

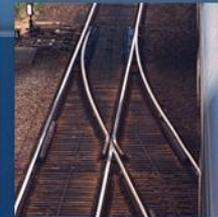


# Point-to-Point Commercial Space Transportation in the National Aviation System

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**Ruth A. MacFarlane Hunter**

SERVING THE NATION AS A LEADER IN GLOBAL  
TRANSPORTATION INNOVATION SINCE 1970



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# Introduction

- **The National Airspace System (NAS) is transitioning from a ground-based air traffic control system to Next Generation (NextGen), a global positioning satellite (GPS)-based system that incorporates technological innovation in navigation, weather forecasting, data networking, and digital communications**
- **The NextGen implementation timeframe is 2025 with mid-tem capabilities by 2018**
- **Long distance, commercial intercontinental point-to-point (PTP) suborbital flights might begin operating within this time period**
- **The interaction between the aviation system and operational PTP flights and necessary mutually acceptable accommodations need to be addressed**

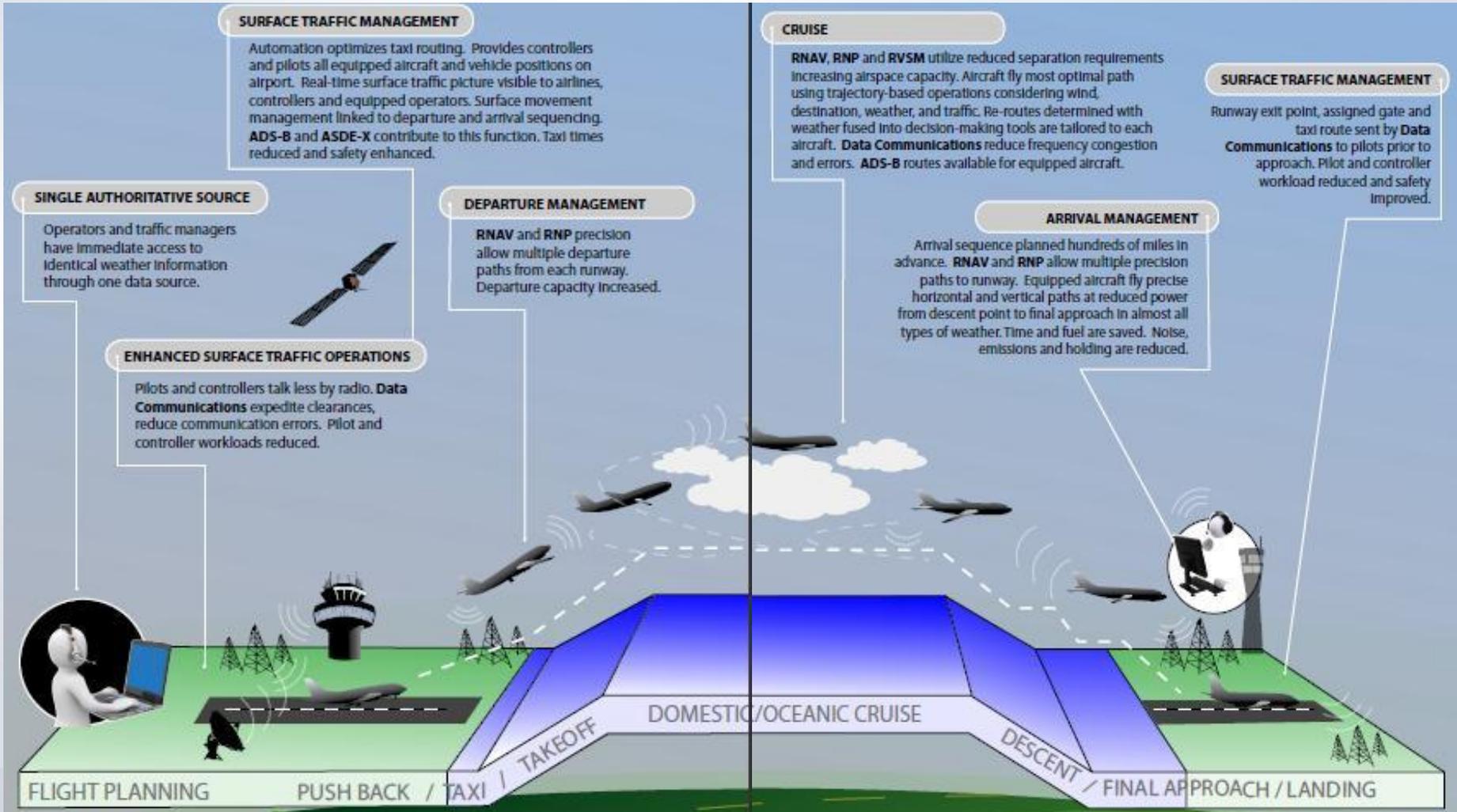
# What is NextGen?

