AEWG Crosscutting WG: AAM Partnership Strategy

November 17, 2020

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All material is DRAFT and some or all elements to the strategy could change at the government's sole discretion

AEWG Crosscutting WG: AAM Partnership Strategy Agenda

General Session		
Time	**Topic**	**Speaker**
11:00AM – 11:05AM	Introduction	Davis Hackenberg
11:05AM – 11:10AM	NASA Welcome from NASA ARMD Deputy Assoicate Administrator of Policy	Jon Montgomery
11:10AM – 11:20AM	AAM Overview	Davis Hackenberg
11:20AM – 11:35AM	ACO Partnership Process	Colin Theodore
11:35AM – 11:50AM	National Campaign Overview	Starr Ginn
11:50AM – 12:15PM	General Session Q&A	Davis Hackenberg, Colin Theodore, Starr Ginn
Transition to Breakouts (5 min)		
12:20pm – 1:00pm *(Choose One)*	**Breakout 1:** • NC-1 Overview • Flight Annex • Information Exchange Annex	Starr Ginn
	Breakout 2: • NC-2 Overview • CNSI Annex • AFCM Annex	Kenneth Goodrich Paul Nelson Mary Stringer
	Breakout 3: • NC-1 Overview • Infrastructure Annex • Airspace Annex	Shivanjli Sharma Kevin Witzberger
	Breakout 4: • Crashworthiness Annex • Community Planning and Integration Annex	Justin Littell Nancy Mendonca

Logistics

- **General Session** *(11:00AM – 12:15PM ET / 8:00AM – 9:15AM PT)*
  - **Platform:** YouTube Live Stream
    - Go to the NARI registration site and/or AEWG Portal for the link
  - **Q&A:** Conferences.io
    - Enter https://arc.cnf.io/sessions/ww7e/#!/dashboard into your browser
    - Questions will be addressed *if times permits or at the facilitator's discretion*
- **Breakout Sessions** *(12:20PM – 1:00PM ET / 9:20AM – 10:00AM PT)*
  - **Platform:** MS Teams
    - To access the individual breakout rooms, use the MS Teams meeting links in the agenda
    - The agenda is accessible at the following URL: https://nari.arc.nasa.gov/cwg-agenda
  - **Q&A:** MS Teams microphone, chat, and "Raise your hand" functions
    - Leave your cameras/webcams off to preserve WiFi bandwidth
    - Use your mute/unmute button (e.g. remain on mute unless you are speaking)
    - Enter comments/questions in the chat
    - Click the "Raise your hand" button if you wish to speak
    - Say your name and affiliation before you begin speaking

NASA Welcome

Jon Montgomery, NASA ARMD Deputy Associate Administrator for Policy

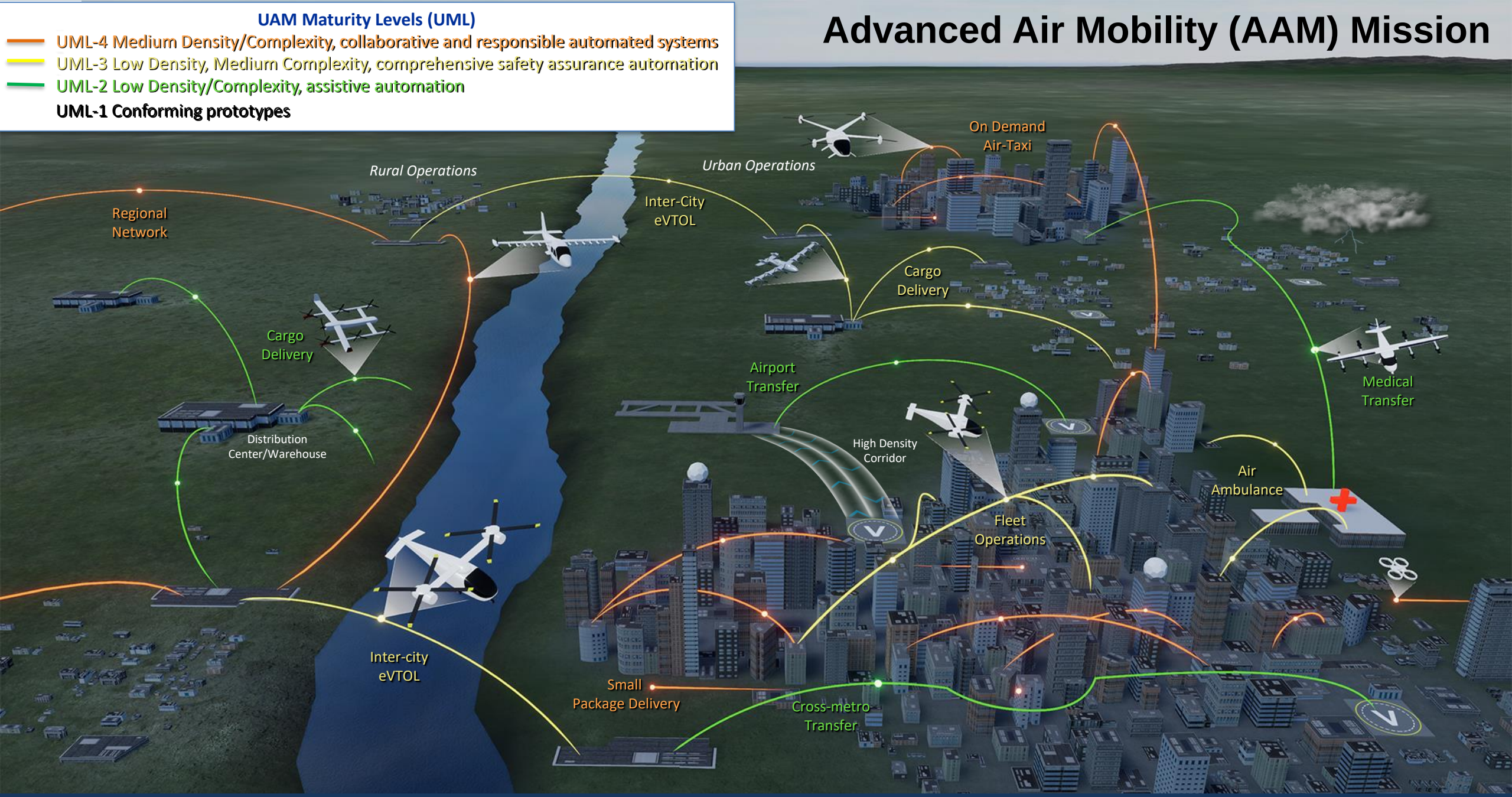
AAM Overview

Davis Hackenberg

Advanced Air Mobility (AAM) Mission

UAM Maturity Levels (UML)

- UML-4 Medium Density/Complexity, collaborative and responsible automated systems
- UML-3 Low Density, Medium Complexity, comprehensive safety assurance automation
- UML-2 Low Density/Complexity, assistive automation
- **UML-1 Conforming prototypes**



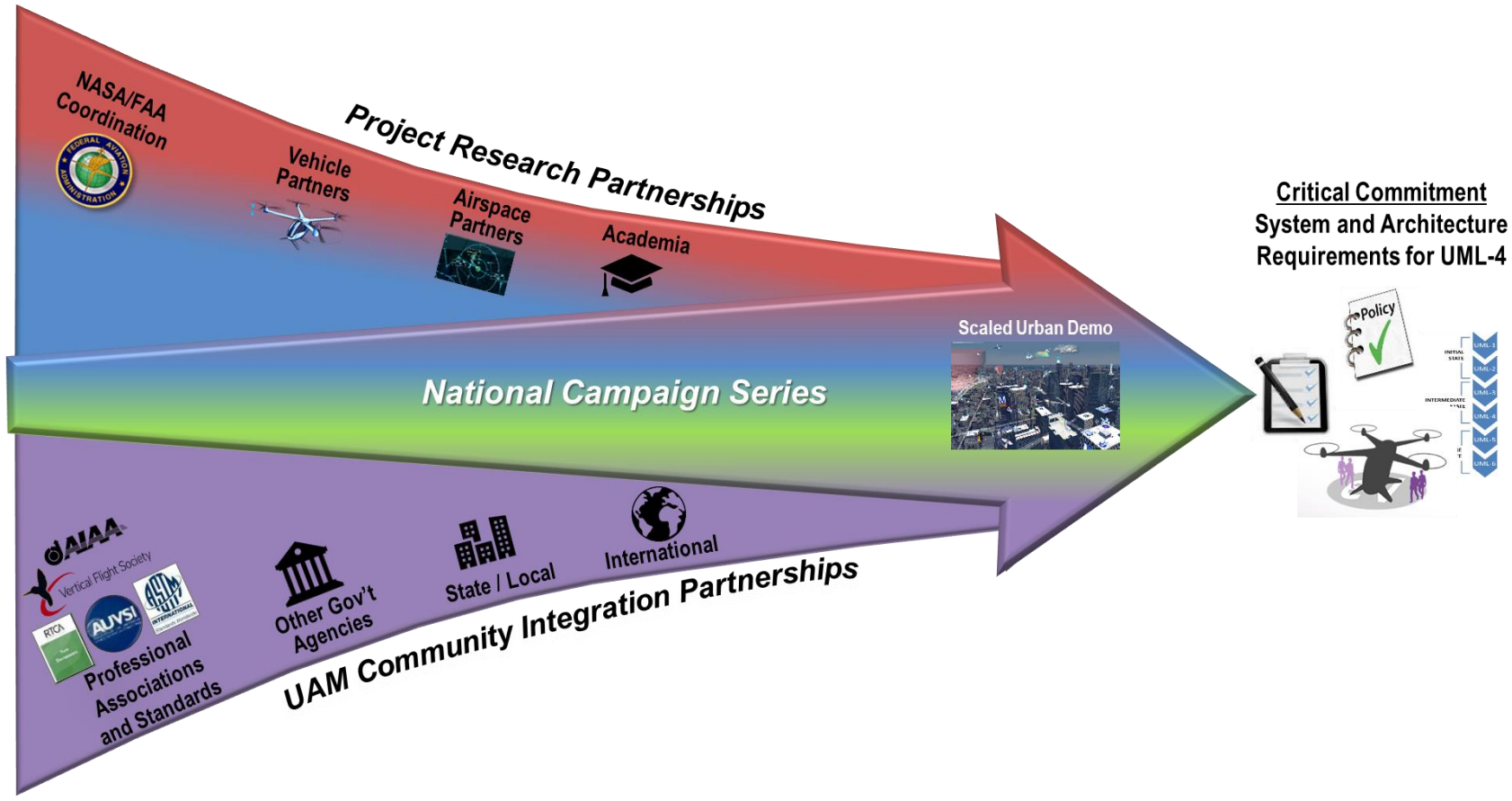
Safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions

AAM Ecosystem Partnership Strategy

- Foundational research partnerships in existence and developing
- NASA/FAA AAM WGs are beginning formal execution

- Continue to Leverage NC as a centerpiece of the partnership strategy

- AAM Ecosystem Working Groups (AEWG) are providing a valuable opportunity space for localities, international, and standards organizations



FAA, AAM Ecosystem Working Groups (AEWG) and research partnerships are providing valuable input spanning vehicle, airspace, and community partners across the globe

AAM Mission Critical Commitment

Vehicle Development and Operations Develop concepts and technologies to define requirements and standards addressing key challenges such as safety, affordability, passenger acceptability, noise, automation, etc.

Airspace Design and Operations Develop UTM-inspired concepts and technologies to define requirements and standards addressing key challenges such as safety, access, scalability, efficiency, predictability, etc.

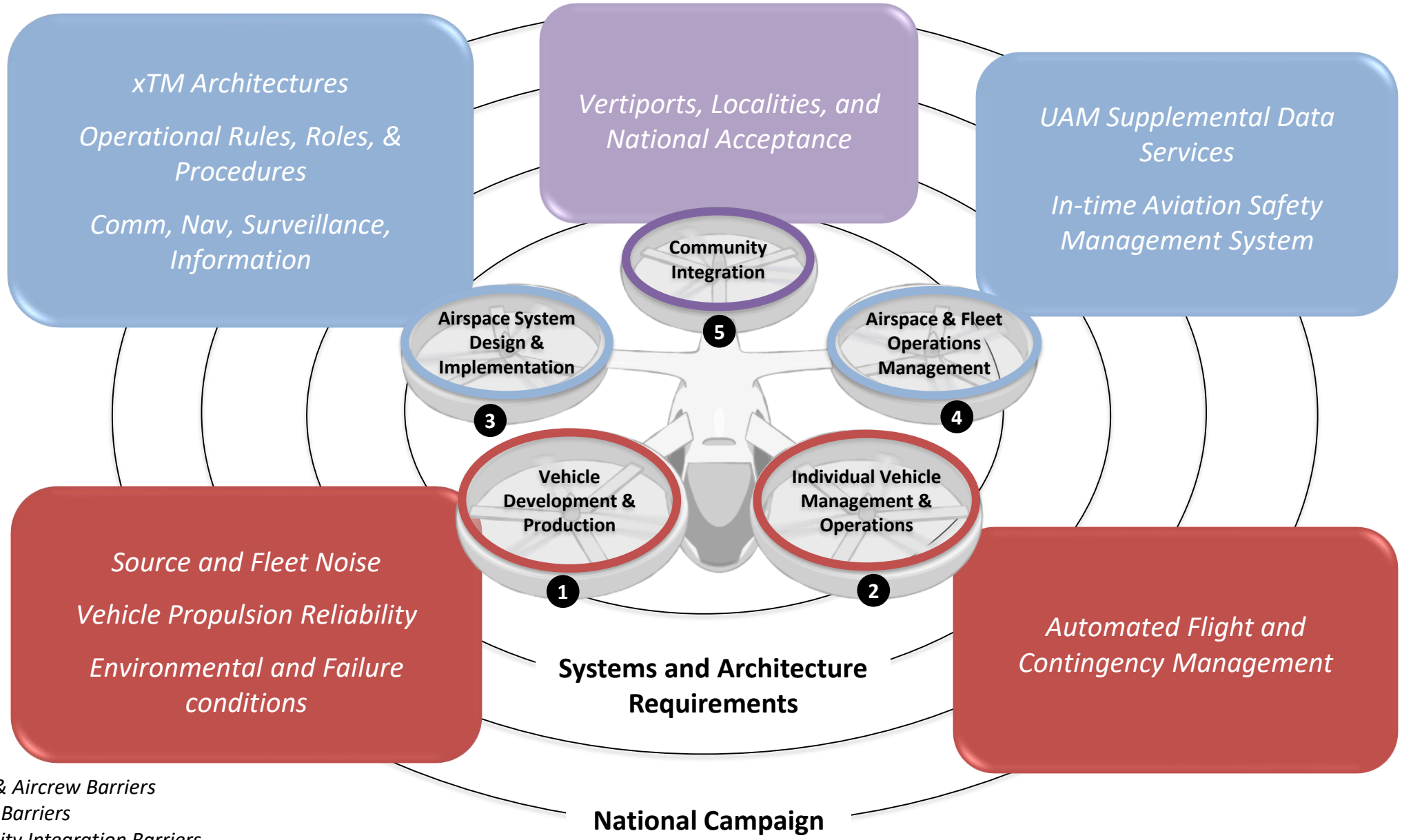
Community Integration Create robust implementation strategies that provide significant public benefits and catalyze public acceptance, local regulation, infrastructure development, insurance and legal frameworks, etc.

Critical Commitment:

Based on validated operational concepts, simulations, analyses, and results from National Campaign demonstrations, the AAM Mission will deliver aircraft, airspace, and infrastructure system and architecture requirements to enable sustainable and scalable medium density advanced air mobility operations

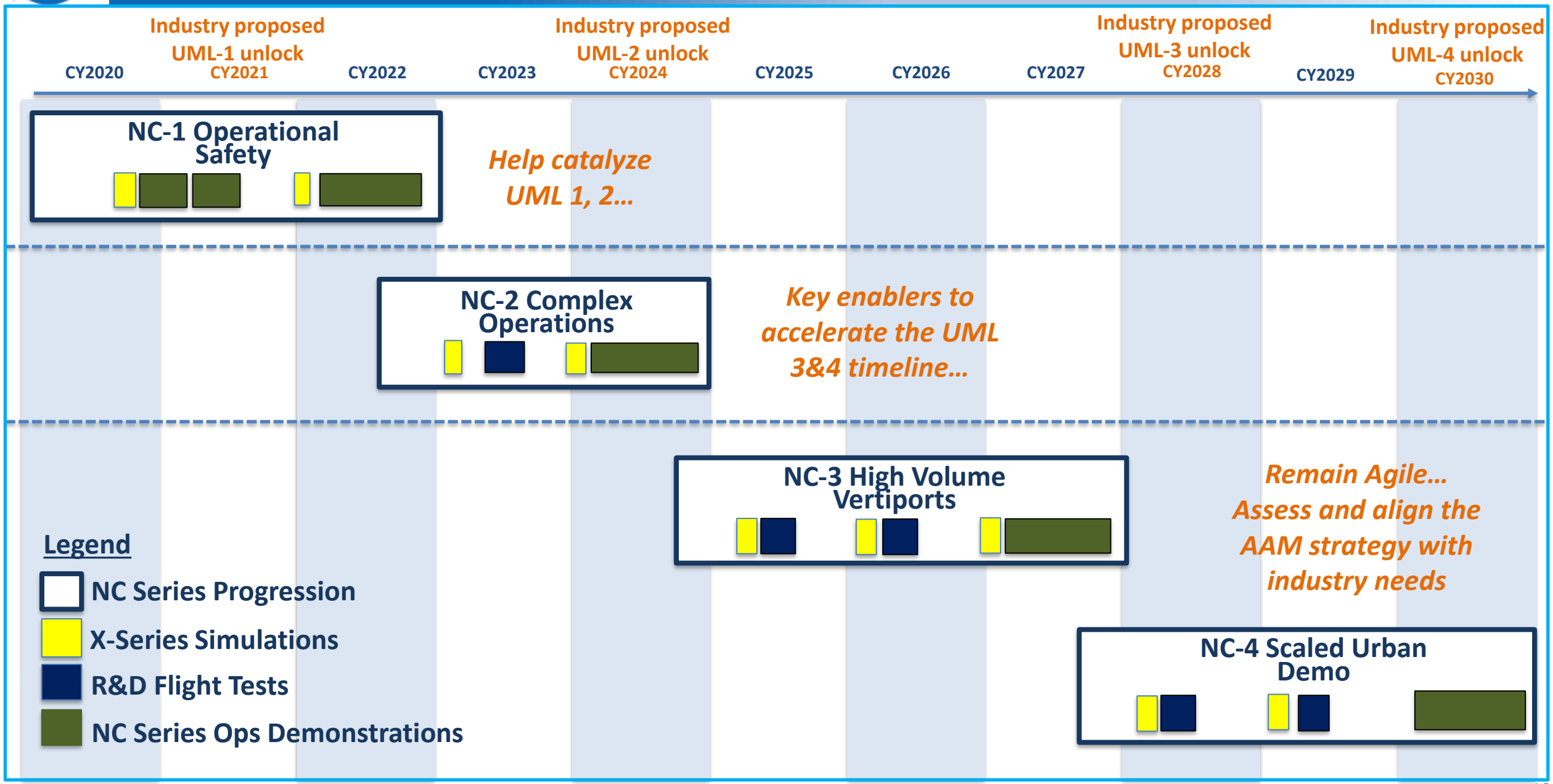
Achieving "systems and architecture requirements" will require *enabling activities* such as 1) the AAM National Campaign Series 2) a robust Ecosystem Partnership model and 3) NASA ARMD R&D Execution.

