



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

A Mid-Term Step Toward NextGen

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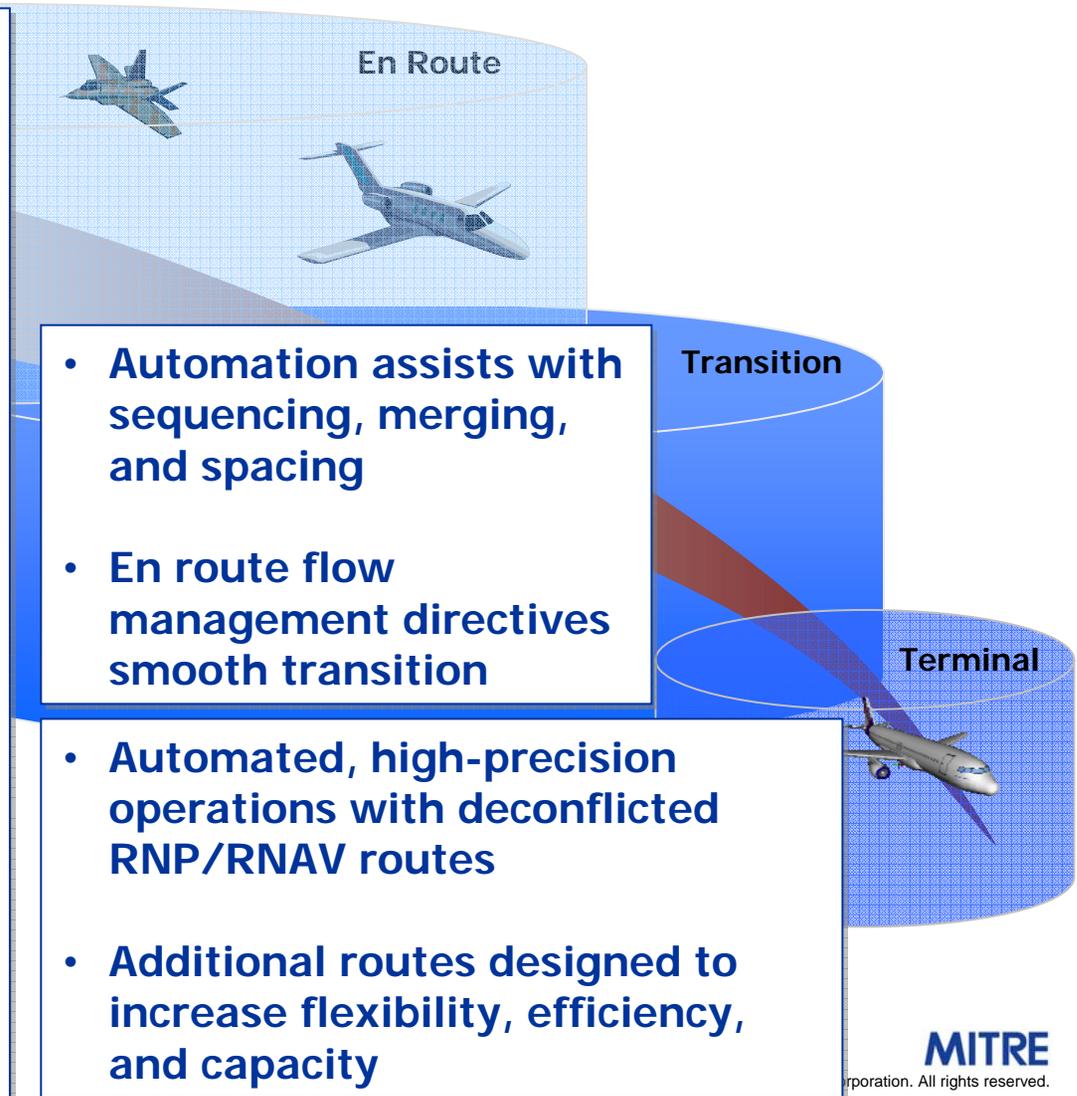
Presented at the ICNS Conference 2007

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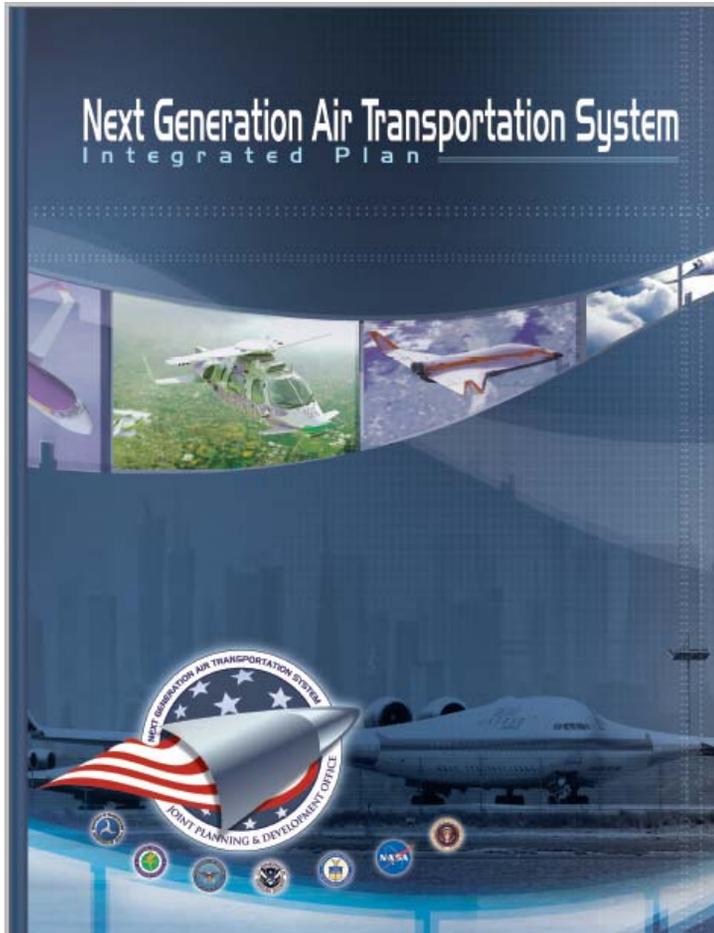
Proposed Concept of Operations

