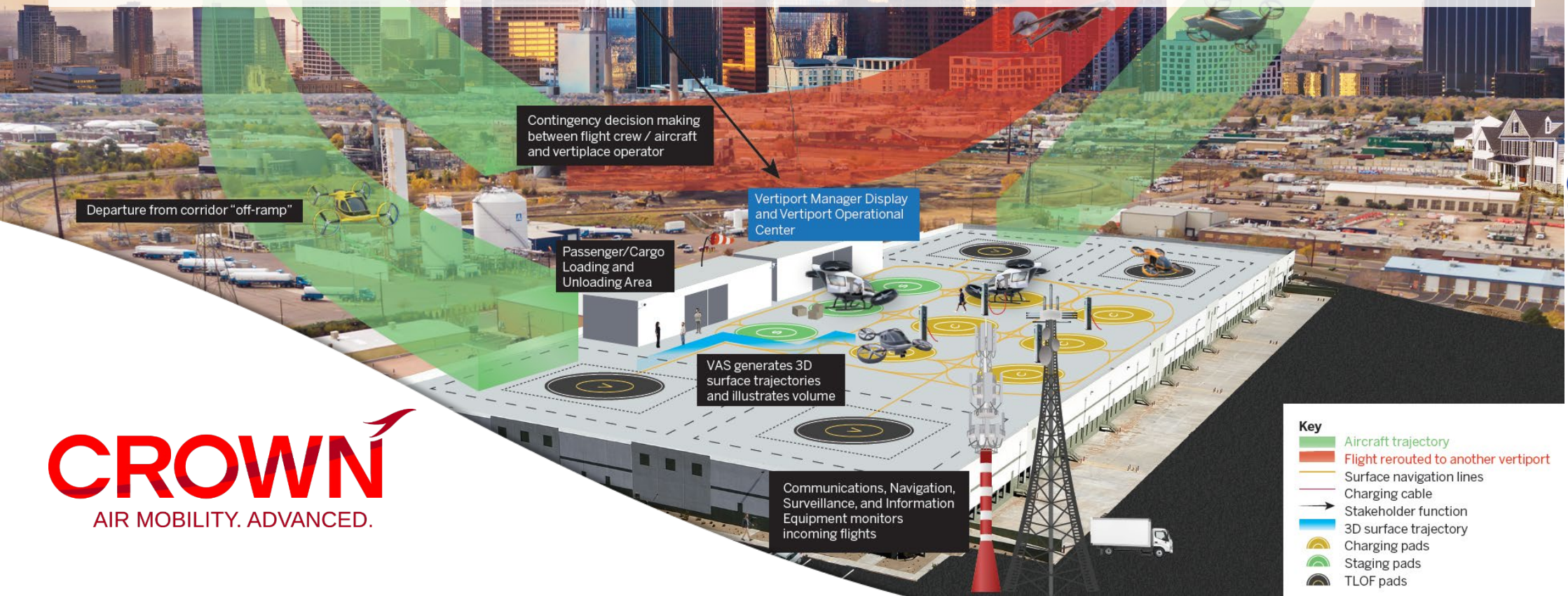
High-Density Automated Vertiport Concept of Operations Overview

NASA AAM Ecosystem Working Group
Vertiport Automation System Architecture

September 2nd, 2021



CROWN
AIR MOBILITY. ADVANCED.

NUAIR
MAKING FUTURE SKIES SAFER

NASA

Oneida County 1798 New York

MOSAIC ATM

5α

BOEING

Deloitte.

