RFI - A Growing Challenge

Radio Frequency Interference (RFI) is a growing challenge to satellite transmission. RFI reduces bandwidth efficiency, degrades service, impairs customer experience and can lead to financial penalties, especially for broadcasters who are licensed to transmit high-profile events. As space becomes more crowded with satellite signals, including launches of LEO and MEO constellations, incidents of interference are expected to rise.

Mitigating the effects of an RFI incident, however, can be complicated and costly. Before you can know how to reduce the effects of RFI, you need to know its nature and point of origin. In some cases, RFI cannot be mitigated at all, resulting in dead-capacity where the satellite frequency band is abandoned.

Sources of RFI

The major sources of RFI are unwanted-carrier, X-Pol and Adjacent Satellite Interference (ASI). Other sources such as LTE (C-band), Radar, Cellular, VSAT, SNG and Jamming can affect satellite transmission locally at an earth station, or globally where RFI impacts the satellite and the entire beam. Unintentional interference is somewhat random in nature. It can be caused by incorrect operation of SNG or VSAT terminals or equipment malfunction. Intentional jamming incidents, while rare, are increasing globally, and in particular in the more volatile regions of the world. These events are especially hard to mitigate in a timely manner, due to lack of cooperation from the jammer.

Existing RFI Solutions

When service is interrupted by severe global interference caused by unwanted carriers such as VSAT, radar, etc., the first course of action for the satellite operator is to shift the service to an alternative frequency, and then locate the source in order to try to eliminate it at its point of origin.

To locate the source of RFI, the operator can use geolocation methods, requiring coordination between adjacent satellite operators and access to expensive tools. RFI impact can also be lessened by reducing transponder gain, which also reduces RFI signal power. This process, while often effective, is problematic and cannot be used in many cases due to link-budget limitations. Instead, local interference is usually handled by moving or protecting the receiver antenna. These methods are resource-intensive and can lead to major breakdowns in service delivery.
As operators launch more satellites and more services come online, existing methods of mitigation do not meet the challenge posed by increasing RFI. NovelSat has developed a new and innovative software technology package to enable satellite users to deliver continuously reliable satellite services even while various types of RFI are present. The NovelSat RFI mitigation software package includes the following tools.

Embedded RFI Analysis Tools

NovelSat offers enhanced RFI analysis tools in every NovelSat NS2000 Demodulator and its Modem series to enable satellite users to identify RFI incidents in real-time. This is mainly useful for local interference sources which are not visible to the main teleport or broadcast hub.

Robust Receiver Algorithms

The NovelSat NS2000 Satellite Demodulator offers advanced receive algorithms to cancel interference. Since there are many types of RFI, each with distinctive characteristics, no single receiver algorithm is applicable. For example, mitigating CW RFI is completely different from cancelling Radar RFI. So, NovelSat developed a set of advanced mitigation algorithms and detection mechanisms to handle the most common types of RFI.

Advanced Waveforms

NovelSat NS3 and NS4 are advanced waveforms that include built-in mechanisms to further increase resilience to interference, as well as other signal-disrupting impediments such as phase noise and weather fluctuations.

Carrier ID Injection

The new DVB-CID standard is now mandatory for all modulators in mobile satellite stations (DSNGs) in the US and is available in all NovelSat solutions. It encodes a Carrier-ID (CID) into the satellite transmission signal which contains contact information that can be used to locate and communicate with the operator of the interfering signal.
Case Studies

Military Installation

**Problem:** Global interference from Ku-Band Radar with two interference signals @ 13.932 GHz & 13.985 GHz. Use of these frequencies was strictly limited.

**Solution:** Customer implemented NovelSat version of DVB-S2 and NovelSat NS3 at different sites.

**Results:** Dramatic reduction of FER (Frame Error Rate) with both DVB-S2 and NovelSat NS3 transmission – see table.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Constellation</th>
<th>FEC</th>
<th>Link Margin (dB)</th>
<th>FER (Standard Receiver)</th>
<th>FER* (NovelSat NS3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVB-S2</td>
<td>QPSK</td>
<td>4/5</td>
<td>1.8</td>
<td>4.4x10^-3</td>
<td>&lt;10^-7</td>
</tr>
<tr>
<td>DVB-S2</td>
<td>BPSK</td>
<td>3/5</td>
<td>1.6</td>
<td>1.3x10^-3</td>
<td>&lt;10^-7</td>
</tr>
<tr>
<td>DVB-S2</td>
<td>BPSK</td>
<td>3/4</td>
<td>3.4</td>
<td>7.4x10^-3</td>
<td>&lt;10^-7</td>
</tr>
<tr>
<td>NovelSat NS3</td>
<td>QPSK, BPSK</td>
<td>All</td>
<td>1-3</td>
<td>-</td>
<td>&lt;10^-7</td>
</tr>
</tbody>
</table>

*FER (Frame Error Rate) of < 10^-7 Indicates Negligible Interference

European DVB-T2 Terrestrial TV Integrator

**Problem:** A provider of Digital Terrestrial TV with thousands of sites, receiving satellite TV transmissions and converting them into terrestrial

**Solution:** NovelSat advanced RFI mitigation algorithms implemented in NS2000 Satellite Demodulators.

**Results:** Although the interference persisted, the DVB-T2 signal was error free wherever the NovelSat solution was implemented.

Global Video Distribution Network

**Problem:** Customer experienced global narrow-band (Ku-band) interference from jamming that made it impossible to decode the satellite signal.

**Solution:** NovelSat NS3 implemented in the NovelSat NS2000 Satellite Demodulator.

**Results:** With jamming mitigation up to 15dB better than a DVB-S2 standard receiver, NovelSat NS3 was able to overcome this narrow-band interference and enable normal operation.