NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Session 1.5: ATMRI UAS Programme

16 March 2021

Outline

- Overview of ATMRI UAS Program
- Challenges of UTM in Singapore
- Research Focus and Showcase
- Future Works

Overview of ATMRI UAS Programme

Background

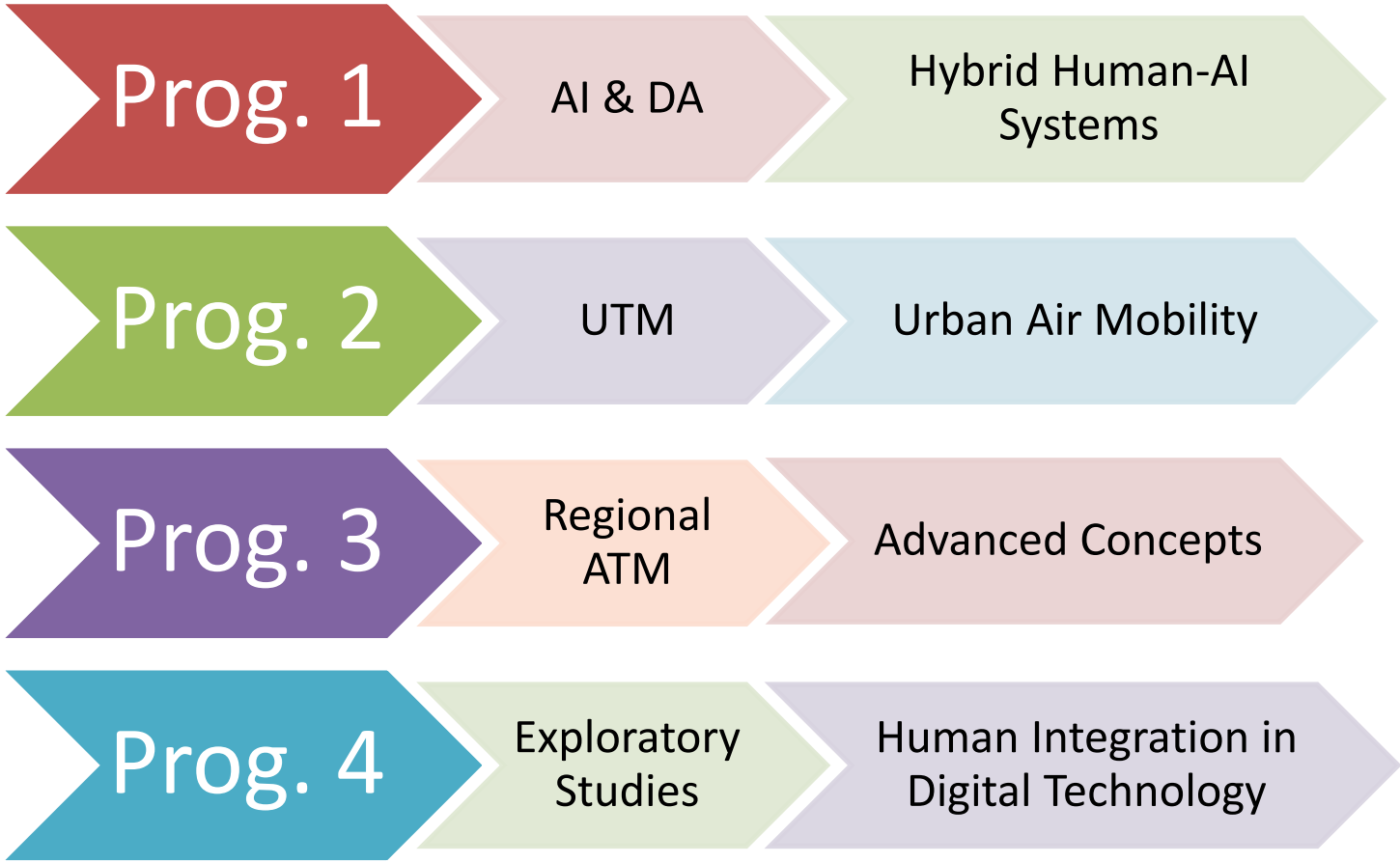
Established since 2013 as a CAAS-NTU joint-research and experimental centre, initially to:

- Maintain Singapore as a leading air hub
- Contribute to regional ATM modernisation
- Conduct high-quality ATM research
- Nurture talents for the future in Singapore

Objectives 2023

1. To become a world **leader in AI & Data Analytics Research** for ATM
2. To become a world's **Center of Excellence** for UAS/UAM Traffic Management Research
3. To become the **Regional Hub** for ATM studies
4. To become a world **leader in innovation to enhance ATM operations**

