

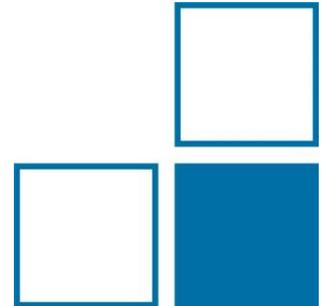


Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

Development of the Airborne Measurement Platform

EMWT, December 6th 2017

Marius Mihalachi



Contents



- PTB UAS fleet
- UAS Setup
- Differential GNSS
- Interconnect Board
- Mission Planning
- Android App

- Use of UAS as universal measurement platform
- Up to 4 kg payload
- Onboard position and attitude stabilization
- Standalone flight system by means of GNSS and magnetometer
- Automatic flying of waypoints, flying around points of interest, triggering of waypoint-events
- Holding of a measurement position, flight time of 10 – 20 min.
- Telemetry data, FPV (First Person View)

PTB UAS Fleet



PTBee 1



PTBee 2

PTB UAS Fleet



PTBee 1



PTBee 2



PTBee 3A



PTBee 3B



PTBee 3C



PTBee 3D

PTB UAS Fleet



PTBee 4

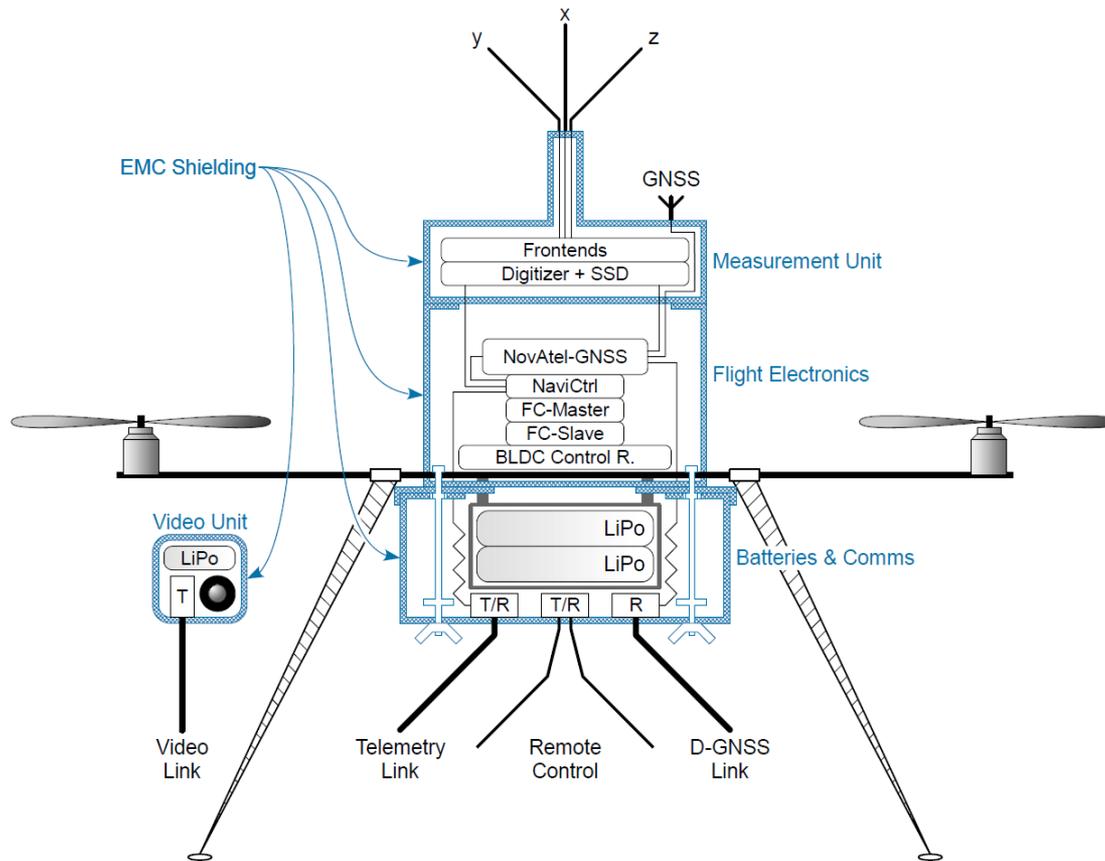


PTBee 3C

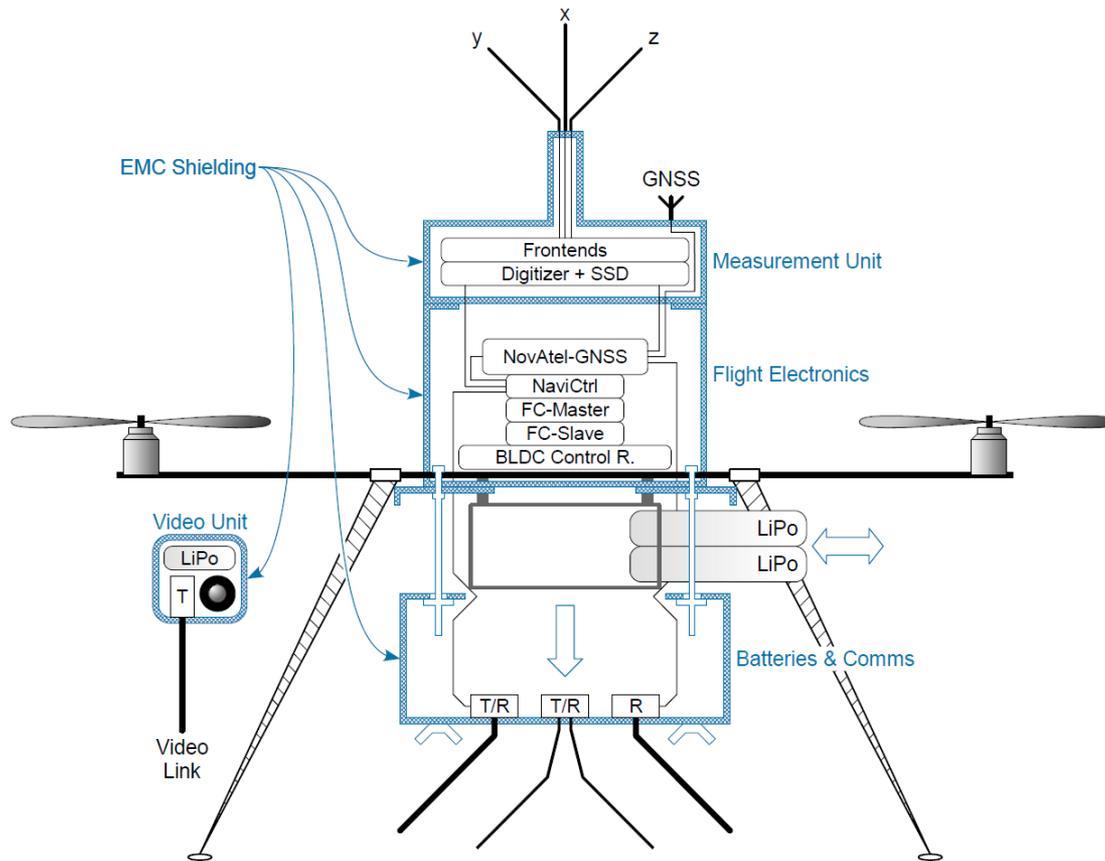


PTBee 3D

UAS Setup



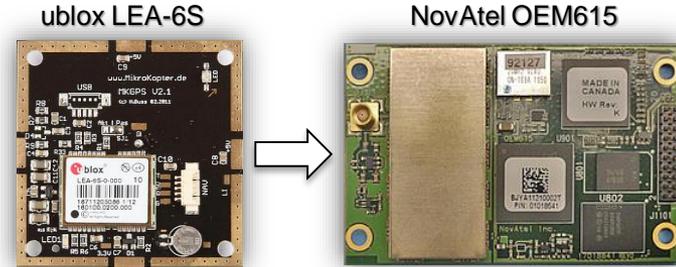
UAS Setup



UAS GNSS Receiver

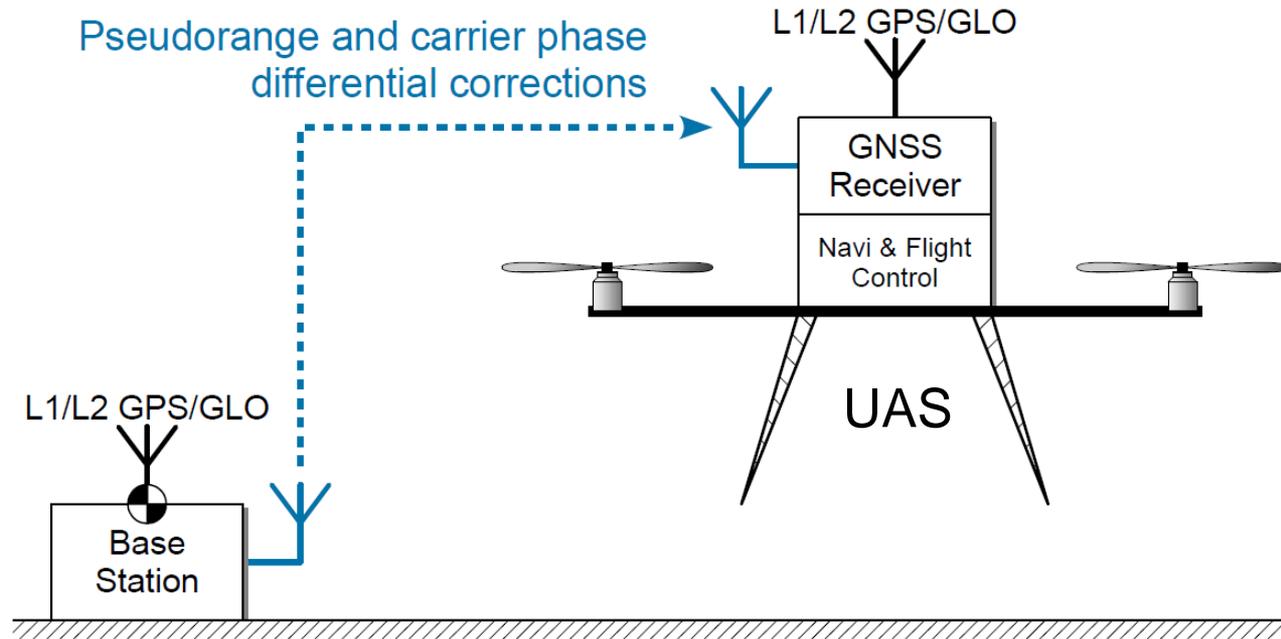
Receiver	ublox LEA-6S	NovAtel OEM615	
Antenna	Passive	Active	
	Patch	Helix	
	GPS	GPS, GLONASS	
	L1	L1, L2	
Horizontal Accuracy (Datasheet)	L1	2.5 m CEP	1.5 m RMS
	L1+L2	---	1.2 m RMS
	SBAS	2.0 m CEP	0.6 m RMS
	PR-DGNSS	---	0.4 m RMS
	RTK (RT-2®)	---	1 cm + 1 ppm RMS
Max. Refresh Rate	5 Hz	20 Hz	

