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L-band spectrum sensing for cognitive GEO-LEO dual satellite networks

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Introduction

- Two-tier satellite model where LEOs coexist with GEOs.

GEO Satellite

LEO Satellite

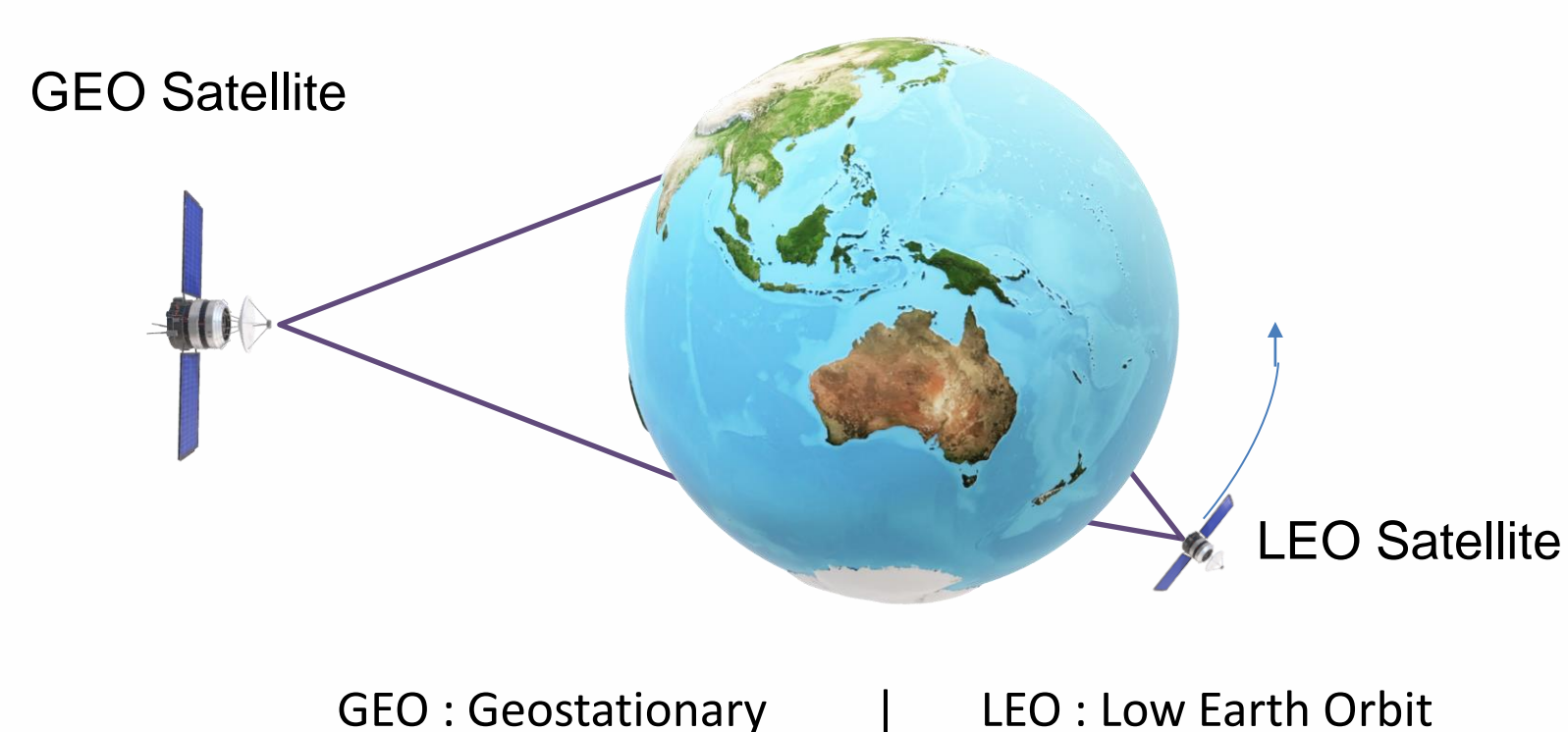GEO : Geostationary | LEO : Low Earth Orbit

Fig. 1. Dual Satellite Network.

