EFICA RTT Focus

- Expanded focus includes:
  - Traffic flow management
  - Ground-based scheduler
  - Flight deck merging and spacing
  - Integrated approach
- Four new products (under formulation)
  - Implications of weather on traffic management strategies
  - Storyboarding terminal airspace operations for NextGen
  - Develop concept of operations for arrival management
  - Develop integrated ground-based scheduling technology and flight deck merging and spacing
- EDA work will continue

Efficient Flow into Congested Airspace (EFICA) RTT

NASA's En Route Descent Advisor (EDA) is controller decision-support tool supports 3DPAM

Human-in-the-loop Simulation

- Software development and hardware integration
- First 3DPAM simulation: April 27, 2009
- Shakedown of EDA Build 4.0.
- Controller participants: facility managers and recently-retired controllers from Denver Center

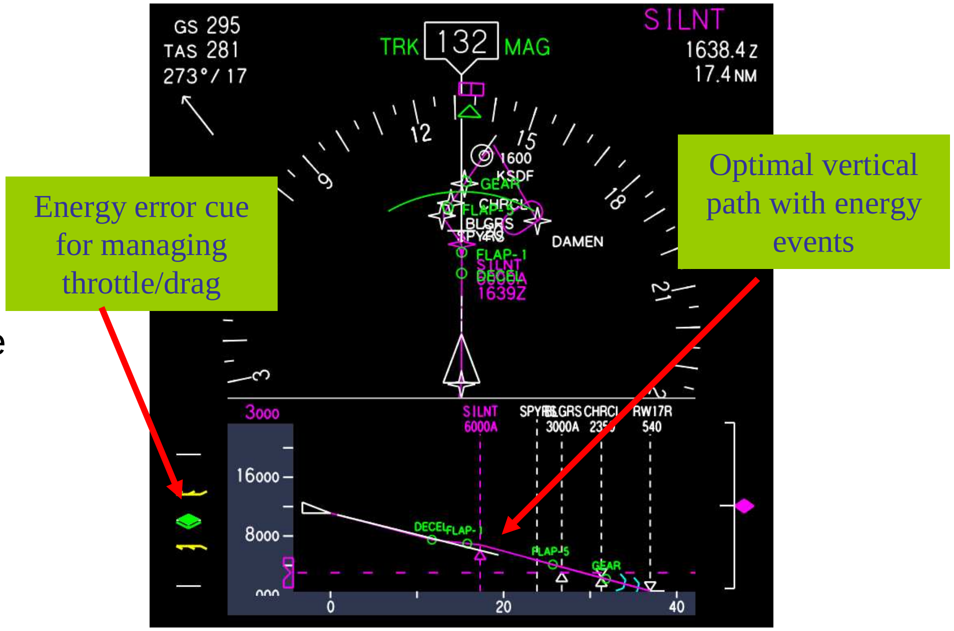
Two field tests at Denver Center

- First field test (September 2009): data collection for assessing real-world descent trajectory uncertainty
- Develop uncertainty models for incorporation in future simulations. Goal is to provide more defendable simulation results for basing final FAA investment decisions
- Test will include a commercial (United and Continental) flights into Denver, along with an FAA test aircraft (Global 5000 business jet)
- Second field test (December 2010): EDA prototype in front of sector controllers for real-time, operational decision support
- FAA final investment decision: 2012, Tentative Deployment: 2015
- Post ERAM Build 3

NextGen-Airspace Project
Energy Navigation

Conduct simulations to identify the benefits of energy navigation concept and technology called energy Navigation (eNAV)

