



Performance Measurements

*Low Transmit Power*

*WAIC System*

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## Overview

### Motivation:

Demonstrate feasibility of a WAIC system that complies with a  $-20\text{dBm}$  e.i.r.p transmit power limit

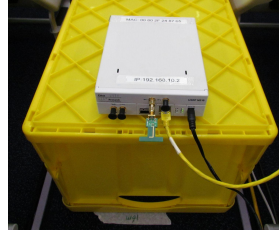
### Outline

- Measurement System
- Environment
- Measurement results
- Conclusion



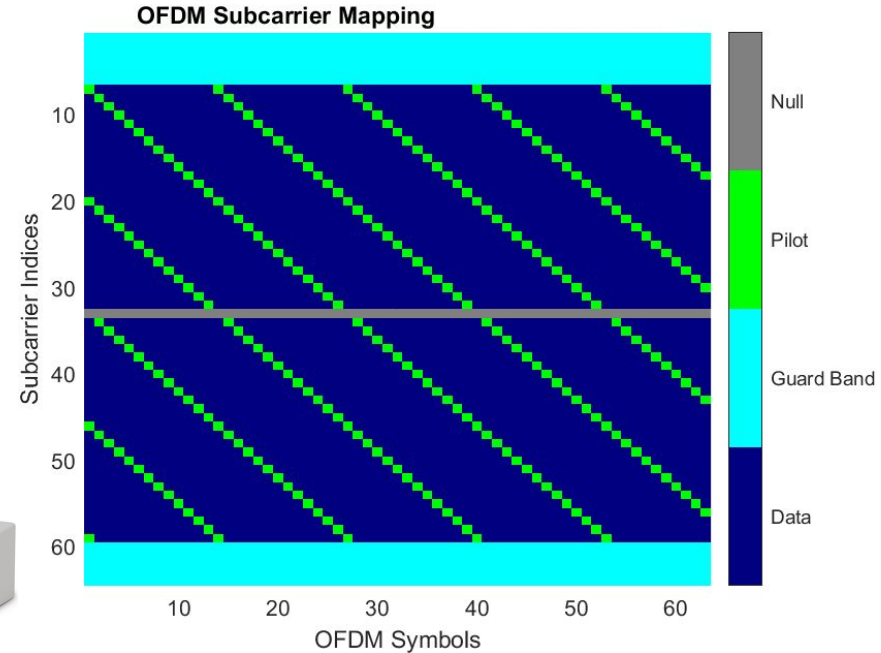
# Measurement System: Transmitter configuration

## ETTUS N210 SDR



### OFDM system:

- Bandwidth 10MHz
- Subcarrier spacing 195.3125kHz
- Symbol rate 7.5Msym/s,
- Parallel concatenated turbo code with Rate  $\frac{1}{3}$
- Data rate 2.5Mbps (with BPSK)
- Total output power -20dBm



