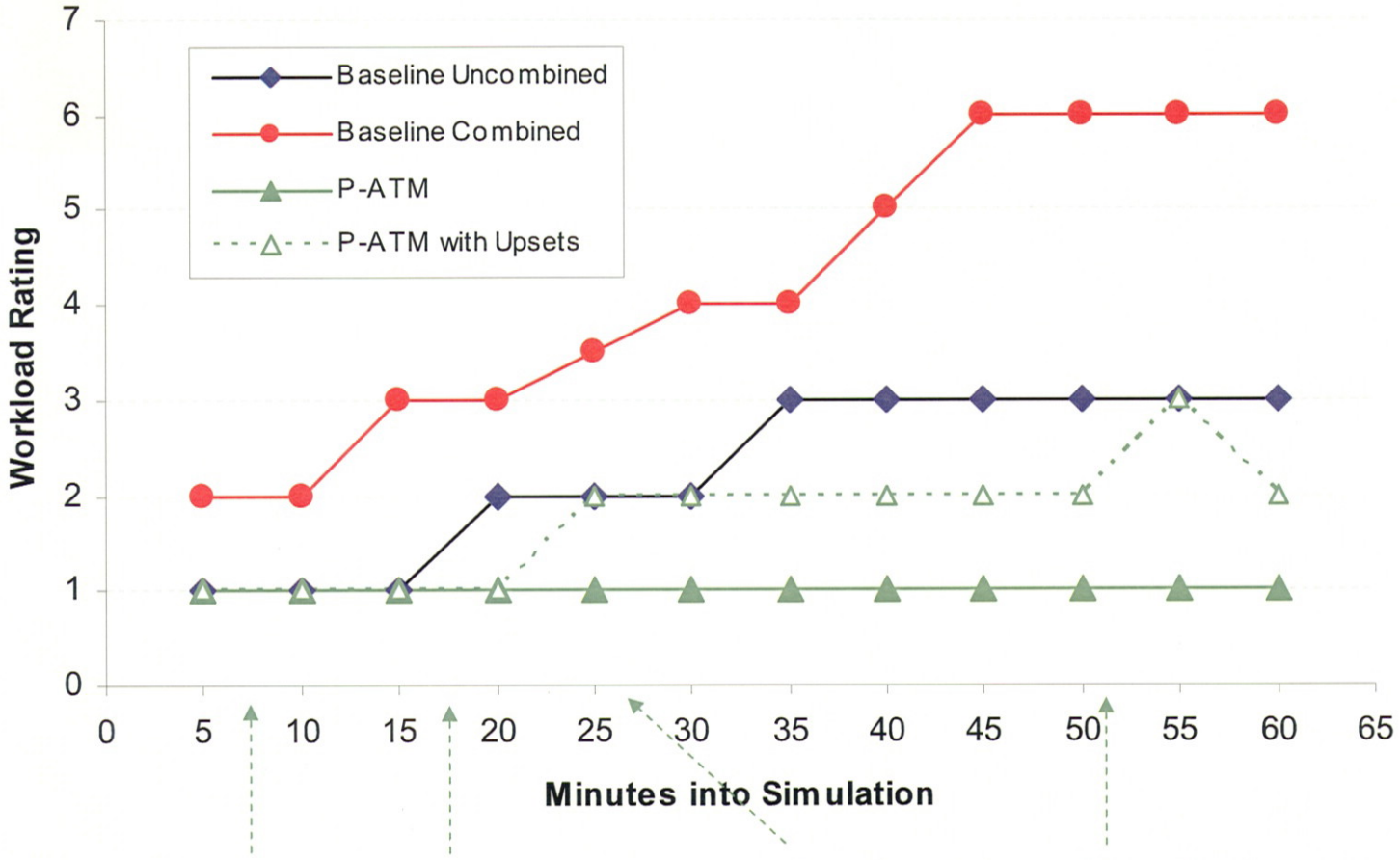
Preliminary R&D Results, in-depth analysis are still being conducted

Terminal Experiment Results

Controller Workload



UPSETS:

- Lateral deviation from RNAV arrival procedure
- Aircraft misses downwind turn on RNAV arrival
- Aircraft makes drastic heading off route
- Aircraft misses turning down to the south runway

