DRONE ENABLE

ICAO's Unmanned Aircraft Systems (UAS) Industry Symposium (UAS2017)

Friday, 22 September, 2017 @ ICAO HQ, Montreal, Canada

Session: ***UTM – A common framework with core boundaries for global harmonization***

Framework for urban Traffic Management of Unmanned Aircraft System (uTM-UAS)

presented by

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Collaborators

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Agenda

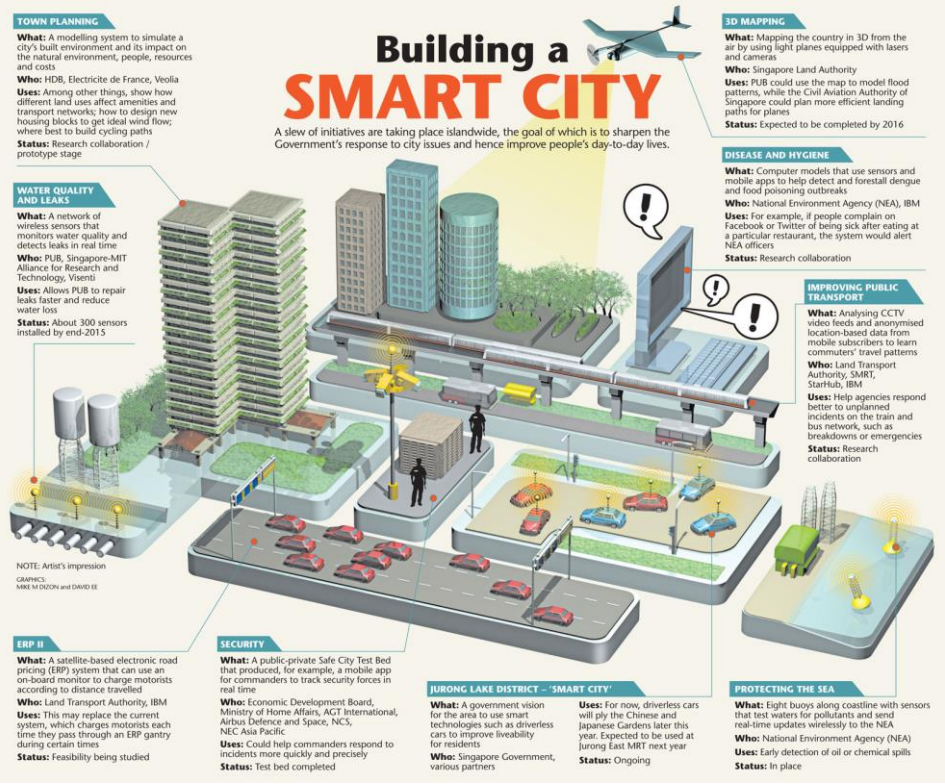
1. Introduction
2. Motivation
3. Signature of Singapore's Urban Infrastructure
4. Proposed UTM Framework
5. A Singapore Case Study
6. Summary

Introduction

To define a Framework for an urban Traffic Management (uTM) System to operate Unmanned Aircraft Systems (UAS) effectively, safely and efficiently

Motivation

- **Growing demands for UAV operations by government agencies, recreational and commercial users**
- **Government Initiatives: Future Smart City & Future Mobility (unmanned systems, including UAVs); Singapore: Garden City with 100% urbanized; area: 720 km^2; population: 5.6+ million)**



Drone Applications in Urban Environment

Popular applications:

Videography

Surveillance

Inspection

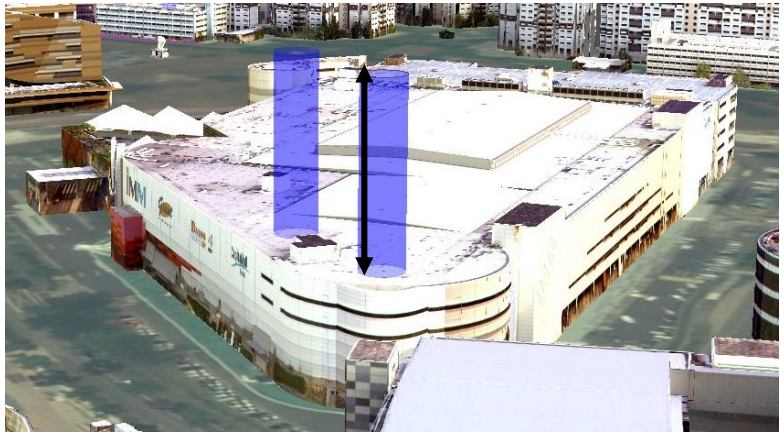
Delivery

Future scenario: Multiple drones operated at the same time

Signature of Singapore Urban Infrastructure: Proposed Guidelines

- Zoning of urban town in small areas (for efficient and effective management of drone operations)
- Retail area @ designated supply/delivering point
- Residential area @ designated demand/receiving point
  - Multi storey carpark
  - Open area

Signature of Singapore Urban Infrastructure: Proposed Guidelines



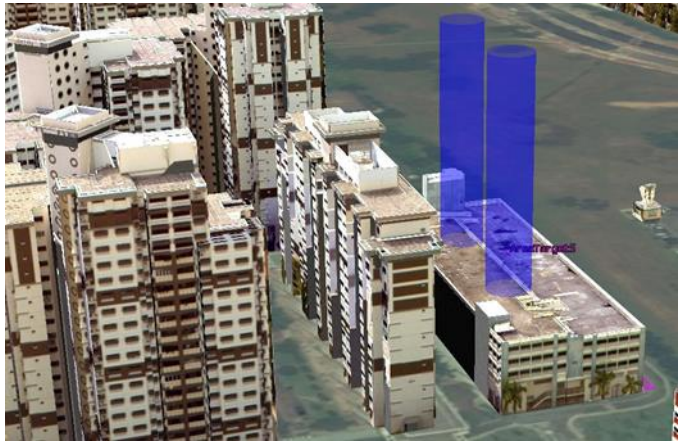
Height of Take-off and Landing (ToLd: up to 60m (200ft)

Distance between Take-off and Landing (ToLd): 20m

- Zoning of urban areas
- Retail area @ designated supply/delivering point
- Residential area @ designated Radius of service coverage

Note: For cost-effective, make good use of existing urban infrastructure and facilities

Signature of Singapore Urban Infrastructure: Proposed Guidelines



Multi storey carpark

Open area

- Zoning of urban areas
- Retail area @ designated supply/delivering point
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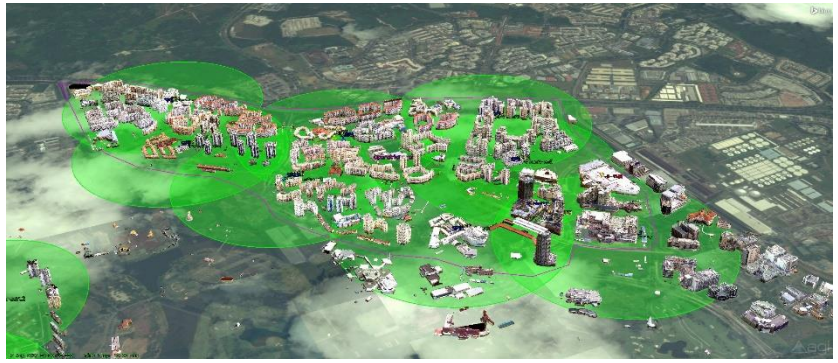
- Radius of service coverage

Signature of Singapore Urban Infrastructure: Proposed Guidelines



- Zoning of urban areas
- Retail area @ designated supply/delivering point
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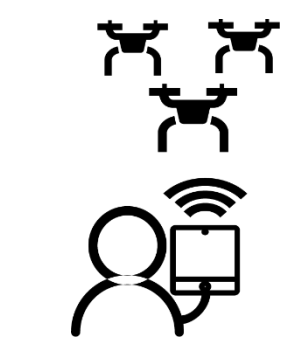
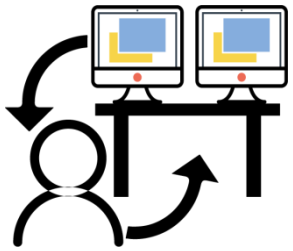
  - Multi storey carpark
  - Open area
- Radius of service coverage