- 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



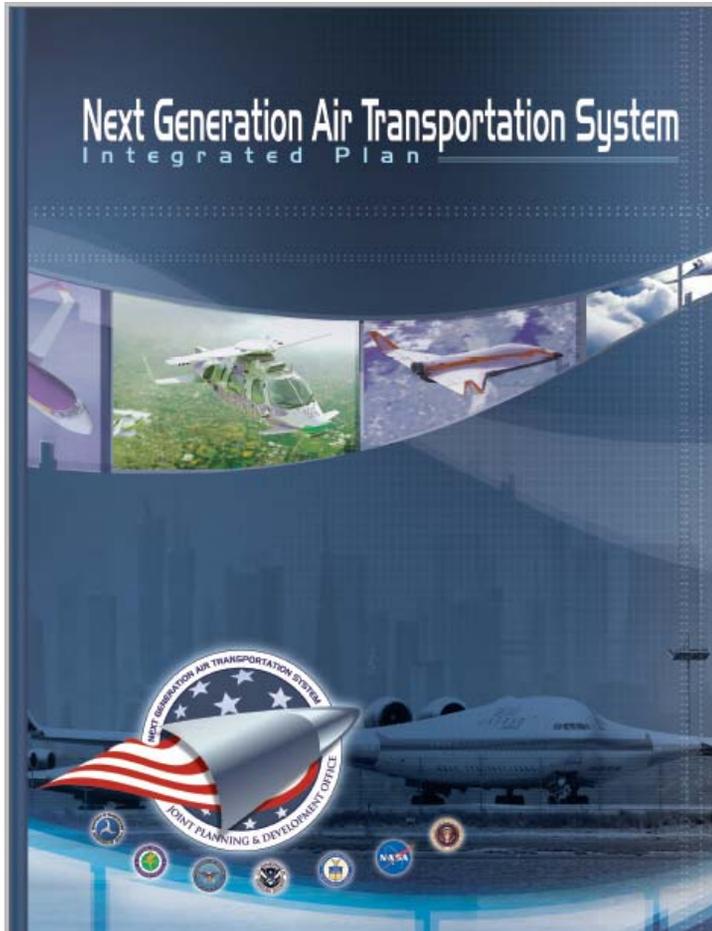


NextGen Integrated Plan and Concept of Operations





NextGen Integrated Plan and Concept of Operations



Joint Planning
and
Development Office

Concept of Operations
for the
Next Generation Air Transportation System

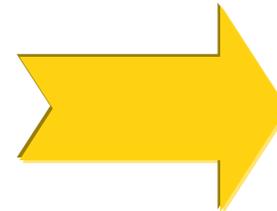
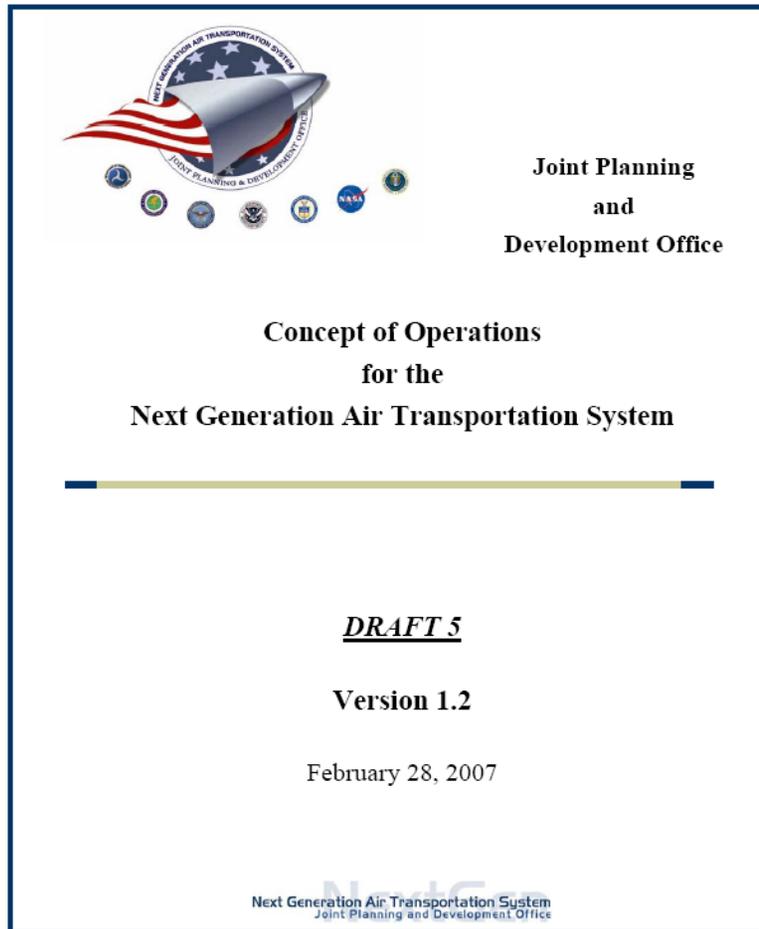
DRAFT 5

