

WWRF Huddle 2026
Medipole University
Istanbul, Turkey

Aerospace Communications
mini-Huddle
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UAV, Aerospace Communications Global Taxonomy

UAV Categories

Use Cases

Radio Propagation
&
Channel Model

Spectrum
Considerations

Energy
Requirements
Piloting and
Communications

Regulatory Aspects

New Technologies
AI, O-RAN

Status of
Standardization
3GPP & ITU

Security
Considerations

Unmanned Ariel Vehicle (UAV) Categories - I

- No single standard for UAV classification
- Categories according to different criteria
 - functionality,
 - weight/payload, size,
 - endurance,
 - wing configuration,
 - control methods,
 - cruising range,
 - flying altitude,
 - maximum speed
 - energy supplying methods, Tethered or non-Tethered
- Non-Tethered (by far the most common category)
 - Fixed Wings
 - Launch pad at take-off a requirement;
 - Forward flight helps maintain Altitude
 - Mainly Defence related Missions
 - Rotor Wing
 - Vertical take-off,
 - 3D movements and adaptable flight patterns
 - Capacity to hover at a point above Ground

Unmanned Ariel Vehicle (UAV) Categories - II

- Example Classification as per Australian Civil Aviation Authority (CASA).
- Date 2022 (??)

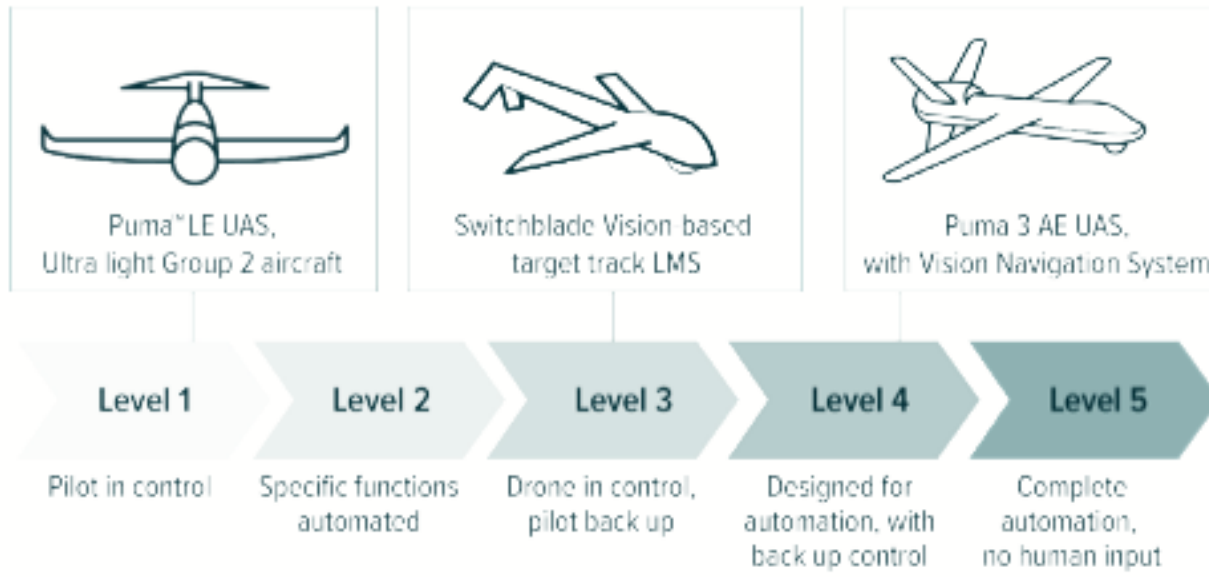
	Micro (the weight $\leq$ 100g)	Very Small (100g<the weight<2kg)	Small (2kg $\leq$ the weight<25kg)	Medium (25kg $\leq$ the weight $\leq$ 150kg)	Large (the weight>150kg)
Prototype	Kogan Nano	Parrot Disco	DJI Spreading Wings S900	Scout B-330 UAV helicopter	Predator B
Weight	16g	750g	3.3Kg	90kg	2223kg
Payload	N/A	N/A	4.9kg	50kg	1700kg
Machine for Flying	Multi-rotor	Fix-wing	Multi-rotor	Multi-rotor	Fix-wing
Range	50-80m	3km	N/A	N/A	1851km
Altitude	N/A	N/A	N/A	3km	15km
Flight Time	6-8 min	45 min	18 min	180 min	1800 min
Speed	N/A	80 km/h	57.6 km/h	100 km/h(horizontal)	482 km/h
Power Source	Li-battery 160mAh /3.7V	LiPo Battery 25A 3-cell /2700mAh	LiPo Battery (6S, 10000mAh-15000mAh, 15C(Min))	Gasoline (Heavy fuel availability is discretionary)	Turboprop Engine with 950 shaft horsepower
consumption of power	N/A	N/A	Hover: 1kW. Maximum: 3kW	power generator for payload: 1.5kW	The engine: 712kW