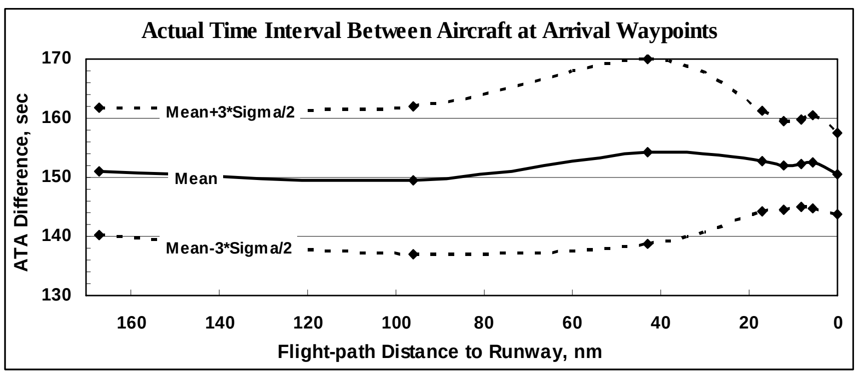
- Enabling research pursued in FY2009
  - Optimized vertical trajectory development algorithms that minimizes fuel, noise, and emissions
  - Dynamically recomputed to reflect changing winds
  - Flap/gear deployment timed to manage energy
  - Energy error guidance cue eliminates excessive throttle and speed brake usage
- Analysis and integration done in FY2010
  - Conduct non-piloted batch simulation of maximum capacity arrival rush with and without eNAV to determine benefits
  - Airborne Spacing for Terminal Arrival Routes algorithm used to achieve and maintain precise temporal spacing between aircraft from different flows to same runway
  - Systematic variations of wind uncertainty, traffic mix, and initial conditions
  - High fidelity models provide accurate fuel and noise metrics



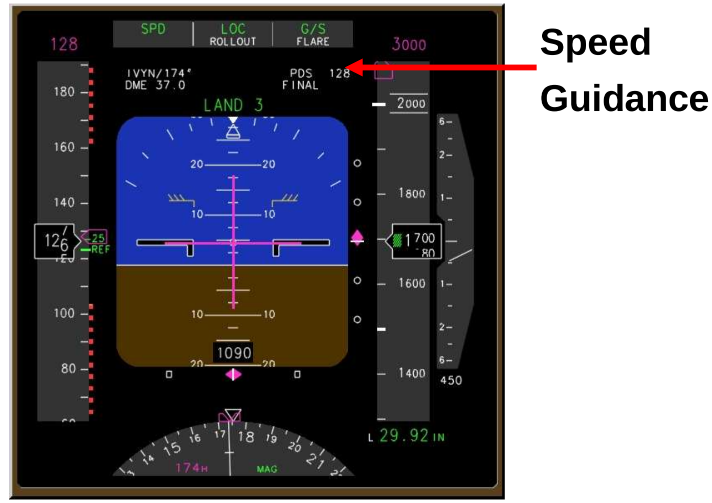
Navigation Display

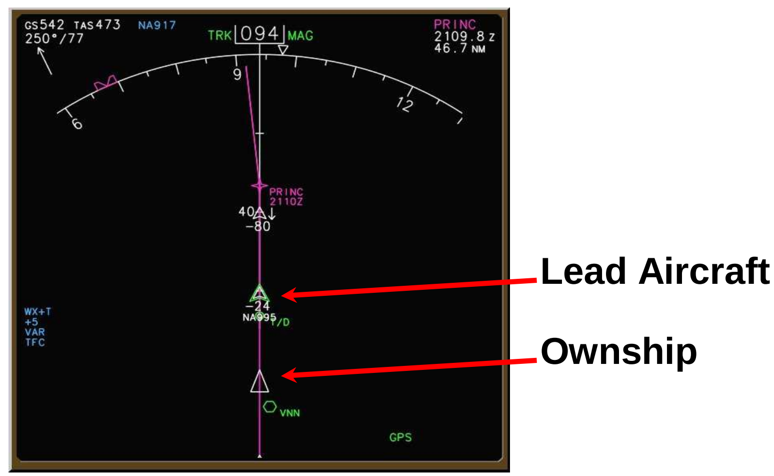
Refine Algorithms for Merging and Spacing Operations to a Single Runway

- Examined the flight deck merging and spacing technologies to increase throughput at the runway threshold
  - A human-in-the-loop simulation was conducted using 26 pilots and 3 controllers
  - Flight crew followed on-board speed guidance to maintain controller assigned spacing using Airborne Spacing for Terminal Arrival Routes system



Higher runway threshold accuracy was maintained (0.8 sec error) indicating that higher throughput can be maintained



