10º Congresso do Comité Português da URSI: Comunicações em cenários de segurança e emergência

Antenna array to increase the communication range of UAV

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creating and sharing knowledge for telecommunications

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Outline

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3. Ground station antenna
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   - Simulated results

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1. Introduction

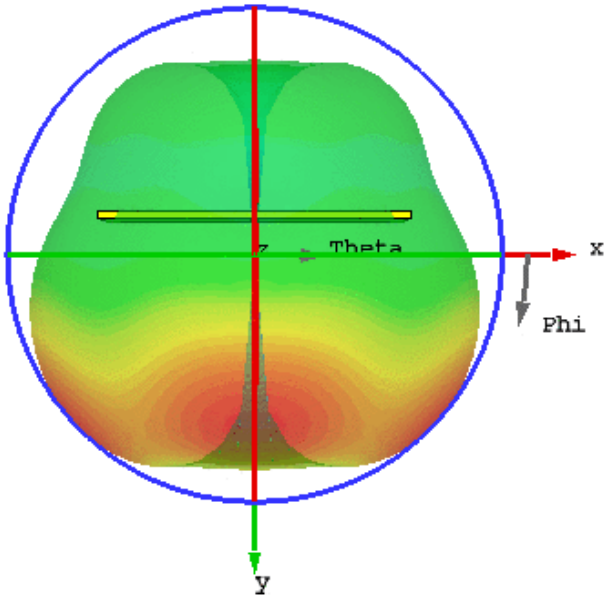
UAV

- Unmanned aerial vehicles are used for military, special operation and also in a growing number of civilian applications;
- It is necessary to be able to communicate over long distances, specially in war scenarios, for this is necessary that the antenna has a good performance in terms of gain;
- It will be improved the performance of UAV antenna and ground station antenna too.

2. UAV antenna

Monopole

- $\lambda/4$ length;
- 2 dBi of gain;
- Omni-directional coverage.



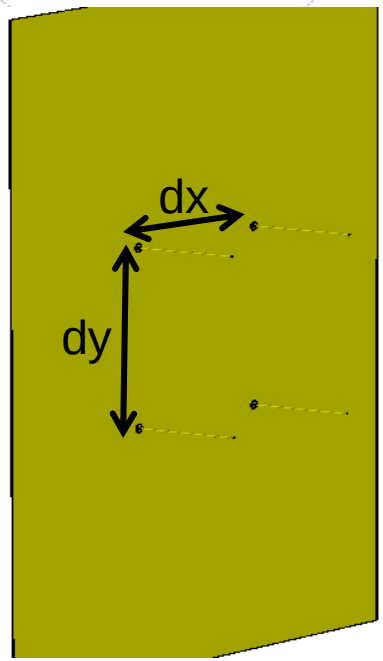
Antenna developed

- It is necessary into account the size, weight and the useful space in the UAV structure;
- It will be used the UAV fuselage as ground plane (carbon fiber);
- 2 x 2 monopole elements;
- 1.335GHz frequency.

2.1 Design of monopole antenna array

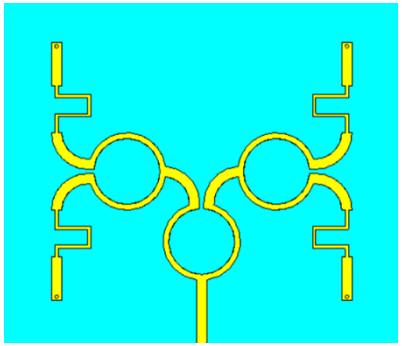
Distance between elements:

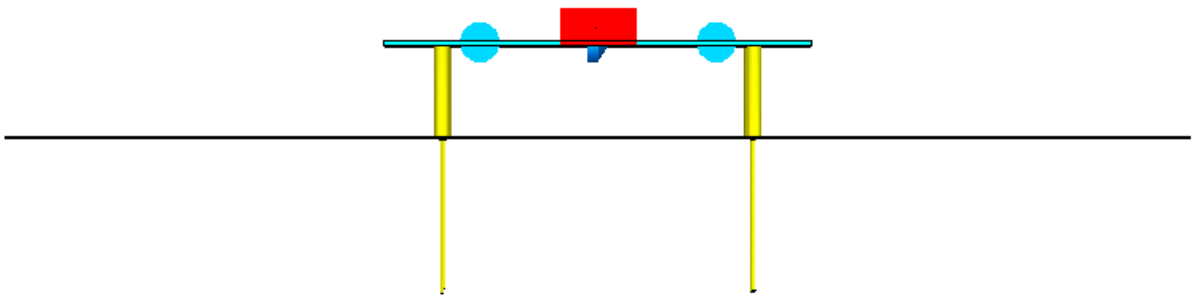
- dx = 94.76 mm;
- dy = 109.5 mm;
- Ground plane: carbon fiber.



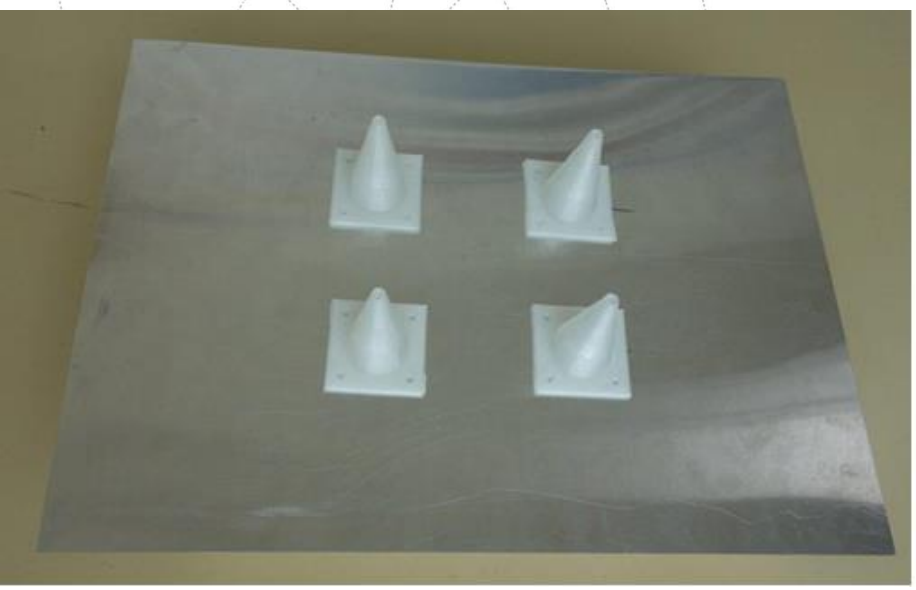
Feeding network:

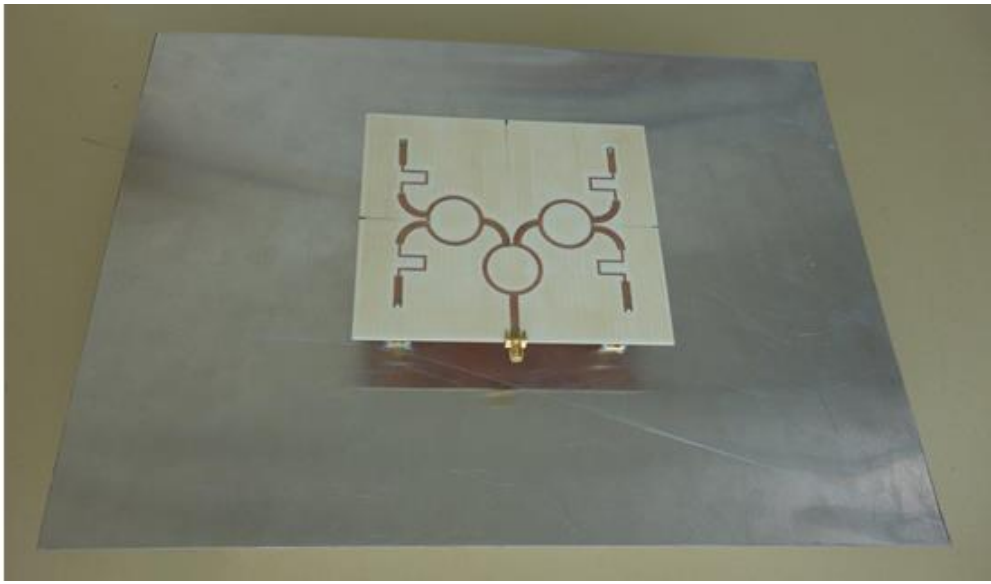
- 1 x 4 Wilkinson power divider;
- Distance between feeding network and antenna ground plane: 32 mm.





