



# UAS General Knowledge

Movements

Principles of Flight

Maintenance

Flight Mode

Data Connection

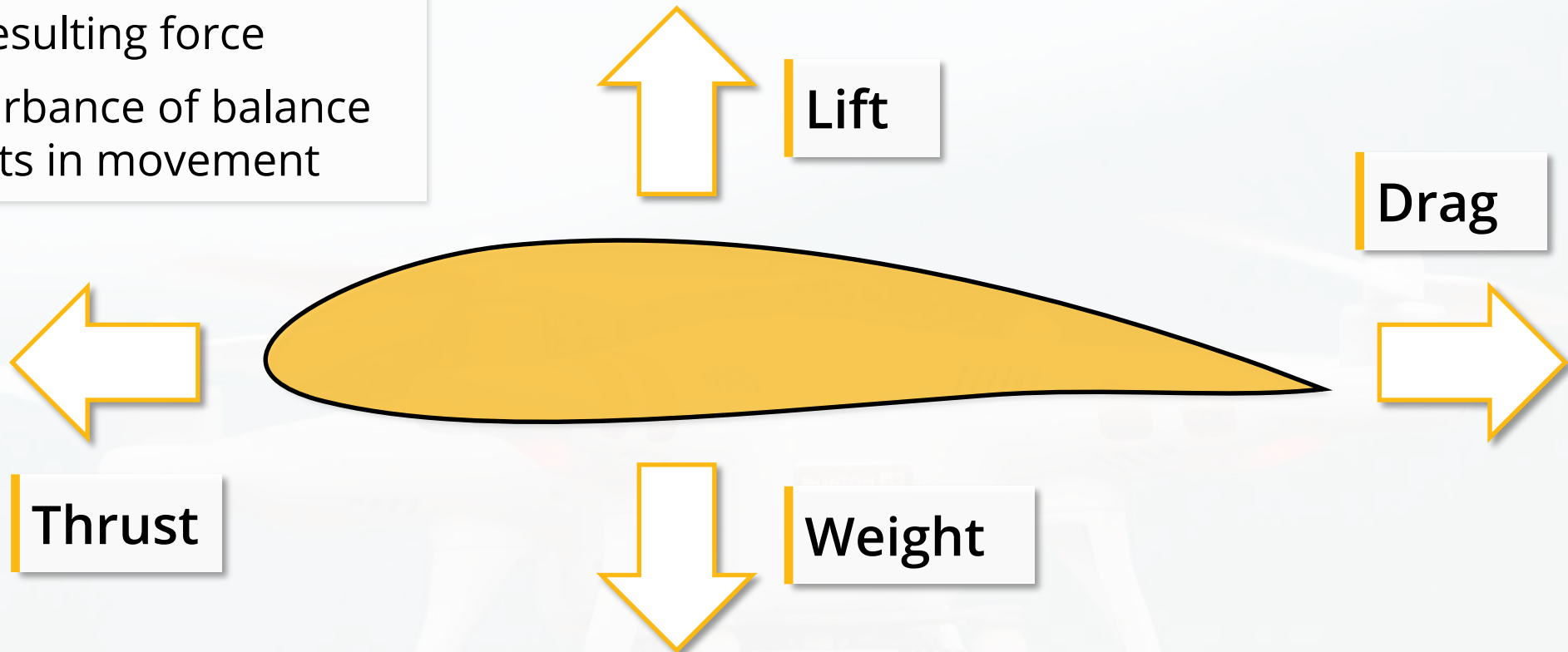
shortcut

# Aerodynamic Forces

## Steady, straight flight

- Equilibrium
- No resulting force
- Disturbance of balance results in movement

Rotor blade = Aerofoil



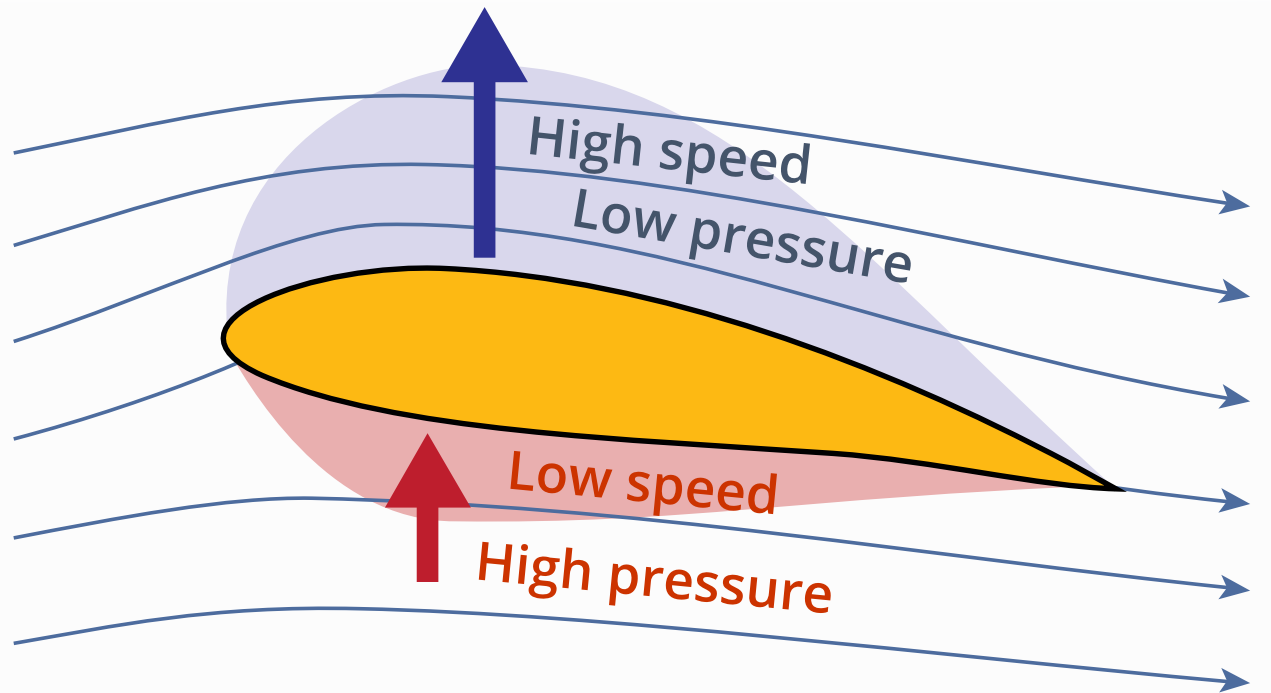
# Lift

## Lift experiment



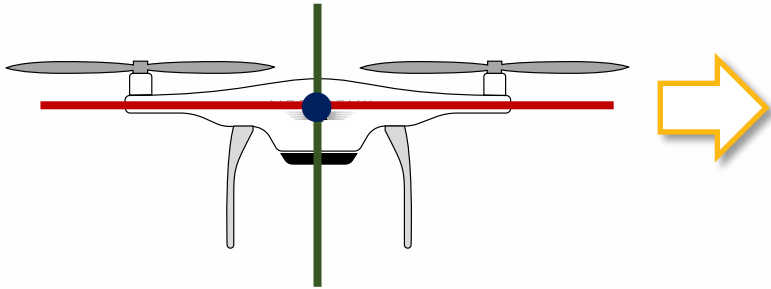
