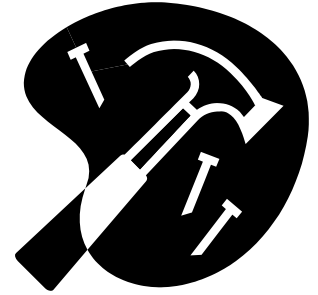


# Team Skylight

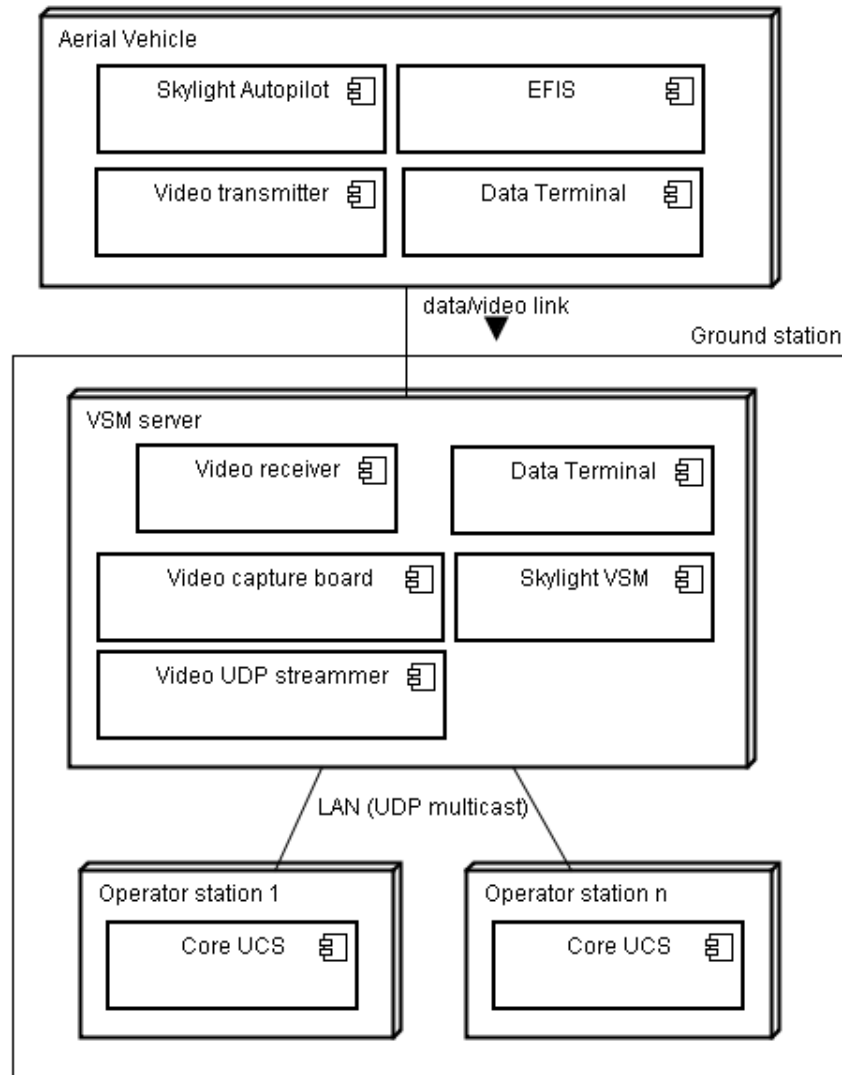
UAV Outback Challenge 2010  
Oral presentation

# System Design



- **Airframe:** Rascal-110 kit
- **Autopilot:** Realtime Java application (custom made)
- **IMU:** Accel+gyro+magnetometer running on multi core processor (custom made software)
- **Datalink:** Aerocomm 900MHz 1W modem
- **Video:** Sony blockcam with gyro stabilized PTZ gimbal (custom made)
- **Control:** STANAG 4586
- **Ground station:** Notebook based multi-operators/views Java application (custom made)

