

UAV BASED OFF-AIR DVB-T1/2 & ATSC 3.0 BASE LINE MEASUREMENTS

1 Introduction

LS telcom developed a DVB-T1/2 and ATSC 3.0 drone based measurement system. The measurements are performed over the air (OTA) and focus on quality of service measurements for quick assessment of base line transmissions from a transmit antenna system. The measurements provide the network and the multiplex operator with the confidence that the transmission problem is not linked to this specific transmitter site.

2 Measurement Results

We include various signal parameter measurements of the transmitted signal. This can be expanded in conjunction of the client to ensure that we include all parameters which need to be measured. We can include various measurement devices to ensure that we provide a comprehensive report that comply to the requirement of the customer. We are aware of the time that is spend on report generation and therefore we include auto report generation to ensure that we produce the results at the earliest possible opportunity.

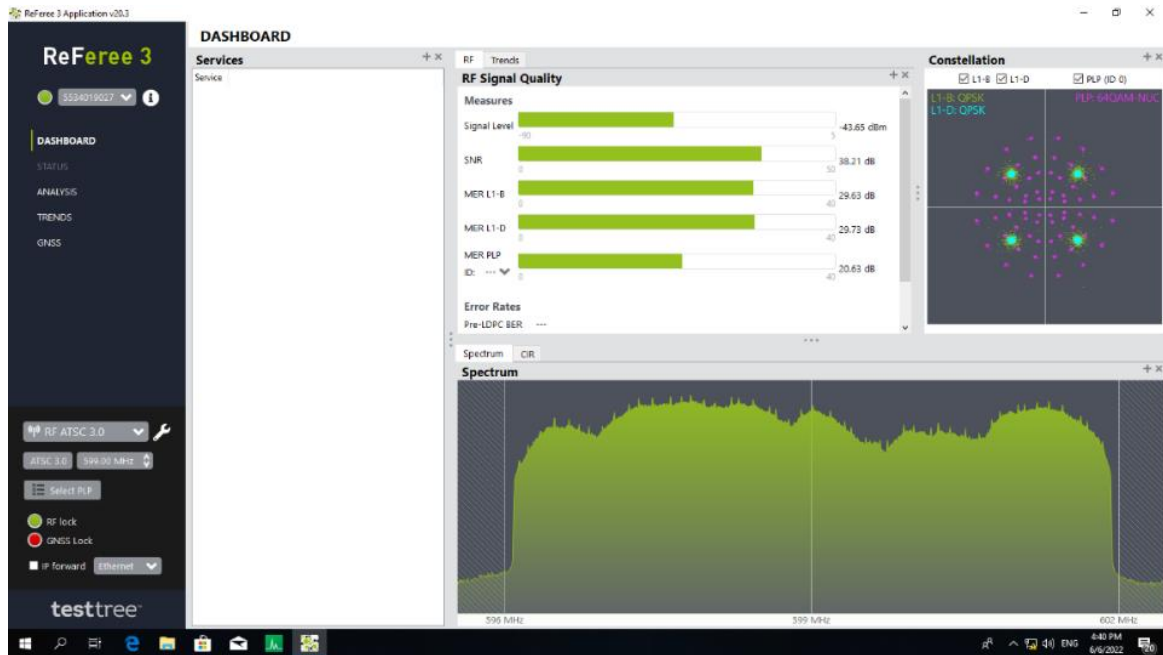
The standard set of DVB-T1/T2 and ATSC 3.0 base line measurements that can be achieved with a few drone flights include:

- Signal to Noise measurements
- Modulation Error Rate results for total transmission and individual PLP's
- Bit Error Rates
- Channel Impulse Response at the receiver point
- Field strength level
- Channel plot and shoulder attenuation
- Station ID (if available)
- PLP IDs

- Programme services per PLP
- PLP constellation info
- Location of the source of measured signals
- Detail spectrum plot and other transmission visible at the measurement location
- Interference sources and the angel of the interference source at the measurement point.
- Antenna elevation & azimuth pattern and ERP measurements
- Absolute source location of radiation point (height and azimuth) of the antenna carrying the wide band signal transmission.