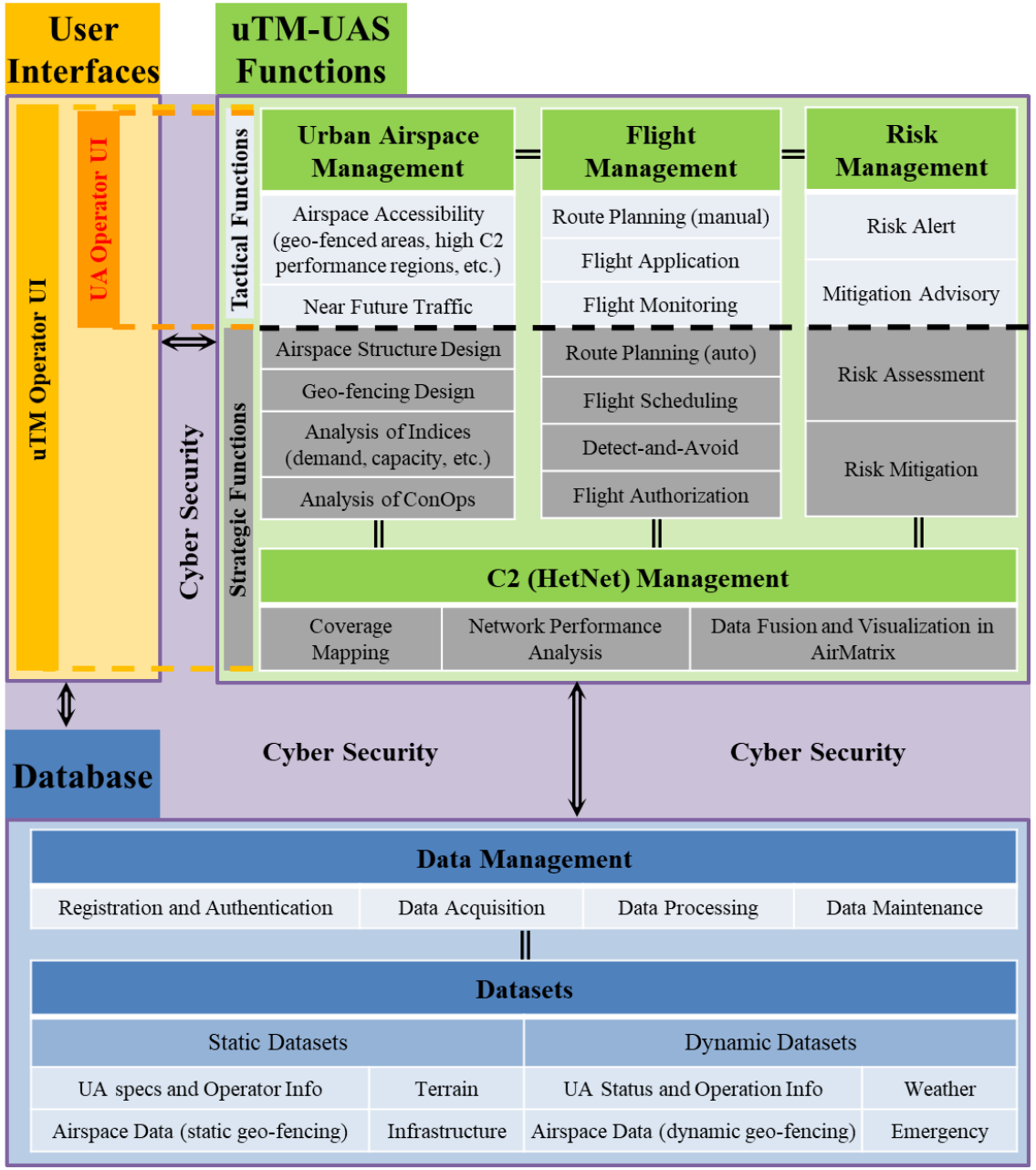
Key Requirements for Urban UTM Framework

- **Reliable systems with essential functionality to ensure effective, safe, and efficient UAV Operations**
- **Flexible, dynamic and optimal airspace management developed specially for urban environment**
- **Enabling technologies, risk modelling and management required/suitable for urban environment**

Proposed *Modular* UTM Framework

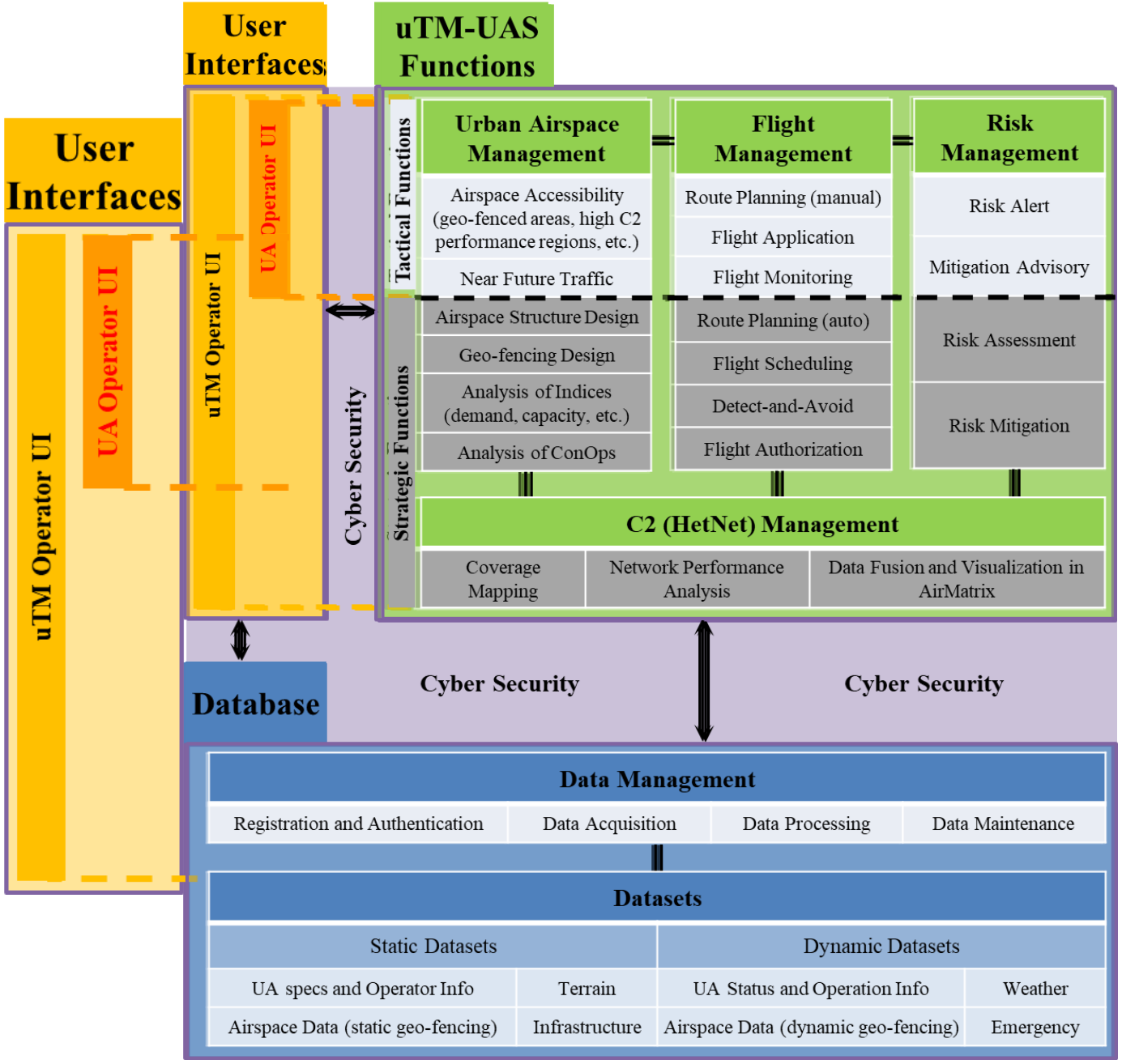




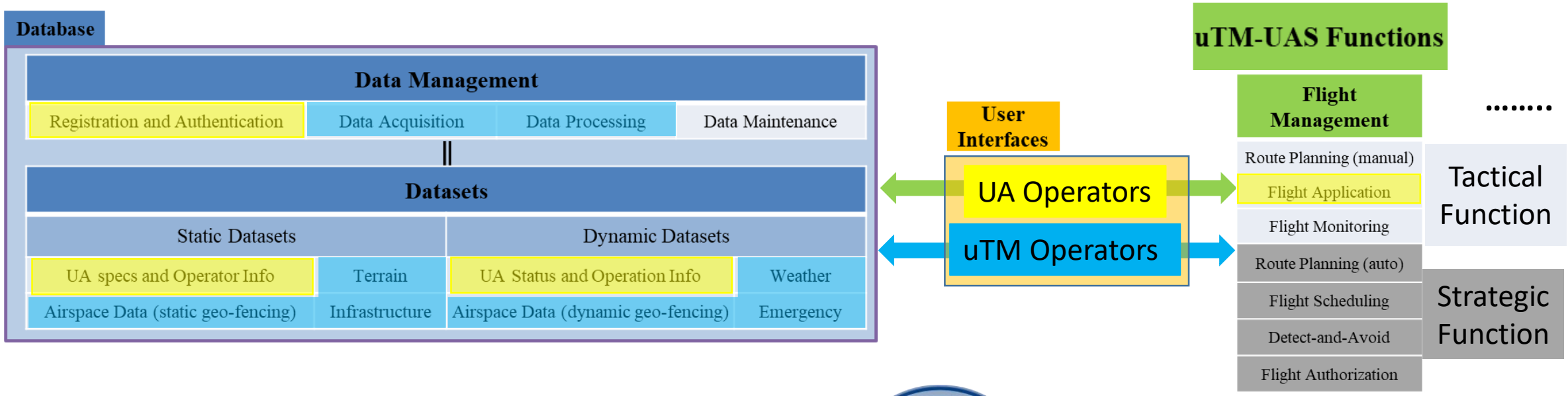


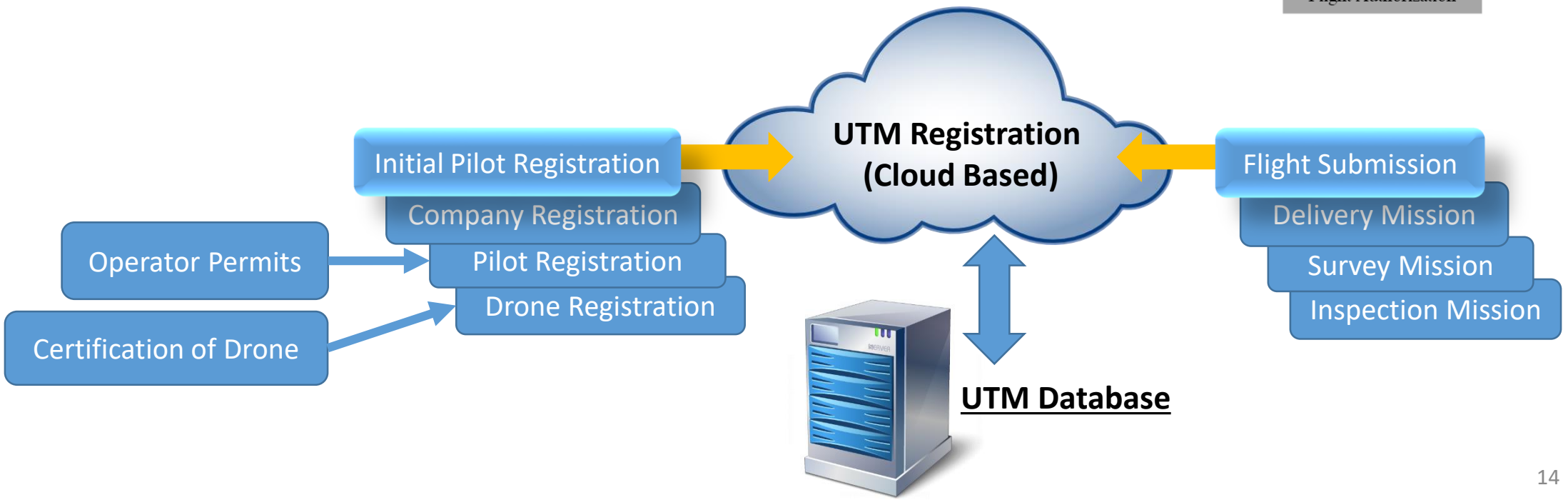
Advantages of Modules: Different topics, areas, and sub-areas can be added and removed systematically for particular conditions, cases and applications considered.

