Session:
What is UTM and why is it separate from, but interoperable with, ATM?

Alignment of UTM to ATM on Safe Drone Operations

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE
Air Traffic Management Research Institute

ICAO

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Thursday, 13 September 2018; 11:00-12:30; Chengdu, China

DRONE ENABLE

ICAO's Unmanned Aircraft Systems (UAS) Industry Symposium

ICAO Headquarters, Montréal, Canada, 22 - 23 September 2017

Since Drone Enable/1 launched one year ago, we have seen many initiatives by various aviation bodies and companies!

Growth of Drone Applications

FAA Drone Registry Tops One Million

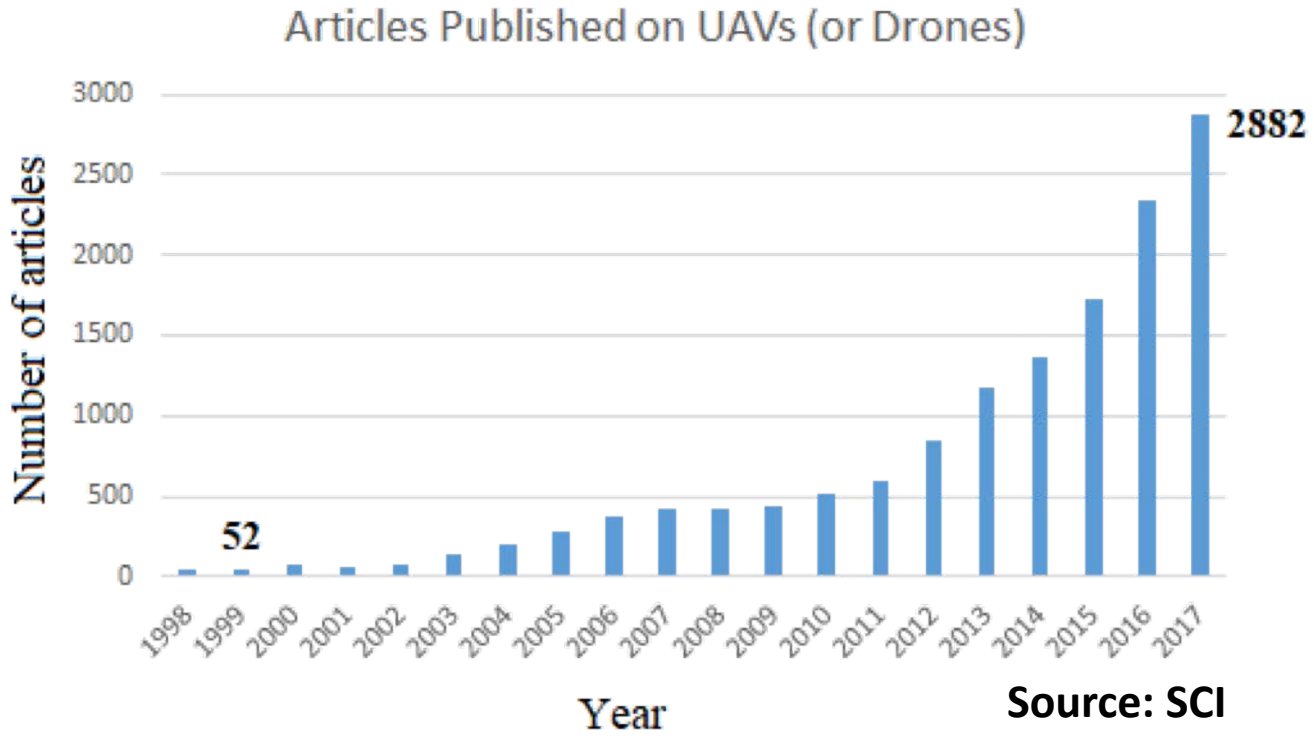
WASHINGTON - U.S. Department of Transportation Secretary Elaine L. Chao today announced at the Consumer Electronics Show that the total number of drones now registered with the Federal Aviation Administration (FAA) has eclipsed one million.