Unmanned Ariel Vehicle (UAV) Categories - III

- Recent proof of very quickly expanding market for UAV's for warfare
- Public Information – Source eBook Published by Microwave Journal in 2025
- Just for information. No further discussion expected

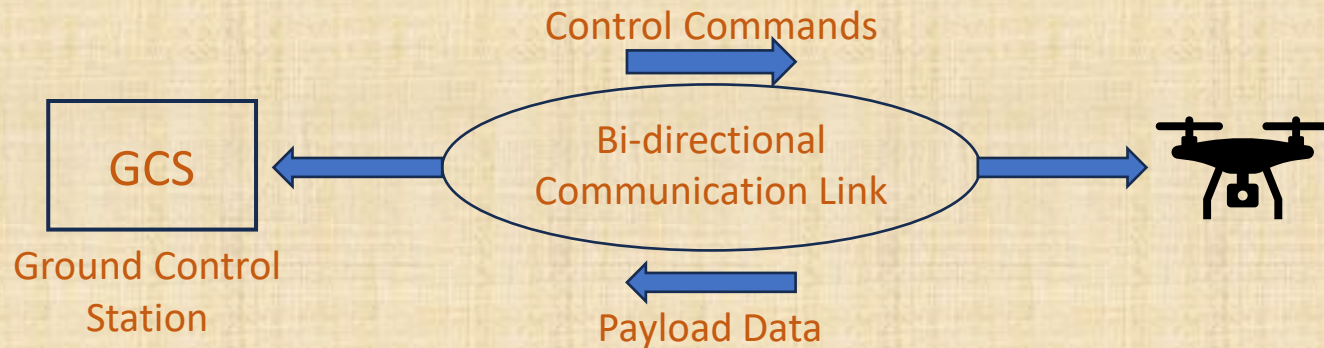
AUTONOMY LEVELS FOR KEY AEROVIRONMENT DRONE PLATFORMS CONTINUE TO ACCELERATE RAPIDLY

Sources: Global X ETFs with information derived from: AeroVironment Investor Relations. Accessed August 2024.



Communication Architecture of and example Data Rates for non-Tethered UAV

- Communication Architecture of non-Tethered UAV
- Communication data rates as per 3GPP standardisation



