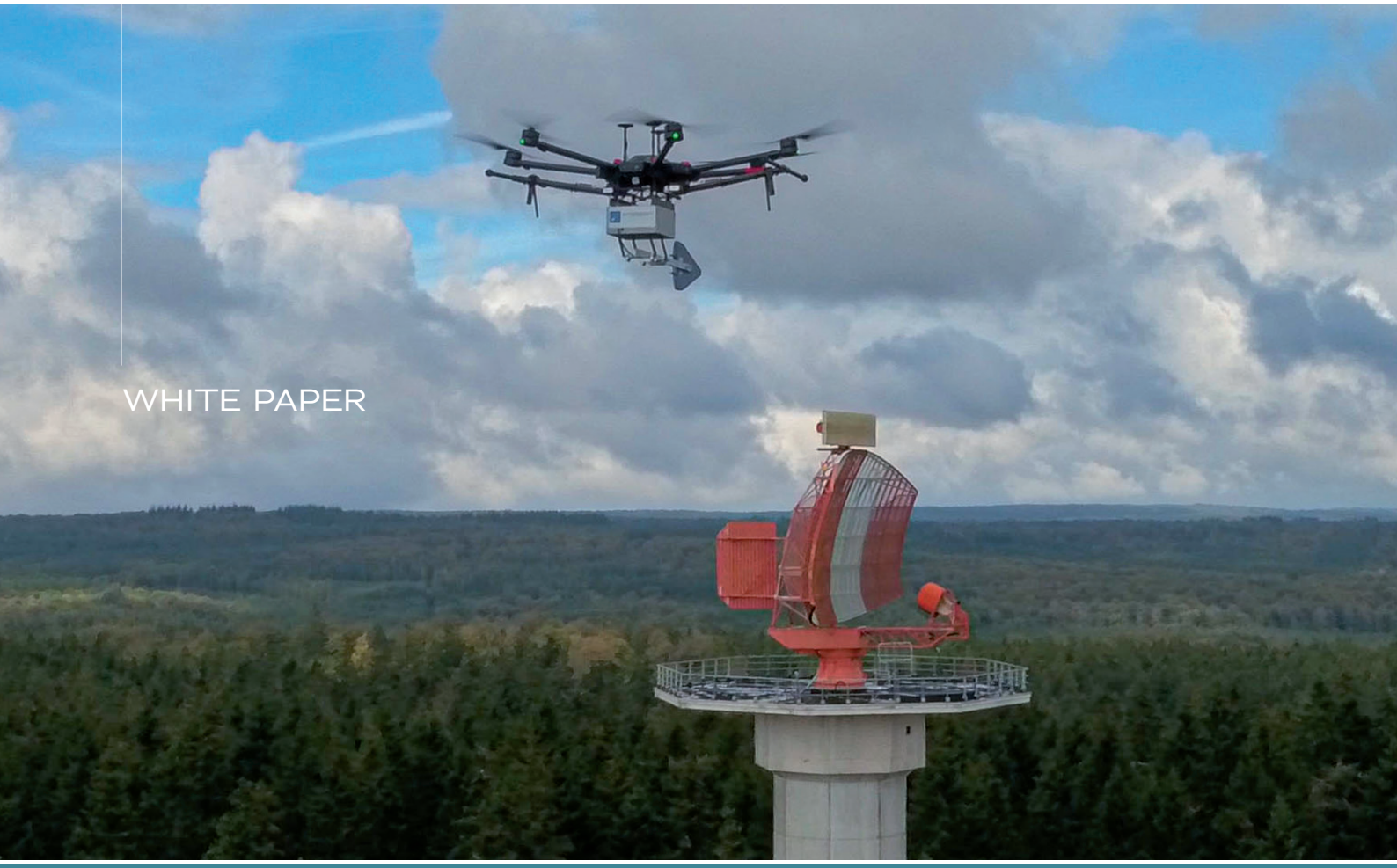
SkyRF

CNS measurements as-a-service



WHITE PAPER

Take your CNS measurements to the next level

We make the sky safer

INTERSOFT SERVICES

skyguide

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EXECUTIVE SUMMARY

SkyRF is the **drone platform delivering radio frequency (RF) measurement services** for performance analysis on Communication, Navigation and Surveillance (CNS) installations.

The dedicated equipment onboard SkyRF and the software platform were specifically designed for measuring NavAids and Radar performance in the Far Field. Measuring and analyzing signals at elevation was never before so easy, accurate and reliable. SkyRF complements ground measurements and ***reduces the need for flight checks up to 50%.***

SkyRF reduces the need for flight checks up to 50%.

