AIRSPACE INTEGRATION

ENABLING SCALABLE, EFFICIENT, AND SAFE ACCESS TO AIRSPACE

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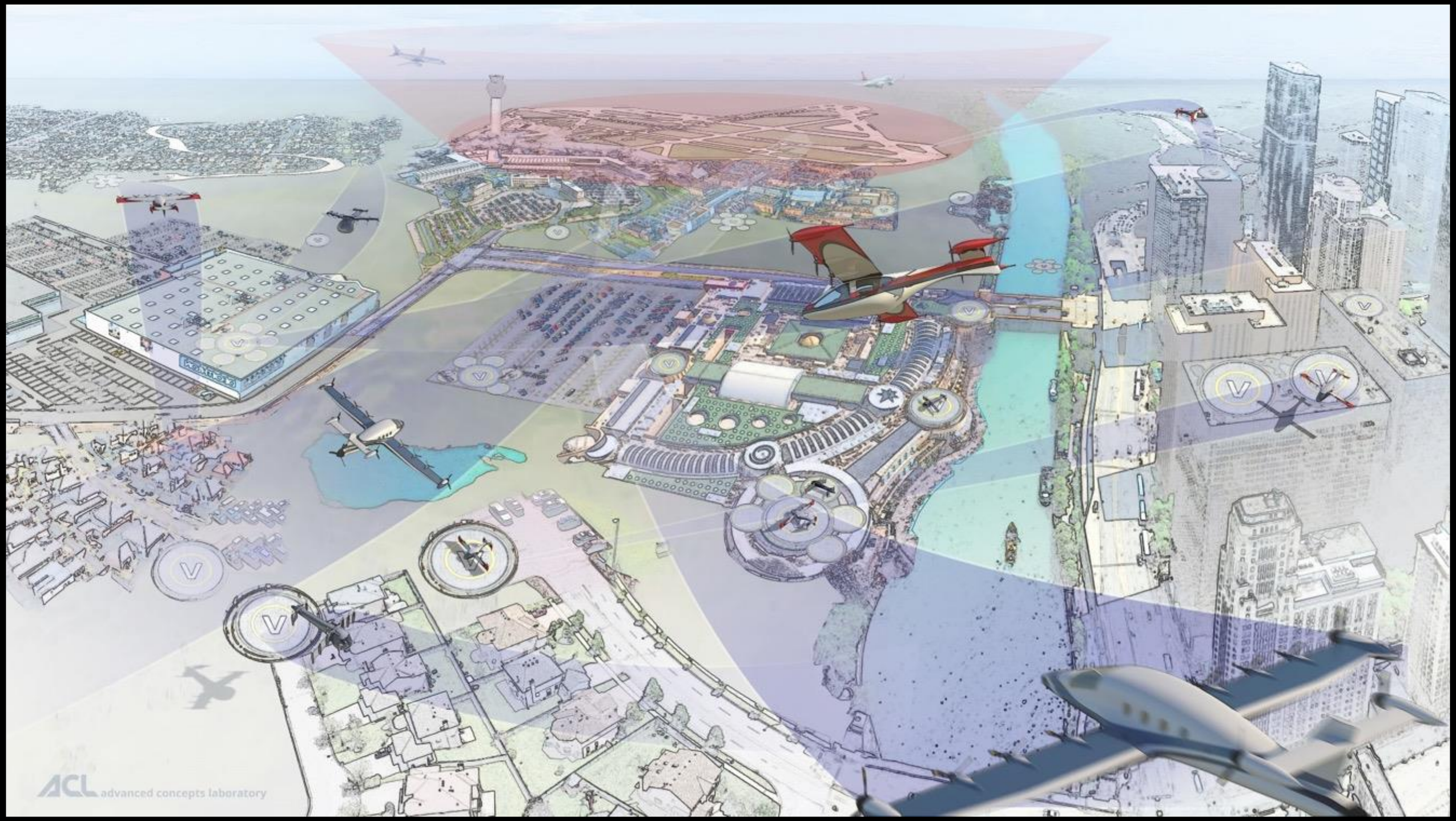
CURRENT AIRSPACE OPERATIONS