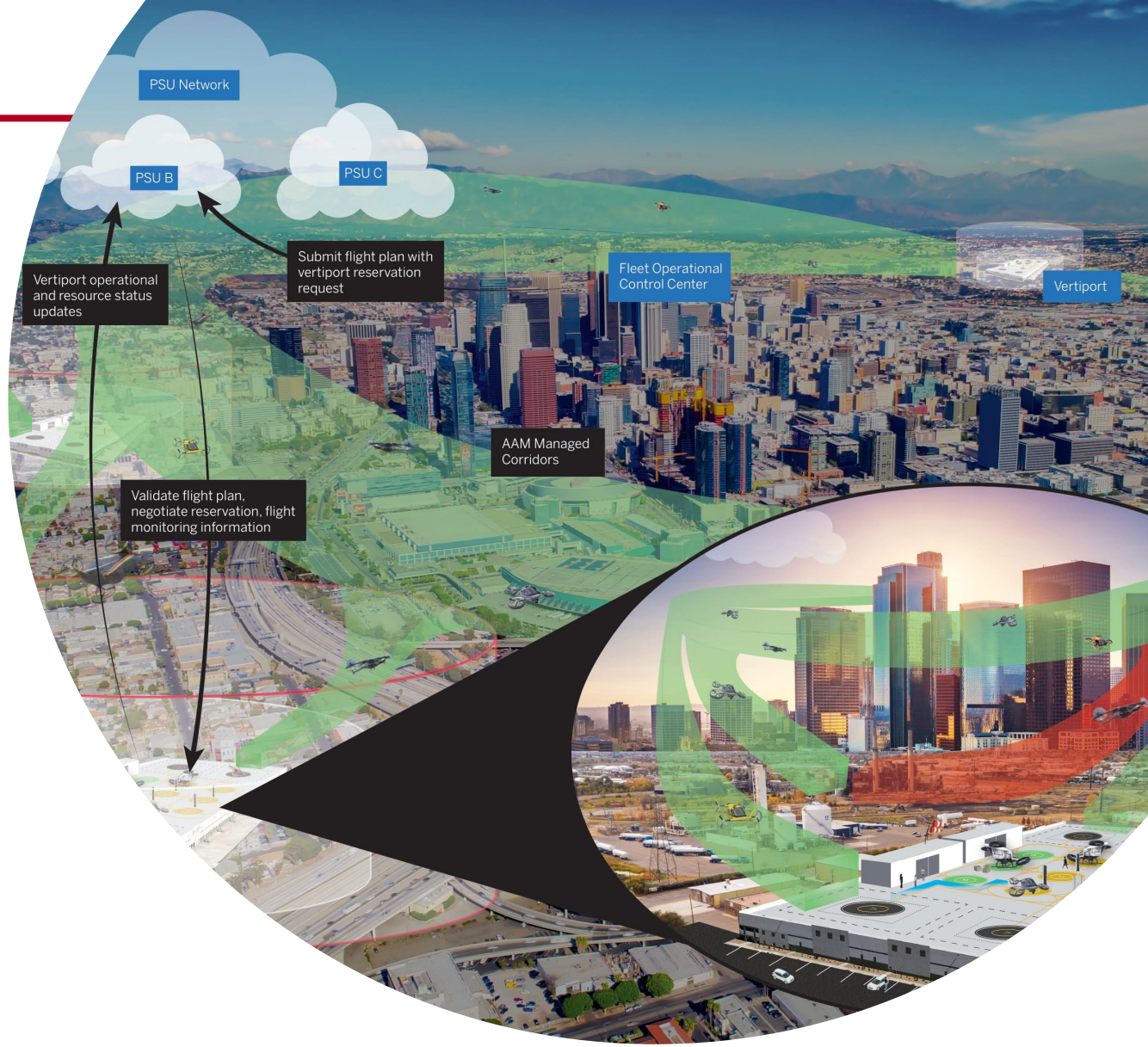
GAMA

Helicopter Association International

Motivation

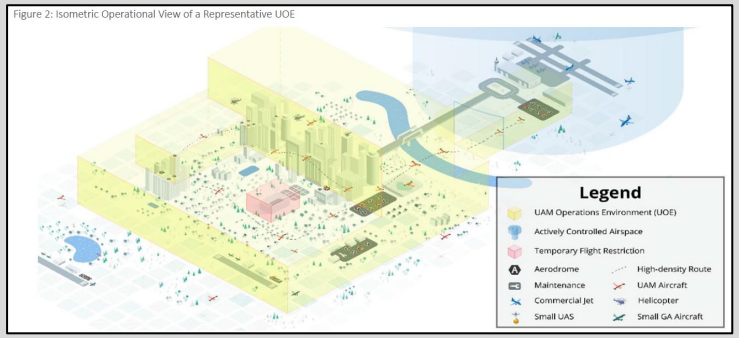
Develop a concept of operations to:

- Identify relevant requirements, considerations, barriers, and enabling technologies
- Inform operationalization of vertiports and maturation of vertiport automation technologies at UML-4



Prior Foundational Work

NASA UAM Vison ConOps UML-4



ONEIDA COUNTY 1798 NEW YORK

NUAIR
MAKING FUTURE SKIES SAFER

BOEING

Deloitte.