NASA AAM Mission Priorities



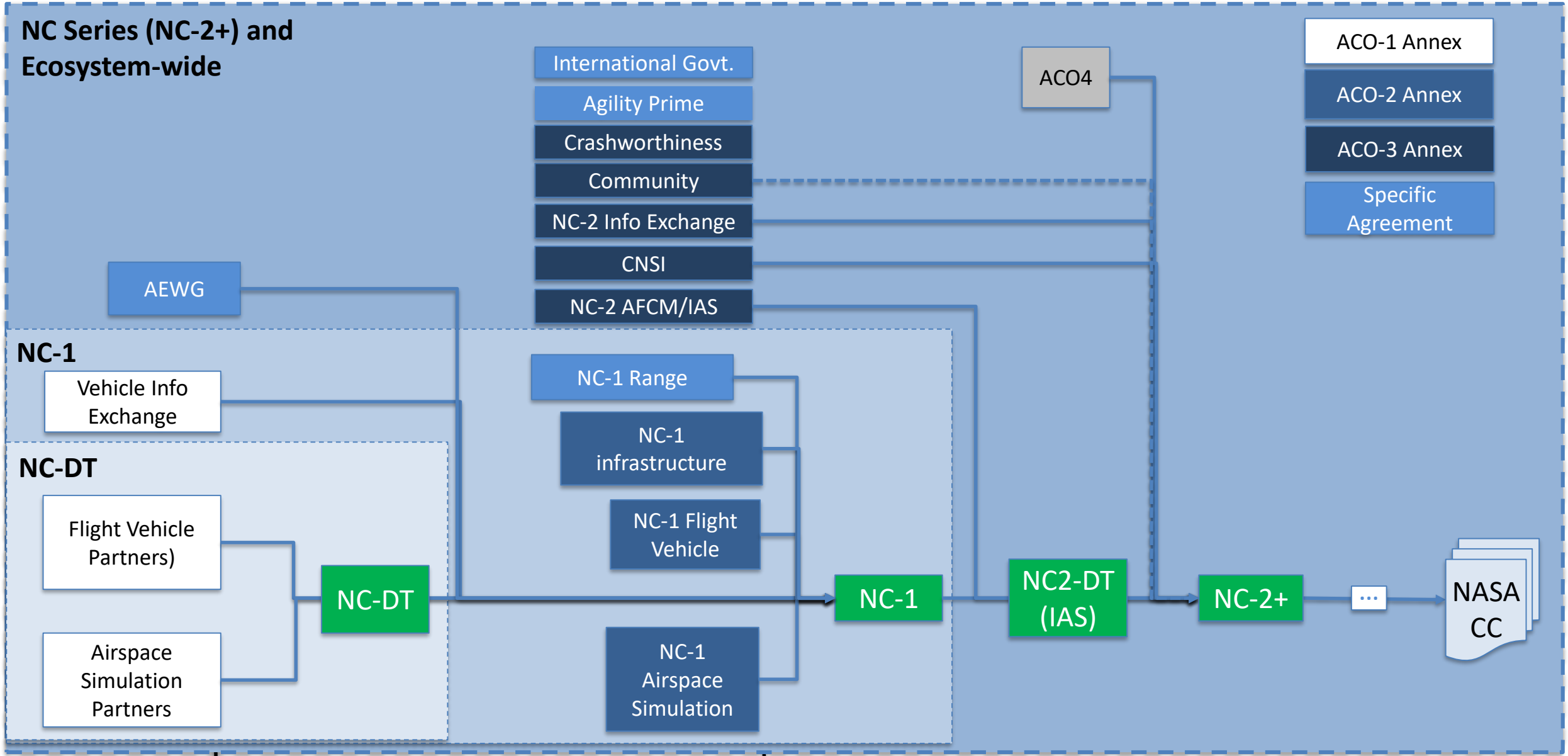
- *Aircraft & Aircrew Barriers*
- *Airspace Barriers*
- *Community Integration Barriers*
- *Pillar number*

National Campaign Series support of the Industry Timeline



UML "unlocks" based on a range of publicly available industry projections and conversations with partners; not a consensus view

NASA AAM Mission Partnership Agreements
Announcement of Collaborative Opportunity (ACO)



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ACO Partnership Process

Colin Theodore

Partnership Process

- Partnership Process – Announcement of Collaborative Partnership Opportunities (ACO)
  - Describes the 2 opportunities mentioned earlier:
    - ACO-2 – National Campaign 1 participants
    - ACO-3 – AAM research and development partnerships
  - Contains all the information you need to know:
    - Details of partnerships we're looking for with these ACOs
    - Who's eligible, how to propose, what information we'd like in proposals, etc.
    - How NASA will evaluate proposals and select partners

- Agreements:
  - Partnering under Non-reimbursable Space Act Agreements
  - Leveraging an Umbrella / Annex Agreement approach
  - Releasing template agreements along with ACO
    - Open to modifications to the template agreements

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ACO Process FAQs

- How are these ACOs different from the ACO released last year?
  - Re-branded to National Campaign from Grand Challenge
  - Expanding to Advanced Air Mobility (AAM) with an emphasis on Urban Air Mobility (UAM)
  - Adding research and development partnerships to work with larger NASA AAM portfolio

- Who is eligible to propose?
  - U.S. Companies with technologies or capabilities specific to annex content
  - All relevant companies (including international) for NC Flight agreements, but flights must be performed at U.S.-domestic ranges

- How do I propose?
  - Use today to identify where in the structure you fit
  - View beta.SAM.gov on or around January 31 for final announcement, verify where you fit, and propose in response to the evaluation criteria

ACO Process FAQs

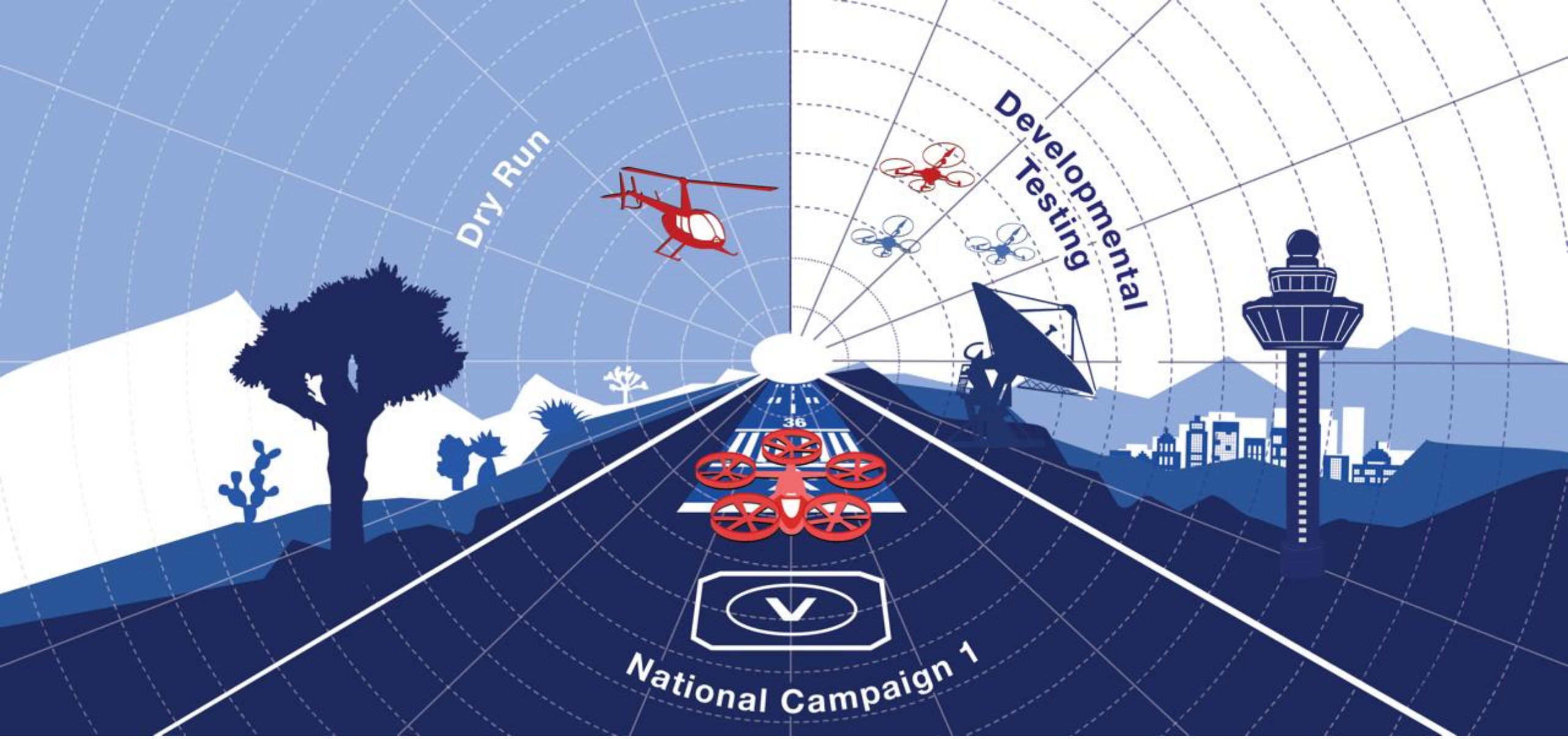
- How does NASA evaluate proposals?
  - Specific criteria will be found in the ACO for each partnership type
  - Generally, by selecting the best value and best chance of success
    - Note that “value” strongly considers the ability of the proposal to make significant impacts on the industry

- What if I am relevant to multiple annexes?
  - Submit responses that covers all annexes you are interested in
  - In your responses, include broader elements to your strategy for context and mention the other annexes to which you are also responding

- Do I need to partner with other AAM companies in order to participate in the National Campaign?
  - A key purpose is to encourage AAM innovators to work together
  - Partnerships are encouraged, but not required for NC-1

National Campaign Overview

Starr Ginn



Advanced Air Mobility National Campaign

Starr Ginn - NC Lead, David Zahn - Airspace Principal Investigator

NC DT Dry Run as Risk Reduction for DT

The primary objectives of these flight tests are to demonstrate maneuvers for key flight characteristics of UAM vehicles, prove out initial concepts for UAM operational approaches and departures, and demonstrate each of the elements that are expected to form UAM mission profiles.

NC DT Dry Run Objectives

NC-1 Objectives

Dry Run at AFRC

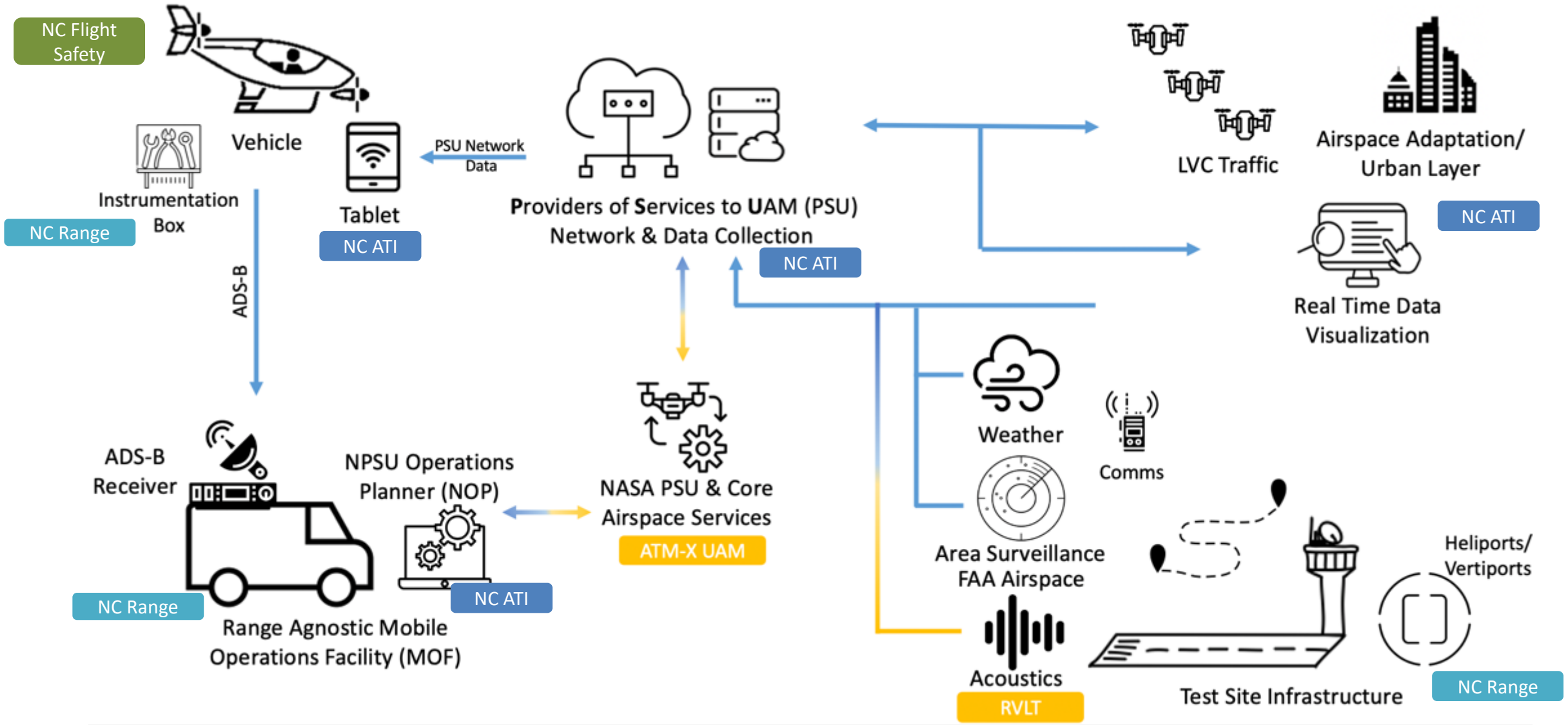
ATI LVC & Data Collection

NC Developmental Test with Joby

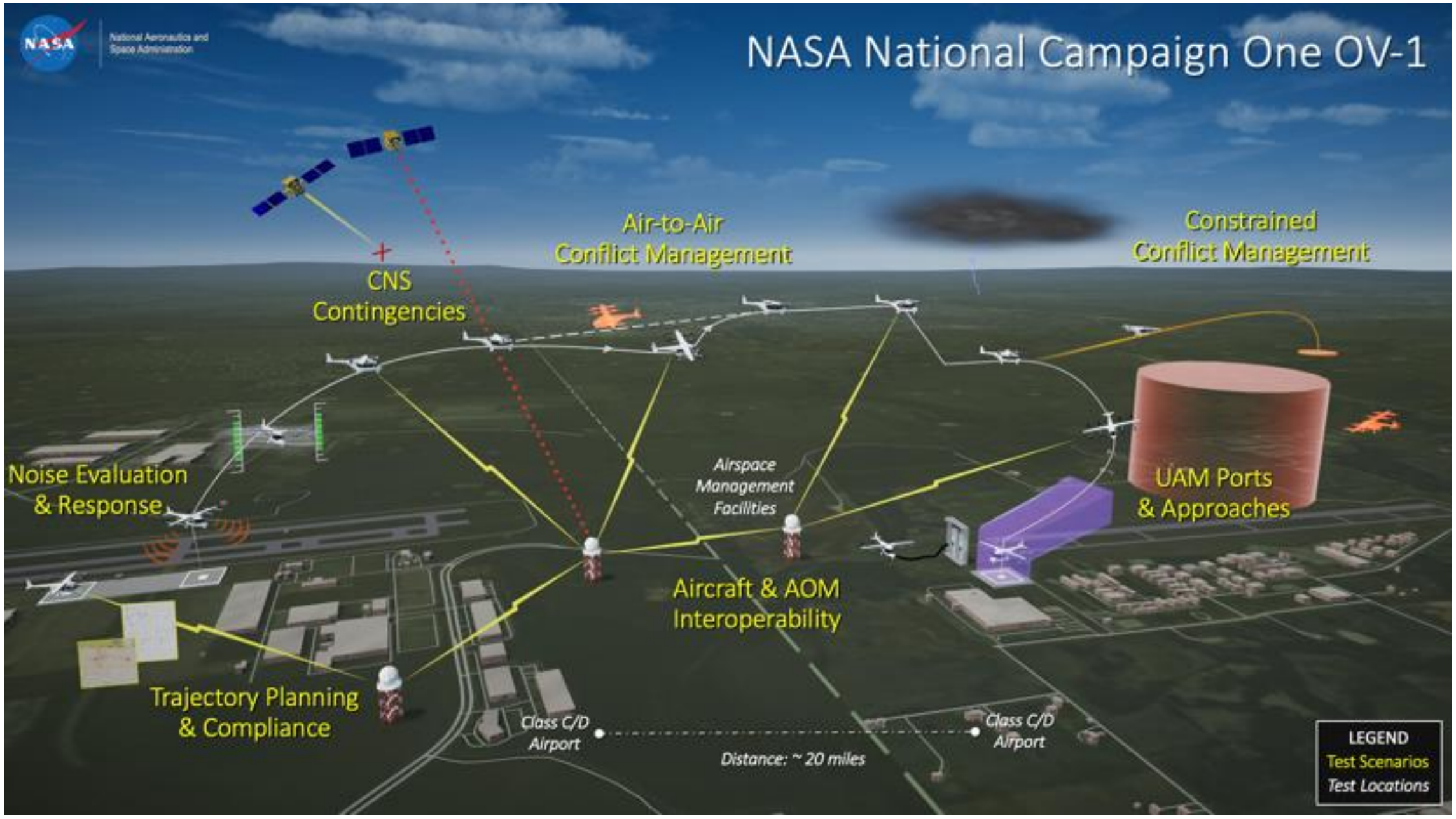
- Operational assessment and revision of NC scenarios using a helicopter as a stand in representative vehicle
- Assessment and development of Mobile Operations Facility (MOF) and its capabilities prior to deployment
- Assess operational processes for integrated operations with vehicle and airspace and data collection in the field

NC DT - Flight Interfaces Diagram

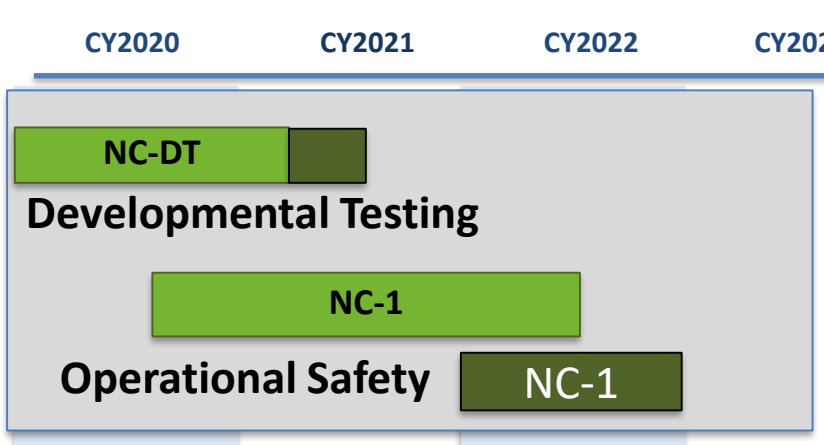
DT Flights with Joby mirrors Dry Run Build #3 but with flights and acoustic testing at Partner Test Sites



NC-1 Operational View



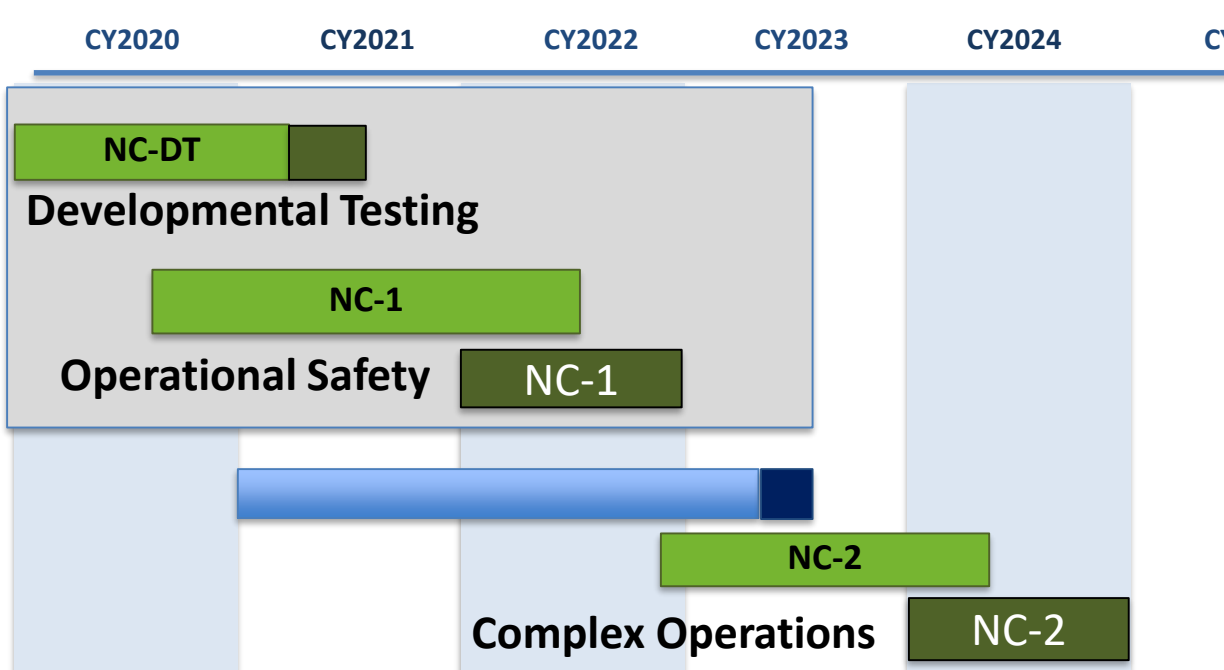
National Campaign Execution – NC-1



NC-1: UAM scenarios and contingencies **safely** flown in the **current NAS** with **current rules** while identifying gaps in FAA Standards