Version 1.2

February 28, 2007

Next Generation Air Transportation System
Joint Planning and Development Office

NextGen Integrated Plan and Concept of Operations



NextGen

Trajectory-Based Operations

Aircraft Data Communications

Performance-Based
Operations and Services

Separation Management

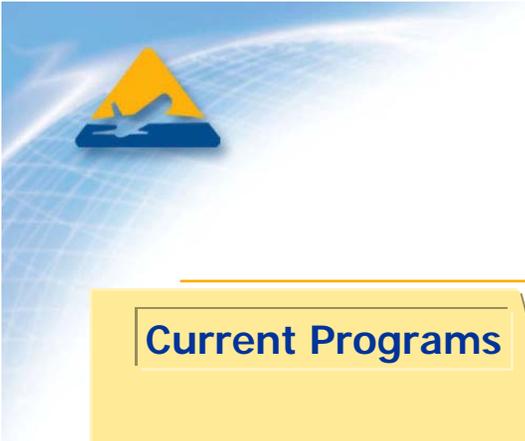
Collaborative ATM

Precision Navigation

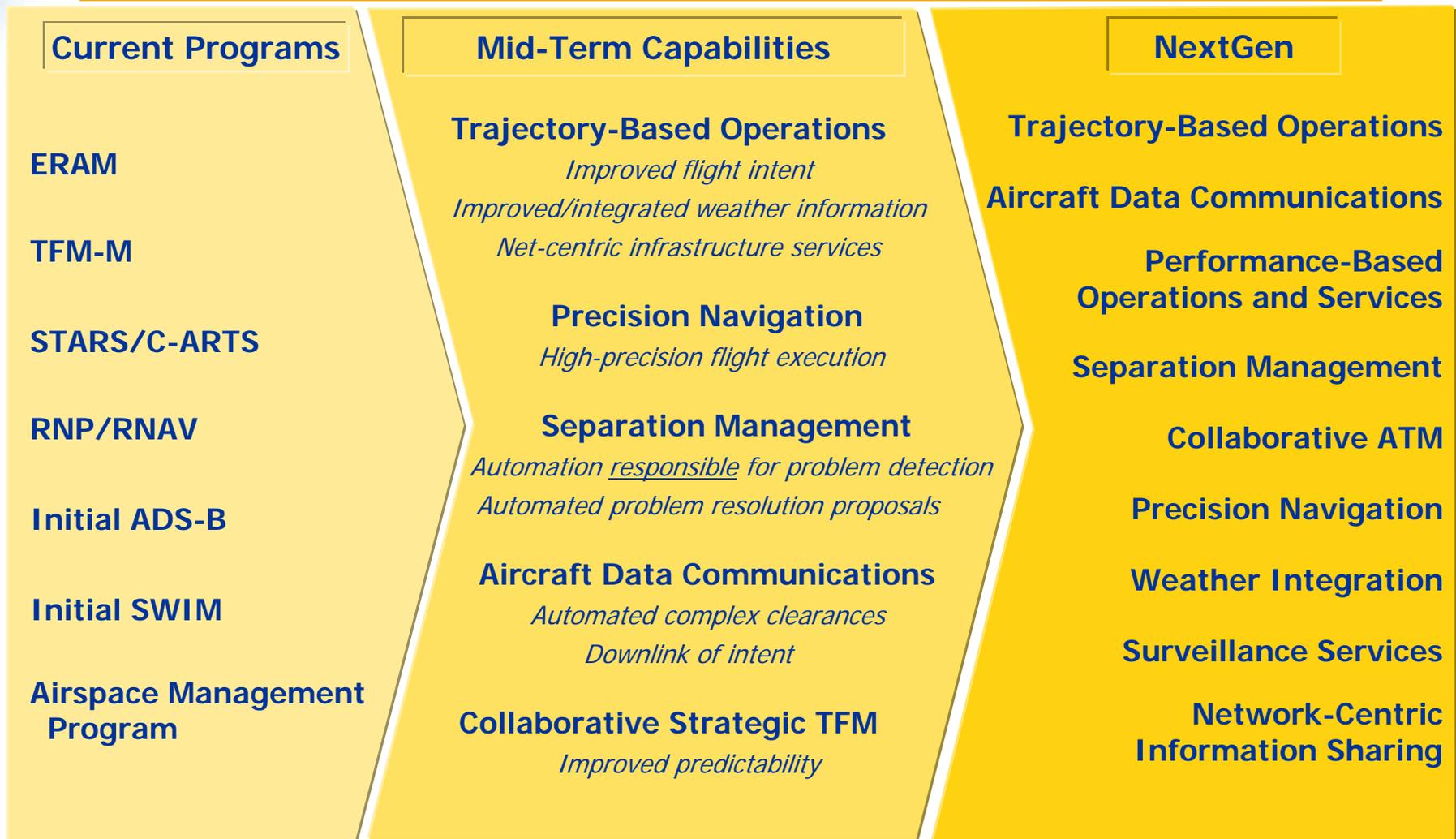
Weather Integration

Surveillance Services

Network-Centric
Information Sharing



Realizing NextGen





Realizing NextGen

Mid-Term Capability Portfolio

ERAM Enhancements

*Automated Problem Resolution
Integrated Controller Suite
A/G Data Communications Integration*

TFM-M Enhancements

*Enhanced Time-Based Metering
Probabilistic Prediction of Congestion
Enhanced Departure Sequencing Tool
Automation for Collaboration with Users
Automation for Flow Initiatives*

STARS/C-ARTS Enhancements

*Merging and Sequencing Tools
Route Adherence Monitoring
A/G Data Communications Integration*

**Avionics Equipage/
Flight Planning Systems**

RNP/RNAV Expansion

Precise Navigation

Air/Ground Data Communications

*Complex Clearance Delivery
Flight Intent Downlink
User Requests*

ADS-B

Aircraft Separation

SWIM

Net-Centric Information Sharing

**Airspace Redesign
Optimize Improvements**

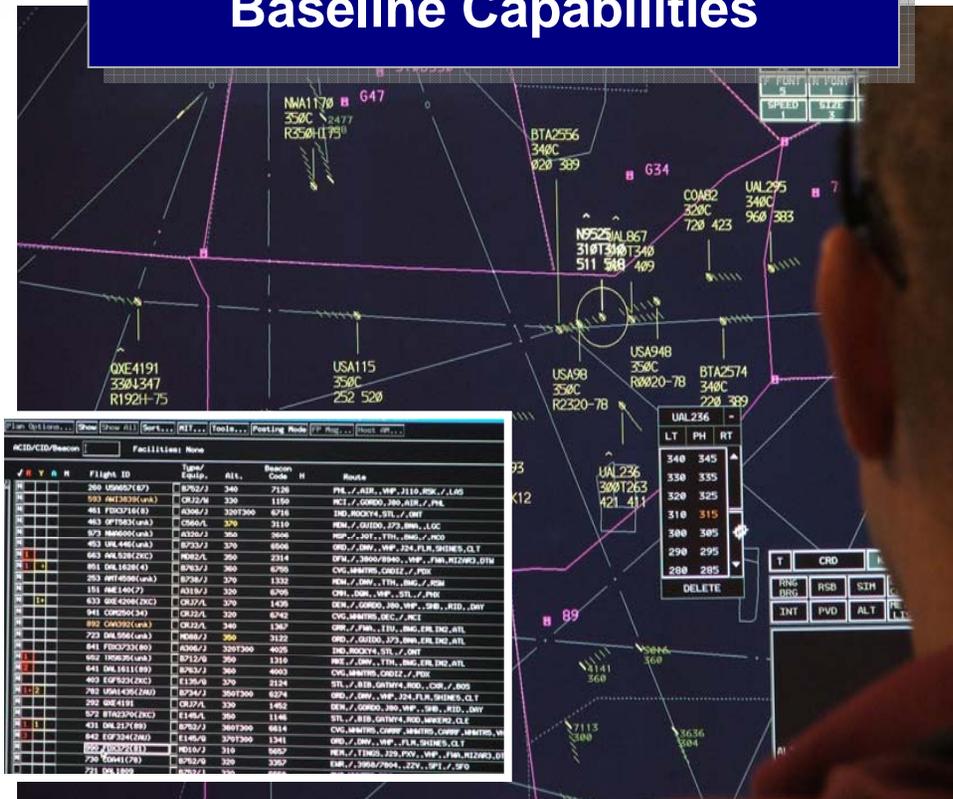
Procedures, Training



En Route Operations

Changes in the Controller's Job

Baseline Capabilities

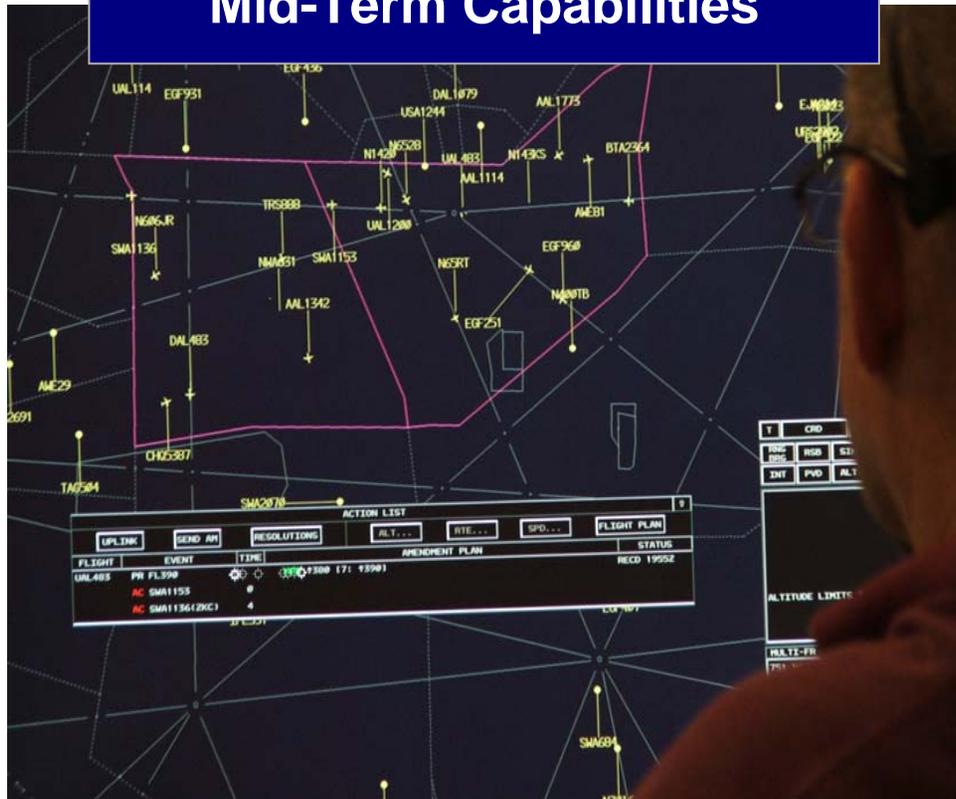


- Manual scanning of situation display
- Manual detection and resolution of problems
- Performing routine ATC tasks
- Handling TFM initiatives and pilot requests
- Voice communications



