—particularly the **V-band (50–75 GHz)**—for 6G backhaul, inter-satellite links, and broadband data transmission.

Designing a High-Frequency Satellite Ground Station for V-Band Spectrum Monitoring

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SPECTRUMX

BACKGROUND

- As **lower frequency bands** become increasingly **congested**, wireless and satellite industries are turning to higher frequencies.
- Particularly the **V-band** (50-75 GHz) is of interest to support next-generation networks such as **6G** and **inter-satellite links**.
- Yet few university labs possess the tools to detect or study signals at these frequencies.

OBJECTIVE

Design and **implement** the foundational infrastructure for a **campus-based satellite ground station** capable of **detecting** and **measuring power levels of high-frequency** signals, beginning with the V-band

RESEARCH QUESTIONS

- **Frequency Identification:** Which segments of the V-band are currently used for terrestrial or satellite transmissions, and which are feasible for detection on campus?
- **Feasibility & Benchmarking**: What existing systems or research projects operate in these frequencies, and what hardware architectures do they use?
- **System Design**: What antenna, LNA, and receiver chain are required to detect V-band signals, and how can existing equipment (e.g., RadioHound) be adapted?
- **Data Measurement Strategy:** How can detected signal power be recorded, calibrated, and analyzed to characterize propagation and atmospheric effects?

Project Plan

Overview

1. **Frequency Band Research (W1-2):** Review FCC/ITU allocations and ongoing Ka-, V-, and W-band applications to select a target frequency for detection. Document existing satellite and terrestrial transmitters within 40-100 GHz.
2. **Reference Benchmarking (W3-4)**: Identify existing academic or commercial mmWave ground-station projects operating near V-band. Analyze component chains and data pipelines to inform hardware and software design.
3. **System Design & Procurement (W5-6)**: Define the receive chain and acquire components: antenna, LNA, downconverter, and spectrum-analysis or SDR module.
4. **Integration & Testing (W7-10)**: Assemble and verify each stage of the RF chain. Begin with controlled-source testing at 60 GHz (WiGig) to confirm power detection capability and evaluate signal stability, environmental effects, and receiver sensitivity.

Technical Approach

- **Receive-Only Detection:** The initial system will measure received power, focusing on unlicensed 60 GHz (WiGig) and experimental V-band signals.
- **Hardware Chain:** Horn antenna → LNA → Downconverter → Spectrum Analyzer / SDR
- **Software & Analysis:** Python-based logging for time-series power measurements; use of GNU Radio for live visualization.
- **Validation:** Test with known terrestrial 60 GHz transmitters before extending to satellite signal detection attempts.

Benchmark & Reference System

The University of Notre Dame' IrishSat Student Club currently operates a satellite ground station equipped with **Yagi antennas** for **UHF** and **VHF** bands, capable of **receiving** and working on decoding **CubeSat signals**. This existing setup serves as a benchmark for developing the high-frequency system envisioned in this project.

Expected Impact & Future Work

- Establish a scalable framework for V-band detection and measurement, laying the groundwork for Notre Dame's first high-frequency satellite monitoring system.
- **Future work**: expand to E-band (71-86 GHz) and Ka-band (26-40 GHz) monitoring.

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