- Increased use and a growing number of satellites in space.

  - Lower frequency bands are heavily congested.

  - Cognitive radio technology for spectrum sharing.

Aims

- Identify possible time and frequency domain spectral opportunities for cognitive radio technology, in a portion of the L-band used by the Inmarsat Broadband Global Area Network (BGAN) downlink.

Methods

- Develop a measurement platform to capture real GEO satellite signals.

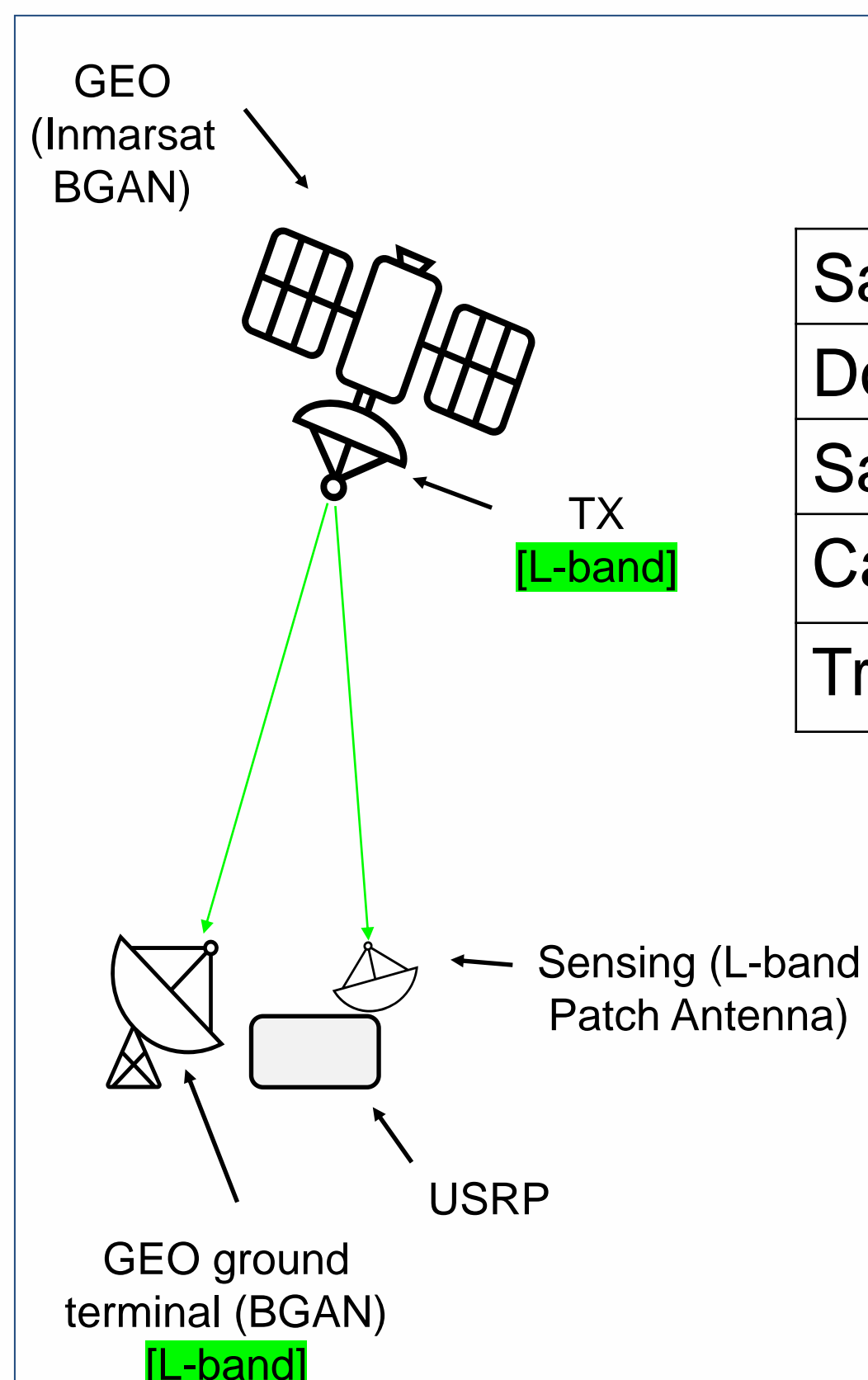- Determine time and frequency domain spectral opportunities for cognitive radio technology.