2.1 Design of monopole antenna array (1)

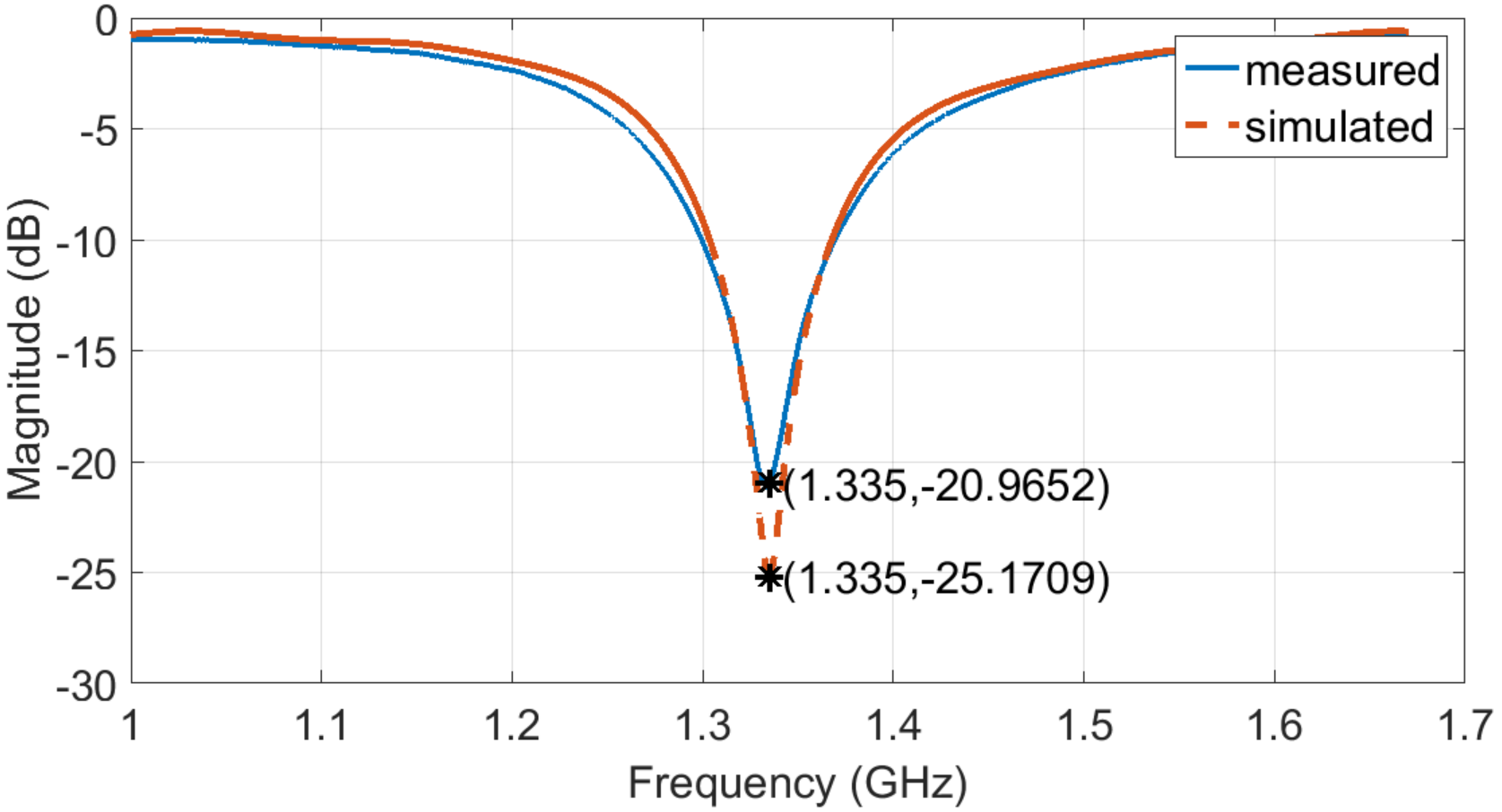




- In order to protect the monopoles, it was built four cones and fixed it on the ground plane structure;
- The feeding network board was fixed to the back side of antenna ground plane.

