

Air Traffic Operations Laboratory

where ideas take flight

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ATOL: What Is It?

The Air Traffic Operations Lab is a multi-fidelity, part-task, aircraft and air traffic operations simulation facility

Used to explore interactions between new airborne and ground-based tools in a Next-Generation ATC environment, including:

- Concept-level flight operations research, looking at human decision making, situation awareness, transfer of authority/responsibility, etc.
 - Performance impact assessments of new operational concepts on the National Airspace System (NAS)
 - Rapid prototyping of new flight deck tools and automation
 - Concept-level safety assessments
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- Identification and evaluation of future communication, navigation, and surveillance (CNS) infrastructure requirements
 - Controller-pilot data link
 - Precision trajectory-based ops
 - Air-to-air data exchange



ATOL Video (RAPTOR Experiment)

NASA Administrator Charlie Bolden visits the ATOL



ATOS: What Is It?

The Airspace and Traffic Operations Simulation is the actual simulation software that runs in the ATOL

Simulates airborne vehicles, ground-based air traffic management tools, and the supporting CNS infrastructure, including:

- Medium-fidelity computer workstation-based simulations of a wide range of subsonic transport aircraft (150,000 lbs through 875,000 lbs)
- High-fidelity simulations of Air Route Traffic Control Center (ARTCC) and Terminal Radar Control (TRACON) controller workstations
- Simulation of Controller-Pilot Data Link Clearance (CPDLC) communications, multiple selectable levels of Required Navigation Performance (RNP), and Automatic Dependent Surveillance Broadcast (ADS-B) with tunable range limits and interference effects
- Also includes connections to other facilities:
 - High-fidelity fixed- and motion-base flight deck simulations in NASA Langley's Cockpit Motion Facility (CMF)
 - Research labs at NASA Ames Research Center, the FAA Technical Center, and Embry-Riddle Aeronautical University

ATOS Modes of Operation

- **Batch Mode:**

- Uses banks of computers to simulate interactions between hundreds of aircraft (one aircraft per computer)
- Procedures-based pilot model controls each aircraft individually