- **Lift** is caused by different pressures above and below the aerofoil
- **Angle of attack:** angle between wing chord and airflow

## Lift generation on an aerofoil



# Directions of movement

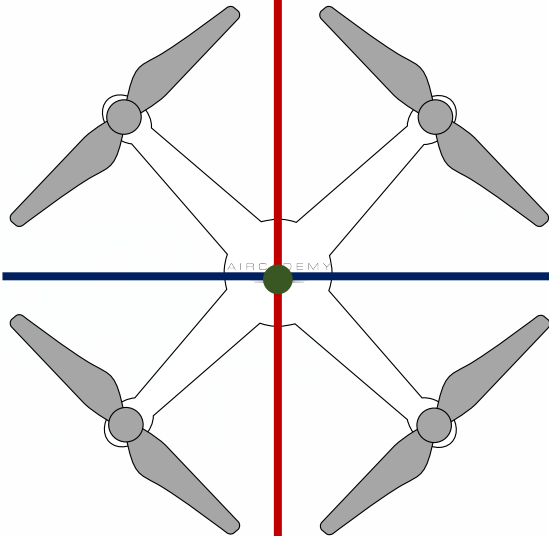
Normal axis (*Yaw*)



Direction of flight

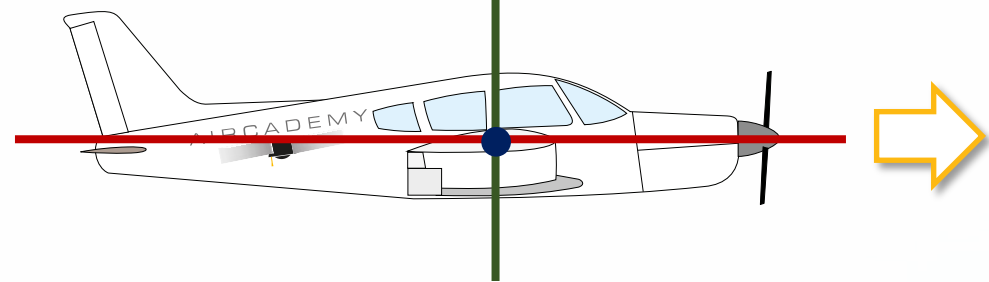


Longitudinal axis (*Roll*)



Lateral axis (*Pitch*)

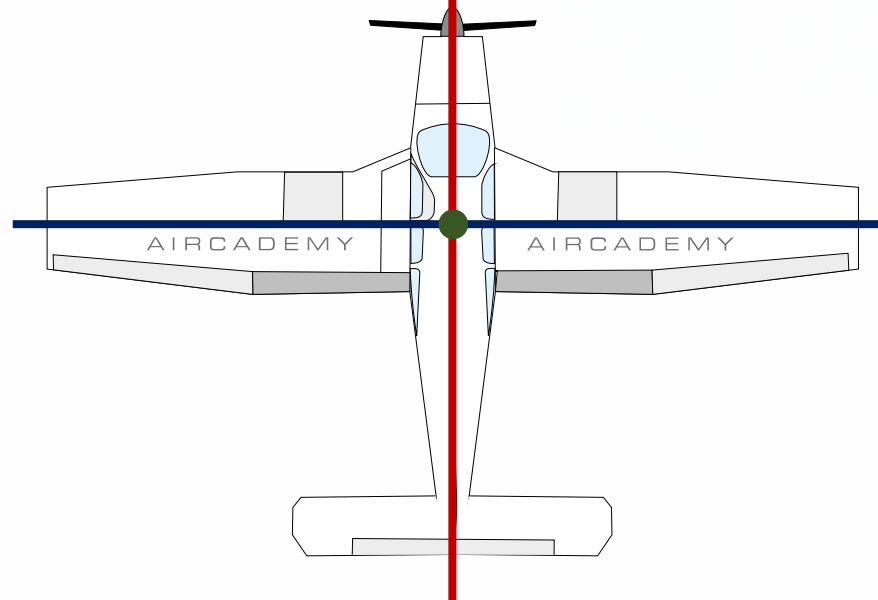
Normal axis (*Yaw*)