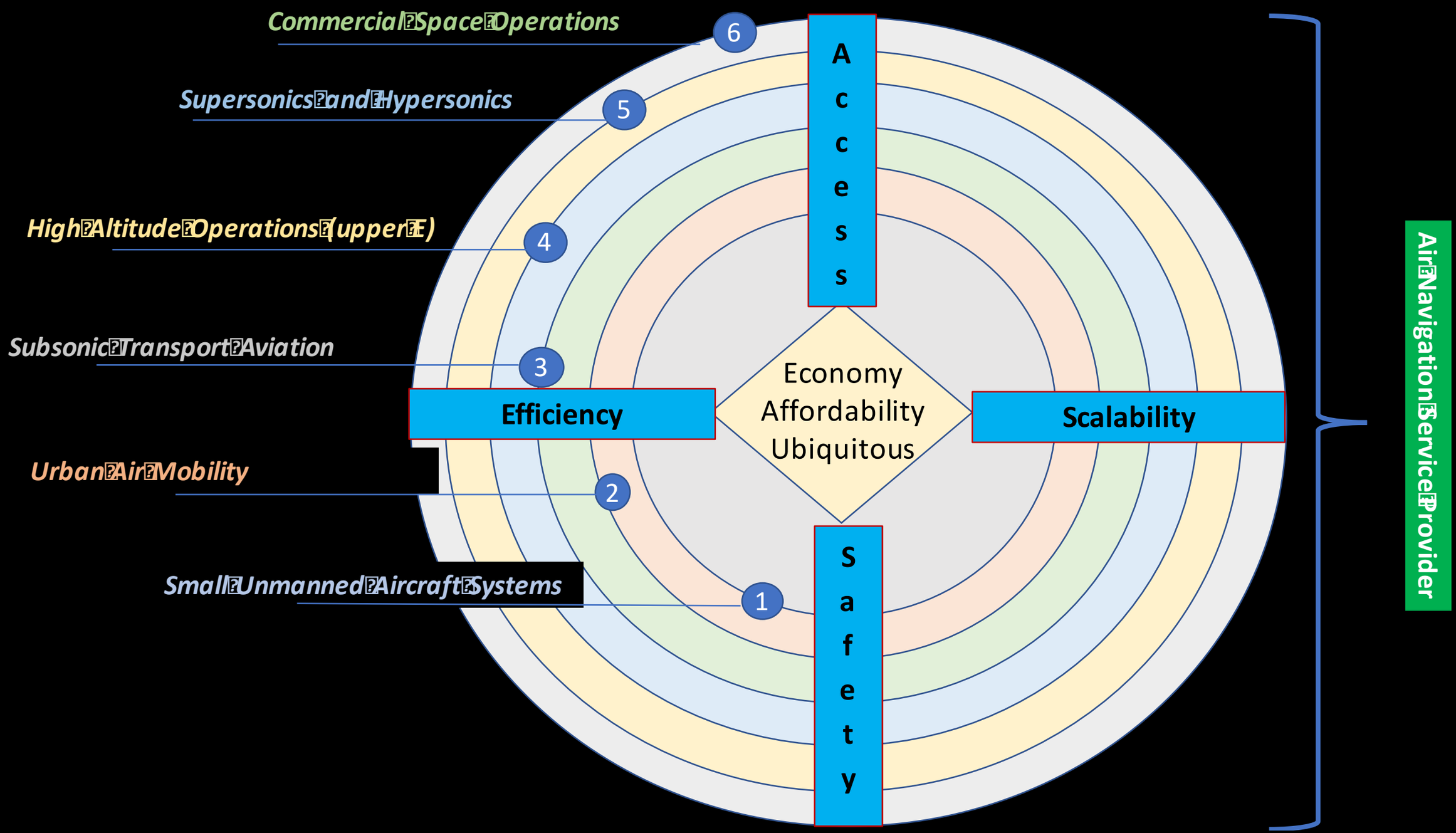
SMALL UNMANNED AIRCRAFT SYSTEMS

VERTICAL TAKE OFF AND LANDING (VTOLS)