Table 1 Details related to GEO satellite signal capture process.

Satellite	Inmarsat-4F1
Downlink (DL) frequency band	1525 - 1559 MHz
Satellite position , longitude	143.5 ° East
Capture location	Sydney
True North	345 degrees

GEO (Inmarsat BGAN)

TX [L-band]

Sensing (L-band Patch Antenna)

USRP

GEO ground terminal (BGAN) [L-band]

Fig. 2. Capturing real GEO satellite signal.

L-Band Patch Antenna + LNA → RF / DC → Nooelec Smartee SDR + Bias Tee → IQ → Laptop (Process Data)
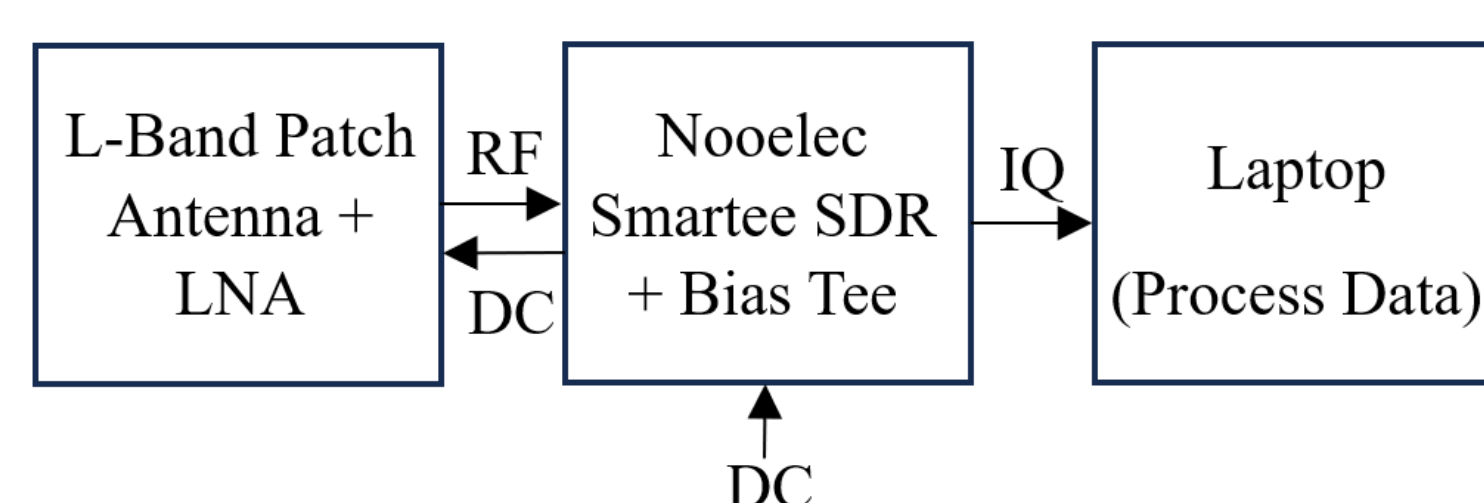DC