SkyRF supports commissioning, **certification and maintenance of primary & secondary radar, ILS & DME, TACAN & VOR**, featuring unique advantages:

- Complete radar up- and downlink measurement, no need for checking multiple subassemblies individually
- Much lower operational impact, less downtime, less support from technicians or managers required
- Instant, reliable and repeatable measurements, no estimates, no theoretic calculations but real measurements

SkyRF offers **CNS measurements as-a-service**. As such, CAPEX investments and the need for qualified flight testers, insurance and a lot of administrative overhead are avoided. With SkyRF, commissioning, certification and maintenance of CNS are performed **faster, more accurate and at a much lower cost.**

SkyRF operates **manufacturer independent** and is available for ANSP's and military operating CNS NavAids and Radar.

It's offered under a preferred partnership between Intersoft Electronics Services and Skyguide. Intersoft Electronics Services has 35 years of experience in developing RF measurement equipment. Skyguide is pioneering the integration of unmanned aircraft into airspace.

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Challenges of CNS system assessment

The assessment of CNS systems is bound to strict directives. ICAO Annex 10, ICAO doc 8071 and STANAG 3374 outline the performance criteria for Communication, Navigation and Surveillance systems, as well as the measurement protocol.

- ICAO performance criteria and measurement protocol

The limitations of ground measurements

The correlation between ground measurements and flight checks is a discriminator for the frequency with which flight checks should be performed. Ground measurements suffer however from geographical and constructional obstructions. The locations to set up ground measurement equipment are limited. There's often no way to avoid interference from other RF sources.

- geographical and constructional obstructions
  RF-interference

These limitations often result in poor ground measurement results, boosting the required frequency of flight checks. The ICAO specified nominal periodicity is 180 days.

The cost of flight checks

When a flight checker goes off blocks, the counter starts to run. First of all, there is the cost of fuel and the carbon emissions we all want to avoid. Secondly, flight checks are a time-consuming activity with an major operational impact. Systems go in down-time, experienced pilots must be hired, flights must be carefully scheduled – and possibly rescheduled – depending on weather conditions, notification messages should be published, system technicians must be stand by, etc. Finally, the execution of measurements during flight checks is critical and hard to repeat without deviations.

- Noise pollution
- Cost of fuel and carbon emissions
- Enormous operational impact
- Poor repeatability

Hurray for drones... but beware of the limitations of COTS equipment

For many years, even decades, this has been the way to assess CNS systems. Now, drone technology opens new possibilities. Obviously, drones do not replace flight checks (yet). Drone measurements are complementary to ground measurements, avoiding its limitations. Consequently, drone measurements correlate better with real flight checks and that allows to reduce the frequency of the flight checks according to ICAO.
However, hooking up available off the shelf measurement equipment under a drone doesn't work out well. It's too heavy, to fragile and doesn't have adequate air-to-ground communication.

- to heavy, to fragile
- no adequate air-to-ground communication

How SkyRF addresses these challenges

The ICAO directives on measurement protocol state that the **frequency of test flights can be reduced when the correlation with ground measurements improves**. SkyRF measurements correlate much better with real flight tests than ground measurements, because obstructions are avoided and RF interference suppressed. As such the frequency of test flights is potentially reduces by up to 50%.

SkyRF can be considered a ground measurement at elevation. By performing the RF measurement at slight elevation, this is how to **look over obstructions** such as buildings, trees and hills.

At elevation, SkyRF is **further away from interfering** high frequency electronics and other telecommunication installations at ground level. Remaining interferences are suppressed by numerous **smart signal processing techniques**.

Obviously, when reducing the frequency of test flights, **costs, carbon emissions and operational impact decrease.**

Thanks to a clear measurement protocol with well-defined trajectories and an extraordinary **system stability**, SkyRF ensures a great repeatability of measurements.

SkyRF is not just a piece of COTS electronics under a COTS drone. The state-of-the-art RF measurement equipment was **specifically designed for light weight and robustness** and **integrated with the selected drone platform**.

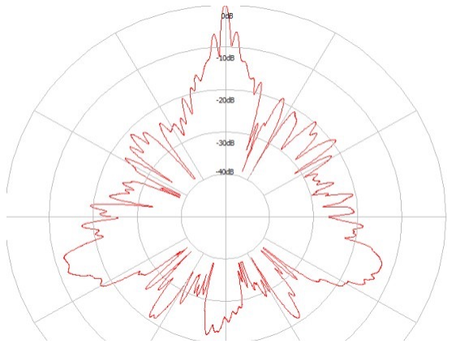
SkyRF is designed to deal with the complex RF environment in which it operates. **The drone's RF control signals, the RF measurement and the air-to-ground communication are isolated** and do not interfere with each other.