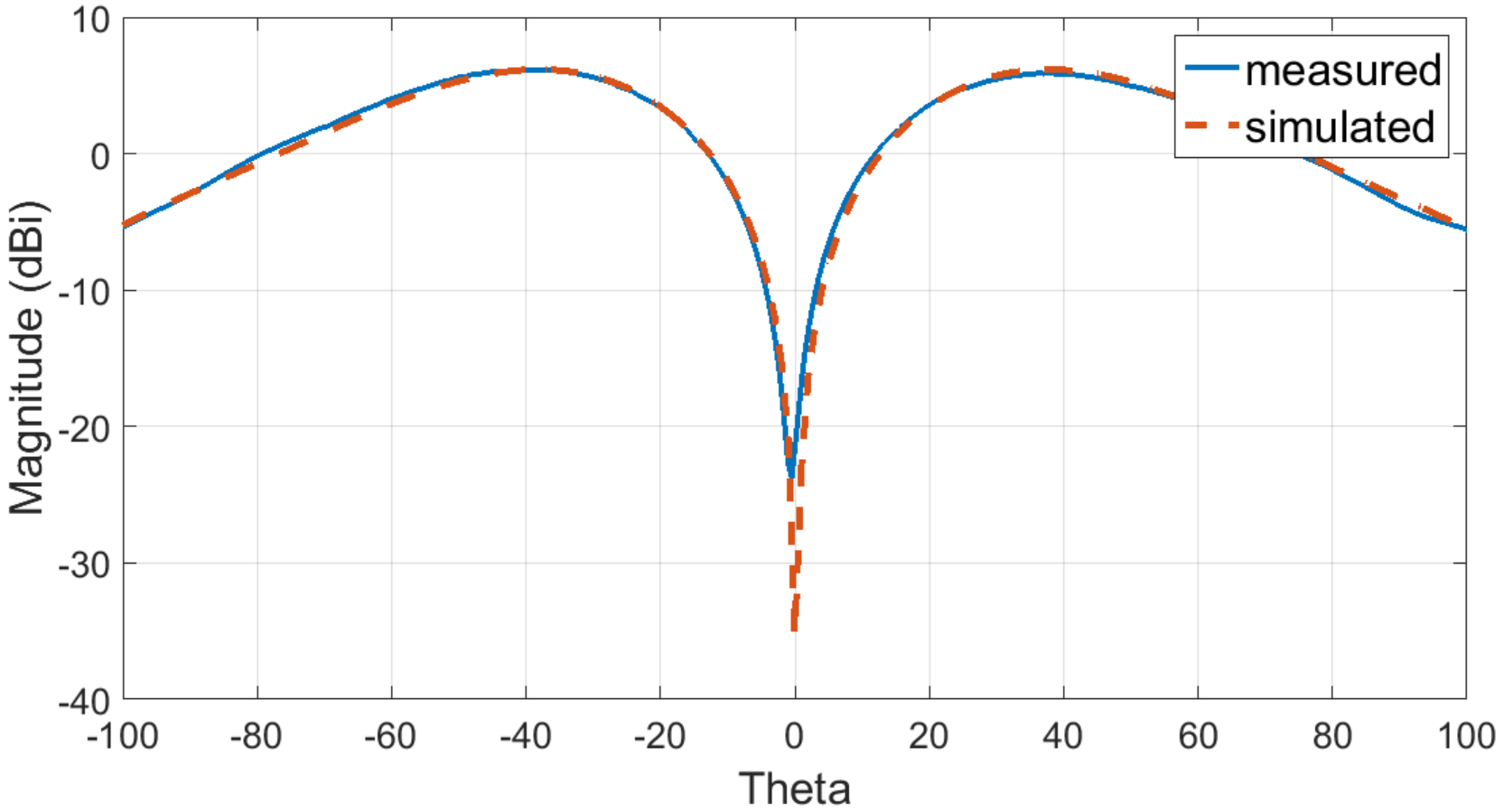
2.2 Design of monopole antenna array (1)

