



# Systems Technologies for the Next Generation Air Transportation System

NASA's Airspace Systems Research

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# Background



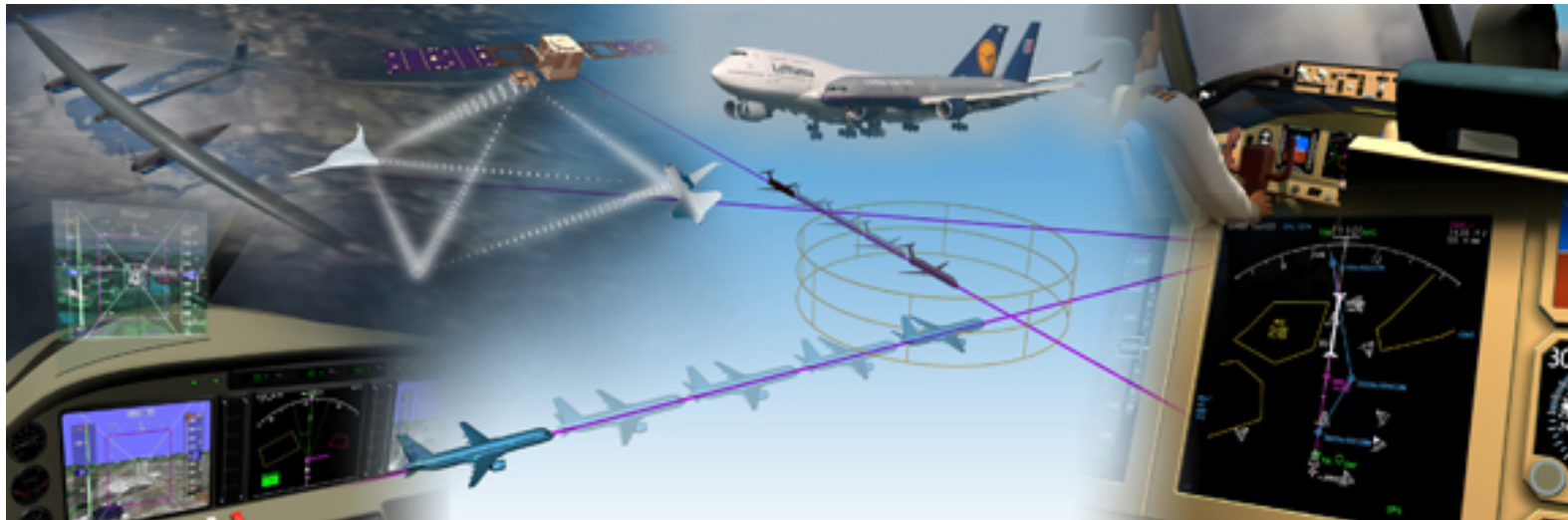
Demand for aviation is expected to increase, creating the need for a system that:

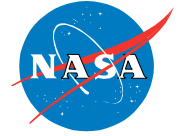
- Provides two or three times capacity together with increased safety, security, efficiency and environmental capacity
- Accommodates a range of vehicles including very large aircraft, very light jets, unmanned aircraft systems and space launches