Proposed UTM System – Framework Structure

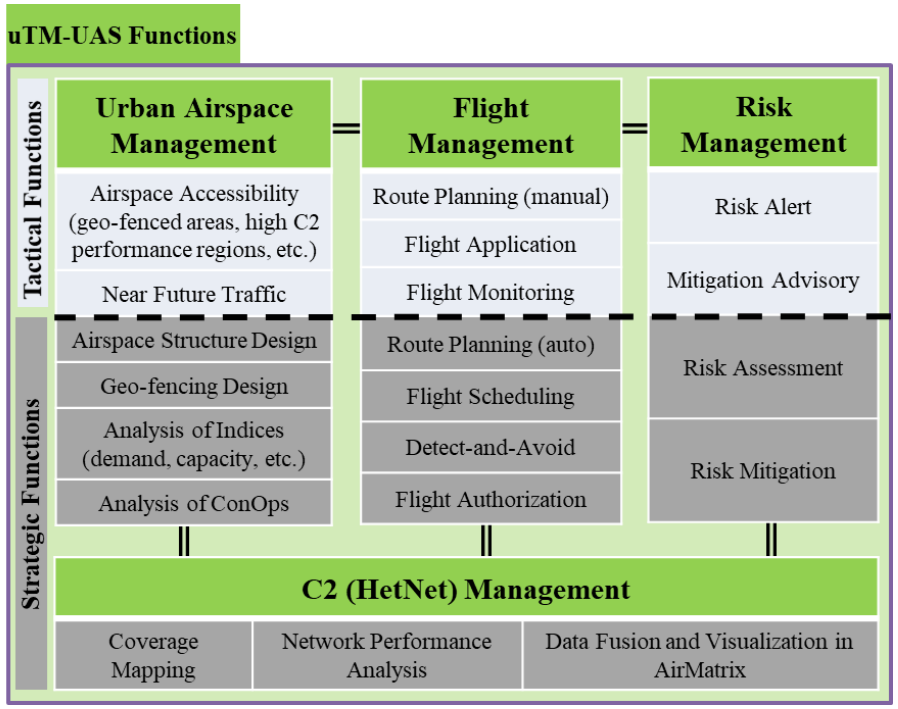


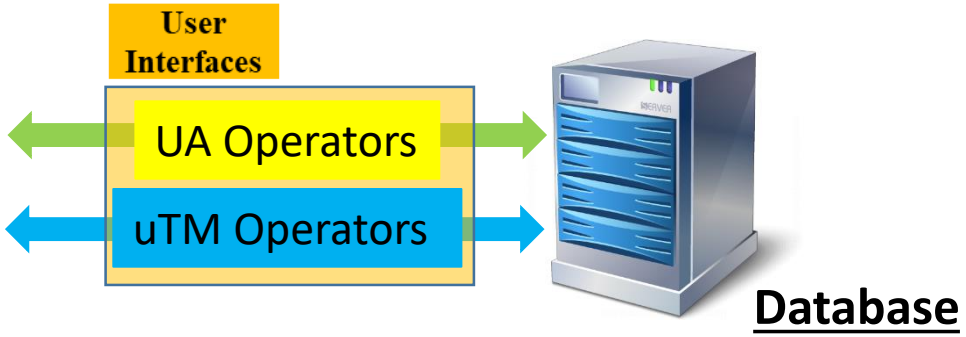
Framework Structure – Database





Framework Structure – uTM-UAS Functions

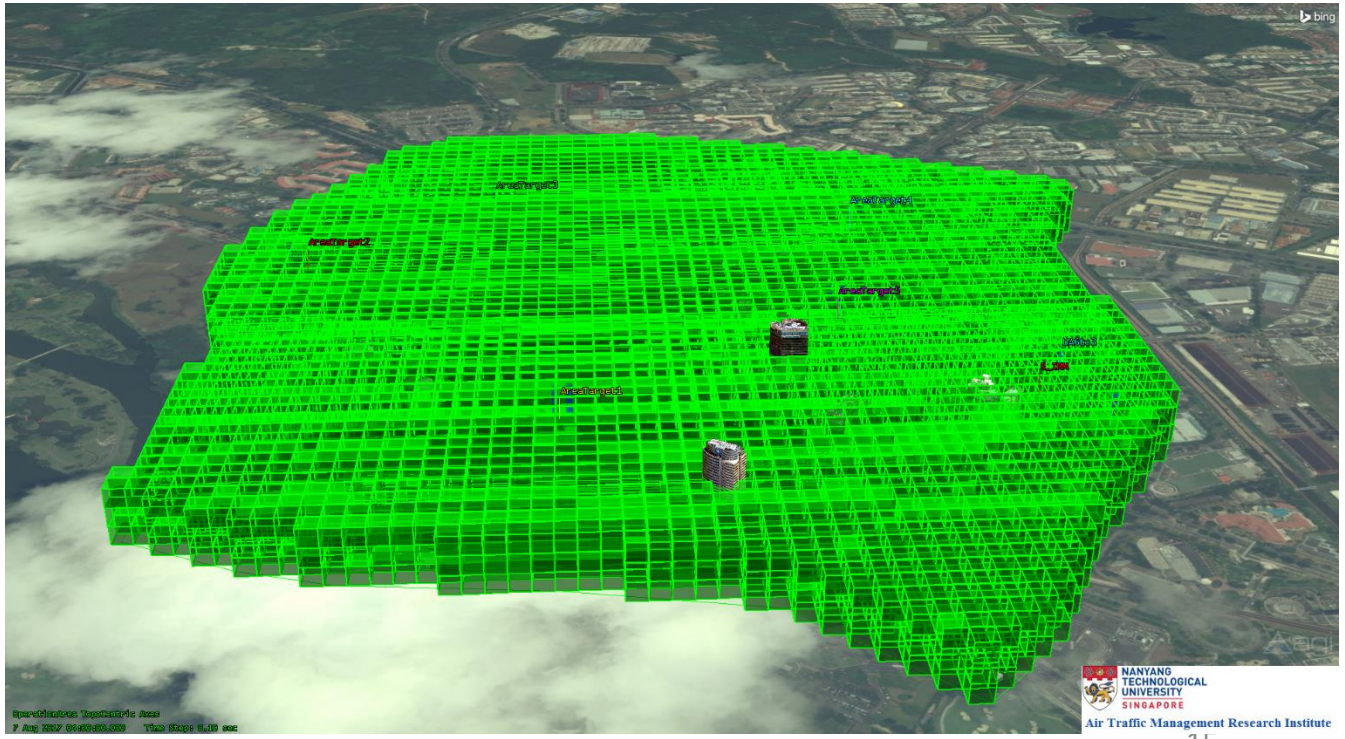




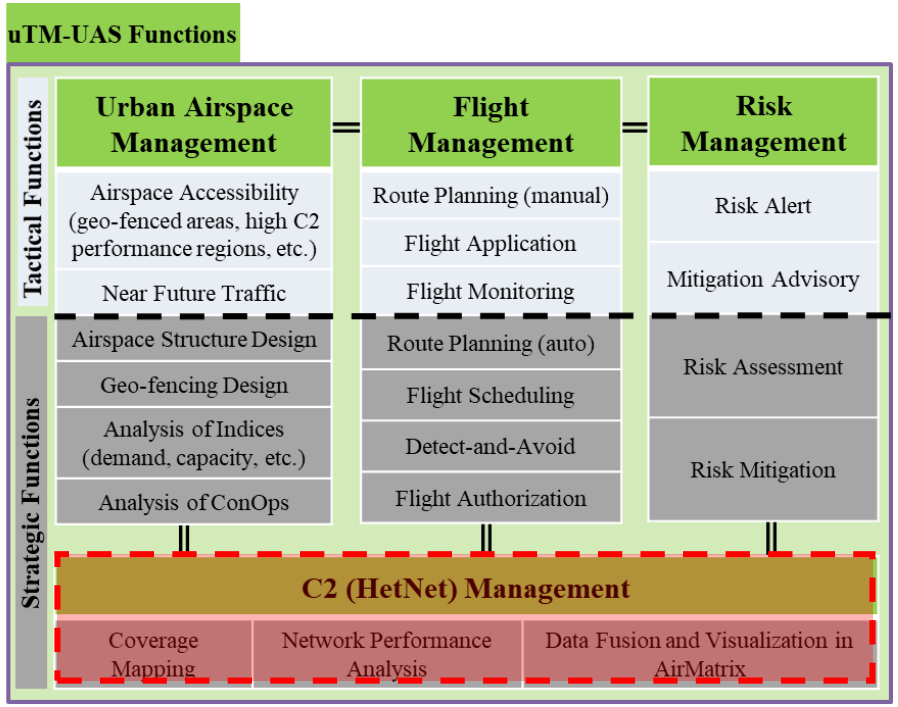
Database

Proposed solutions for managing urban airspace: **AirMatrix**

- Multi-layered in altitude
- *Airblocks* in latitude and longitude