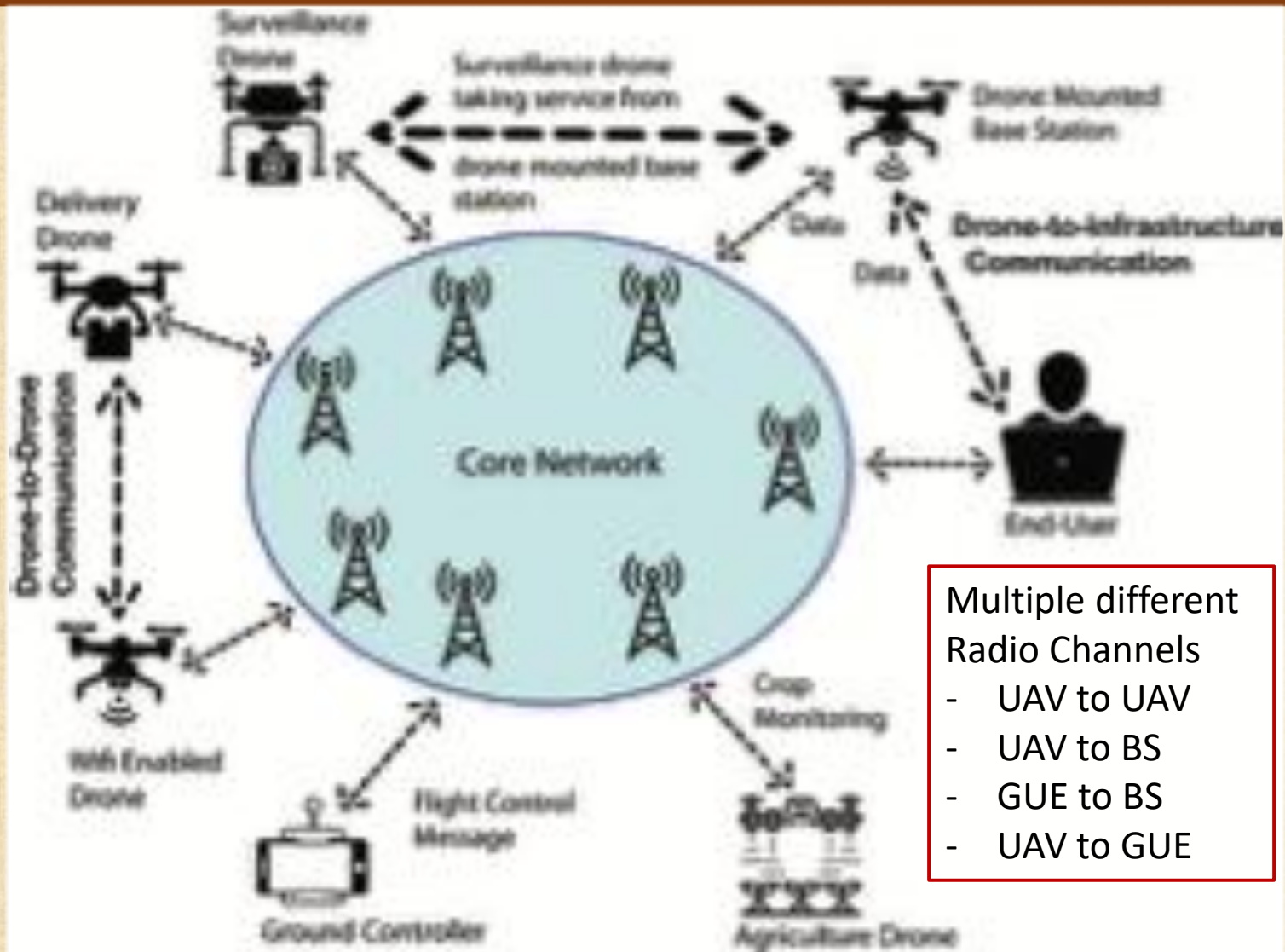
	Data Type	Data Rate	Reliability	Latency
Downlink Ground Stn to UAV	Command and Control	60-100 Kbps	10^{-3} packet error rate	50ms
Uplink UAV to Ground Stn	Command and Control	60-100 Kbps	10^{-3} packet error rate	
	Application Data	Upto 50Mbps	X	Same as for terrestrial user