RMS = 1.2 x CEP



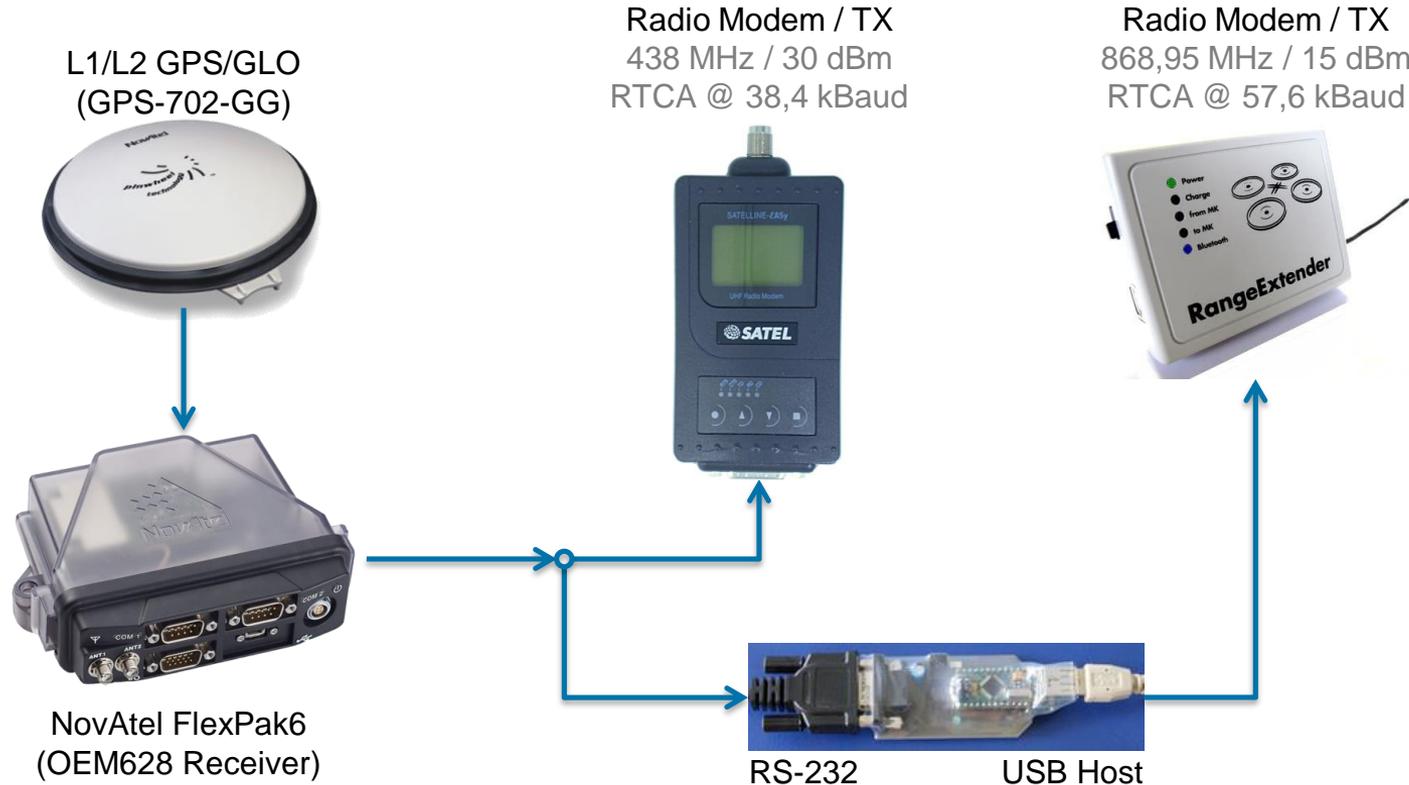
Differential GNSS

Overview



Differential GNSS

Basis Station



Differential GNSS

Basis Station

- After power-up the receiver starts the position averaging. During the averaging time the receiver will generate no correction data.
- As soon as the averaging process is completed, the receiver starts to generate correction data. The following RTCA Type 7, NovAtel proprietary, binary messages are used in order to transmit the GNSS differential corrections:



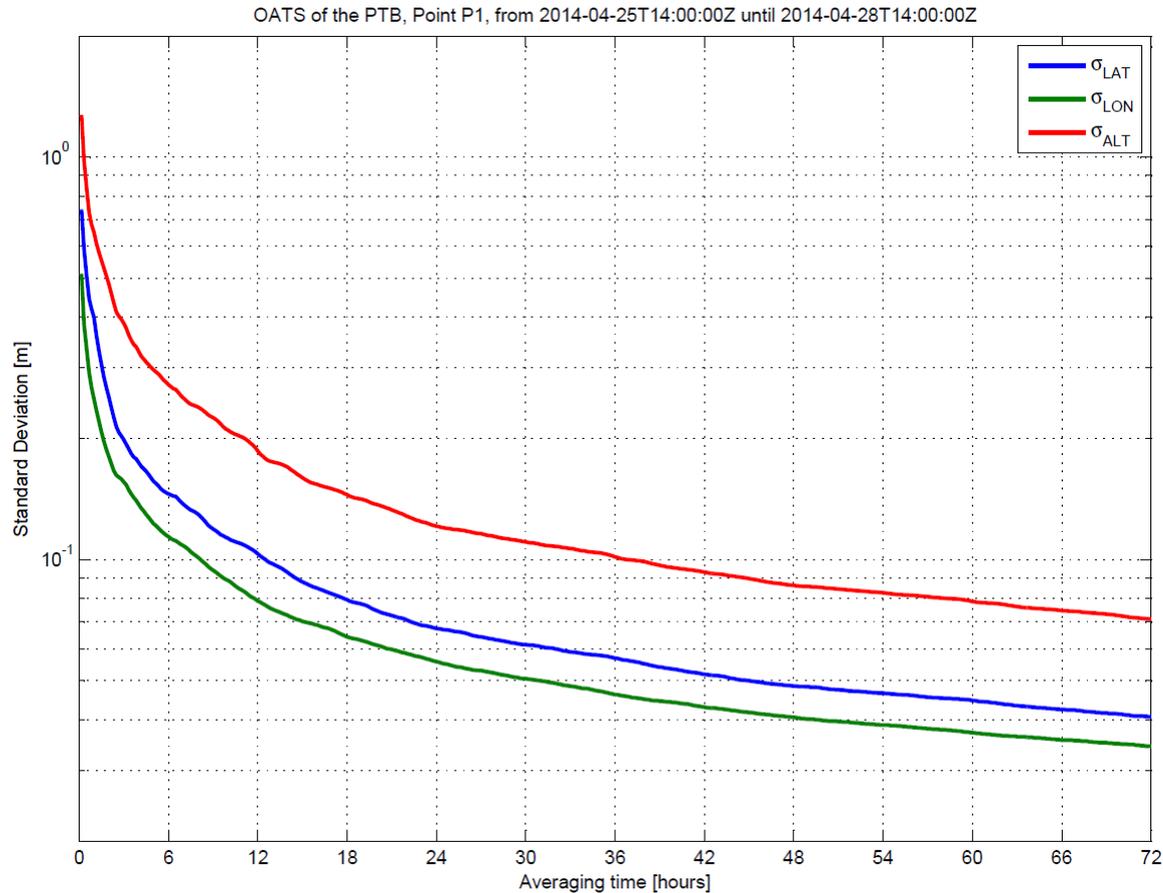
NovAtel FlexPak6
(OEM628 Receiver)

ΔT	Message	Contents
1 s	RTCAOBS2 (805)	Base Station Observations
5 s	RTCA1 (10)	Differential GPS Corrections
10 s	RTCAREF (11)	Base Station Parameters
10 s	RTCAEPHEM (347)	Ephemeris and Time Information