URBAN AIR MOBILITY: SMALL DRONES TO LARGER PASSENGER CARRYING VTOLS

AIRSPACE USER TYPES ARE INCREASING



BASIC ARCHITECTURE

Extension of UAS Traffic Management

NAS Data Sources

Supplemental Data Service Provider

Inter-data provider communication and coordination

- Terrain
- Weather
- Surveillance
- Performance

Common data

NAS state

National Airspace System - ATM

Flight Information Management System (FIMS) - FAA

Constraints, Directives

Requests, Decisions

Operations, Deviations

NAS impacts

UAS/Urban Air Service Supplier (USS)

Inter-USS communication and coordination

- Operations
- Constraints
- Modifications
- Notifications
- Information

Operations, Constraints, Notifications, Information

Operation requests
Real-time information

Color Key:

ANSP Function

Operator Function

Other Stakeholders

Public Safety

Public

Urban air Operator

Urban Air Operator

UAS Operator

UAS

UAS

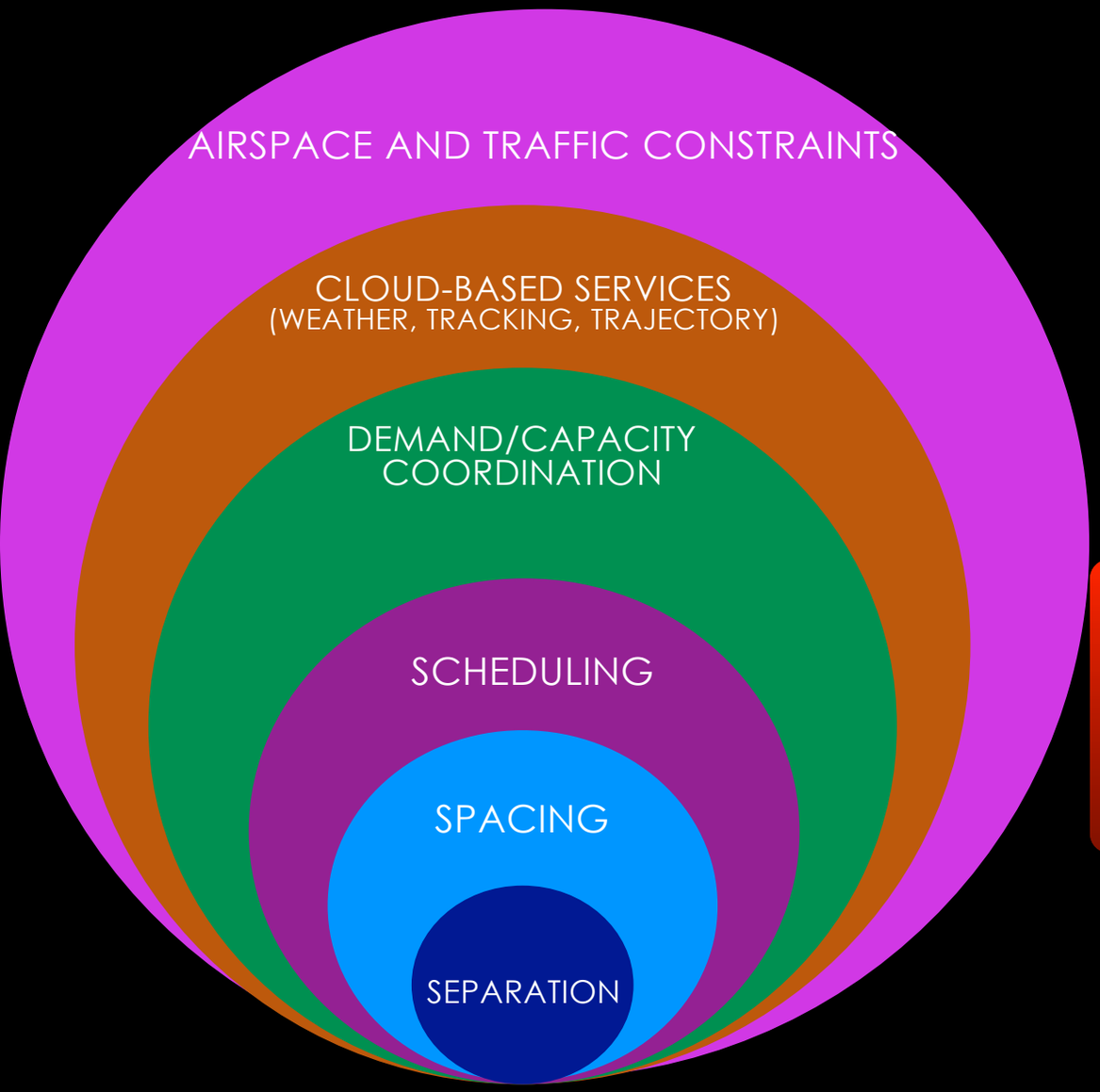
VTOL

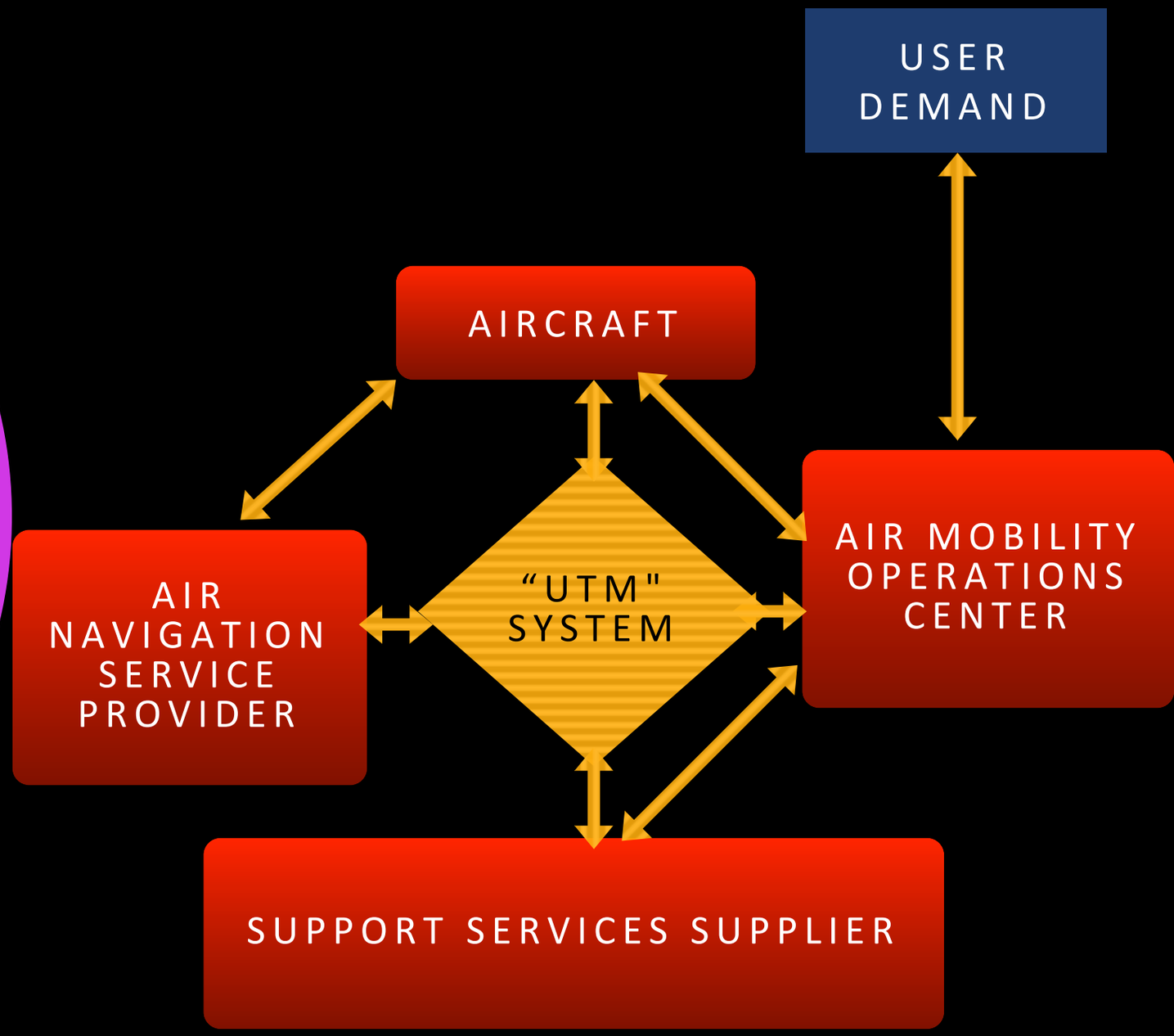
URBAN AIR MOBILITY AIRSPACE INTEGRATION PRINCIPLES

- No burden on current system
- Cooperative and interoperable with other users
- Performance and risk-based