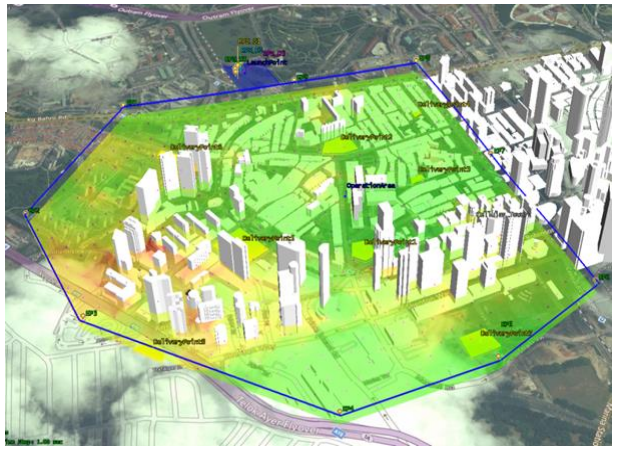


Framework Structure – C2 Management

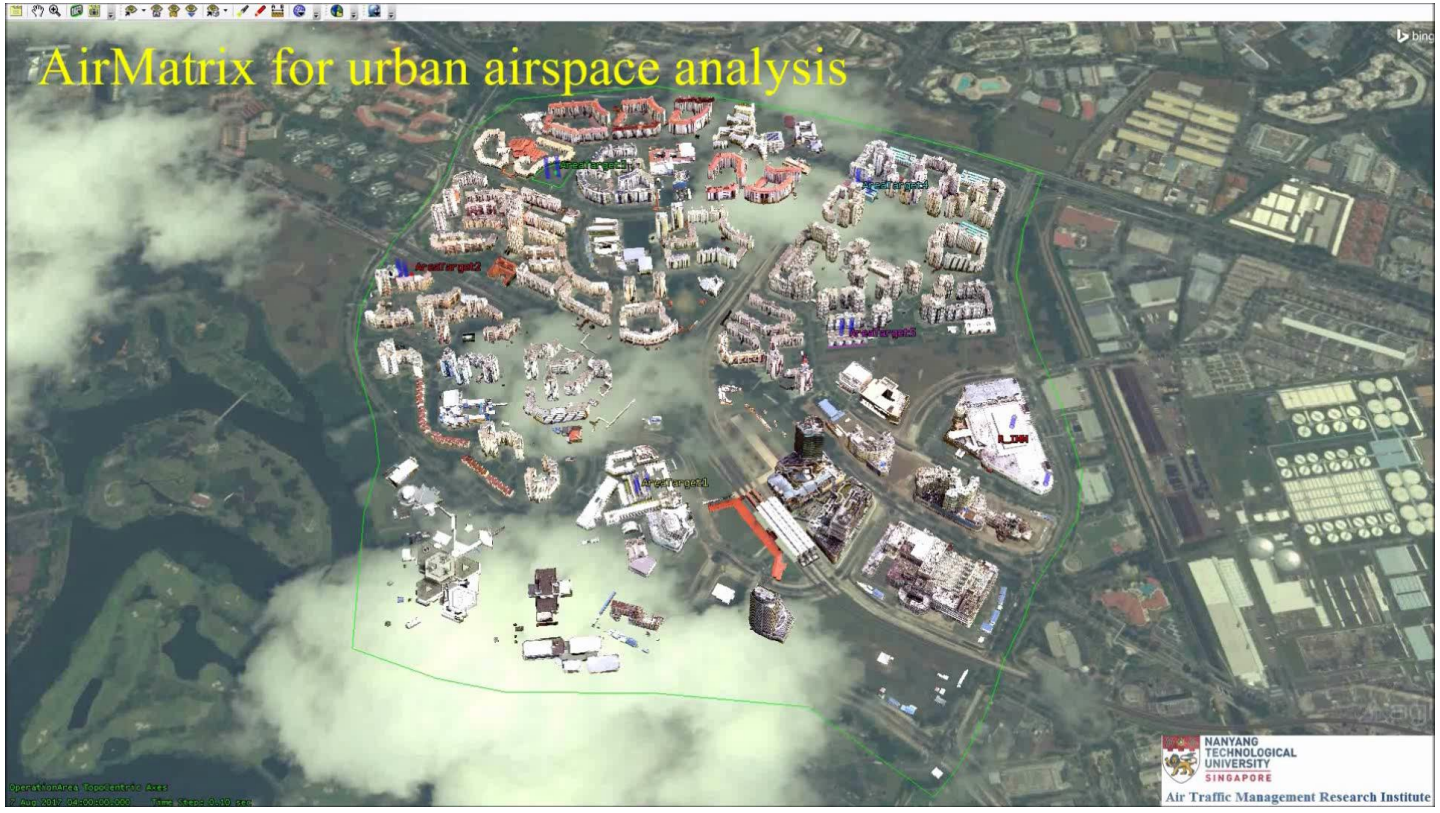


Actual Flight Validation

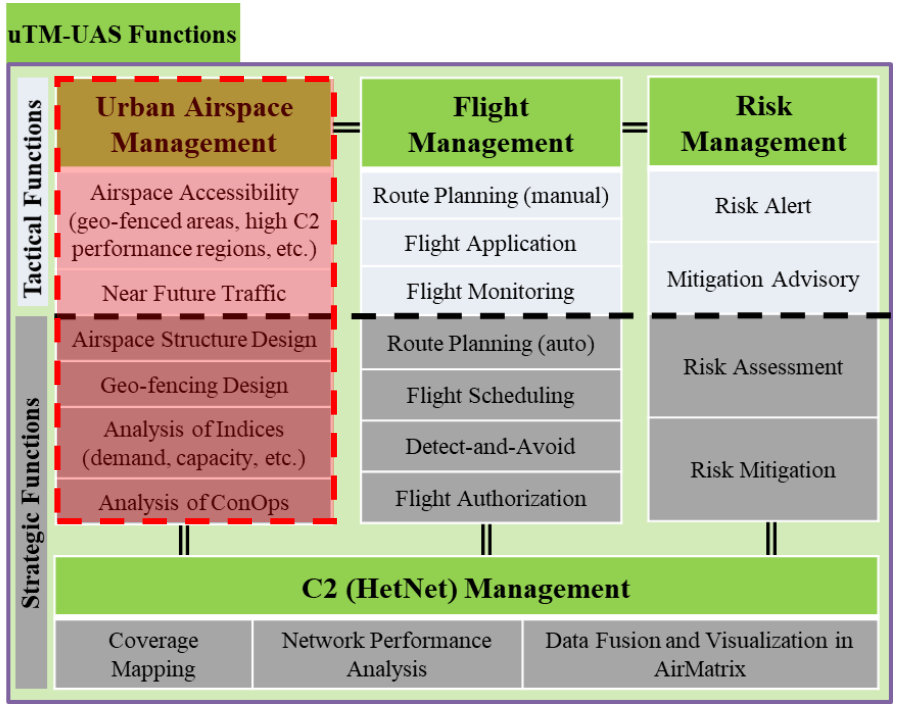
Coverage Mapping

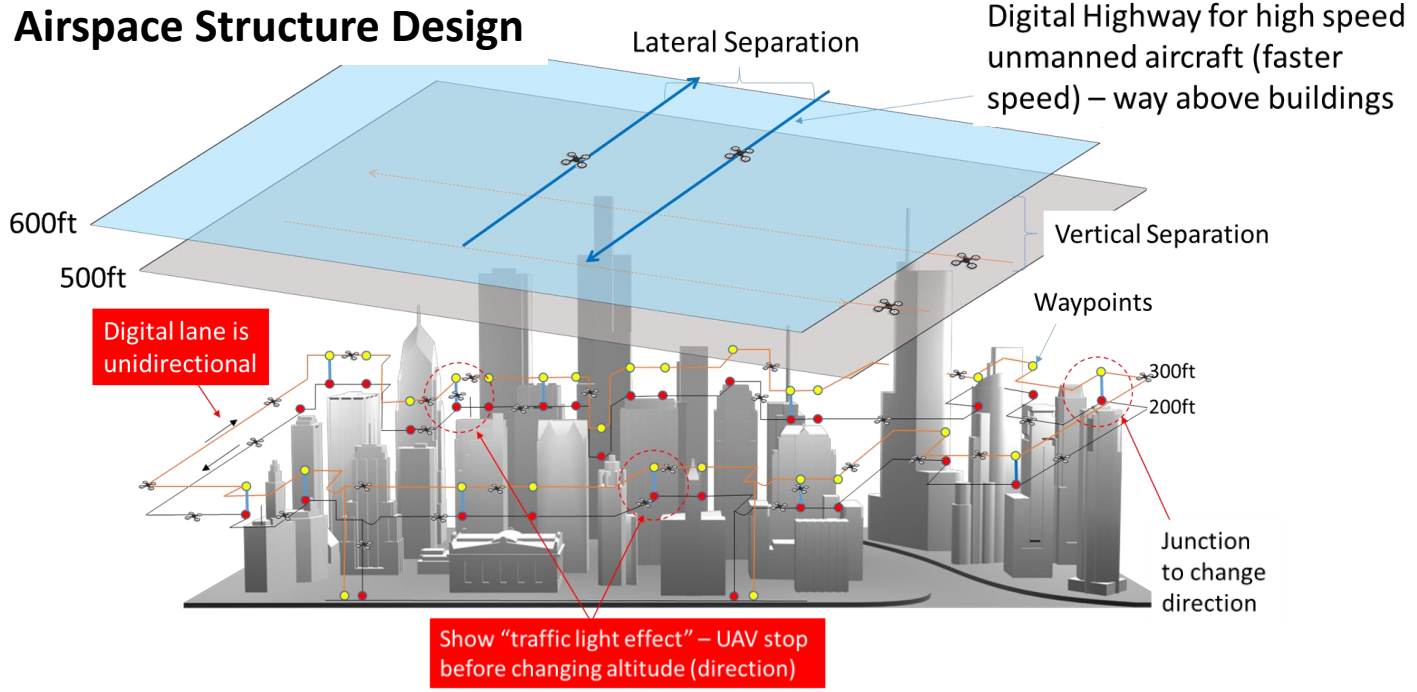


- Able to analyse *coverage mapping* based on real network data performance
- Able to determine the performance of individual airblocks
- Provide a reference for the function of uTM-UAS modules