# Achieving Future Air Transportation Capability

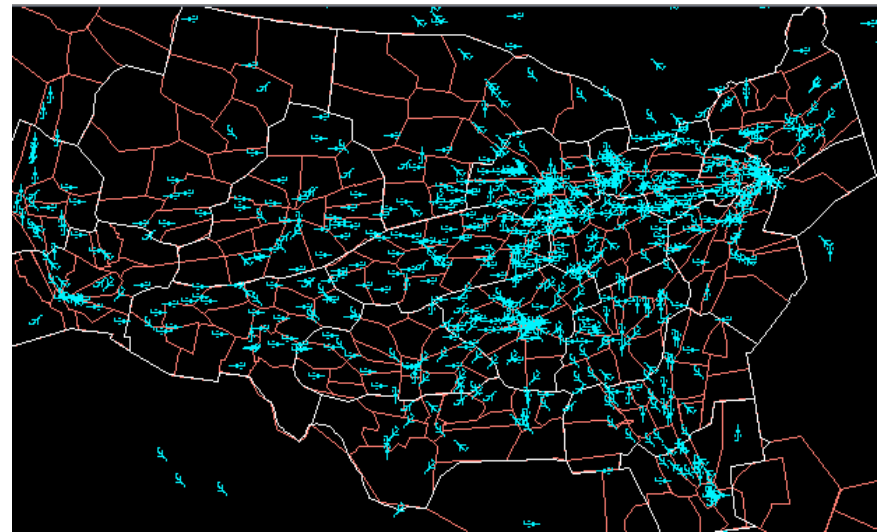
- The Next Generation Air Transportation System vision requires a shift to trajectory-based operations using 4D trajectories, reduced separation in dense traffic, dynamic resource allocation to meet demand, and more
- Significant research challenges must be met to mitigate system constraints to address the demand/capacity imbalance problem in a safe, equitable, and efficient manner





# Airspace Systems Program

Objective: Develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the NextGen.



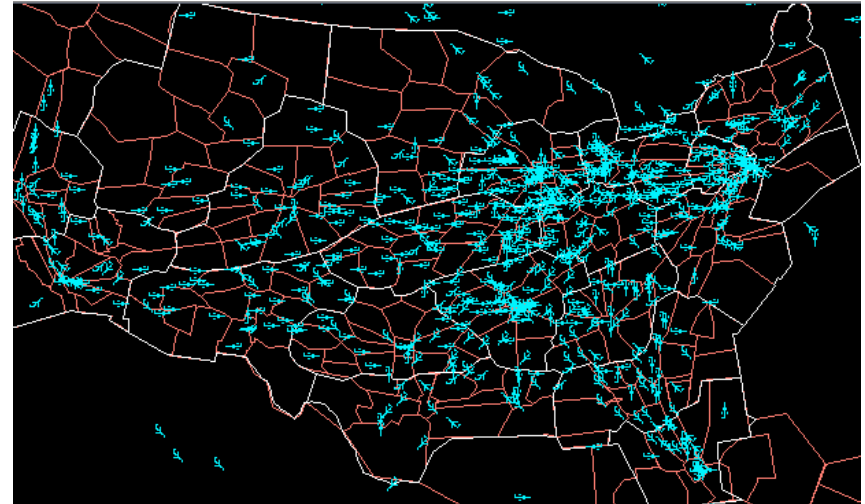


# Current Program Structure



## NextGen - Airportal

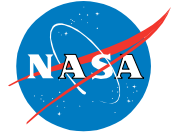
- Safe and Efficient Surface Operations
- Coordinated Arrival/Departure Operations Management
- Airportal and Metroplex Integration



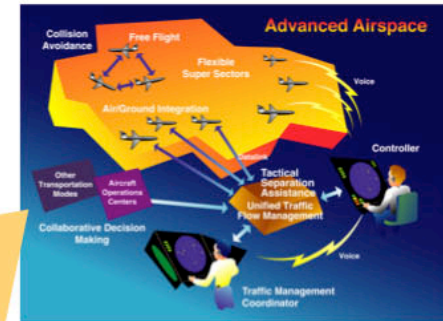
## NextGen - Airspace

- Dynamic Airspace Configuration
- Traffic Flow Management
- Separation Assurance
- Airspace Super Density Operations
- Trajectory Prediction, Synthesis and Uncertainty
- System-Level Design, Analysis and Simulation Tools