- Capture **operational performance data** relevant to AAM **terminal base operations**
- Assess **viability of candidate vertiport** designs and establish initial criteria
- Assess AAM aircraft/airspace **performing departure and arrival procedures, including contingencies**
- Demonstrate an **airspace operations management concept** with AAM vehicles
- Perform an initial characterization of the **noise footprint** of one AAM vehicle through ground noise measurements

National Campaign Execution – NC-2

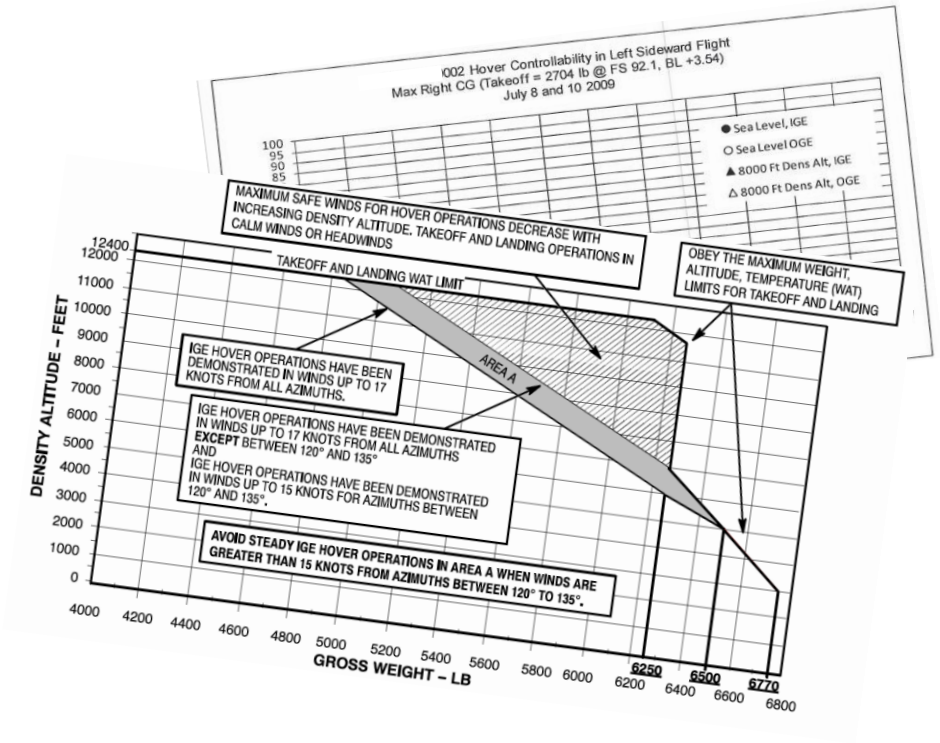


NC-2: NC-1 scenarios/contingencies with **automation for airspace and vehicle integration** to demonstrate dynamic rerouting

- **Assess** candidate **vehicle automation, flight, operational, and piloting requirements** for consideration in certification
- Assess refined **departure and arrival procedures** and **proposed right-of-way and off nominal procedures** with automated dynamic rerouting **exchange between vehicle and airspace service provider**
- Gain airspace **industry acceptance by standards** development organizations adopting NC-2 findings, software, and lessons learned

FAA Partnership with the NC is to “Anchor and Evolve Standards”

Collaboration with cross cutting lines of business in the FAA to develop NC scenarios, UAM task elements, and procedures ***anchored*** in today’s NAS

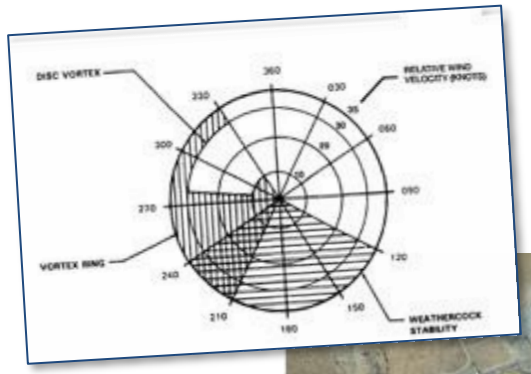


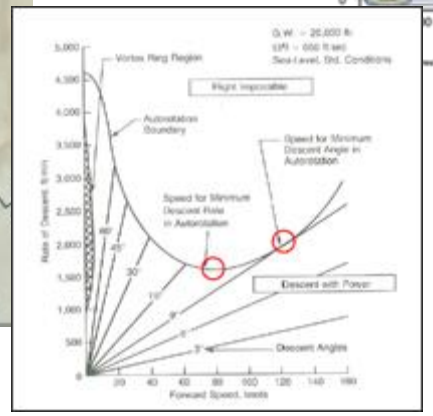
Leverage operational flight demonstrations and the data collected across the NC series to inform and ***evolve*** appropriate standards for UAM vehicles and policy to enable integration into a future NAS

NASA National Campaign flight demonstrations can provide the path to demonstrate a UAM vehicle in the Urban environment... ...well prior to certification

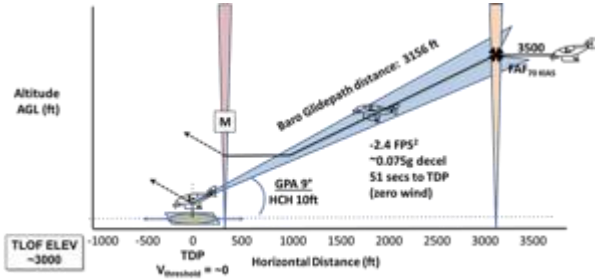
Key interest areas

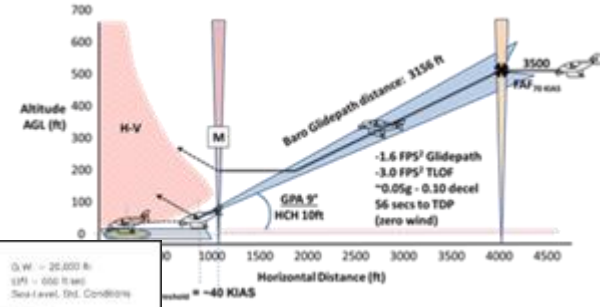
Low Speed Controllability/Performance in Urban Environment

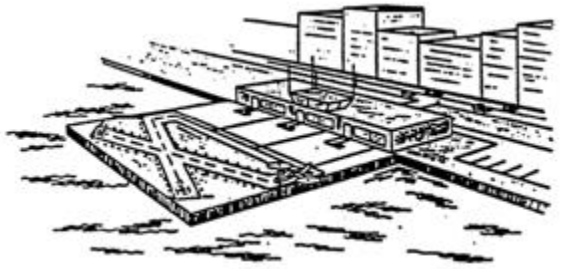




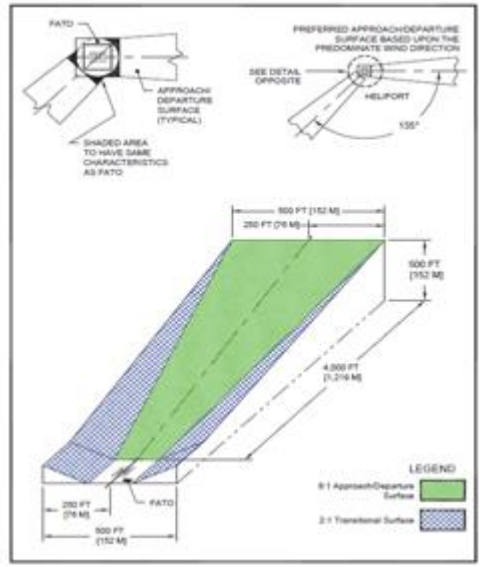
Condensed UAM Approaches/Airspace







Required evolutions to existing standards to enable UAM



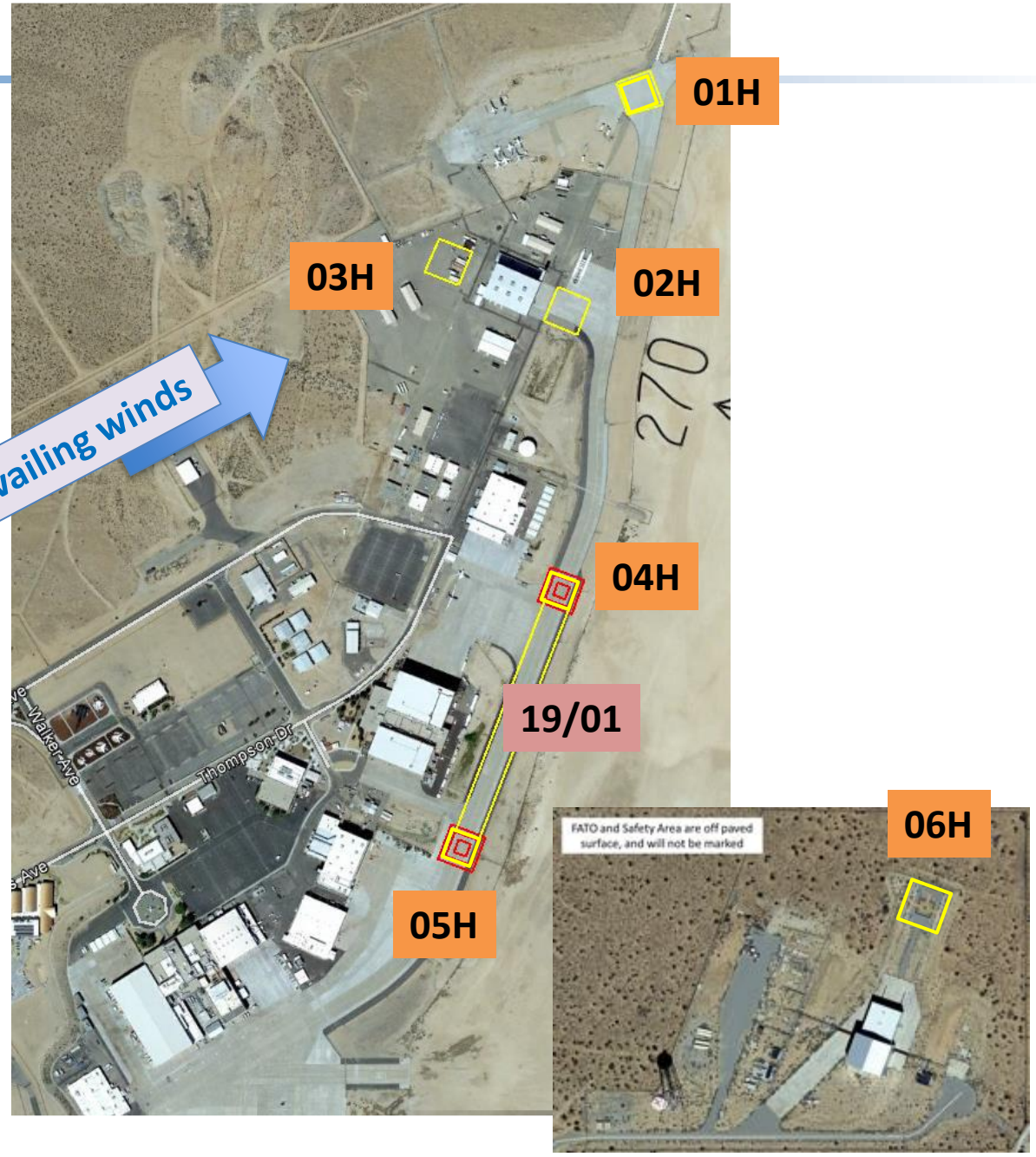
AAM NC Terminal Ops

6 AAM NC *"UAM Heliports"*

- 40x40ft TLOF
- Northern Heliports suitable for wind/controllability studies
- All Heliport design/placement IAW AC 150/ 5390-2C Heliport Design

1 AAM NC *"UAM Vertiport"*

- 1090ft length x 120ft width TLOF/FATO
- 01H + 02H + 03H = XEDW *Research Airport*
- 04H + 05H + 19/01 = XVPT *Research Airport*
- 06H = XX33 *Research Airport*



XEDW - 02H

RNAV - XEDW (02H)

Facility Search

Identifier: XEDW

AIRNAV Data

Airport	
AIRPORT ID	XEDW
STATE	CA
COUNTRY	US
MVAR	E12
STATUS	Active

Runway: 02H (A)

General	
LANDING LENGTH	31050 FT
TRUE BEARING	21.01°
PUB DATE	09/28/2020
FI RWY LENGTH	
FI RWY HEIGHT	

Helipad	
LATITUDE	N34° 57' 24.3720"
LONGITUDE	W117° 52' 57.7200"
ELEVATION	2279.0 FT
ELLIPSOID ELEV.	2173.7 FT
MODEL / SOURCE	WGS84 / E
HORZ. DATUM	WGS84
VERT. DATUM	EGM_96
CALC ELLIP HT	2173.8 FT
IS DISPLACED	

XEDW - 02H - 033

LOCATION	34°57'32.88"N 117°52'54.07"W	FREQ/ALT	120.7
LDG. DIR.	315°	C/S	ARFC Tower
[illegible]	Concrete	GO AROUND	
ELEV(Ft)	2277' MSL	LZ MARKING	Paint
SLOPE	0°	[illegible]	Active

A picture of the HLZ from an approach view.

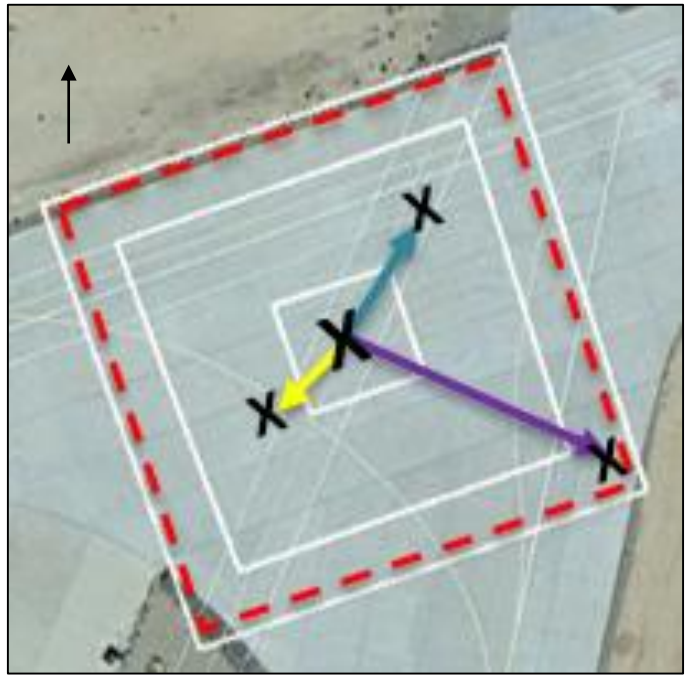
HAZARDS: Solid Rocket Boosters rightside of LZ
REMARKS: Active Taxi-Way Approach End of LZ
INSTRUCTIONS: Constant Rate Decent Decel Approach to 10 ft AGL over center of LZ from FAF.
HLZ POC: Erin Waggoner Alt:N/A

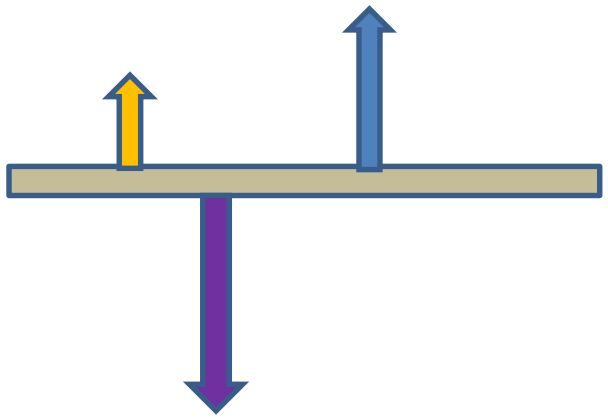
UNCLASSIFIED // REL FOUO //

Info Updated Sep 1 2020 Photo Updated Sep 1 2020

Product Results Data Element Card

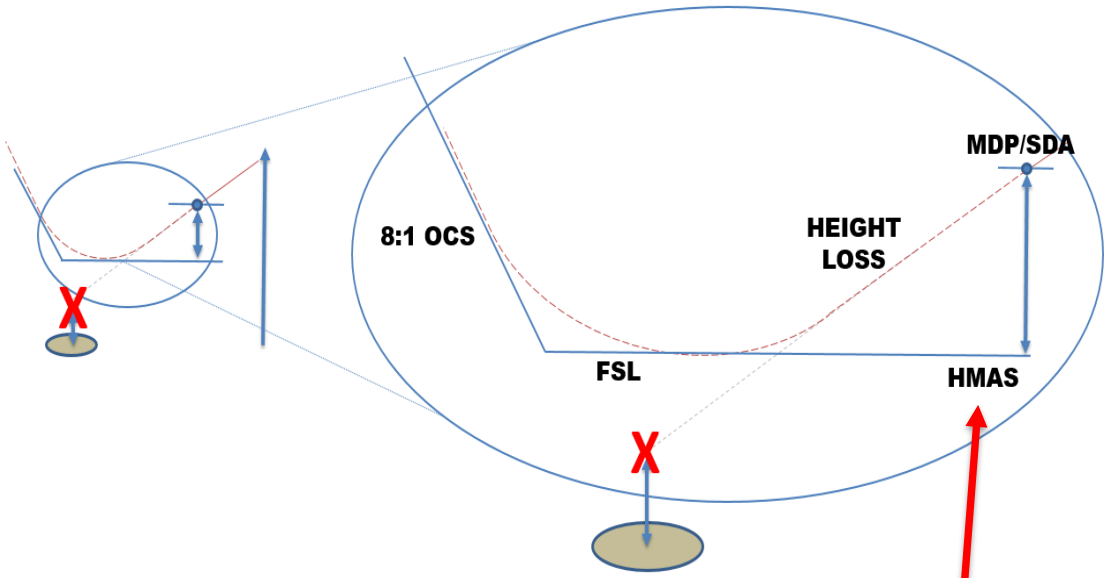
Spatial Data Position Errors **Area A – XEDW – 01H**

