in cooperation with

Institute of
Space Systems

HOCHSCHULE BREMEN
UNIVERSITY OF APPLIED SCIENCES

Flight
Operations
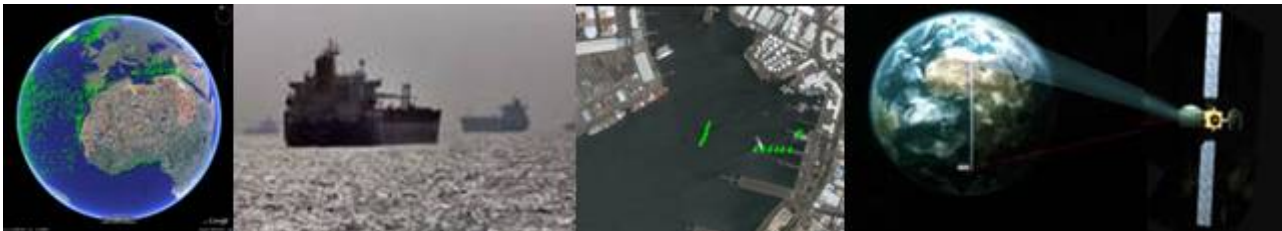
Technical Note TN-14-1:

TN 14.1: PASTA MARE Airborne campaign procedures

Preparatory Action for Assessment of the Capacity of Spaceborne Automatic
Identification System Receivers to Support EU Maritime Policy

DG MARE Service Contract MARE/2008/06 – SI2.517298

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Prepared by:	Gerd Eiden				*Consortium Internal* G Eiden (Luxspace) G. Ruy (Luxspace) Rob Goldsmith (ComDev) Colin McLaren (ComDev)			
Approved by:								
Application authorized by:					*External* Fabrizia Benini *(DG MARE)* Christos Kontorouchas *(DG MARE)* Iain Shepherd *(DG MARE)*			
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Applicable and Reference Documents

RD 1	Preparatory Action for Assessment of the Capacity of Spaceborne Automatic Identification System Receivers to Support EU Maritime Policy – Pasta Mare Technical Proposal Call for Tenders No MARE/2008/06
RD 2	Technical Note TN-09: Critical Review of ESA proposed Design and Software
RD3	Technical Note TN-11-1: Receiver Hardware ICD
RD4	Technical Note TN-11-2:Receiver Software ICD
RD5	Technical Note TN-11-3: Drawing Tree

1 Scope

This Technical Note gives an overview of the planned airborne campaign, foreseen to capture RF signals in the AIS frequency band.

2 Aircraft operator

The Flight Department of the Delft University of Technology (Delft, NL) operates a laboratory aircraft suitable to conduct the AIS test flight campaign. The staff is experienced in flying laboratory equipment, both from a flight operational point of view as from a technical support point of view.

Research Test Pilot and the contact point is Ir. A.C. in 't Veld.

3 Aircraft (PH-LAB Cessna Citation II)

Delft University of Technology operates a small business-jet aircraft as a laboratory aircraft, which serves as a platform for aerospace research and student experiments. The aircraft is suited for a wide range of research projects, and a number of systems and airframe modifications have been installed to accommodate various needs.

Figure 1: Cessna Citiation II aircraft

The Citation II is a twinjet aircraft of conventional aluminium construction. Its two Pratt & Whitney JT15D-4 turbofan engines enable a maximum operating altitude of more than 13 km (43,000 ft) and a maximum cruising speed of 715 km/h (385 KTAS) to be attained. The flight envelope allows a wide range of operations to be performed. On-board OEM equipment includes a three-tube Electronic Flight Instrument System (EFIS), a Flight Management

System (FMS) with a Global Positioning System (GPS) sensor and a Flight Director / Autopilot.

The Citation features a 10.7 m3 pressurized cabin that may be accessed through a 1.3 m x 0.6 m door. It can accommodate a maximum of eight observers in addition to the two-pilot cockpit crew.

|	
Manufacturer	Cessna Aircraft Company
Span	15,91 m
Length	14,40 m
Height	4,84 m
Engines	Pratt & Whitney
Max thrust	2500 lbs / 11100 N
Wing area	30 m2
Aspect ratio	8,8
Cabin diameter	1,47 m
Cabin length	6,38 m
Take-off distance	1081 m
Landing distance	745 m
Max cruise altitude	43000ft / 13,1 km
Max take-off weight	14600 lbs / 6636 kg
Max landing weight	13500 lbs / 6136 kg
Max Mach number	0,705
Max cruise speed	386 KTAS / 715 km/h
Maximum payload	1,400 kg (3,100 lbs) (crew + equipment)
Endurance	(1,400 kg payload) 2h30min
	(2,250 kg fuel, 550 kg payload) 5h30min