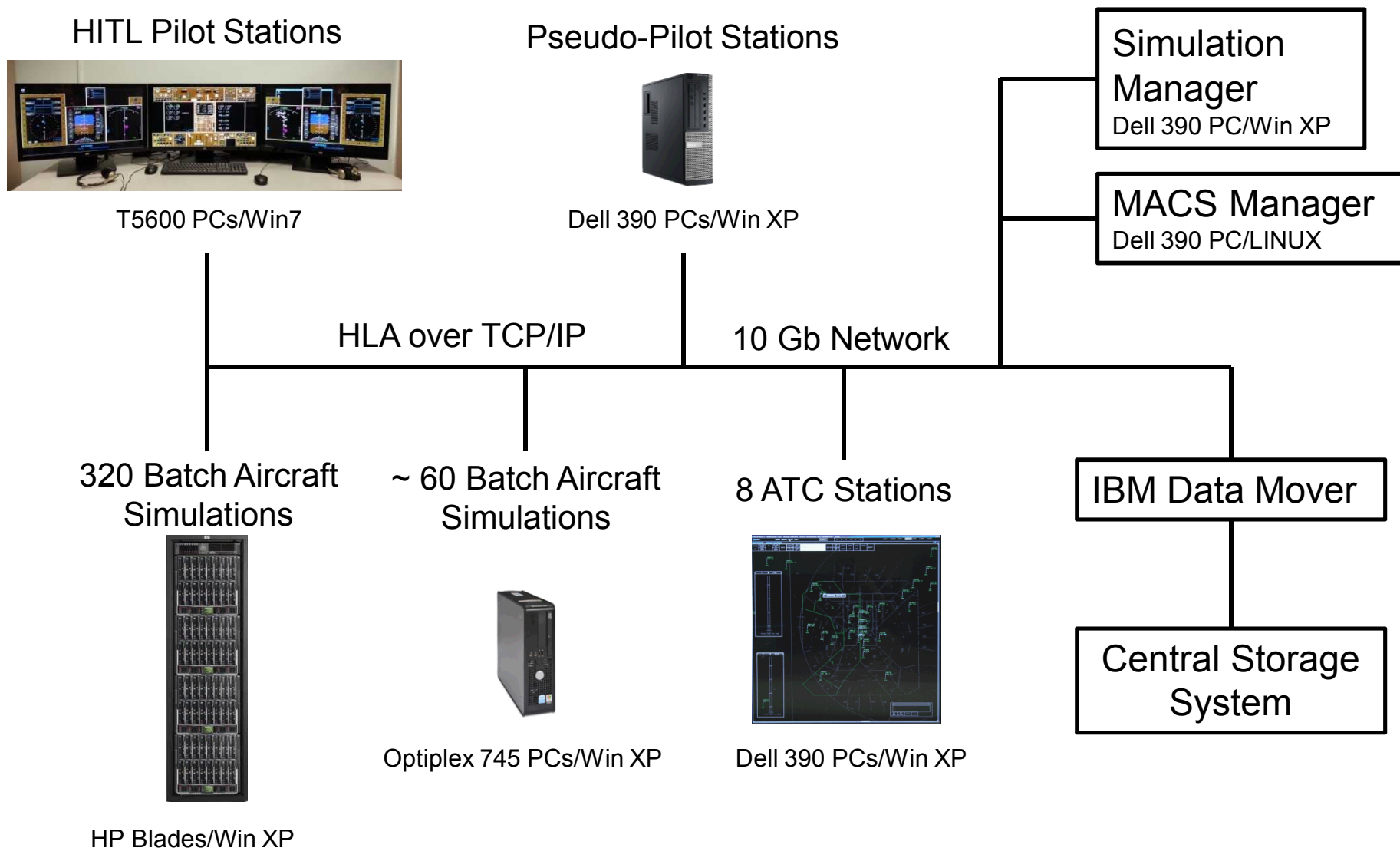


- **Human-in-the-Loop (HITL) Mode:**

- Some aircraft flown by either one or two pilots
- Usually includes many additional batch (pilot model-flown) aircraft
- Also usually includes air traffic controllers



ATOS/ATOL Architecture



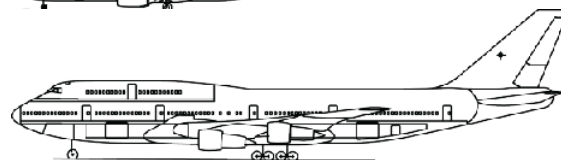
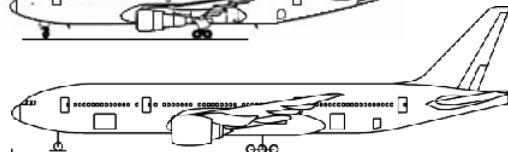
ATOS Aircraft Simulation Features



- **Six-DOF aerodynamic/engine models in real-time C++ code**
- **Research prototype flight management system (FMS)**
 - ARINC 424 navigation database
 - Trajectory generation, lateral and vertical (LNAV/VNAV) path guidance
- **Full-featured autopilot /flight director systems**
- **Simulated ARINC 429 digital data bus for avionics data flows**
- **Flight deck displays and control panels (single- or dual-crew)**
 - Based on Boeing B-777-200, includes electronic flight bags (EFBs)
 - Implemented in C++ with OpenGL graphics

ATOS Aircraft Simulation Models

Primary HITL aircraft	
NB250_2E40 NASA_CMF	Narrow body jet, 250K lbs, 2 engine, 40K thrust
Additional batch aircraft	
NB137_2E22	Narrow body jet, 137K lbs, 2 engine, 22K thrust class
WB315_2E48	Wide body jet, 315K lbs, 2 engine, 48K thrust class
WB535_2E77	Wide body jet, 535K lbs, 2 engine, 77K thrust class
Future batch aircraft	
NB053_2E09	Regional jet, 53K lbs, 2 engine, 9K thrust class
NB172_2E27	Narrow body jet, 172K lbs, 2 engine, 27K thrust class
WB875_4E48	Wide body jet, 875K lbs, 4 engine, 48K thrust class



ATOS Air Traffic Control (ATC)

- **Traffic Management Advisor (TMA)** tool for arrival scheduling and runway balancing
- **Air Route Traffic Control Center (ARTCC) simulation**
 - Based on current Display System Replacement (DSR) version
 - Conversion underway to En-Route Automation Modernization (ERAM) system
- **Terminal Radar Control (TRACON) controller workstations**
 - Used to simulate “feeder” and “final” TRACON positions
 - Based on current Common Automated Radar Terminal System (CARTS) version
 - Conversion underway to new Standard Terminal Automation Replacement System (STARS)





- **Simulation of Controller-Pilot Data Link Clearance (CPDLC) communications**
 - Based on Aircraft Communications Addressing and Reporting System (ACARS) text-based protocols
 - Supports investigation of new concepts requiring large amounts of data flow
 - Provides multiple flight crew interfaces to data link system
 - Multifunction Control/Display Unit (MCDU), similar to B-747
 - Integrated into system monitoring displays, similar to B-777 and B-787
- **Selectable levels of Required Navigation Performance (RNP)**
 - Supports differences in position estimation and flight technical error
 - Allows assignment of procedures requiring high levels of precision
- **Automatic Dependent Surveillance Broadcast (ADS-B) simulation**
 - Broadcasts location, speed, and other information on ownship
 - Model determines probability of reception for each transmission
 - Supports tunable range limits
 - Includes interference effects, even for aircraft not actively simulated

ATOS Facility Connections