The 1,000,000 total registration figure includes 878,000 hobbyists, who receive one identification number for all the drones they own, and 122,000 commercial, public and other drones, which are individually registered.

- Jan 10, 2018

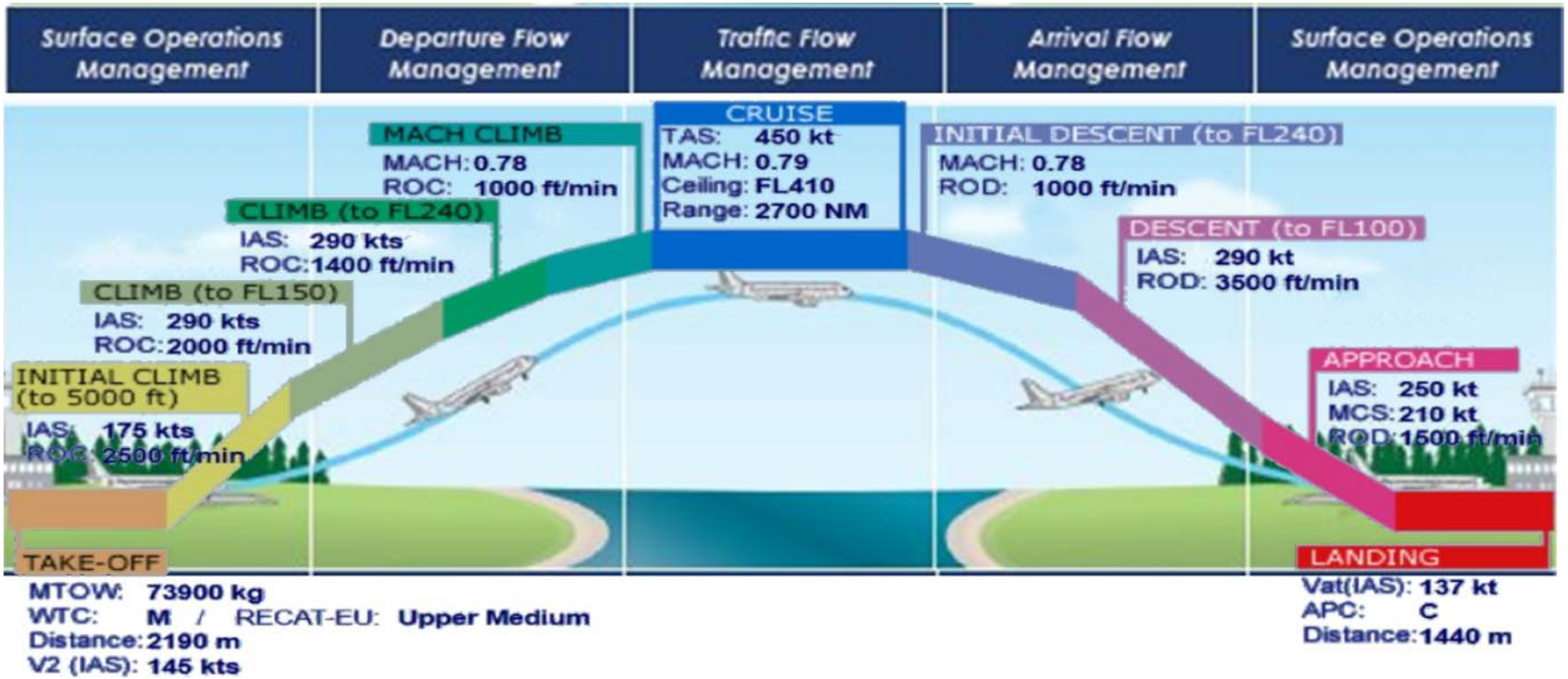
About 88% of drones registered are for the recreational use!

A fast-growing R&D area, too!



1999: One article/week; 2017: 55 articles/week!

