

# A Waning Crescent Quasi-Yagi Microstrip Antenna for Wireless Sensing Networks

Instituições Associadas



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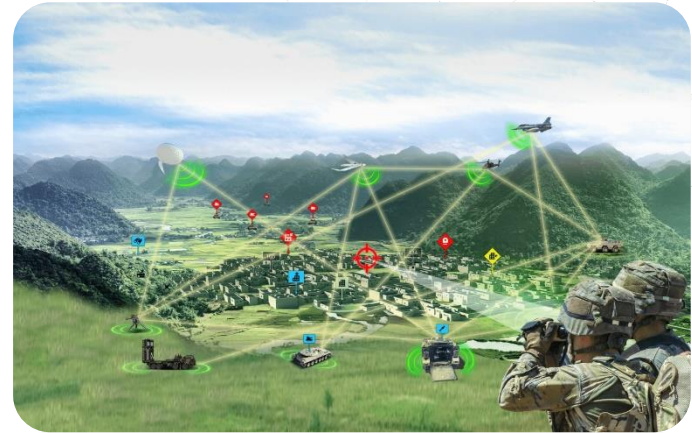


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# Wireless Sensing Networks

Wireless Sensing Networks (WSNs) are often being offered as a solution for monitoring networks, such as:

- Environmental monitoring;
- Security;
- Health;
- Agricultural monitoring;
- Hazard detection.

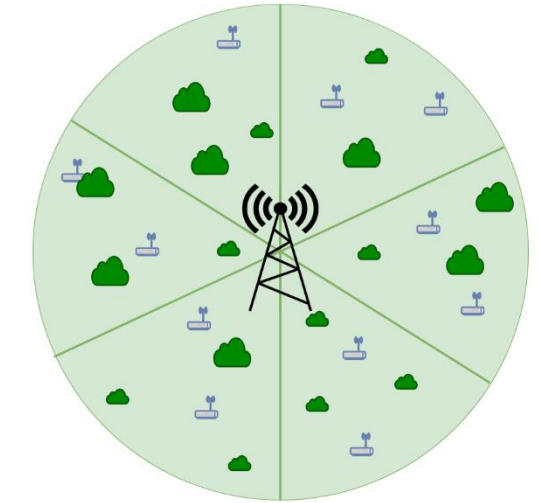


[Source]- <https://defbrief.com/2020/02/05/israel-buying-fire-weaver-sensor-to-shooter-system/>



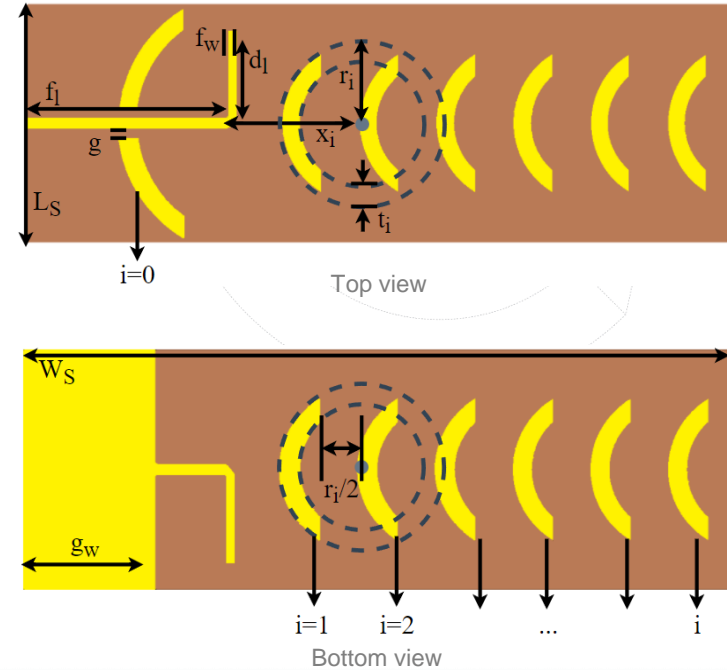
# Wireless Sensing Networks

- A WSN is typically composed of a large number of sensor nodes, scattered in a certain monitoring area;
- A base station is utilised to collect the environmental data and forward it to higher layer network for further analysis;



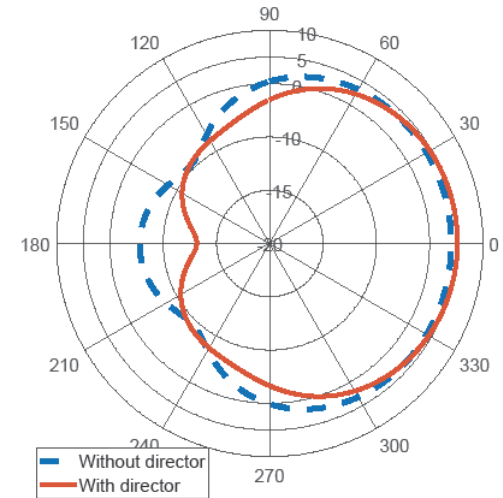
# Antenna layout

- Layout characteristics:
  - Based on planar Quasi-Yagi layout;
  - Metallic parasitic elements are added as directors, in order to focus the radiated energy in one direction;
  - The antenna is composed by a microstrip dipole, a waning crescent reflector over a ground plane and, six waning crescent directors.
  - Band of operation: 2.4GHz ISM band;
  - Double sided FR4 substrate ( $\epsilon_r=4.4$  and  $\tan(\delta)=0.014$ ).