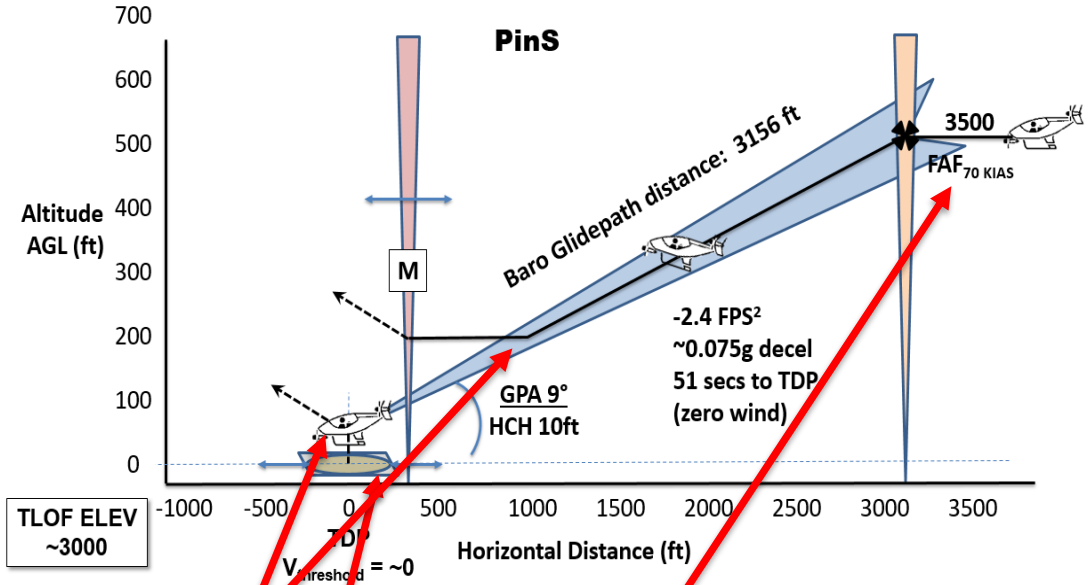




Instrument	Location	Elevation	Vertical Error (from Garmin)	Lateral Error (from Garmin)
Garmin Handheld Survey	(34 57 32.88 N, 117 52 54.07 W)	2274 ft.	Most Accurate	Most Accurate
Google Earth	(34 57 32.84 N, 117 52 54.20 W)	2276 ft.	+2 ft.	(-0.04 degrees, .+0.13 degrees) 11.55 ft. 249.50 True Bearing
TARGETS	(34 57 32.69 N, 117 52 53.29 W)	2241 ft.	-33 ft.	(-0.19 degrees, - 0.78 degrees) 67.71 ft. 106.48 degrees True Bearing
Surveillance Broadcast Services Monitor	(34 57 33.01 N, 117 52 53.97 W)	2280 ft.	+6 ft.	(+0.13 degrees, -0.10 degrees) 15.56 ft. 32.34 True Bearing
FIAPA	Pending Flight Data			

NC-1 Dry Run Approach



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HDR EDWARDS AFB              CAUSARAA      XSIAP UAM RNAV (GPS) (RNP 0.1)                                  ORIG      W        No Vol. Number
SUSAH CAARAAA   01H  0     NARY N36592635W121585688E016000118         1800018000P    050050M NASA ARMSTRONG, EDWARDS AFB       G
SUSAH CAARAACWAYP1 K20    W     N36531470W122023776                      E0136     NAR          WAYP1                        G
SUSAH CAARAACWAYP2 K20    W     N36580996W122065528                      E0137     NAR          WAYP2                        G
SUSAH CAARAACWAYP3 K20    W     N36554361W122044421                      E0136     NAR          WAYP3                        G
SUSAH CAARAACWAYP4 K20    W     N36572703W122014031                      E0136     NAR          WAYP4                        G
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SUSAH CAARAACWAYP6 K20    W     N37002862W121523103                      E0136     NAR          WAYP6                        G
SUSAH CAARAACWAYP6 K20    W     N37002865W121523111                      E0136     NAR          WAYP7                        G
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SUSAH CAARAAFR040  WAYP1 020WAYP32HC0EE B 010    TF                                  + 02900                      C PS     G
SUSAH CAARAAFR040  WAYP4 010WAYP52HC0E  A       IF                                          18000                C PS     G
SUSAH CAARAAFR040  WAYP4 020WAYP52HC0EE B 010    TF                                  + 02900                      C PS     G
SUSAH CAARAAFR040  R     010WAYP52HC0E  I       IF                                  + 02900      18000070        C-PS     G
SUSAH CAARAAFR040  R     020WAYP62HC0E  F 051   TF                                  + 02895           WAYP6 K2HCC   PS     G
SUSAH CAARAAFR040  R     030WAYP62HC0EY M 031   TF                                    02295           000          C PS     G
SUSAH CAARAAFR040  R     040         0  M      CA                          0010     + 02295                      C PS     G
SUSAH CAARAAFR040  R     050WAYP72HC0EY         TF                                  + 05100                      C PS     G
SUSAH CAARAAFR040  R     060WAYP72HC0EE  R      HM                          05670040 + 05100          070         C-PS     G
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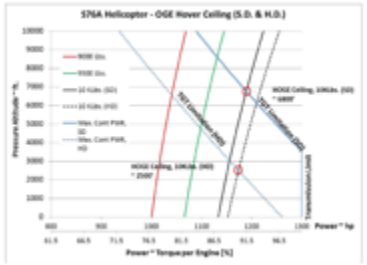
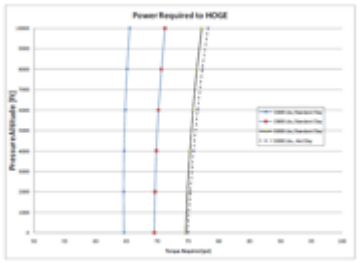
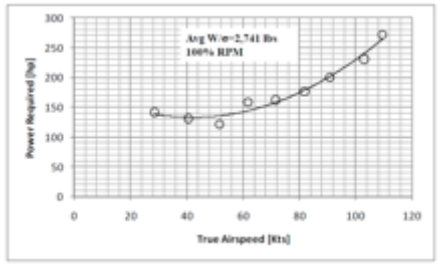
Performance requirements evolution



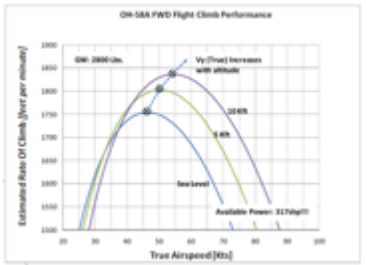
Hover Ceiling



IGE vs OGE



Level Flight



Climb Perf (V_Y)

Application of foundational tests/data to e/VTOL

- How do Power relationships in Helicopters compare to e/VTOL vehicles?
- Where do existing performance requirements for engines need to evolve for e/VTOL?
- How sensitive is e-power to atmospheric conditions?
- What is means (prior to takeoff) to determine propulsion system is capable of delivering the power required to achieve the published performance?
- How does “fuel” efficiency variation with airspeed/altitude/GW compare between helicopter and e/VTOL?
- What evolutions in Flight Test Techniques will be required for e/VTOL certification?
- How do automate dynamic rerouting between the pilot and operator of an airspace service provider?
- As UAM scales how will we mange spatial data integrity?

General Session Q&A

Davis Hackenberg, Colin Theodore, Starr Ginn

Logistics

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    - Use your mute/unmute button (e.g. remain on mute unless you are speaking)
    - Enter comments/questions in the chat
    - Click the "Raise your hand" button if you wish to speak
    - Say your name and affiliation before you begin speaking

National Aeronautics and Space Administration

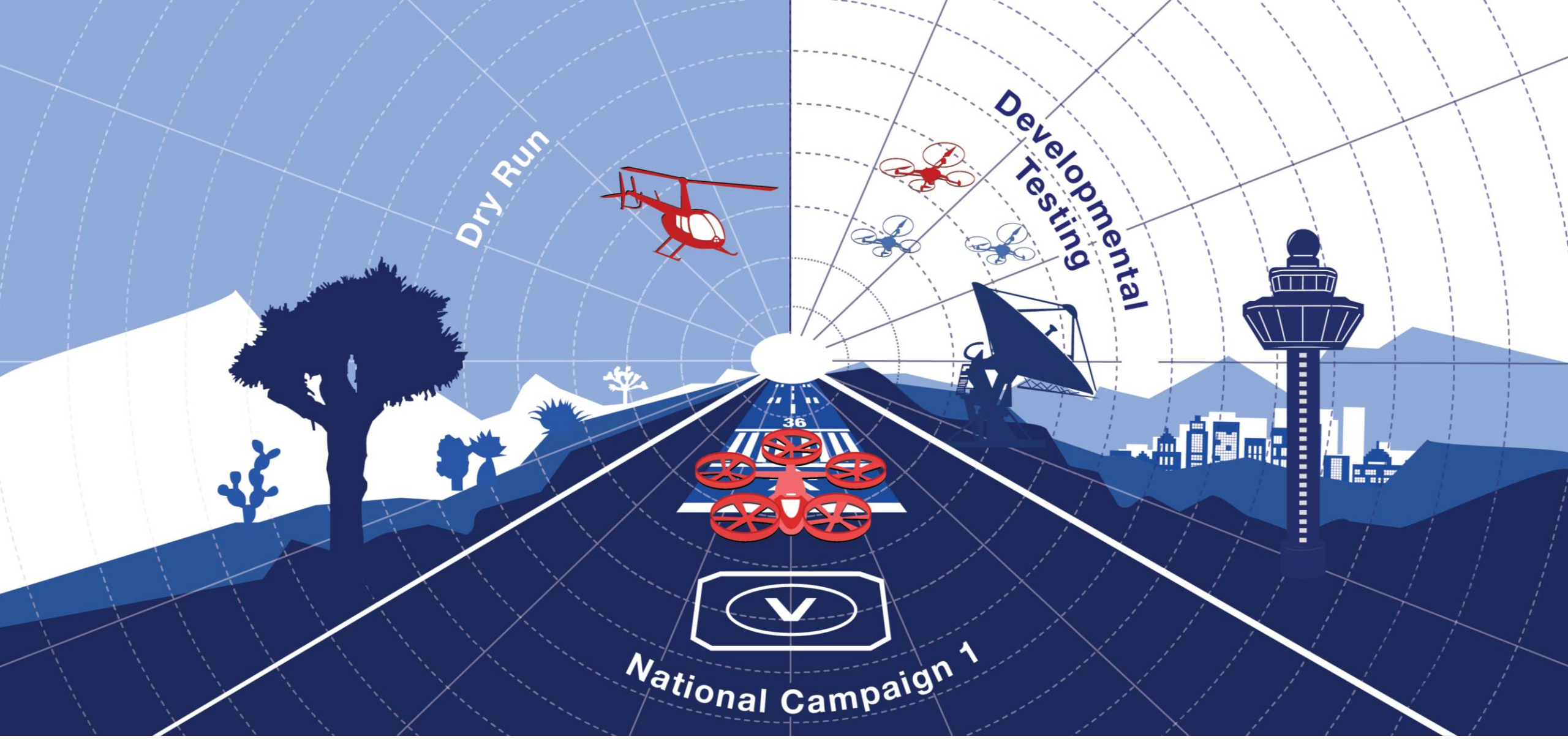
Breakout Sessions

(12:20PM – 1:00PM ET / 9:20AM – 10:00AM PT)

To access the individual breakout rooms, use the MS Teams meeting links in the agenda accessible here:
https://nari.arc.nasa.gov/cwg-agenda

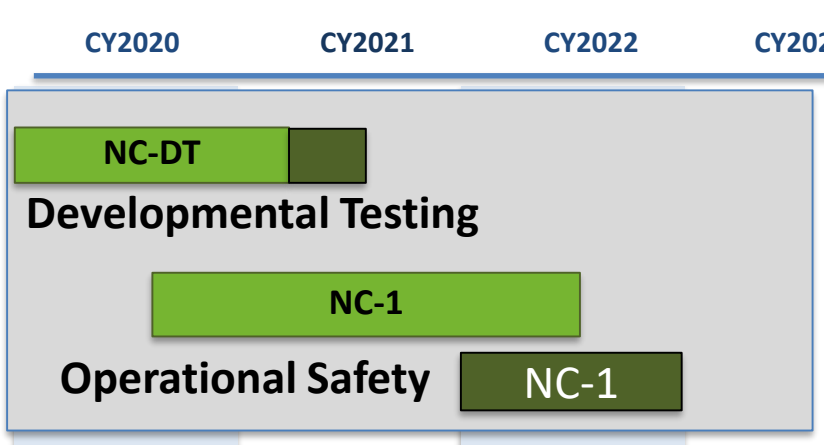
Breakout Session #1: NC-1 Overview, NC-1 Flight Annex, NC-2 Information Exchange

Starr Ginn



Breakout #1 NC-1 Flight Annex and NC-2 Information Exchange Annex
Starr Ginn National Campaign Lead

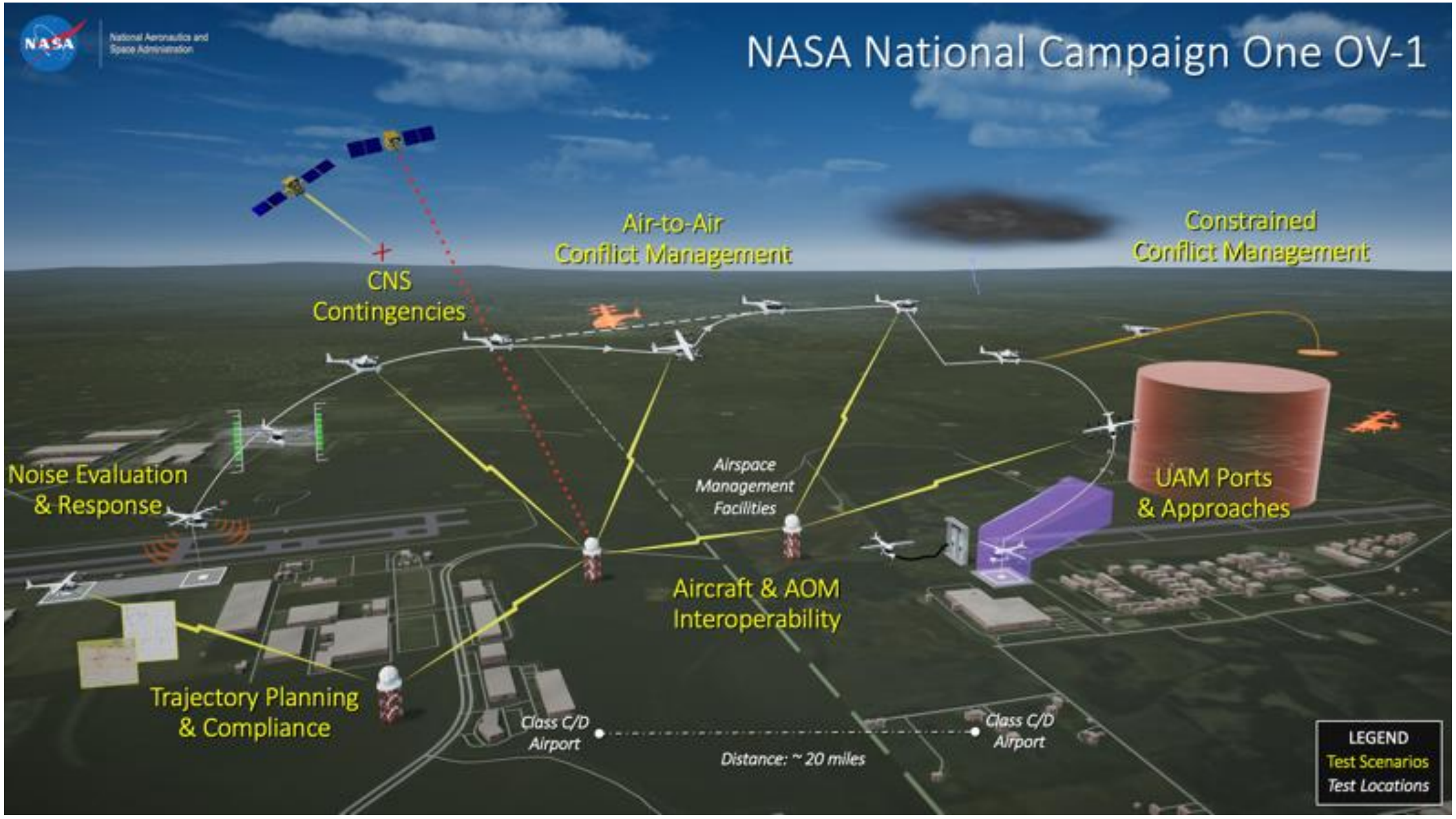
National Campaign Execution – NC-1



NC-1: UAM scenarios and contingencies **safely** flown in the **current NAS** with **current rules** while identifying gaps in FAA Standards

- Capture **operational performance data** relevant to AAM **terminal base operations**
- Assess **viability of candidate vertiport** designs and establish initial criteria
- Assess AAM aircraft/airspace **performing departure and arrival procedures, including contingencies**
- Demonstrate an **airspace operations management concept** with AAM vehicles
- Perform an initial characterization of the **noise footprint** of one AAM vehicle through ground noise measurements

NC-1 Operational View



NC-1 Flight Annex NASA Roles and Responsibilities

- Dedicate NASA management and systems engineering teams to develop and execute the NC-1 activity by coordinating with Partner vehicle and associated airspace service provider to execute NC-1 integrated scenarios.
- Provide a Flight Safety Review and sign-off for Partner vehicle/vehicles that will be flown manned/unmanned as part of the NC-1 activity using the process outlined in AFG-7900.3-001, AFOP-7900.3-022, and AFOP-7900.3-023.
- Integrate Partner-provided command and control or telemetry link and AAM airspace services within a flight test infrastructure to connect to the NASA communications system for communications and data recording.
- Provide Differential GPS (DGPS) payload package for the Partner to mount on their vehicle for onboard recording of aircraft high precision position during NC-1 flights. This system is not used for real-time data monitoring.
- Assist Partner and associated airspace services provider in developing Interconnection Security Agreement(s) in accordance with NIST 800-47.
- Collect Partner AAM vehicle data to include tracking and trajectory compliance, and vehicle robustness to contingencies of the Partner AAM vehicle, and other data such as pilot workload and vehicle emergency procedures during execution of the NC-1 scenarios.
- Collect acoustic measurements of the Partner AAM vehicle during execution of the NC-1 acoustics (and other) scenarios at the test range chosen by Partner for NC-1 flights..
- Publish a final report with the findings from NC-1 that covers the Partner activities and results.

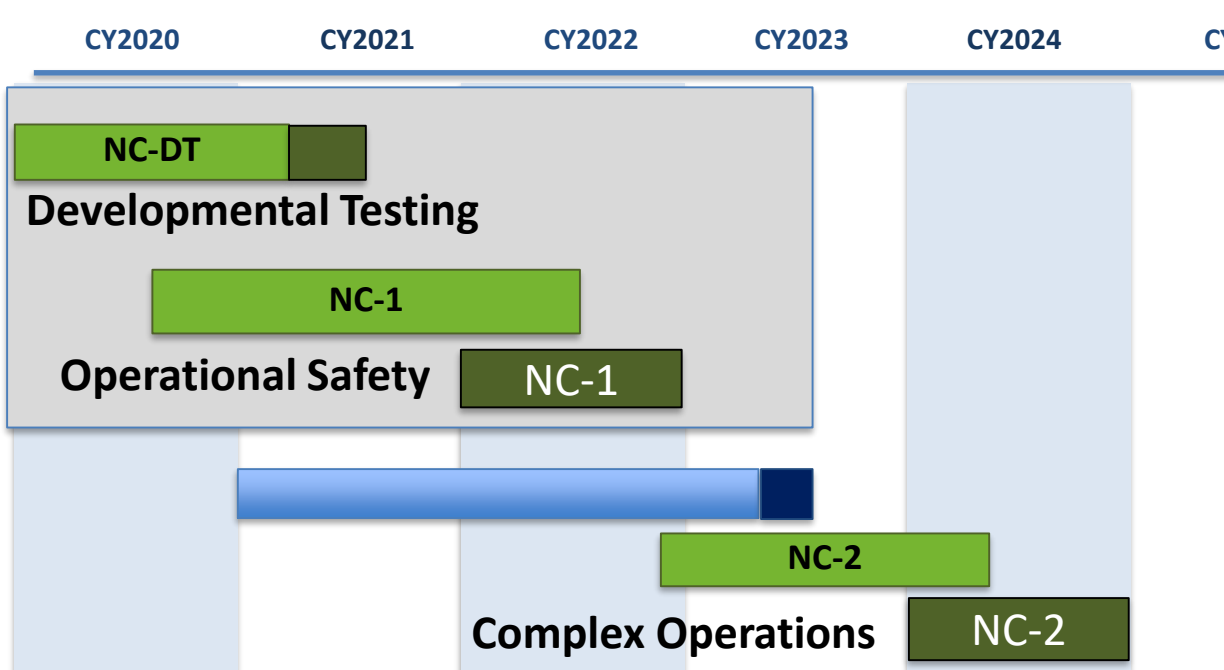
NC-1 Flight Annex Partner Roles and Responsibilities

- Provide documentation of intent to fly Partner vehicle(s) as part of the NC-1 activity, including: intended range or location for NC-1 flights, a schedule of anticipated NC-1 flights at the intended range or location, descriptions of the integrated scenarios that would be attempted, description of airspace services provider partner systems and capabilities, a list of additional partners and partner capabilities that will be leveraged in participating in NC-1, and any other information relevant to the Partner NC-1 flight activities.
- Provide vehicle design and analysis data to enable NASA to review range and ground safety for vehicles that will be flown unmanned, and additionally full airworthiness for vehicles that will be flown manned. Provide description of the proposed integrated vehicle and airspace operations that Partner intends to perform as part of the NC-1 flight activities to enable NASA to review intended flight operations and provide a flight clearance prior to NC-1 flights.
- Provide VHF/UHF radio to pilot in command for standard National Airspace System (NAS) operations.
- Provide C-Band Beacon for primary Range Safety Tracking.
- Provide vehicle with ADS-B Out for secondary source of Range Safety Tracking.
- Integrate NASA-provided DGPS payload package onboard Partner vehicle for recording of aircraft position during NC-1 flight operations, and de-integrate and return the package to NASA post flight activities.
- Comply with the NASA communications and any other interfaces that NASA defines for the NC-1 activity and provide real-time flight data during execution of NC-1 scenarios.
- Provide vehicle design and vehicle CAD models prior to flying NC-1 acoustics scenarios to help ensure that the acoustic measurement capabilities are best deployed for the particular Partner vehicle.
- Provide and fly a AAM vehicle or vehicles, along with associated AAM airspace services, to conduct safety and integration scenarios for the NC-1 activity in accordance with the NC-1 Scenarios document.
- Fly vehicle acoustics scenarios at the intended test range for NC-1, and measure and provide vehicle tracking and state data.
- Provide input to NASA covering Partner lesson learned, recommendations for future NC events, and details of flights conducted, and scenarios performed. This input will be used by NASA to write the report referenced in the NASA responsibilities section.

