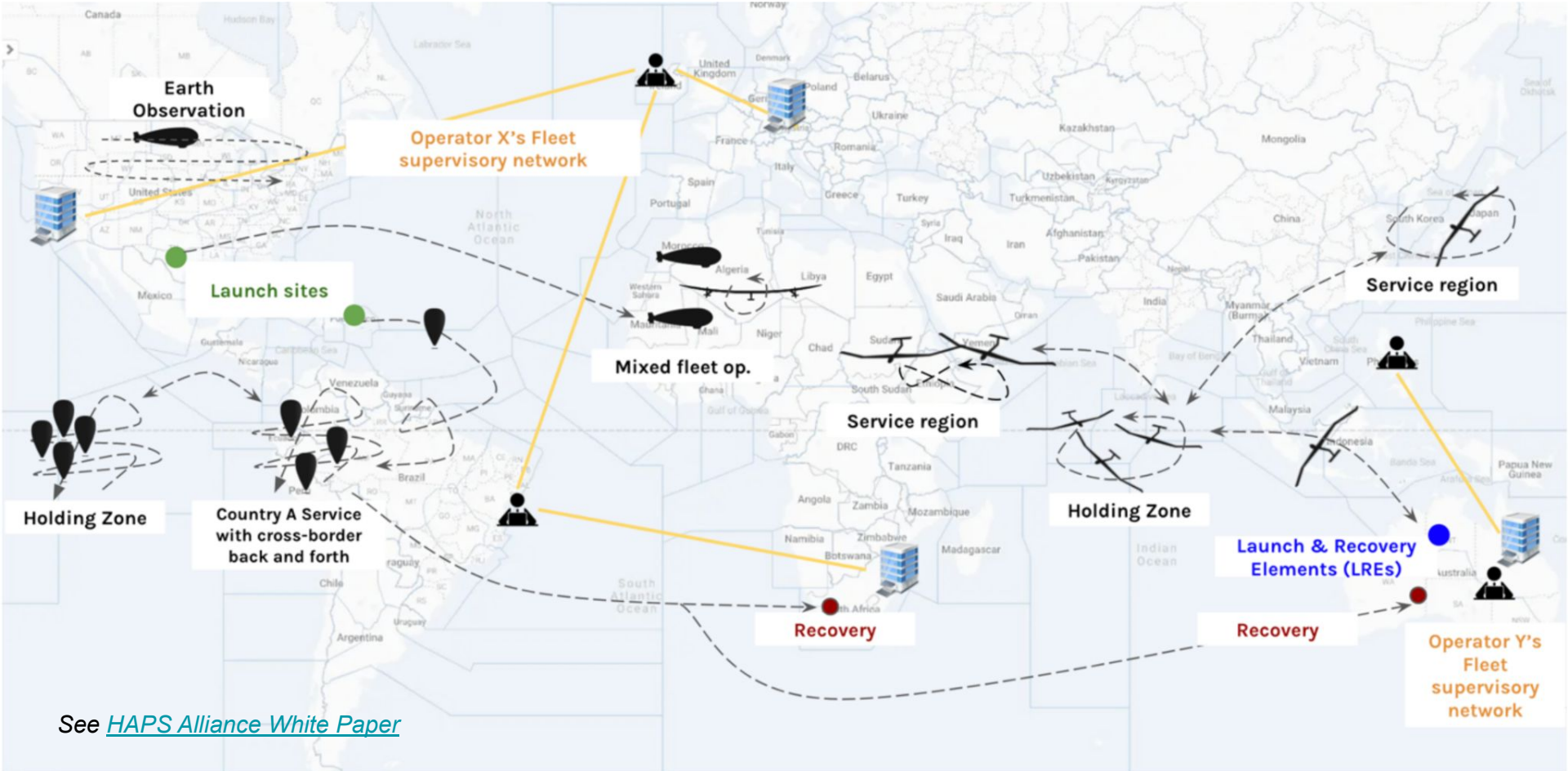
HAPS Alliance

HAPS ALLIANCE

VIEWS ON IMPLEMENTING HIGHER AIRSPACE MANAGEMENT THAT SUPPORTS HAPS

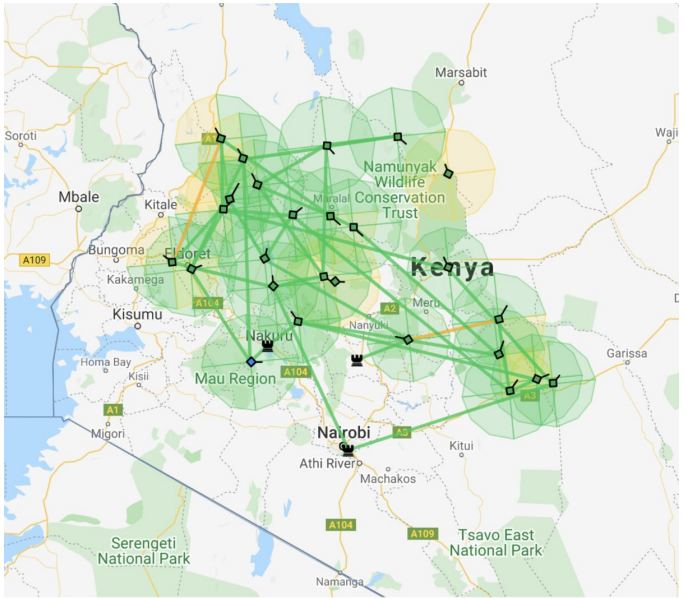
A Unique Operating Concept



See [HAPS Alliance White Paper]