## Measurement System:

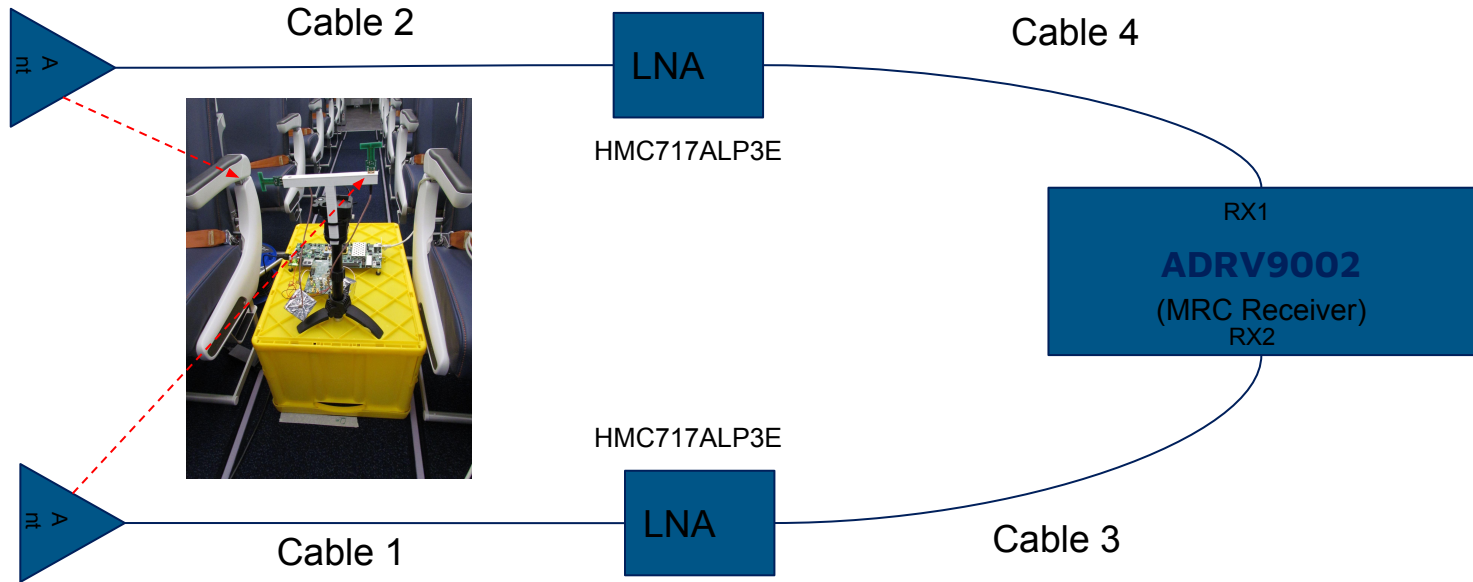
Ettus N210 output power measured at RF port 1



- Total output power of -21.3dBm

# Measurement System: Receiver configuration

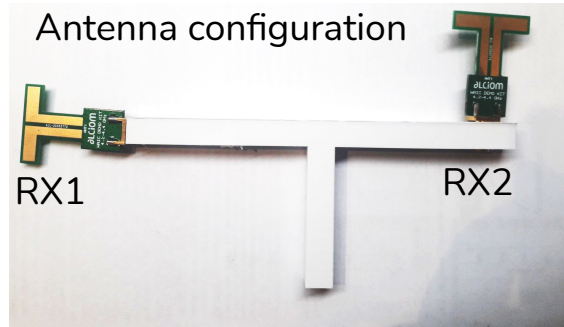
## ADRV9002 with 2 RX + LNA



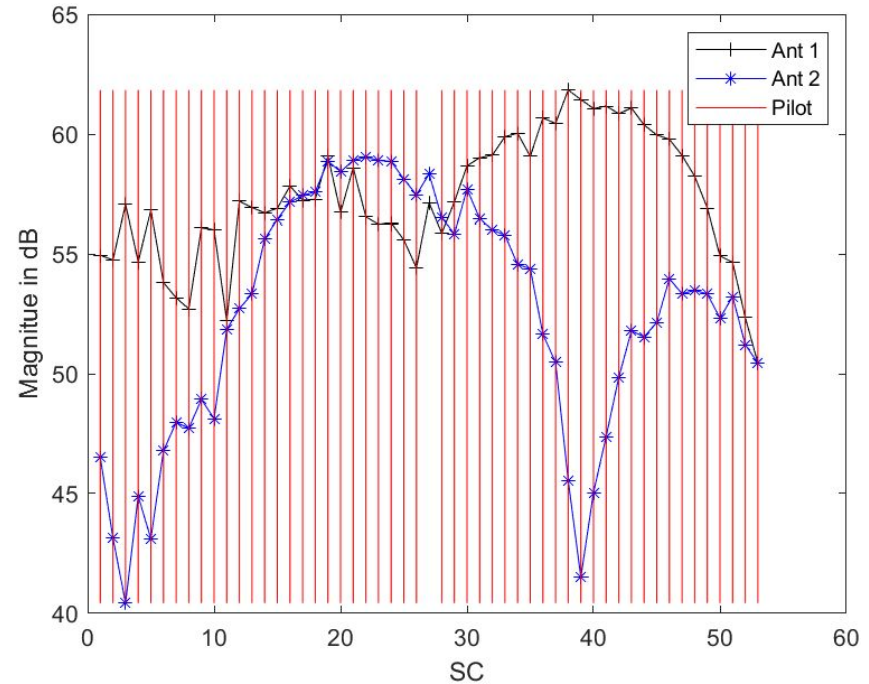
## Measurement System: Receiver properties