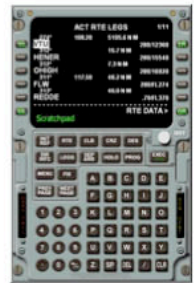
# Historical Roadmap for ATM



## NextGen



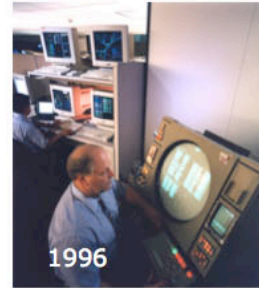
## Research Products



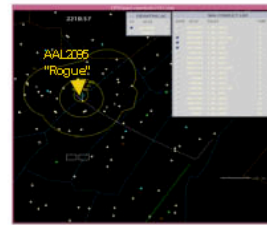
Flight Management Systems



Traffic Management Advisor Build 1



Arrival Metering



Rogue Evaluation and Coordination Tool



UAV Operations in the NAS

1970

1980

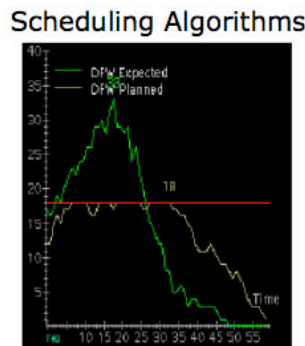
1990

2000



1973

Optimal Guidance



Scheduling Algorithms



Simulations



Intelligent Software



Field Test



Human Factors



Benefits Analysis

## Research Spectrum

# Airspace Systems Program: A New Focus



- NASA's Airspace Systems Program is planning new system experimentation activities to address community recommendations
- Overall goal is to integrate advanced operational concepts, technologies and procedures to safely increase both system capacity and airspace system efficiencies