Schedule and Milestones

NASA to provide airworthiness, and range and ground safety process and requirements documents.	Within 1 month of signing Annex
NASA to provide communications interface documents and requirements to Partner.	Within 1 month of signing Annex
Partner and NASA to start vehicle airworthiness, and range and ground safety, review process.	Within 1 month of signing Annex
NASA to provide a liaison contact to help Partner through Airworthiness and Range Safety process, and in developing Interconnection Security Agreement.	Within 1 month of signing Annex
Partner to provide documentation of intent to participate in NC-1 flight activities, including a list of scenarios that will be flown, list of contributing partners (including airspace partner) and their capabilities, anticipated flight schedule, any other relevant information.	Within 1 month of signing Annex
Partner to provide vehicle envelope expansion flight data to demonstrate vehicle flight readiness.	3 months prior to flying in NC-1
Partner to provide vehicle design and CAD models to support noise measurements and noise data processing.	3 months prior to flying in NC-1
NASA to provide Differential GPS (DGPS) payload package for Partner to integration on their vehicle prior to flying in NC-1.	3 months prior to flying in NC-1
NASA and Partner to complete airworthiness, and range and ground safety, approvals for flight in NC-1.	1 month prior to flying in NC-1
Partner associated airspace service capabilities to demonstrate and document compliance with the NASA UAM Core Services API.	1 month prior to flying in NC-1
NASA to provide acoustics measurement capabilities at intended test range and collect acoustics measurements for Partner vehicle.	July 2022 – November 2022
Partner to fly integrated scenarios as part of NC-1 activities.	July 2022 – November 2022
NASA to deliver a final set of vehicle acoustics data to the Partner.	March 2023
Partner to provide input to NASA covering Partner lessons learned, recommendations for future NC events, and details of flights conducted and scenarios performed.	March 2023
NASA to provide final report with findings from NC-1 flight activities to demonstrate integrated vehicle/airspace scenarios.	March 2023

National Campaign Execution – NC-2

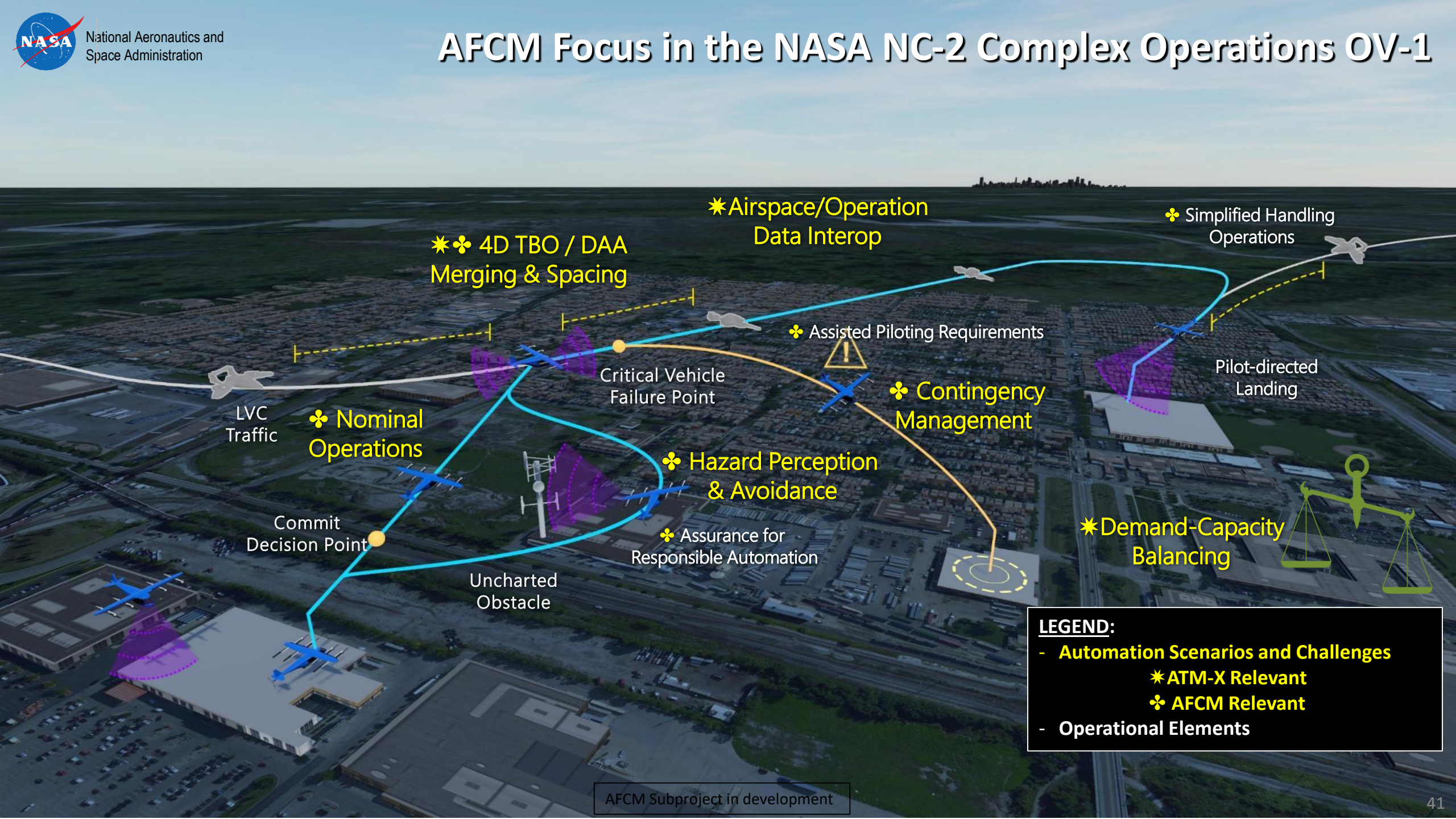


NC-2: NC-1 scenarios/contingencies with **automation for airspace and vehicle integration** to demonstrate dynamic rerouting

- **Assess** candidate **vehicle automation, flight, operational, and piloting requirements** for consideration in certification
- Assess refined **departure and arrival procedures** and **proposed right-of-way and off nominal procedures** with automated dynamic rerouting **exchange between vehicle and airspace service provider**
- Gain airspace **industry acceptance by standards** development organizations adopting NC-2 findings, software, and lessons learned

National Aeronautics and Space Administration

AFCM Focus in the NASA NC-2 Complex Operations OV-1



NC-2 Information Exchange Annex NASA Roles and Responsibilities

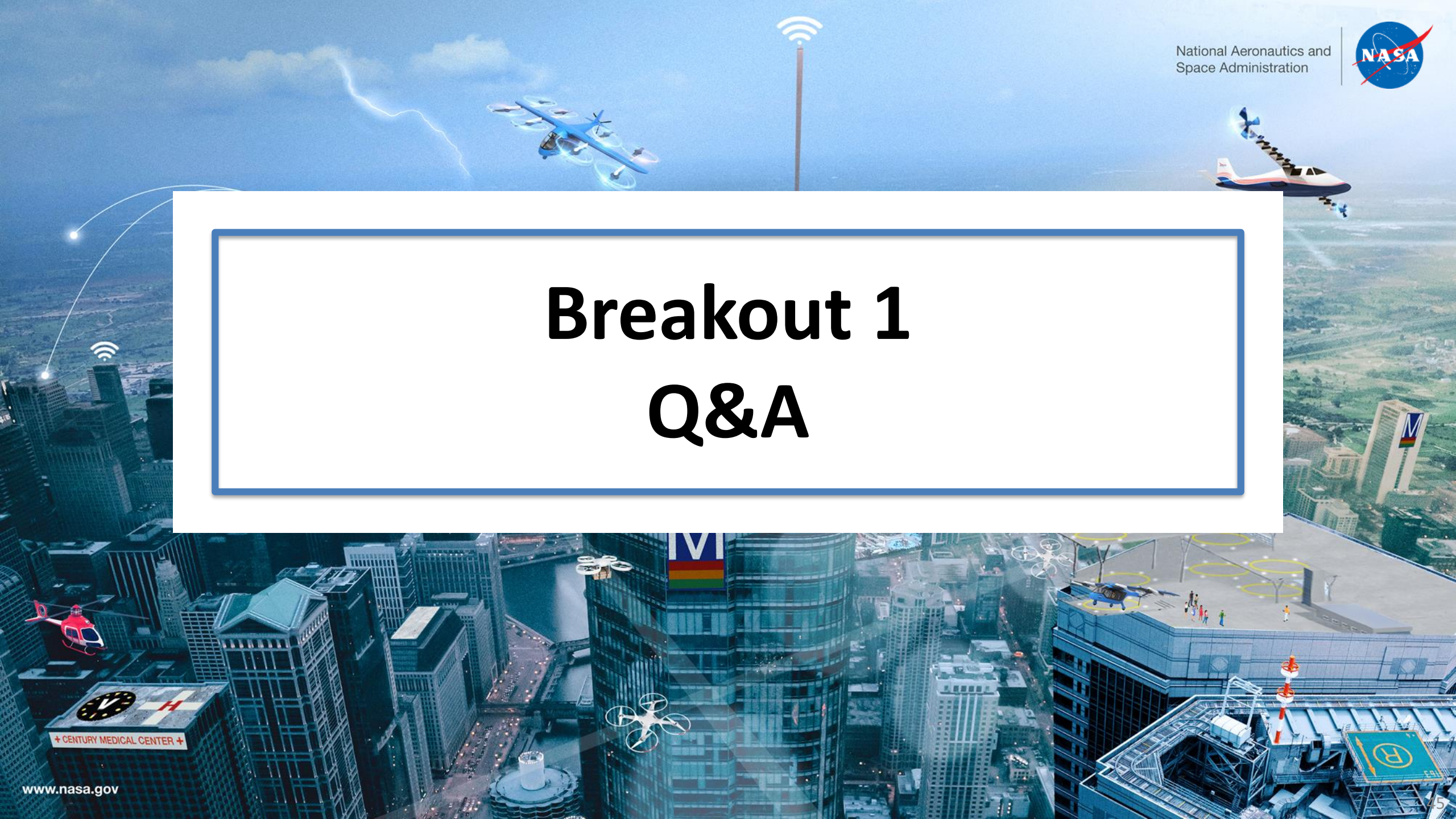
- Dedicate NASA management and systems engineering teams to develop plans for NC-2 by coordinating with Partner in information exchange in preparation for NC-2 flight and flight support operations.
- Provide an early flight readiness review board to evaluate Partner's capability maturity level in preparation for NC-2 flight operations, including at NASA's discretion, shadowing of Partner design, build and test reviews being conducted external to NASA to help accelerate progress towards NC-2.
- Provide an initial set of NC-2 external range requirements that are intended for Partner to follow when considering NC-2 flights at an external range/airport.
- Provide a set of NC scenarios that demonstrate key aspect of integrated vehicle, airspace and infrastructure needed for AAM operations.
- Conduct information exchange meetings with Partner to help introduce, explain and obtain feedback on NC-2 plans, procedures and goals, requirements for external ranges, and development of integrated AAM scenarios.

NC-2 Information Exchange Annex Partner Roles and Responsibilities

- Provide documentation for Partner plans to support flight operations of integrated scenarios as part of the NC-2 activity, including: details of the integrated scenarios that would be attempted, proposed range (NASA-sponsored or external range), a list of anticipated partners and partner capabilities that will be leveraged in participating in NC-2, any other information relevant to the Partner capability in NC-2. An initial set of NC scenarios is contained in the NC Scenarios document.
- Provide design and analysis data to initiate flight readiness review, and allow NASA to shadow any on-going Partner design, build, test activities that are being conducted external to NASA to help accelerate progress towards NC-2.
- Participate in information exchange meetings with NASA and provide feedback on NC-2 plans, procedures and goals, external range options and requirements, and integrated NC scenarios.

NC-2 Information Exchange Annex Schedule and Milestones

NASA to provide management and systems engineering teams to develop plans for NC-2	**Within 1 month of signing Annex**
NASA to provide an initial set of external range responsibilities and requirements.	Within 1 month of signing Annex
Partner and NASA to start design, build, test safety review process, and, at NASA's discretion, for NASA to shadow any vehicle design, build, test conducted by Partner outside of NASA.	Within 1 month of signing Annex
Partner to provide documentation of intent to support NC-2 flight operations, including a list of scenarios, any partners, range location, any other relevant information.	Within 1 month of signing Annex
Partner to participate in regular NASA-led information exchange meetings to provide feedback on NC-2 plans, processes and goals, range requirements, NC scenarios, etc.	Within 3 months of signing Annex



Breakout 1
Q&A

Thank you for joining the Crosscutting Working Group: AAM Partnership Strategy Session!

Send additional questions or comments to:

arc-cal-nari@mail.nasa.gov

Answers to questions received that are beneficial to the community may be posted publicly

View beta.SAM.gov on or around **January 31, 2021** for the ACO-2 and ACO-3 final announcement.

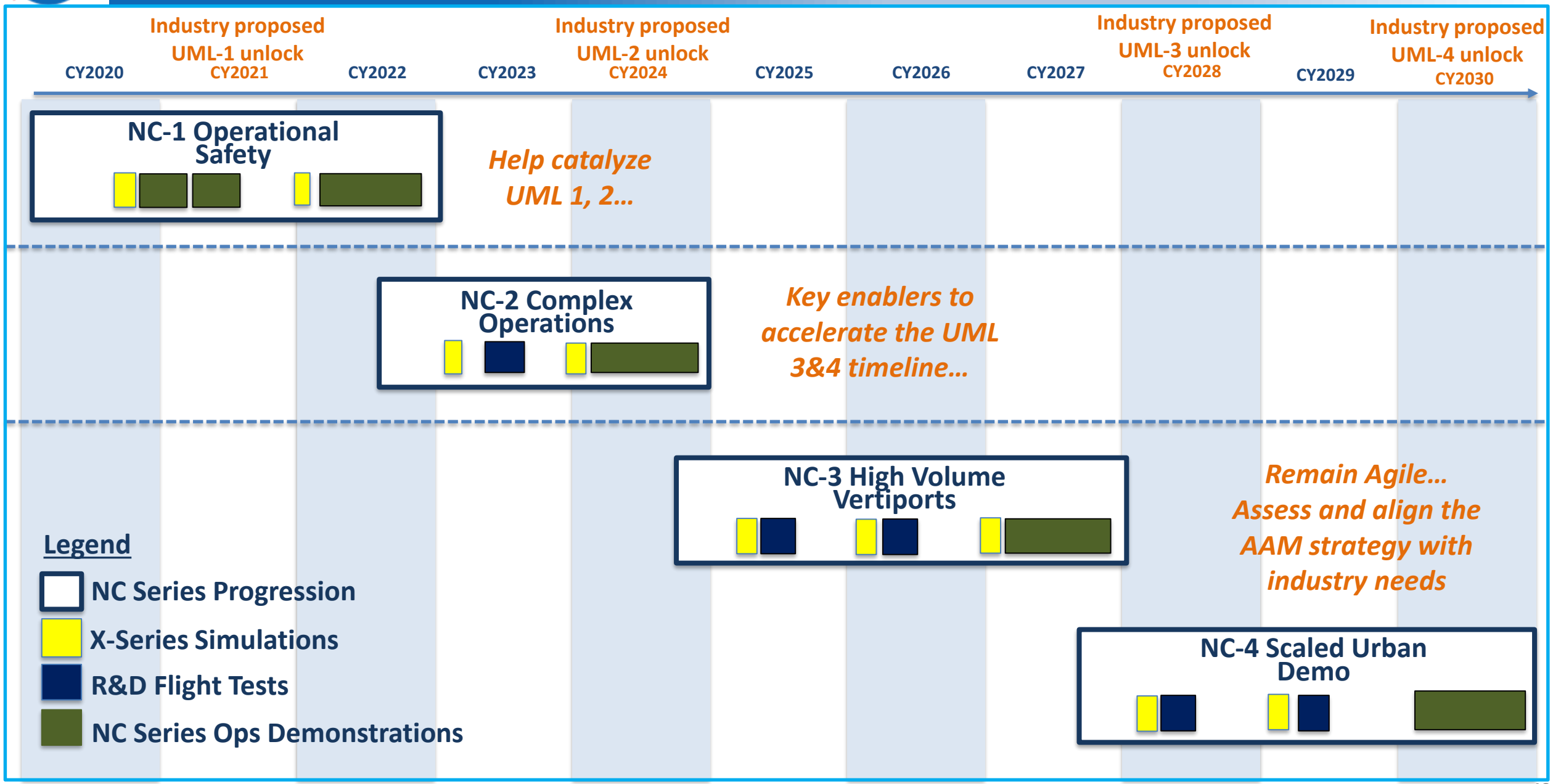
Breakout Session #2: NC-2 Overview, CNSI Annex, AFCM Annex

