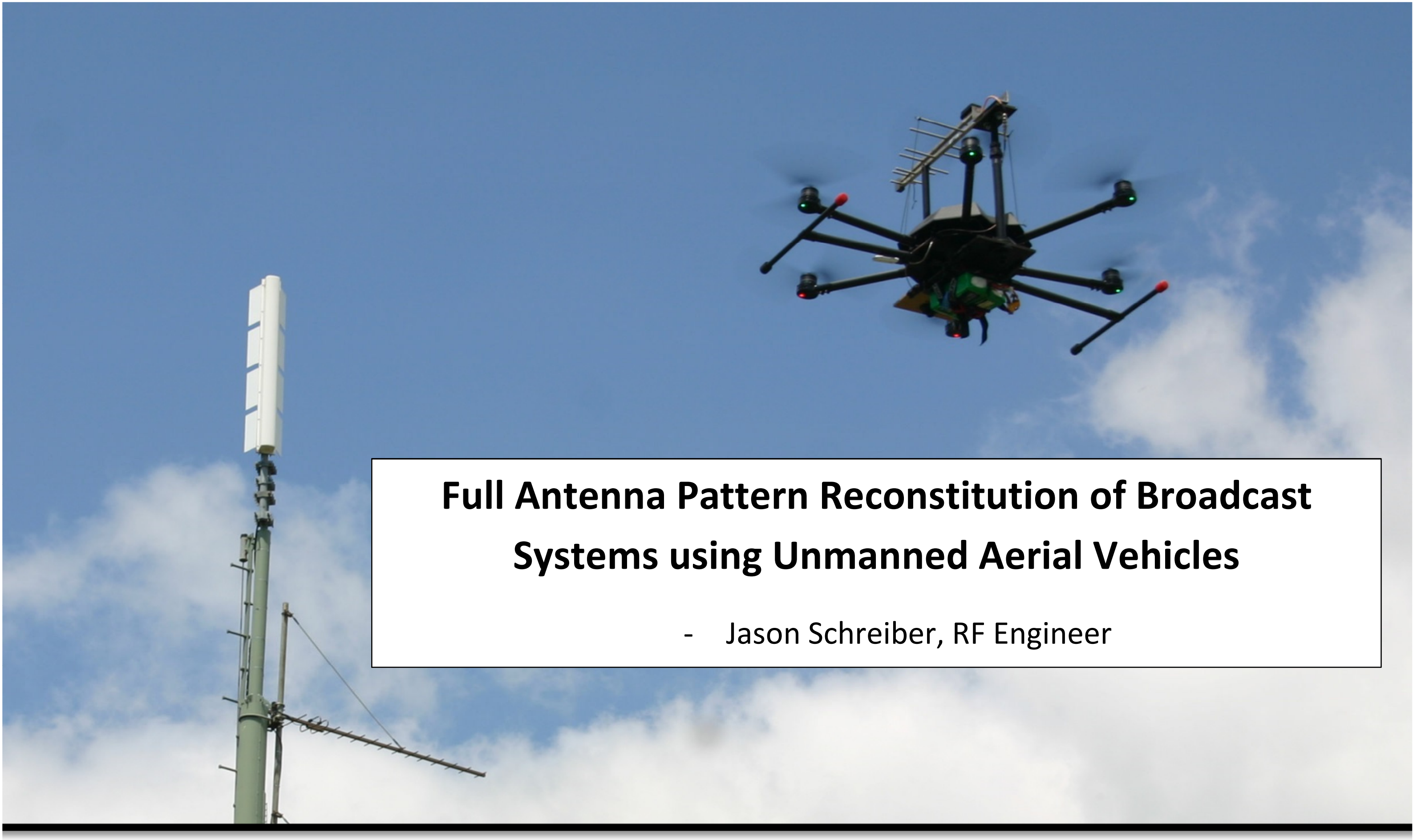

Full Antenna Pattern Reconstitution of Broadcast Systems using Unmanned Aerial Vehicles

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Introduction

With the evolution of Unmanned Aerial Vehicle (UAV) technology, an efficient and accurate way to commission and troubleshoot broadcast antenna systems by making use of this technology can now be realised.

The UAV (with integrated measuring receiver, antenna and on-board computer) can characterise an antenna system with greater precision and timeliness compared to traditional land-based surveys and is more cost effective than helicopter-based solutions. The advantages of such a system are quicker survey times, higher resolution antenna pattern data (potentially to be used in coverage prediction software), less ground reflection issues and more confidence in the broadcast antenna system.

This paper introduces an overview into the methodology and equipment used to realise this solution and concludes with the external considerations needed when using this methodology.