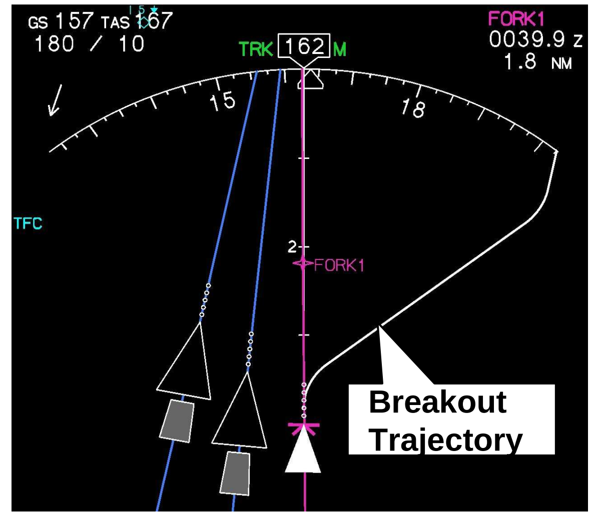


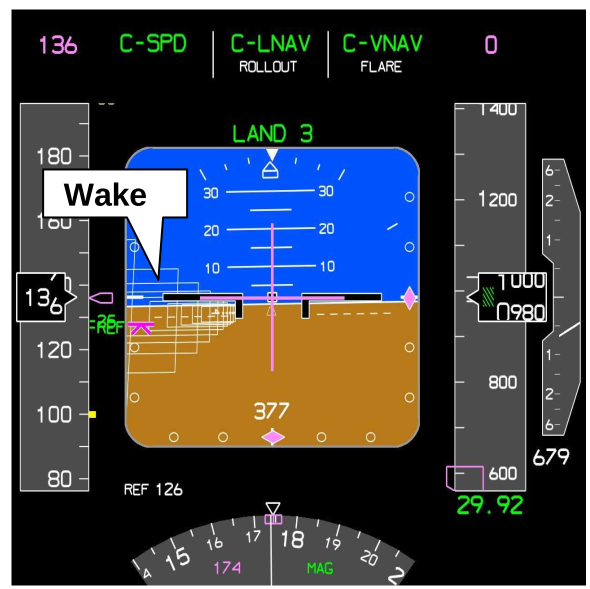
M/S 3.6.02 (4QFY09)

Procedures and Technologies for Initial ASDO ConOps

- **Triple Very Closely Spaced Parallel Runway** Study was completed in August 2008
  - 8 pilots - 24 runs per pilot
  - DFW adapted for the study
  - Three aircraft echelon formation with the leader in the leftmost position
  - Navigation display showed 3 aircraft, predictor dots, wake location, breakout trajectory and a longitudinal situation indicator
  - Navigation display alerted for wake intrusion and aircraft blunder
  - Yellow alert indicated breakout might be imminent
  - Red alert indicated breakout was immediately necessary
  - Breakout trajectories were flown manually
- Variables studied
  - Cause for breakout (wake or aircraft deviation)
  - Location of breakout (above or below 500 feet)
  - Position of ownship (center or trailing)
- M/S AS.2.6.07 (3QFY11)

Pilot participants successfully flew the simulator accurately and safely within and across all conditions during all of the study scenarios.





Air/Ground Functional Allocation High Value Focus Area

- Issue:
  - Lack of clarity in the allocation of new functions to the aircraft and flight crew is a significant risk (includes human/automation as well as aircraft avionics/ground automation allocations).
- NASA action taken:
  - NextGen – Airspace project re-alignment completed in November 2008
    - - address FY2008 JPDO gap analysis