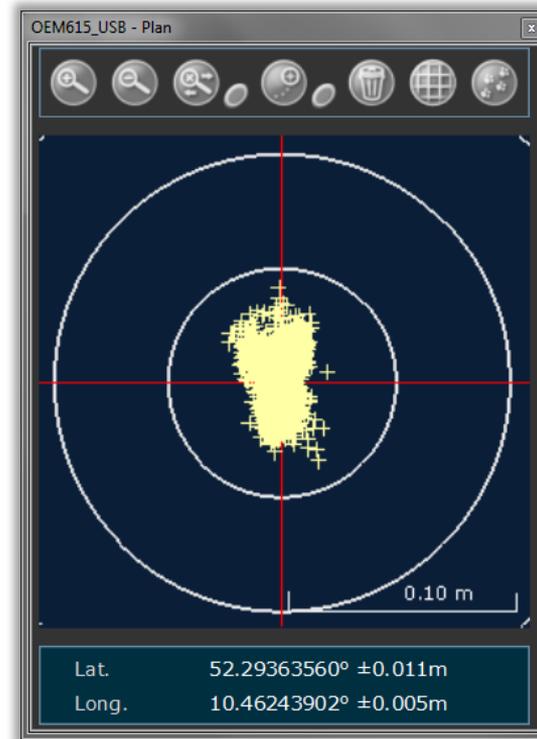
Reference Points for Differential GNSS



Differential GNSS: Position Averaging

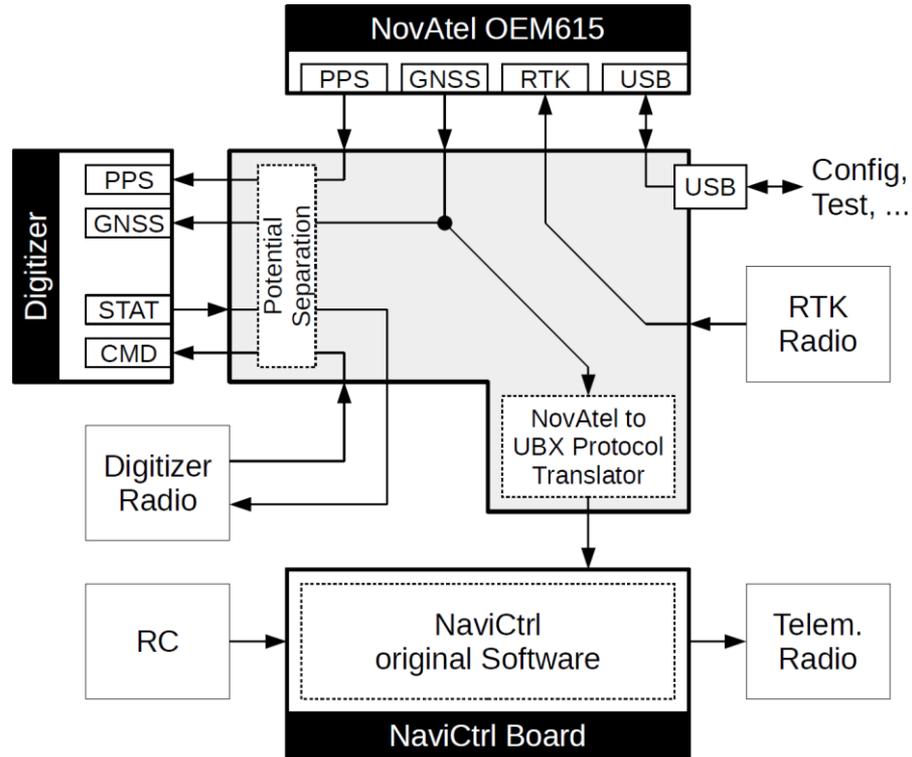


Differential GNSS: Stationary Position



Measurement duration: 3 hours

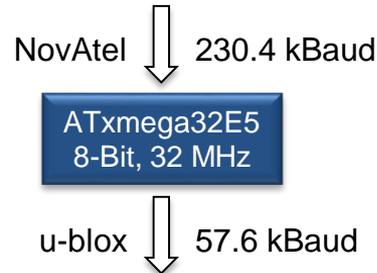
Interconnect Board



Interconnect Board

Protocol Translator