ATM: Phases of Flights



Source: https://www.airport-technology.com/contractors/traffic/airbusprosky/attachment/airbusprosky2/
https://contentzone.eurocontrol.int/aircraftperformance/details.aspx?ICAO=A320&ICAOFilter=a320

Safety: Approaches and Procedures (Manned Aviation)

Collision-free Approaches

Different departure time

Route: Waypoints; STAR (Standard Terminal Arrival Route)

SID (Standard Instrument Departure)

Height: FL360; Speed: 290 knots

Safety separation/Well Clear (1000ft; lateral 3 miles etc.)

Procedure to follow

Enabling systems/technology (CNS) tested/applied for decades

Certificate to follow (RTCA DO-178B, DO-254, etc.); Redundancy

Pilot and ATCO (professional and skillful)

Stringent certification/assessment; suspended for mistakes/errors

Manned and Unmanned Airspace

UTM + ATM

ATM
Regulated
Respect law

ATM Enablers
- Communication
- Procedure
- Contingency

Manned Airspace

Enforcement
(Procedure)

UTM
Professional
Want to respect law

Unmanned Airspace

Enforcement

UTM
Amateurs
What law?

Recreational

Enforcement?
Even yes, not
necessary to follow

Unmanned (low altitude; sUAVs) vs. Manned aircraft

Same utmost priority: Safety
(Manned Aviation: highly regulated industry, procedures & operations)

Differences:

- Neither pilot nor passenger on board (different considerations)
- Dealing with different scales (weight/size/cost), flight duration/range, operation complexity, level of redundancy

sUAVs: Unknowns/unpredicted; Life cycle of systems and components is rather short (unlike man aircraft/RPAS)

Drone Operations (towards BVLOS)

BVLOS: Beyond visual line of sight

Videography

Surveillance

Inspection

Delivery

Fleet Management: A number of drones operated in the same time period over a managed airspace

To maximize commercial benefits, multiple-drone operations over the same airspace are targeted by industry, together with other users.

Matrix of UAS Growth (Performance-based)

	Crucial Areas
Operations	BVLOS (beyond visual line of sight) Operation
	Autonomous flight
	Altitude restriction; safe separation
	Flight above people (if necessary)
	Airspace integration (ultimately)
	On-Ground Operation – Take-off and Landing (seamless mobility)

	Crucial Areas
Vehicle (UAV)	Identification
	Propulsion
	Airworthiness
	Weight/Height/Speed restriction
	Technology capabilities (DAA, connectivity, safe separation, etc.)

Matrix of UAS Growth (Risk-based)

	Crucial Areas
Risk- & Performance- Based Assessments	Data/Evidences of System Performances
	Social Effects (privacy, noise, etc.)
Multiple-Drone Operations	Capacity, Scheduling, and Efficiency
	Vehicle to fixed/moving objects; Vehicle to vehicle; Technology capabilities (DAA, connectivity, safe separation, etc.)

- Situational Awareness
- Environmental Awareness
- Social Awareness (crucial for urban environments)