Specificities of HAPS affecting airspace management needs

- **Managed as a fleet/network** with increasingly automated fleet management performing system-wide optimization (network/swarm management)
- **Attended from remote location (e.g. one/multiple ops centers).** Operations can be attended from a country other than the country of operations
- **Exception centric CONOPs** -> At altitude, no pilot is assigned to a vehicle, human operators are assigned to handle exceptions as they arise.
- **Varying performance, generally slow moving**. Performance may also vary with time of day.
- **Continuously airborne** (months at a time) missions often planned and assigned while airborne.
- **No clear planning vs. execution phases - may plan/replan dynamically** (every few minutes for some), refining plan and predictions, adapting to changing environment or missions.
- **International trajectories** - Can travel across the globe, take-off and land in different countries, may be stationed across country borders
- **Fly in generally above FL500** (leverage lower altitudes for energy management, optimal wind seeking, etc.)
- Can create locally dense traffic (see example)
- **Unmanned / Uncrewed - No lives aboard** → Severity of inter-HAPS conflict is less than one involving human lives.



A network of 25 interconnected, continuously moving, automated HAPS delivering internet in Kenya in July 2020. Altitude: FL500 - FL620 - Operations managed from multiple locations: London, UK - California, USA, Michigan USA

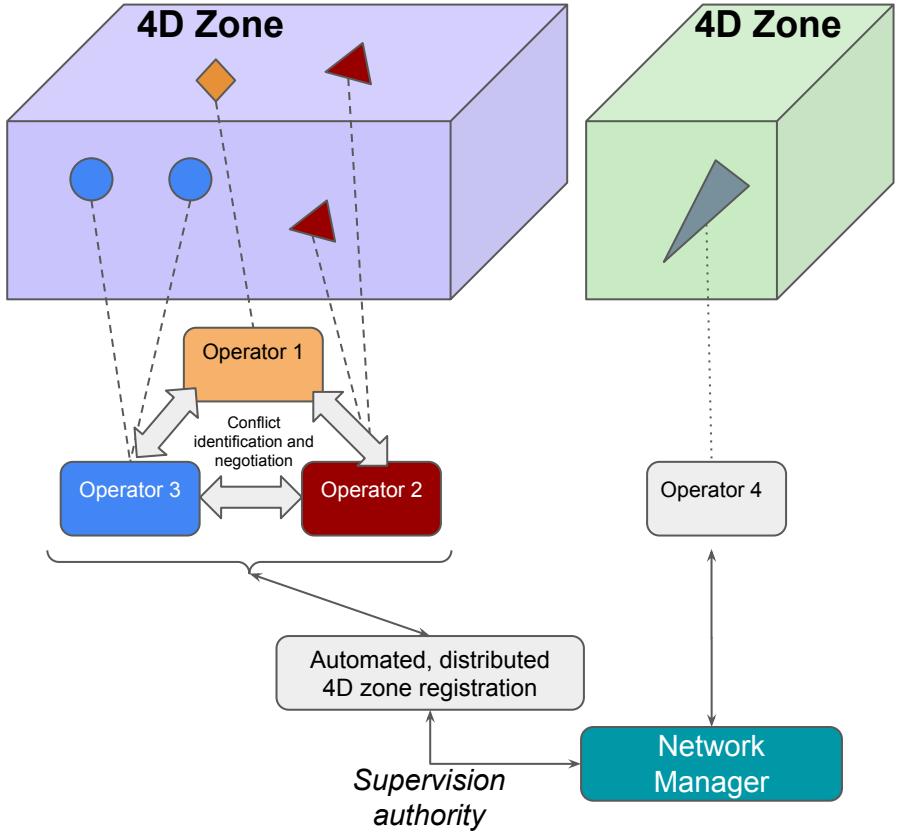
See [HAPS Alliance White Paper]

Key Terms in HAPS Wold

HAPS (High Altitude Platform Systems)	High Altitude Platform Systems HAPS are attended Autonomous Fleet Systems, which include a fleet of craft (i.e., one or more uncrewed vehicles) and the systems that manage them.
Fleet Operations Director	A first-person supervisory role which determines the appropriate procedures and protocols for response to events, especially in an off-nominal situation or incident.
Fleet & Systems Supervisory Network	That which is collectively responsible for supervising the fleet and systems (e.g., the set(s) of people, teams, associated systems, etc.). Responsible parties are not necessarily collocated and execute their respective functions as a virtual team.
Lighter than Air / Heavier than Air	Vehicles can be hybrid and do not fall easily into one aircraft category or the other. Broadly - HAPS fall into two categories. Heavier than Air, require propulsion and True Airspeed to remain airborne. Lighter-than-Air leverage buoyancy to maintain altitude - They may be equipped with some True air Speed Capability, which may be turned on/off dynamically, but which is not necessary to maintain altitude or safe operations.