Research Programmes



Programme 2
UAS&UAM Traffic Management & Systems

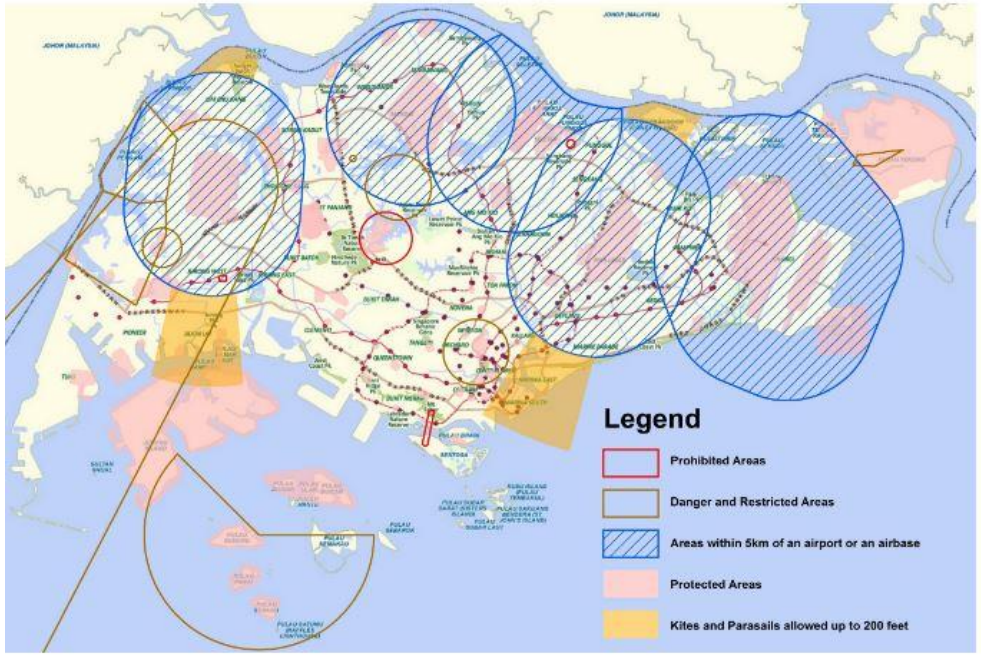
Director: Prof Low Kin Huat

4 objectives:

- Deliver **Traffic Management** solutions in urban environment
- Study **integration of UAS with other mobility means** into urban airspace
- Study applications of enabling technologies to enhance **safety & reliability** of flight operations
- Conduct **field tests** of developed solutions

Challenges to UTM in Singapore

Challenges of UTM in Singapore



https://www.unmannedairspace.info/uncategorized/singapores-caas-develop-uas-traffic-monitoring-system/

- **Limited available airspace for UTM & UAM operations**

https://www.youtube.com/watch?v=Fz5s1ZSZusY

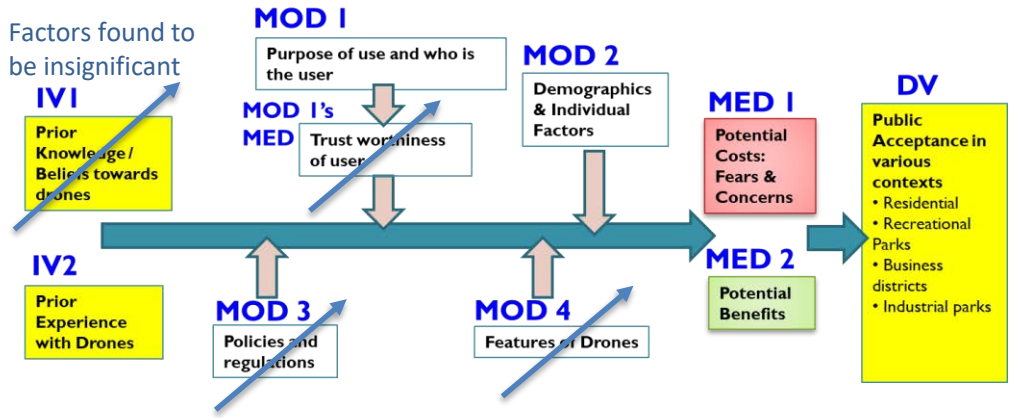
- **High population density and densely distributed high-rise buildings**

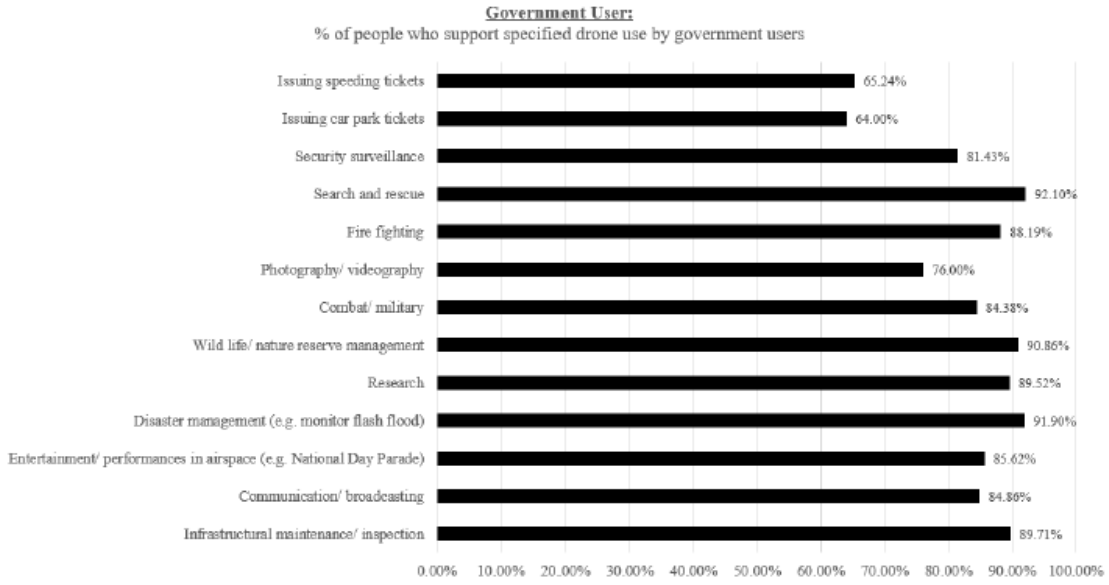
- Challenges of developing UTM&UAM in Singapore

- The ConOps proposed for Singapore context would need to solve these challenges by adopting emerging technologies and effective management.