# System Definition and Context

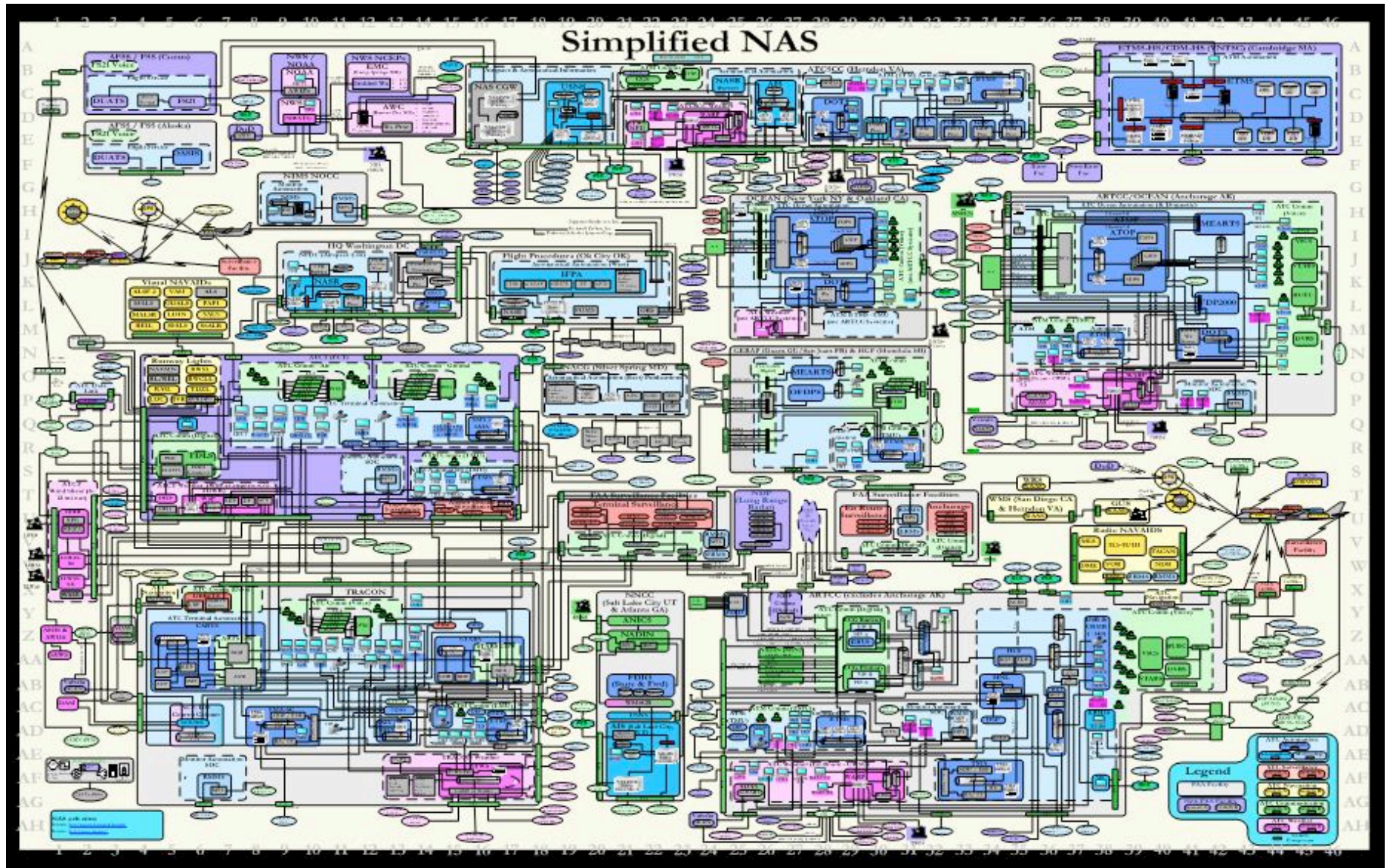


Within the context of NextGen and air traffic management, the following definitions apply:

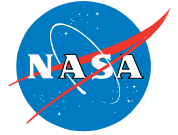
- System refers to a merging of technologies, procedures, and humans to accomplish an air traffic management operation
- An Operation refers to an activity (or collection of activities) such as efficient management of flows of en route aircraft or of interdependent cues of arrival and departure aircraft including surface movements



# NextGen is a Complex System



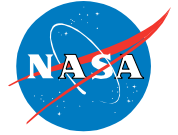
# Integrated Systems Applications



Airspace Systems Program has a unique mission and core competency

- Successful history of moving ATM research out of NASA labs and into the field
- Systems analysis and integration of multiple concepts are done by NASA
- System-level applications are done by FAA and contractors
- Important to keep expertise engaged in the full life cycle moving capabilities from TRL 1 through 6
  - Airspace Systems needs this spectrum of competencies within the program

# Addressing Needs



- Community is collectively and continually maturing requirements for NextGen
- Formed Research Transition Teams (RTT) to help transition NASA developed technology to the responsible implementing organizations
  - Efficient Flow into Congested Airspace
  - Integrated Arrival/Departure/Surface
  - Multi-Sector Planner
  - Dynamic Airspace Configuration
- Systems analysis can inform priority selection of technologies for maturation and systems application
  - Assess collective impact of NASA's concepts and technologies
  - Study interaction between research focus areas (e.g., Traffic Flow Management and Dynamic Airspace Configuration)