Integrated Arrival/Departure/Surface RTT Activities

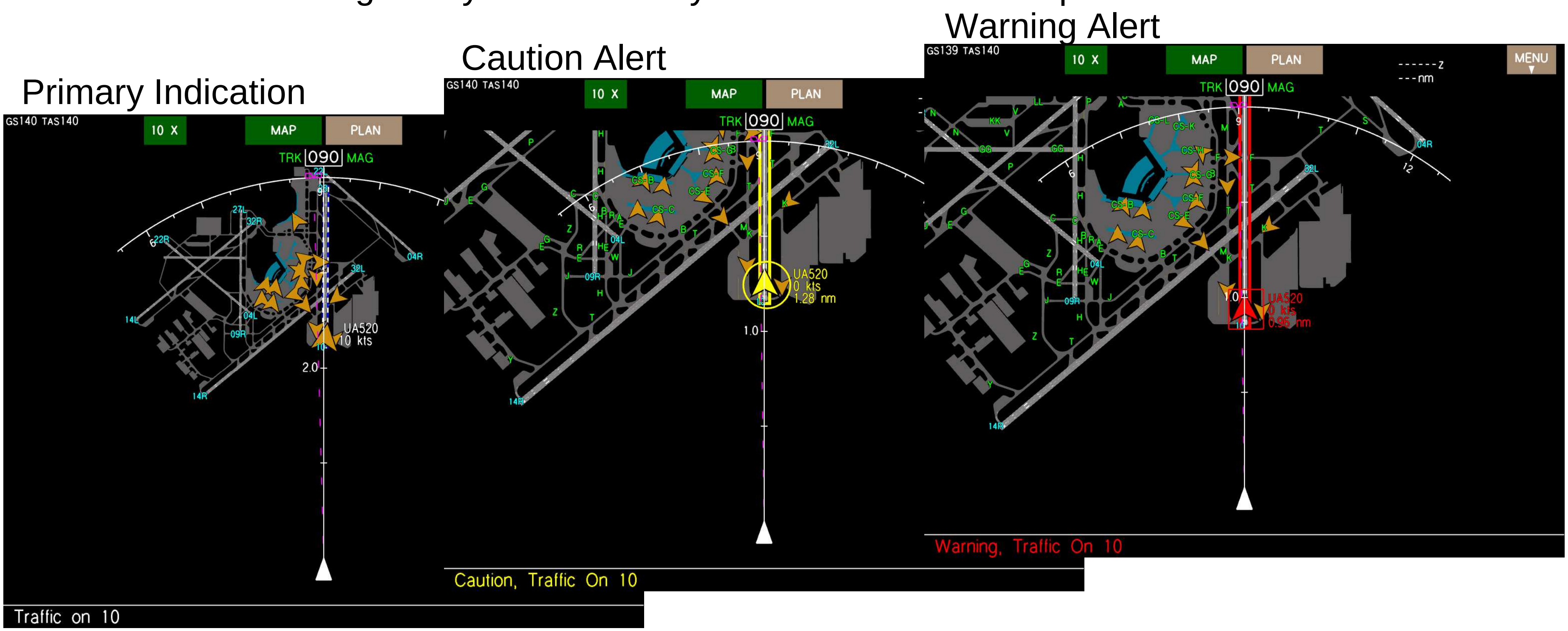
- Initiated with proposed joint FAA/NASA testbed activities
  - Update NTX for NASA testbed
  - Integrate with a tbd FAA testbed (e.g. MEM, SDF, South FL)
  - Both FAA and NASA expressed cruise to gate, gate to cruise viewpoint
- Expanded RTT to include FAA groups that cover arrival/departure operations (not just surface)
  - Required some reorganization
  - Expanded group significantly
- FY09 goal to deliver work plan including
  - testbed upgrades (integration plan)
  - concepts and technologies to be evaluated in testbed

Integrated Arrival/Departure/Surface RTT

- Develop a work plan to integrate Airportal milestone outcomes in surface and arrival/departure technologies and concepts
- These technologies and concepts will help achieve integrated arrival/departure/surface operational goals ("cruise-to-gate, turn, gate-to-cruise")
- Conduct simulation evaluations to assess capacity-related factors for particular terminal area(s) using the new technologies and concepts
- Insert new algorithms in testbed for surface and arrival/departure management
  - advanced evaluations of new scheduling algorithms
  - Provide arrival and departure schedule information to other TFM systems
  - Taxi conformance functions
  - Runway balancing, including system perspective
  - Surface taxi monitoring
  - Results from human performance assessments
- Evaluation will determine the capacity contributions for these functions

Conflict Detection and Resolution

- NextSafe Usability Study recently concluded in Research Flight Deck (RFD) Simulator
  - Comparison of flight deck interfaces for display of traffic intent information, based on near-, mid- and far-term display technologies (collaboration w/IIFD project)
- Preliminary Analyses Suggest
  - Enhanced situational awareness
  - Increased ability to detect and avoid hazardous situations
  - Critical to enabling safety and efficiency benefits in NextGen operational environment



Surface map showing indications and alerts when traffic is on runway during an approach