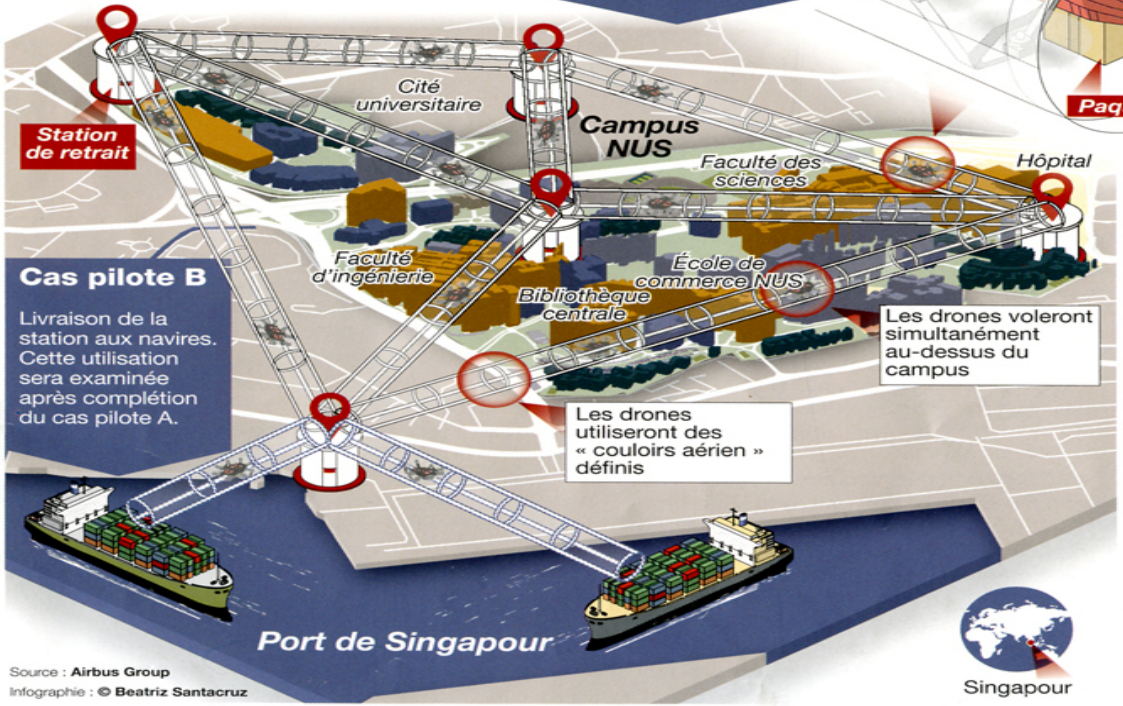
SKYWAYS

Solution de livraison urbaine

Le projet Skyways d'Airbus prévoit de livrer de petits colis aux étudiants et facultés sur le campus de la National University of Singapore à l'aide de drones.

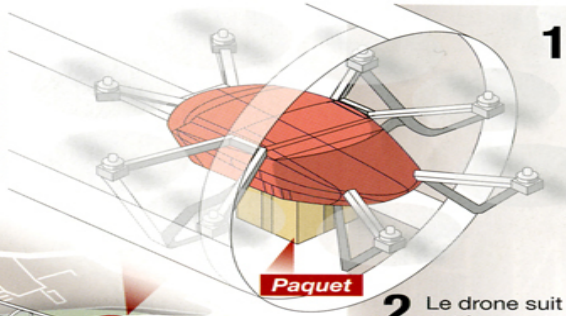
Cas pilote A

Livraison de colis sur le campus de la National University of Singapore (NUS) via le réseau Skyways.



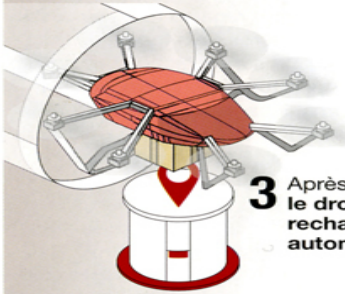
Cas pilote B

Livraison de la station aux navires. Cette utilisation sera examinée après complétion du cas pilote A.