En Route Operations Changes in the Controller's Job

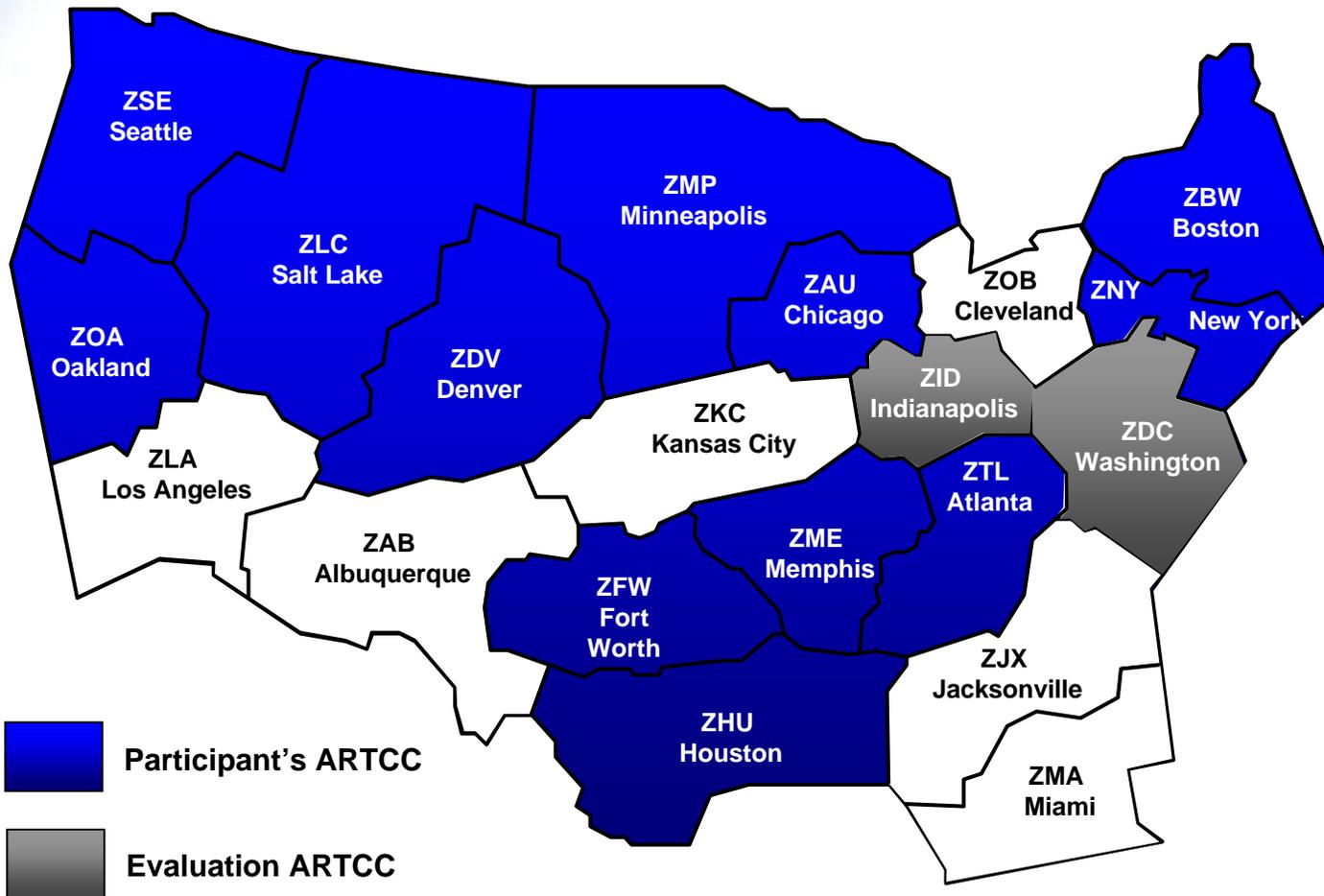
Mid-Term Capabilities



- Integrated sector display
- Action List manages control events
- Routine ATC tasks are automated
- Automation assists with TFM initiatives and pilot requests
- Data communications



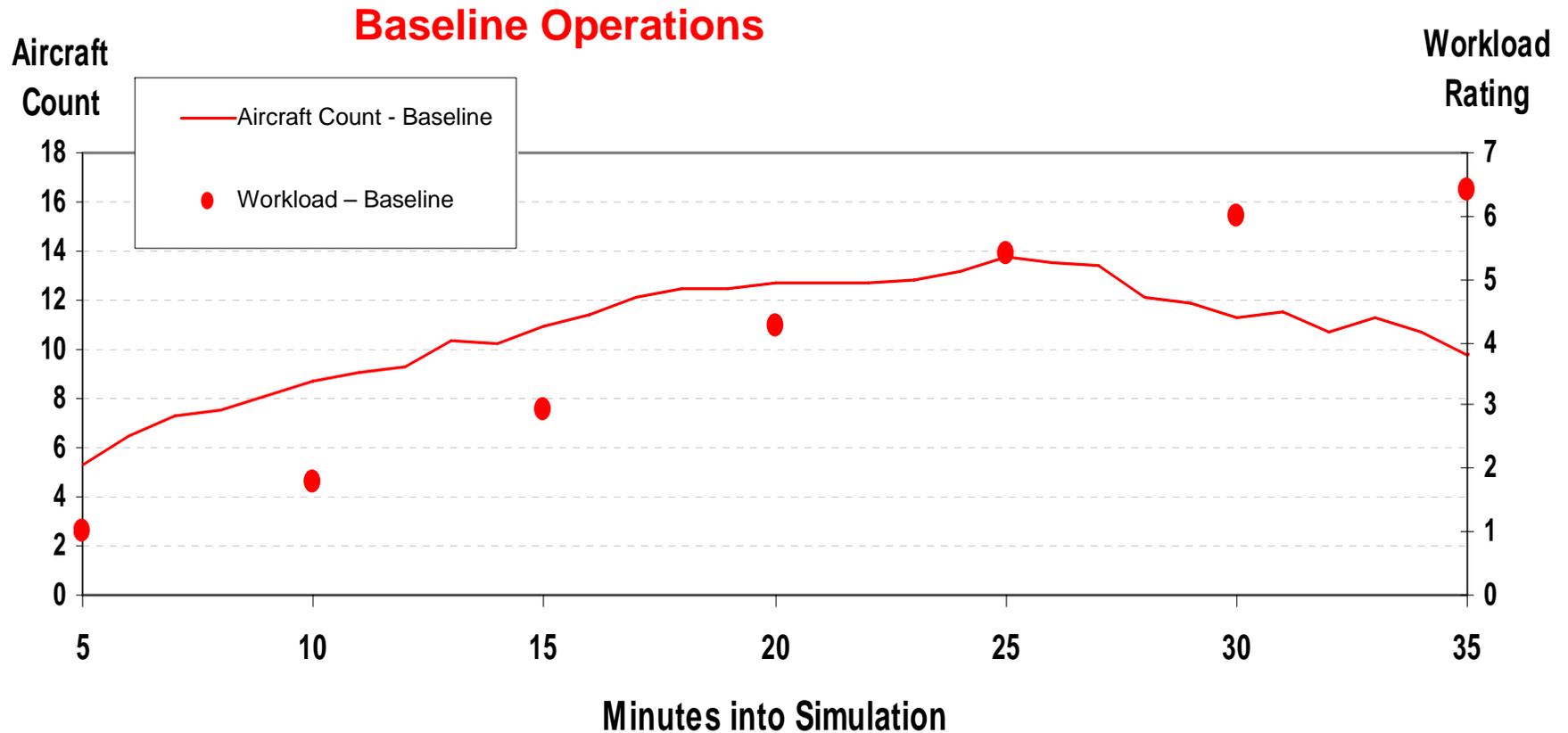
En Route Concept Validation Human-in-the-Loop Experiments