Transmission Requirements for UAV Applications

UAV Application	Mission Height meters	Payload Data Latency (ms)	Payload Data Rate DL/UL
Drone Delivery	100	500	300 Kbps/200 Kbps
Video Capture	100	500	300 Kbps/6 Mbps
AP or BS in Drone coverage	500	100 to 500	20 to 50 Mbps both directions
Surveillance	100	3000	300 Kbps /10 Mbps
Infrastructure Inspection	100	3000	300 Kbps /10 Mbps
Drone Fleet Show	200	100	200 Kbps/200 Kbps
Precision Agriculture	300	500	300 Kbps/200 Kbps
Search and Rescue	100	500	300 Kbps / 6 Mbps
Drone Assisted Vehicular Networks	100 to 300 Depends on Coverage Area	50 to 100	300 Kbps/300 Kbps

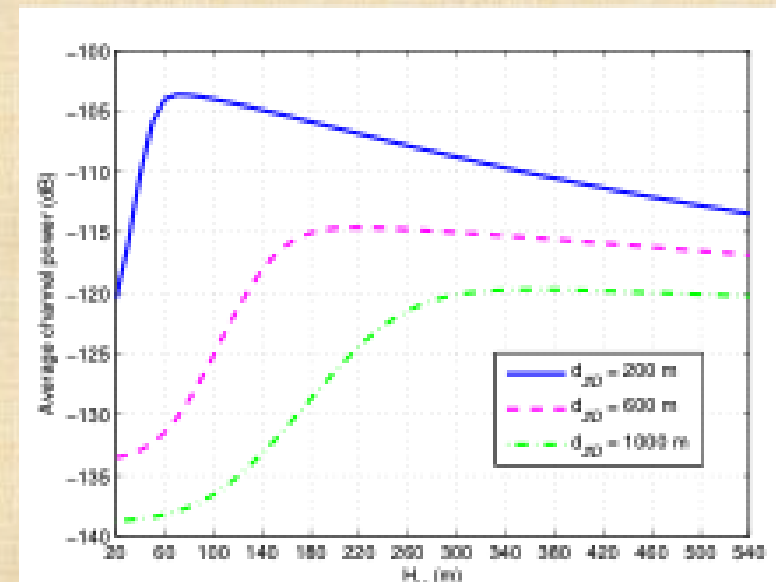
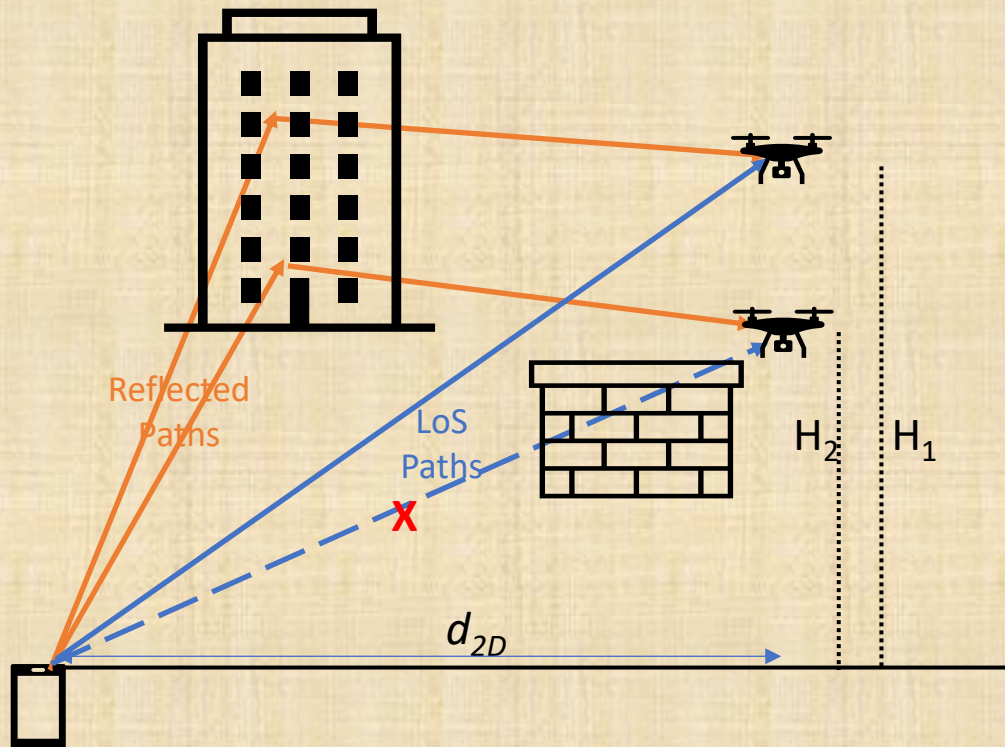
Examples of UAV application scenarios