1 Le drone Skyways **est un octocoptère** qui transporte des conteneurs aériens chargés dans sa partie inférieure.

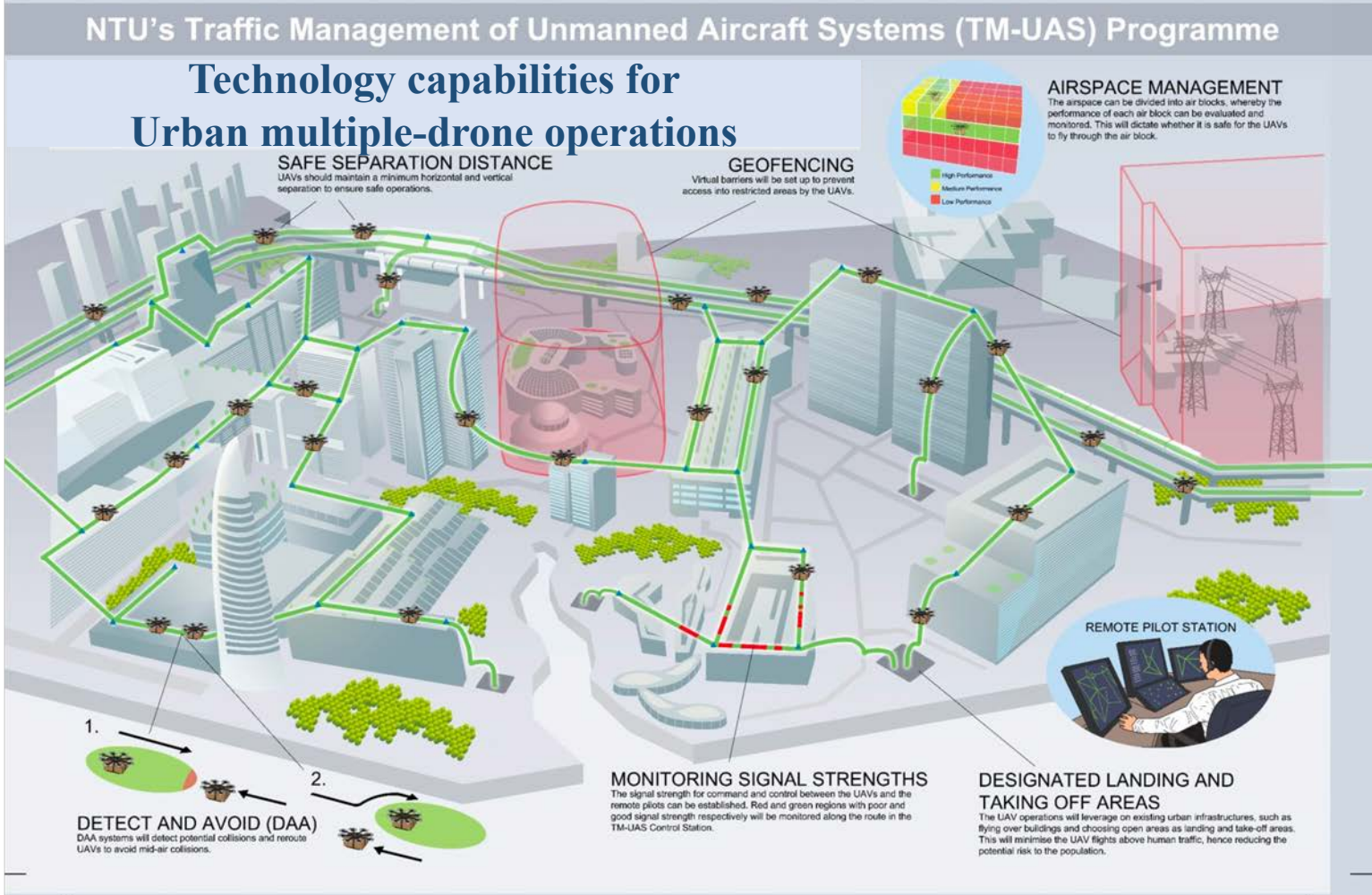
2 Le drone suit une trajectoire entièrement automatisée **et atterrit sur une plate-forme définie.**



3 Après l'atterrissage, **le drone se recharge automatiquement.**

4 Les clients finaux reçoivent une **notification de livraison sur leur téléphone mobile** et vont chercher leur colis à la station de retrait.