Surface 4D Trajectory-Based Operations

Experiment Goal

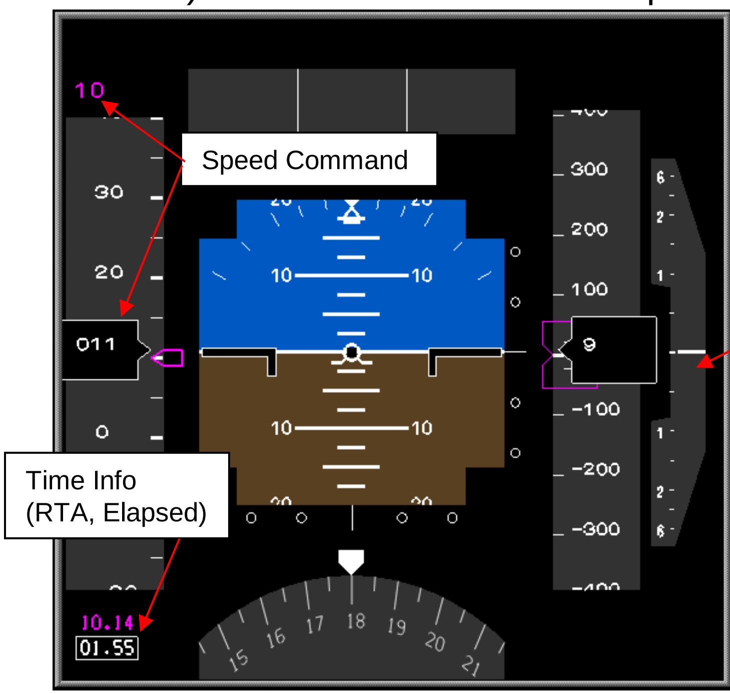
Characterize distribution of pilots' Time of Arrival (TOA) performance to inform development of Surface Traffic Management (STM) algorithms.

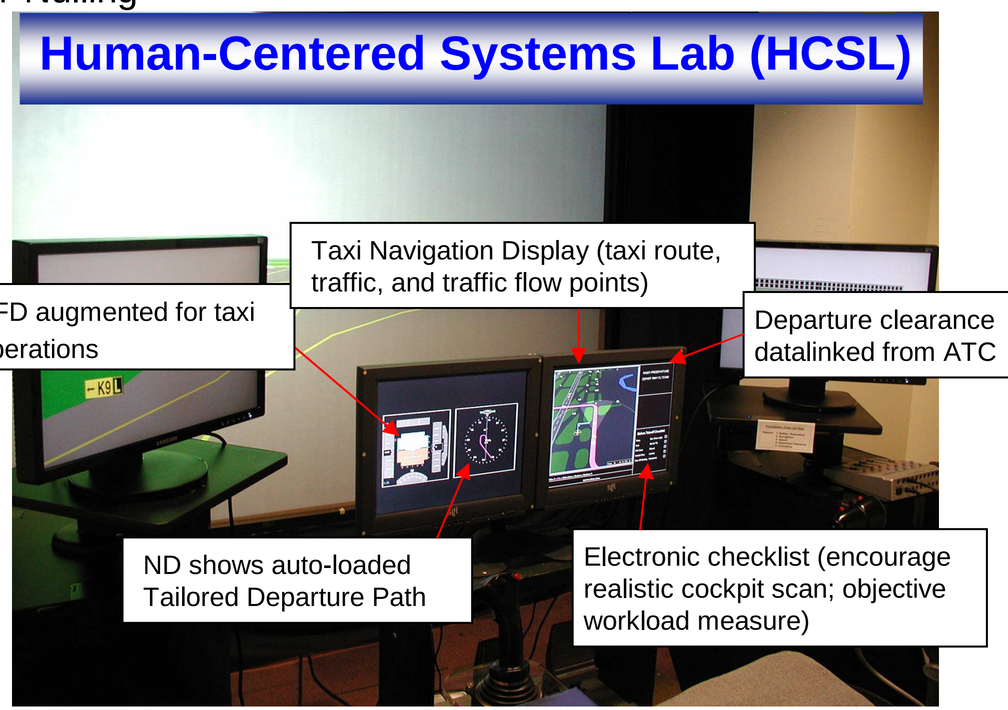
Compare three STM concepts:

1) Single traffic-flow point - ensures on-time arrival at destination runway
2) Occasional (3) traffic-flow points - enables traffic sequencing at important intersections
3) Frequent (5) traffic-flow points - enables dynamic system re-optimization, close coordination

Compare two NextGen Time-based Taxi Ops implementations:

1) Current-day Avionics without Speed Error-Nulling
2) Advanced Avionics with Speed Error-Nulling





Initial Aircraft-Based Low Altitude, Runway, and Taxiway Conflict Detection and Resolution (CD&R) Algorithms

Images from CAAT simulation evaluation show warning alert generated when aircraft gaining on traffic ahead during taxi