# Program Adjustments for FY2010

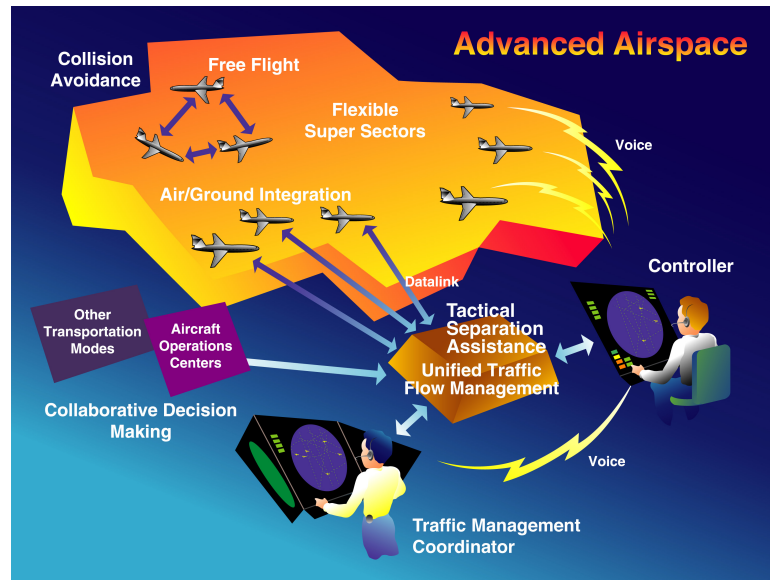
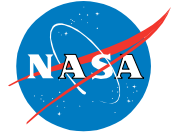


- Airspace Systems Program will organize its existing research portfolio into a different project structure with commensurate budget increase

<i>CURRENT</i>		<i>PROPOSED</i>
NextGen - Airspace		NextGen - Concept and Technology Development
NextGen - Airportal		NextGen - Systems Analysis, Integration, and Evaluation

- Foundational Research Focus Areas from Airspace and Airportal projects will be consolidated in CT&D
  - Continue legacy of ATM concept development for gate-to-gate solutions
- Cross-cutting systems analysis, simulation, and integration elements from Airspace and Airportal will be consolidated in SAI&E
  - Greater emphasis will be included for integrated test and evaluation in relevant test-bed environment

# Refocused ASP Portfolio



## NextGen - Concept & Technology Development

- Dynamic Airspace Configuration
- Traffic Flow Management
- Separation Assurance
- Super Density Operations
- Safe and Efficient Surface Operations

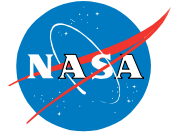


## NextGen - Systems Analysis, Integration & Evaluation

- Systems Analysis (e.g., collective impact)
- Interoperability (e.g., trajectories)
- Integration, Test, and Evaluation of System Concepts
  - Research Transition Teams (RTT)



# Program Structural Approach and Characteristics



## *NextGen - Concept and Technology Development Project*

- Enhance state-of-the-art of ATM research
- Concept development
- Initial algorithm development
- Initial software development
- Initial analysis and/or human-in-the-loop simulation
- Determination of concept/technology feasibility and benefits

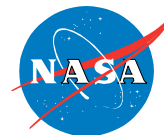
## *NextGen - Systems Analysis, Integration, and Evaluation Project*

- Assess collective impact of technologies
- Concepts are matured to a level where integration and interdependency considerations outweigh foundational research
- Skill set required to mature further is broader than foundational research project