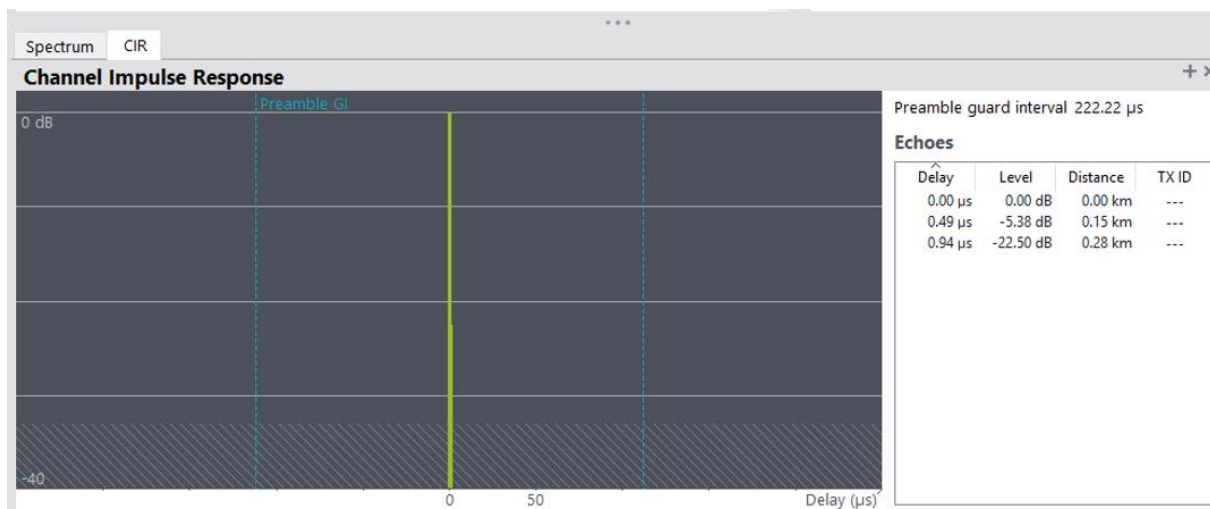
Sample of measurement results are included below:

2.1 Signal parameter measurements & Constellation

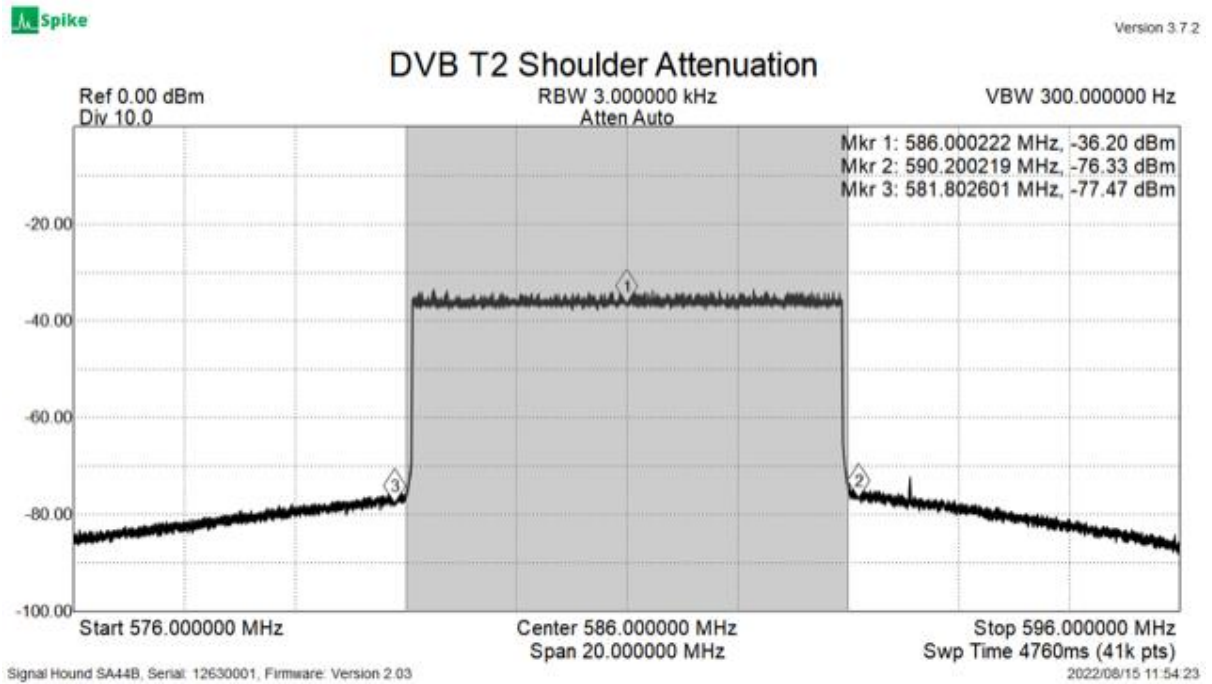


2.2 Channel Impulse Response at the receiver point

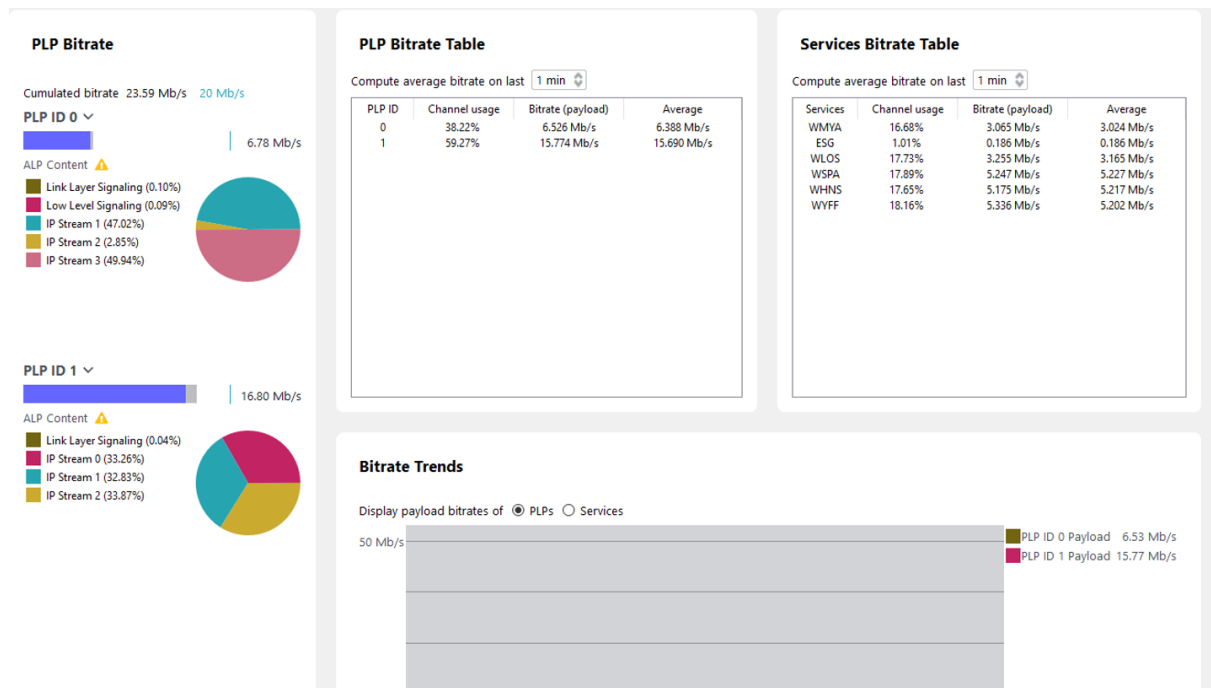
The channel impulse response below indicates the delay, level and distance of such responses that are present.



