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Antennas for Emerging Satellite Services

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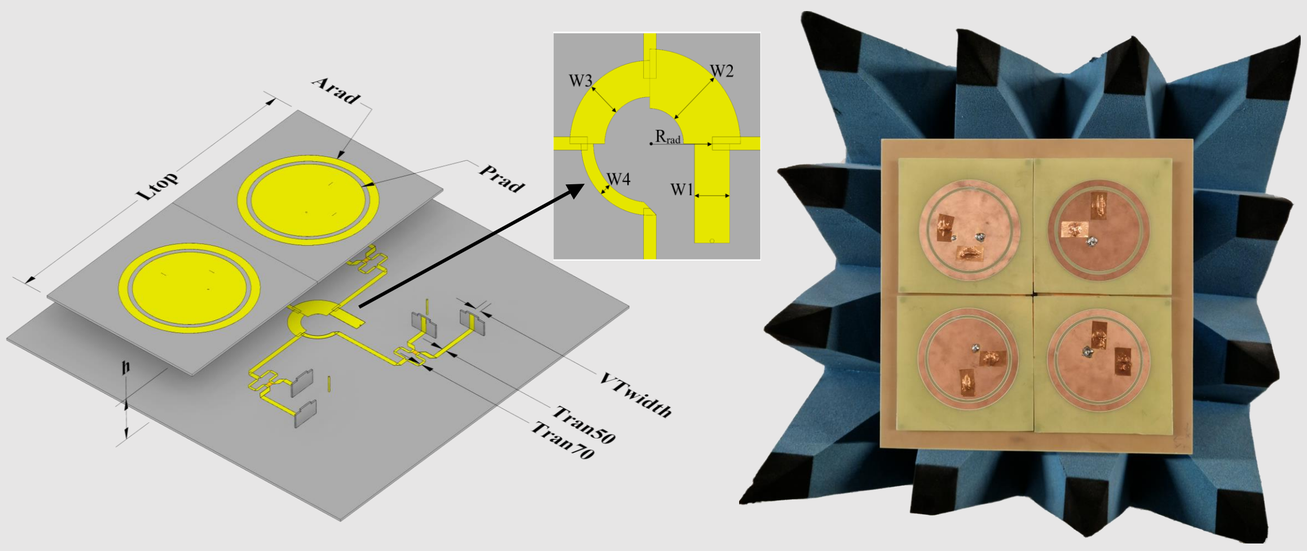
Abstract
The project explores new technology developments in the satellite communication area. It aims to contribute to solving challenges facing satellite communication antennas at the moment such as the move to higher frequencies, cost, size reduction and signal reliability.

Current Research
A wideband antenna array for broadband global area network (BGAN) portable terminals. The proposed antenna operates in the L-band with receive band (Rx) at 1518-1559 MHz and transmit band (Tx) at 1626.5-1675 MHz. The antenna employs a 2×2 array of air-spaced annular-ring loaded circular patches. The measured results show a 3 dB axial-ratio bandwidth better than 70% (1113 - 2314 MHz) and a 10 dB S_{11} bandwidth of 56.7% (1170 - 2095 MHz). The measured peak gain is 13.6 dBic.



Simulated 3D model

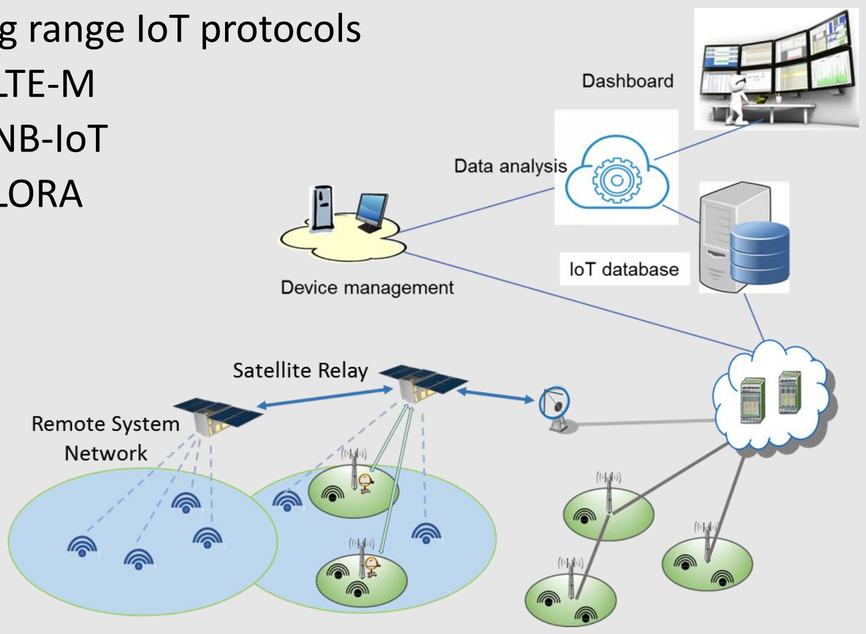
Fabricated antenna

	Simulated	Measured
Peak gain (dBic)	12.44 dBic	13.6 dBic
Return loss (dB) @ 1.6 GHz	29.256 dB	22.7 dB
Impedance BW (%)	52.35 %	56.66 %
AR BW (%)	87.62 %	70.09 %

How can this project help solve the UN SDG challenges by leveraging industry and academic partnerships?
Satellite communication contributes to solving UN SDG challenges such as 9,11,12,13 and 15. With the help of satellite communication, people can have access to the internet and constant contact with others around the world during natural disasters or conflicts within the country. Satellites are used to observe the planet from above which helps predict the weather and any climate changes.
The collaboration between the academia and industry can increase the performance of those satellite services by introducing new scientific equipment and increasing the data transfer rates.

Satellite IoT Terminals
Satellite based IoT terminals are meant for use in remote locations. They enable data gathering and system monitoring of networks located in remote locations, such as wind turbine farms. The terminals gather all the necessary data from a network and subsystems nearby and transmits it through a satellite to another location for it to be analysed.

Specifications
- Portable and fixed configurations
- Low mass, low cost and small size
- Ultra-reliable connectivity
- Beam switching /steering capabilities
- Long range IoT protocols
  - LTE-M
  - NB-IoT
  - LORA



Benefits
- Enables global machine-to-machine (M2M) connectivity
- Ideal for off-grid/remote locations when combined with energy harvesting systems
- Real time system health monitoring in remote locations

Challenges
- Large LEO satellite constellation is needed for constant and steady connectivity
- Power consumption increases when operating at higher frequencies and higher data transfers
- Strictly regulated spectrum

References
[1] Z. Wang, S. Fang, S. Fu and S. Jia, "An Inmarsat BGAN Terminal Patch Antenna Array With Unequal Input Impedance Elements and Conductor-Backed ACPW Series-Feed Network," in *IEEE Trans. Antennas Propag.*, vol. 60, no. 3, pp. 1642-1647, March 2012, doi:10.1109/TAP.2011.2180325.

[2] P. Wang, J. Zhang, X. Zhang, Z. Yan, B. G. Evans and W. Wang, "Convergence of Satellite and Terrestrial Networks: A Comprehensive Survey," in *IEEE Access*, vol. 8, pp. 5550-5588, 2020, doi:10.1109/ACCESS.2019.2963223.

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