Source : **Airbus Group**
Infographie : **© Beatriz Santacruz**



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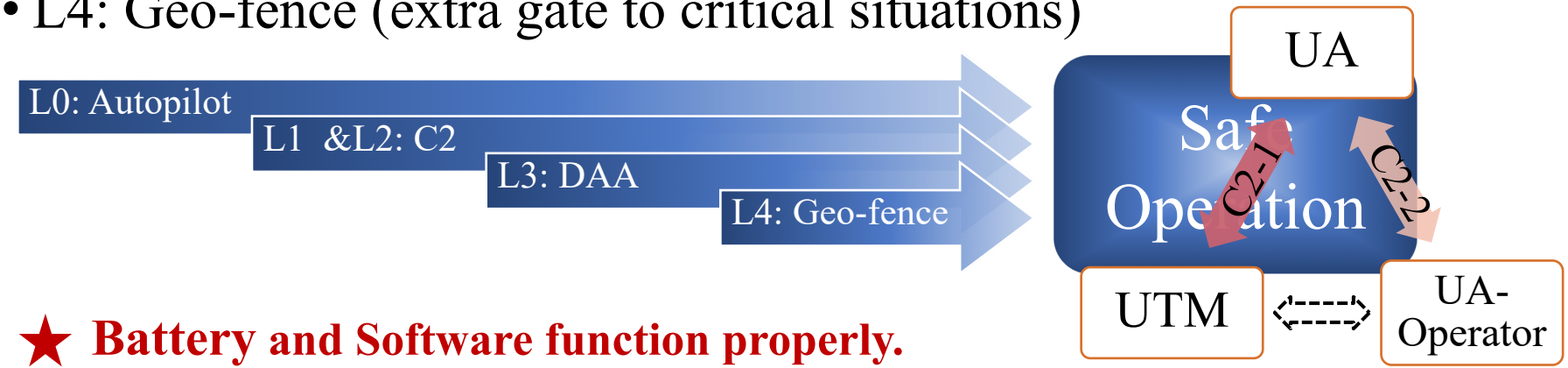
UAS Performance-based Redundancy Level

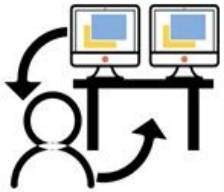
- L0: Basic Autopilot + DAA (*open field* and *clear sky*)
- L1: C2 UA – UA-Operator datalink (RTL/land at a specific place)
- L2: C2 UA – UTM datalink
- L3: DAA + Auto Navigation (avoid collision damage in auto mode)
- L4: Geo-fence (extra gate to critical situations)



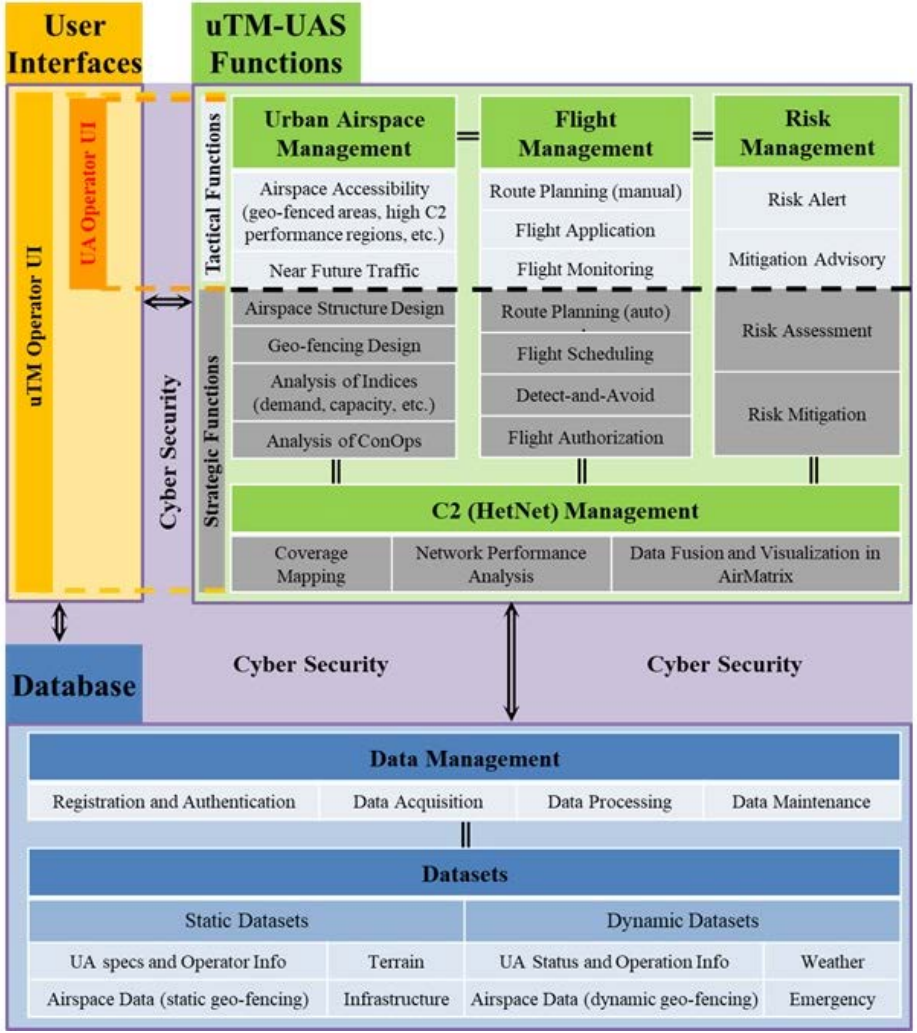
★ **Battery and Software function properly.**

