This session will give you

- Basic understanding of drones
- A briefly overview of some of the most common drone types
- Basic understanding of the relation between price, features and performance between different drones
- Some examples of what type of drone to procure
- Some knowledge about the security considerations that might affect the use of drones
Objectives

Three types of drones including two types of rotor crafts

- Single rotor (helicopter)
- Fixed-wing (airplane)
- Multicopter (multirotor)
Single rotor helicopter

- Single lifting rotor with two or more blades.
- Traditional manned helicopter.
- Strong, fast and efficient.
- The directional control is maintained by varying blade pitch via servo-actuated mechanical linkage.
- A single rotor helicopter is generally more difficult to fly.
Different type of drones

Fixed-wing aircraft

- Must have air moving over their wings to generate lift
- This means they must stay in forward motion
- Cannot hover in one spot in the way a helicopter can.
- Cannot provide the same level of precise positioning
- Lightweight, less energy consuming, generous flight time
- Commonly used for 3D mapping, agriculture survey
Different type of drones

Multicopter

- An aircraft with more than one rotor, generally 4-8 rotors.
- Utilize differential thrust management of independent motor-prop units to provide lift and directional control.
- The motors are controlled by an automatic flight controller.
- Takes input from the operator and different sensors to provide a semi or fully automatic and stable flight.
- Ideal for precise missions when accuracy is of importance.
- A multicopter is fairly easy to fly.
Different type of multicopters

**Quadcopter**
- Cheap, simple and easy design. Fairly efficient.
- 4 rotors, opposite spin directions than its neighbours
- The airframe can be designed in different setups.
- X configuration commonly used for aerial photography
- 4 rotors will not give any redundancy.

**Hexacopter**
- 6 rotors in X, Y or + configuration. X most commonly used.
- More payload capacity than quadcopters
- 6 rotors will give redundancy. Will easily continue fly with 5 rotors.
- More expensive and less efficient than a quadcopter

**Octocopter**
- Heavy lifters but less efficiency than a quadcopter
- Different configurations, X or + configuration
- X8 = 2 motors per arm (a quad with 8 motors)
- Will continue to fly with as many as four rotor failures
- More complex design, more motors and hardware will lead to a higher price
Drone technology

Components

- A multicopter needs a flight controller, a fixed-wing can do without but will usually have one.
- Flight controller contains several internal and external sensors such as barometers (altimeters), gyroscope, compass, temperature, GNSS, etc.
- Logs from sensors can be used in post evaluation and research.
- Brushless motors (modern motors with high efficiency)
- Propellers with correct size and pitch
- Batteries - lithium ion polymer
Peripherals

Some other things we need in our field usage.

- Transceiver (transmitter and receiver) to control the drone
- Monitors or FPV googles (if using a camera)
- Sensors to be carried by the drone
- Chargers for batteries
- Emballage for transportation
- Spare parts (propellers, landing gears, etc)
- Catapult or ramp if using fixed wing
Drone technology

Navigation

- Accelerometer, gyroscope, compass, magnetometer will assist with the navigation
- GNSS (GPS, Glonass, Galileo, Beidou) will give the position and exact location
- A barometer will increase the accuracy of the height
- All these sensor data can be used for post processing of the mission in combination with external sensors used
- Navigation might be affected in Arctic regions due to magnetic variations and interference, positioning of the magnetic north pole and weak GNSS signals
Power sources

Lipo batteries

- Cold batteries will give you reduced power and can be potentially dangerous in case of voltage drop
- Flying in cold climate is usually no problem as long as you can provide warm batteries on take off
- A mobile telephone with bad battery will stop working. A drone with bad battery will fall down
- Charging must be performed with a specific charger
- Never leave fully charged batteries in storage (applies to no “smart batteries”)
- “Smart batteries” will take care of charging, monitoring, discharging and temperature control
Safety and warnings

Lipo batteries

- High energy, can be extremely flammable
- Never charge without monitoring the batteries
- Batteries need to be transported according to IATA rules which will limit to total energy content. The **Watt Hour Rating** will decide
- Usually batteries, even small batteries, need to be carried in the hand luggage

[IATA](http://www.iata.org/whatwedo/cargo/dgr/Documents/LithiumBattery_PassengerFlyer.jpg)
IATA rules for batteries

For more information contact your airline or visit:
www.iata.org/dangerousgoods

Whether a lithium battery can be carried by air or not depends on its configuration and either Watt-hour (WH) rating (for rechargeables) or Lithium Content (LC) (for non-rechargeables).