Direction of flight



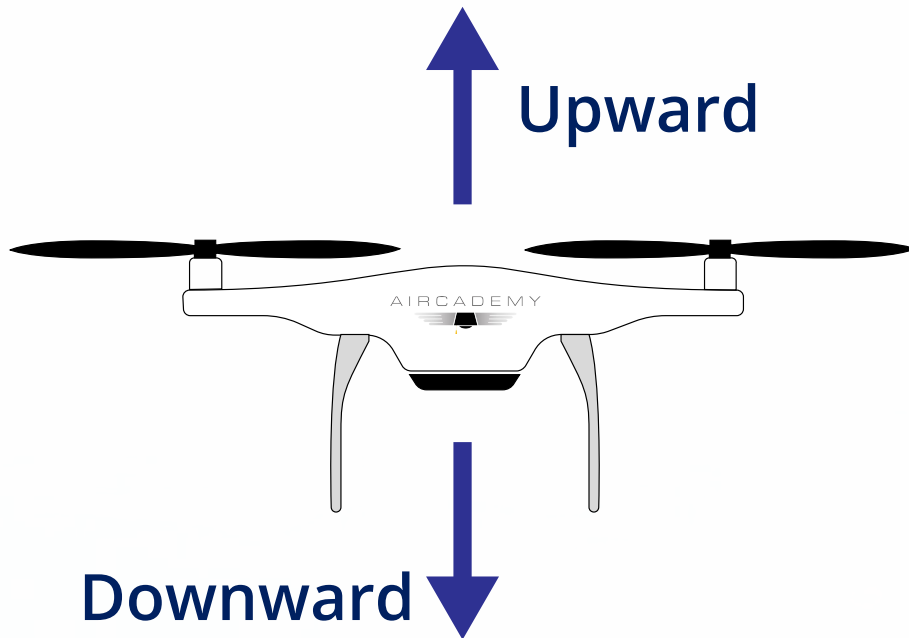
Longitudinal axis (*Roll*)



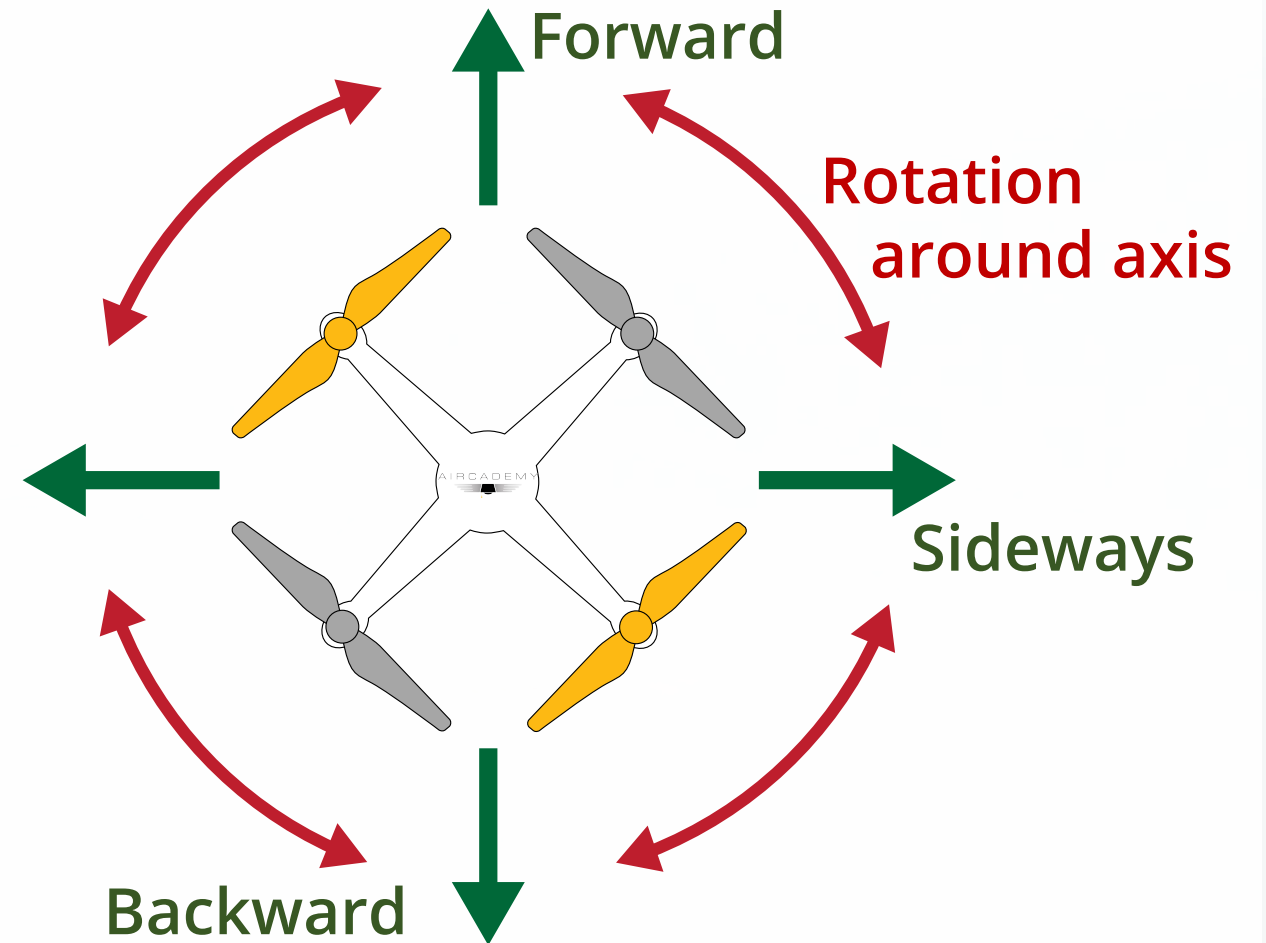
Lateral axis (*Pitch*)