Ken Goodrich, Paul Nelson, Mary Stringer

Ken Goodrich

NC-2 OVERVIEW

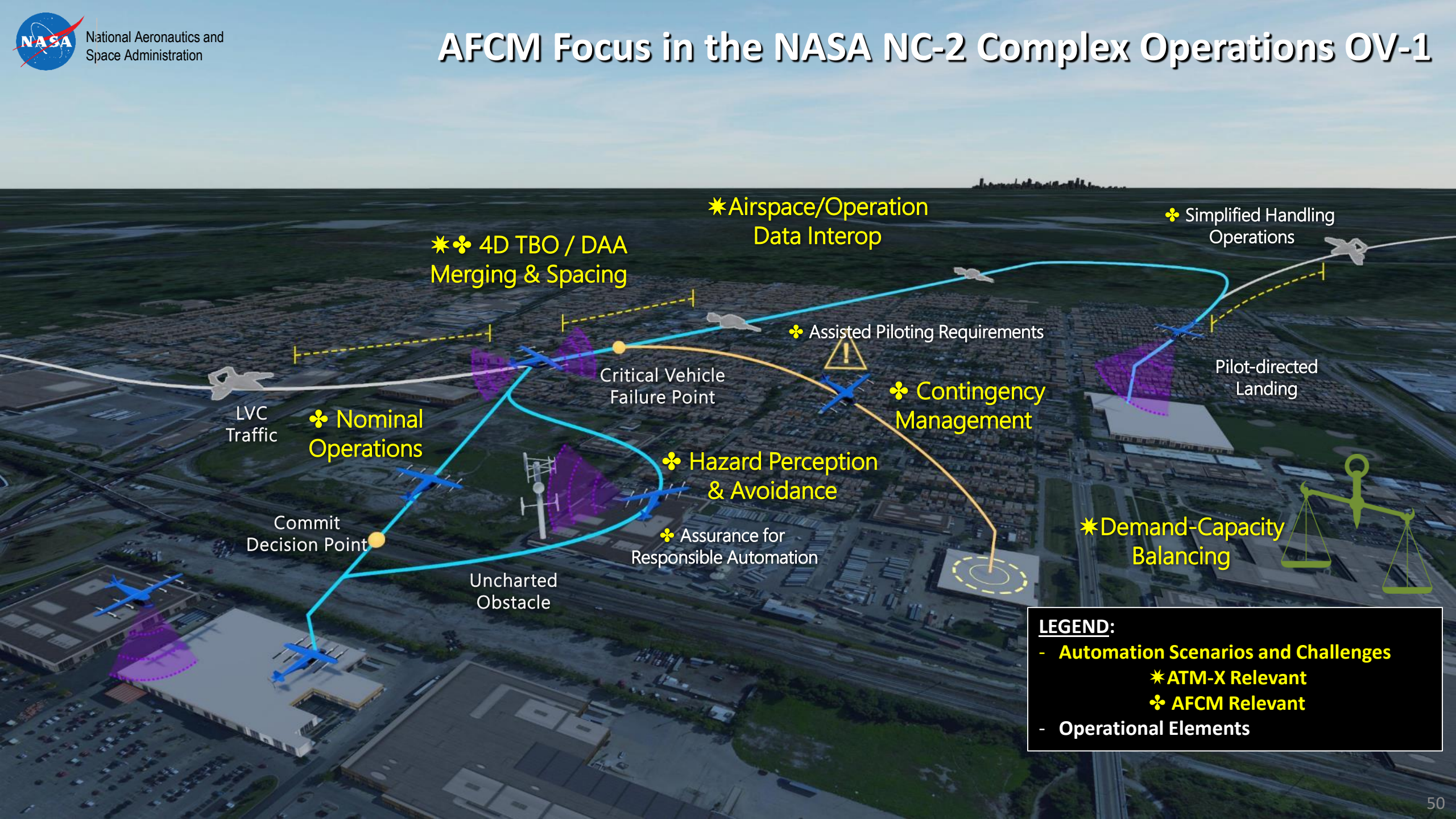
National Campaign Series support of the Industry Timeline



UML "unlocks" based on a range of publicly available industry projections and conversations with partners; not a consensus view

National Aeronautics and Space Administration

AFCM Focus in the NASA NC-2 Complex Operations OV-1



LEGEND:
- **Automation Scenarios and Challenges**
  - **✷ATM-X Relevant**
  - **✤ AFCM Relevant**
- **Operational Elements**

CNSI ANNEX

CNSI Annex Responsibilities

NASA will use reasonable efforts to:	Partner will use reasonable efforts to:
Provide access to an aircraft for flight test activities.	Provide NASA with information about the expected performance of each candidate technology for UAM operations and the viability of using each technology for nationwide UML-4 deployments.
Integrate all CNS candidate hardware onto the aircraft with assistance from Partner.	Lend CNS candidate technologies to NASA for flight test evaluations.
Provide Partner with guidance regarding the packaging, integration, and operation of all CNS candidate hardware to meet all applicable NASA flight safety standards.	Provide any necessary infrastructure that may be required to evaluate each candidate CNS technology.
Develop flight test plans jointly with Partner to ensure that each candidate CNS technology is evaluated in a manner in which it is designed to operate.	Provide guidance to NASA regarding the integration and configuration of each candidate CNS technology.
Operate the test aircraft in a manner that replicates UAM-like flight to the best of the test aircraft's ability.	Provide in-person assistance, if necessary, to NASA with the integration and configuration of each candidate CNS technology
Collect data on the performance of each candidate CNS technology.	Participate in the development of the evaluation plans and procedures for each candidate CNS technology.
Collect additional data deemed necessary for the proper evaluation of all CNS technologies, which may include, but is not limited to, aircraft position, attitude, atmospheric conditions, and cabin temperature.	Provide Subject Matter Experts for engineering reviews for all flight test events.
Evaluate industry provided architectures and provide analysis and feedback on system feasibility and scalability	Provide scalable CNS architecture recommendations for use in UML-4 and beyond
Work with partners to evaluate relations and needs for participation in the NC Flight Test Infrastructure	Provide information on NC Flight Test participation planning, desired partnerships and support needs

CNSI Annex Schedule and Milestones

Milestone	Schedule
Partner to brief NASA on the candidate CNS technology, including expected performance for UAM and viability as a UML-4 service	Within 1 month of signing Annex
NASA to brief Partner on all NASA flight safety rules and procedures that may impact the integration and operation of the candidate CNS technology	Within 4 months of signing Annex
NASA and Partner reach agreement on CNS technology configuration, integration, operation, performance metrics, and flight test plans	Q4FY21
Partner to deliver to NASA all hardware required to integrate and operate CNS technology candidates	Q4FY21
NASA, with support and possibly in-person assistance from Partner, to complete the integration of CNS technology candidates onto the test aircraft	Q1FY22
NASA window to perform all test flights	Q3FY22-Q4FY22
NASA to deliver final evaluation, including post-flight data analysis	Q4FY22

Mary Stringer

AFCM ANNEX

Tier Two: AFCM Annex Responsibilities

NASA will use reasonable efforts to:	Partner will use reasonable efforts to:
Collaborate with partner on identification of key barriers for path to certification of simplified handling interfaces and automation systems for UAM maturity transition to UML-4	Deliver detailed CONOPS, UAM ecosystem interface vision and hazard analysis
Collaborate with partner in developing automation testing requirements formulation, testing approach, and data analysis approaches for simulation and flight testing as it relates to NASA developed reference architectures and similar partner technologies of interest	Deliver technical status on critical technologies' development and maturity
Collaborate with partner on identification of reduced piloting requirements for simplified vehicle operations for UML-1 through 4.	Deliver (if relevant) simplified handling control inceptors and displays to NASA
Collaborate with partner on identification of methods of compliance, assurance methods and testing approaches to inform and accelerate regulatory changes required to enable transition to UML-4	Deliver relevant automation algorithms to NASA for review
Host modeling and simulation comparison events studying relevant technical areas	Deliver (if relevant) performance models for sensors and vehicles to NASA
Share relevant test data, results and analysis with partner	Assist in testing requirements formulation, testing approach definition, and data analysis for simulation and flight testing of all provided systems to support development of design guidelines and minimum performance requirements definitions.
Incorporate results and lessons into NASA and FAA CONOPS	Provide information and input on upcoming internal high-fidelity simulation and flight test activities specifically as they pertain to automated systems, and operational demonstrations
Provide recommendations to strategic standards bodies and FAA with a goal of accelerating regulatory processes	Deliver assurance method formulations and software suites for design-time and run-time assurance research for relevant automation-use case systems

Tier Two: AFCM Annex Schedule and Milestones

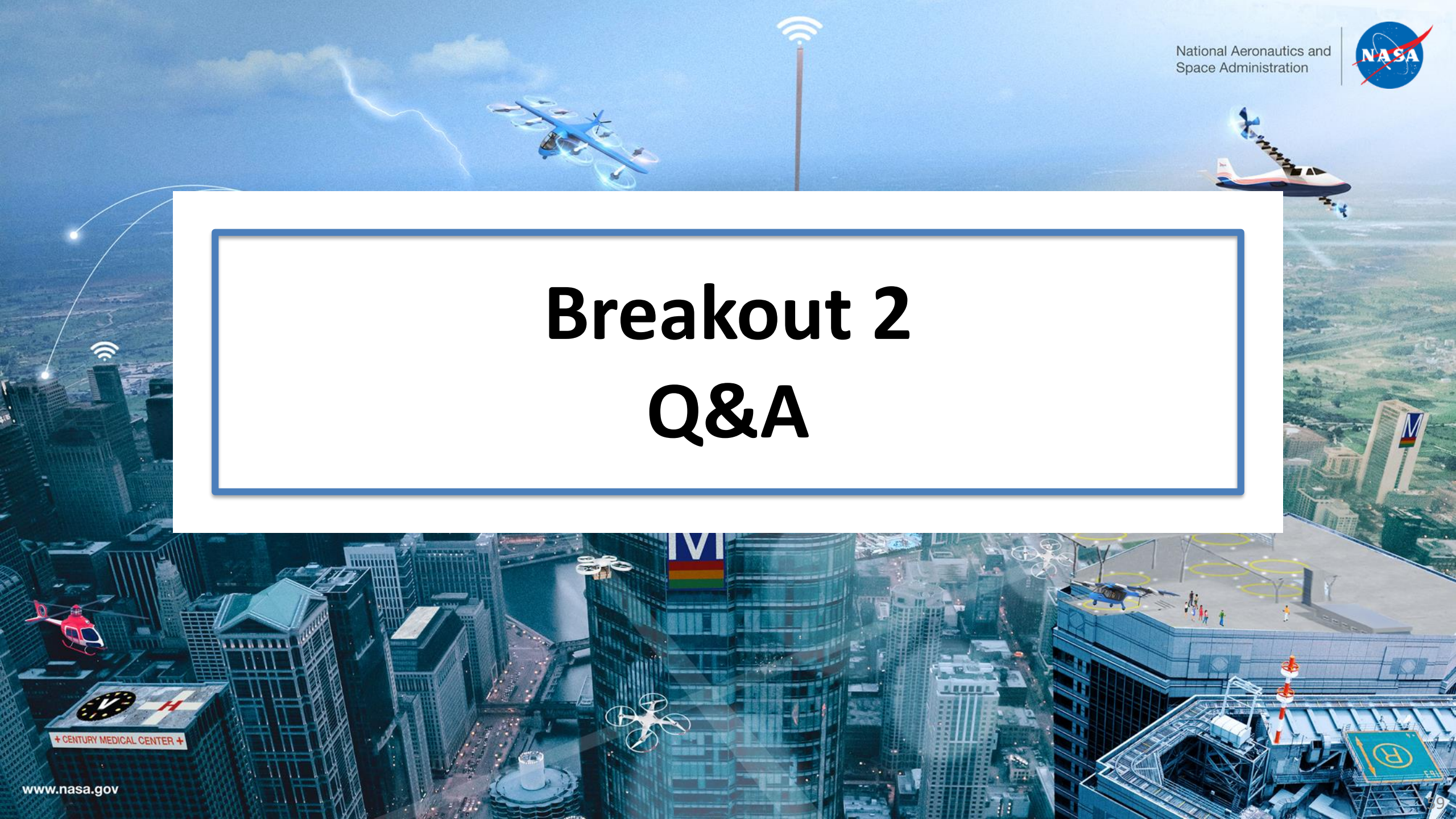
Milestones/Deliverables	Description	Schedule
Partner CONOPS/Interfaces/Vision	Detailed CONOPS description, use cases, ecosystem interface vision, and evaluation of key barriers for industry.	3 months after execution of Annex
Partner Software Models, System Technology, or Hardware (as appropriate)	Simulation models (auto-navigation and autopilot subsystems, vehicle dynamics, flight management systems, DAA algorithms, sensor fusion, contingency management response, Human Machine Interfaces and displays, etc) and development strategy and maturity for review by NASA.	3 months after execution of Annex
Partner System Architectures	MBSE based architectures for use in NASA automation architecture and requirements development.	3 months after execution of Annex
Joint NASA-Partner Paper on Pilot-Automation Roles and Responsibilities	White paper on Pilot/Automation roles and responsibilities enabling transition to UML-4 (Audience: ACO partners, Automation WG, GAMA, ASTM F44)	12 months after execution of Annex
Joint NASA-Partner Paper on Simplified Handling and Operations	Preliminary SHO Development Roadmap (Audience: ACO partners, Automation WG, GAMA, ASTM F44)	12 months after execution of Annex
Joint NASA-Partner Paper on Flight Path Management Automation	Flight Path Management Automation System Concept Review -Concept and roadmap review of AOP for UAM community. (Audience: ACO partners, Automation WG, GAMA)	12 months after execution of Annex
Joint NASA-Partner Paper on Assurance	Preliminary assessment of assurance requirements and strategies for “responsible”, highly-augmented flight controls (Audience: ACO partners, Automation WG, GAMA, ASTM F44)	18 months after execution of Annex
Joint NASA-Partner Experiment Reviews	Participation in modeling and simulation comparison events and documented lessons learned.	10 months after execution (first), 22 months after execution (second) of Annex

Tier One: AFCM Annex Responsibilities

NASA will use reasonable efforts to:	Partner will use reasonable efforts to:
Collaborate with partner on identification of key barriers for path to certification of simplified handling interfaces and automation systems for UAM maturity transition to UML-4	Deliver detailed CONOPS, UAM ecosystem interface vision and hazard analysis
Collaborate with partner in developing automation testing requirements formulation, testing approach, and data analysis for simulation and flight testing of all provided systems	Deliver technical status on critical technologies' development and maturity
Collaborate with partner on identification of reduced piloting requirements for simplified vehicle operations for UML-1 through 4.	Deliver (if relevant) simplified handling control inceptors and displays to NASA
Collaborate with partner on identification of methods of compliance, assurance methods and testing approaches to inform and accelerate regulatory changes required to enable transition to UML-4	Deliver relevant automation algorithms to NASA for review
Host modeling and simulation comparison events studying relevant technical areas	Deliver (if relevant) performance models for sensors and vehicles to NASA
Host engineering reviews for all simulation events and take inputs from partner on technical objectives	Deliver relevant avionics hardware for flight testing on IAS-1 vehicle(s) and provide technical support as needed for system integration
Incorporate partner provided algorithms, performance models for sensors and vehicles into testing plan	Assist in testing requirements formulation, testing approach definition, and data analysis for simulation and flight testing of all provided systems
Collaborate on data analysis and evaluation with partner	Send appropriate SMEs to engineering reviews for all simulation events
Share results with strategic standards bodies and FAA with a goal of accelerating regulatory processes	Provide information and input on upcoming internal high-fidelity simulation and flight test activities specifically as they pertain to automated systems, and operational demonstrations
Provide information on upcoming National Campaign flight test opportunities for automated systems, and operational demonstrations	Deliver assurance method formulations and software suites for design-time and run-time assurance research for relevant automation systems

Tier One: AFCM Annex Schedule and Milestones

Milestones/Deliverables	Description	Schedule
Partner CONOPS/Interfaces/Vision	Detailed CONOPS description, use cases, ecosystem interface vision, and evaluation of key barriers for industry.	3 months after execution of Annex
Partner Software Models, System Technology, or Hardware (as appropriate)	Simulation models (auto-navigation and autopilot subsystems, vehicle dynamics, flight management systems, DAA algorithms, sensor fusion, contingency management response, Human Machine Interfaces and displays, etc) and development strategy and maturity for review by NASA.	3 months after execution of Annex
Partner System Architectures	MBSE based architectures for use in NASA automation architecture and requirements development.	3 months after execution of Annex
Joint NASA-Partner Paper on Pilot-Automation Roles and Responsibilities	White paper on Pilot/Automation roles and responsibilities enabling transition to UML-4 (Audience: ACO partners, Automation WG, GAMA, ASTM F44)	12 months after execution of Annex
Joint NASA-Partner Paper on Simplified Handling and Operations	Preliminary SHO Development Roadmap (Audience: ACO partners, Automation WG, GAMA, ASTM F44)	12 months after execution of Annex
Joint NASA-Partner Paper on Flight Path Management Automation	Flight Path Management Automation System Concept Review -Concept and roadmap review of AOP for UAM community. (Audience: ACO partners, Automation WG, GAMA)	12 months after execution of Annex
Joint NASA-Partner Paper on Assurance	Preliminary assessment of assurance requirements and strategies for “responsible”, highly-augmented flight controls (Audience: ACO partners, Automation WG, GAMA, ASTM F44)	18 months after execution of Annex
Joint NASA-Partner Experiment Reviews	Participation in modeling and simulation comparison events and documented lessons learned.	10 months after execution (first), 22 months after execution (second) of Annex
Joint NASA-Partner Technology Integration	Joint effort to incorporate partner provided system technologies into NASA reference framework and testing plan. Execute test plan, analyze and ensure results are represented to RTCA, GAMA and ASTM.	Within 48 months of execution of Annex



Breakout 2
Q&A

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arc-cal-nari@mail.nasa.gov

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Breakout Session #3: Infrastructure Annex, NC-1 Airspace Annex

Shivanjli Sharma, Kevin Witzberger

Shivanjli Sharma

INFRASTRUCTURE ANNEX

Engaging with Infrastructure Providers for the NC

The NC will be soliciting proposals from industry to provide infrastructure and services to support the NC-1 flight activities at test range(s) selected by the NC-1 vehicle partners.

The infrastructure needed to support safe and robust operating environments can range from:

- Infrastructure associated with the vertiports and heliport surface operations
- Sensors and automation needed for takeoff and landings
- Electrical charging and electrical grid interface and capacity capabilities
- Communication uplinks and downlinks for data communications from the vehicle to third party airspace service providers/operators/Air Traffic Control (ATC)
- Navigation capabilities, as well as ground and/or air-based surveillance capabilities to monitor location, air traffic, non-cooperative traffic, hazards, and terrain
- Supplemental data service providers for third party airspace service providers
- Supplemental data services for integration with local government authorities
- Etc.

The infrastructure providers include technologies, both hardware and/or software, such as sensors and algorithms that bridge communication and situational awareness between vehicles, airspace provides, operators, and UAM ports to provide communication and data sharing in a secure fashion to enable high density operations.

Infrastructure Annex Responsibilities

NASA will use reasonable efforts to:	Partner will use reasonable efforts to:
Dedicate NASA management and systems engineering teams to develop and execute the NC-1 activity by coordinating with Partner infrastructure provider and any associated hardware/software system capabilities to support execution of NC-1 integrated scenarios.	Provide an infrastructure system (or system components) that can be demonstrated as part of NC-1 flight demonstrations.
Provide a liaison to facilitate participant system connection to the NC Flight Test Infrastructure (FTI) system, including development of an Interconnection Security Agreement in accordance with NIST 800-47.	Provide design documents specifying infrastructure system capabilities, input requirements, and intended final use.
Define and provide the NC FTI system architecture to support the connection of the Partner infrastructure service, hardware, and/or software and data collection.	Provide an infrastructure system concept of operations, assumptions and system design.
Provide a NC FTI system interface and method for Partner to check connection and data formats with the NASA NC FTI system.	Provide documentation of intent participate in NC-1 flight activities, including: ability to deploy to a test range, a schedule of anticipated NC-1 integration activities at a test range, descriptions of the NC-1 scenarios that would be supported and serviced provided, a list of partners and partner capabilities that will be leveraged in participating in NC-1, and any other information relevant to the Partner participation in NC-1.
Provide a NASA Liaison to help the Partner through any NASA Airworthiness and/or Flight Safety Review processes that are needed to participate in NC-1 flight activities.	Interface with the NC FTI system through NASA defined interfaces or protocols.
Integrate Partner-provided infrastructure systems within the NC FTI system. Specific details of the FTI interface requirements will be provided to the Partner after signing Annex.	Provide an existing company System Security Plan to be reviewed by NASA for content required for the Interconnection Security Agreement.
Provide guidance documentation on NC-1 data gathering and data collection requirements.	Share Partner-recorded data to verify system functionality.
Collect Partner infrastructure data during execution of the NC-1 scenarios. This includes information provided as part of the infrastructure service as well as data regarding the quality, robustness, and security of the provided service.	Comply with the NASA communications and any other interfaces that NASA defines for the NC-1 activity and provide real-time data during execution of NC-1 scenarios.
Publish a final report with the findings from NC-1 that covers the Partner activities and results.	Provide necessary data to evaluate system capabilities including information such as response times and message latency information.
	Provide input to NASA covering Partner lesson learned, details of flights supported and services provided, scenarios supported, and recommendations for future NC events. This input will be used by NASA to write the report referenced in the NASA responsibilities section.