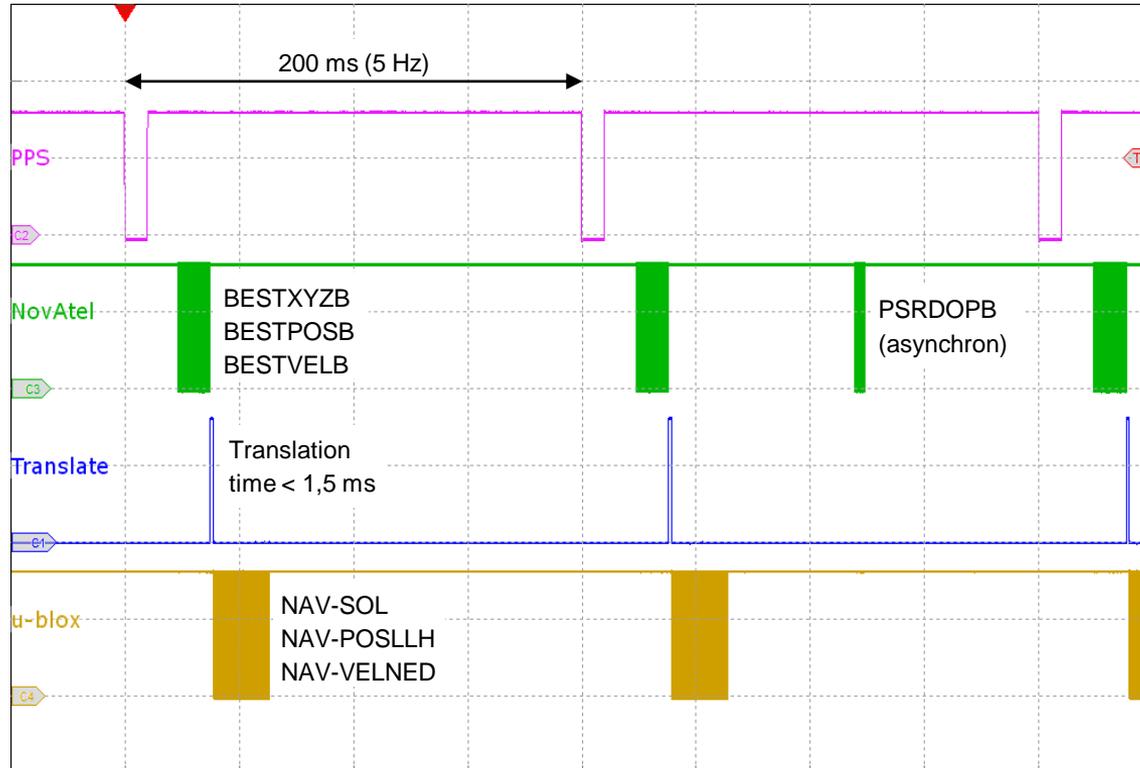
Message	Bits	Time / ms	Description
BESTXYZB	1440	6.250	Best available Cartesian position and velocity in ECEF coordinates
BESTPOSB	1060	4.601	Best available position in longitude/latitude/height coordinates
BESTVELB	760	3.299	Best available velocity information
Total:	3260	14.149	