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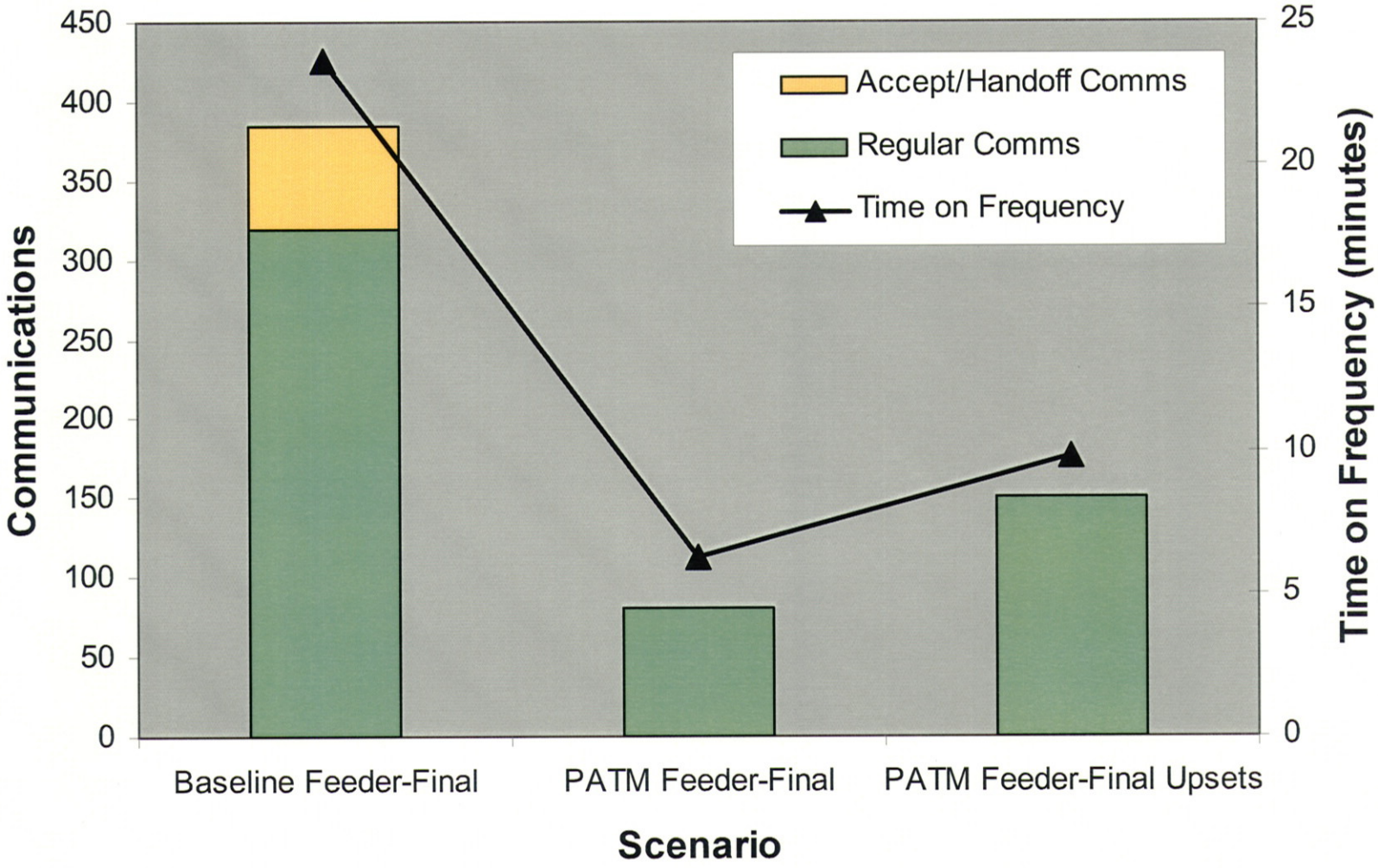
Preliminary R&D Results, in-depth analysis are still being conducted