# Movements

## Vertical movements



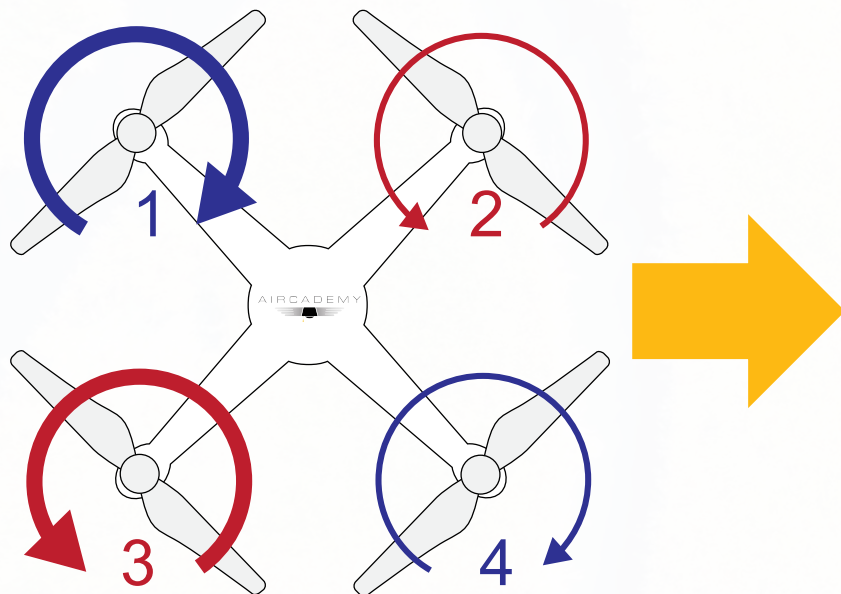
## Horizontal movements



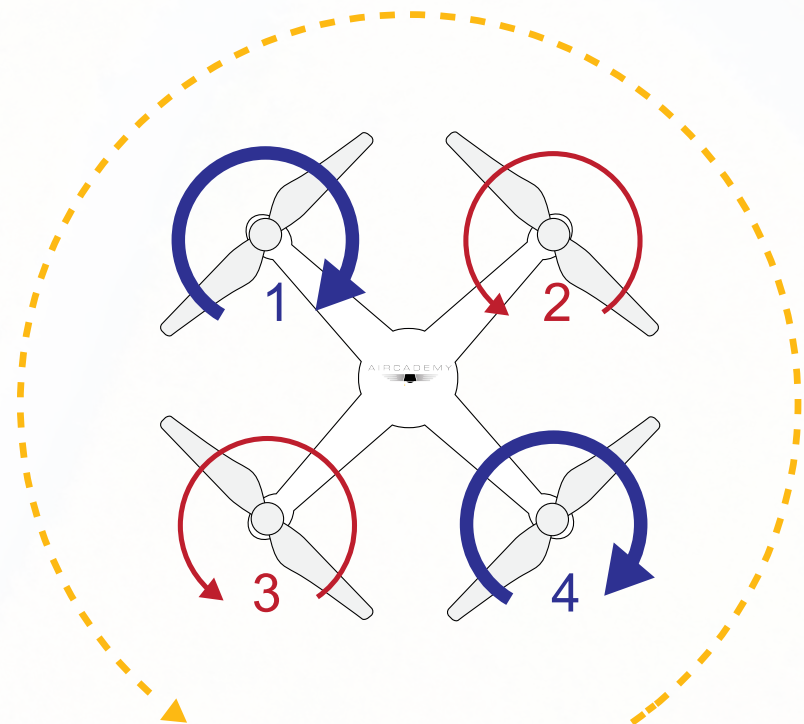


# Movement and Rotation

## Horizontal Movement



## Rotation



# Main Components

## Propulsion system

- Energy source (batteries)
- Motors
- Power distributor

## Speed controller

- ESC (Electronic Speed Controller)
- Controls rotation speed of the propellers

## Propeller

- Wings
- Converts rotational into upward movement

## Computer

- Records and processes information from all sensors
- Sends data to speed controller

## Firmware

- Based on pre-installed software
- Must be updated regularly

## Control

- Control from ground
- Data is sent by radio communication to the flight electronics