Table 1: Aircraft technical Specifications

15.911 m

4.572 m

14.402 m
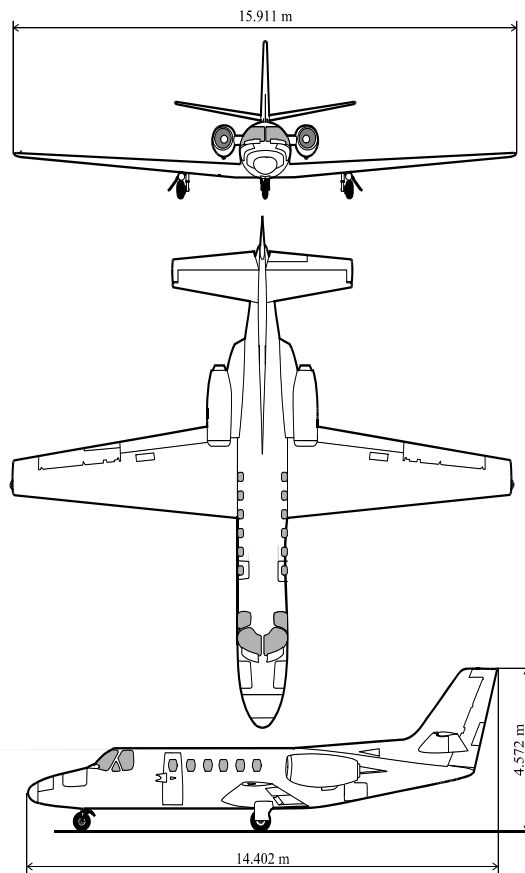
Figure 2: PH-LAB Cessna Citation II

3.1   Flight Test Instrumentation System and Special Features

The aircraft has several special test research capabilities and a few are listed below:

- The Flight Test Instrumentation System (FTIS) is the heart of the on-board data-acquisition system. It supports analog, serial (RS 232, 422, 485), synchro, ARINC and Ethernet interfaces and a powerful computer that allows high-speed data-logging and realtime processing.
- a separate electrical system dedicated to powering on-board test equipment, isolated from the aircraft electrical system for added safety;
- an additional stand-alone 3000 psi hydraulic system for operating test equipment or research actuators;
- provisions on the fuselage for mounting an external pod, for example with instrumentation or a radar;
- numerous facilities in the cockpit and the cabin for accommodating test equipment;
- a multi-channel digital data acquisition and recording system that can handle a large number of parameters with high accuracy at a high sample rate
- a "roof rack" on top of the fuselage that can accommodate multiple antennas, as well as underwing panels configured for antenna installation;
- a programmable high-resolution LCD display panel mounted in front of the right-hand instrument panel.
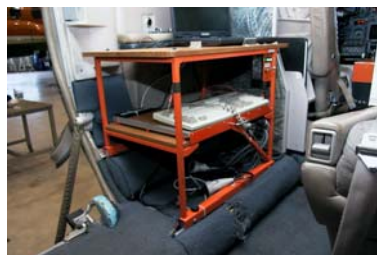
Figure 3: Instrument racks

3.2 Antenna overview

The aircraft is equipped with a series of antennas out of which the DM C50-17 antenna is capable to receive the AIS messages. Antenna measurement performed in the range 160MHz to 164MHz resulted in a VSWR (Voltage Standing Wave Ratio) of 1:1.61. Return loss measurement using the same test-box yields 12.6dB return loss. Assuming a threshold of 1:2, the antenna is suitable in the range 116MHz through 165MHz.

