BREAKOUT SESSION ACCOMPLISHMENTS

• What are minimum viable products to make progress towards increasingly autonomous flight and operations in the NAS
• Where will collaboration be most productive
• Possible collaborative demonstrations
• Steps toward operationalization of increasingly autonomous systems.
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BREAKOUT SESSION 1: Identify needs and minimum viable products.
MINIMUM VIALBE PRODUCT

• A minimum viable product is a product with just enough features to satisfy early customers, and to provide feedback for future product development.
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NEEDS OF SMALL UNMANNED AIRCRAFT SYSTEMS

- DATA
  - List of data that industry would share
  - IP can be stripped
  - Data needs to have context because vehicles are so diverse
- Airspace structure for sUAS ops below 400 feet (and above)
  - Adoption of UTM
- Further development/adoptions of UTM Conops (needed so technology can be developed to support)
- Simplified vehicle operations to manage human operator workload for complex systems
- Micro-climate information (data)
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MINIMUM VIABLE PRODUCTS

- “Straw man products”
- Data sharing website/product to be used to develop safety case, improve/verify operations, etc.
- Template for use of autonomy in low-risk applications (e.g., agriculture or island-hopping)
- A path for assurance of M:N operations
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BREAKOUT SESSION 2: Identify research gaps requiring attention in order to implement increasingly autonomous operations in complex airspace and areas.
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RESEARCH GAPS AND NEEDS

• Data
  • Data sharing
  • Failure rates, modes
  • Micro climates and urban canyons – weather characterization and prediction; GIS
  • Health and trajectory data
  • Role of data in progressing... in increasing levels of autonomy
  • Integrity, quality, and other certification related data requirements
• Operator machine teaming / trust in automation
  • Public trust
  • At what point is the automation “good enough”?
• Assuring safety (assurance & certification) of deterministic and adaptive machine learning algorithms/AI
• Algorithms requirements for heterogeneous operations in large scale environments
  • Mesh networks
• Industry work with NASA ATC simulation labs
M:N operation requirements for both for operators and system integration
  - Operator workload, SA
Remote ID range requirements for congested environments and for different operations types
Interoperability with Air Traffic Control
Migrating to data link from voice environment (incl. dissimilar redundancy)
Dissimilar redundancy
  - Validating, reconciling data from redundant dissimilar systems
New sensors & sensor fusion
DAA
  - Detect and avoid sensors
  - Automated alerting and guidance
  - Targeted geofencing
  - Detect and decide
Non-cooperative traffic avoidance and back-up navigation
Security, cybersecurity
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BREAKOUT SESSION 3: Identify strategy that will lead to collective demonstrations and operational implementation of increasingly autonomous systems in the national airspace system.
ENABLING AUTONOMOUS FLIGHT & OPERATIONS IN THE NAS

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ACTION PLAN FOR COLLECTIVE DEMONSTRATIONS

• Real world use cases that have value to the public will help with public acceptance
• Ideally, data from demos would be shared amongst participants and/or public
  1) Test new sensing capabilities for micro-Wx and analysis.
  2) Then experiment with how this influences safe sUAS operations in suburban test range and urban canyons. Do tests with and without micro-climate sharing.
  3) A succession of $m$ (human operators) : $n$ (aircraft) operational tests
    1: small $n$
    2: small $n$ (with appropriate sharing/handoff between human operators)
    2: large number of aircraft (Shively lab demonstration 2:8)
    $m : n$ tests – needs to be done in context of environment, capability of autonomy onboard, etc.
4) Diverse redundancy for communication links
   • For example 5G and WiFi flying over Moffett Field with negotiation and data sharing
   • Then in urban canyon with a noisy radio environment
   • Demonstrations of procedures with loss link, etc.

5) A series of experiments on acceptable levels of noise

6) Flying over people and valuable property (reference ASSURE program)
   • Safe disintegration upon impact
   • Land/ditch away from people and valuable property
   • With and without parachutes
7) Flying mixed sUAS and other aircraft, starting with limited COAs
Collective data sharing demonstration.
  • For example, Blackstone, VA has 50% sUAS operations. VA test site.
  • Experience is that data collection needs to be done in the context of a safety case
(There is an IPP portal for providing data)
Another example is with Bell operating out of 2 airports, and a safety corridor
  • NASA has already extended AFRS to unmanned aircraft incidents
  • NY test site has been collecting large amounts of data over last 2 years, but only 2% analyzed. They are collecting data from all of Syracuse airspace including Griffith AFB. LVC-DE environment is currently difficult to be used because of cybersecurity requirements and lack of NASA resources to help manage.
8) Demonstrations of certifiable autonomy
   • Autonomously handling a graded series of failures that now requires a human pilot or operator.
   • Certification of run-time monitors and watchdogs.
   • Non-adaptive AI and pre-trained machine learning
   • Adaptive AI
backup
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Research gaps and needs

- Certification
  - Research data on assurance
  - Certification/licensing of AI/neural network applications (including hybrid non/deterministic systems)
- Human machine collaboration
- Trust – pilot’s trust of system and vice versa
  - Human’s contribution to safety
  - How do we learn to use systems that are predictably unreliable?
- M:N operations; understand operator workload, especially under off-nominal conditions
- New sensors and sensor fusion to work in high velocity, highly dynamic environments
  - Computer vision
- Dense, heterogeneous operations, not homogeneous swarms
- Capture more data on failure modes in automated systems
  - Real-time performance monitoring and contingency management
- Data-link and migration away from voice
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**Action Plan for Collective Demonstrations**

- Real world use cases that have value to the public will help with public acceptance
- Ideally, data from demos would be shared amongst participants and/or public
- Utilize LVC-DE capability (IT security makes it difficult)
- Urban canyon demonstration
  - suburban and city environments
  - Weather and flow sensors collect data
  - Model data and experiment in simulation and real flight test
  - Drones operating with and without micro-climate information in an urban canyon
- Incrementally automate and demonstrate increasingly autonomous systems
  - Incrementally place pilot functions onto automated system and test
  - Drone interacting safely with ATC
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ACTION PLAN FOR COLLECTIVE DEMONSTRATIONS

• Flying over ‘real’ people (one step beyond TCL-4)
  • In urban canyon, where loss of link is common
  • Demonstrate loss of link and appropriate measures/contingencies (using standardized loss of link behaviors?)
  • Multiple UAS coordinating with each other – mixed
  • Demonstrate graceful degradation; Safe to Ditch/Safeguard
• Demos around acceptable noise – similar to Low Boom Flight Demonstrator
• Hack-a-thons (similar to DoD hack-a-thons)
  • Autonomy algorithms and ways to defeat them
• M:N demonstrations
  • Incrementally increase ratio of vehicles to operators; build on previous demos
  • How does context (vehicle capabilities, mission complexity) matter for that ratio?