Development of a High-Fidelity Simulation Environment for Shadow-Mode Assessments of Air Traffic Concepts

Alan G. Lee - SMART-NAS Test Bed Deputy Technical Lead
John E. Robinson
Jack (Chok) Lai
NASA Ames Research Center

November 14, 2017
Example Recent Human-in-the-Loop Simulation
Trajectory-Based Operations for Arrival
Example of Future SMART-NAS Test Bed-enabled Simulation

Gate-to-Gate Simulation

Arrival and Departures

- SFO Tower
- Ramp Tower
- NorCal Terminal Area
- Oakland En Route

Arrivals

- SFO
- Los Angeles En Route
- SoCal Terminal Area
- LAX

Departures

- SFO
- NorCal Terminal Area
- Oakland En Route

NASA Lab

NASA Aircraft Simulators

NASA Lab

NASA Lab

FAA Lab

NASA Tower Simulator

NASA Tower Simulator

NASA Aircraft Simulators
SMART-NAS Test Bed Goals

The SMART-NAS Test Bed will provide a test environment that will aid in:

• Performing Multiple-Air Traffic Management (ATM) Domain Evaluations

• Increasing Assessment Pace

• Collaborating with Stakeholders

• Testing During Concept Maturation

• Performing Live, Virtual and Constructive Operations
Outline

• SMART-NAS Test Bed Vision
• SMART-NAS Test Bed Implementation Status
• SMART-NAS Test Bed Utilization
• Next Steps
• Conclusion
SMART-NAS Test Bed Vision
Test Bed Requirements

1) Provide standardized environment to design, conduct, and analyze real-time simulations

2) Integrate real ATM systems, high-fidelity emulators, and aircraft without modification

3) Leverage advances in software assurance, cloud-computing, big data, and real-time analytics

4) Permit adaptability and scalability to future simulations

5) Deliver incremental capabilities with demonstrable value to early users
Test Bed Architecture

Test Bed Visualization Services

DDS – Data Distribution Service

Test Bed Support Services

Stakeholder Tools

Traffic Generators

ATM Functional Services

Trajectory Generator

Scheduler

Conflict Detection

Conflict Resolution

UAS Traffic Management (UTM)

External Simulators

UAS Live Virtual Constructive-Distributed Environment (LVC-DE)

GovCloud

Component A

Component B

Component C

Component D

Component X
Test Bed Elements and Capabilities

Support Services
- Web-based Services
- Scenario Generation
- Simulation and Asset Configuration
- Command, Control, Monitor, Archive
- Analysis Support
- Libraries

Live Data and Flight Assets
- Allow extension by NASA and Industry stakeholders
- Enable sharing of capabilities and simulation artifacts

 ATM Automation
- Permit concurrent high-fidelity simulations
- Leverage historic data
- Incorporate fielded ATM and ATC systems

 Lab Infrastructure
- Connect geographically distributed capabilities

 Real-Time ATM Concepts
- Simulate current and alternative multiple ATM domain concepts

• Integrate live, virtual, and constructive operations
Concept of Operations

Web Browser
User

Web Server

User Account
Component Library
Scenario Library
Simulation Library

Scenario Generator
Command, Control and Monitoring

FAA SWIM
ATM Data Warehouse

Support Tools
- Data Recording
- Data Replay
- Visualization
- Analytics

NextGen Applications
Traffic Generators

DDDS Global Data Space

• Data Recording
• Data Replay
• Visualization
• Analytics
SMART-NAS Test Bed
Implementation Status
Scenario Generation GUI
Simulation Configuration: GUI
Integration Example: SWIM, Traffic Generator, Conflict Detection, and Viewer
Simulation Configuration
Integration Example: SWIM, Traffic Generator, Conflict Detection, and Viewer
Test Bed Utilization

• SNTB Scenario Generation service
  • Used for two Human-in-the-Loop (HITL) simulations
  • Planned to be used by 2 other Projects

• Provided Live FAA SWIM Traffic Data Feed
  • Real Time Safety Monitoring
Next Steps

• Integrating Live Virtual Constructive simulation capability

• Working with Integrated Demand Management (IDM) Project - Automated Simulation Capability

• Expanding network capability

• Maturing current capabilities
Conclusion

The SMART-NAS Test Bed

• will be a collaborative, rapidly deployable, and distributed ATM simulation and test environment
• will provide a flexible and scalable architecture
• enable simulations spanning multiple-ATM domains
• is being developed incrementally for value to early users
Backup Slides
Program Overview

• Originally under: Shadow Mode Assessment Using Realistic Technologies for the National Airspace System (SMART-NAS) Project
• Continuing under: Air Traffic Management – Exploration (ATM-X)
• Phased development
  • 2014-2015 SMART-NAS Test Bed architecture NASA Research Agreements (NRAs) by four industry teams
  • 2015 In-house proof-of-concept demo of key technologies by Ames and Langley Research Centers
  • 2016-2020 Full-scale development focused on customer use cases