- Efficient
- Safe
- Scalability and sustainability

BUILD ON THE FOUNDATION OF
UNMANNED AIRCRAFT SYSTEM TRAFFIC MANAGEMENT (UTM)

CONNECTED SYSTEM FOR SCALABILITY





FLEXIBILITY WHERE POSSIBLE, STRUCTURE WHERE NECESSARY

AIRCRAFT

SEPARATION
LAST/FIRST 100 FT
ENHANCED FLIGHT RULES

AIR NAVIGATION SERVICE PROVIDER

DIRECTIVES
DEMAND/CAPACITY MANAGEMENT
AIRSPACE CONSTRAINTS
MANAGED BY EXCEPTION

"UTM" SYSTEM

OPERATIONS CENTER

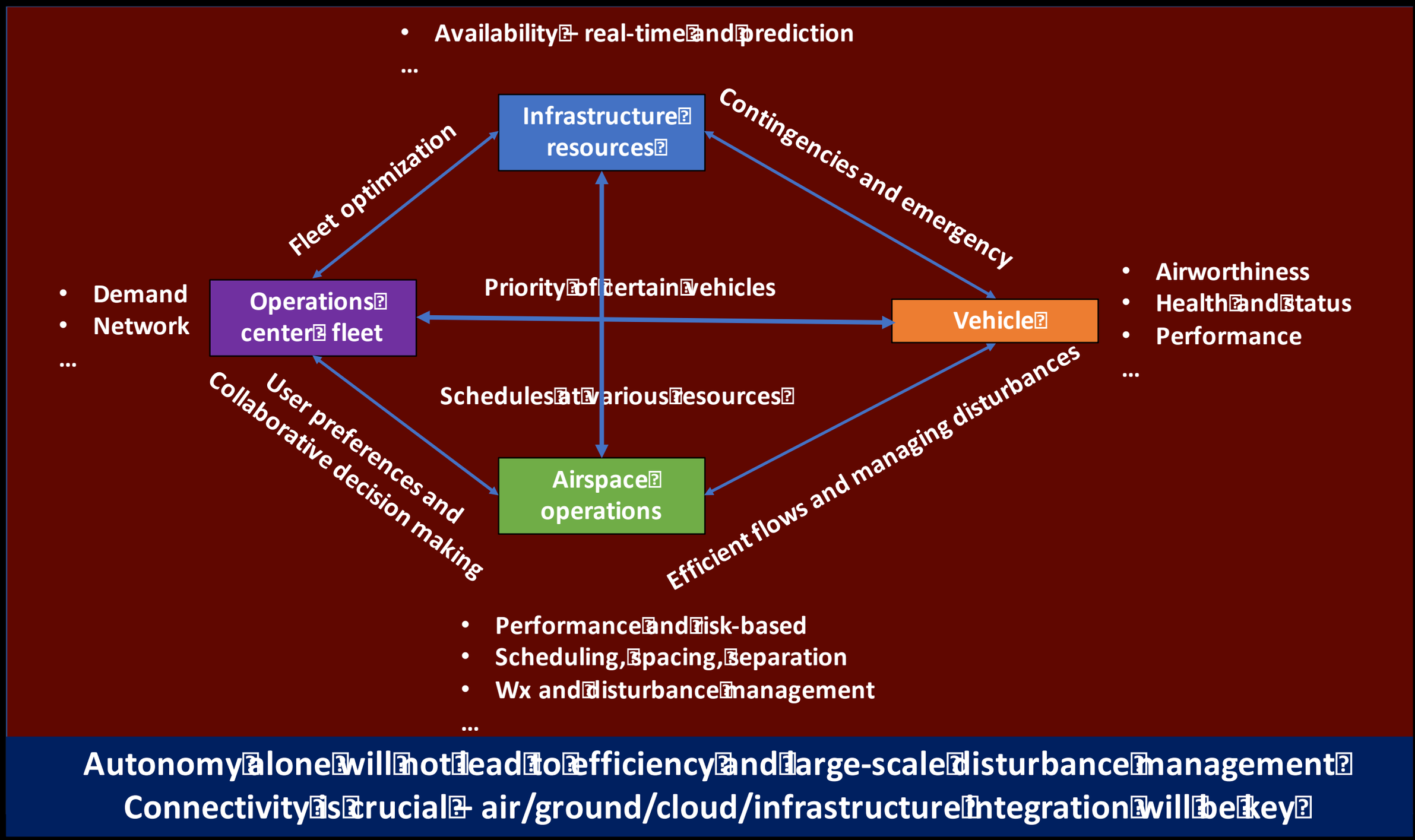
TRAJECTORY PLANNING
SCHEDULING OPERATION
DYNAMIC ROUTING
FLIGHT AND FLEET MONITORING
CONTINGENCY SUPPORT