Use the following table to determine if your battery is acceptable:

<table>
<thead>
<tr>
<th>Watt-hour (WH) or Lithium Content (mAh)</th>
<th>Self-contained</th>
<th>Carry-on Baggage</th>
<th>Checked Baggage</th>
<th>Operation Approved</th>
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</thead>
<tbody>
<tr>
<td>&lt; 100 Wh (100 mAh)</td>
<td>Self-contained</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Spare</td>
<td>Yes (Box lost)</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>&gt;100 Wh (100 mAh)</td>
<td>In Equipment</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Self-contained</td>
<td>Yes (Box lost)</td>
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<td>&gt;100 Wh (100 mAh)</td>
<td>In Equipment</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Spare batteries may not be placed in checked baggage.

Batteries contained in equipment such as laptop computers, camcorders, mobile phones, etc. must be switched off and measured. IATA is aware that they cannot be accidentally activated when placed in checked baggage.

Examples of Lithium Batteries:

- Small Lithium Batteries and Cells include portable sizes batteries, watch batteries, MP3 player batteries and most original laptop batteries. The maximum rating for these batteries is 100 watt-hours (Wh) or 100 milliampere-hours (mAh).
- Medium Lithium batteries and cells include larger batteries and cells - examples include some extended life batteries for laptop computers, and batteries used in medical or portable electronic equipment. A "standard" battery provides between 100 and 1000 watt-hours of power. Larger battery packs are beyond scope of the IATA regulations covered below.
- Large Lithium batteries and cells are primarily those used in industry. A large rechargeable battery provides over 100 watt-hours of power. Larger batteries may be found on some electric and hybrid vehicles, as well as mobility devices and robots.

Note: Other commercially available types of batteries such as Ni-Cad, Lithium ion, and alkaline can be carried safely in either checked or carry-on baggage provided they are adequately protected against short circuit.
Payload

- Payload will affect flight time of the drone.
- For a multirotor aircraft 1 gram extra will reduce 1 second
- Custom payload will often require custom drones which will increase the price
- Higher price will not increase simplicity but for sure increase complexity
When to choose what?

Consider a multirotor if you...

- Want a cheap, simple and portable unit for taking basic pictures
- Want high quality, high resolution pictures
- Will do precise inspections or measurements
- Will carry any kind of sensors or payload
- Want something that is fairly easy to fly

Consider a fixed wing if you...

- Require a long flight time
- Will do mapping and survey of large areas
- Already know a bit of flying or can deal with a bit of a learning curve
- Don’t mind carrying around a fixed wing (some might be lightweight but bulky)
- Can spend a bit more $$$ from your budget
- Want to use sensors that doesn’t care about moving around in the air all the time
Objectives

Actors and market

- Multirotor - DJI world market largest manufacturer for amateurs and professionals
- Small nisch actors will serve the rest of the professional market for multirotors
- Fixed wing – recreational use (DIY) or professional market high end, small nisch actors
### Comparison DJI basic

**MAVIC PRO**
- **Starting At**: $749

**PHANTOM 4 ADVANCED/+**
- **Starting At**: $1,199

**PHANTOM 4 PRO/+**
- **Starting At**: $1,499

<table>
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<tr>
<th></th>
<th>Mavic Pro</th>
<th>Phantom 4</th>
<th>Phantom 4 Pro</th>
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<td>1/2.3&quot;</td>
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<tr>
<td>Film Rate</td>
<td>12.35 MP and 4K Video</td>
<td>12 MP and 4K Video</td>
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<td>Shutter Type</td>
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<td>60 Mbps</td>
<td>100 Mbps</td>
</tr>
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<td>Camera Image</td>
<td><img src="image1.png" alt="Mavic camera" /></td>
<td><img src="image2.png" alt="Phantom 4 camera" /></td>
<td><img src="image3.png" alt="Phantom 4 Pro camera" /></td>
</tr>
</tbody>
</table>
Comparsion DJI basic

- Operational out of the box
- Very easy to transport and to carry
- Everything you need included (except ipad or telephone)
- Focus amateur or semi professional video production, ok for photography
- Possible but not recommended for 3D mapping
DJI mid range

INSPIRE 1

- Operational almost out of the box
- Fairly easy to transport
- Dual operator
- Detachable/replaceable cameras
- Focus on semipro or professional video production
- Starts at US$ 3000

INSPIRE 2
DJI high end

DJI MATRICE 200 SERIES COMPARISON

- Matrice 200
- Matrice 210
- Matrice 210 RTK

- High end series. Starting at US$ 10 000.
- Modular with cameras for inspection, thermal camera.
- Additional precise positioning with RTK
- Focus: professional survey and inspection
Other brands

https://sensefly.com/
http://www.trimble.com/
https://leica-geosystems.com
http://smartplanes.com/
Where to start?

Start with a Hubsan X4, $40

If you can fly this one – you can fly anything…
Thank you
Any questions?