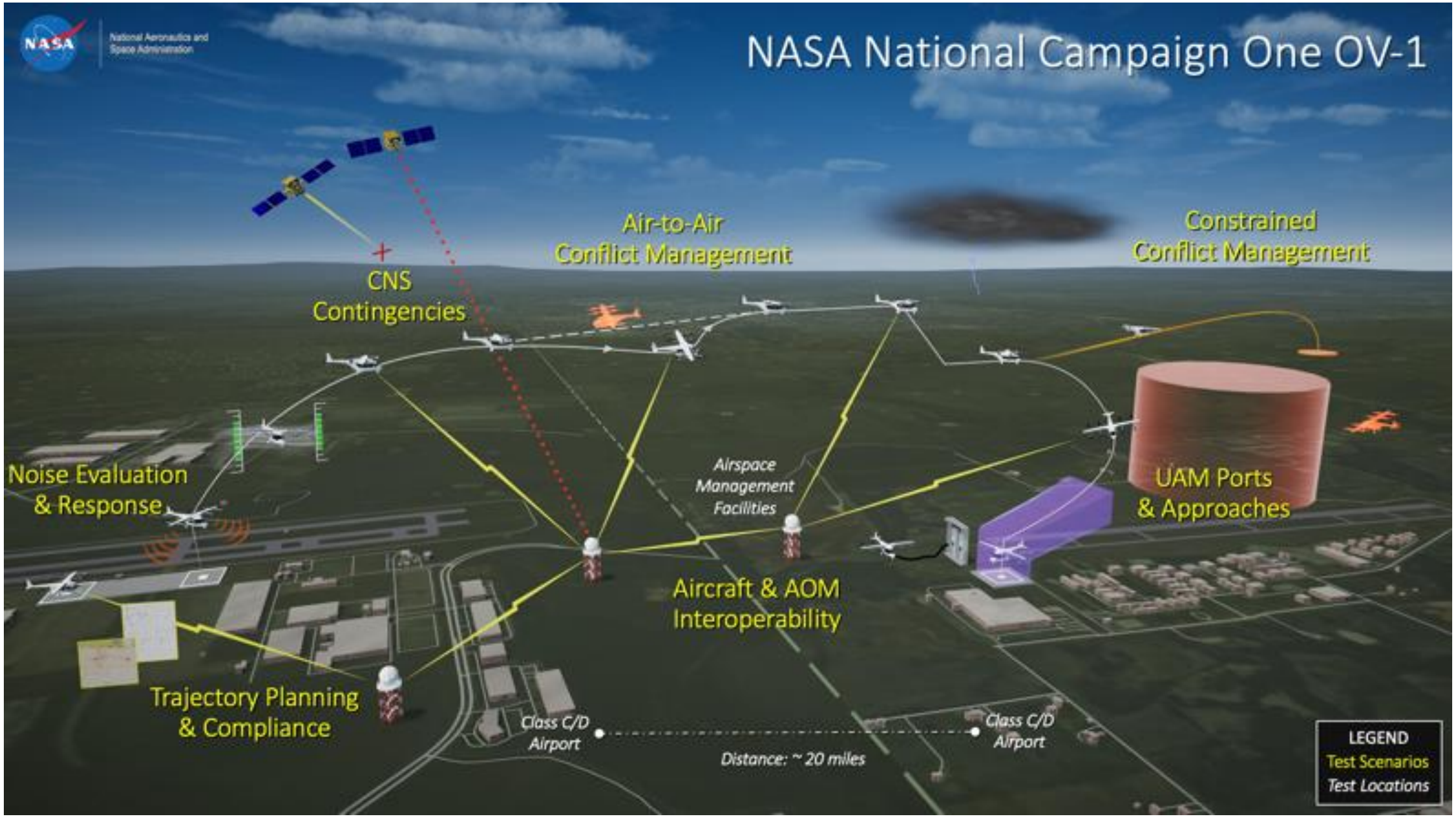
Infrastructure Annex Milestones and Schedule

Milestone	Schedule
NASA to provide NC Flight Test Infrastructure system documentation and interface details.	Within 1 month of signing Annex
NASA to provide a liaison contact to help Partner in developing Interconnection Security Agreement.	Within 1 month of signing Annex
Partner to provide documentation of intent to participate in NC-1 flight activities, including initial infrastructure system design, intended use details, list of scenarios that will be flown, list of contributing partners and their capabilities, anticipated testing and integration schedule, any other relevant information.	Within 1 month of signing Annex
Partner to provide existing System Security Plan – System Security Plan covering Partner test network, to be reviewed by NASA for content required for Interconnection Security Agreement	Within 1 month of signing Annex
Partner to provide hardware and/or software system functional description of infrastructure system or service – Document describing the functionality of the hardware/software components to be used for NC-1 flight demonstrations	Within 3 months of signing Annex
NASA to provide Data Recording Documents, and any other needed documents, that define NASA and Partner data collection during NC-1 flight demonstrations.	3 months prior to flying in NC-1
NASA and Partner to complete airworthiness, and range and ground safety, approvals for flight in NC-1.	1 month prior to flying in NC-1
Partner to demonstrate and document compliance with NC FTI system interface.	1 month prior to flying in NC-1
Partner to support NC-1 flight activities at an external range.	July 2022 – November 2022
Partner to provide input to NASA covering Partner lessons learned, details of fight activities and scenarios supported, and recommendations for future NC events.	March 2023
NASA to provide final report with findings from NC-1 flight activities to demonstrate integrated vehicle/airspace scenarios.	March 2023

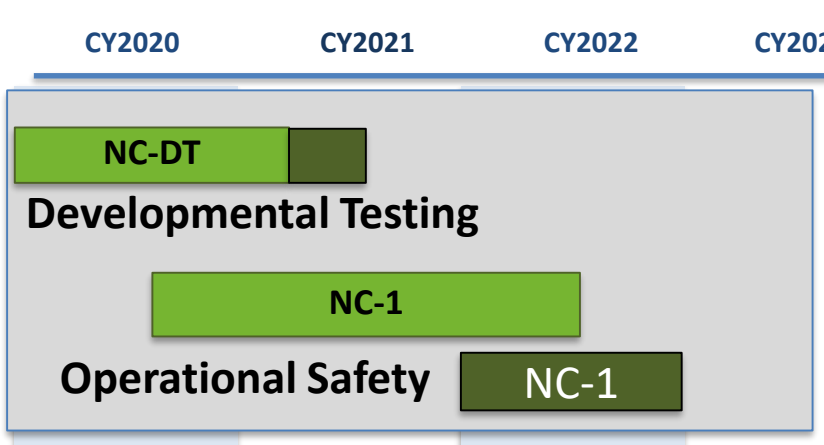
Kevin Witzberger

NC-1 AIRSPACE ANNEX

NC-1 Operational View



National Campaign Execution – NC-1



NC-1: UAM scenarios and contingencies **safely** flown in the **current NAS** with **current rules** while identifying gaps in FAA Standards

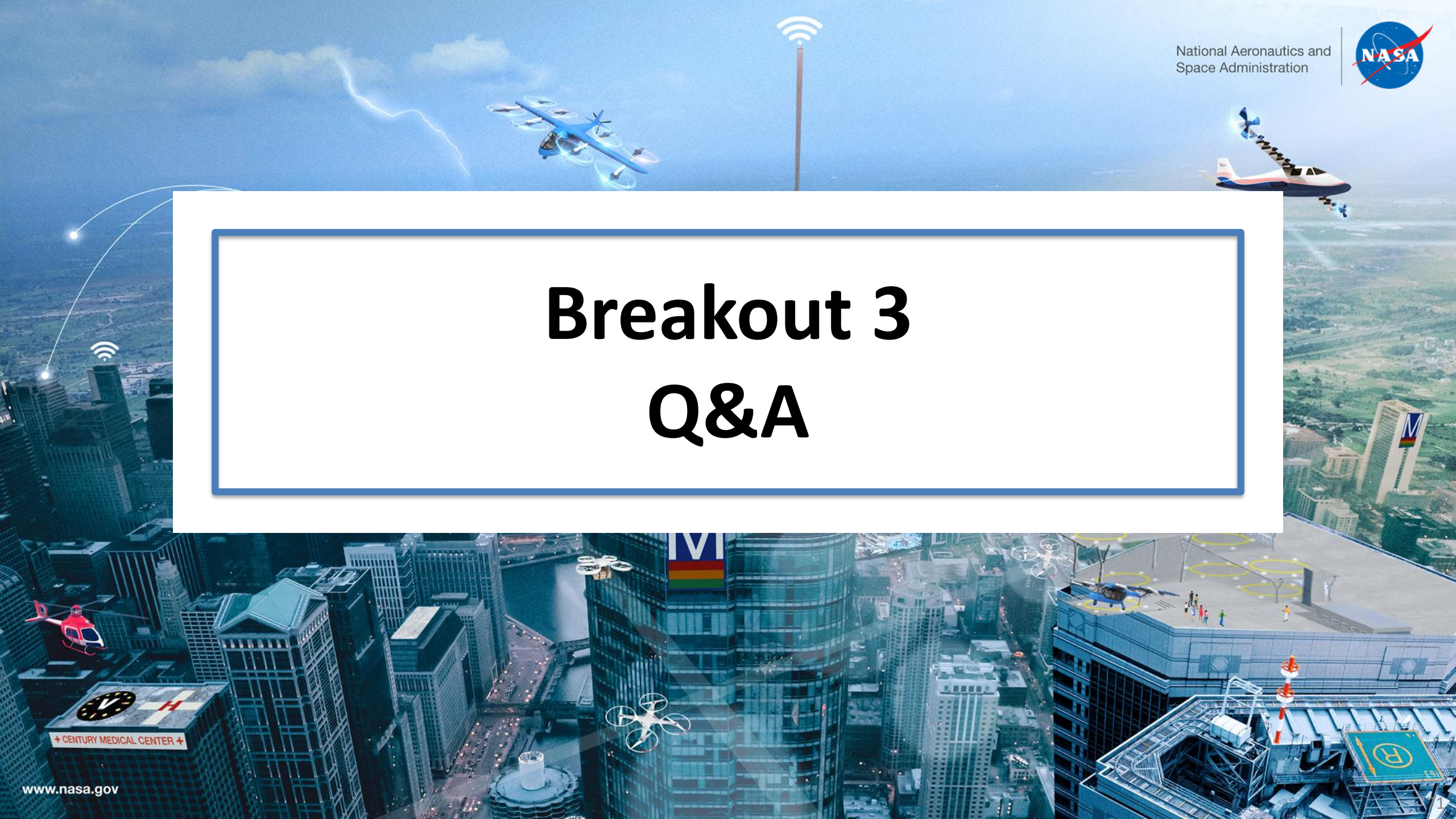
- Capture **operational performance data** relevant to AAM **terminal base operations**
- Assess **viability of candidate vertiport** designs and establish initial criteria
- Assess AAM aircraft/airspace **performing departure and arrival procedures, including contingencies**
- Demonstrate an **airspace operations management concept** with AAM vehicles
- Perform an initial characterization of the **noise footprint** of one AAM vehicle through ground noise measurements

NC-1 Airspace Annex Responsibilities

NASA will use reasonable efforts to:	Partner will use reasonable efforts to:
Dedicate NASA management and systems engineering teams to develop and execute the NC-1 airspace simulation activity by coordinating with NC-1 Partner airspace services to demonstrate NC-1 integrated scenarios in a relevant airspace simulation environment	Provide an airspace operations management system (or system components) that can be demonstrated in simulation for the NC-1 X4 simulation activity.
Provide an Airspace liaison to facilitate participant system connection to the NASA Urban Air Mobility (UAM) Core Services, including development of an Interconnection Security Agreement.	Provide initial design documents specifying airspace management capabilities, input requirements, and intended final use.
Define and provide the NC Testbed, a Federated Airspace Management system architecture to support the connection of the Partner airspace system and data collection	Provide an airspace concept of operations, assumptions and system design.
Provide a NASA UAM Core Services API and interface acceptance tools for Partner to check connection and data formats with NASA AAM airspace simulation.	Provide virtual aircraft target generation with the following capabilities: • Ability to dynamically re-route around constraints as well as accept a specific re-route from the regulatory authority similar to UTM, X3, or other activities. • Ability to handle contingencies (as outlined in NC-1 scenarios) dynamically and not scripted. • Ability to strategically de-conflict scheduled operations similar to UTM, X3, or other similar activities. • Ability to generate up to vehicle traffic consistent with 100s of simultaneous operations with their target generators and also conform to those trajectories.
Provide access to NASA UAM Core Services and test matrix for connectivity testing of Partner airspace services.	Provide an existing company System Security Plan to be reviewed by NASA for content required for the Interconnection Security Agreement.
Provide guidance documentation on NC-1 data gathering and data collection requirements. Guidance will include Data Recording Documents, and any other needed documents, that define Partner and NASA data collection during NC-1 airspace X4 simulation activities.	Obtain a signed Interconnection Security Agreement with NASA.
Provide an experiment plan that exercises the integrated X4 simulation scenarios defined in the NC-1 Scenarios document.	Share Partner-recorded data to verify system functionality.
Execute NC-1 X4 airspace simulation activities with Partner airspace technologies and services and collect data in accordance with the Data Recording Documentation.	Demonstrate data transfer to and from NASA UAM Core Services interface vehicle flight data (virtual) and/or external services (surveillance, weather, etc.).
Publish a final report with the findings from NC-1 that covers the Partner activities and results.	Complete NASA-provided experiment plan that exercises the integrated NC scenarios defined in the NC-1 Scenarios document.
	Provide necessary data to evaluate system response times and message latency information.

NC-1 Airspace Annex Milestones and Schedule

Milestone	Schedule
NASA to provide NASA UAM Core Services API and documentation of connection services (based on NASA UTM TCL4 https://utm.arc.nasa.gov/index.shtml)	Within 1 month of signing Annex
NASA to provide an Airspace liaison to facility Partner connection to NC Testbed and development of an Interconnection Security Agreement	Within 1 month of signing Annex
Partner to provide Airspace system ConOps and design, including documentation describing airspace services, required data sources and integration plans	Within 1 month of signing Annex
Partner to provide existing System Security Plan – System Security Plan covering Partner test network, to be reviewed by NASA for content required for Interconnection Security Agreement	Within 1 month of signing Annex
NASA to provide X4 Simulation System Design – System design based on NASA UAM research system, including updated NASA UAM Core Services API	2 months after signing Annex
Partner to provide Airspace software system functional description – Document describing the functionality of the Airspace software components to be used for the NC-1 simulation system	3 months after signing Annex
NASA to provide a X4 Simulation Test Plan – Test matrix based on UAM Concepts and NC-1 simulation system design	3 months prior to simulation
NASA to provide Data Recording Documents, and any other needed documents, that define NASA and Partner data collection during NC-1	3 months prior to simulation
NASA to provide GC Airspace Simulation System – Integrated NC-1 simulation complete with partner airspace system	August 2021
Partner to demonstrate airspace services in simulation – Execution of NC-1 simulation with airspace components	October 2021
Partner and NASA to share final data from NC-1 execution – Delivery of relevant data collected during scenario testing	2 months after completion of simulation
NASA to write and deliver final NC-1 report – Report documenting the NC-1 simulation execution	5 months after completion of simulation



Breakout 3
Q&A

Thank you for joining the Crosscutting Working Group: AAM Partnership Strategy Session!

Send additional questions or comments to:

arc-cal-nari@mail.nasa.gov

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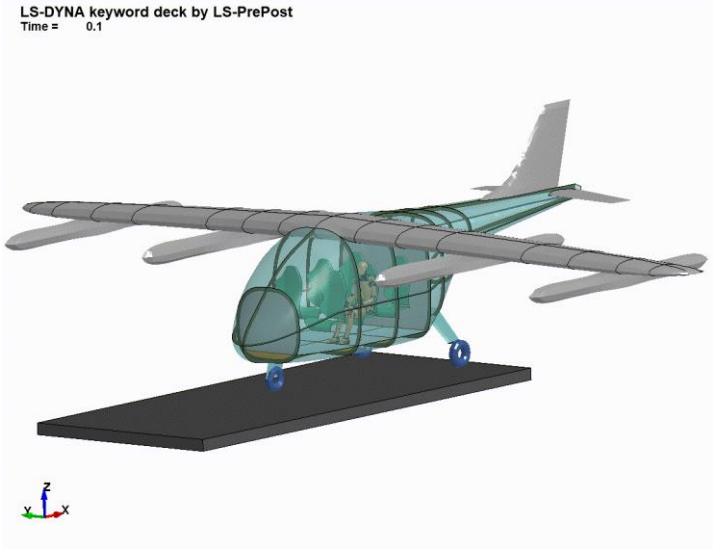
View beta.SAM.gov on or around **January 31, 2021** for the ACO-2 and ACO-3 final announcement.

Breakout Session #4: Crashworthiness Annex, Community Planning and Integration Annex

Justin Littell, Nancy Mendonca

Introduction

- NASA Langley Research Center has played a critical role in aircraft safety for the past 40+ years through the use of full-scale crash test research.
  - Rotorcraft, General Aviation, Transport in both Civilian and DoD sponsored research programs
- Full scale crash testing is critical in providing critical data used in regulatory requirements
  - Dynamic seat tests in 14 CFR § 23.562 and 27.562
- With new and novel eVTOL designs, performance under dynamic impact scenarios remains unknown
  - GA and rotorcraft has 50+ years of accident data and crash test to guide design and development
- Obtaining impact data on these aircraft (or representative construction) will provide regulatory bodies and standards organizations critical data to be able to create requirements necessary for eventual market adoption and maturation



NASA Langley Research Center Full-Scale Test Example

Crashworthiness Research and Testing Annex NASA Roles and Responsibilities

- Develop the Test Plan – which includes information about vehicle configuration, impact conditions, Anthropomorphic Test Device (ATD) usage and placement, and sensor placement/usage
- Provide all ATDs and seats (if not already present) – ATD sizes will range from 5th to 95th percentile, and type will be either from regulatory requirements – Hybrid II or FAA Hybrid III, or advanced – THOR, WIAMan
- Conduct 3D pre- and post-test point cloud scanning
- Conduct the crash test per the Test Plan
- Acquire all sensor and video data
- Provide test data to Partner. Test data includes airframe sensor and ground camera data. *Data will not include seat or ATD data*
- Perform post-test inspections which may include: vehicle disassembly, material removal, NDE methods and/or visual inspections of failed and partially failed components and document results
- Report out results (anonymized as much as possible) as NASA Technical Memorandum and/or technical reports to standards organizations for consideration of standards developments

Crashworthiness Research and Testing Annex Partner Roles and Responsibilities

- Provide an airframe test article(s) in good condition. Test articles do not need to be entire airframes, but at minimum be cabin sections with build characteristics close to final design.
- Provide data regarding airframe build to NASA as needed
- Provide data regarding flight characteristics including expected performance conditions (if known), weight, center of gravity and inertia properties necessary for test
- Provide guidance to NASA to identify hard points used for lifting and swing with appropriate margins of safety
- At partner discretion, be present for crash testing and post-test inspections
- Remove test article from NASA when post-test inspections are complete