Schematic Representation

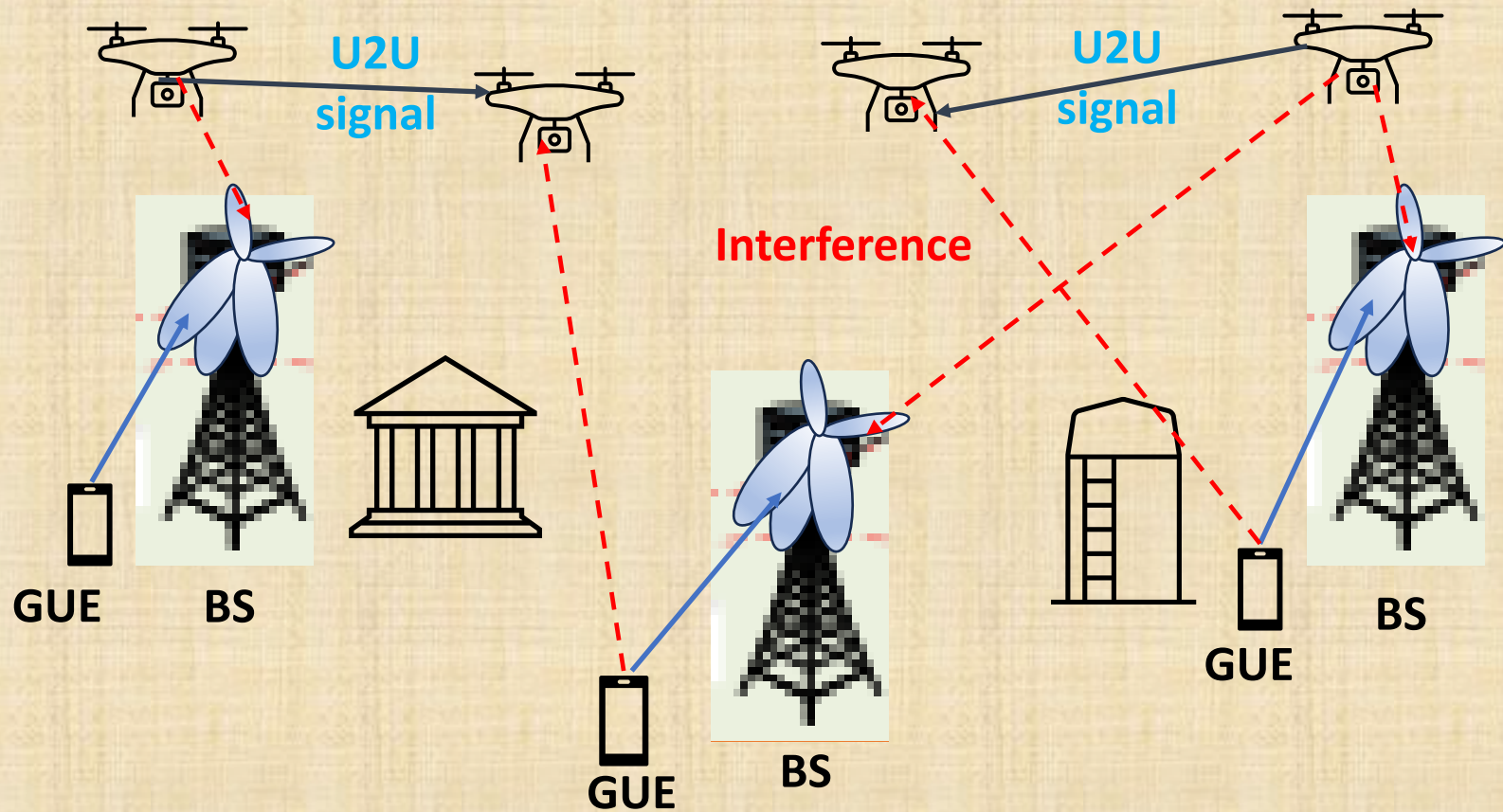


Wireless Channel in Drone Communication

- UL signal strength at UAV receiver varies with UAV height
- Elevation Angle dependent Probabilistic LoS Channel Model - based on the statistical modelling of the environment
- 3GPP GBS (Ground Base Station) – UAV Channel Model. Altitude between 1.5 to 300m