Message	Bits	Time / ms	Description
NAV-SOL	600	10.417	Navigation solution information (in ECEF coordinates)
NAV-POSLLH	360	6.250	Geodetic position solution (longitude/latitude/height)
NAV-VELNED	440	7.639	Velocity Solution in NED (North/East/Down) coordinates
Total:	1400	24.306	

Interconnect Board

Protocol Translator



Mission Planning



#Sat 6
Datenlink: OK
Modus: FREE
Zeit: 0:00
Höhe: 0m
Geschw. [m/s]: 0.2

Wegpunkt
0:00 [s]
[m]
[m/s]

49mAh
130 139 149 158
14.6V
7.0
GPX-Log: gestoppt

r1 = 50 m
r2 = 100 m

BT1: 30°C 0A
BT2: 30°C 0A
BT3: 27°C 0A
BT4: 28°C 0A
BT5: 27°C 0A
BT6: 26°C 0A
BT7: 30°C 0A
BT8: 28°C 0A

Nr.	Zeit	Radius	WP-Event	Steigrate	Höhe	Richtung	Geschwind	Kameraneig	Prefix	Latitude	Longitude
1	--	--	--	--	20	--	--	--	--	52.2921964	10.4569155
2	10	10	100	30	20	P1	30	AUTO	P	52.2921964	10.4576513
3	10	10	100	30	20	P1	30	AUTO	P	52.2918783	10.4574357
4	10	10	100	30	20	P1	30	AUTO	P	52.2917465	10.4569155
5	10	10	100	30	20	P1	30	AUTO	P	52.2918783	10.4563953
6	10	10	100	30	20	P1	30	AUTO	P	52.2921964	10.4561788
7	10	10	100	30	20	P1	30	AUTO	P	52.2925146	10.4563953
8	10	10	100	30	20	P1	30	AUTO	P	52.2926464	10.4569155
9	10	10	100	30	20	P1	30	AUTO	P	52.2925146	10.4574357

Wartezeit: [s] Höhe [m]