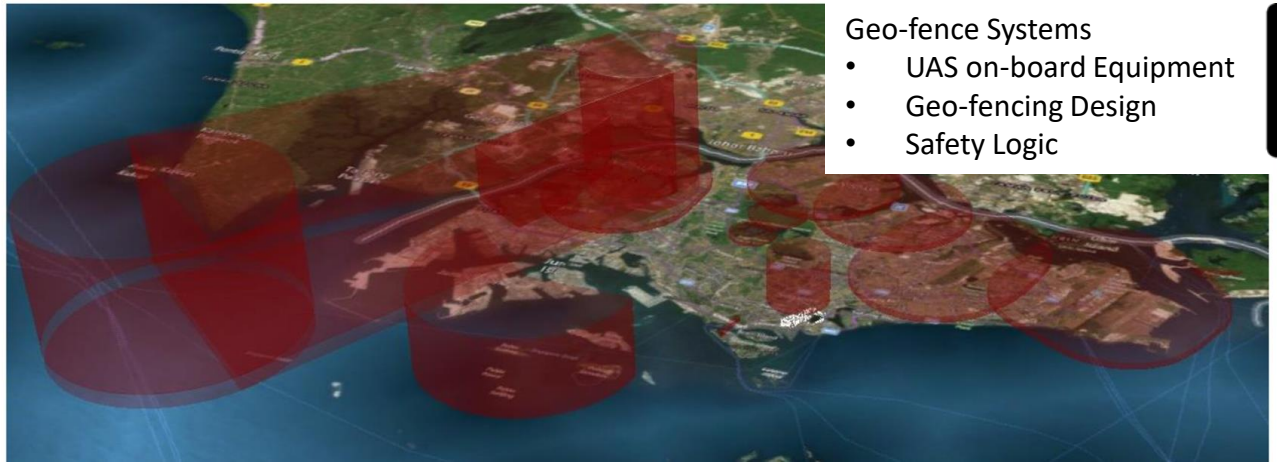


Framework Structure – Urban Airspace Management



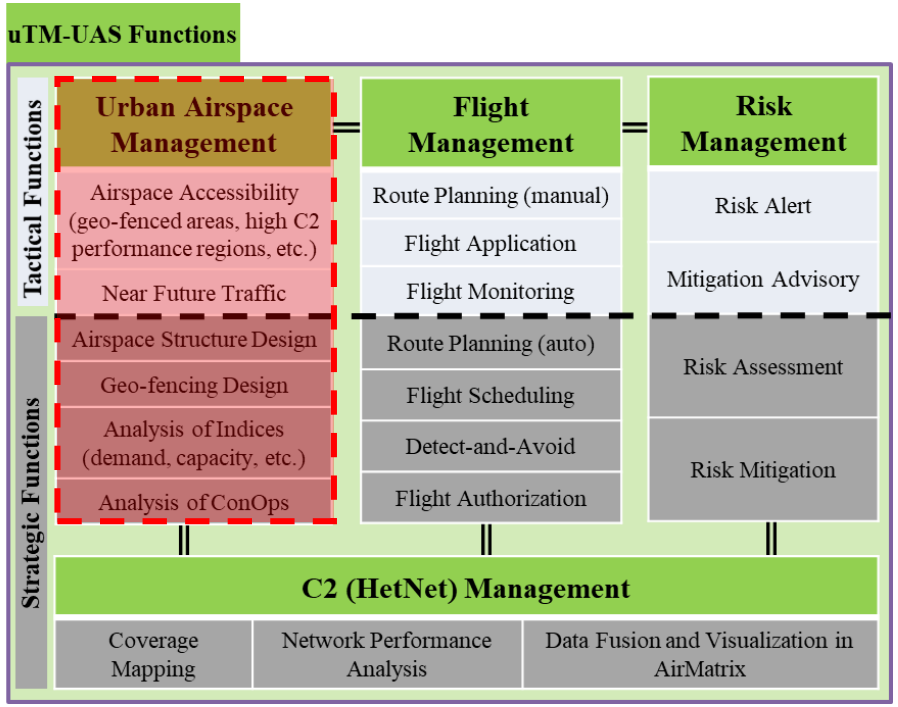


- Allow uTM operators to study and design different airspace structures
- Allow the extraction of essential geometric data for analytical studies



Geo-fence Systems
- UAS on-board Equipment
- Geo-fencing Design
- Safety Logic

Framework Structure – Urban Airspace Management



Distance from Supply Area to Service Area 1 & Service Area 2: 1.3 km & 2 km, respectively

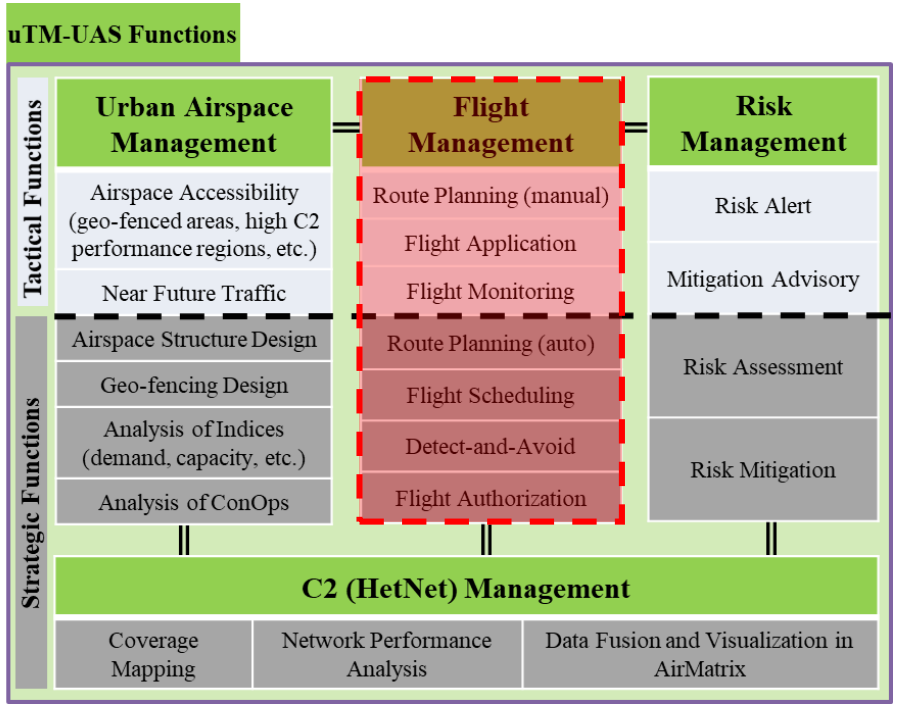
- Allow uTM operators to study and design different airspace structures
- Allow the extraction of essential geometric data for analytical studies
- Able to simulate traffic of UAS operations and to study airspace performance, such as capacity, efficiency and safety

Analytical Study of Capacity

- Performance of UA
- Separation requirements
- Reaction time (similar to car crash prevention analysis)

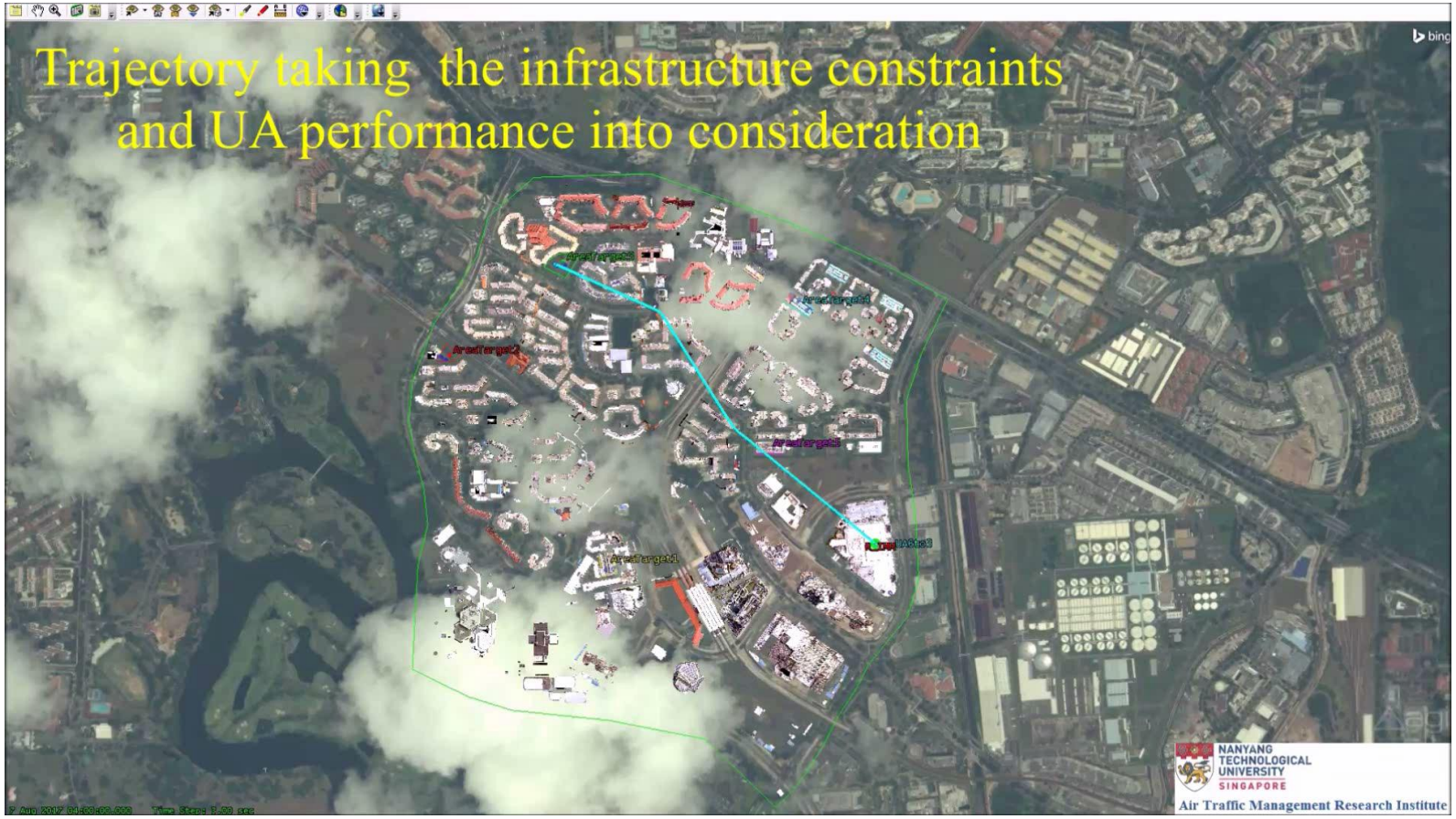
	Two Sec Reaction Time		50 ft Lateral Separation	
Service Area	1	2	1	2
Maximum Capacity from Supply to Service Areas	66	99	88	133
Maximum Capacity from Service to Supply Areas	92	104	123	139