CROWN
AIR MOBILITY. ADVANCED.

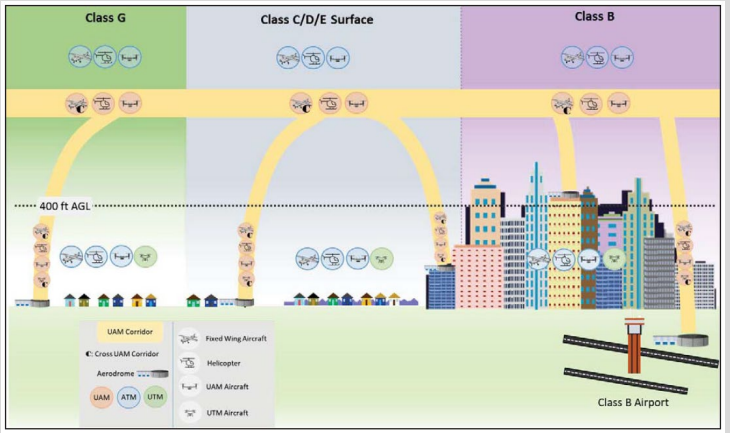
MOSAIC ATM

Helicopter Association International

5α

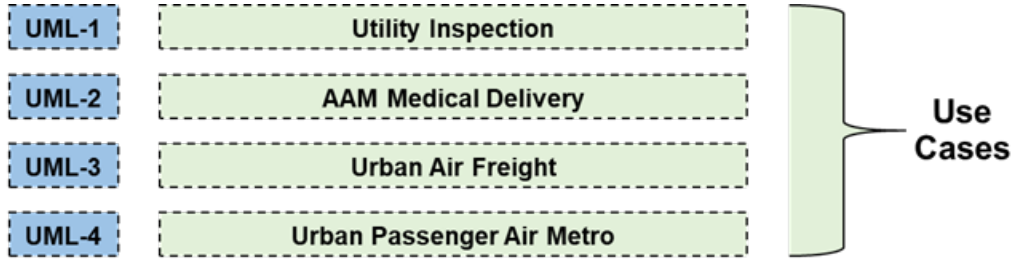
GAMA

FAA UAM ConOps V1.0



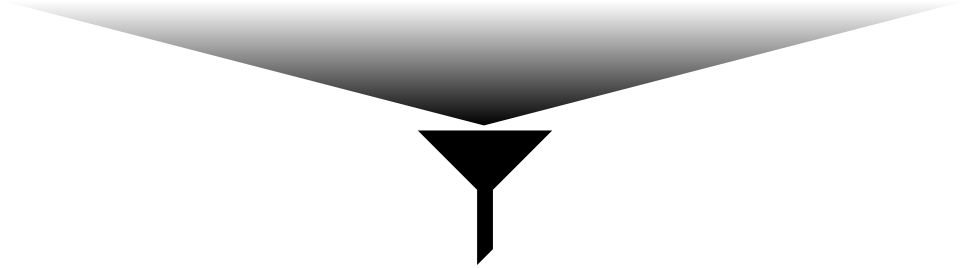
Concept of Operations Development Process

1 Develop Business Use Cases



2 Literature Review

120 Sources Reviewed and Cataloged



Literature Review Process

32 Sources Identified as “Primary Importance”

3 SME Interviews

17 Organizations Interviewed

Organizations Interviewed:

- OEMs & Hardware Suppliers
- UAS Service Suppliers
- Heliports & Airports
- Fleet Operators
- SDSPs
- Regulators
- MRO Providers