Terminal Experiment Results

Controller Communications



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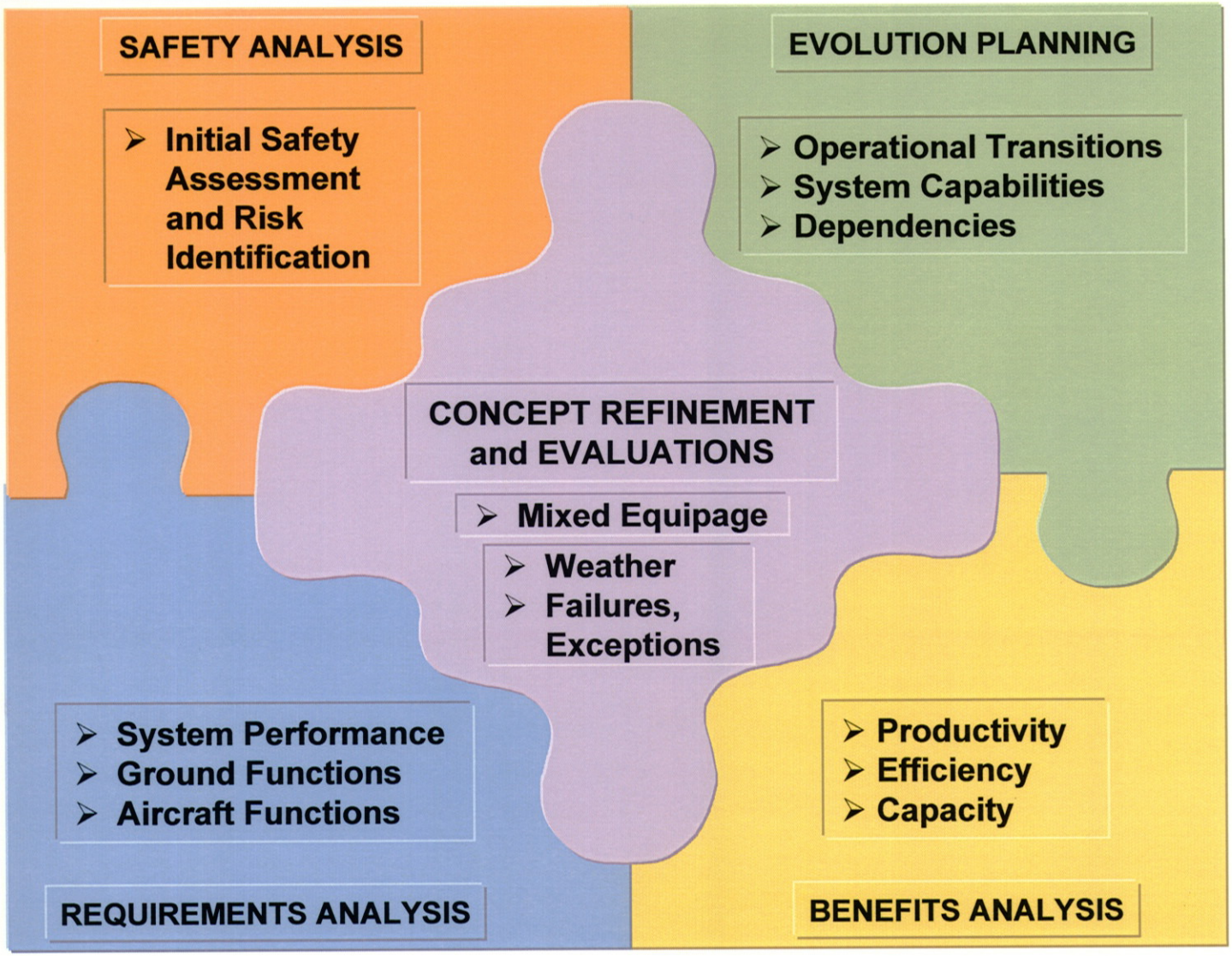
NextGen Solution Focuses



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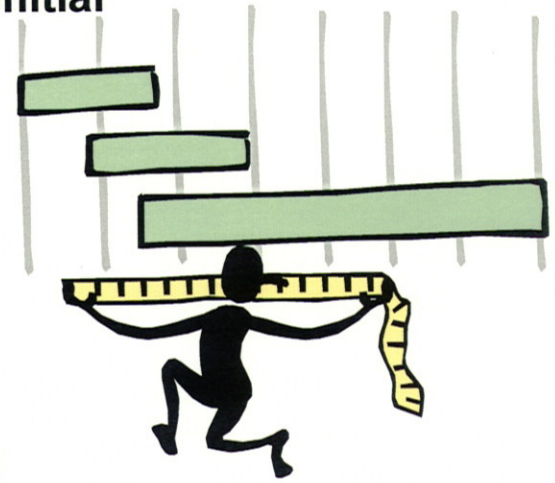
Real Progress

- NextGen Concept of Operations and Enterprise Architecture baselined June 2007
- Integrated Work Plan baseline and Business Case (E-300) to be completed this summer

Complete Baseline of the NextGen Plan Nearing Completion

- FAA initial system changes underway (infrastructure and initial applications)
  - ADS-B
  - SWIM
  - DataCom
  - Voice Switch
  - Demonstrations

NextGen Implementation Proceeding



- FAA mid-term plan in development (Operational Evolution Partnership)
- NASA research aligned (long-term transformation)
- Near-term interagency initiatives:
  - NextGen Network-enabled Weather Joint Program Office, Safety Management System, Net-centric Information System

NextGen Interagency Initiatives are Developing

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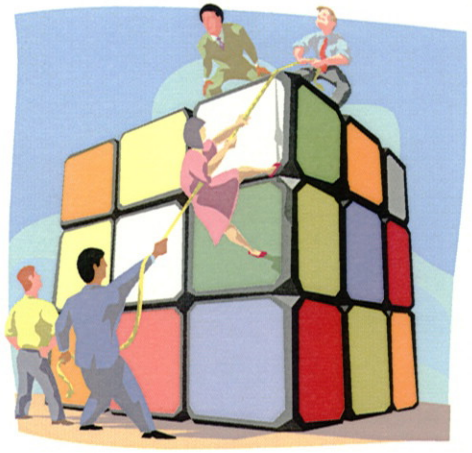
Challenges