- Twelve Supervisors from three regions
- Compared baseline and proposed operational concepts
- Simulations with 25% increased traffic levels



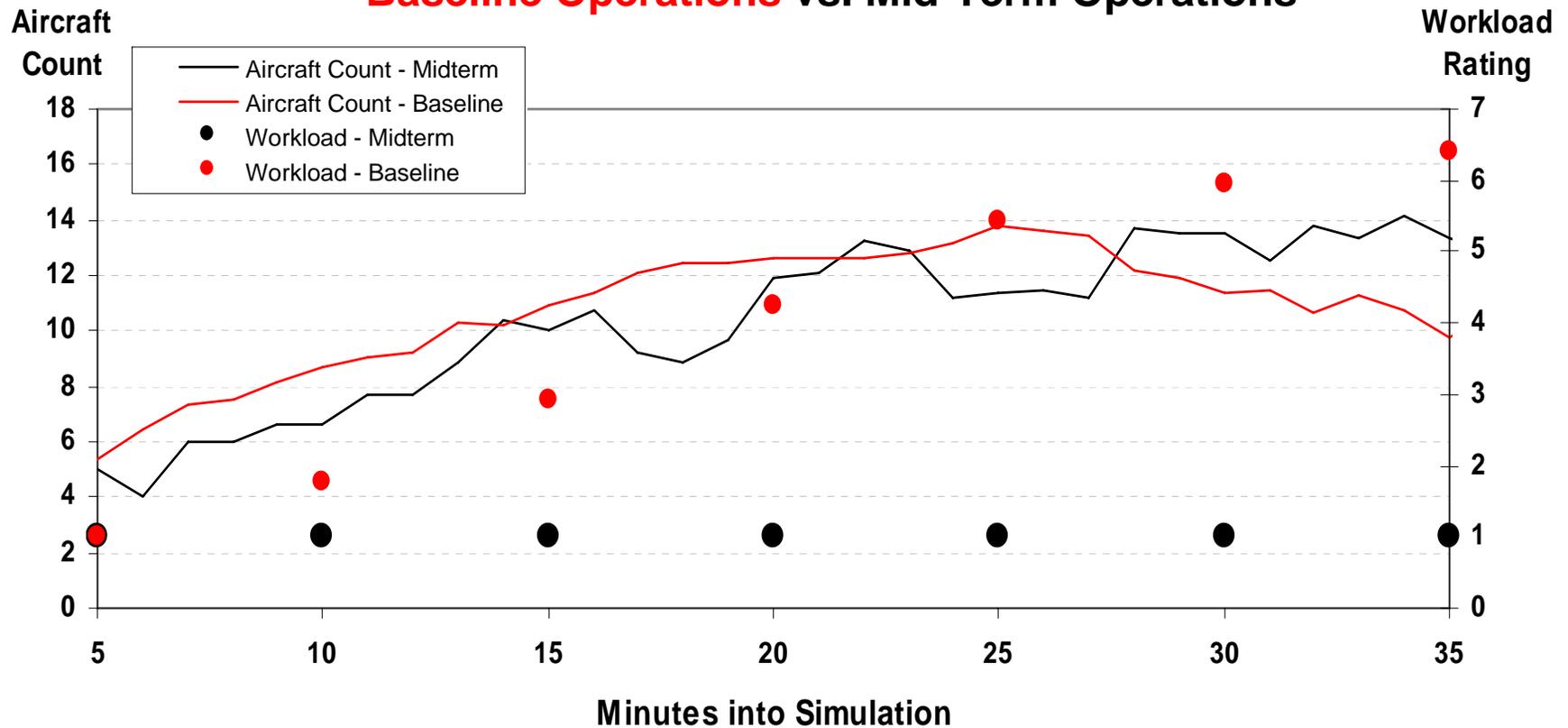
En Route Experiment Results Controller Workload