# System Design

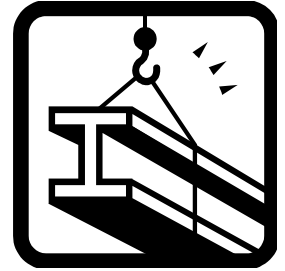


# System Evolution



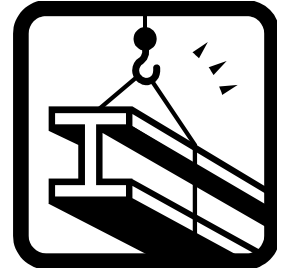
System	Version 1 (2008)	Version 2 (2009)	Version 3 (2010)
Main Data Link	3G/GSM based	WiFi with high gain antennas	900MHz modem with omni antennas
EO sensor	Nokia N95 camera	Fixed camera	Custom made georeferenced gimballed camera
Image transmission	Photos over 3G	2.4Ghz Video transmitter	2.4Ghz Video transmitter
UAV Control	Custom	Custom	STANAG-4586
Sensor/actuator processing hardware	Single microcontroller	Single microcontroller	Two 8 core microcontroller on 4 layered PCB
Onboard computer	Nokia N95 with MIDP autopilot	VIA EPIA PX x86	Gumstix Overo ARM
IMU	Thermopiles/pressure sensors and 5Hz GPS	Thermopiles/pressure sensors and 5Hz GPS	Gyro/accel/magn/pressure sensors and 10Hz GPS
Watchdogs	Hardware	Hardware	Hardware and all software elements
Power plant			3W

# Approach to Safety



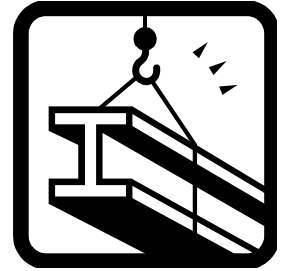
- Rules of Safety as part of every mission
  - Setup the various Safety Actions needed to handle dangerous situations
    - Ex.: If “Insufficient thrust power”, then “Loiter with roll descending to ground”
  - Define mission limits
    - altitudes, boundaries, time of operation etc
  - Define manual recovery location
  - Mission validation

# Approach to Safety



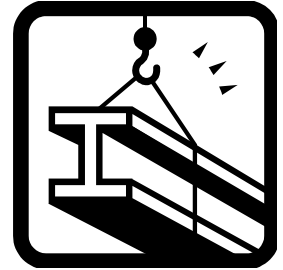
- Flight Termination
  - A completely independent element from the main processor that monitors overall system heart beat signals.
  - A backup battery gives it the hability to perform Flight Termination even if the main battery dies or when in RC control

# Approach to Safety



- Loss of Datalink
  - A special Safety Action was developed to perform the link recovery procedures, so if it is not detected any kind of link activity during a certain amount of time, that Action will take place
  - If link recovery is not possible, the vehicle will return to home and wait for a manual RC recovery
  - If manual recovery is not possible, Flight Termination will take place

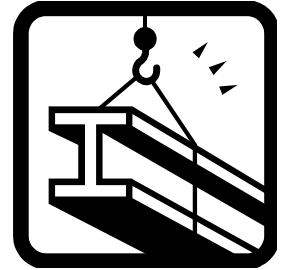
# Approach to Safety



- Loss of GPS
  - A special Safety Action was developed to handle all procedures needed for a safe GPS recovery attempt
  - If autopilot doesn't get current vehicle position updated regularly, it will activate this Safety Action
  - If GPS link recovery is not possible, the ground operator will return to home by commanding roll using a joystick while being guided by video camera and IMU telemetry



# Approach to Safety



- Autopilot lockup
  - If any element of autopilot gets locked (hw or sw), no heart beat signals will be received by the Flight Termination device, so it will execute Flight Termination

# Expected performance

- Safe operation on all phases
  - Extensive tests were done on low, mid, high controls, communications, navigation and in-flight controls. Various improvements on those subsystems were added as result of the tests
- Enough autonomy for the mission
  - We use a 3W engine with a small carburator along with a 65Wh LiPo battery

# Expected performance

- No communication blackouts
  - The chosen modem is suitable for long range operations. Tests showed great performance.
  - We can monitor modem RSSI in realtime, so if communication is going to be bad, we can take safety actions before that happens.