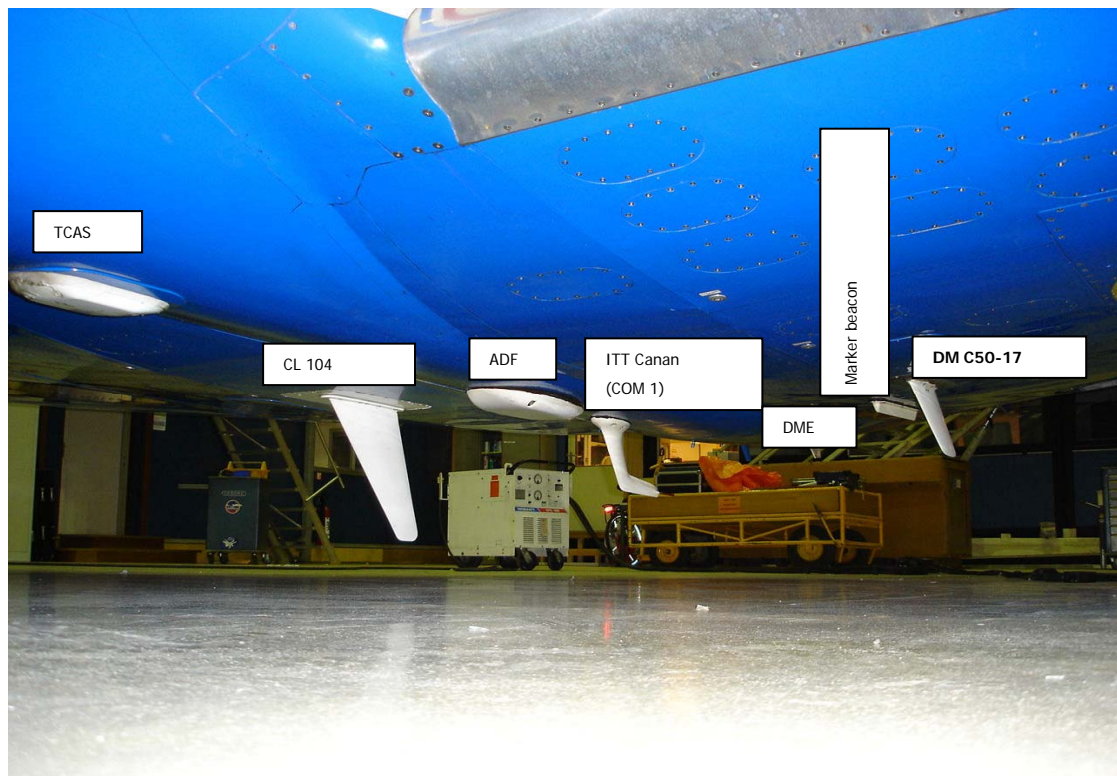The antenna connector, it is a PN connector: Radiall R161083 Coax cable RG 400 double shield.

Figure 4: Antenna configuration

4 LuxSpace Equipment Set-up

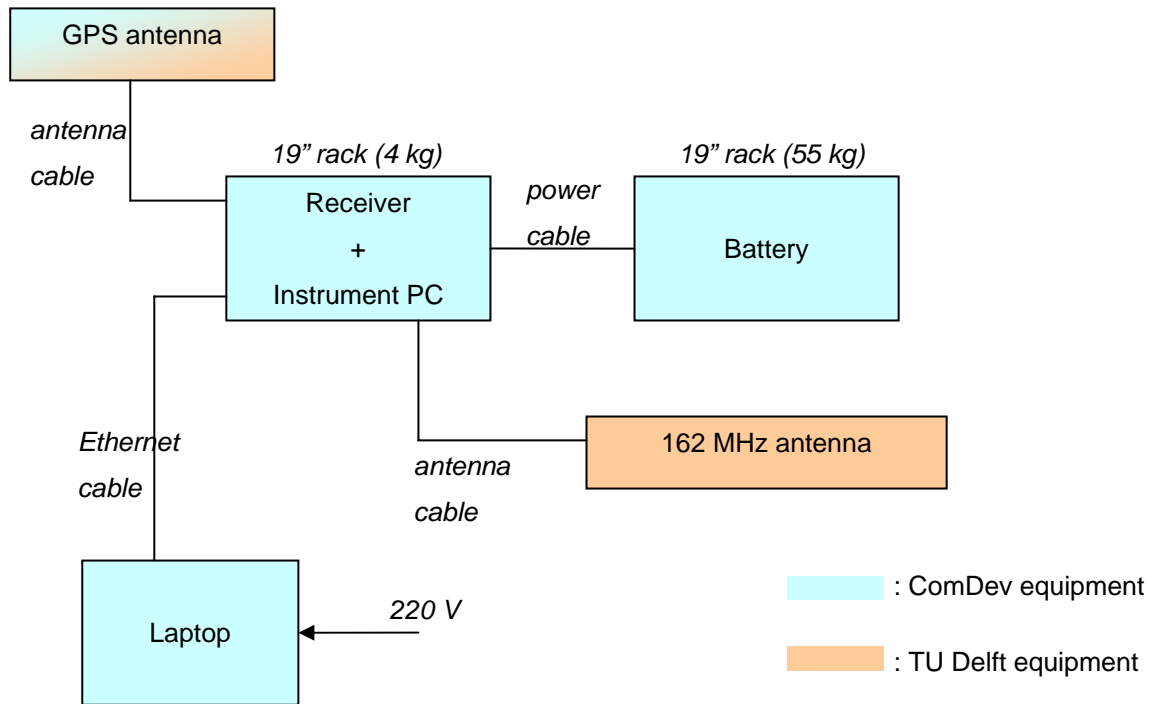Figure 5 shows the AIS receiver setup on the aircraft.