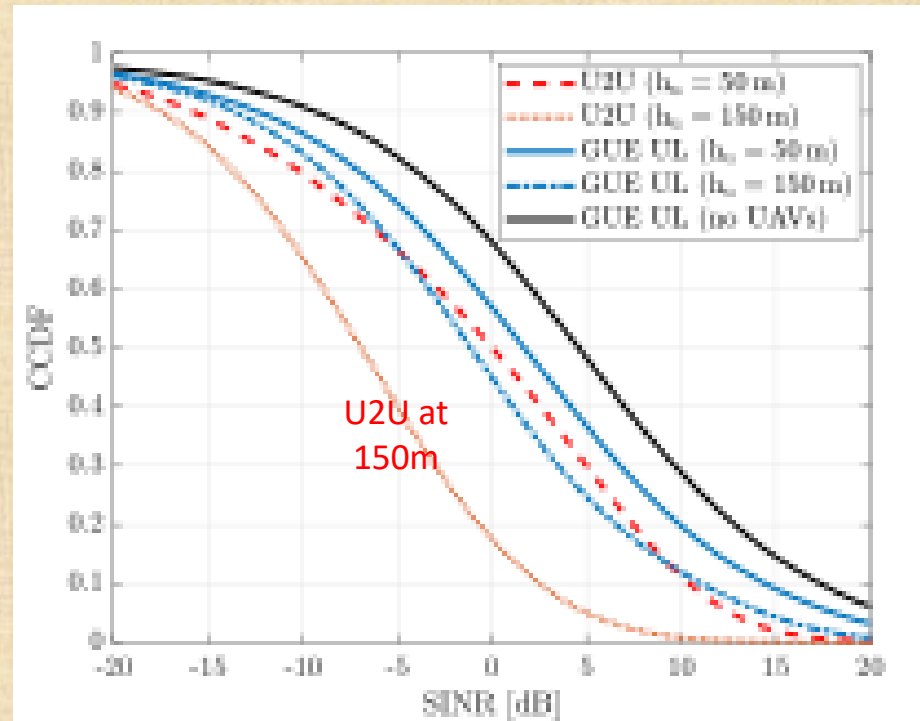


Co-existence of UAV-to-UAV and GUE to BS Communication Scenario



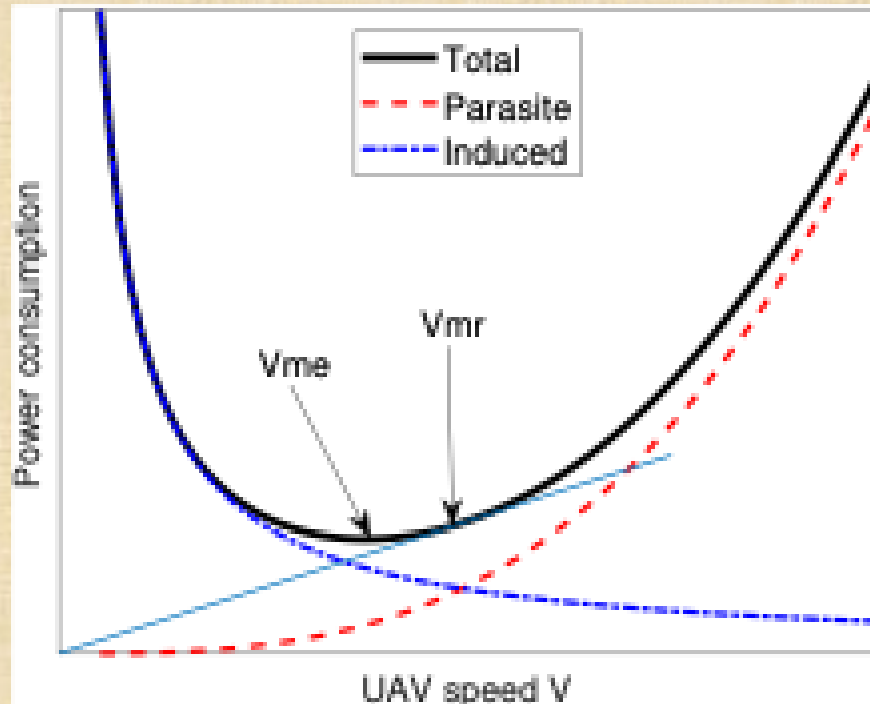
Performance in Co-existence Scenario – Impact of Channel Model

- Mild-impact of U2U Comm over GUE to BS performance as UAV interference is received through BS antenna sidelobes
- Both U2U and GUE – UL links degrade as UAV elevation increases due to increase in probability of LoS and hence of interference between links
- Closer UAV to UAV spacing coupled with UAV Tx power control improves both link categories
- A trade-off exists between U2U performance and GUE UL Performance