# Expected performance

- Controllable delivery of the bottle
  - An object drop planner utility on ground station will calculate a flight plan for bottle drop based on wind estimation and upload it to vehicle when authorized
  - Our tests showed that creating manually a good plan for object drop while in mission would be very hard



# Expected performance

- Take-off to search area: 5 min
- Primary search: 10 min
- Secondary search: 6 min
- Back to home: 5 min
- Flight time: ~30 min



# Lessons learnt



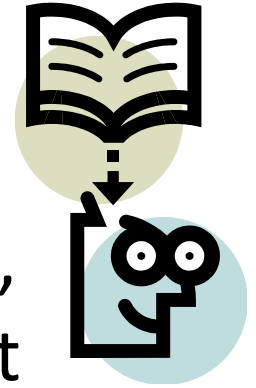
- An UAV System has many complex parts, from aerodynamics to hardware, software, mechanics, legal and personnel perspectives
- The success of the platform depends on well trained pilots/operators using systems that were built with extreme care and tested against different situations

# Lessons learnt



- During a flight, things happen very fast. The pilot/operator needs to be prepared for a fast and good reaction too
- Simulation is essential for developing this kind of platform
  - Even initial PID parameters adjusted in simulators proved to be effective in real world

# Lessons learnt



- Each subsystem needs time of maturation, so iterative development is very important
- Creating a UAV system almost from scratch is very hard, but a lot of fun too!
- Come to Australia at least 2 weeks before the Challenge!
  - Our flight was cancelled and our baggage was delayed so we lost almost 4 days waiting for them and had only 1.5 day for all assemblies!



# Our ground station

**Skylight Ground Control Station**

File Tools Window Help

+ Mission Alerts Pre-flight Configuration View **Payloads**

Payload Control - EO/IR device (#7) [LOI3] @40:40:4...

Payload: EO/IR device (#7)

Sensor number: 0 0 Set

Operating mode: Active ACTIVE Set

Azimuth: 0 0 Set

Elevation: -90 -90 Set

Horizontal FOV: 55 54 Set

Zoom level: + -

Control Map 2D - 40:40:40:00 [LOI5]

6.5 km

Manual recovery

Loiter Search Area

Data link recovery

Search entry Search exit

Alt: 655.07 ft (AGL)

G Speed: 82.14 km/h

775951° (151°46'33.425" L)

rpm 1  
1.1x4  
engin

CHT 1  
229.7  
deg

batt1  
26.40  
volt

ignil  
0.000  
0/1

Lailn Railn Lailn Railn Lailn Railn Lailn Railn  
-0.019 0.019 -0.019 0.019 -0.019 0.019 -0.019 0.019  
1,deg 1,deg 1,deg 1,deg 1,deg 1,deg 1,deg 1,deg

elev1 elev1 elev2 elev2  
0.701 0.701 0.701 0.701  
deg deg deg deg

rudr1 rudr1 rudr2 rudr2  
0.375 0.375 0.375 0.375  
deg deg deg deg

camra camra camra camra camra camra  
3.4x4-25.94-4.1x4 329.5-89.86 48.16  
X Y Z hdng pitch roll

Vehicle Control

Name	Info	Control [LOI]
Vehicles		
10:10:10:00	Skylight	
EO/IR device (#1)	EO/IR device	
Dispensable payload ...	Dispensable pa...	
40:40:40:00	Skylight	In Control [LOI5]

Timer

Type label here...

00:00:00

.000

Timer Timer

Loiter Director - 40:40:40:00 [LOI5]

300 300 10 30 60 90

150 120 90 60 30 0

1440 1280 1120 960 800 655 480 320 160 0

km/h GSpeed

ft AGL

Activate

Radius: 300

Loiter Director - 40:40:40:00 [LOI5]

Flight Director/Manual Override - 40:40:40:00 [LOI5]

WA CWB Next # Edit

			Flight
0	2	Edit	
0	3	Edit	
0	4	Edit	
0	1	Edit	

14:35  
26/09/2010

# Our autopilot



# Questions?