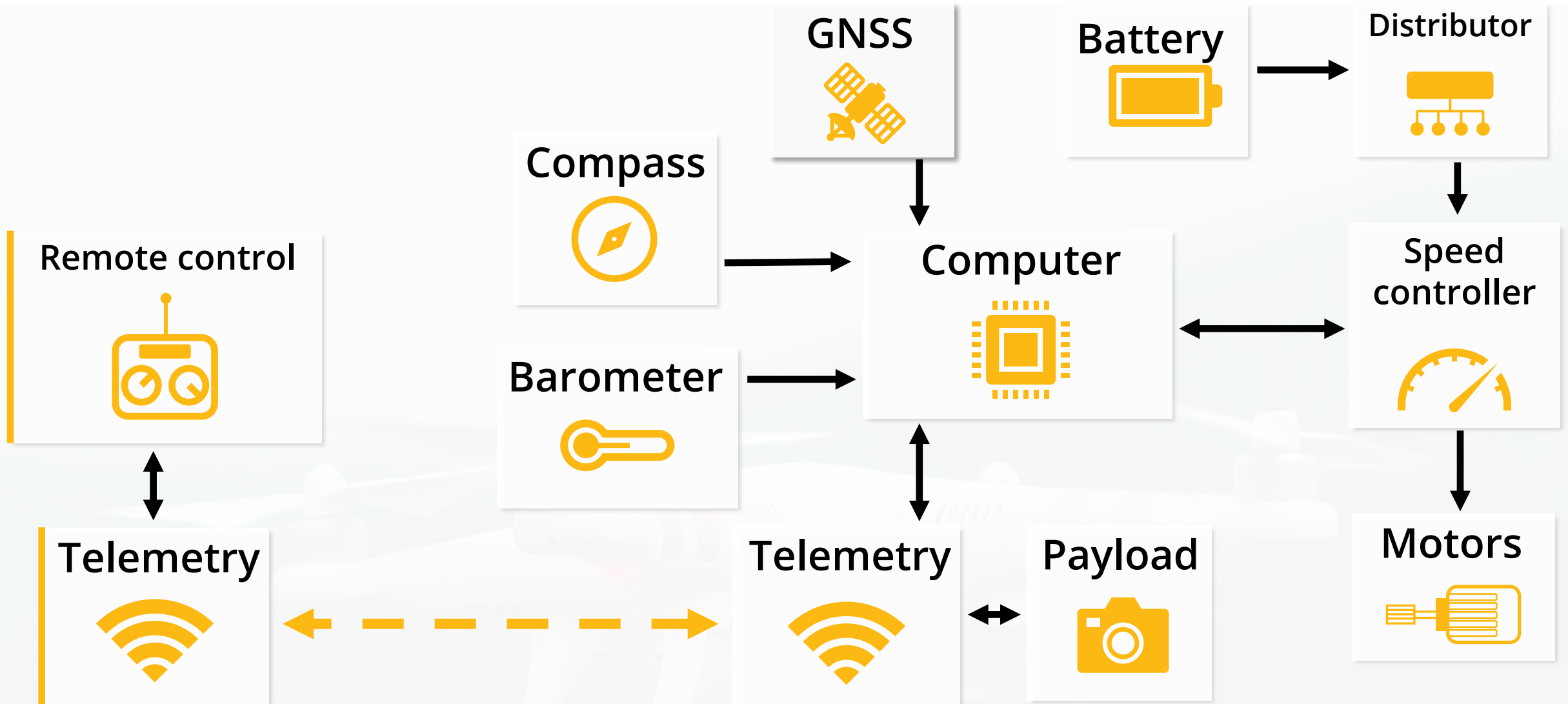
## Telemetry

- Radio link between controller and flight electronic
- Sender and receiver

## Other

- Lights, gimbal, gear
- Sensors
- Payload

# Schematic View





# Restrictions and Limitations

## Flight Time

- Max. flight time: optimal conditions
- Fast loss of potential capacity with LiPo batteries
- Subtract 20% of max flight time

## Speed

- Max. 15 m/s
- Operation limited to wind speeds < 10 m/s
- Caution with gusts!

## VLOS

- Manufacturer information only partially relevant
- UAS must remain within VLOS
- Influence of obstacles

## Weather

- Avoid flights in rain, snow or hail
- Caution with propeller icing
- Overheating of motors
- Battery capacity decrease with cold temperatures

# Limitations

## Heavy impacts

- Caution during landing!
- Impact on other systems
- Damage is not always visible

## Fatigue

- Can affect all elements
- Caused by several smaller incidents
- Important: Check before every flight!

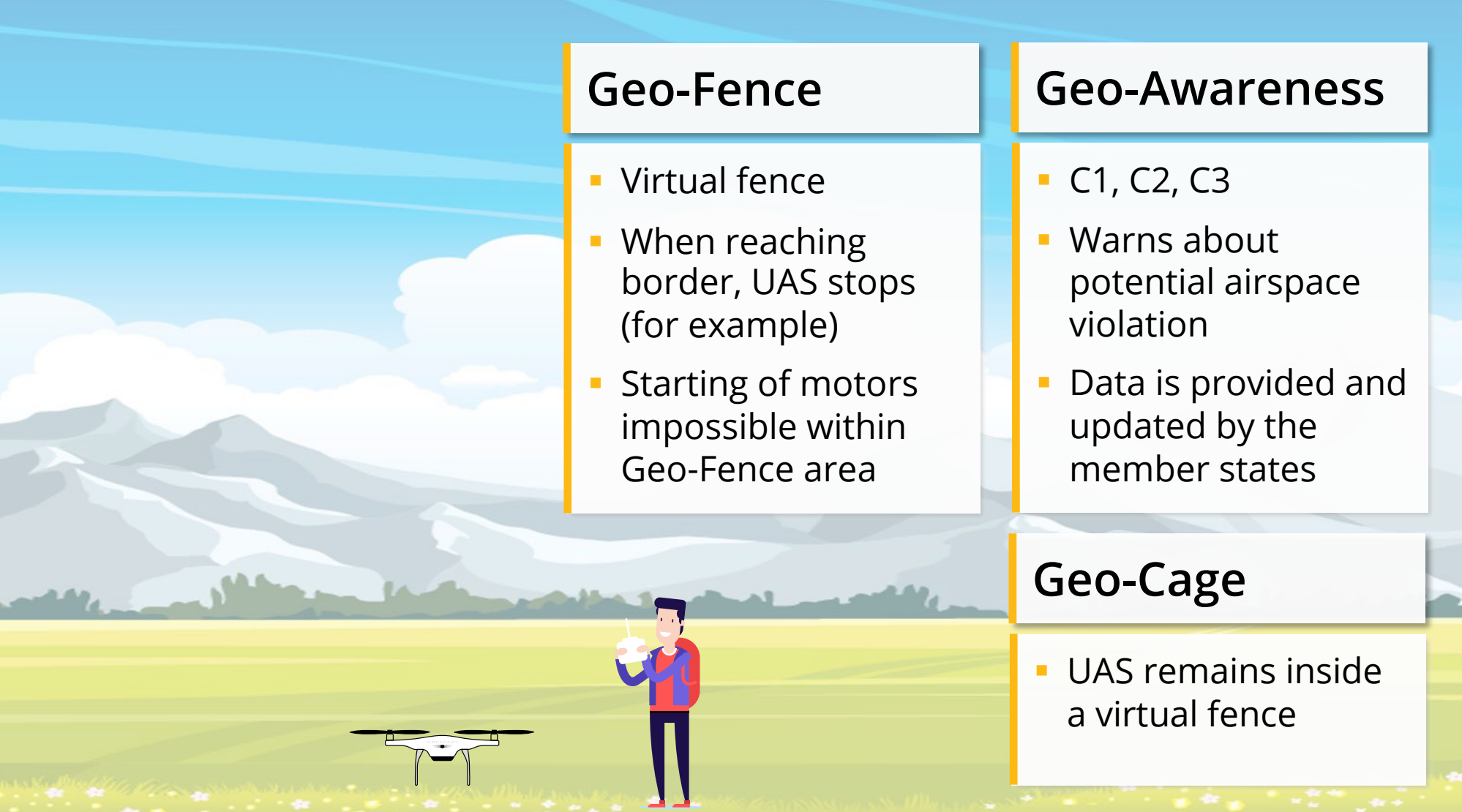
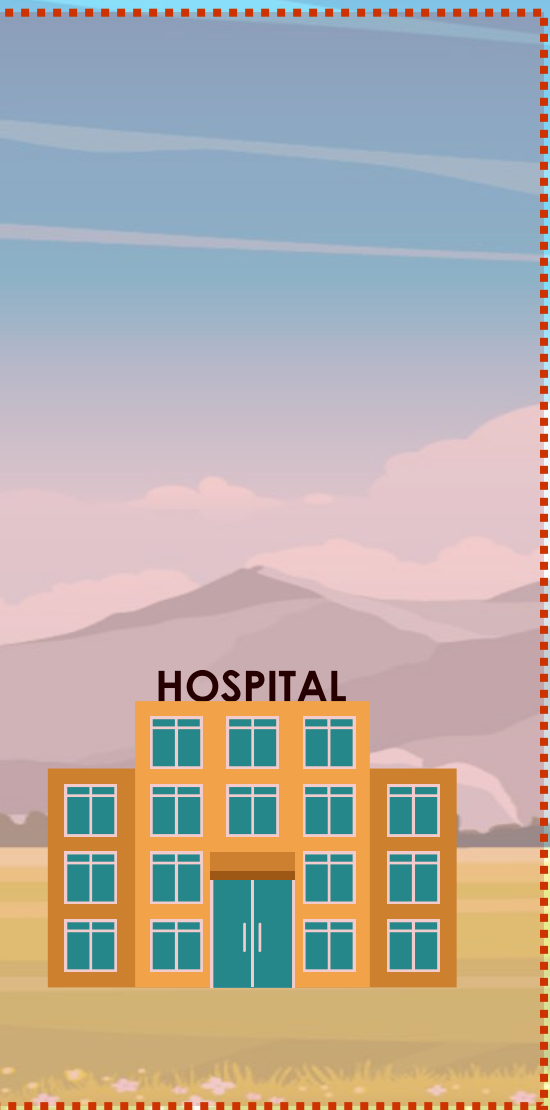
## Propeller damage