- NextGen is an ongoing, wide-ranging transformation of the United States' national airspace system (NAS)
- NextGen will allow flights to operate more closely on more direct routes and will enhance terminal operations to improve safety, reduce delays, and enable reduced carbon emissions, fuel consumption, and noise
- NextGen technological enhancements increase NAS capacity and improve situational awareness for all system stakeholders
- NextGen will provide a single authoritative source of NAS-wide, four-dimensional NextGen network-enabled weather (NNEW) information, which consolidates various ground-, airborne-, and space-based weather observations and forecasts and is integrated with decision support tools

# NextGen Operations

- In NextGen, trajectory-based operations will allow pilots and dispatchers
  - to select their own optimal flight paths, rather than follow the existing interstate-like grid in the sky
  - to perform intelligent re-routes that improve throughput safely by employing improved navigation, communications, weather data, and air traffic control (ATC) information
- FAA traffic managers and flight operators will work collaboratively to resolve major demand and capacity imbalances
- Departure and arrival management will use improved navigational and visibility tools, such as Automatic Dependent Surveillance-Broadcast (ADS-B) and Airport Surface Detection Equipment, Model X (ASDE-X) to improve flow at high density airports
- Arrivals will be optimized by facilitating a continuous descent to touchdown without level segments

# NextGen Mid-Term Features and Flight Phases



# NextGen Enablers

- **ADS-B can provide complete cockpit situational awareness of all traffic known to the ATC system using GPS**
- **ASDE-X collects data from a variety of sources to track vehicles and aircraft on the airport movement area and obtain identification information from aircraft transponders**
- **System-Wide Information Management (SWIM) identifies industry standards and products to ensure interoperability between NAS systems and network-enabled information sharing, weather, and operations**
- **Data Communications (Data Comm) will provide automated, comprehensive data connectivity, automate repetitive messaging tasks, and supplement voice communications**
- **Performance-Based Operation depends on Area Navigation (RNAV), which enables aircraft to fly any desired flight path within navigation aids coverage area, and on Required Navigation Performance (RNP), which is RNAV with onboard performance monitoring and alerting capability**
- **NextGen Network Enabled Weather**

# Key Issues

- **Air Traffic Management**
  - National Strategy
  - International Coordination
  - Safety
- **Reusable Launch Vehicles (RLVs)**
  - Operating and Physical Environment
  - Equipment
  - Passenger and Cargo Accommodations
  - Security and Emergency Response
- **Terminals**
  - Logistics
  - Equipment
  - Security and Emergency Procedures
- **Human Factors**
- **Weather**
- **Environmental Impact**
- **Military Operations**

# Air Traffic Management

- PTP commercial traffic may eventually preclude handling as exceptions
- PTP developers will need to know in advance “ATM rules of the game” and associated equipment requirements
- U.S. currently lacks a National Strategy - no single U.S. agency has total responsibility for commercial operations in space
- International activities underway to harmonize worldwide aviation standards with NextGen under International Civil Aviation Organization (ICAO) and similar cooperation needed for suborbital PTP transportation since no body of law currently exists. ICAO could appropriate unto itself the authority by interpreting the term “aircraft” to include spacecraft
- Concerns about FAA safety regulations; potential spaceport customization
- Adequate separation must be maintained during the relatively short time that the PTP RLV is transiting the NAS

# Terminals

- **Supply chain logistics require that PTP launch and landing terminals be readily accessible to passenger and cargo markets in densely populated areas to exploit PTP time savings**
- **Will need to provide rapid cargo and passenger turnaround**
- **Would benefit from NextGen SWIM and communications capabilities**
- **Security will require physical protection measures, hazmat handling and protection, access control and IDs, pre-flight clearance of ground and RLV crew, passengers, and cargo**
- **Will need emergency plans, procedures, and exercises to deal with accidents and incidents of all types, including violent weather, fires internal or external to the facility, explosions, flooding, hazardous materials spills, and physical intrusion**

# Reusable Launch Vehicles

- PTP RLVs' communications, avionics, and maneuverability capabilities will determine how smoothly they can be integrated into a full- implemented NextGen airspace
- Need equipment to provide visibility in NextGen, weather information, situational awareness, and some maneuverability to prevent NAS conflicts
- Steep glide slopes, unpowered flight, and limited maneuverability are all issues that need to be considered in conjunction with RLV dense airspace operations
- Instrumentation and avionics must operate reliably in NAS and space, not clear if blackout is a problem
- Passenger and cargo security screening, preparation, loading procedures, onboard restraints, weight and balance, emergency response procedures