Public Perception to UTM in Singapore

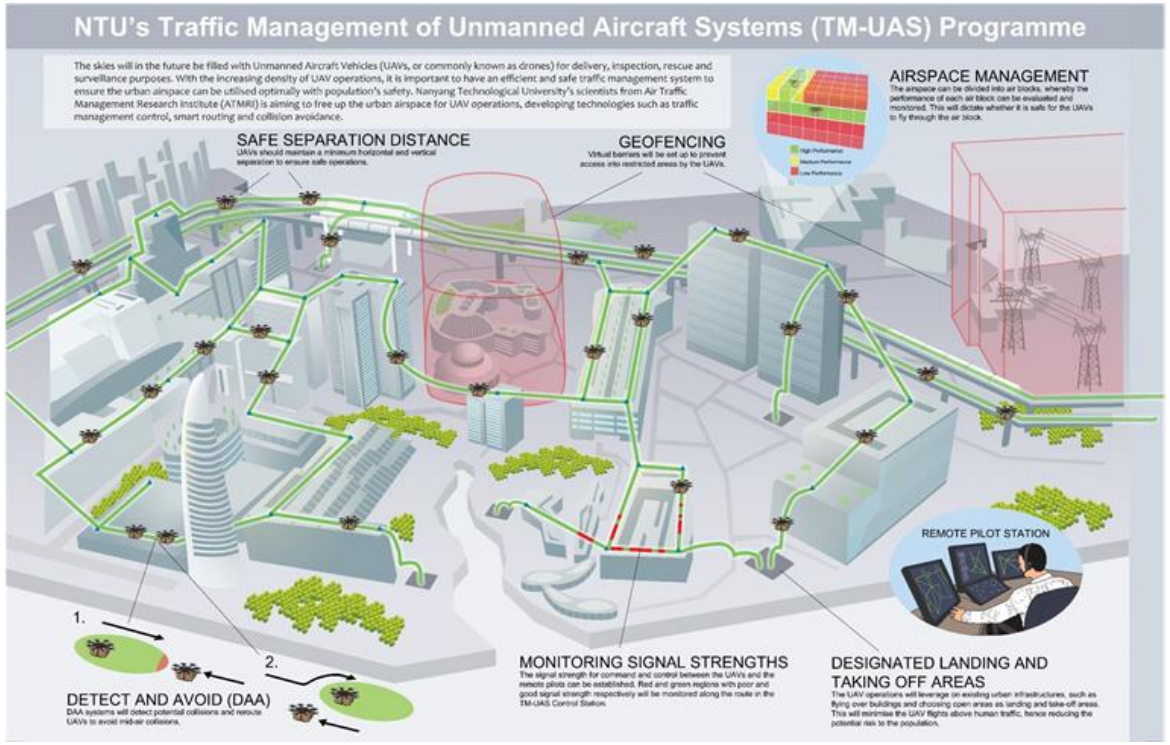
- Survey with n= 1050
- General acceptance to drone usage in Singapore
  - Higher acceptance to drone performing government work (S&R, disaster management, etc.)
  - Lower acceptance to air-taxi and photography
  - Higher acceptance for usage in industrial area and lower in residential
- For residential area, MED1 > MED2. Opposite for business, industrial, and recreational areas.