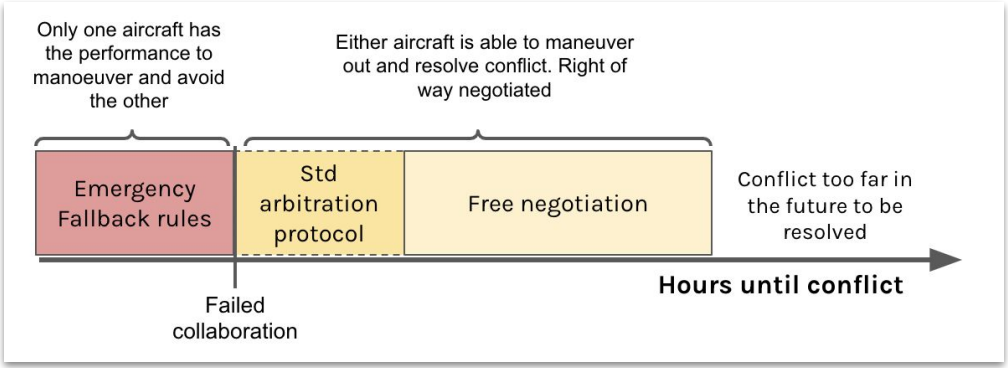
Views on Airspace Management

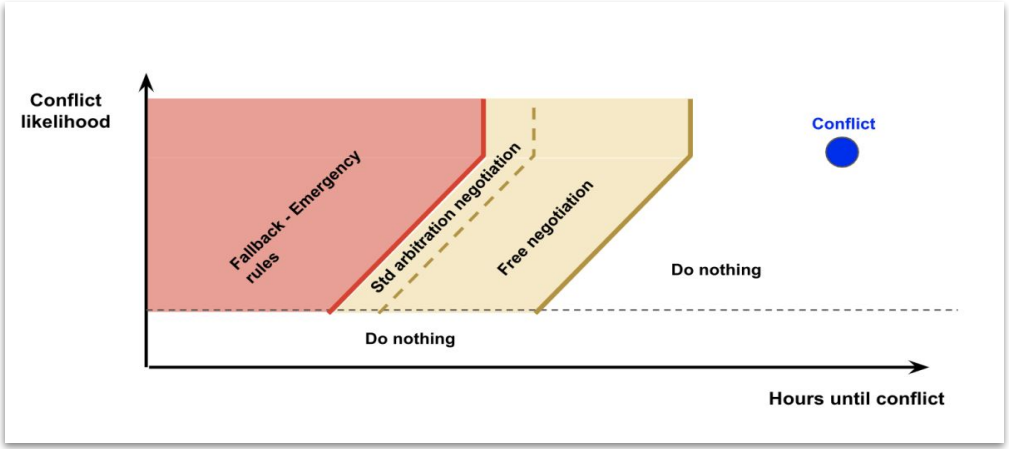
- **Need for distributed traffic management** with “UTM-like” DSS, assigning 4D zones to operators (no-single separation provider in an airspace)
- **Enable multiple operators self-deconflicting in one 4D zone (directly or through 3rd party)**
- **Network Manager oversees 4D zone allocation**, and acts as interface for operators unable to get automated assignment,
- **4D zones serve as density management** and segregation between collaborative and non-collaborative traffic (e.g. ATM traffic)
- **Need for continuum timeline from planning to execution**: support partial “rolling-window” flight plans (A-?) continuously updated, refined, extended or modified while airborne



Inside a 4D zone operators share intents, performance and negotiate resolution

- **4D intent volumes*** with probability contours shared between relevant operators on **rolling time window** (continuously extended, updated)
- **Shared performance** (how long it takes me to avoid you) **enables operators to start resolving conflicts at an appropriate time.**
- **Conflicts identified on timeline basis** to keep negotiation possible (a.k.a both operators are within capability to avoid the other)
- **Standard arbitration protocol** guarantees timely decision and fairness. Static right of way rules only for emergency.
- Negotiation scheme **built to incentivize efficient airspace use** (accurate position and intent, non-greedy planning).





See AIA Paper

** A 4D intent volume here is conceptually similar to 4D trajectory, but the 3D boundaries of the volume are not necessarily constant in time, and may contain probability contours (think hurricane track).*

Embrace the opportunity to radically Innovate in Airspace Management.

- A system that is generic enough to suit HAPS' diverse and unique needs, will be future proof and suited for future aircrafts to come.

- We must embrace d distributed/decentralized airspace management to promote innovation. Distributed systems are the future, and are more resilient/secure than centralized ones.
  - UTM-Like DSS for 4D-Zone assignments
  - Operator managed deconfliction of 4D intent volumes/trajectories between relevant actors (sharing intents and negotiating).

- Implement a Crawl - Walk - Run approach. Start with simple bilateral operator to operator deconfliction agreements for early testing (e.g. Zephyr - Loon deconfliction over Australia)

- Include the HAPS Alliance in the design of ECHO implementation