S11 parameters:



2.2 Design of monopole antenna array (2)

Radiation pattern:



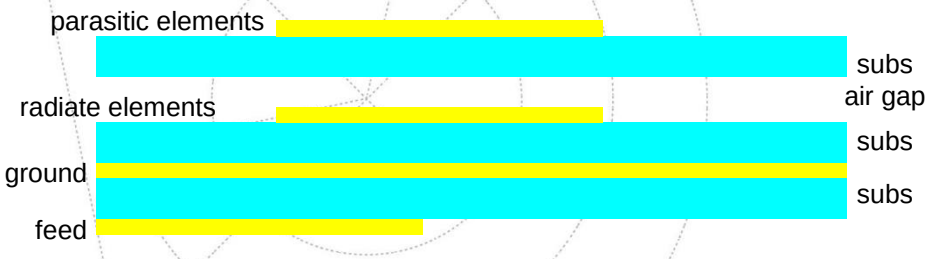
3. Ground station antenna

- The ground station antenna usually provides the higher gain part of the link;
- No size and weight limitation;
- It can be used directive antennas like:
  - Yagi;
  - Microstrip patch;
  - Parabolic reflector.

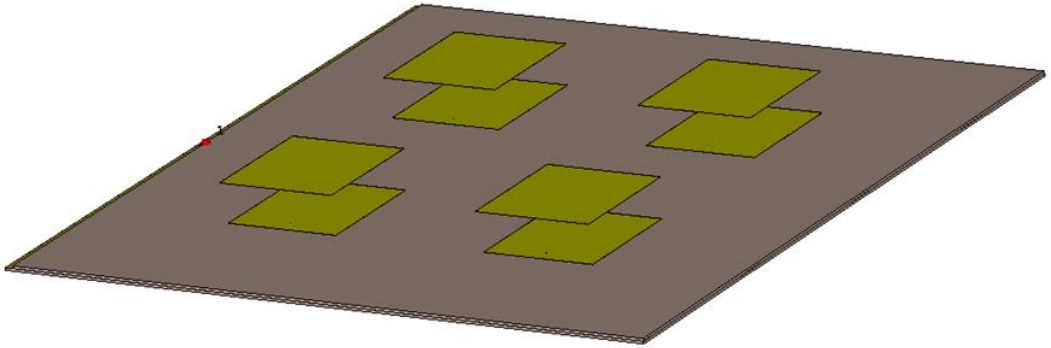
Antenna developed

- 2 x 2 stacked microstrip antenna array in order to increase the gain and the bandwidth.

3.1 Design of stacked microstrip antenna array

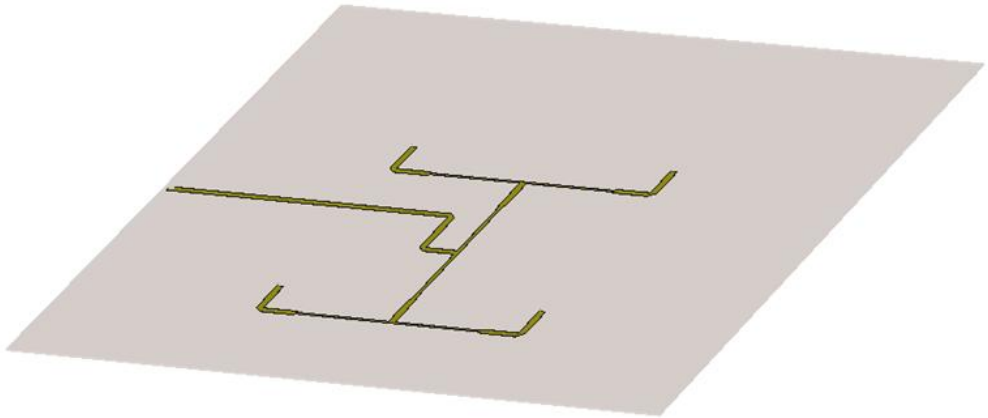


- Roger Ro4725JXR ($\varepsilon_r = 2.55$);
- Substrate thickness: 1.54 mm (3 layers);
- Air gap: 22.5 mm.