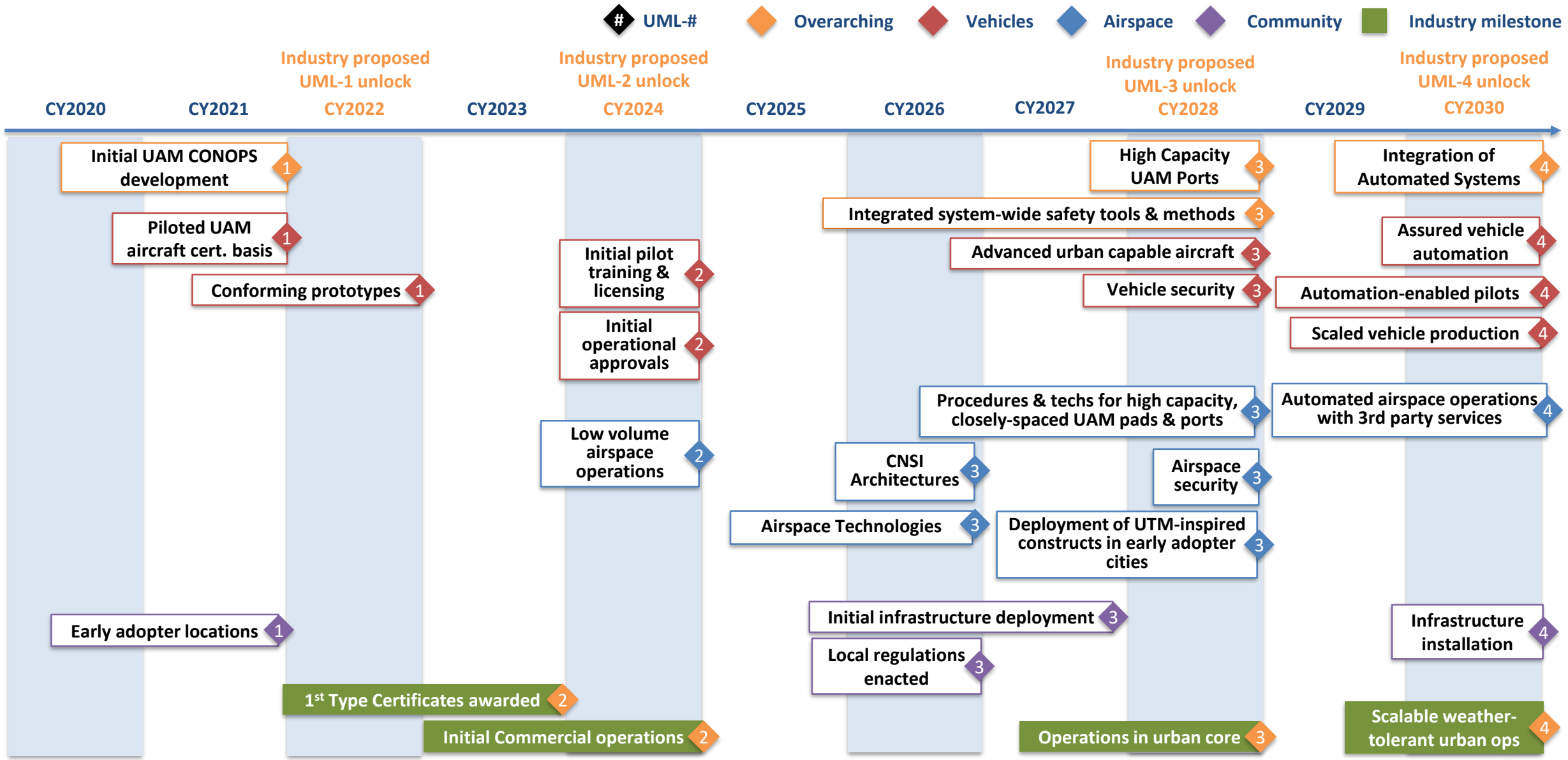
Crashworthiness Research and Testing Annex Schedule and Milestones

***Subject to change**

	Milestone	Date
1	Partner provide build details of test article(s)	Within 1 month of signing Annex
2	NASA to provide Test Plan to Partner	Within 1 month of completing Milestone 1
3	Partner to provide test article(s)	Within 4 months of completing Milestone 2
4	NASA begin buildup of test article(s)	Within 1 month of completing Milestone 3
5	NASA work with Partner to establish test date within test window	Within 1 month of completing Milestone 4
6	NASA to conduct crash test of Partner's test article(s)	Between Oct 2021 and September 2023
7	NASA to provide test data to Partner	Within 1 month of completing Milestone 6
8	NASA to conduct post-test inspection of test article(s)	Within 1 year of completing Milestone 6
9	Partner to remove test article(s) from NASA facility	Within 1 year of completing Milestone 7
10	NASA publish report	Within 1 year of completing Milestone 8

COMMUNITY PLANNING AND INTEGRATION ANNEX

Industry proposed timeline[1] and milestones



1 Based on a range of publicly available industry projections; not a consensus view; aggressive

Community Planning and Integration Annex

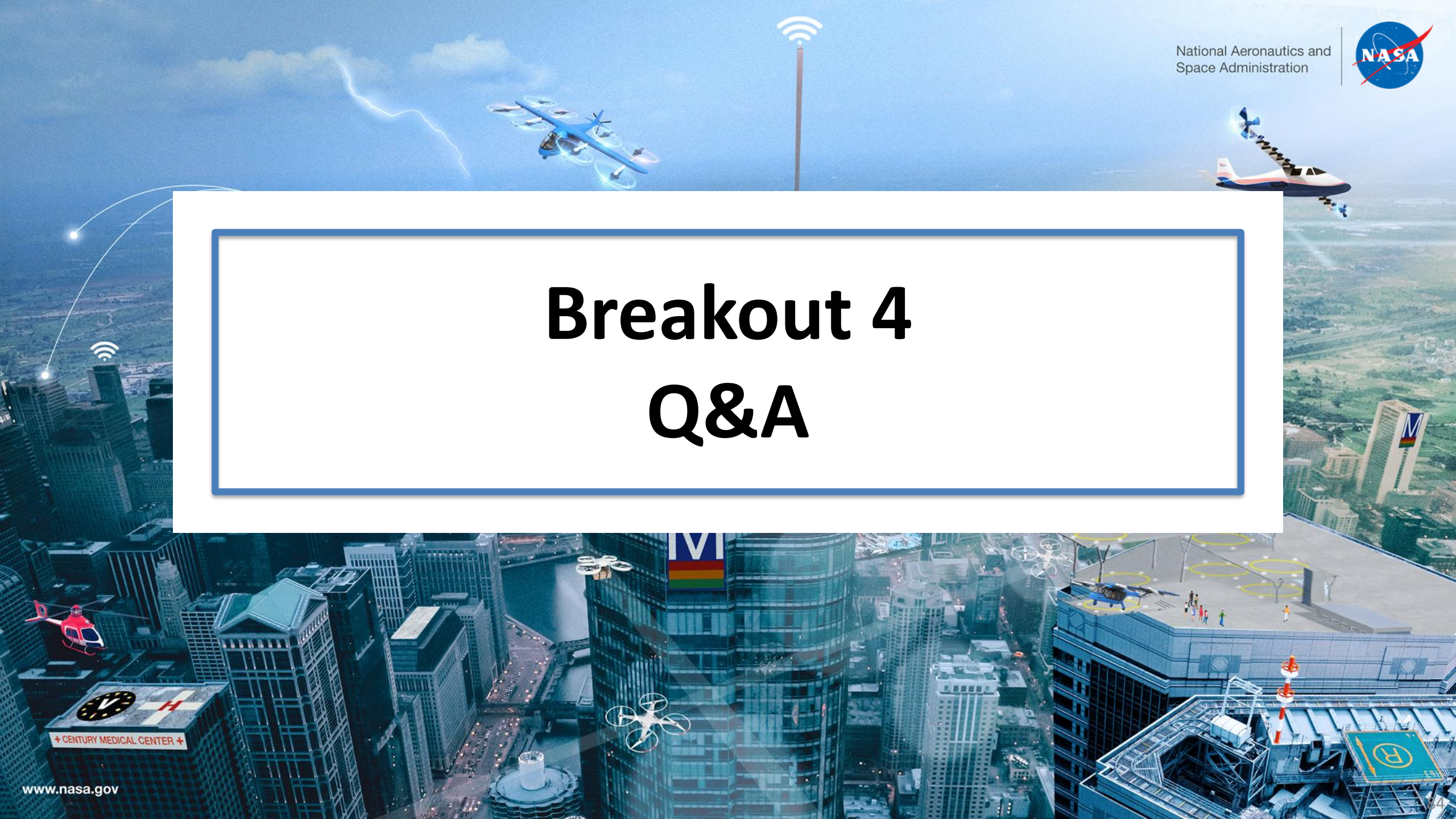
- **Community Annex:** Strategically the purpose of the partnership is to produce a plan for UAM operations. The plan will be used to
  - Support community-wide information exchanges,
  - Accelerate early adoption of AAM applications,
  - Ensure public confidence in AAM safety, and
  - Facilitate community-wide learning towards operational AAM services

- **Key Deliverables**
  - AAM Local Integration Plan
  - Common national taxonomy
  - Best practices for public acceptance strategies
  - Best practices across local integration plans

- **Key Activities**
  - Initial information Meeting exchanges
  - Table top workshops – 4 minimum, to develop/review Local Integration Plan

Community Planning and Integration Annex

- **Evaluation Criteria:**
  - Early Adopter Cities/Regions
    - Possesses current AAM-related goals and plans which would be both potential areas benefiting from collaboration with NASA and that would provide valuable lessons learned for other cities adopting AAM
  - Team Composition
    - A well-constructed team would have everyone "in the room" needed to plan, provide input, approve, and execute early adoption activities.
    - It could include: Transportation planners, safety or emergency response personnel and planners, infrastructure or zoning planners, emergency responders or personnel engaged with community outreach or collaboration. Other members of the team can include airport and hospital operators, local universities, community and civic organizations that would work at local, state, regional or national levels to enable Advanced Air Mobility (AAM) operations. Team members can also include representatives from the local business community such as real estate developers, vehicle manufacturers, operators interested in investing and or operating AAM related systems, potential vertiport operators, infrastructure (e.g., communications, navigation and weather information) providers, and utility entities and companies, and local representatives that are participating in other multi-modal or Smart Cities initiatives, if applicable.
  - Compliance with Umbrella SAA and Annex templates
    - The respondent should demonstrate their ability to sign and execute an Umbrella SAA and the “AAM Community Planning and Integration Annex” as defined.



Breakout 4
Q&A

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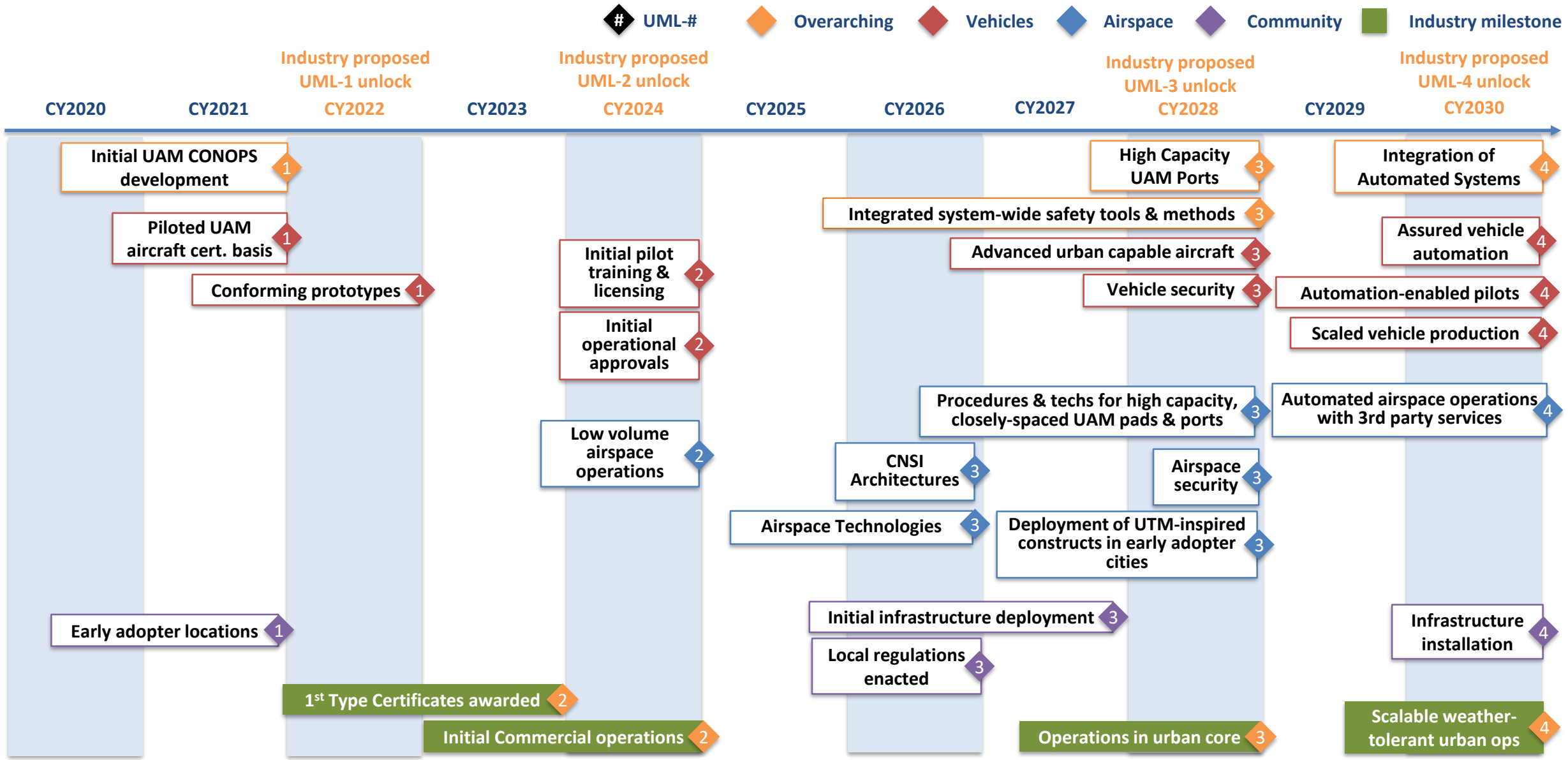
BACK-UP

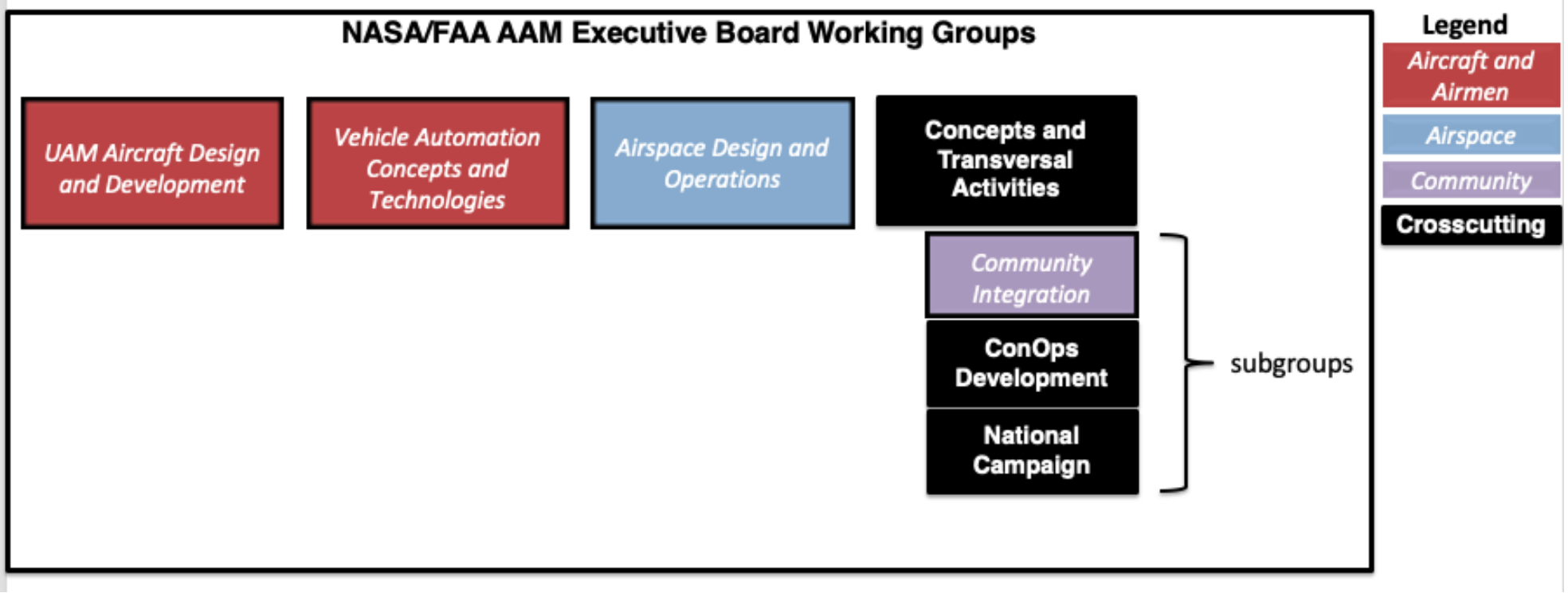
Industry proposed timeline[1] and milestones



1 Based on a range of publicly available industry projections; not a consensus view; aggressive

NASA/FAA AAM WG Structure

- Executive leadership has jointly agreed to a WG structure to continue formalizing AAM planning and execution strategies
- Multiple working groups are extensions of previous collaborations
- All working groups have been through an iteration of a cross-agency planning cycle



AAM Ecosystem Working Groups (AEWG)

Align on a common vision for AAM

Learn about NASA's research and planned transition paths

Adopt a strategy for engaging the public on AAM

Collectively identify and investigate key hurdles and associated needs

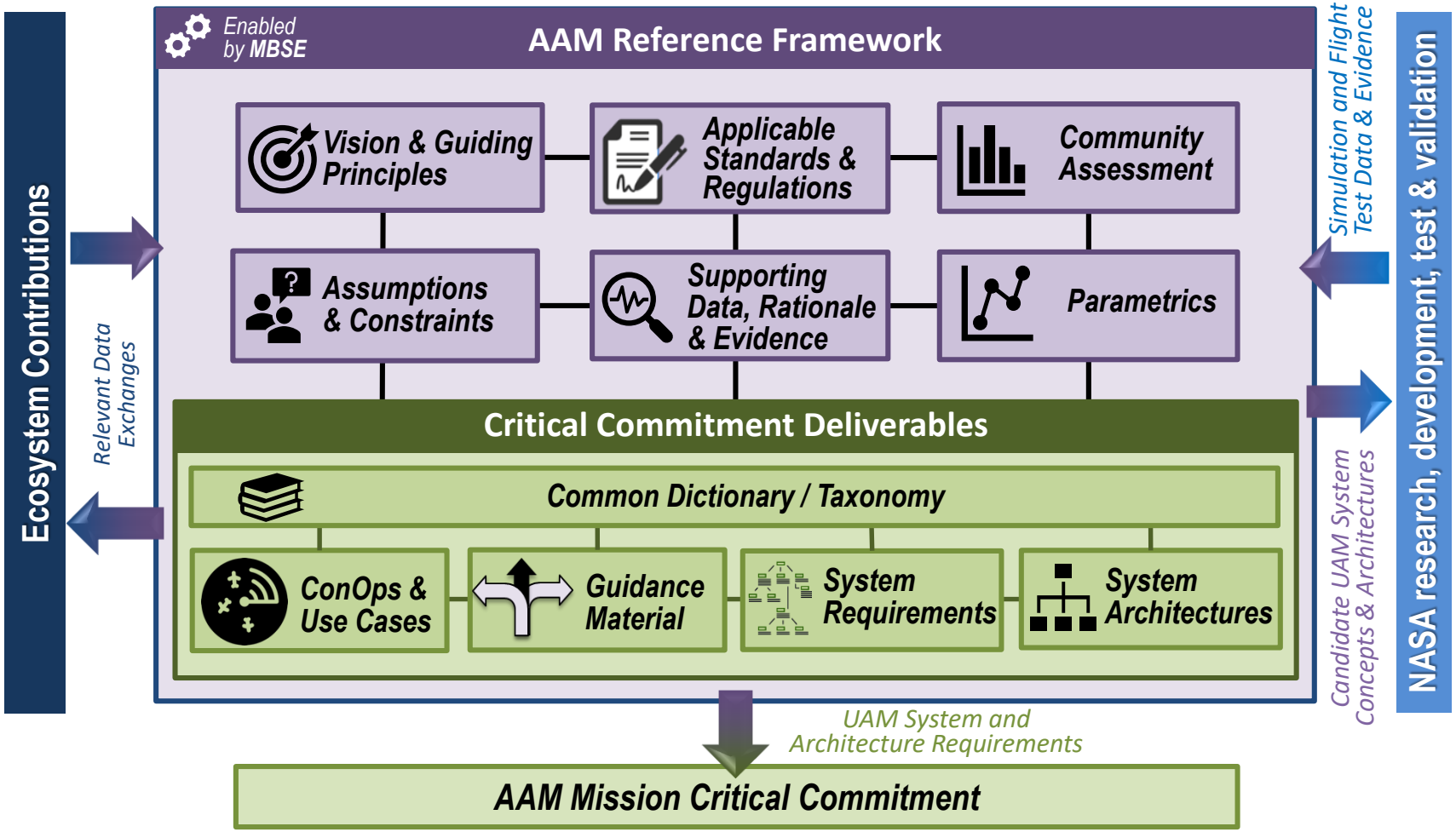
Develop AAM system and architecture requirements

Support regulatory and standards development

Form a connected stakeholder community

Accelerate the development of safe and scalable AAM flight operations by bringing together the broad and diverse ecosystem

AAM Reference Framework & Deliverables Supporting the Critical Commitment



Collaborating with other federal/state/local governments and industry organizations across the AAM Ecosystem to develop a comprehensive set of AAM system and architecture requirements for medium density operations.

MBSE = Model Based Systems Engineering