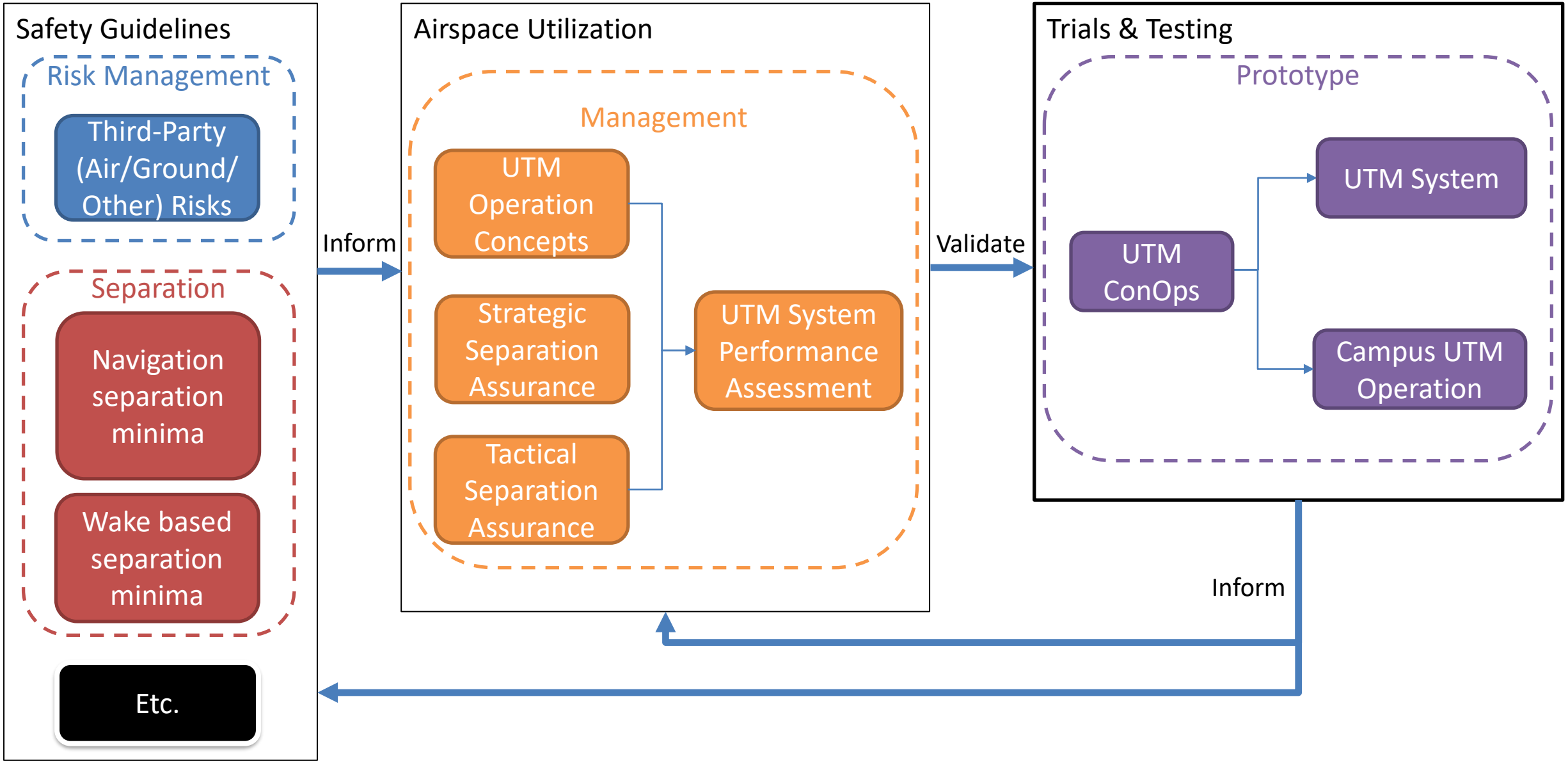


Adaption of UTM for Singapore Contex

- Operating under instrument flight rule (IFR)-like conditions
  - Risk based tiering of airspace and requirements (e.g. RNP, tracking)
  - Tracking (transponders etc.)
  - Trajectory Conformance (Separation minima)
  - Automated pre-flight separation assurance and approval
  - Semi-automated tactical separation control



Baby-steps: Staring with low-risk airspaces


Safety Guidelines
Risk Management
Third-Party (Air/Ground/ Other) Risks
Separation
Navigation separation minima
Wake based separation minima
Etc.
Inform
Airspace Utilization
Management
UTM Operation Concepts
Strategic Separation Assurance
Tactical Separation Assurance
UTM System Performance Assessment
Validate
Trials & Testing
Prototype
UTM ConOps
UTM System
Campus UTM Operation
Inform