SkyRF is the solution

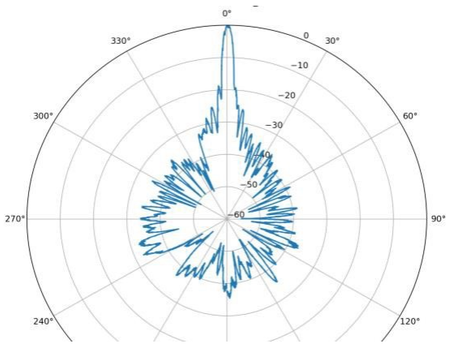
Radar – Horizontal Polar Diagram

For radar systems using AESA (Active Electronically Scanned Array) antennas or conventional rotating antennas, it is important to perform HPDs at different ranges, azimuths, and elevation angles. With SkyRF this can be achieved in a minimal amount of time with great flexibility for PSR and SSR/IFF radar systems. Measurement flights are performed while maintaining a live feed with the measurement software, guaranteeing correct results! For uplink measurements, there's no radar downtime required.

- **Instant HPDs, no downtime required**
- **Multiple ranges, azimuths and elevation angles at once**
- **SkyRF life feed for real time data**



HPD with urban interference and negative elevation angle.



HPD of the same radar at a positive elevation angle, away from obstructions and interference sources.

More reliable HPD measurements at elevation

Buildings, terrain obstructions, and negative measurement angles can cause distorted HPD graphs. Therefore, it is crucial that measurements are taken in the Far Field, at (multiple) positive elevation angles as presented below. SkyRF enables these measurements to be performed with speed and precision

- **Far Field measurements**
- **Multiple positive elevation angles**
- **No obstructions nor interference**

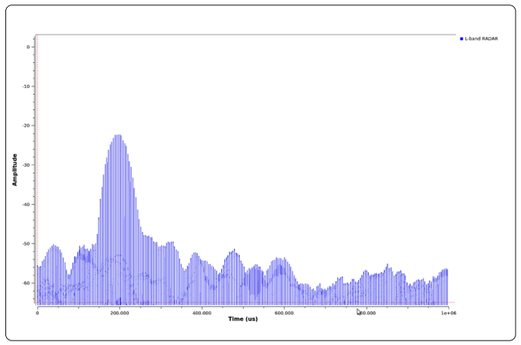
Radar – Vertical Polar Diagram

Radar – Vertical Polar Diagram

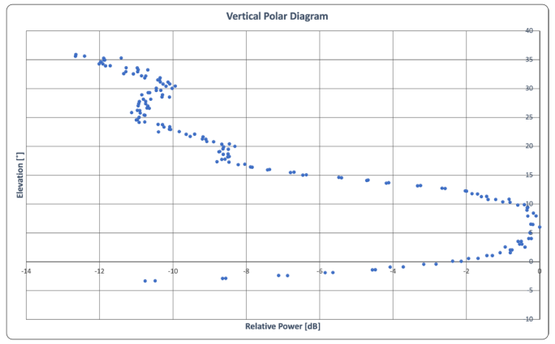
VPD information can be measured while flying vertically relative to the radar. SkyRF compensates for slant range and terrain deviations to calculate the maximum Power for every elevation angle in relation to the radar system. The results are displayed in a live feed from the flying platform. VPD measurements can be executed for both PSR and SSR/IFF radar systems.

Combining the VPD, frequency, radar positioning, and maximum output power enables calculation of a radar's maximum operational range which can be visually represented in a Blake Chart. Measuring the VPD diagram in the free space is the ultimate tool to verify the complete transmission system health quickly and accurately as this includes the transmitter(s), RF combining, waveguide or coaxial connections, rotary joint, and antenna system. For uplink measurements, there's no radar downtime required.

- **From cone of silence to negative elevation angles**
- **Slant range correction**
- **SkyRF life feed for real time data**
- **Full TX system health check**



VPD | Vertical Polar Diagram



VPD | Vertical Polar Diagram

Possibility to make a VPD for each beam seperately (Downlink)