Objective

To verify and diagnose the "shape" of new and existing broadcast antenna systems and verify Effective Radiated Power (ERP) measurements based on:

- GPS location data (accurate to ±2m)
- Calculated Free space path loss
- Calibrated receive antenna gain factors
- Calibrated Feeder losses
- Measured Received field strength / channel power (accurate to ±1.5dB)
- Correction factors associated with the sampling methodology (i.e. AM, FM, DAB+, DVB-T)

The above can be achieved by measuring the Horizontal Radiation Pattern (HRP) at the height of the Vertical Radiation Pattern (VRP) peak. The VRP is typically measured in the front of each antenna panel face and is measured from 10° above the horizon to the height of the first recovery lobe, local environment permitting.

The end result is a fully characterised antenna system with an uncertainty of less than ±3dB.

Overview / Methodology

The methodology follows that of the ITU Recommendation ITU-R SM.2056-1 *"Airborne verification of antenna patterns of broadcasting stations"*. Further to these recommendations, the UAV, with measuring equipment, will be setup using custom developed software that enables real-time configuration, measurement logging and reporting. The logging software allows for the input of a variety of broadcast services to be logged. Depending on the broadcast site characteristics, omnidirectional or directional antennas can be used. Once service and broadcast site information has been finalised, a 'distance' in the Far Field (FF) is chosen to perform a VRP flight to determine the peak height of the HRP. An HRP (full circumference) is performed at the peak VRP. Received data is logged and real-time calculations of HRP, VRP and ERP are performed and can be seen by the operator on the ground.

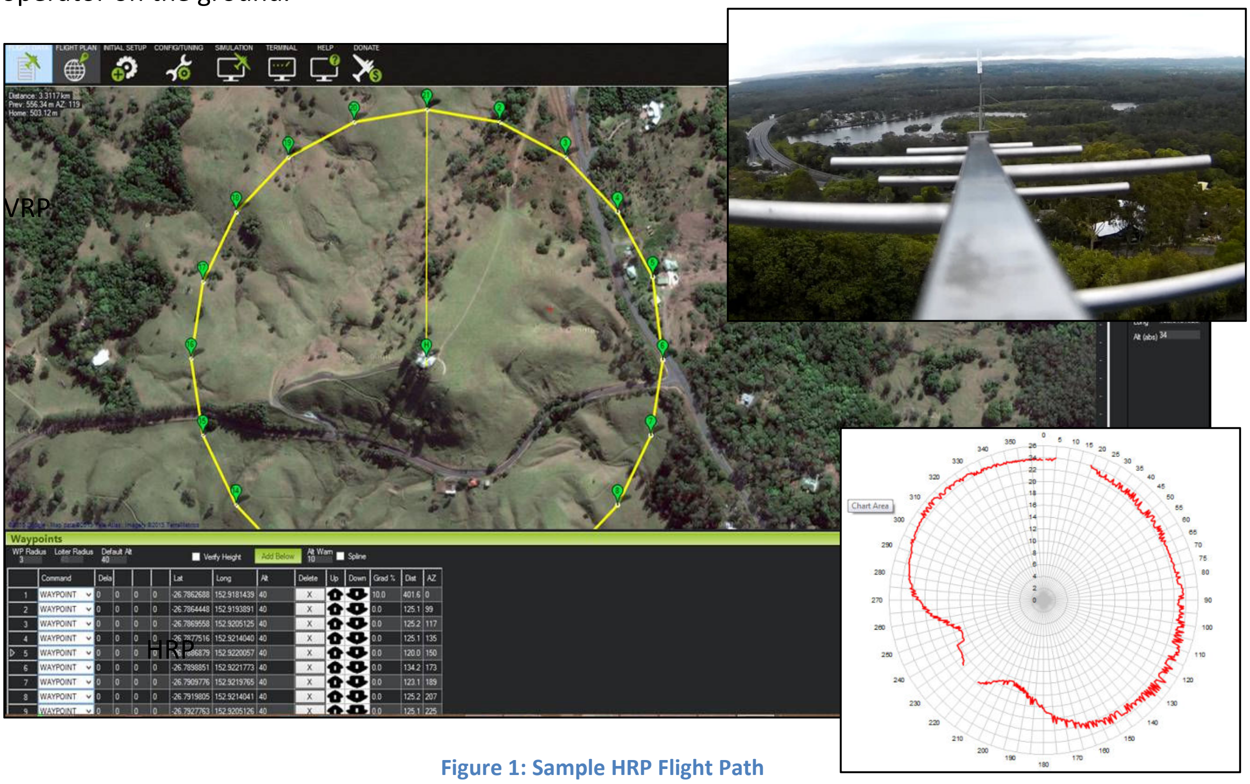

Figure 1: Sample HRP Flight Path

The flight course can be modified on-the-go if the need arises to remeasure a certain section of the antenna. A preliminary report will be available once the UAV has landed.