4 Trade Study & NASA Feedback Integration

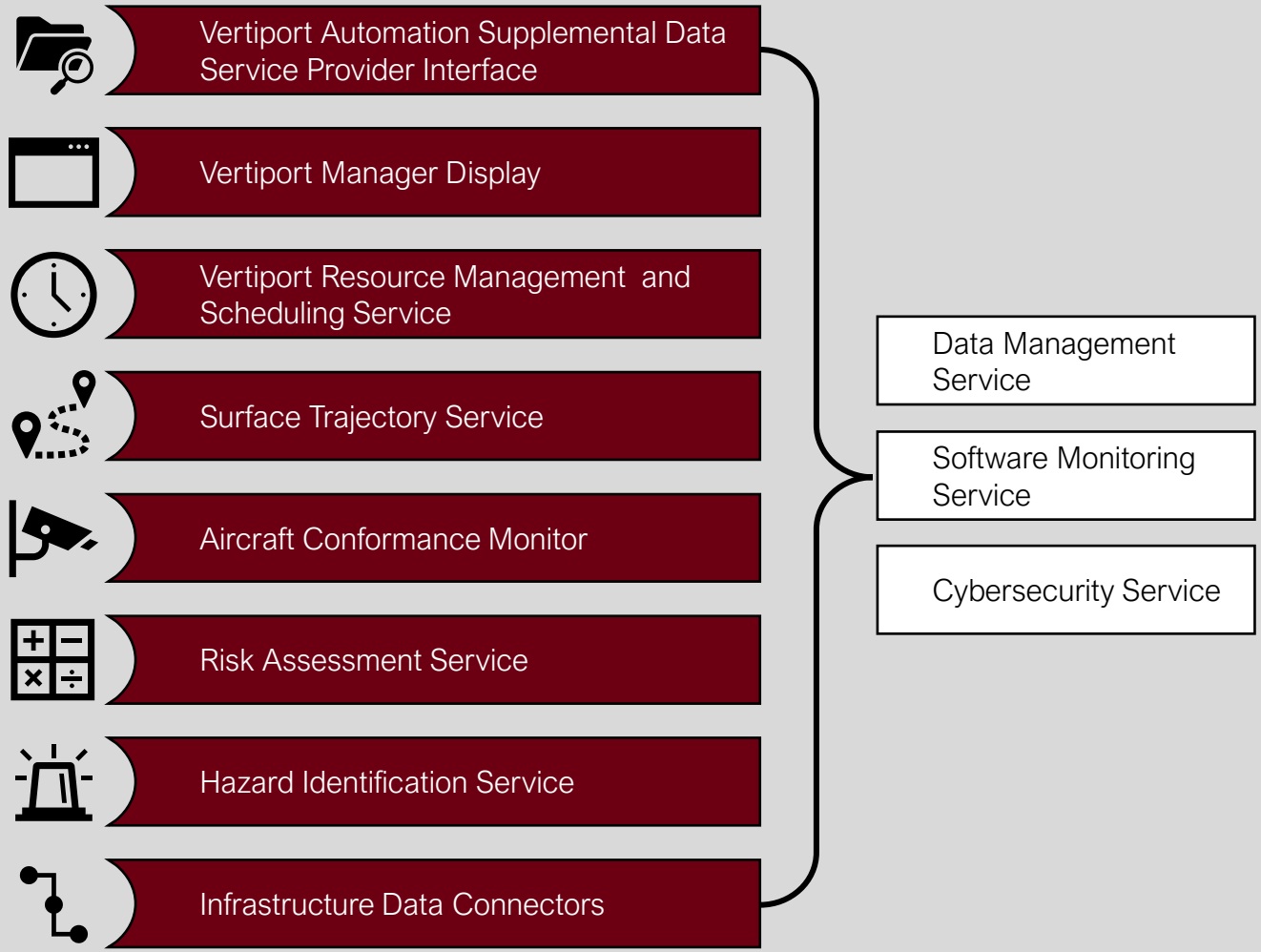
Integrated Vertiport Trade Study Gaps and Mitigation

NASA Feedback

1. Initial business use cases identified and presented for review
2. Feedback provided from NASA and internal team
3. Catalogued and addressed all relevant feedback on use cases

Document Organization[1]

1. Introduction	Purpose and Scope
	Assumptions and Constraints
	UML Mapping
	Operational Stakeholder Descriptions
2. Current State	Description of Current State
	AAM Vertiport State-of-the-Art Assessment
	Vertiport Challenges and Barriers
3. Desired Changes	Rationale for Changes
	Description of Desired Changes
4. Future State Concept of Operations	Description of the Proposed System
	Operational Environment
	Operational Stakeholders
	Vertiport Automation System Services
	Vertiport Automation System Relationships
	Configuration Decisions
5. Operational Scenarios	Base Nominal Scenarios
	Off-Nominal Scenarios
	Resource Allocation
6. Summary of Impacts	Operational Impacts
	Organizational Impacts
	Impacts During Development
7. Analysis of Proposed System	Summary of Improvements
	Disadvantages and Limitations
	Alternatives and Tradeoffs Considered
	Path Forward