Framework Structure – Flight Management

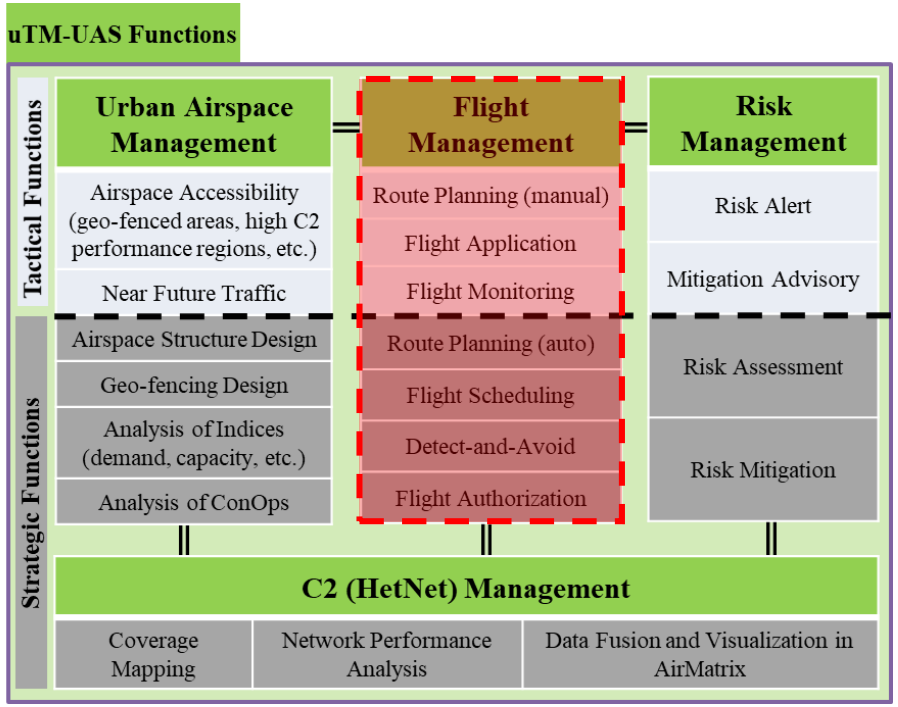


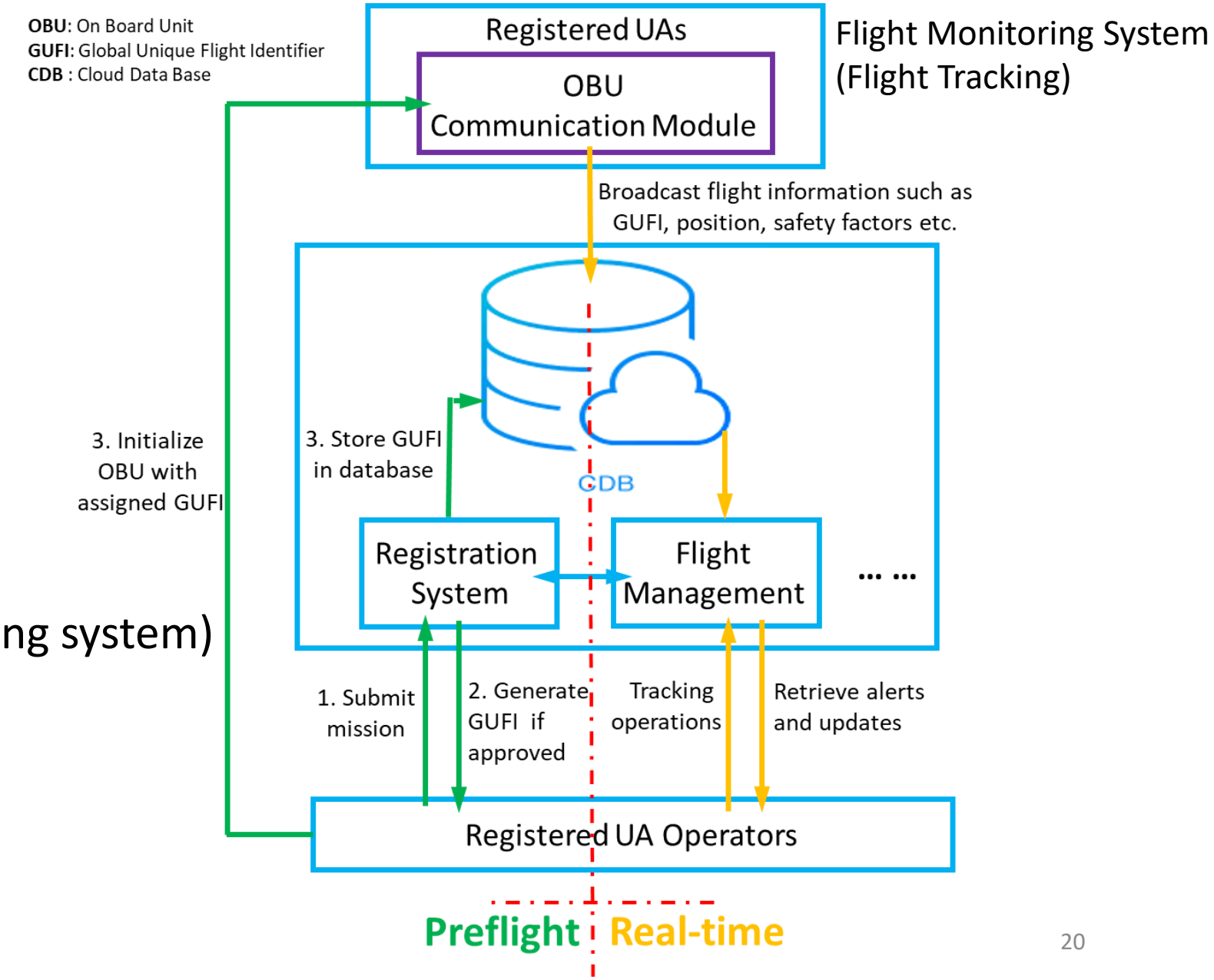
- Manage flight **planning** (airblocks, well-clear consideration etc.)