SUPPORT SERVICE SUPPLIERS

WEATHER
TRACKING
SEPARATION
3D MAPS
SPACING
COMMUNICATION

RESEARCH TO DETERMINE SERVICES, PERFORMANCE NEEDS, AUTOMATION CAPABILITIES FOR SCALED OPERATIONS

CONNECTIVITY IS KEY



EMBRACING INNOVATION IN AVIATION WHILE RESPECTING ITS SAFETY TRADITION

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UTM STYLE AIRSPACE OPERATIONS ENVIRONMENT

- **Cooperative**
- **Intent-sharing**
- **Digital: data exchanges among operators**
- **Standardized application protocol interfaces**
- **Air/ground integrated**
- **Service-oriented architecture**
- **Role for third parties**

Space Traffic Management

High Altitude UTM (upper E)

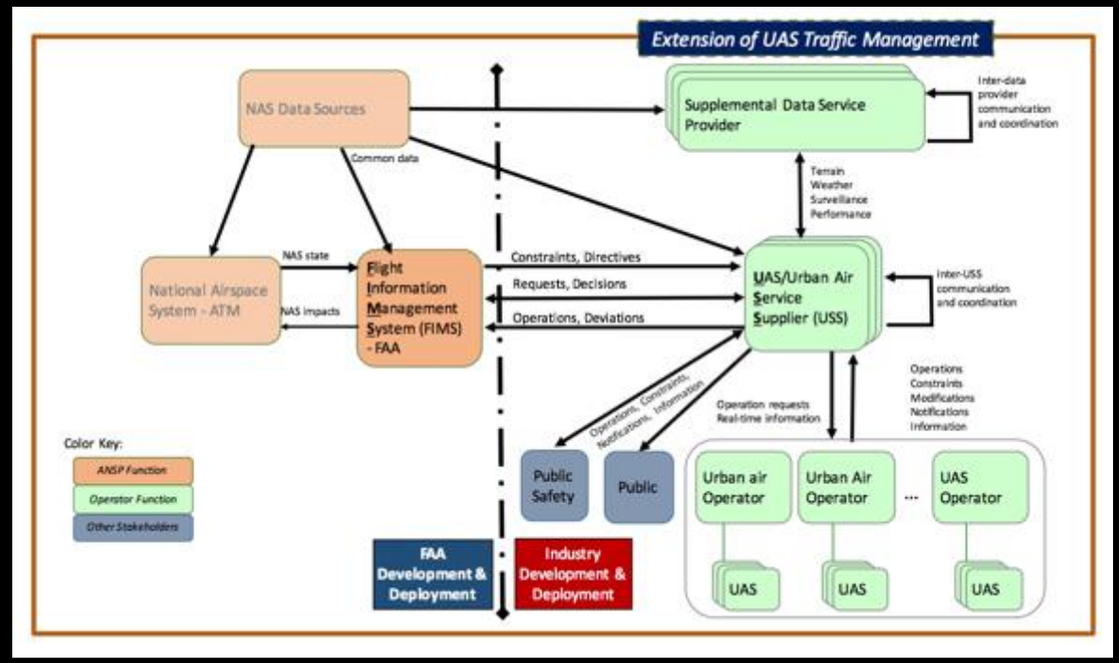
Conventional Manned Aviation (Class A, B, C, D, E)