- Collisions or tip over
- May cause vibrations that can lead to motor damages
- Immediate replacement!

## Motor service life

- Theoretically up to 20,000 h
- Ingress of sand, dust and water leads to significant reduction of lifetime
- Frequent careful checks!

# 'Geo'-Systems



## Geo-Fence

- Virtual fence
- When reaching border, UAS stops (for example)
- Starting of motors impossible within Geo-Fence area

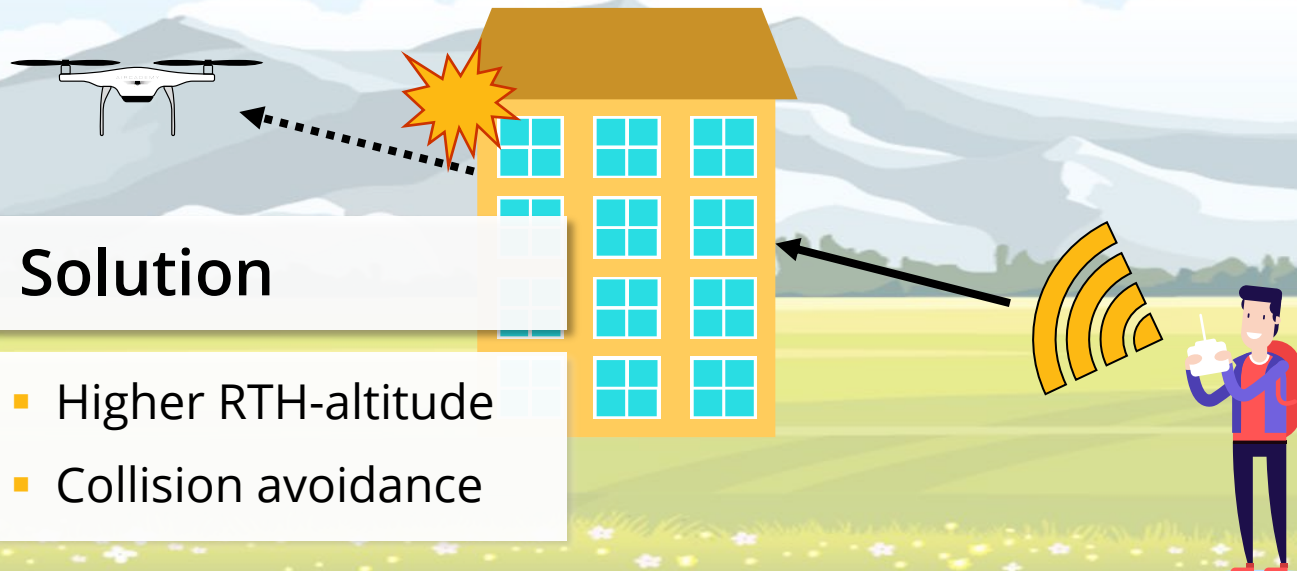
## Geo-Awareness

- C1, C2, C3
- Warns about potential airspace violation
- Data is provided and updated by the member states