[1] *ConOps Organization Based on IEEE Standard 1362-1998.*

Vertiport Automation System

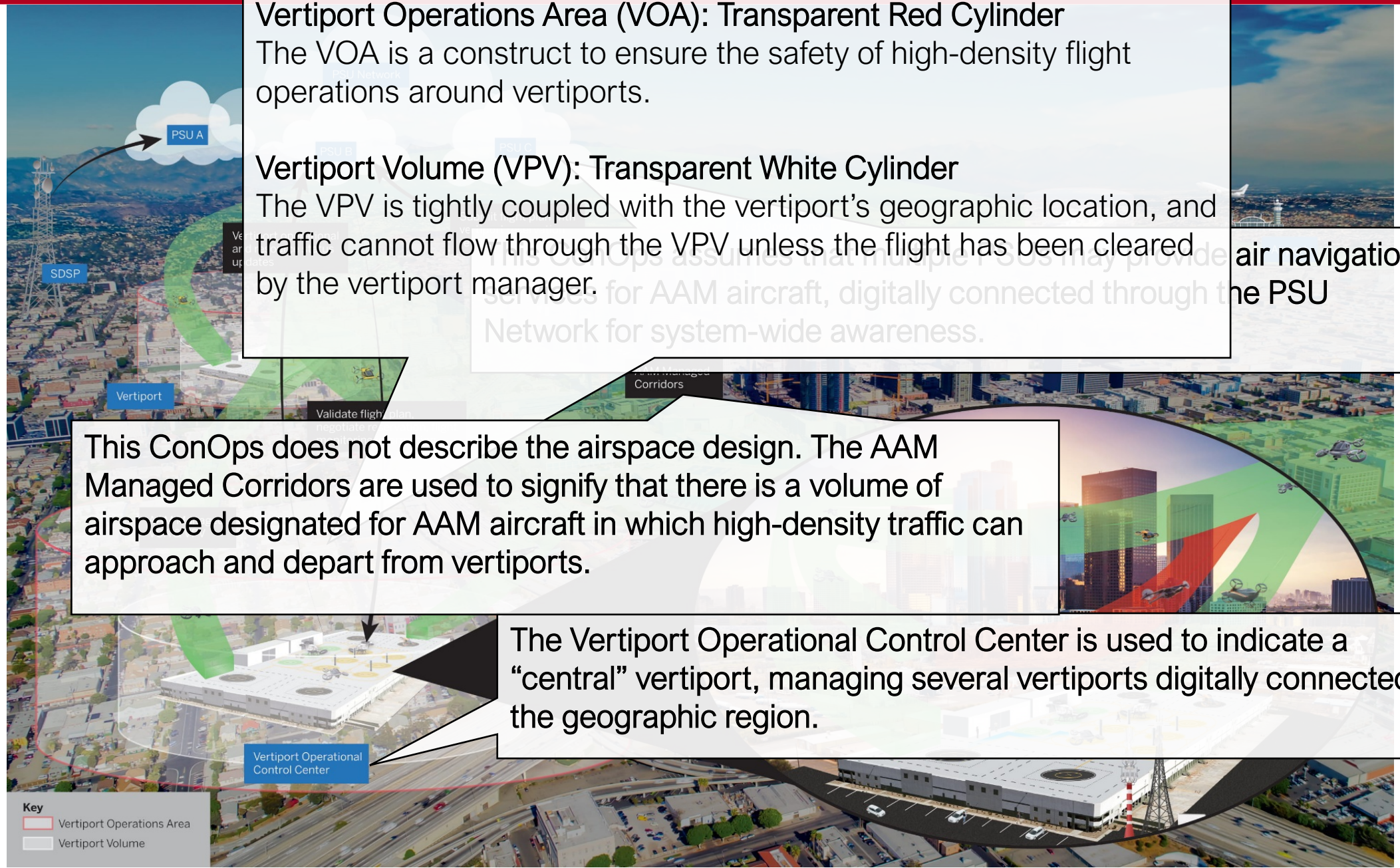
VAS Services	Service Role	Service Description
Vertiport Resource Management and Scheduling Service	Core Function	Responsible for determining vertiport configurations, implementing business rules, enforcing community and government-imposed requirements, and responding to resource requests to **strategically allocate and assign vertiport resources**.
Vertiport Automation Supplemental Data Service Provider	External Interface	**Standardized interface** allowing stakeholders to make **API calls** to the VAS and to use subscription as a means of direct communications to and from the VAS deployed at the vertiport.
Surface Trajectory Service	Support Function	Determine taxiway and gate availability and **update a nominal or pre-planned 4D surface trajectory** (latitude, longitude, height above vertiport surface, and time) for aircraft surface movement.
Vertiport Manager Display	Support Function	**Physical user interface** (UI) that describes the current state of vertiport operations and provides sufficiently detailed information to **adjust business objectives and configuration settings** and help clear operational anomalies and hazards.
Infrastructure Data Connectors	Support Function / Safety	**Connects vertiport infrastructure**, whether owned and operated by the vertiport or an SDSP, to VAS Services. Examples include Weather, Foreign Object Debris Detection, Surveillance, Charging, Noise, Communications, and Resource Service.
Aircraft Conformance Monitor	Safety	**Monitors aircraft conformance** on the vertiport surface and within the surrounding airspace for **compliance** with scheduled arrival and departure operations.
Hazard Identification Service	Safety	Receives anomaly alerts from the Aircraft Conformance Monitor and Software Monitoring Service, detects anomalies using vertiport infrastructure sensors, **identifies hazards from those anomalies**, and sends identified hazards to the Risk Assessment Service.
Risk Assessment Service	Safety	Supports the vertiport Safety Management System (SMS) program by automating parts of the Safety Risk Management process through **estimating pre-identified hazard risks**.
Data Management System	Common Software	**Manages data across the VAS** and serves as the central repository and database manager, ensuring that each service has access to the right data at the right time.
Cybersecurity Service	Common Software	**Authenticates and validates data requests** from external users, between VAS services, and monitors for anomalies in VAS services for indications of security breaches.
Software Monitoring Service	Common Software	Ensures that each VAS service is behaving as expected and **provides an assessment of operational status** for each service.