En Route Experiment Results Controller Workload

Baseline Operations vs. Mid-Term Operations

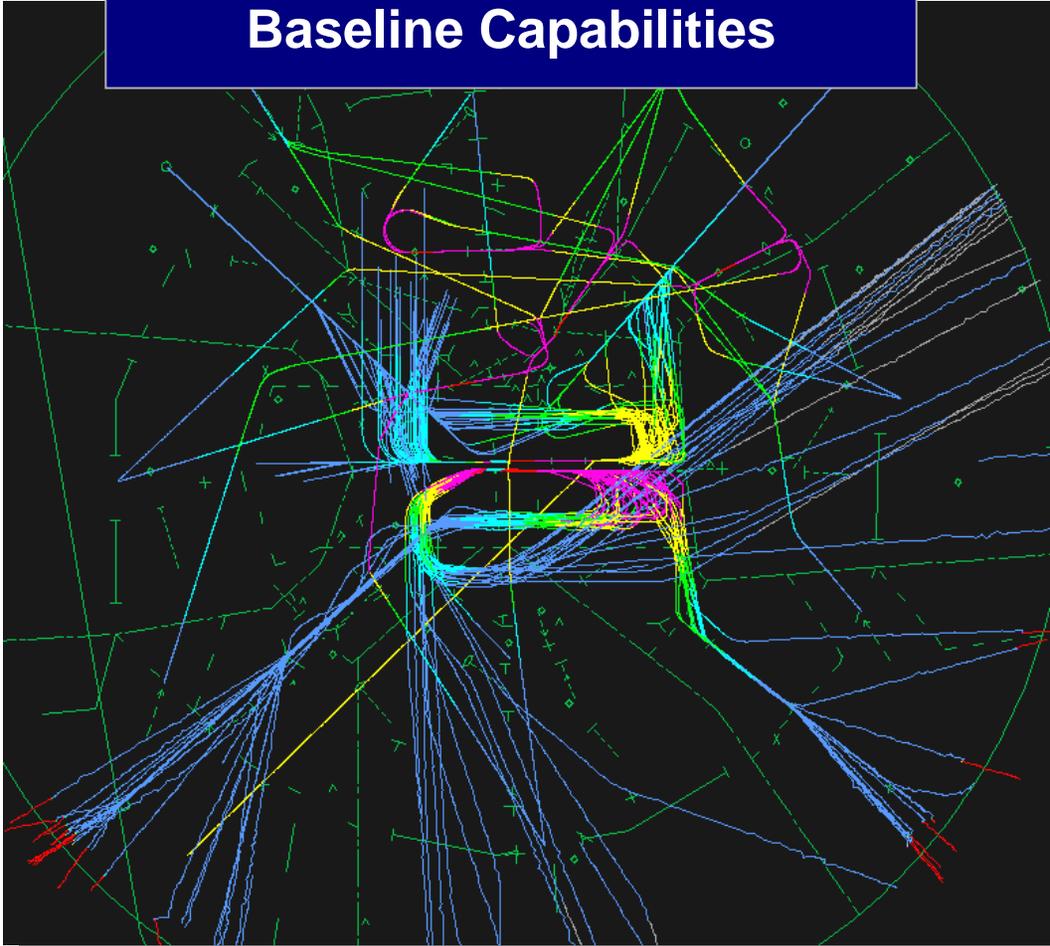




Terminal Operations

Changes in the Controller's Job

Baseline Capabilities

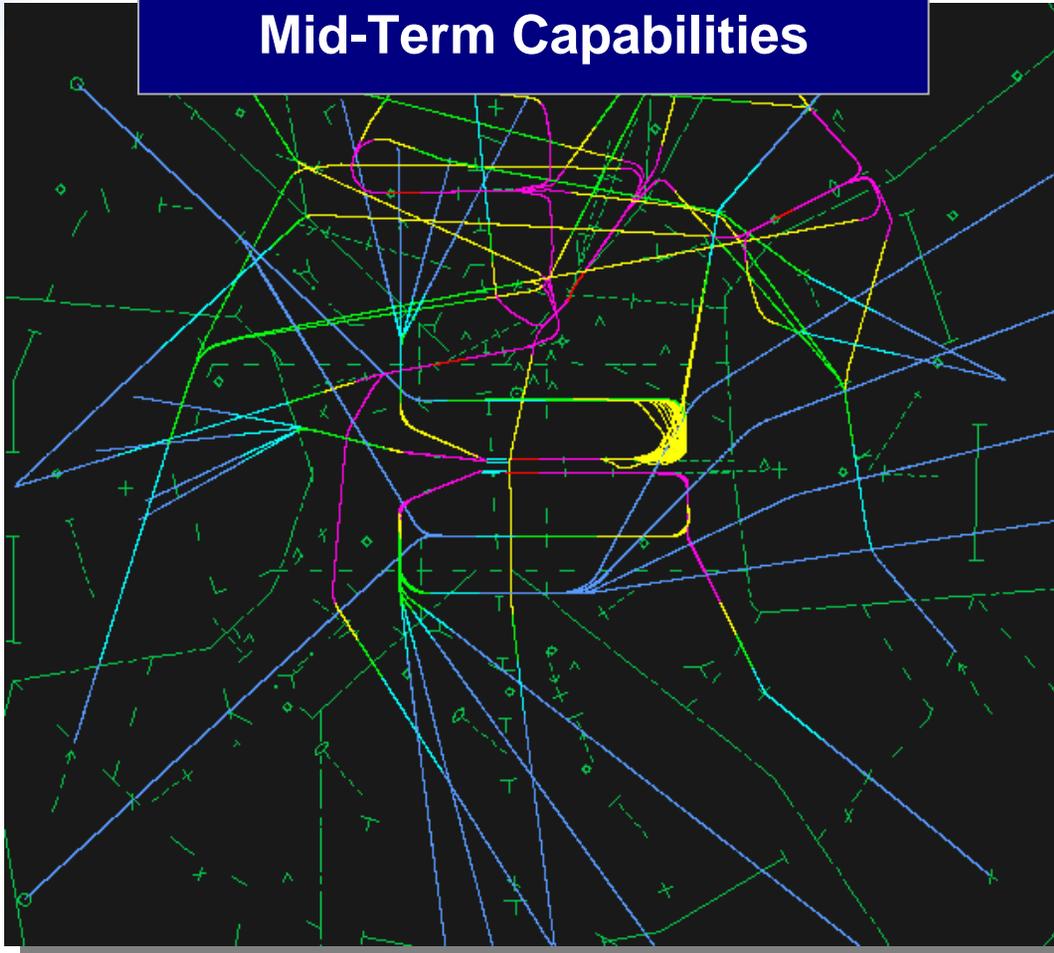


- Radar vectoring and altitude and speed clearances
- Merging and sequencing
- Voice communication
- Manual detection and resolution of conflicts
- Performing routine ATC tasks



Terminal Operations Changes in the Controller's Job

Mid-Term Capabilities

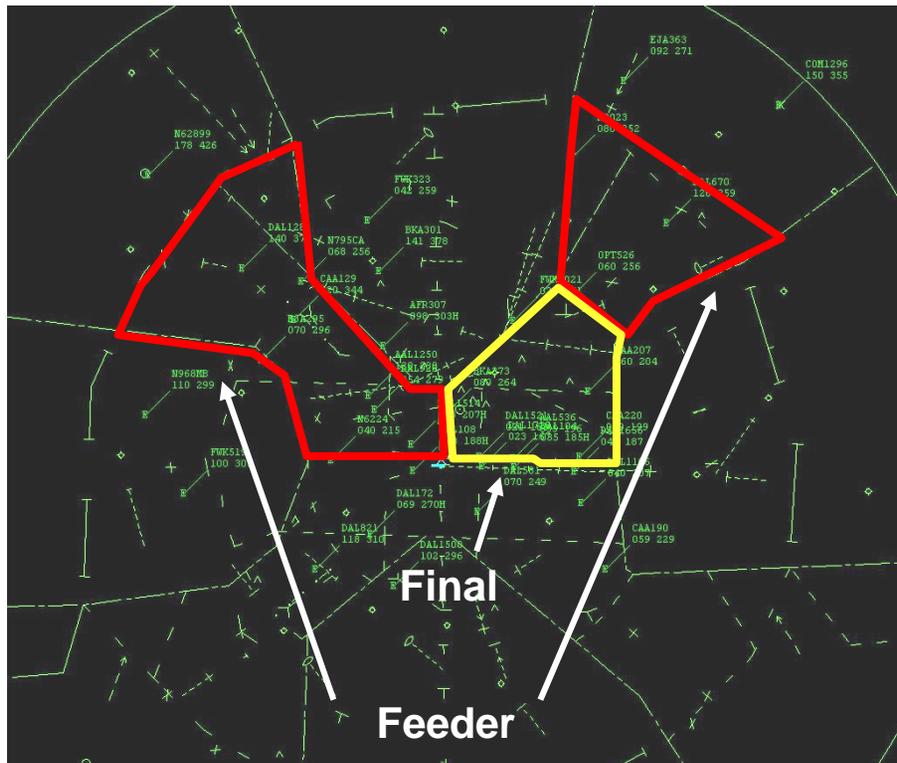


- Pre-planned **RNAV/RNP routes** with procedural separation
- Improved **traffic management** and automation support
- **Data communications** for handoffs, as available
- Automation support for **route adherence** monitoring
- Automation/Data Comm to **minimize routine tasks**