## Geo-Cage

- UAS remains inside a virtual fence

# Reliability (fail safe)



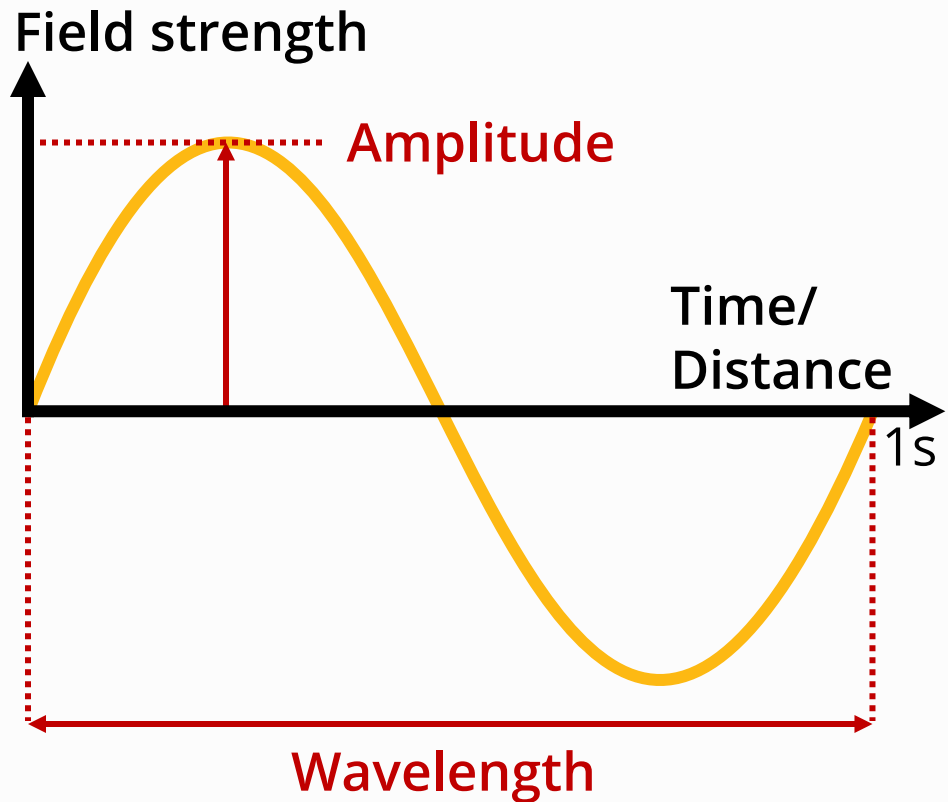
## Solution

- Higher RTH-altitude
- Collision avoidance

## 'Return to Home' Modes

- **Failsafe**
  - Signal interruption > 3 sec.
  - Cancelled if signal is available
- **Smart**
  - Additional collision avoidance system
  - Avoids approaching obstacles
- **Low battery**
  - Activated on reaching critical battery level

# Radio Wave Propagation

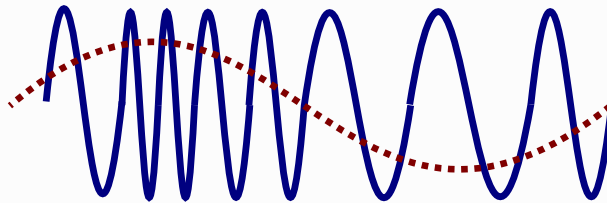


## Physical values of wave propagation

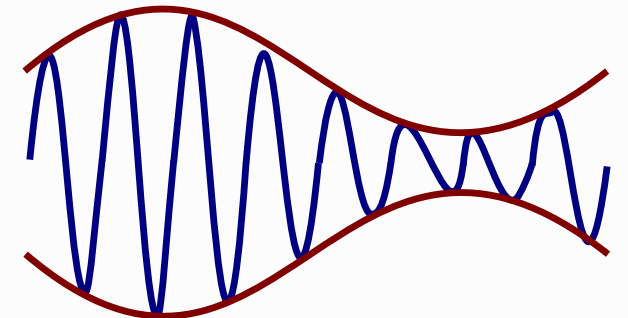
- **Wavelength:** Distance of complete oscillation
- **Amplitude:** Maximum deflection from baseline
- **Frequency:** Number of oscillations per second

The higher the frequency, the shorter the wavelength

## Frequency modulation



## Amplitude modulation

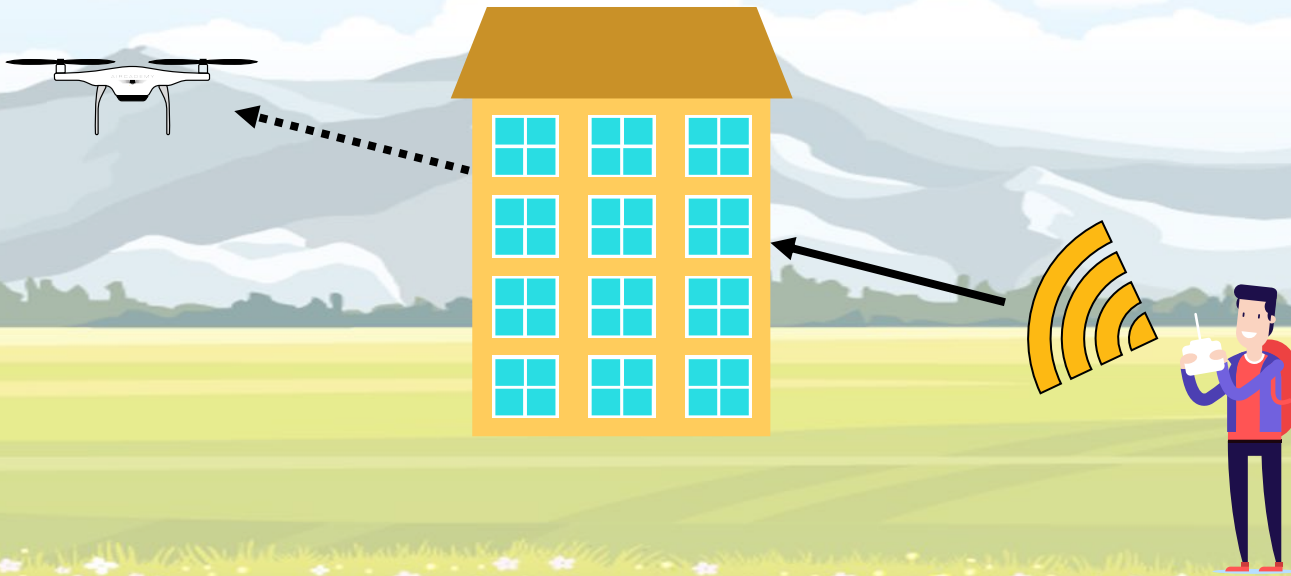




# Radio Wave Propagation

## Direct Waves

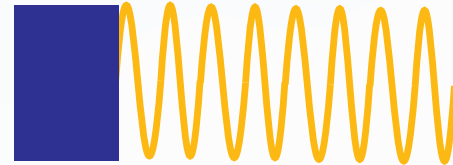
- Straight propagation from transmitter
- Direct line of sight necessary