- Achieving Integration
- Pace of Implementation
- Overcoming Technical Hurdles
- Changing Policy and Culture



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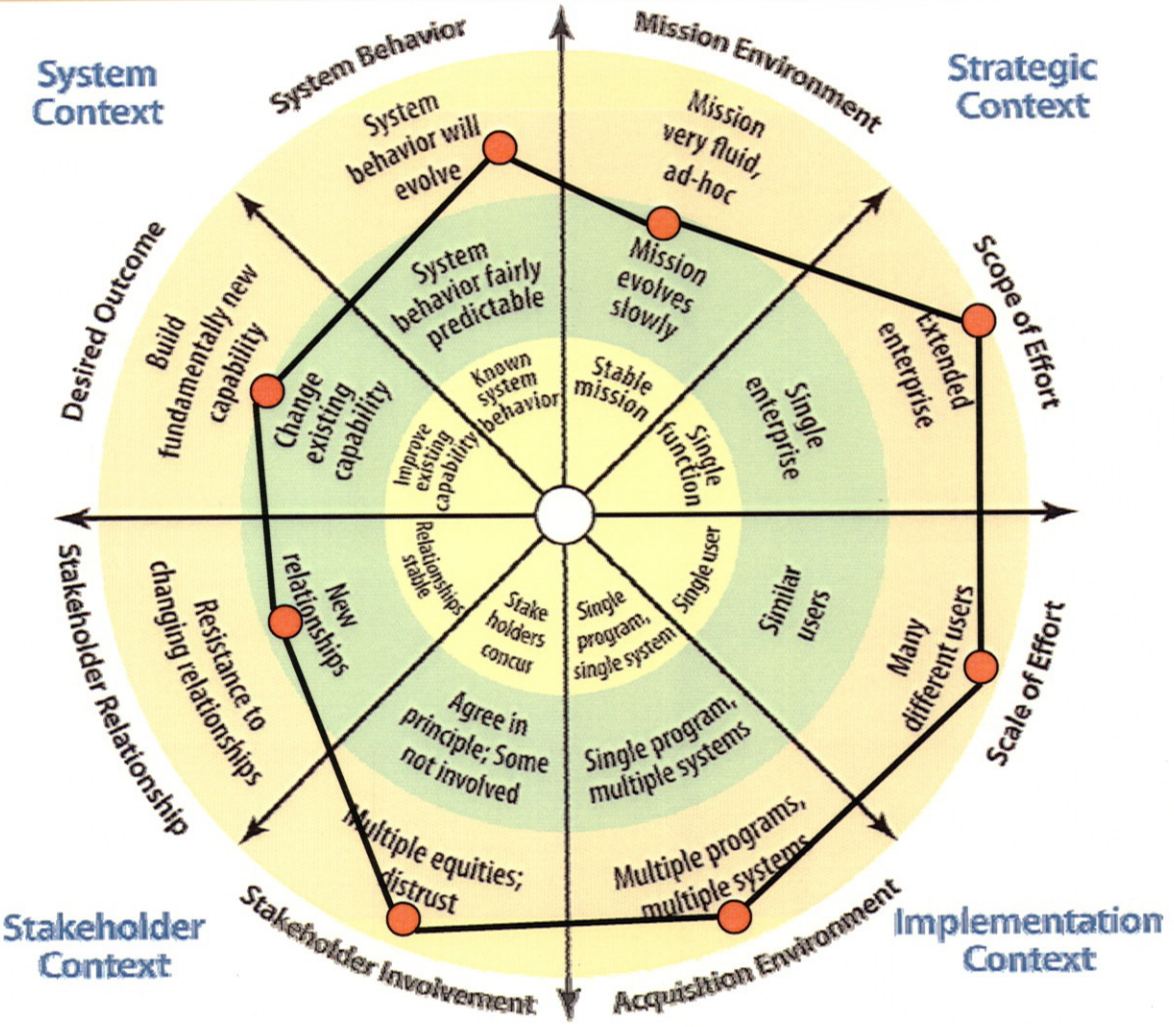
NextGen Enterprise System Engineering Challenges



Enterprise System Engineering Profiler ™

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Conclusion: Getting to NextGen

- We are
  - Creating and carrying out the Plan to get to NextGen
    - Defining NextGen applications at specific locations
    - Defining and implementing intermediate steps toward NextGen (e.g., P-ATM, mid-term concept)
  - Coordinating budgets, goals, investment priorities, and research activities
  - Leveraging the capabilities of federal agency and private sector organizations

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Thank you!

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