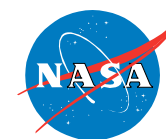


# Next Steps

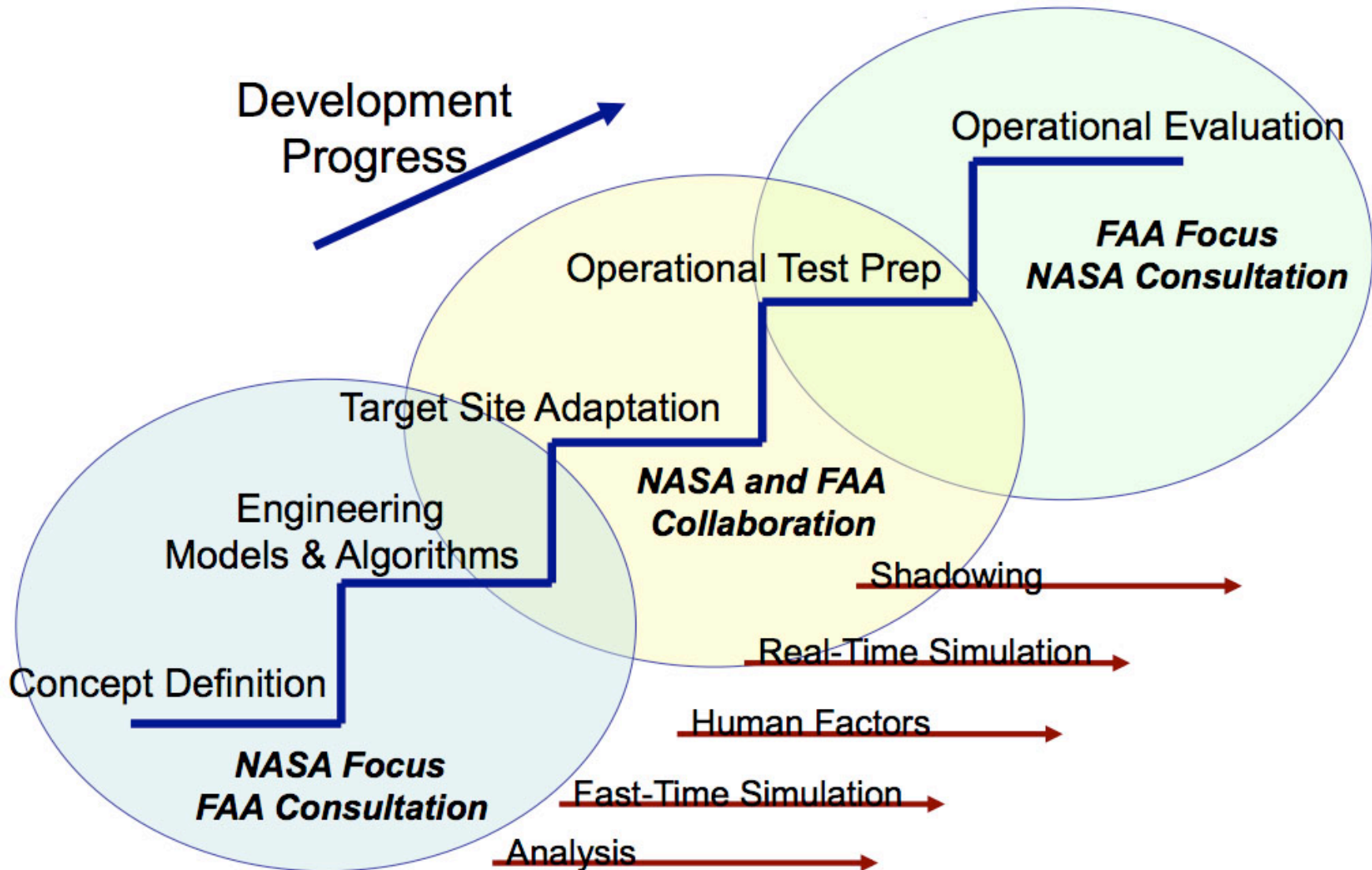
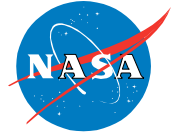
- Describe the Systems Analysis, Integration, and Evaluation research activity
- Provide an overview of the Airspace Systems structural changes necessary to support this direction (currently underway)



# *Enabling NextGen*



# R&D Progression







# Motivation

- NASA's Advisory Council (NAC) recommended in Apr. '08:
  - *“ARMD should plan and develop candidate systems-level research projects of highest priority that should be evaluated and considered by NASA for augmentation in the FY2010 (and out years) budget request. These projects should be consistent with the objectives and themes of the National Aeronautical R&D Policy and Implementation Plan, leverage NASA's unique expertise and competencies, and reflect the priorities of the NRC's Decadal Survey for aeronautics.”*
- Appropriations Act, 2008 (H.R. 2764; Public Law 110–161); December 2007
  - *“A portion of the increase above the President's budget request should be applied to the research, development and technology demonstration activities of the Next Generation Air Transportation System (NextGen) to address ATM needs.”*