Preliminary Investigation of Civil Tiltrotor in NextGen Airspace

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Rotorcraft in the Next Gen Airspace

• Demonstrate analytically that rotorcraft can be successfully integrated into Next Gen airspace
• Identify unique Next Gen technologies and concepts of operations that might be required to maximize safe, efficient, environmental responsive, and economic employment of rotorcraft in the Next Gen airspace
• Demonstrate with modern, accepted analysis/simulation tools that rotorcraft can be a potential solution to airport/airspace congestion
• Provide insights into rotorcraft-specific technology advances that will be required
Making Sure Rotorcraft Requirements are Factored into Next Gen Tech & CONOPS

- Primary emphasis of Next Gen implementation is, not unexpectedly, on subsonic fixed-wing jet aircraft

- It is vitally important to ensure that rotorcraft requirements are adequately factored into Next Gen technologies and concepts of operation

- Without proper attention to rotorcraft-specific technology and operational questions and issues the full potentiality of future rotorcraft systems might not be realized
NASA Airspace Systems’ NRA Effort

• Ongoing Airspace Systems-sponsored “Advanced Vehicles in Next Gen Airspace” study; in the final few months of an 18-month study effort by two contractor teams

• NASA provided Sensis-led NRA team 90-PAX LCTR2 reference design for airspace modeling effort‡

• But consensus within SRW is that NRA Effort needs to be expanded upon -- that led to the initiation of SRW-sponsored “Civil Tiltrotor (CTR) in Next Gen” study

“CTR in Next Gen” Study Tasks

Year 1

- Task 1: Identify CTR Attributes Using tiltrotor design tools
- Task 2: Develop CTR operational procedures and ConOps using high fidelity Manned simulator

Performance optimization

Year 1 report
CTR performance attributes
CTR fleet BADA database
CTR 4D Trajectories

Year 2

- Task 3: Identify CTR metrics In NextGen
- Task 4: NextGen system analysis tool survey
- Task 5: CTR system performance analysis and tradeoffs In NextGen using NAS system tools

Additional gaps

Year 2 report
CTR performance and tradeoffs In NextGen

Year 3

- Task 6: Safety and risk mitigation for CTR in NextGen
- Task 7: Disaster relief effectiveness evaluation for CTR in NextGen
- Task 8: Identify future research and critical topics

Report #1
Report #2
Report #3
Not One, but a Family of Vehicles Being Studied

- CTR airspace simulations will be based on a fleet of 10-, 30-, 90-, and 120-PAX vehicles
- 10- and 30-PAX vehicle design heritage based, in part, on BA-609 and V-22
- 90- and 120-PAX vehicles will be clean-sheet conceptual designs based on Bell Helicopter technology projections for IOP’s of 2020.
- Additionally, both VTOL and STOL takeoff and landing profiles will be incorporated in the pilot-in-the-loop and airspace simulations
- Bell PRESTO sizing analysis used for vehicles
Progress to Date

- Nine months into Year 2 effort
- Design requirements for family of CTR vehicles agreed to by team
- Conceptual designs completed for 10-, 30-, and 120-PAX vehicles
- Demand modeling and informal team assessments established a baseline fleet size for vehicles for 2025 time frame
- Given design data, BADA models are developed
- Pilot-in-the-loop simulations completed
- Coupled ACES/AvTerminal airspace simulations have begun
## General Conceptual Design Requirements

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<td>Cruise Speed, ktas</td>
<td>Fallout</td>
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(1) VTOL is assumed to be a Cat A procedure and is a target for 10 and 30-pax designs
(2) Target
30-Pax CTR Cont.

- 34 x 72 Aft Entry Door
- 34 x 72 Fwd Entry Door
- Lavatory

Dimensions:
- 95.0
- 88.0
- 21.0
- 21.0
- 21.0
- 21.0
- 2.0
- 72.0 Floor
- 21.50 Floor
- 70.0 Cabin Height
- 72.0 Floor
- 91.50 cockpit
- 352.0 cabin length

This seat only on aft row at aft bhd
Pilot-in-the-Loop Simulations

- Pilot-in-the-loop simulations were performed at Bell Helicopter
- Because of simulator logistics reasons terminal area simulations were at Miami airport (MIA)
- ACES airspace simulations, though, will focus primarily on Northeast Corridor
- Pilot-in-the-loop simulations tested applicable terminal area CONOPS
- Additionally, Bell simulator data was used to validate BADA/ACES models
Fixed-Base Simulator used in PITL Sim
Coupled ACES/AvTerminal Simulations

- During Year 2 effort, CTR BADA models was transformed to ACES models
- ACES is a well-known NASA-developed airspace simulation tool
- AvTerminal is a Sensis-developed terminal area tool
- Airspace simulations are being used to assess impact of CTR fleet to increase capacity/throughput of congested airports in 2025 time frame
- Study primary focus will be on Northeast Corridor
- CTR fleet size for 2025 was based in part on demand modeling and informal team assessments
Northeast Corridor Nine Airport Network

ACES CTR Flight Tracks

[Map showing flight tracks between PIT, BWI, DCA, IAD, JFK, and BOS, colored by destination with various numbers indicating flight frequencies.]
“Productivity Index” to refine Flight Profiles
CTR Fleet Noise and Emissions Modeling

- **BADA**
  - Performance & Profiles

- **CTR Performance Deck**

- **ACES**
  - Congestion / Delay
  - Enroute track data

- **AvTerminal**

- **AEDT**
  - Fuel burn, noise
  - and emissions

- Excess/transit time
  - terminal area trajectory and
  - track data

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CTR in NextGen - 18
Future Plans -- CTR Public Service/Disaster Relief Modeling

- Public service missions are a singular and key aspect of rotorcraft; CTR will be no different
- During Year 3 effort, specialized simulation tools will be used to assess utility of CTR fleet for disaster relief missions
- Prototypical scenario to consider is a hurricane relief effort
- One possibility to consider in analysis is a CRAF-like (Civil Reserve Air Fleet) CTR civilian fleet response to disaster scenario
Concluding Remarks

• A challenging but valuable exercise so far

• SRW-sponsored “CTR in Next Gen Airspace” study significantly leverages off Airspace Systems Program “Advanced Vehicles in Next Gen” NRA Studies

• Already gaining considerable insights from CTR conceptual design and pilot-in-the-loop sim efforts

• Coupled ACES/AvTerminal airspace simulations have begun
Questions?