Figure 5: Equipment setup

TU Delft is responsible for the proper installation of the equipment as well as for the flight acceptance procedures.

5 Schedule

The mission time window for the installation, the flight campaign and equipment de-installation is planned to take place between 21. May and 4th June 2010.

If for any reason the mission cannot be conducted, an alternative time window is reserved from 24th June – xxx.

In order to check the proper functioning of the equipment, a one hour test flight over the North Sea is foreseen.

6 Flight Route

In order to cover both high and low density areas the following flight route is foreseen:

Day 1: Amsterdam – North Sweden (Airport tbd): North Sea, Baltic Sea

Day 2: North Sweden – Ireland (Airport tbd): North Sea, Atlantic

Day 3: Ireland – South Portugal (Airport tbd): Atlantic, Portuguese Coast, Gibraltar

Day 4: south Portugal – Amsterdam: Spanish and French Mediterranean Coast

A detailed flight plan including necessary stop overs for refueling etc. is currently prepared by TU Delft.
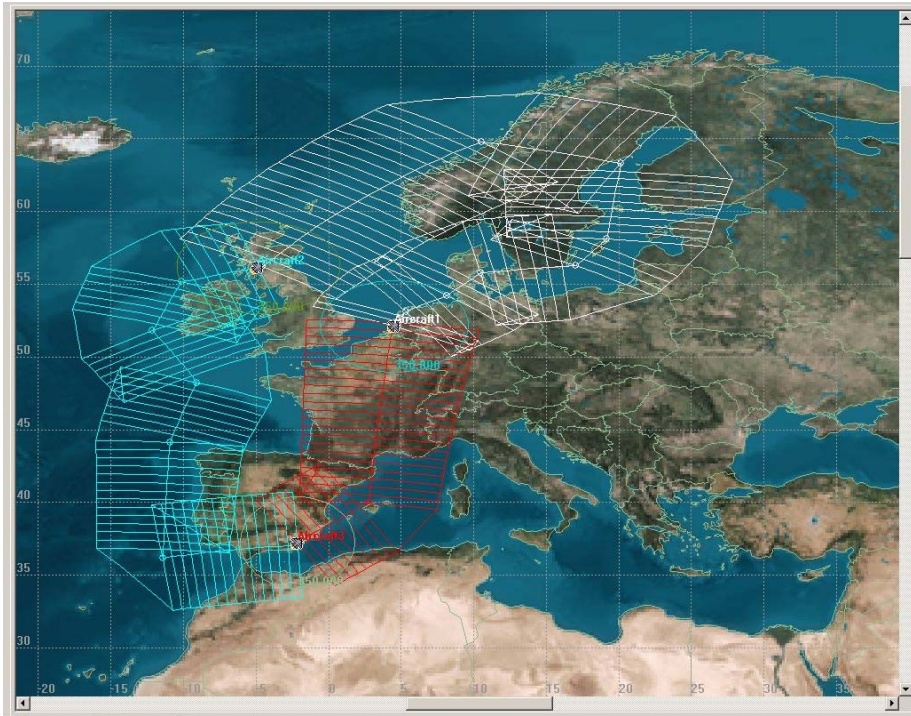

Figure 6: Flight campaign test areas

As specified in [RD1] and requested in the ToR, flight altitude will be 40.000 feet at a cruising speed of 700km/h.

7 Data capture

It is foreseen to capture in total 12 hours raw RF signals in the AIS frequency band [see RD3 – RD6].

After reception from an external antenna the input signal is amplified by the low noise amplifier which is limited to bandwidth of approximately 2 MHz centred on 162 MHz by a specifically designed input SAW filter.

At the output of the LNA there is a 3dB splitter which feeds two receiver chains, one for each AIS channel (161.975MHz and 162.025MHz). The output of the each chain of the receiver is 450 kHz, which is fed via the Radio interface board to the input A/Ds of the X400M card.

Implemented in the Xilinx Virtex 5 FPGA is COM DEV's standard demodulation package, which has been utilised on a number of previous programmes. This package samples the 450

kHz IF at 1.80Msps using an Fs/4 demodulator and then subsequently decimates and filters to a ±12.5 kHz channel.

This results in an output sample rate at 28.125 ksps with a 12 bit I and 12 bit Q per channel.

This data is stored onto the embedded PC hard drive together with timestamp and GPS position data derived from the X3-timing card.

Raw AIS signals are stored on the receiver and transferred via the USB interface to a data storage device.