Research focuses and showcase

RISK CONSIDERATIONS

Collision Probability Evaluation of UAS Intruding into Aerodrome

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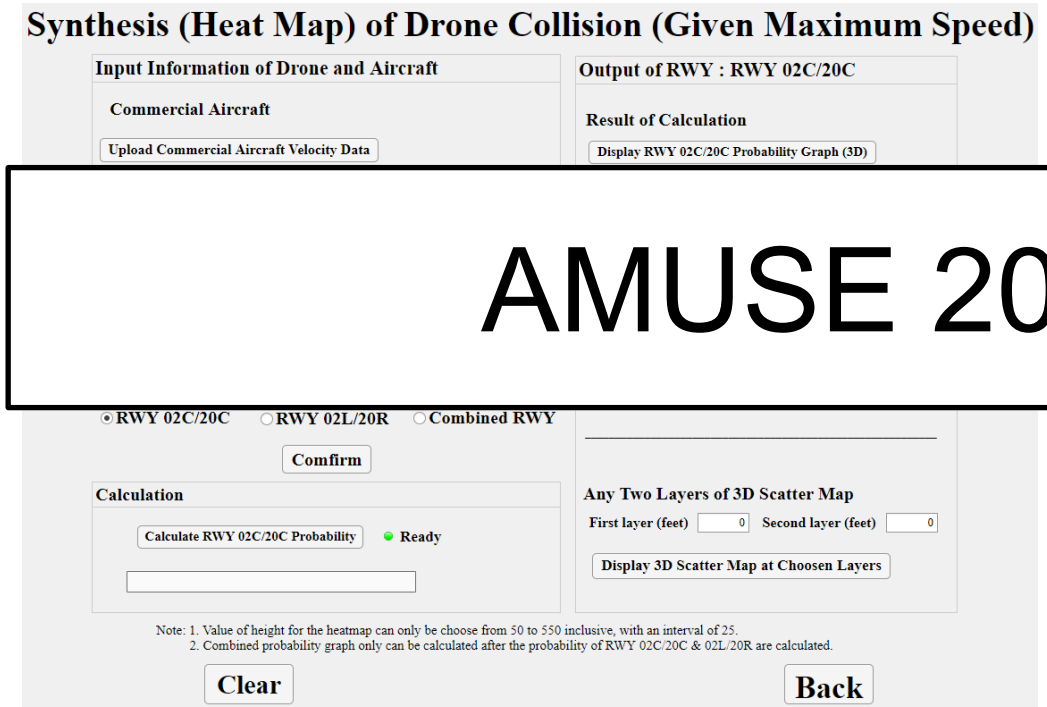
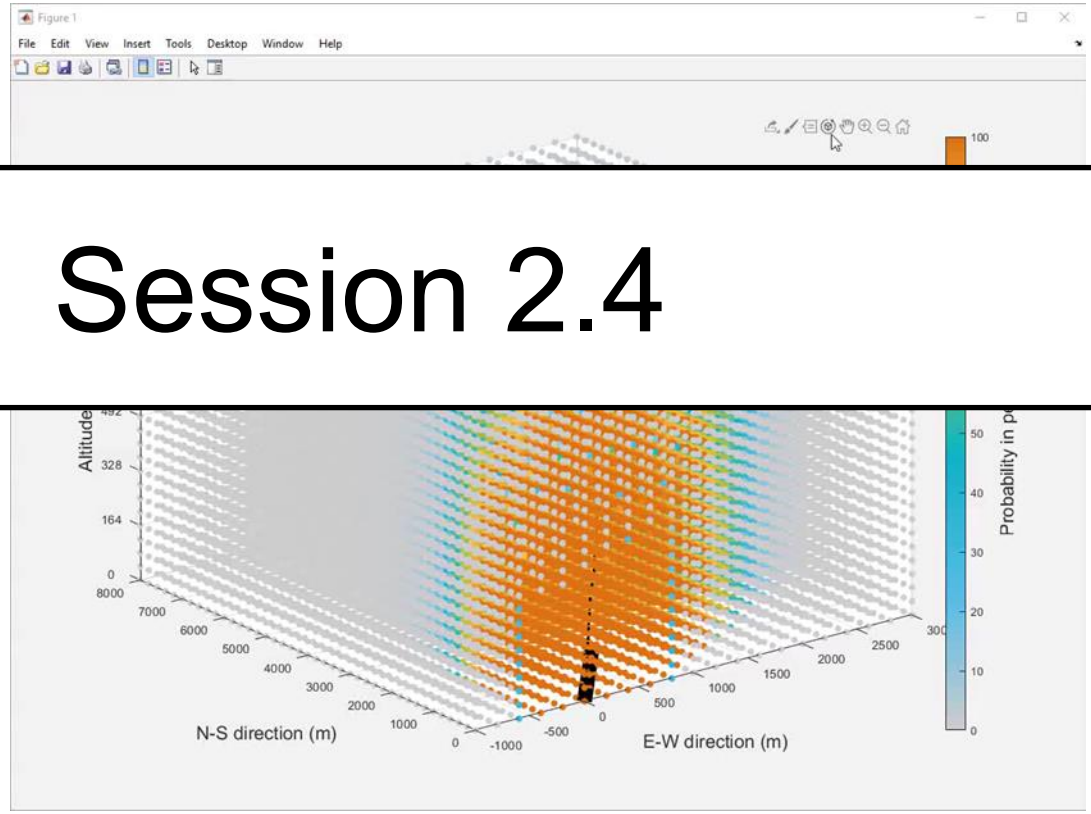
Establishing the risk based alert boundaries for aerodrome

- Interface to generate risk-mapping for intruding UAS into Changi Airport.



- Heat-map showing collision risk posed by intruding UAS on departure aircraft from Changi Airport runway 02C.

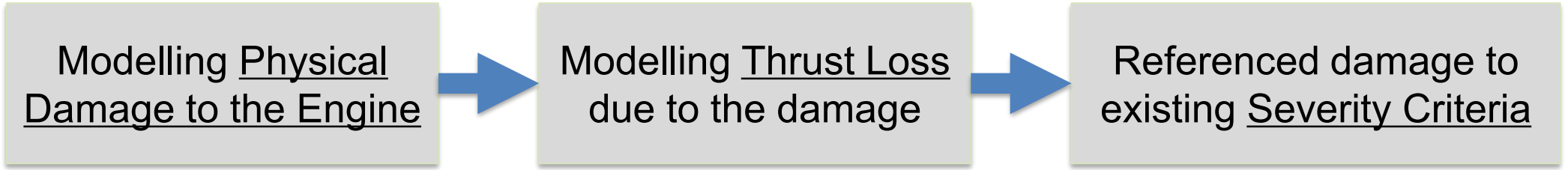


AMUSE 2021 Session 2.4

Collision Severity Evaluation - Overview

- To address the **Collision Severity Evaluation**, the research team utilised computer-based simulations to establish an initial understanding.