Operational Viewpoint – 1 Diagram (Integrated View)

Vertiport Operations Area (VOA): Transparent Red Cylinder
The VOA is a construct to ensure the safety of high-density flight operations around vertiports.

Vertiport Volume (VPV): Transparent White Cylinder
The VPV is tightly coupled with the vertiport's geographic location, and traffic cannot flow through the VPV unless the flight has been cleared by the vertiport manager.

air navigation
he PSU



This ConOps does not describe the airspace design. The AAM Managed Corridors are used to signify that there is a volume of airspace designated for AAM aircraft in which high-density traffic can approach and depart from vertiports.

The Vertiport Operational Control Center is used to indicate a "central" vertiport, managing several vertiports digitally connected in the geographic region.

High-Level Operational Assumptions

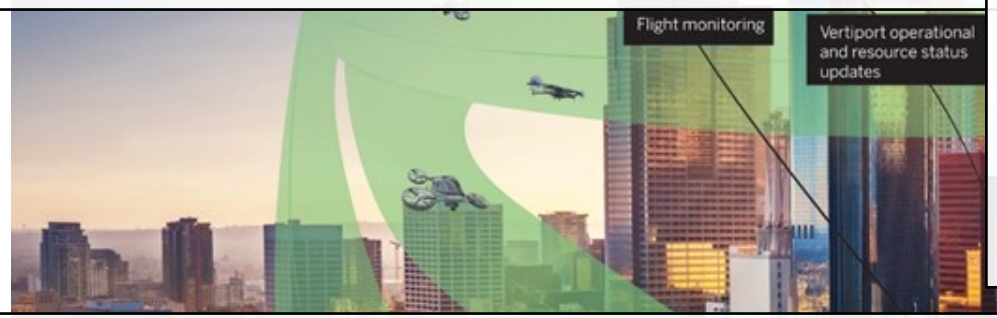
- Vertiport operations assume predetermined approach and departure fixes
- The Vertiport Operations Area (VOA) and Vertiport Volume (VPV) will be charted on aeronautical charts
- The PSU manages the airspace in the VOA and VPV
- Air traffic will be a mix of piloted, semi-automated, and fully automated aircraft
- Flight crews will be remote or onboard the aircraft
- Sufficient CNSI technology will be onboard the aircraft
- Vertiports may need to comply with local, state, or federal regulations
- The PSU is responsible to act as the broker of timing, routing, and sequencing of aircraft in AAM Corridors
- AAM aircraft will follow 4D required navigation performance (RNP) trajectories

