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.

SMALL UNMANNED AIRCRAFT SYSTEMS

BREAKOUT SESSION 1: Identify needs and minimum viable products.

MINIMUM VIABLE 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/adoption 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

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RESEARCH GAPS AND NEEDS

- 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 date 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.

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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.

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ACTION PLAN FOR COLLECTIVE DEMONSTRATIONS

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

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ACTION PLAN FOR COLLECTIVE DEMONSTRATIONS

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.

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ACTION PLAN FOR COLLECTIVE DEMONSTRATIONS

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?