Urban Air Mobility

Low-altitude small UAS

PATH FOR SCALABILITY

- Architecture, roles/responsibilities and technology that allows self-management as much as possible
- Air traffic control interacts indirectly for the majority of flight - for constraints and directives, and airspace changes
- Operator plans and schedules operation through UTM



- Tracking via wireless, satellite, ADS-B, or beacon-based systems connected through UTM
- Air-ground-cloud integrated system for scalability (spacing, separation, flow management, etc)
- Last/first 100 feet for safe and automated take-off and landing
- Vertiport design and operations for multiple simultaneous arrivals and departures

AIR, GROUND, CLOUD INTEGRATED OPERATIONS AND SYSTEM

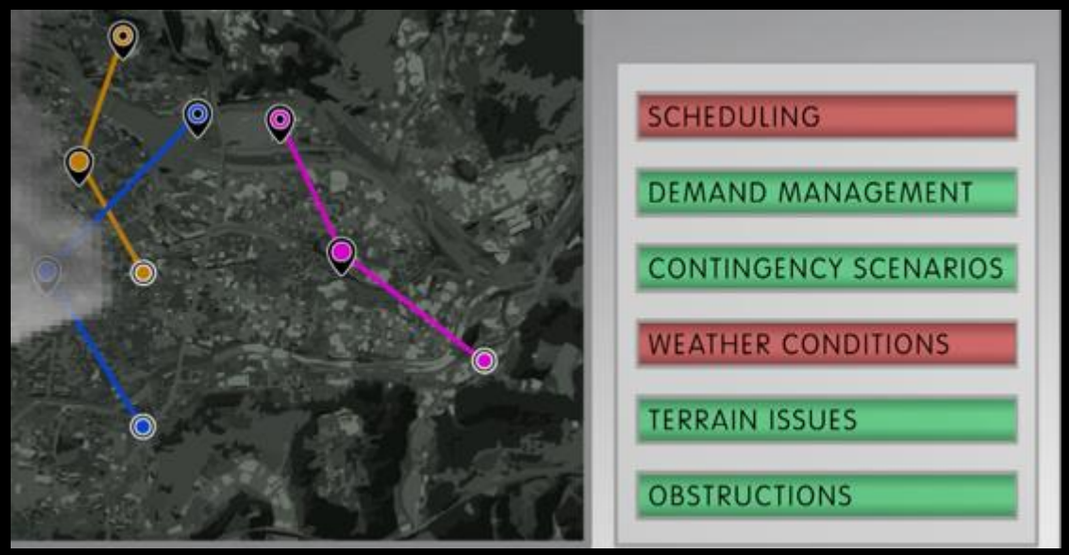
CRAWL-WALK-RUN APPROACH

Low-density: Initial Operational Capability

- Helicopter routes using today's procedures
- Entry into controlled airspace thru UTM
- Users: conflict-free trajectories and own tracking

Medium-density: Interim Operational Capability

- User creates conflict-free trajectories
- Interoperable, cooperative, and intent sharing
- Self-managed operations



High-density: Mature Operational Capability

- Fully-autonomous planning, scheduling, separations, entry/exit controlled airspace, interoperability, and contingency management
- Multiple, simultaneous take-offs and landings

RESEARCH NEEDED TO IDENTIFY REQUIREMENTS FOR SCALED OPERATIONS

RESEARCH

- Scalable en route and arrival/departure operations
- Cooperative and interoperable operations
- Design of vertiports with multiple vertipads
- Weather tolerant operations (75% delays are due to Wx)
- Off-nominal conditions and contingency operations
  - High winds, wind shears, up drafts, etc.
  - Power depletion
  - Bird strikes
- Requirements (e.g. reserve fuel)
- Integrated air/ground/cloud/infrastructure connected system