Terminal Concept Validation Human-in-the-Loop Experiments

Baseline

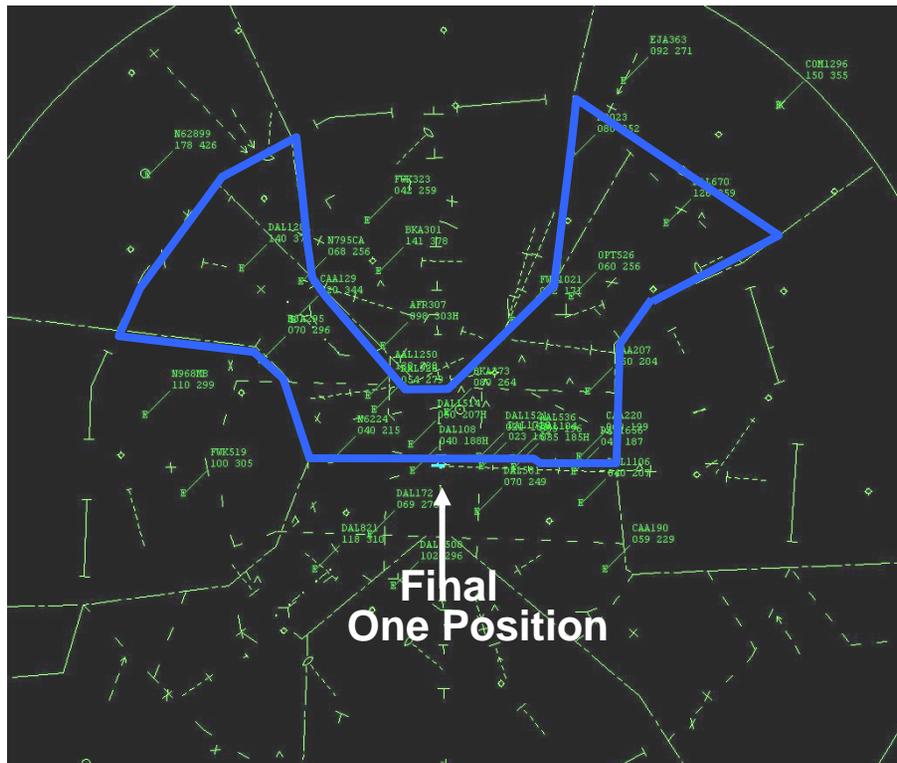


- Examined Atlanta TRACON operations with Atlanta Supervisors
- Compared baseline operations with proposed mid-term concept of operations
- Evaluated whether one controller could work both the feeder and final airspace
- Traffic levels at maximum airport capacity

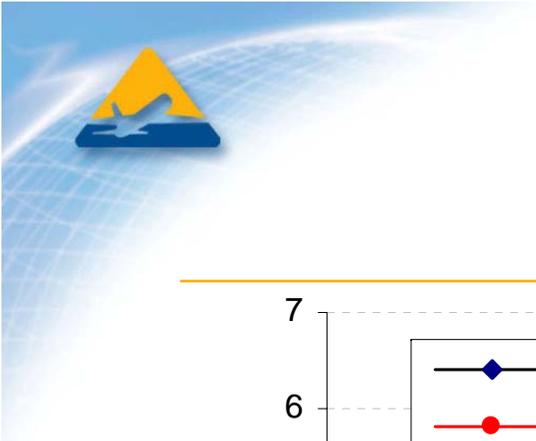


Terminal Concept Validation Human-in-the-Loop Experiments

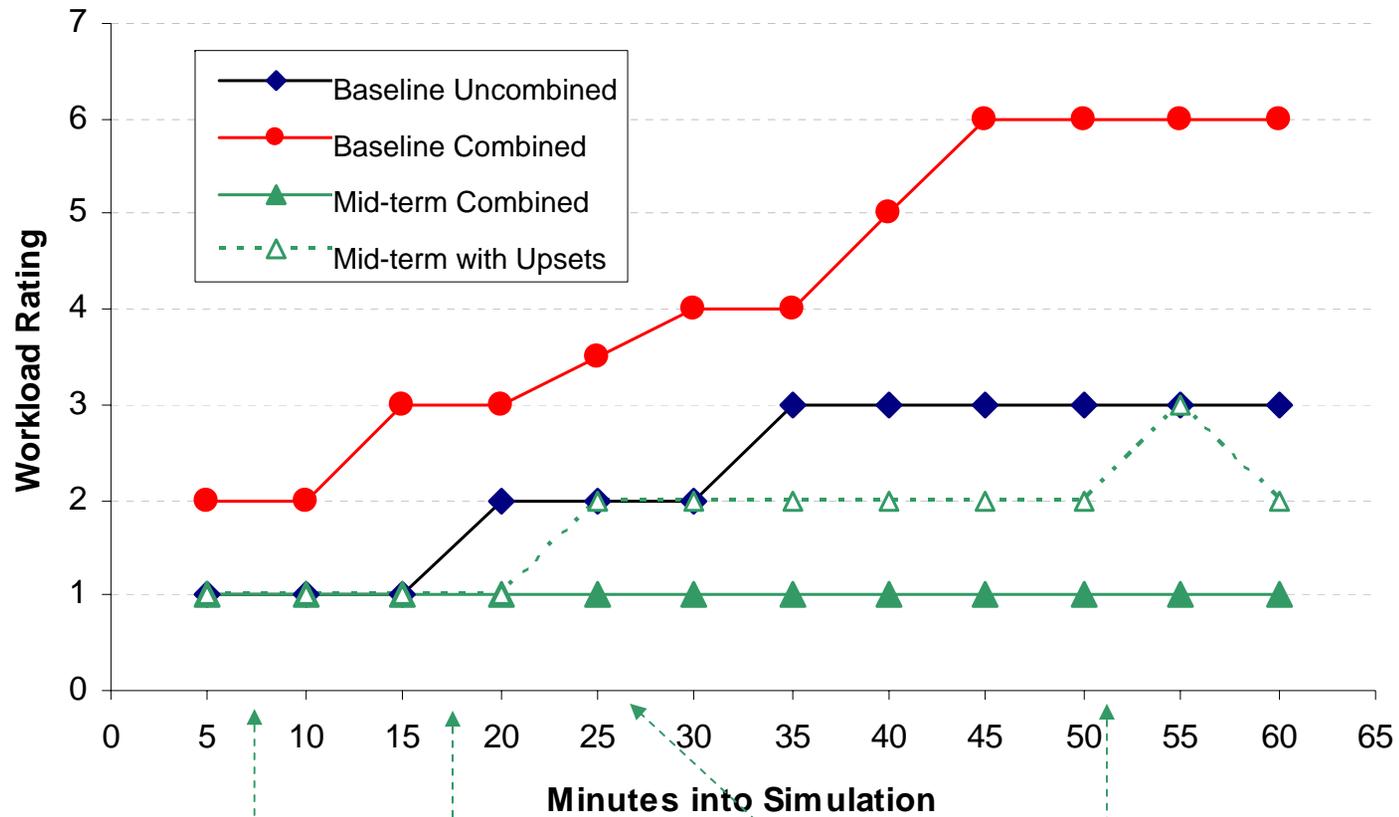
Future



- Examined Atlanta TRACON operations with Atlanta Supervisors
- Compared baseline operations with proposed mid-term concept of operations
- Evaluated whether one controller could work both the feeder and final airspace
- Traffic levels at maximum airport capacity