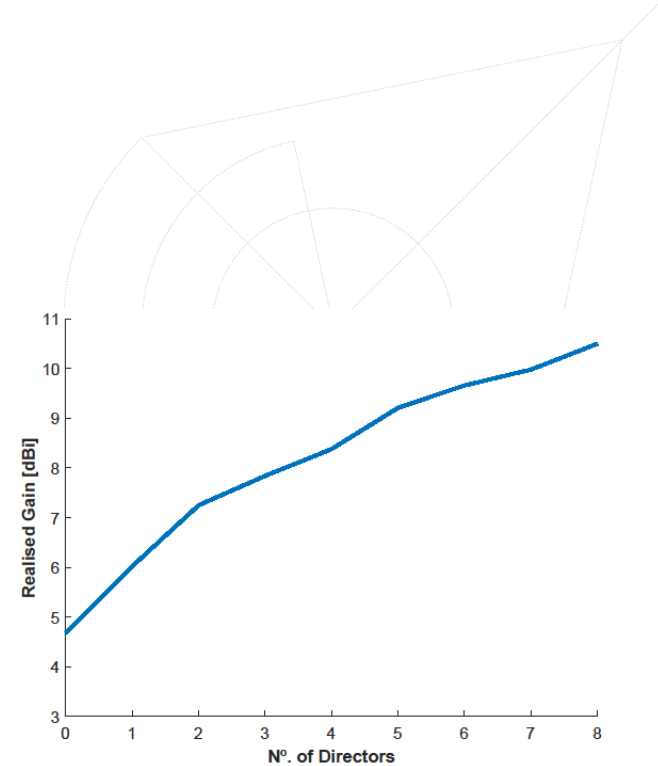
# Antenna optimisation

- The proposed antenna configuration was dimensioned with the assist of a full wave electromagnetic solver (CST MWS), in an iterative design approach;
- The feeding element (dipole) was firstly optimized, followed by the addiction of a waning crescent director;
- The director ensured a gain increase of 1.65dB (from 4.37 to 6.02dBi).



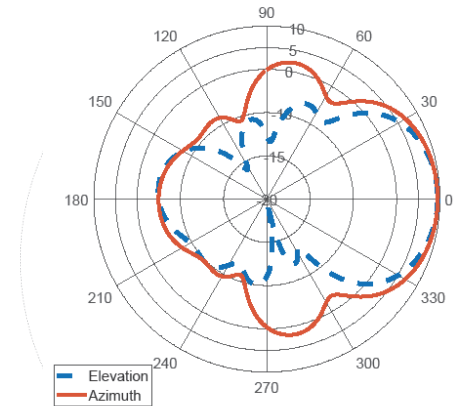
# Antenna optimisation

- A parametric workout was carried out to access the gain improvement against the number of directors;
- The directors were added progressively to the layout at  $x_i = x_{i(i-1)} + 18\text{mm}$ ;
- The difference from 6 to 8 directors is 0.81dB, while the difference from 4 to 6 is 1.24dB;
- With 6 directors the design achieves a gain of 9.6dBi.

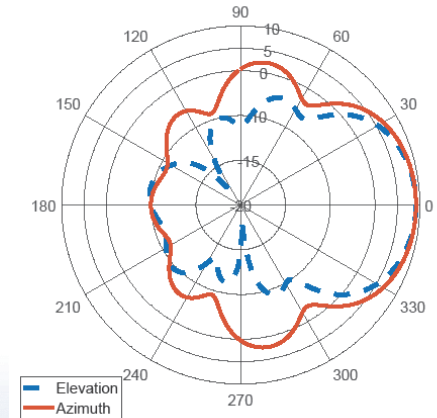


# Antenna optimisation

- To further improve the back-to-front ratio of the antenna an additional waning crescent was added, over the ground plane, to serve as a reflector;
- After optimization, the best back-to-front ratio was of 18.63dB, an improvement of 4.28dB, from the case without reflector;
- In this configuration the antenna gain is also slightly improved by 0.1dB.



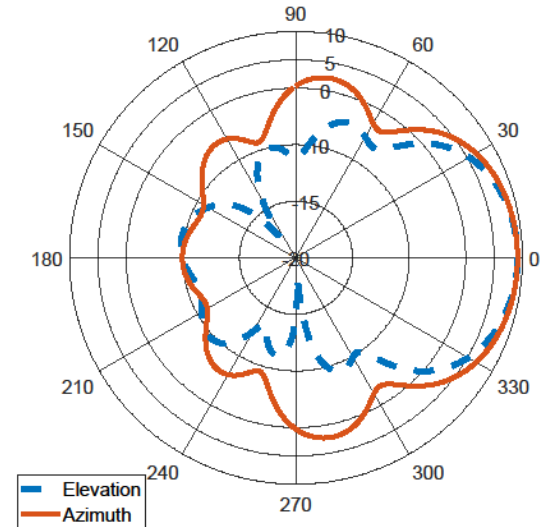
Without a reflector.



With reflector.

# Simulation results

- Antenna characteristics:
  - Realised Gain: 9.7dBi, at 2.44GHz;
  - Half-power beamwidth: 60° (Az plane);
  - Back-to-front ratio: 18.63dB.
  - Band of operation: 2.2 to 2.53GHz.





# Conclusion

- A novel lunar waning crescent microstrip Quasi-Yagi antenna was proposed on this paper. The antenna is comprised of a dipole as the driven element, a waning crescent reflector and six equal waning crescent directors;
- After proper antenna optimisation, the antenna yield 9.7 dBi of realized gain, a HPBW of  $60^\circ$  (Az) and a back-to-front ratio of 18.63 dB, at a resonating frequency of 2.44 GHz.
- Further work will aim at antenna prototyping and experimental characterisation and subsequent implementation on a multi-sector base-station.



# Acknowledgment

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