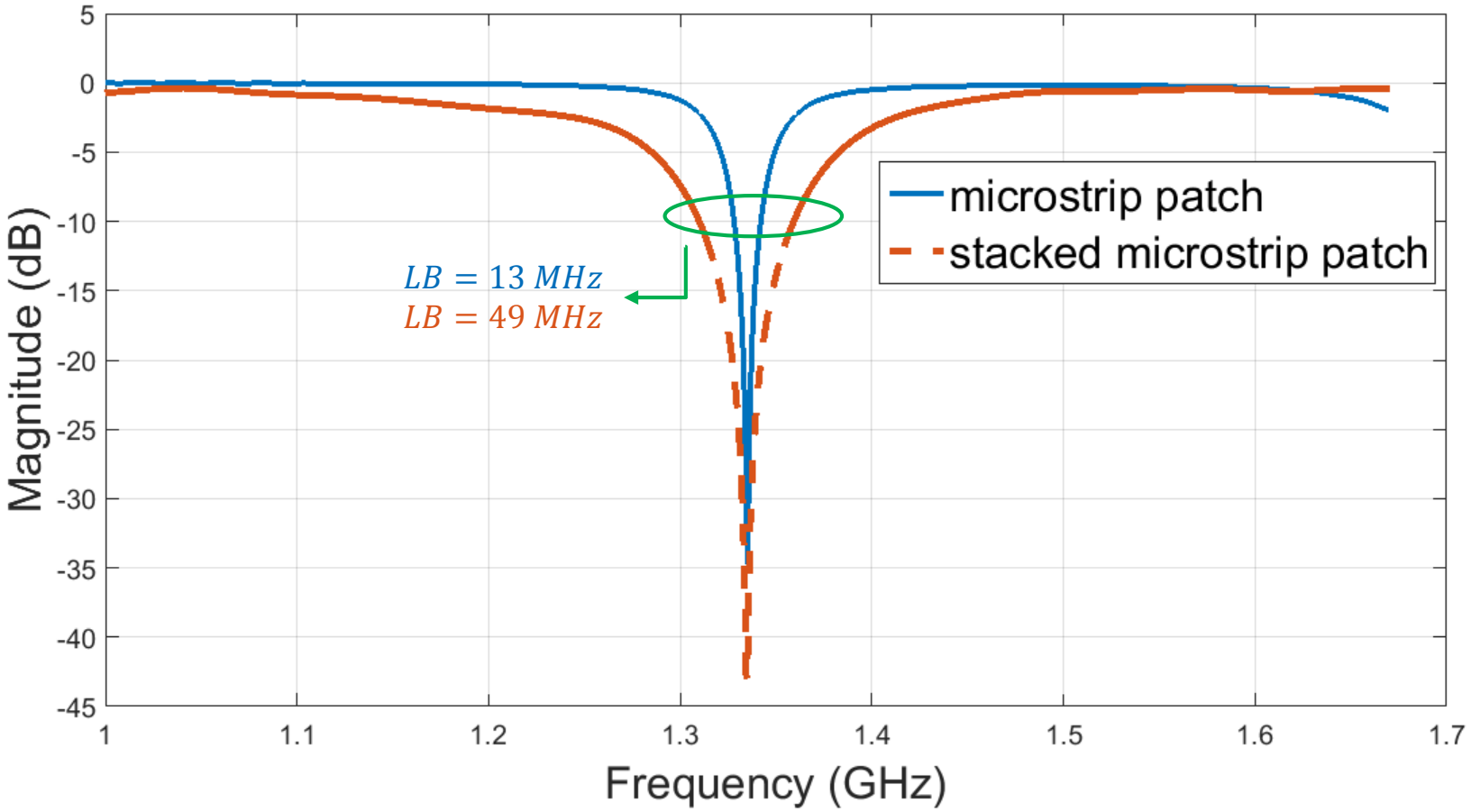
Top view with radiate and parasitic elements