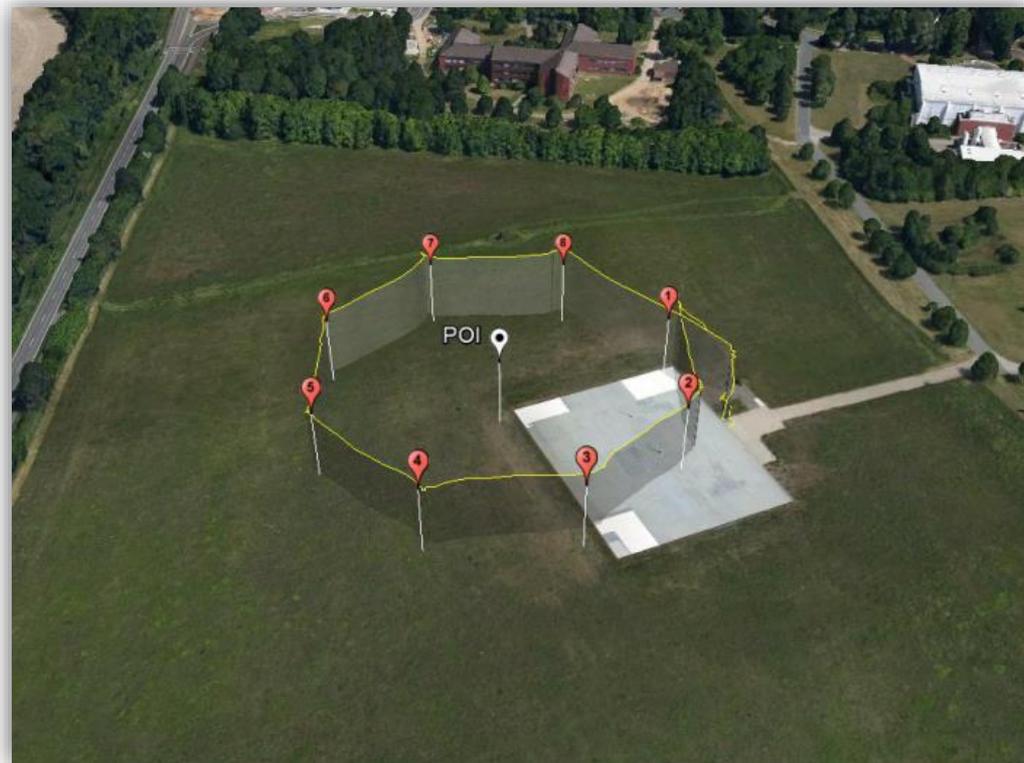
Radius: [m] Steigrate [0.1m/s]

WP-event-Kanal: Richtung

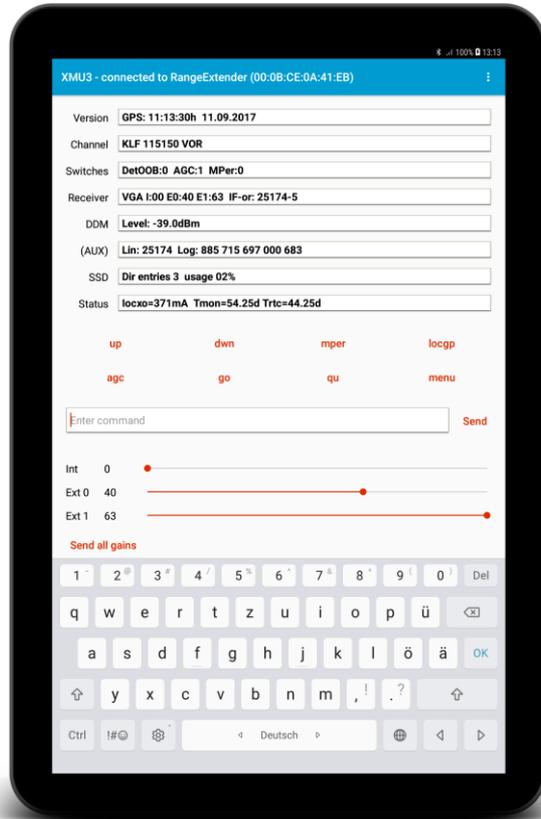
Geschwindigkeit[0.1] Kameraneigung[°]

WP-Prefix:

Flight Data in Google Earth

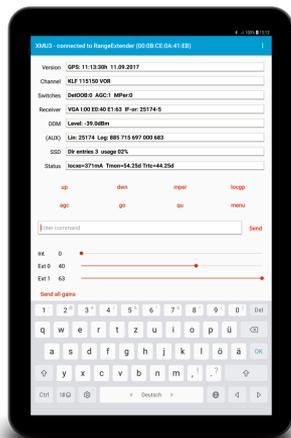


Android App



- Standard Android App (apk), current version is 3.2
- Full duplex communication over Bluetooth
- Macro definitions for frequently used commands
- (Re-) configurable by the *Digitizer Board* during operation

UAS Operation during Measurement



Summary



- A commercially available UAS was converted into a **scientific airborne platform for on-site EM measurements**
- Measurements can be carried out in a given point in space for an arbitrary* time duration and with minimal influence on the measured field
- The positioning precision of the platform was greatly improved by use of state-of-the-art GNSS receivers
- The EMC susceptibility was improved against in and out of band interferences by means of shielding
- Video documentation of each measurement flight as well as real-time video downlink (FPV)
- Real-time monitoring and control of the measurement unit using the Android App

* Subject to the life of the battery pack



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