Taxi and Takeoff

1. PSU coordinates takeoff time slot with vertiport and aircraft is sequenced for taxi and takeoff
2. Flight crew and aircraft taxi on vertiport generated 4D surface trajectories while self-separating
3. Aircraft arrives at the departure pad, PSU performs airspace checks, and clears the aircraft for takeoff

Land, Taxi, and Deplane

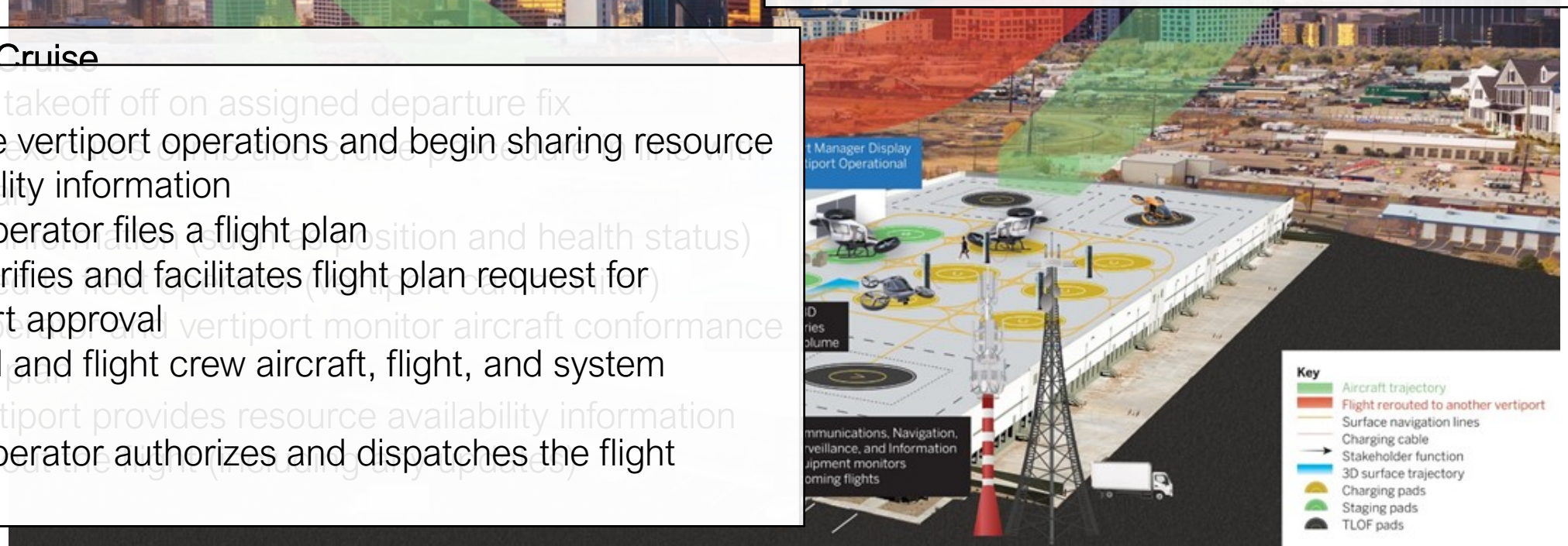
1. The aircraft and flight crew are responsible for navigating the approach while remaining clear of static or dynamic obstacles
2. The aircraft lands, and inform stakeholders of arrival
3. The vertiport generates a 4D surface trajectory to navigate to the appropriate surface destination
4. The vertiport monitors for potential hazards that would impact surface movement and generates alerts if necessary
5. Passengers or cargo is offloaded from the aircraft assisted by ground crew



Climb and Cruise

Pre-Flight

1. Initialize vertiport operations and begin sharing resource availability information
2. Fleet operator files a flight plan
3. PSU verifies and facilitates flight plan request for vertiport approval
4. Ground and flight crew aircraft, flight, and system checks
5. Fleet operator authorizes and dispatches the flight



