TXMISSION

Spectrum Monitoring from Space

Technology White Paper

Historically, satellite operators have used spectrum monitoring systems as an essential part of their strategy for carrier management and ensuring quality of service. This includes identifying the sources of rogue interference signals as a first step towards their removal. As well as policing satellite spectrum, monitoring systems are also used for intelligence gathering. It is now possible to extend ground-based capabilities to in-orbit and airborne monitoring of satellite signals. Benefits include direct geolocation of sources of interference and a greater ability to track mobile transmitters compared to ground-based alternatives. This white paper explores how spectrum monitoring applications can be hosted on LEO satellites and UAVs.

Overview

Continuous monitoring of spectrum allows carrier occupancy to be characterized and any interference to be identified and analysed in real time, including locating the sources of interference geographically. Compliance with spectrum regulations can also be enforced.

By demodulating each received signal, a wide range of important RF parameters can be tracked, such as modulation type and Forward Error Correction (FEC) rate (QPSK 9/10, 8PSK 3/4, etc.), Es/No, Eb/No, carrier and composite power levels, Error Vector Magnitude (EVM), Modulation Error Ratio (MER), etc. Decoding of the signal using forward error correction techniques can be used to recover the underlying transmitted data stream.

We will now explore how all these functions can be performed onboard a satellite or in an airborne application.

In-orbit/Airborne Monitoring

TXMission's Quest™ is a high-performance, compact satellite modem designed for use on board LEO satellites and UAVs.

'... there are considerable benefits to be gained from performing spectrum monitoring from space or from unmanned aerial vehicles ...'

Its features provide an ideal starting point for creating and hosting an advanced spectrum monitoring application:

- The modem is a Software Defined Radio (SDR) that is compatible with C, X, Ku and Ka-band operation, allowing a wide spectrum of frequencies to be monitored.
- Its demodulator and decoder support many waveforms including DVB-S2, DVB-S2X, CCSDS, TPC, LDPC, TCM, DVB-RCS2 and Viterbi Reed-Solomon. A wide range of signal characteristics such as Es/No and power levels can be calculated. Advanced signal processing functions that can be exploited in spectrum monitoring applications are also supported.
- A GPS receiver is built into the modem and can be used to accurately determine position and time.

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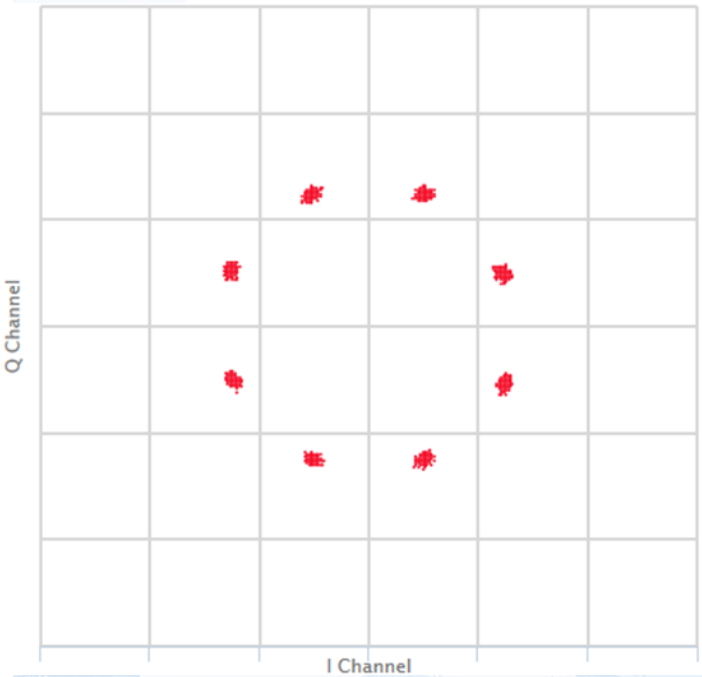
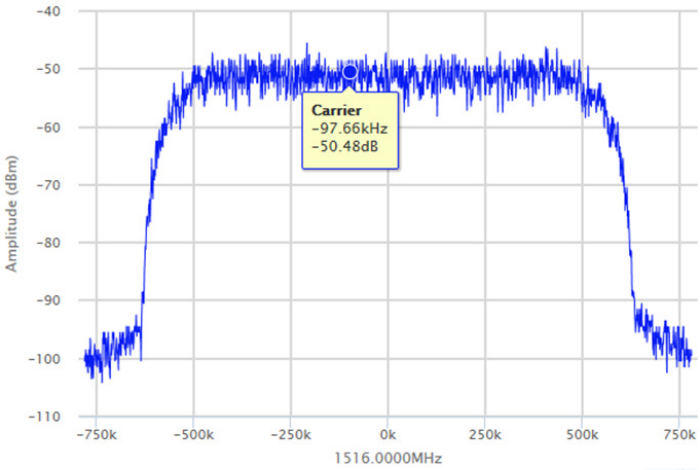
- Data collection in the form of recording and logging is supported by 128GB of mass storage. Highly accurate timestamps can be added to data using the modem's real time clock (or built-in GPS time signal).
- A relational database (used for storing modem configurations and status information) can be readily adapted for storage of monitoring data and onboard spectrum analytics.
- Alarm generation can be tailored to the needs of the spectrum monitoring application, allowing operators to set thresholds for the level of interference above which they should be automatically alerted.
- The modem supports the ability to host third-party applications. This feature turns the modem into an *Application Processor* that can support a full-blown spectrum monitor application that utilizes spare processing power not required by the modem.



Built-in Constellation Monitor



Built-in Spectrum Analyser shows all the monitored spectrum and can zoom in on individual carriers

Carrier Frequency Estimator

In addition to the features already mentioned, the TXMission demodulator has a feature called the *Carrier Frequency Estimator* (CFE) that can quickly scan large amounts of spectrum for carriers.

The front end of the receiver is 125MHz wide and Fast Fourier Transforms (FFTs) can be performed over the entire spectrum to identify segments that contain significant amounts of power representing both legal carriers and unwanted interference. This information is then used to compute approximate center frequencies for the signals, after which the monitoring algorithm attempts to acquire and demodulate each carrier in turn and gather carrier information.

Summary

Spectrum monitoring data can now be captured and processed onboard the satellite or aerial vehicle, with only the results being sent back to the ground. Third-party spectrum analysis applications can be integrated and run on TXMission's onboard *Application Processor* and can be updated over the air, supporting the development of flexible, powerful spectrum monitoring solutions.