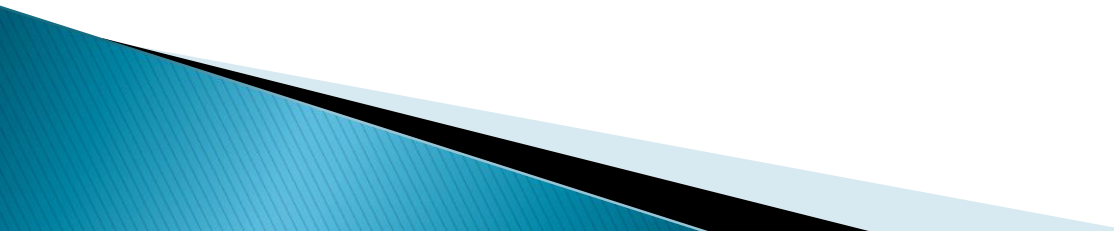# CanberraUAV Workshop Communications links

Feb 2017

Communications

- The ability to:
  - Receive timely telemetry
  - Reliably command the UAV
- Includes RC controllers and GCS computers
- For safety, a UAV must be able to be commanded at any time

Communications

- There are many types of communications
  - Mavlink is independent of the communications hardware
- Will skip over RC controllers
  - Simple, direct manual control of the UAV
  - Range limit of ~500m
  - Limit is more the pilot's eyesight rather than the radio range

Communications

- Link budget tells us the expected range from a given output power (and vice-versa)
  - `EIRP` = Effective Isotropic Radiated Power (power out of antenna)
  - `FSL` = free space loss
  - Radio output (`Pout`) + Antenna gain `G(TX) = EIRP`
  - `Pout + G(TX) - FSL >= G(RX) + P(thres)`
  - P(thres) is the radio sensitivity. Depends on modulation and datarate
- Note all units in dB or dWB

Communications

- Antennas

Low gain, non-directional

High gain, directional

Comms – Point-to-point RF links

- Simple serial->RF radios
- Typically 57600 baud
- Operate on the 915-928 Mhz band (in AUS)
- 20km+ range, limited by line of sight

Comms – 3G/4G modems

- High bandwidth
- Unlimited range*
  ◦ (as long as you've got network coverage)
- Can be difficult setting up a network
  ◦ No public IP's ☹

Comms – Long Range Wifi

- High bandwidth
- 5km range with good antennas
- Complete control of link

Comms – Satellite

- Very, very expensive
- Modem/Antenna size is an issue
- 10–20 kbps bandwidth
- Coverage depends on provider

Comms – Bandwidth
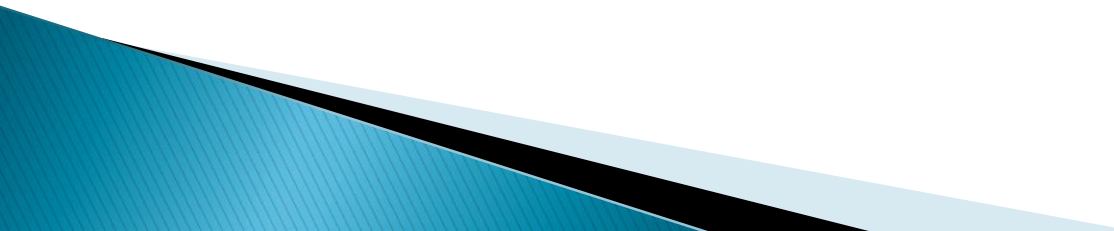
- How much bandwidth do you need?
  - MAVLink typically uses 2-4 kbps
  - Live imagery can use a few 100kbps, depending on resolution, compression and frame rate
  - SSH/remote links to on-board computers?
- What about latency?

Comms – Redundancy

- If the UAV is:
  - Carrying valuable equipment
  - Going beyond line-of-sight
  - Is required to have guaranteed comms
- Then
  - Backup comms links are required

Comms – Redundancy

- Consider
  - What data needs to be prioritised
  - Comms link coverage
  - How quickly the UAV can go to a backup link
  - Independent links based on the same technology, or different technologies?
  - Use a second UAV as a comms relay