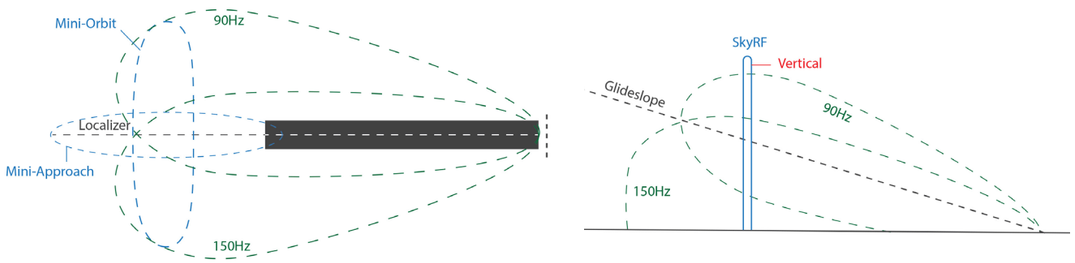
In addition to the VPD pattern in transmit, receive VPD beams (and beam combining) can also be measured with a very high Signal-To-Noise ratio using CW signals that are geographically referenced by SkyRF's differential GPS, inertial, and pressure calculated altitude.

ILS – Instrument Landing System

SkyRF assesses the performance of the ILS Localizer (LLZ) and the Glideslope (GS). To measure the LLZ, the drone flies a Mini-Orbit trajectory in the Far Field. For the GS profile, a Vertical trajectory is flown. The so called Mini-Approach test scenario flies the drone on the glidepath and allows to quickly measure both, LLZ and GS simultaneously. A Corkscrew scenario can be added and combined in a single flight to measure LLZ/GS and DME all at once.

Course, clearance, frequency and absolute power are measured through AM modulation of the 90/150 Hz signals. The difference in depth of modulation (DDM) is an indication of the exact position relative to the landing strip.

- **LOC/GS measurement in the Far Field**
- **AM modulation of 90/150 Hz signals**
- **Preprogrammed flight trajectories**



SkyRF trajectories for LLZ and GS measurement of ILS

ILS Preflight Checker

Measurement data can be live streamed during the flights. As such, parameters like GS angle and sector widths can be monitored on-the-fly. Other parameters that are visualized by the ILS Preflight Checker Software are LOC displacement error, Course / Clearance ratio and Threshold Crossing Height in normal and alarm conditions. The DDM is also plotted versus the azimuth angle.

- **Live data stream and monitoring**
- **LOC displacement error**
- **Course / Clearance ratio**
- **Threshold Crossing Height**
- **DDM versus azimuth angle**

DME – Distance Measurement Equipment

SkyRF interrogates the DME beacon while flying radial and corkscrew trajectories. This preprogrammed aerial measurement can be performed much faster than a real flight check. The distance calculated from the response delay is verified with the GPS distance. Depending on the chosen sampling speed, SkyRF can obtain an accuracy of 10 meter, which is 5 times more accurate than what is needed.

- **Preprogrammed trajectories**
- **High measuring accuracy**
- **RTK GNSS time- and location stamp**

Low power DME stations are often collocated with ILS. SkyRF can measure these combined ILS/DME stations simultaneously. This is a unique feature because LLZ/GS operate in the VHF/UHF band, while DME navigates in the L-band.

- **Simultaneous ILS/DME measurement**

VOR – VHF Omnidirectional Range transmitter

VOR and DME stations are typically collocated. While the DME measures only distance, the VOR adds azimuth data. Both can be measured simultaneously by SkyRF.

- **Simultaneous DME/VOR measurement**

To analyze performance of the VOR, the same trajectories as for DME are used. That allows to measure the azimuth error, FM deviation, RF Level and the 30 Hz and 9960 Hz modulation depths versus azimuth angle and distance. Trajectories are designed, so that also a deep analysis of the cone of silence can be done.

- **Measurement of azimuth error, FM deviation and RF Level**
- **30 Hz and 9960 Hz modulation depths versus azimuth angle and distance**
- **Cone of silence analysis**

TACAN – Tactical Air Navigation system

SkyRF can service the military TACAN stations to the same extend and accuracy as the civil NavAids.

Other NavAids

ILS, DME, VOR and TACAN are the most commonly used NavAids nowadays. SkyRF offers versatile CNS drone measurements as-a-service and can also analyze the performance of any other (older) NavAid equipment such as for example Non-Directional Beacons (NDB). PAPI (precision approach path indicator), GBAS (Ground based augmentation systems) is also possible.

SUMMARY

SkyRF is the most cost effective as-a-service solution for reliable and accurate CNS measurements on the market. It operates manufacturer independent and is available for ANSP's and military operators of CNS NavAids and Radar.

- **Reducing flight checks by up to 50% according to ICAO directives**
- **Reducing carbon emissions**
- **Faster, cheaper, less administrative and logistic overhead than real flight checks**

  +
- **Accuracy, repeatability and reliability exceeding industry standards**

Intersoft Services offers on-site campaigns and interventions and operates a helpdesk to provide customer support.

SkyRF

WE MAKE THE SKY SAFER

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