Route Planning



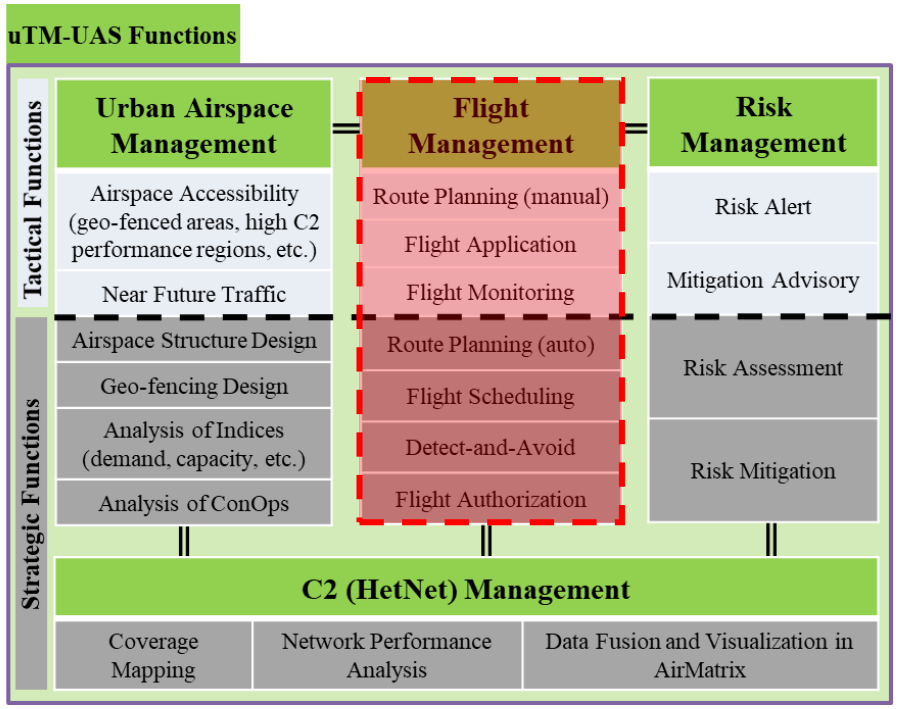
Framework Structure – Flight Management





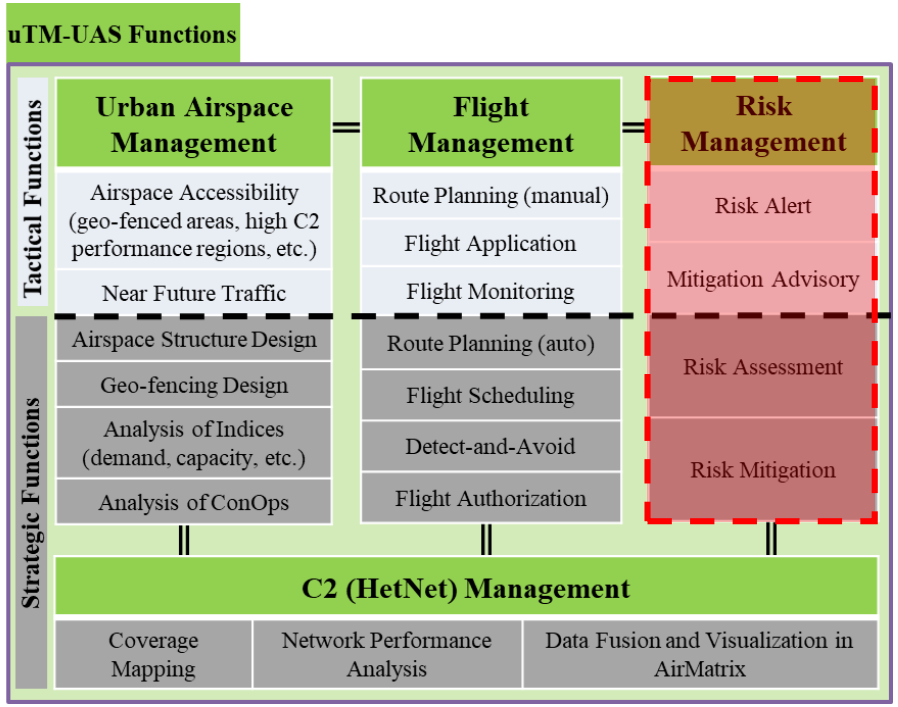
- Manage flight **tracking** (monitoring system)

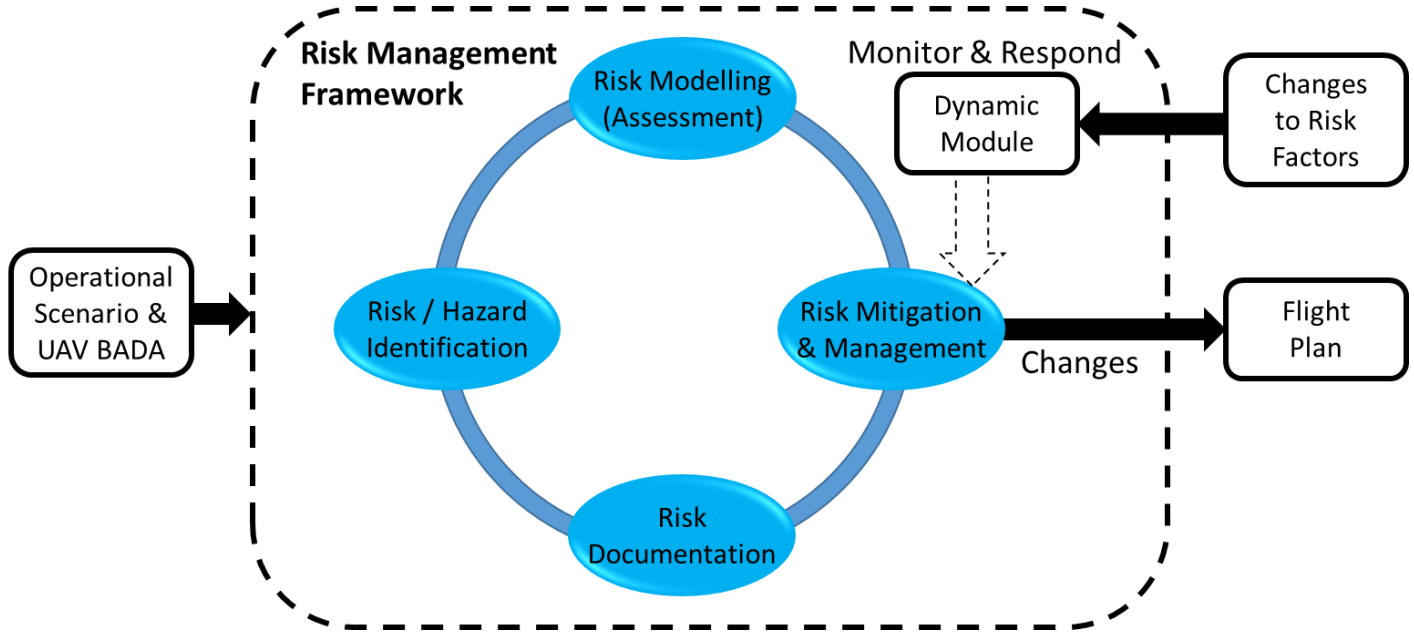
Framework Structure – Flight Management



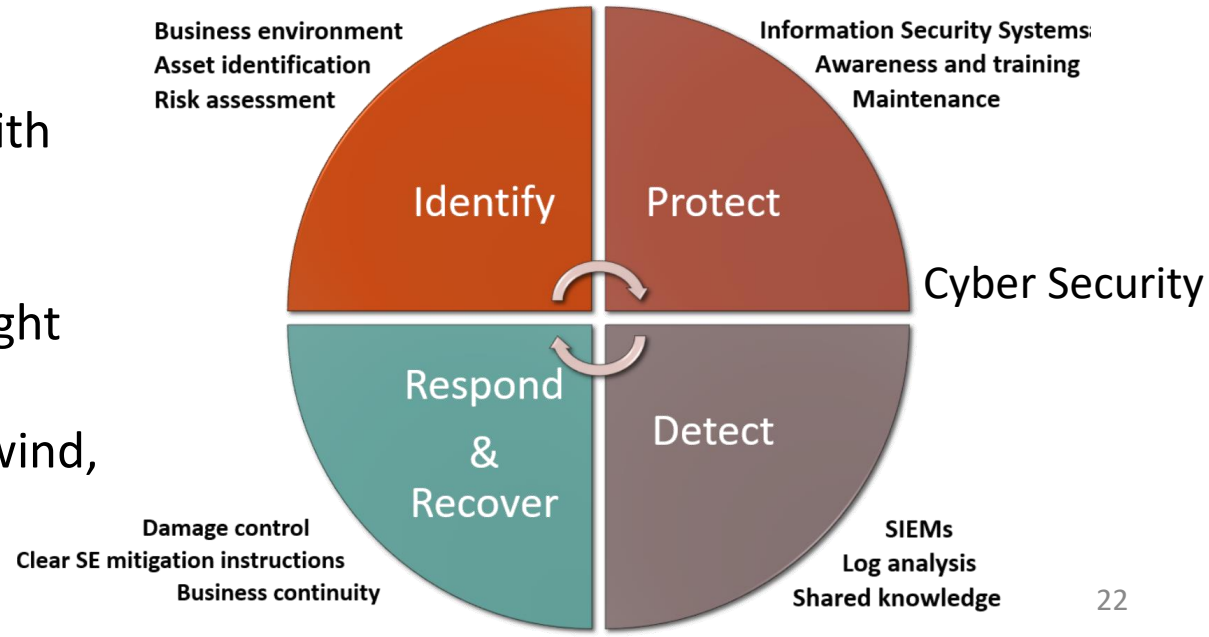
- Manage flight planning and tracking
- Allow optimal route to be developed through route planning function
- Enable live data of flight operations streamed back to database and display in UI for flight monitoring