Two RX paths for reception

- Connected to cross polarized antennas
- Maximum Ratio Combining to compensate frequency selective fading



### Transfer functions





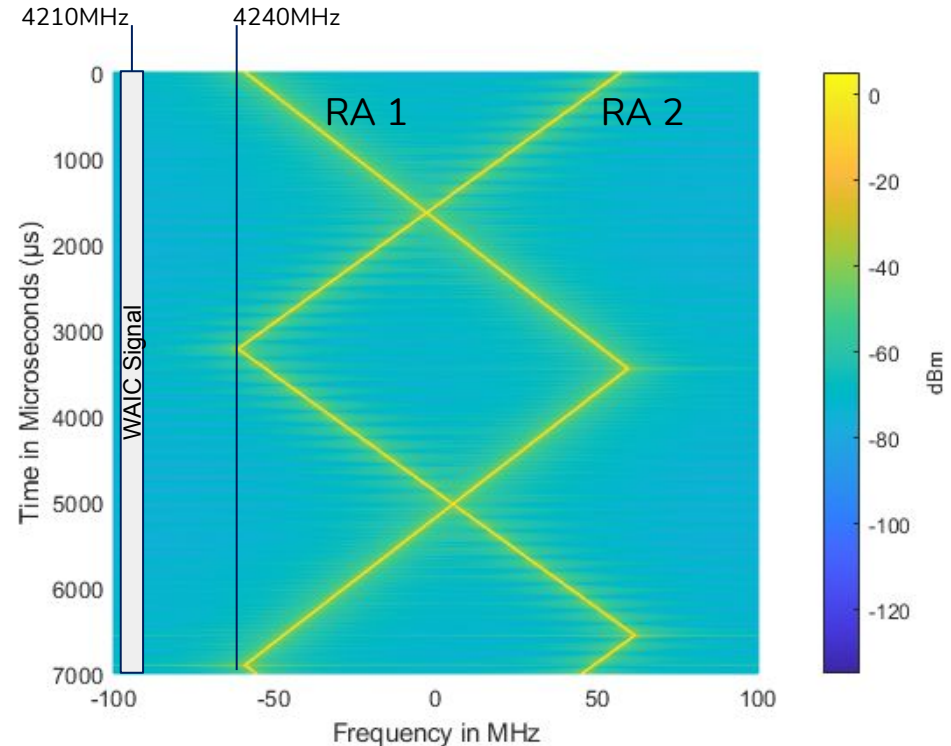
## Environment: Spectrum Sharing

WAIC channels located outside onboard RA sweep range

- With frequency separation between RA signals and WAIC signal

Figure exemplary shows a typical spectrum utilization of two Radio Altimeters :

- with a WAIC signal separated in frequency domain



# Environment: A320 with activated Radio Altimeters



MSN  
10595

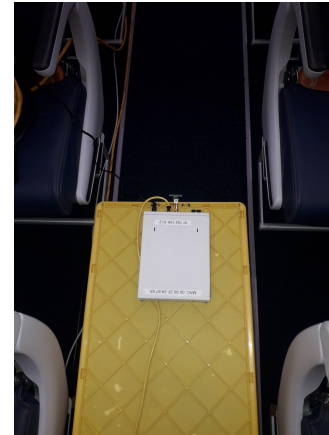
RA



RX -TX Distance  
10m, 16m, 20m, 24m

ADRV  
9002  
(2RX)