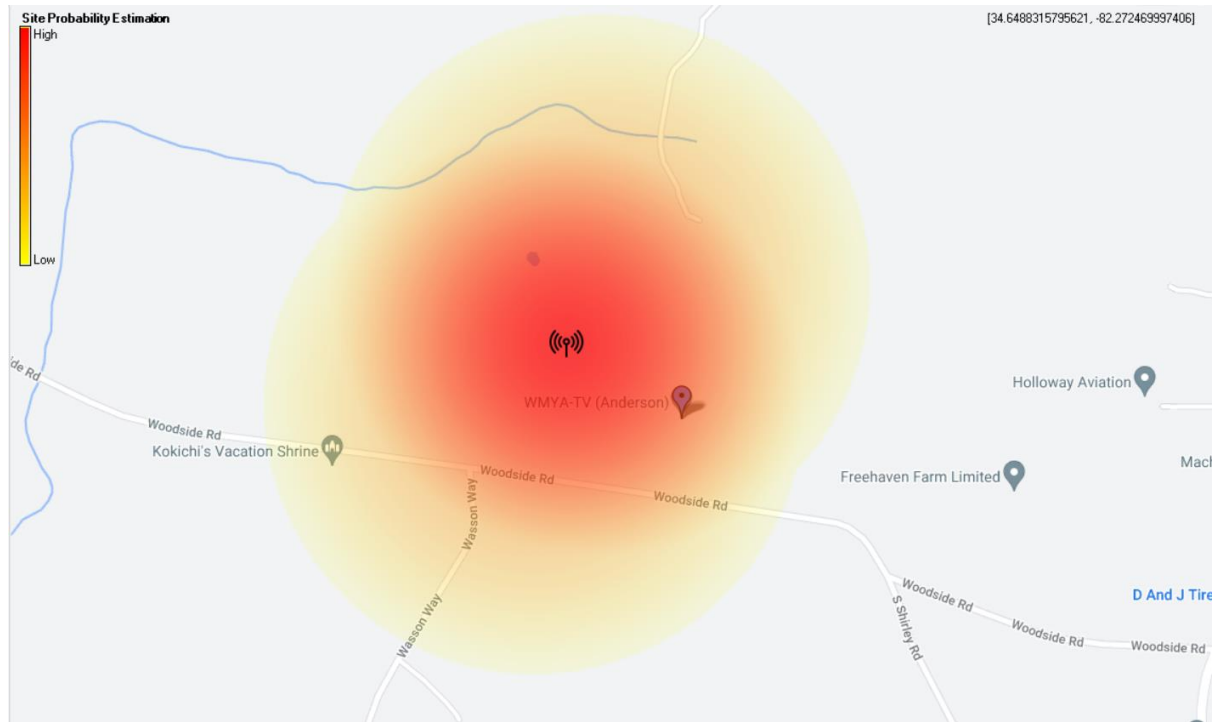
2.3 Channel plot and shoulder attenuation