Framework Structure – Risk Management

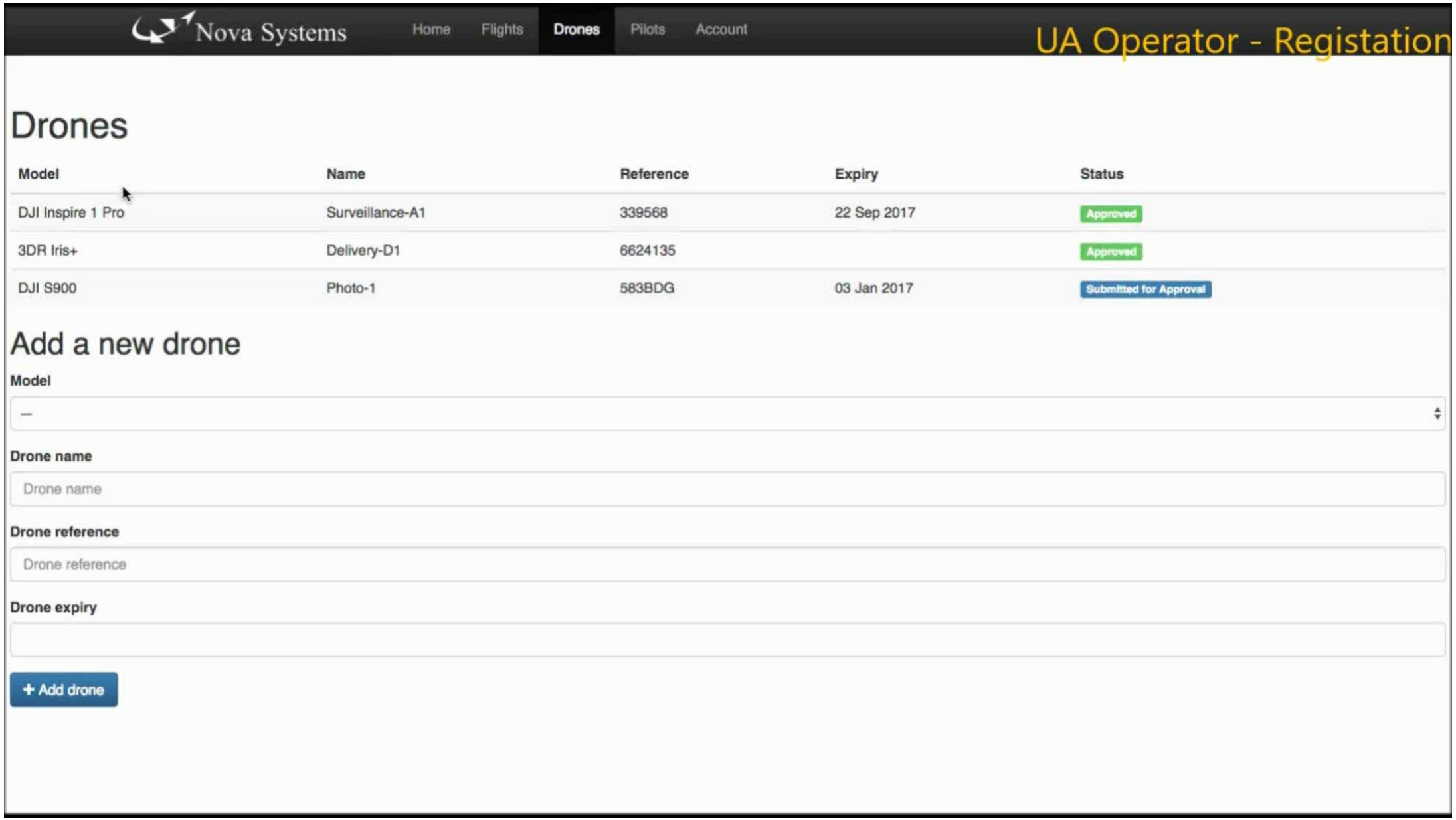




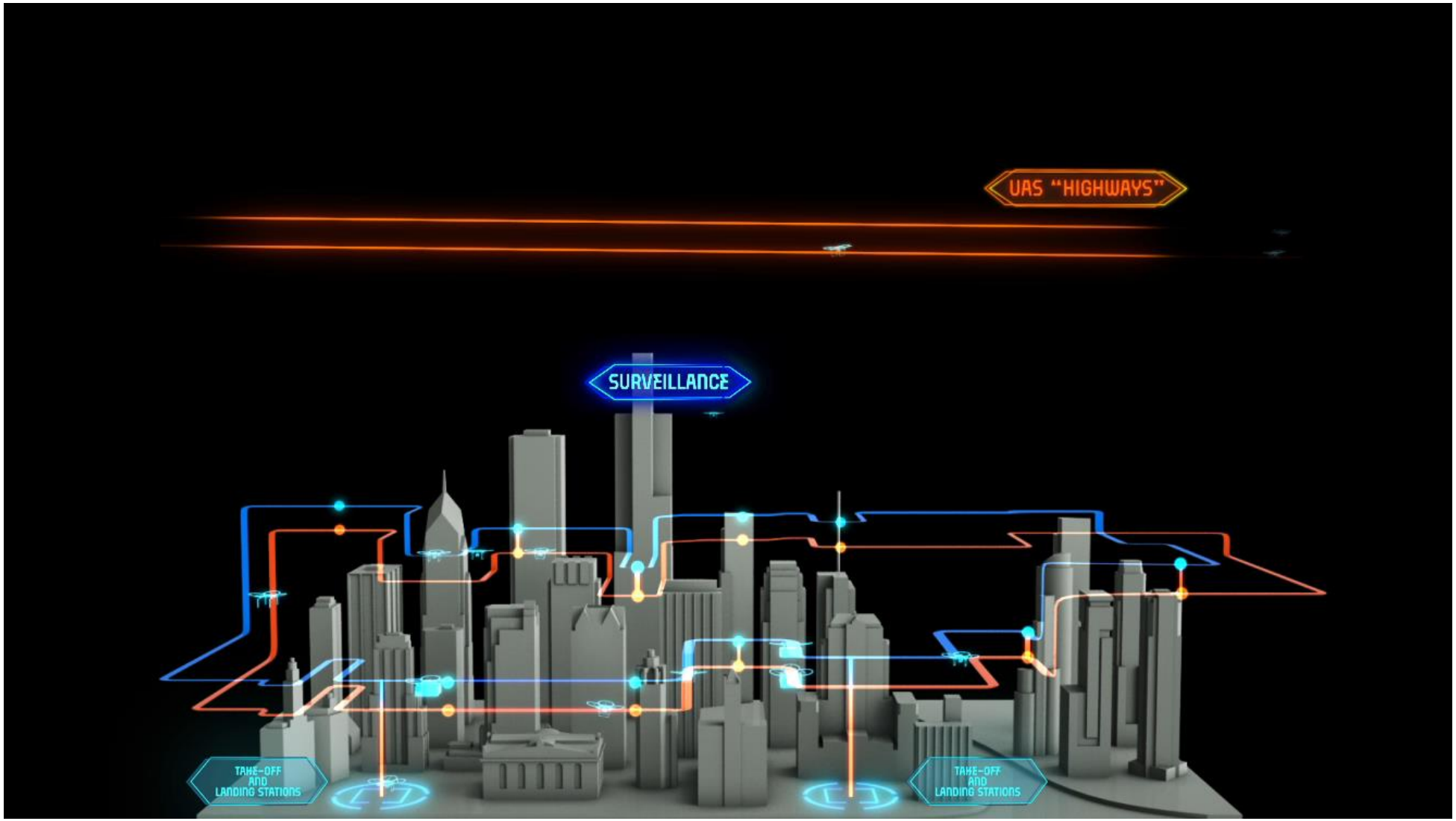
- Estimate and quantify the risk of UAV operations with risk mitigation for different applications
- Able to estimate various risks associated with UA platform, for example, risk assessment by UAV Weight Threshold Study by NTU
- Allow on-line monitoring for various risks (such as wind, rain etc.); provide alerts and advice to all operators



A Singapore Case Study



Future *Urban* Drone Operations and Airspace Management (*version: Sep 2017*)



Main features of drone operations:

- Dynamic airspace planning

- UAS Highways for inter-zone UAV operations

Summary

Effectiveness

- Provided a modular framework with structured workflows
- Developed a system of systems that can communicate among different modules
- Covered *Tactical* and *Strategic* functions for detailed studies and considered other factors, such as cybersecurity, privacy & noise

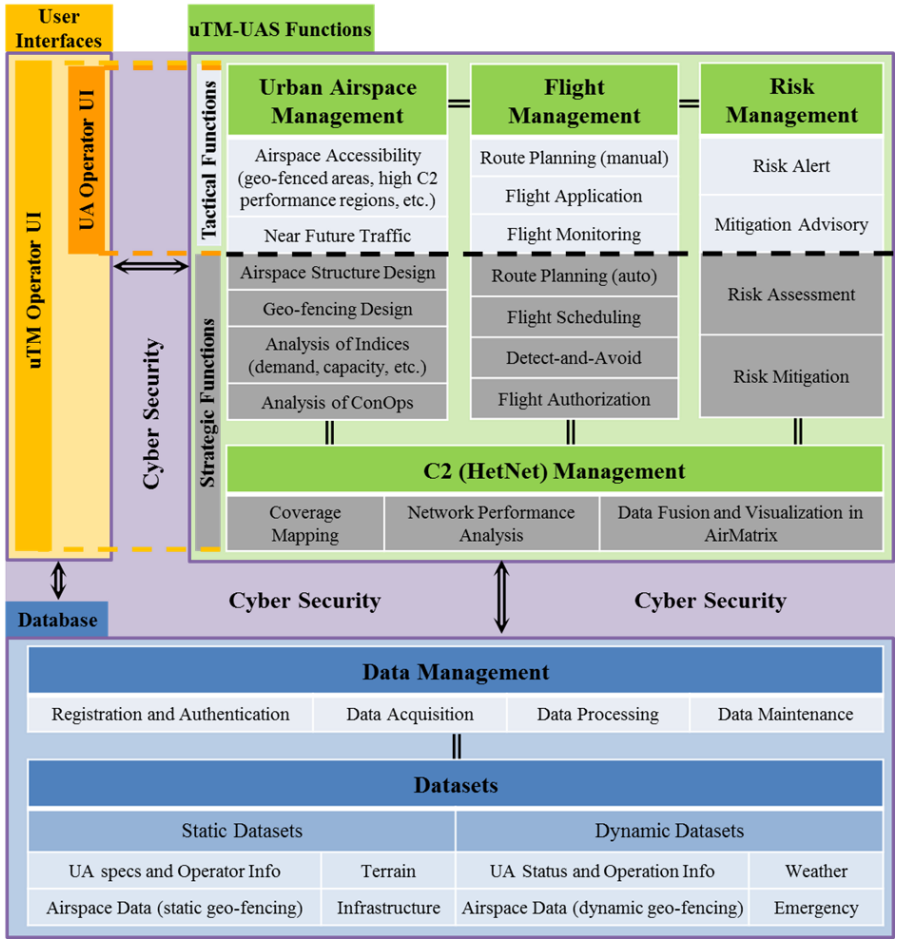
Safety

- Developed a risk management module to ensure all possible risks have been taken into account
- Explored geo-fence safety logic to ensure safe UAV operations
- Covered enabling technologies such as DAA that can be deployed as a safety enabler for UAV operations

Efficiency

- To provide a detailed analysis of the airspace performance by using the proposed AirMatrix formed by Airblocks
- To analyze demand & capacity to ensure efficient traffic flow of UAVs
- To self-generate optimized route(s) for UAV operations

Modular UTM Framework (*version*: July 2017)



A Further Note ….

- A developed modular framework presented in its first version; further revision and expansion are possible by the enhancement and validation of technologies and ConOps
- Research and development programme not only focusing enabling technologies (C2, DAA, Geofence etc.), bust also emphasizing urban traffic management, risk management, capacity planning and dynamic routes
- A “huge” and complex programme requiring more R &D works in collaborate with industry, regulators; working, understand and learning from each other

Thank You for Your Attention ☺

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