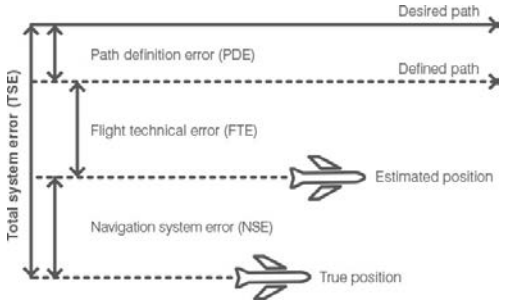
AMUSE 2021 Session 3.4

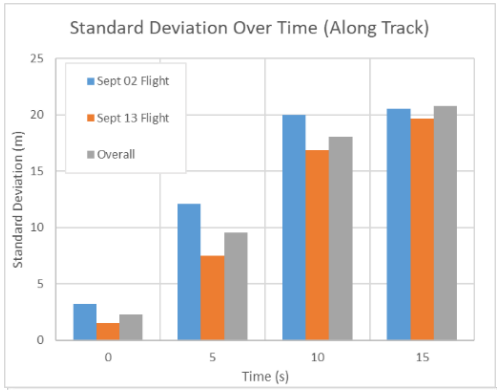


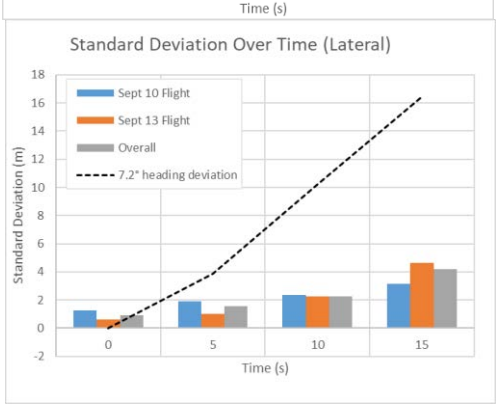
SEPARATION CONSIDERATIONS

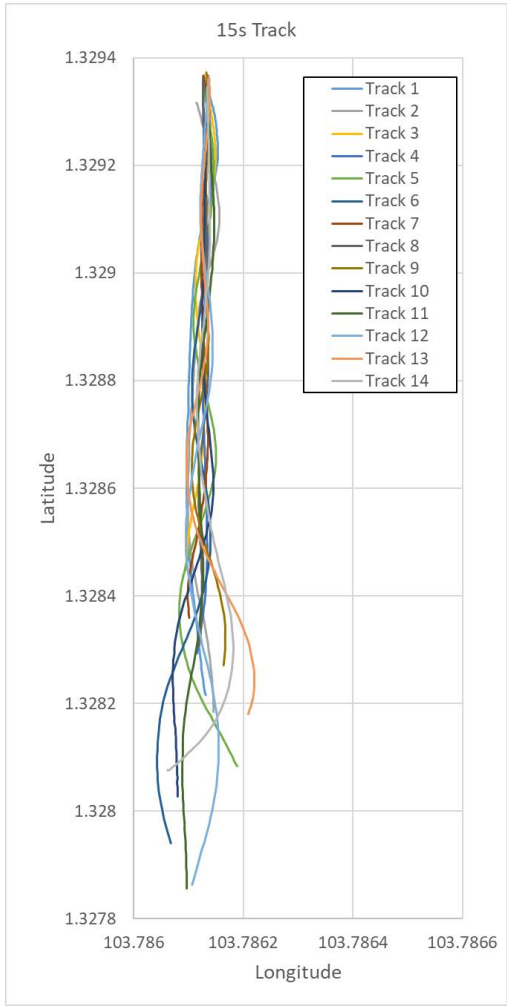
Separation Consideration: FTE

- Path Definition Error
  - Mapping Error
  - Survey Error
- Flight Technical Error
  - Operator Error
  - Flight Controller Error
  - Flight Dynamic & Inertia
- Navigation System Error
  - GNSS Receiver Uncertainty
  - Environmental Interference