Vertiport Automation System Design Considerations

Vertiport Configuration Decisions

Vertiport Types

Vertiport Airspace Integration

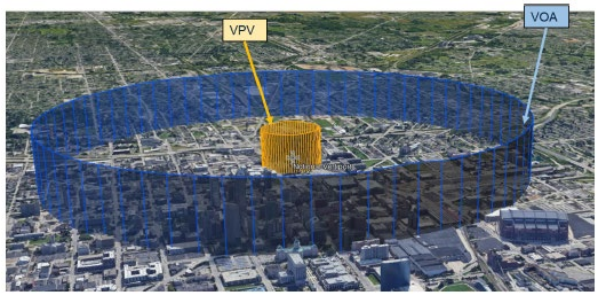


Figure 1: VOA and VPV Sample Boundaries for a Notional Vertiport

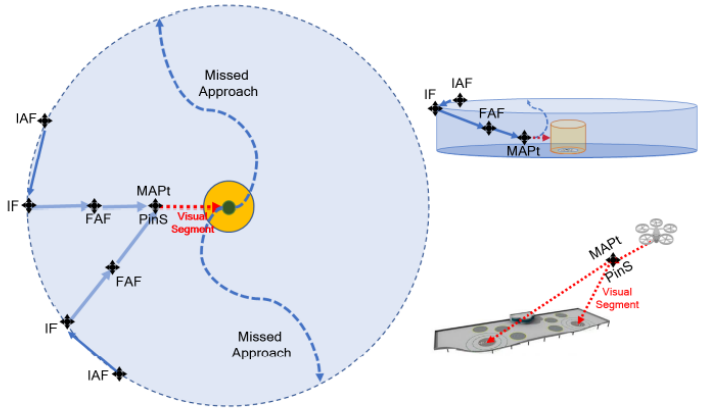
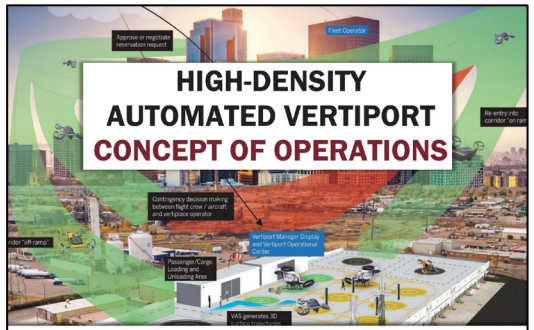


Figure 14: Geographic View of the Vertiport Area

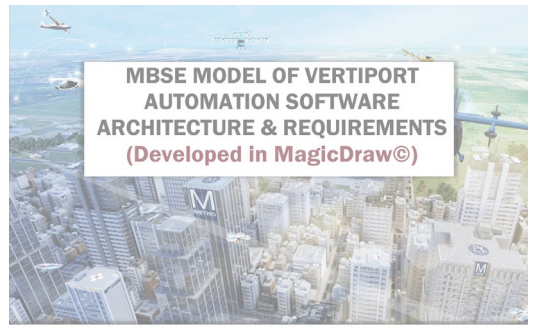
Thank you

New York UAS Test Site (NYUASTS)
Northeast UAS Airspace Integration Research Alliance (NUAIR)
Research Mission Directorate (ARMD) Integrated Aviation Systems Program
(IASP) Advanced Air Mobility (AAM) Project Number 395872
Contract number: NND15SA83B
July 26 2021



New York UAS Test Site (NYUASTS)
Northeast UAS Airspace Integration Research Alliance (NUAIR)
Research Mission Directorate (ARMD) Integrated Aviation Systems Program
(IASP) Advanced Air Mobility (AAM) Project Number 395872
Contract number: NND15SA83B
July 26 2021

New York UAS Test Site (NYUASTS)
Northeast UAS Airspace Integration Research Alliance (NUAIR)
Created in support of National Aeronautics and Space Administration (NASA)
Aeronautics Research Mission Directorate (ARMD) Integrated Aviation Systems
Program (IASP) Advanced Air Mobility (AAM) Project Number 395872
Contract Number: NND15SA83B
July 26 2021



New York UAS Test Site (NYUASTS)
Northeast UAS Airspace Integration Research Alliance (NUAIR)
Research Mission Directorate (ARMD) Integrated Aviation Systems Program
(IASP) Advanced Air Mobility (AAM) Project Number 395872
Contract number: NND15SA83B
July 26 2021