Terminal Experiment Results Controller Workload



UPSETS:

Lateral deviation from RNAV arrival procedure

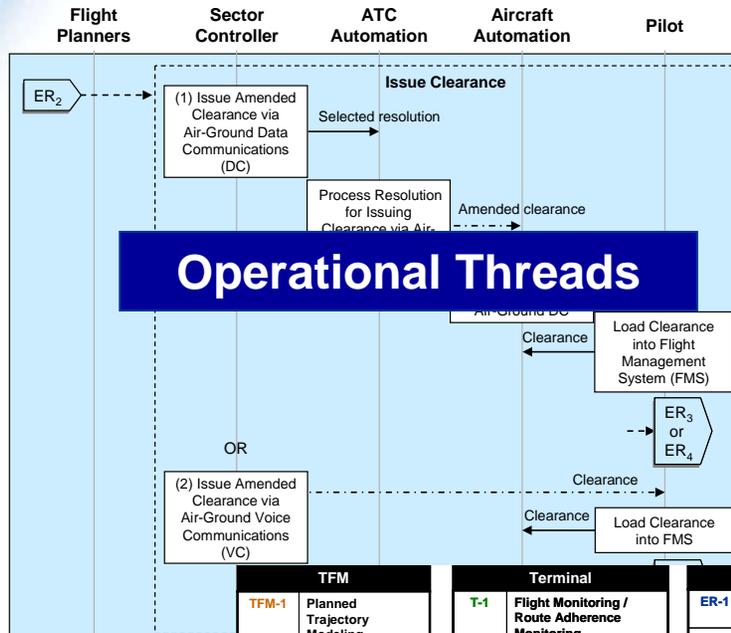
Aircraft misses downwind turn on RNAV arrival

Aircraft makes drastic heading off route

Aircraft misses turning down to the south runway



Initial Safety Assessment Underway



- Defining detailed operational threads and associated system capabilities
- Identifying potential high-level hazards and risk mitigations

System Capabilities

Category	Capability
TFM	TFM-1 Planned Trajectory Modeling
	TFM-2 Automated Congestion Identification and Notification
	TFM-3 Probabilistic Decision-Making
	TFM-4 Integrated Flow Management
	TFM-5 TMI Execution for Implementation of Aircraft-Specific Flow Constraints
	TFM-6 Post-Event Analysis
	TFM-7 Ground-Ground Data Communications
Terminal	T-1 Flight Monitoring / Route Adherence Monitoring
	T-2 Merging and Sequencing
En Route	ER-1 Trajectory Modeling and Flight Monitoring
	ER-2 Problem Prediction
	ER-3 Problem Resolution
	ER-4 Problem Notification
	ER-5 Problem Assisted Trial Planning
	ER-6 Problem Detection and Altitude Change Notification
	ER-7 Problem Detection and Altitude Change Implementation
	ER-8 Problem Detection and Altitude Change Implementation
	ER-9 Problem Detection and Altitude Change Implementation
	ER-10 Aircraft Transfer Implementation
	ER-11 Routine Information Dissemination
	ER-12 Cluster Prediction and Simplification
	ER-13 Sector Resource Management
	ER-14 Air-Ground Data Communications
	ER-15 Ground-Ground Data Communications

Hazard Identification and Mitigation

Identifier	Description	Causes	Potential Effects	Avoidance	Mitigation
ER-2.1	Problem predicted when it should not have been (false alarm)				
ER-2.2	Problem not predicted when it should have been (not predicted)				
ER-2.3(a)	• Aircraft-to-clear air turbulence problem		• Aircraft enters clear air turbulence area that affects safety of flight		
ER-2.3(b)	• Aircraft-to-MPT constraint problem		• Aircraft needs a more drastic maneuver downstream to meet MPT constraint		
ER-2.3(c)	• Aircraft-to-MPT constraint problem		• Aircraft crosses meter point outside of its assigned slot		
ER-2.3(d)	• Aircraft-to-clear air turbulence problem		• Aircraft enters clear air turbulence area that affects safety of flight		
ER-2.3(e)	• Aircraft-to-MPT constraint problem		• Aircraft needs a more drastic maneuver downstream to meet MPT constraint		
ER-2.3(f)	• Aircraft-to-MIT constraint problem		• Aircraft crosses MIT boundary without enough spacing behind leading aircraft		



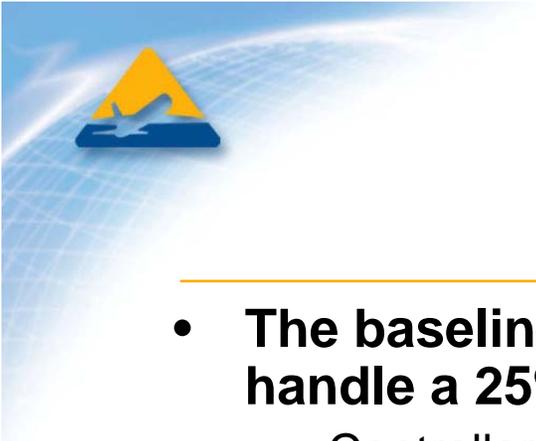
Additional Experiments Underway

En Route

- **High-performance airspace**
 - Severe convective weather
 - Failures and exception events
- **Mixed-performance airspace**
 - % Data communications

Terminal

- **Aircraft equipage levels**
 - % RNAV
 - % Data communications
- **Position combinations**
 - Departure, feeder, and final approach positions
- **Metering performance**
- **Additional decision support capabilities**
 - Route display aides
 - Route adherence monitoring and alerting
 - Tools to aid merging and sequencing of traffic



Summary

- **The baseline operational environment will not be able to handle a 25% traffic increase in complex en route airspace**
 - Controller workload will become unmanageable
- **An operational concept and an integrated set of capabilities have been demonstrated in laboratory experiments to increase controller productivity and keep workload manageable**
 - Under fairly pristine conditions (e.g., good weather, full equipage, limited operational upsets, no system failures)
- **These capabilities form a major step toward NextGen, and could be achieved in the mid term (resources permitting)**
 - They are being incorporated in the Operational Evolution Partnership, along with other important and necessary mid-term capabilities
- **The necessary engineering work is underway**



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT

Thank You

MITRE

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