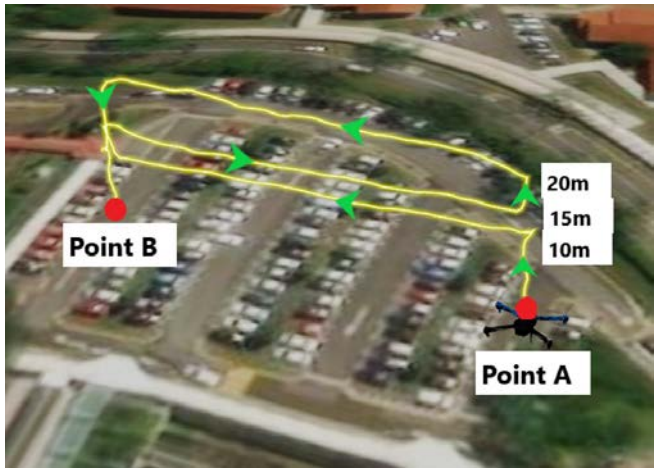


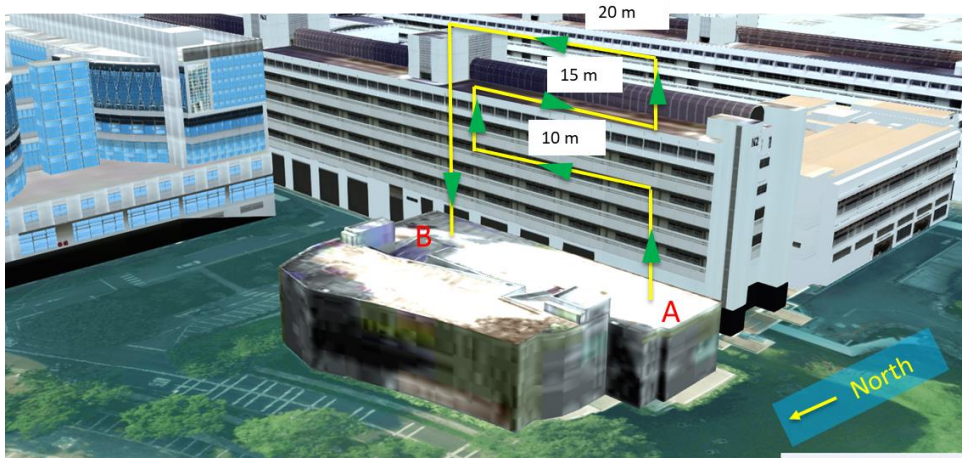




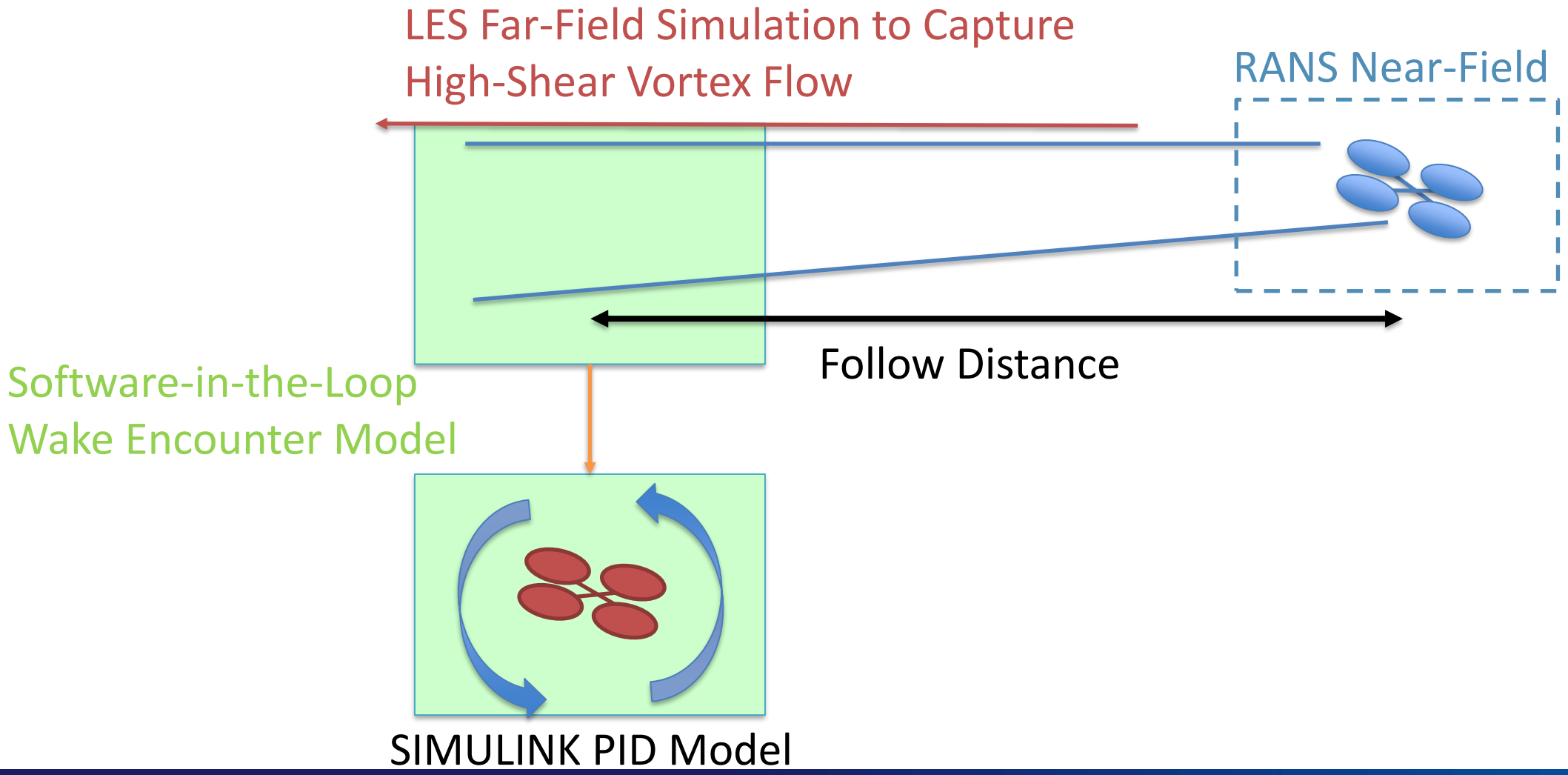
Separation Consideration: NSE

- Path Definition Error
  - Mapping Error
  - Survey Error
- Flight Technical Error
  - Operator Error
  - Flight Controller Error
  - Flight Dynamic & Inertia
- Navigation System Error
  - GNSS Receiver Uncertainty
  - Environmental Interference