UTM Framework (urban; risk-based UTM)

UA Operator



uTM Operator/ Service Provider



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First Comprehensive Circular on BVLOS!

AC UAS-2(0)
1 August 2018

CAAS
Civil Aviation Authority of Singapore

Advisory Circular

ASSESSMENT METHODOLOGY FOR BEYOND VISUAL LINE OF SIGHT (BVLOS) OPERATIONS FOR UNMANNED AIRCRAFT

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1. **GENERAL.** Pursuant to paragraph 88B of the Air Navigation Order, the Director-General of Civil Aviation (DGCA) may, from time to time, issue advisory circulars (ACs) on any aspect of safety in civil aviation. This AC contains information about standards, practices and procedures acceptable to CAAS. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.

Source: CAAS, Singapore

Overview of Assessment Methodology for BVLOS Operations

Risk category	Intended scope of BVLOS Operations	Requirement (Requirement Code)			
		Basic	***Level 1***	***Level 2***	***Level 3***
LOW	• No overflying *uninvolved persons* • Operate away from people and in an area where it is reasonably expected that no *uninvolved person* will be present	• General (BG) • Operational (BO) • Software (BW) • Others (BT)	• Failure Management (LF) • Navigation (LN) • Communication (LC) • Detect and Avoid (LD)		
MEDIUM	• Flying in close proximity to *uninvolved persons*. • Flying over *uninvolved persons*, with flight duration not exceeding 30% of the overall flight.			• General (MG) • Structural (MS) • Software (MW) • Navigation (MN) • Communication (MC) • Detect and Avoid (MD) • Propulsion (MP)	
HIGH	• Flying over *uninvolved* persons • High risk and complex operations				• General (HG) • Software (HW) • Navigation (HN) • Detect and Avoid (HD)

* Incorporated into UTM for Low/Medium/High Risks

(Source: CAAS AC UAS2(0))

Your Thoughts?

- To cover all drones (sUAVs, not RPAS) in UTM consideration?
- If no, what are the criteria/means for drones to be excluded for UTM? By weight? By Flying Height? By kinetic energy? By Operation?

- Motorbikes
- Cars
- Buses
- Trucks

License required

Avoid overkilled and thus counterproductive!

- *Bicycles*

No license required

Outcomes of *Drone Enable*

DE1: Framework of UTM (Sep 2017)

DE2: Identify the needs to align UTM to ATM (Sep 2018)

Next: What are crucial and necessary needs?

How and to what levels/extent of achieving them?

Concluding Remarks

Fast-evolving & game-changing fields: Industry/Commercial Push

Existing and new technologies for sUAVs are to be tested and validated as a whole eco-system

Before it is tested to be stable and reliable, we need to have a set of rules (or guidelines) to “facilitate” the drone operations by incorporated with comprehensive UTM, by learning from good practices developed and tested by ATM, while recognizing their differences with RPAS and manned aircraft

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Looking forward to work with you to identify needs and predict unknowns

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