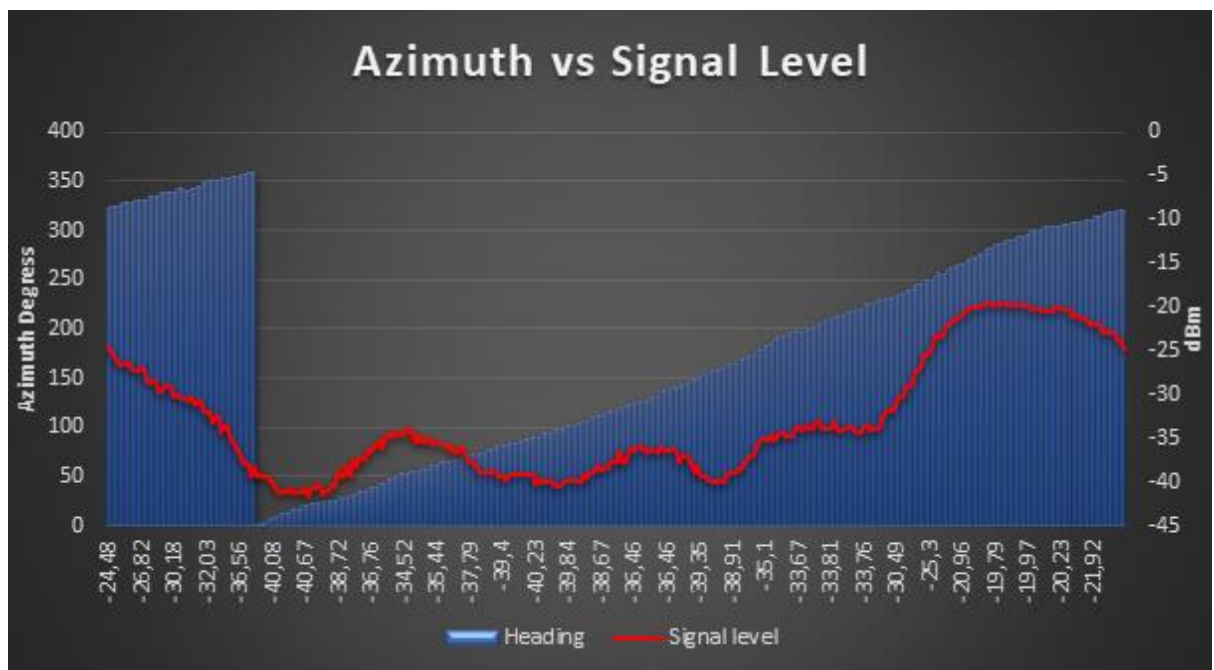
2.4 Station ID (if available), PLP IDs, Services per PLP



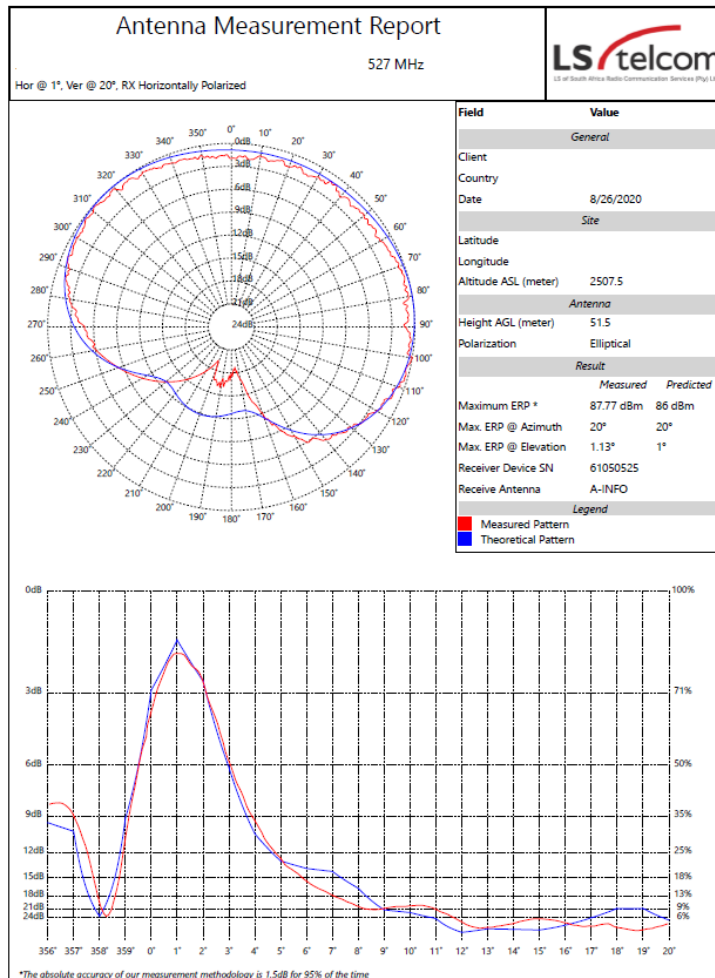
2.5 Location of the source of measured signals