Bottom view with feeding network



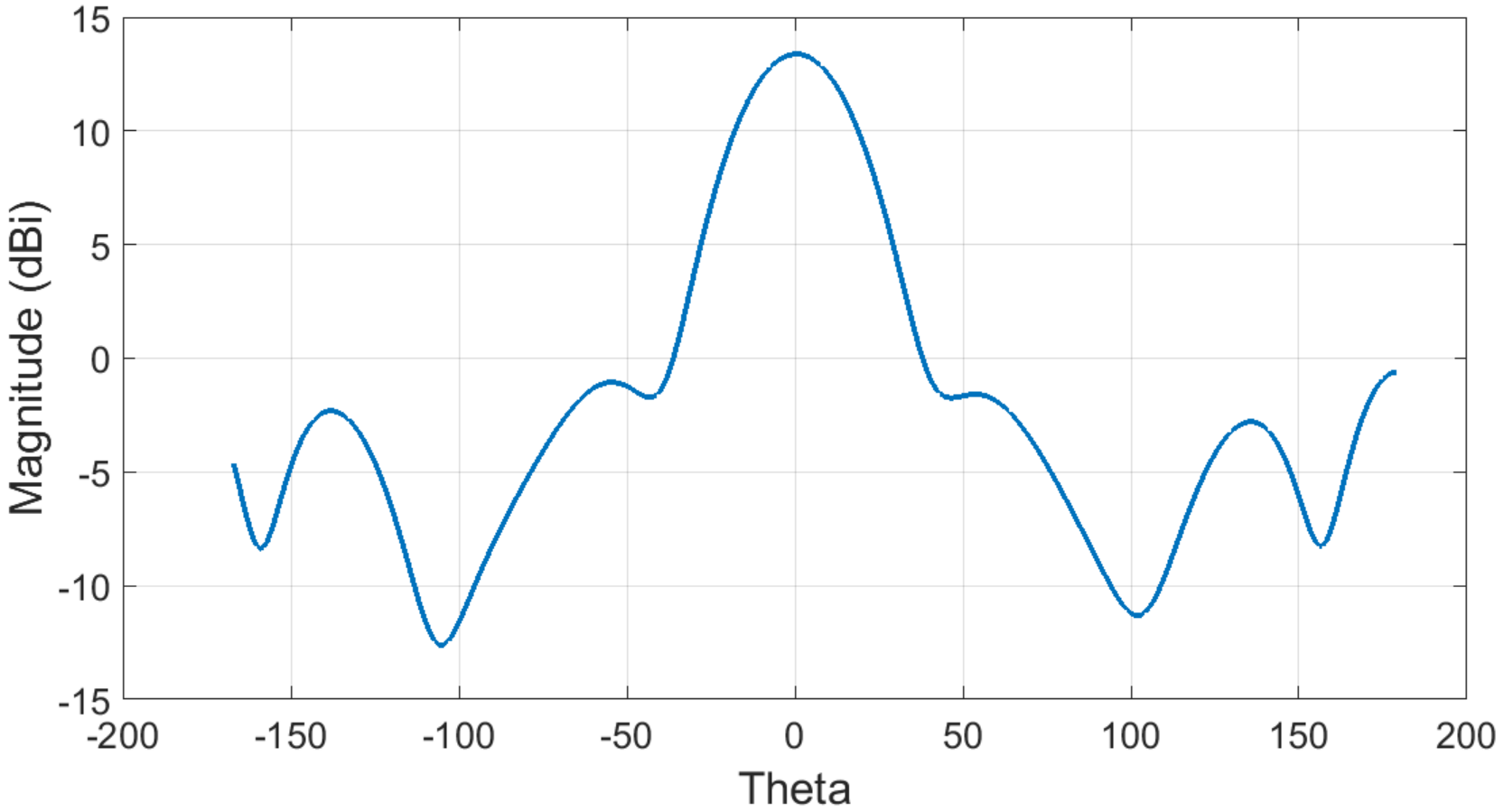
3.2 Simulated results

Comparison between microstrip patch antenna and stacked microstrip patch antenna:



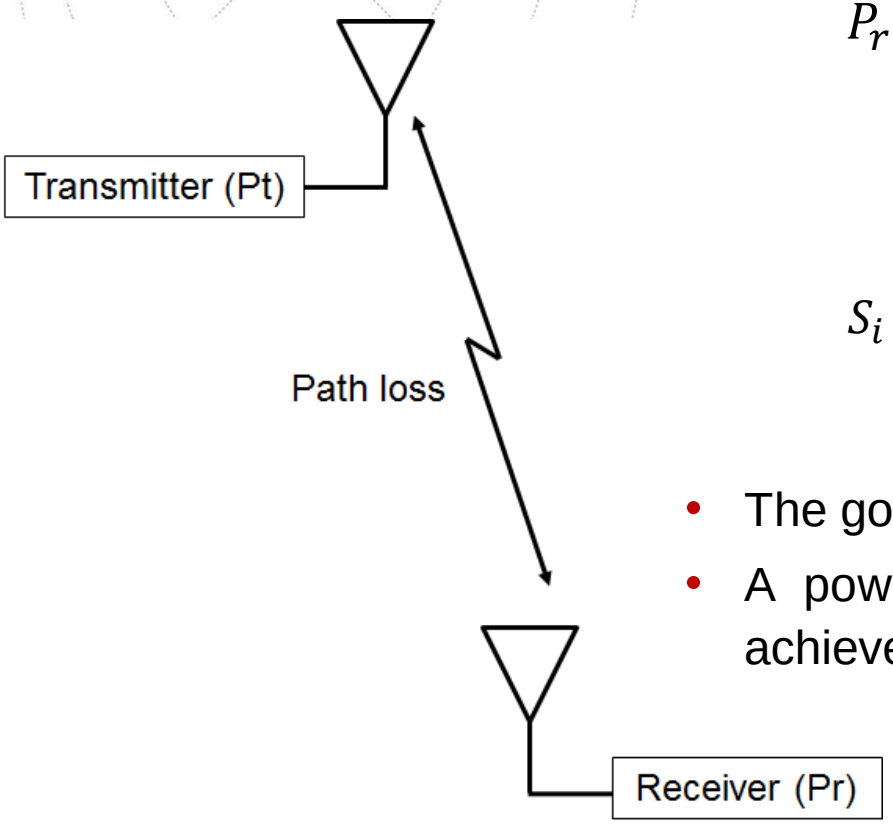
3.2 Simulated results

Radiation pattern:



4. Link budget

- Link budget is an accounting of all the gains and losses in a transmission system;



$$P_r = P_t * G_t * G_r * \underbrace{\left(\frac{\lambda}{4\pi * d}\right)^2}_{\text{Path loss}}$$

$$S_i = -174 + 10log_{10}(LB) + NF + SNR$$

- The goal is to communicate over to 50 km;
- A power amplifier it was choose in order to achieve this goal.

4. Link budget

	Implemented system	Proposed system	With amplifier block
Data rate (Kbps)	8000	8000	8000
RF transmitter power (W)	0,25	0,25	0,068
Sensitivity (dBm)	-90,6	-90,6	-91,1
Bandwidth (KHz)	8700	8700	8700
SNR	11	11	11
RF receiver power (W)	8,7E-10	8,7E-10	7,7E-13
Antenna Rx gain	8	13,5	13,5
Antenna Tx gain	2	6	6
Distance (Km)	0,95	2,86	50

5. Conclusions

- It was developed an antenna array using the UAV structure as antenna ground plane, with about 6dBi of gain;
- In order to increase the bandwidth a stacked microstrip antenna was design for the ground station communication;
- Using this antennas with a rigorous radio communication system, it is possible to obtain a communication range of 50 km, approximately;
- This way, it is possible increase the coverage surveillance, using the UAV.