Comms – Redundancy

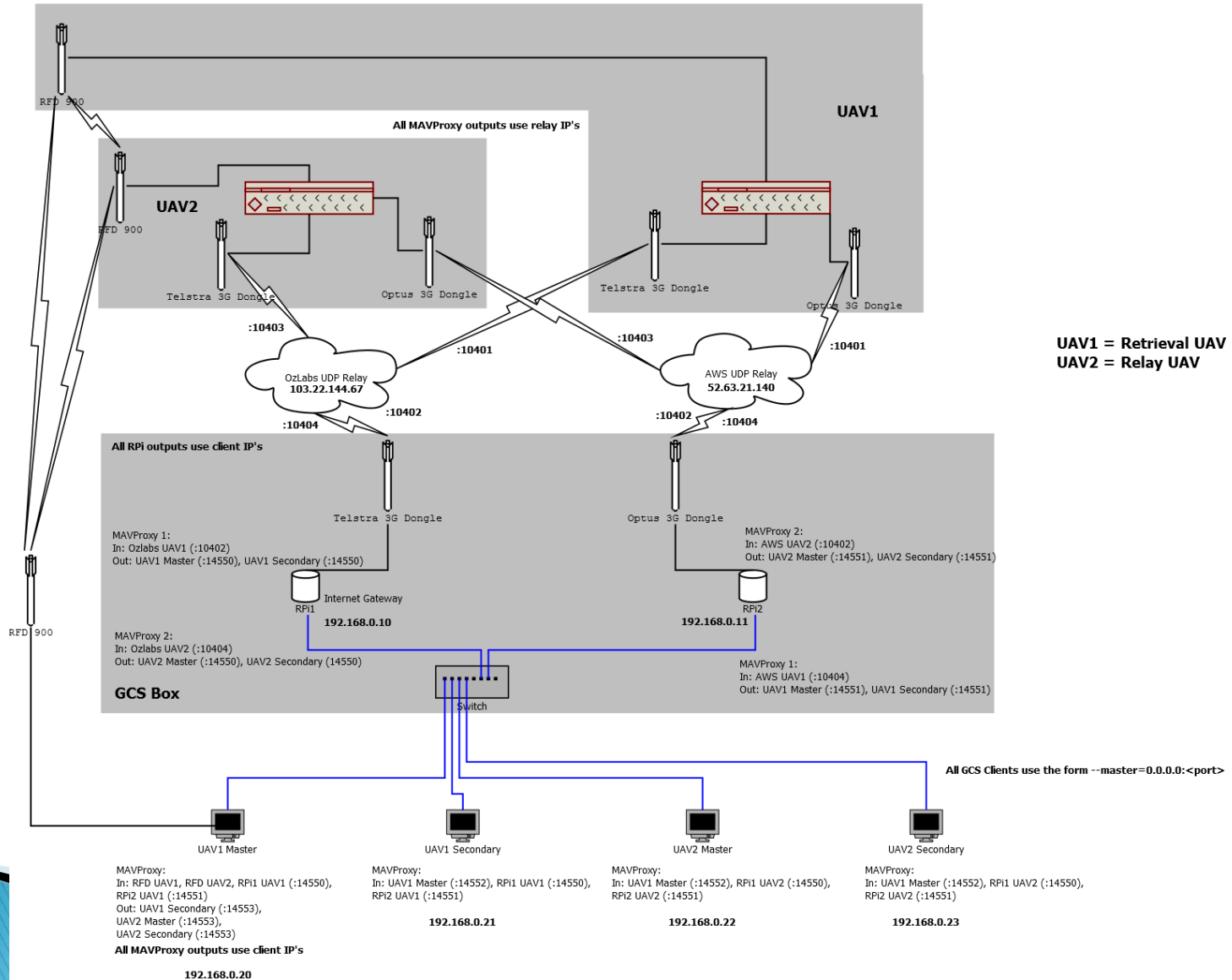- Can be complicated quickly
- Complexity has it's own disadvantages

Comms – Redundancy

RFD 900

All MAVProxy outputs use relay IP's

UAV1

UAV2

RFD 900

Telstra 3G Dongle

Optus 3G Dongle

Telstra 3G Dongle

Optus 3G Dongle

UAV1 = Retrieval UAV
UAV2 = Relay UAV

:10403

:10401

:10403

:10401

OzLabs UDP Relay
103.22.144.67

AWS UDP Relay
52.63.21.140

:10404

:10402

:10402

:10404

All RPi outputs use client IP's

Telstra 3G Dongle

Optus 3G Dongle

MAVProxy 1:
In: Ozlabs UAV1 (:10402)
Out: UAV1 Master (:14550), UAV1 Secondary (:14550)

MAVProxy 2:
In: AWS UAV2 (:10402)
Out: UAV2 Master (:14551), UAV2 Secondary (:14551)

Internet Gateway
RPi1
192.168.0.10

RPi2
192.168.0.11

RFD 900

MAVProxy 2:
In: Ozlabs UAV2 (:10404)
Out: UAV2 Master (:14550), UAV2 Secondary (14550)

MAVProxy 1:
In: AWS UAV1 (:10404)
Out: UAV1 Master (:14551), UAV1 Secondary (:14551)

GCS Box

Switch

All GCS Clients use the form --master=0.0.0.0:<port>

UAV1 Master

UAV1 Secondary

UAV2 Master

UAV2 Secondary

MAVProxy:
In: RFD UAV1, RFD UAV2, RPi1 UAV1 (:14550),
RPi2 UAV1 (:14551)
Out: UAV1 Secondary (:14553)
UAV2 Master (:14553),
UAV2 Secondary (:14553)
All MAVProxy outputs use client IP's

192.168.0.20

MAVProxy:
In: UAV1 Master (:14552), RPi1 UAV1 (:14550),
RPi2 UAV1 (:14551)

192.168.0.21

MAVProxy:
In: UAV1 Master (:14552), RPi1 UAV2 (:14550),
RPi2 UAV2 (:14551)

192.168.0.22

MAVProxy:
In: UAV1 Master (:14552), RPi1 UAV2 (:14550),
RPi2 UAV2 (:14551)

192.168.0.23

The End!

- Link budgets
- Typical types of communications systems
- Redundancy