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Setup

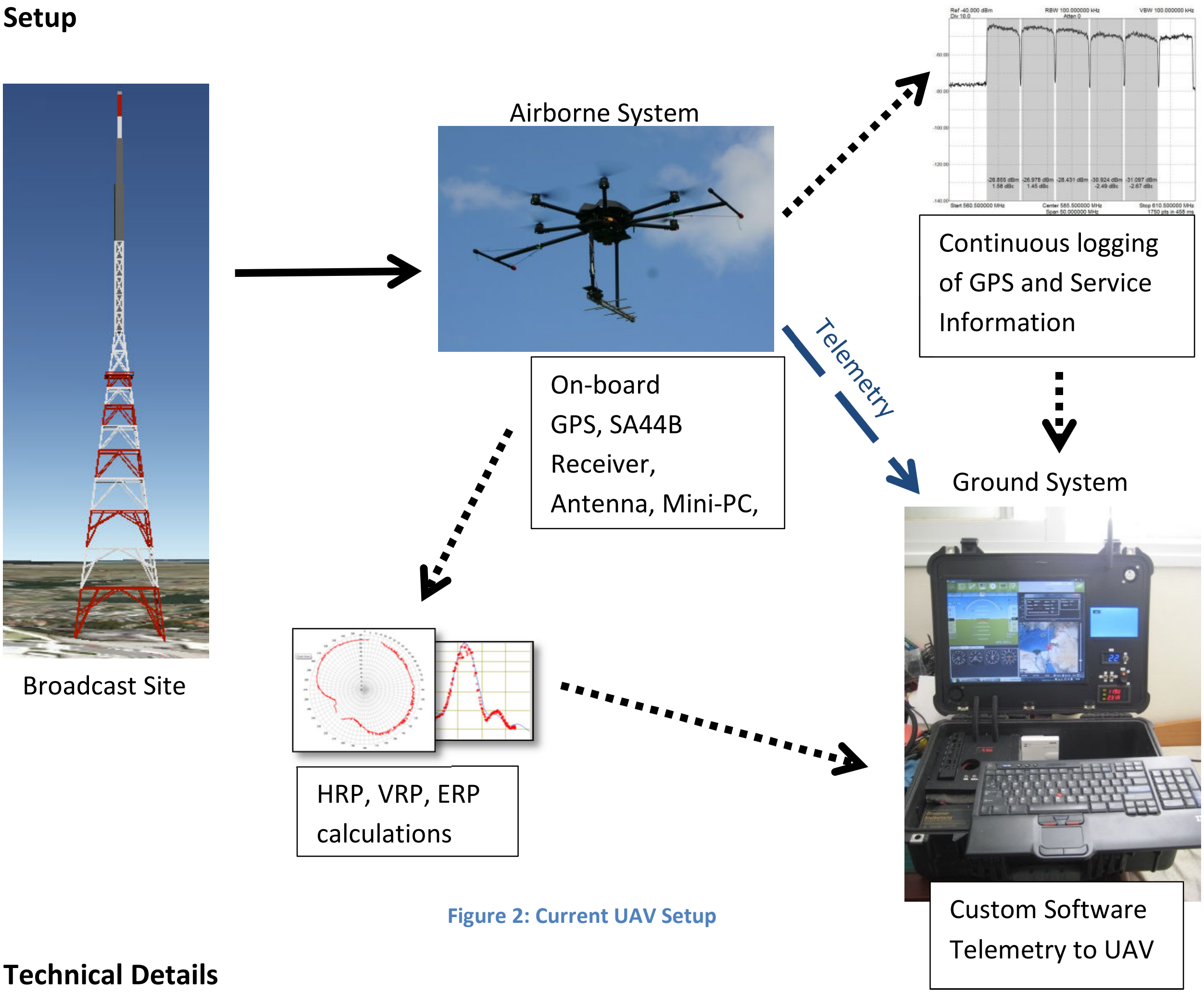

Figure 2: Current UAV Setup

Technical Details

- HRP characterisation to 1° azimuth resolution
- VRP characterisation to 0.1° declination resolution
- ERP uncertainties below ±3dB
- Measurement of up to 10 services at once (AM, FM, DAB+, VHF and UHF DVB-T)
- Signal Hound SA44B Lightweight Receiver (1Hz – 4.4GHz), ±1.5dB Accuracy
- Calibrated Wideband Omni or Directional Antennas
- Integration of redundancy in the UAV system for safety (i.e. redundant motors, parachute systems, dual flight controllers, EMI shielding)
- UAV Flight time of approximately 25mins per flight

Considerations with this method:

	Mitigation
Civil Aviation Safety Authority (CASA) Legislation	Need to be a UAV Certified Operator
CASA approval for UAV operations in populated areas and sites close to airports on a site by site basis	Sufficient lead times for CASA to process area approval, flight plan and safety considerations
Weather conditions (strong wind, rain, etc.)	Plan contingency days
Electromagnetic Interference (EMI)	Fly in Far Field at calculated safe EMI distances.