# Data Link

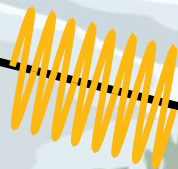
## RFID-Code

RFID Information



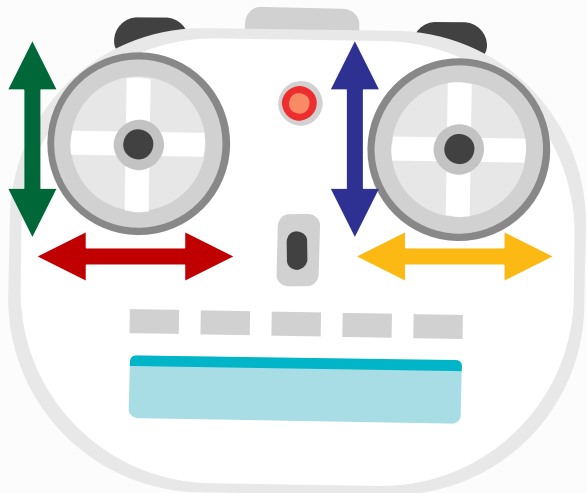
## Radio waves

- 2,4 and 5,8 GHz (UHF)
  - Range about 600 m
- 433 and 868 MHz
  - Higher range
  - Less information
  - Larger antennas
- RFID-Code as prefix
  - Radio Frequency Identification

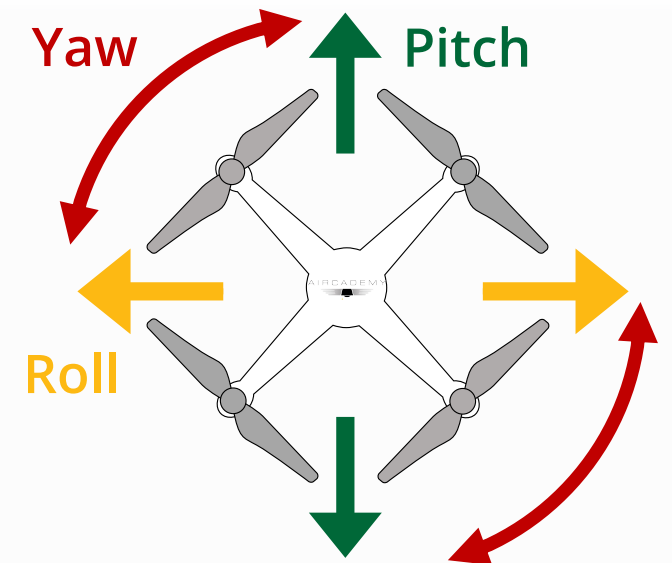
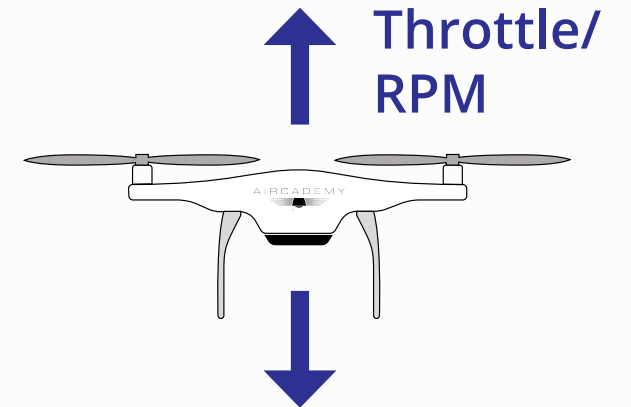
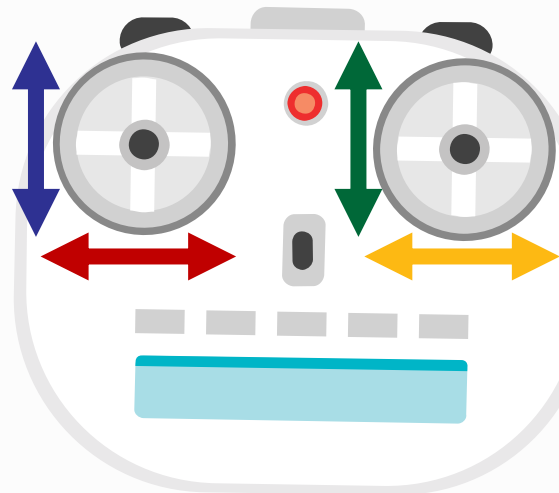


# Control Modes

Mode 1



Mode 2



# Flight Modes



## Pre-programmed

- Flight route along programmed waypoints or coordinates
- High precision

## Manual

- Straight and directionally stable
- Influenced by wind and gravity

## Automatic

- Automatic take-off and landing
- Remote pilot can intervene anytime

## Stabilised

- Altitude mode maintains current altitude
- GNSS-Mode maintains altitude and position

# Maintenance

## Maintenance

- Only qualified personnel can open
- Test flight
- Maintenance protocol

## Intervals

- Self-check, for example after 25 hours
- Professional maintenance according to manual (e.g., after 50h)

## Self-check (e.g., after 25 hours)

### Structure

- Clean
- Examine for cracks
- Retighten screws
- Motors should rotate smoothly
  - Blow out
- Check propeller blades for cracks and damage
- Check antennas (also ground station)

### Hard-/ Software

- Check availability of updates

### Battery

- Check for damages and leaks; exchange if necessary