N210  
SDR  
(TX)



## Environment:

# Radio Altimeter installed on MSN 10595

RA spectrum utilization measured

- onboard MSN 10595
- at receiver position
- with sweep bandwidth of 130MHz

Installed RA Model: Honeywell ALA 52B





## Measurement results

System performance measured at 10m distance

- 20 meter cell radius  
-> 2 Access points per A320
- BER of ~ 0.000001

Highly reliable wireless communication at -20dBm e.i.r.p possible with:

- Limited coverage
- Moderate data rates

RX-TX Distance in Meter	10m	16m	20m	24m
Number of uncoded Bits received*	38.267.316	38.126.880	8.438.112	7.954.056
Uncoded BER	2.4068e-05	0	0	0.00018469
Number of coded Bits received*	12.755.772	12.708.960	2.812.704	2.651.352
Coded BER	2.2826e-06	0	0	8.7098e-06

\*Code Rate 1/3

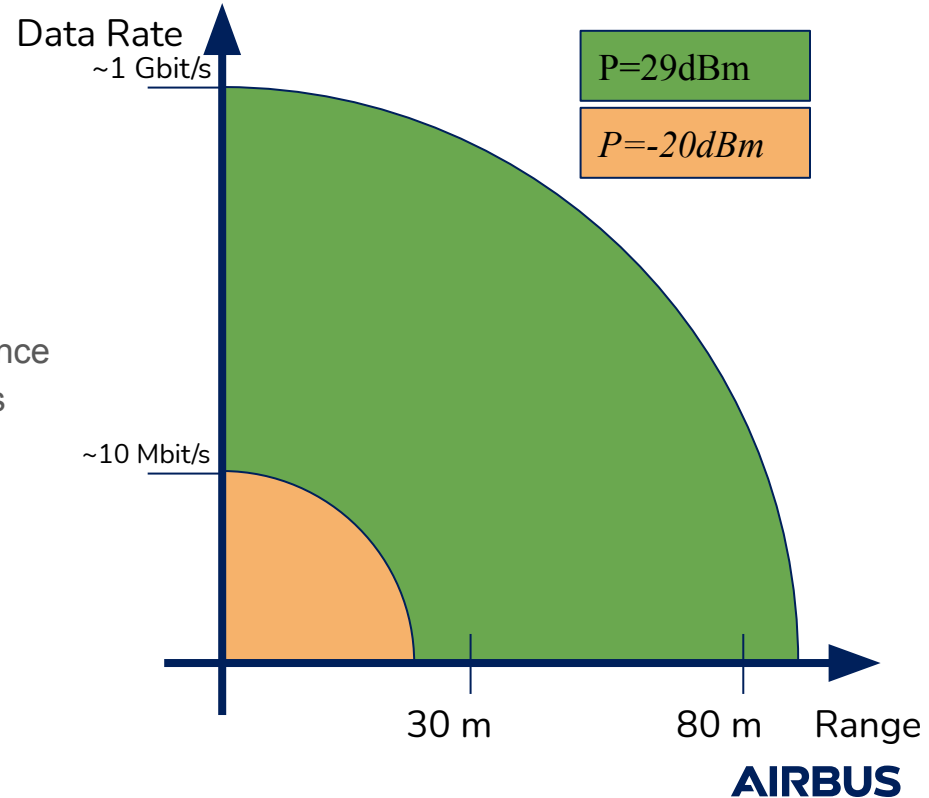
## Conclusions

WAIC solution with -20dBm e.i.r.p is feasible

- with limited solution space
- due to decrease in data rate and radio coverage

However, system under test shows suitable performance for several safety related applications on board Airbus aircraft.

Performance estimates



## Conclusions