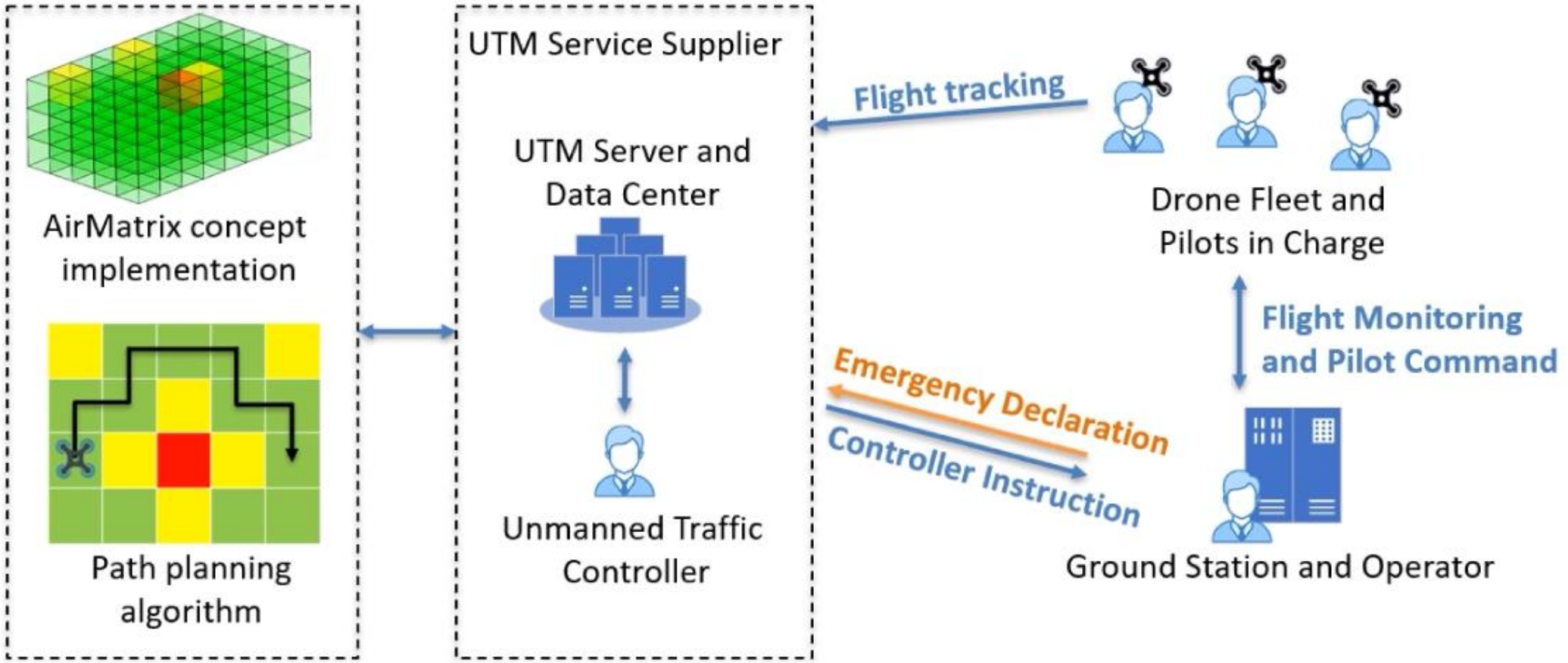
Separation Considerations: Wake



Demonstration with Identical Leader-Follower Pair Wake-Encounter Simulation

UTM AIRSPACE MANAGEMENT

Implementation of Dynamic Geofencing for NTU Campus UTM

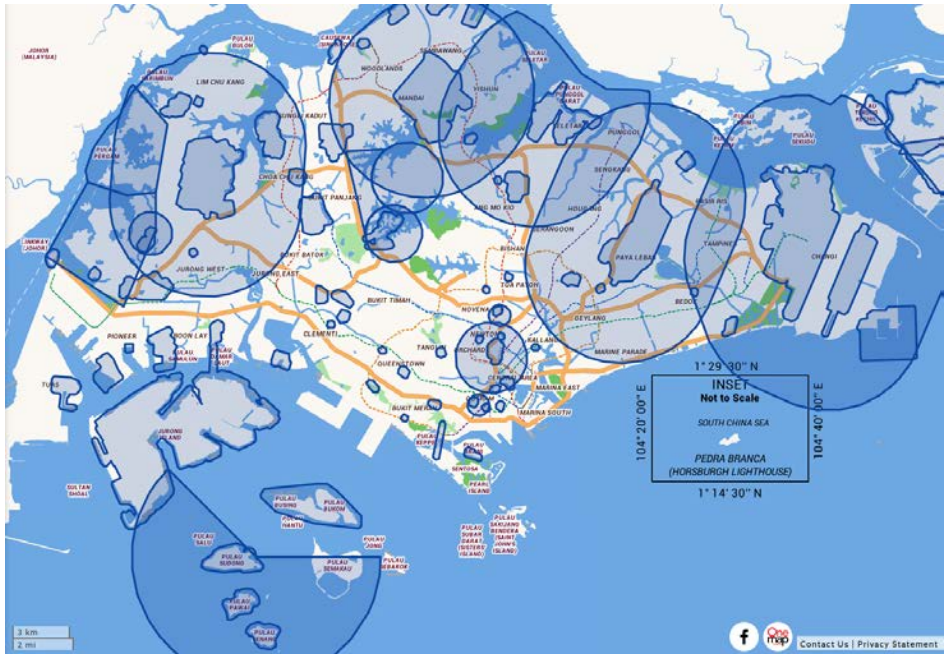


Dynamic Geofencing Workflow

Future Works

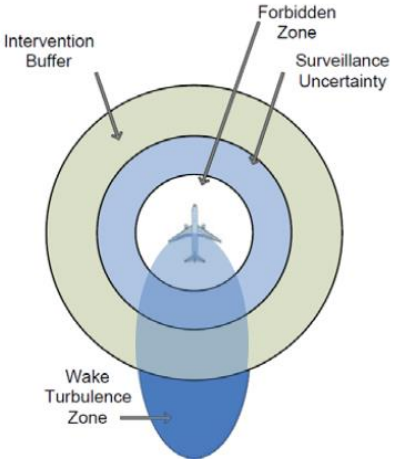
Future Works

- Investigation of risk-based airspace tiering for UTM in Singapore
- Identification of vehicle performance characteristics and thresholds for operation safety
- Improvement of current UTM workflow and airspace management in both strategic and tactical phases



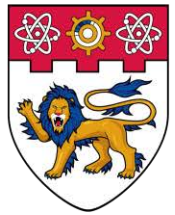
Current UAS restriction zones, https://onemap.sg

Time-based separation for UTM, ATMIR



RESET separation minima, RESET D3.2

Thank you for your attention



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