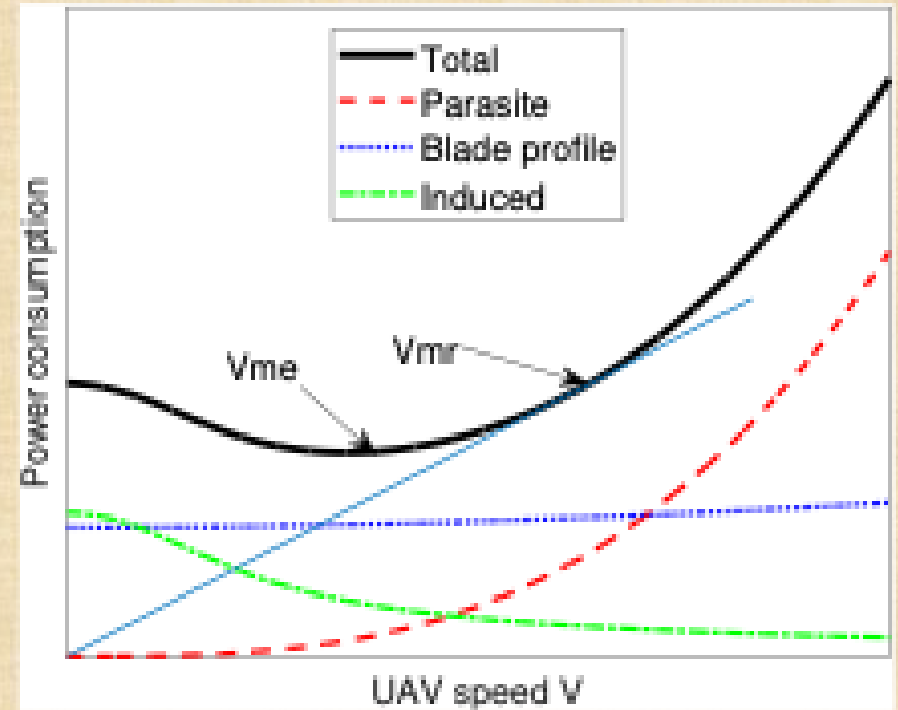


CCDF of the SINR per PRB experienced by: (i) U2U links, (ii) GUE UL in the presence of U2U links, and (iii) GUE UL without U2U links, for $h_u = \{50, 150\}$ m.

Modelling Drone Energy Consumption



Fixed Wing Drone



Rotor Wing Drone

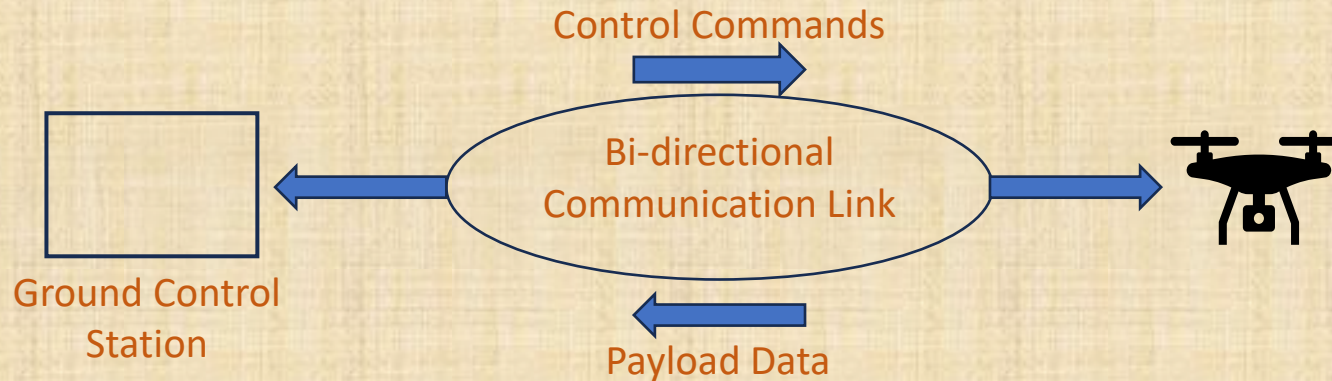
- V_{me} maximum endurance speed; V_{mr} maximum range speed
- Parasite power consumption results from drag due to drone movement and Induced power is due to the drag to lift force for the drone
- For rotor wing drones the Blade Profile results from the drag profile generated the rotation of blades

Other important considerations for UAV Communication - I

- Flying Track Planning
 - For a typical UAV mission the Transport Energy Consumption >> Communication Energy Consumption (except for very small drones)
- Energy Efficiency optimisation while maintaining the mission QoS is essential Predominant mission
- AI/ML baed tools to solve (usually off-line) this problem are required.
- Radio Spectrum
 - Earlier missions in ISM band
 - UAV for Cellular would use the Spectrum as per the native air-interface
 - Adoption of FR2 spectrum under evaluation

Other important considerations for UAV Communication - II

- Cybersecurity for UAV missions
 - multiple radio-links increase the vulnerability



- Physical Security
 - Regulations required for collision avoidance during multi-UAV and UAV fleet missions
- Ex Guidelines set by Federal Aviation Authority USA
 - Public safety authorities can fly aircrafts of max 4.4 pounds
 - UAV's to be maintained in operator LoS and max height allowed is 400ft above average ground level (during the daylight flight conditions)
 - UAV's must remain outside of 5 statute miles from any airport, heliport etc and at sufficient distance from populated areas.

Thanks to all the participants and
Panelists

Prof Nazli Guney

Prof Lokman Kuzu

Prof Metin Ozturk