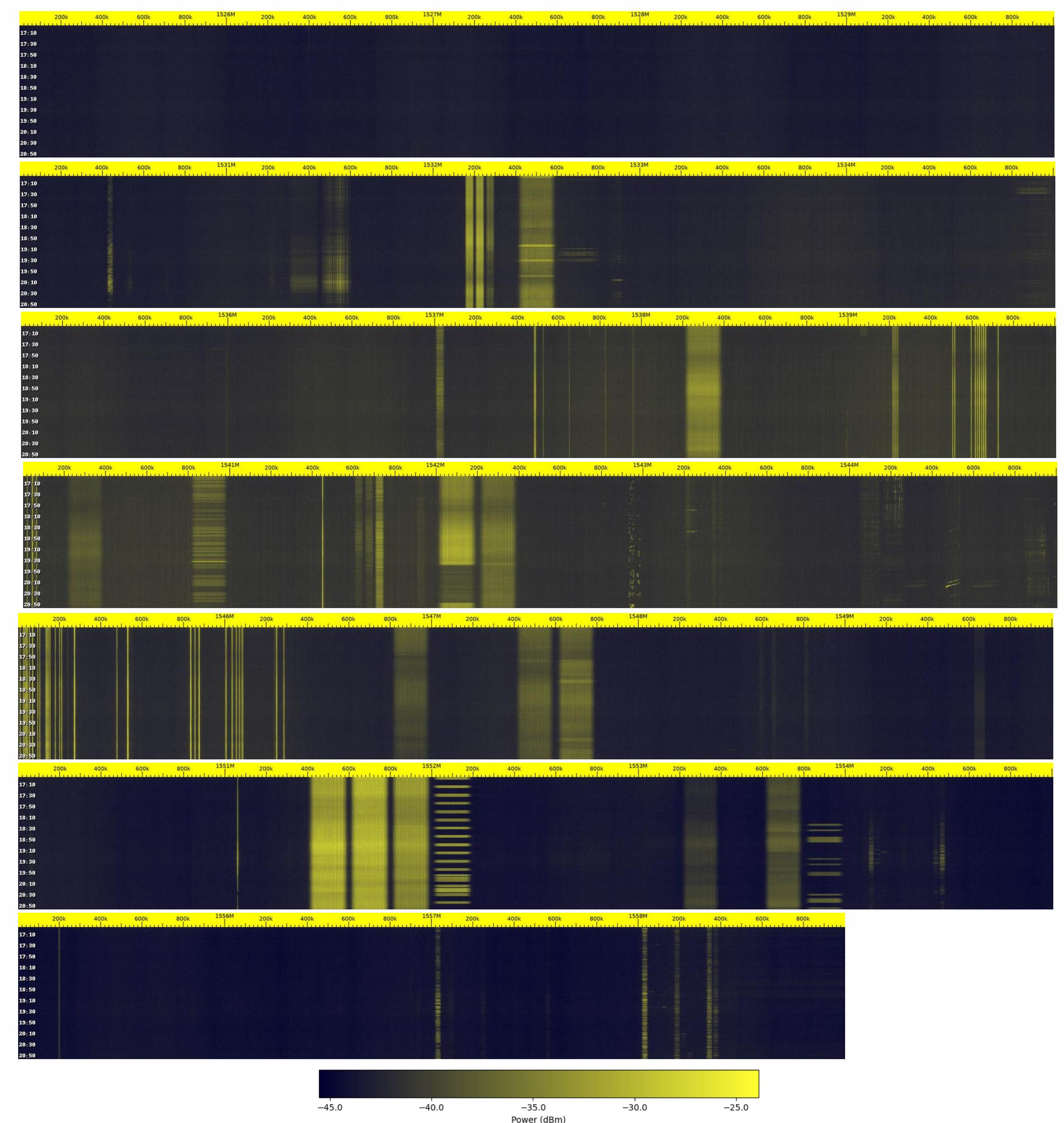**Fig. 3. Measurement Platform - Four-hour capture**

Results

Fig. 4. Four-hour spectrogram captures of Inmarsat downlink.

Table 2 Spectrum availability over the duration of a four-hour capture.

Available Spectrum	<1%	1-20%	20-80%	80-99%	99%+
Total Bandwidth (MHz)	2.71	0.71	3.43	10.42	16.72
Percentage of DL Band	8.0%	2.1%	10.1%	30.6%	49.2%

- Only 8% of the spectrum is occupied more than 99% of the time

- Nearly half of the spectrum is available for 99% of the time or more.

Conclusion

There are possible time and frequency domain opportunities for cognitive radio technology, in a portion of the L-band used by the Inmarsat BGAN downlink

References

[1] K. Weththasinghe, N. Clark, Q. T. Ngo, B. Jayawickrama, Y. He, E. Dutkiewicz, and R. P. Liu, "L-band spectral opportunities for cognitive GEO-LEO dual satellite networks," in Proc. IEEE Int. Sympos. Commun. Inf. Tech. (ISCIT), 2023.

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