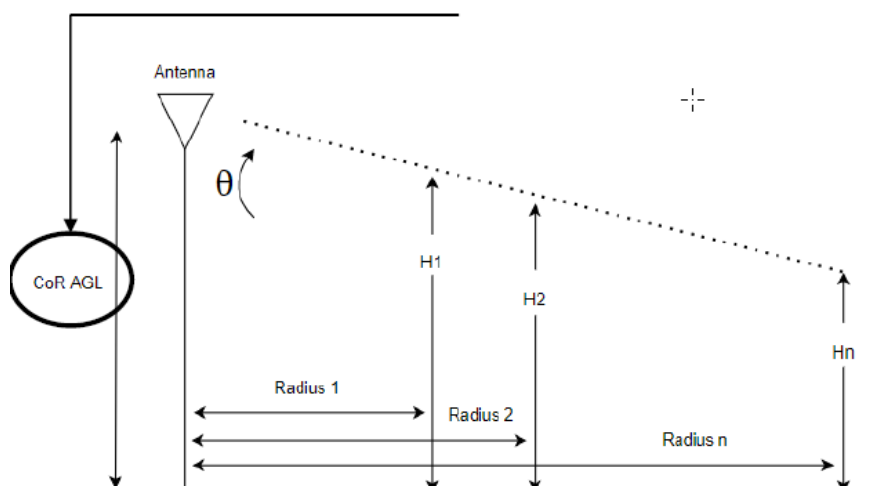
2.6 Interference sources and the angel of the interference source at the measurement point



2.7 Antenna elevation & azimuth pattern and ERP measurements



2.8 Absolute source location of radiation point (height and azimuth) of the antenna carrying the wide band signal transmission



$$CoR = H_n + R_n * \tan(\theta)$$

2.9 Sample table of baseline airborne quality of service measurement results

The following table contains the over the air measurement results together with the minimum compliance limit specified by the client. Measurements were taken at 50 meter above ground approximately 800 meters right in-front of transmit antenna.

Item	Measurement description	Measurement Result PLP ID0	Measurement Result PLP ID1	Client Specification
1	MER L1 B	37dB	37dB	
2	MER L1 D	36dB	36dB	
3	MER PLP	29dB	33dB	
4	SNR	40dB	40dB	
5	Signal level	-18dBm	-15dBm	
6	Pre-LDPC BER	0	0	
7	Pre-BCH BER	0	0	
8	Post-BCH FER	0	0	
9	CIR	0,49uS,-5,38dB,0,15km 0,94uS,-22,5dB,0,28km		
10	Selective Fading (dB)	1.2dB	1.8dB	
11	Shoulder attenuation(dB)	19.8 dB	22 dB	

3 Advantages to Broadcast Industry Players

The measurement system provides the following advantages:

- The measurements are unintrusive and do not require the transmitter to be switched off to perform any of the measurements.
- Full measurement report available within two days after the measurement have been performed.
- The measurements are performed with RTK GPS in order to provide centimetre accuracy to the measurements.
- Our drones are well screened against hight radio frequency fields to ensure safety during the measurement exercised.
- We are a licensed Civil Aviation operator and we ensure that all flights are registered with the relevant authorities.
- LS telcom has more than 20 years of experience in airborne radio frequency measurements.
- The measurement can be expanded to perform a full off-air commissioning report in line with the specific operator and his requirements.