# Human Factors Issues

- **Vehicle pilot/crew initial training and refresher regimens, standards, qualifications, and licensing requirements**
- **Ground crew training, standards, and qualifications requirements**
- **Passenger training and acclimatization**
- **Onboard crew and passenger procedures for and responses to emergencies**
- **Onboard crew situational awareness, shifting activities, interface with instrumentation, cognitive load, and potential confusion**
- **Onboard crew dealing with dense terminal area air traffic**

# Weather

- **Suborbital PTP transportation would benefit from NextGen weather forecasting and communication advances, if NNEW incorporated significant space operations weather elements with its terrestrial weather**
  - **High altitude winds**
    - **PTP trajectory compliance requires knowing suborbital wind conditions**
    - **Best mix for generating high-quality wind profiles may consist of Doppler Radar Wind Profiler combined with balloons**
  - **Triggered lightning for four RLV configurations studied**
    - **Triggering thresholds are uncertain in absolute terms**
    - **Unpowered horizontal landings comparable to medium-sized aircraft**
    - **Boost seems comparable to medium aircraft, but plume adds uncertainty**
  - **Space weather (potentially hazardous effects of natural radiation)**
    - **Exposure of passengers and repeated crew exposure**
    - **Potential shielding for vehicle systems (e.g., avionics & communications)**

# Environmental Impact

- **No current space specific regulation**
- **Terminal areas environmental concerns**
  - **Noise**
  - **Vibration**
  - **Shock waves**
  - **Emissions and contaminants**
  - **Hazardous material handling**
  - **Land use**
- **RLV environmental concerns**
  - **Carbon footprint and effluents**
  - **Volatile fuels and chemicals**
  - **Hazardous cargo**
  - **Debris and contaminants both exposure and creation**

# Military Operations

- **Small Unit Space Transport And Insertion (SUSTAIN) program**
- Based on the view that only space-enabled solutions combine the necessary speed, global reach, and unconstrained overflight
- Would provide space vehicles to transport Special Operations forces
- As a military operation a SUSTAIN mission might be handled as a NextGen exception
- Might address and resolve many relevant PTP operational issues before commercial flights occur if the program advances
- Future capability might even include launching Marines into low earth orbit until time of attack

# Conclusions: Priorities Summary

- **AST and NextGen need to work closely together to define the accommodations necessary for NextGen system aircraft and commercial space transportation vehicles to cohabit the NAS safely**
  - RLV navigation, situational awareness, communications, and control equipment requirements
  - Weather data for space in NextGen
- **Initiate international coordination and issues resolution**
- **Human Factors issues – training, qualifications, equipment interfaces, trajectory maintenance, emergency response, occupant safety**
- **Adequate access to navigation and timing data in space**
- **Terminal and vehicle security requirements**
- **ATM procedures, PTP operational flight rules, and high density operations**
- **Environmental issues**

# Priorities Estimated Timetable

Priority	ATM Issue	Issue to be Addressed	Start Date
1	National Coordination	Institutional and policy decisions take extended periods of time to resolve. Need to address incorporation of space -related issues into NextGen.	2011
2	International Coordination and Control Ground Rules	Institutional and policy decisions take extended periods of time to resolve. Need to initiate coordination for PTP implementation similar to that for NextGen aircraft in international transportation which is being coordinated through ICAO .	2012
3	ATM Communications	Vehicle-to-vehicle, vehicle-to-ground, and automated communications (e.g., ADS-B).	2015
4	Advanced Weather	Ensure that high altitude winds, national lightning detection, and space weather input are incorporated into the weather component of NextGen decision making.	2012
5	ATM in Space	Determine surveillance, situational awareness and control procedure needs	2015
6	Human Factors	Begin addressing training and crew qualification needs, crew/instrumentation interfaces, effect on trajectory maintenance, and emergency response.	2012-2015
7	Occupant Safety Guidance	Address flight safety and emergencies procedures, which may evolve from space tourism flights.	2012
8	Navigation and Timing	Access to advanced technology from space .	2015
9	Security	Security of the terminals and vehicles.	2015
10	Advanced ATM Procedures	RNAV, RNP, and NextGen trajectory-based operations.	2015-2020
11	PTP Operational Flight Rules	Functioning within, leaving, and returning to the NAS ATC and guidance for international operation.	2015
12	Super-Dense Operations	Determine applicability based upon likely terminal locations and	2018
13	Environment - Noise	Stage 4(very quiet) noise standards.	2015
14	Environment - Emissions	Special fuels impacts.	2020
15	Environment - Hazmat	Standards for handling and storage that expand upon existing industrial guidance, where needed.	2020
16	Detailed ATM Operational Procedures	Detailed ATM procedures for eventual scheduled, revenue-generating commercial operations .	2020

# Questions?

