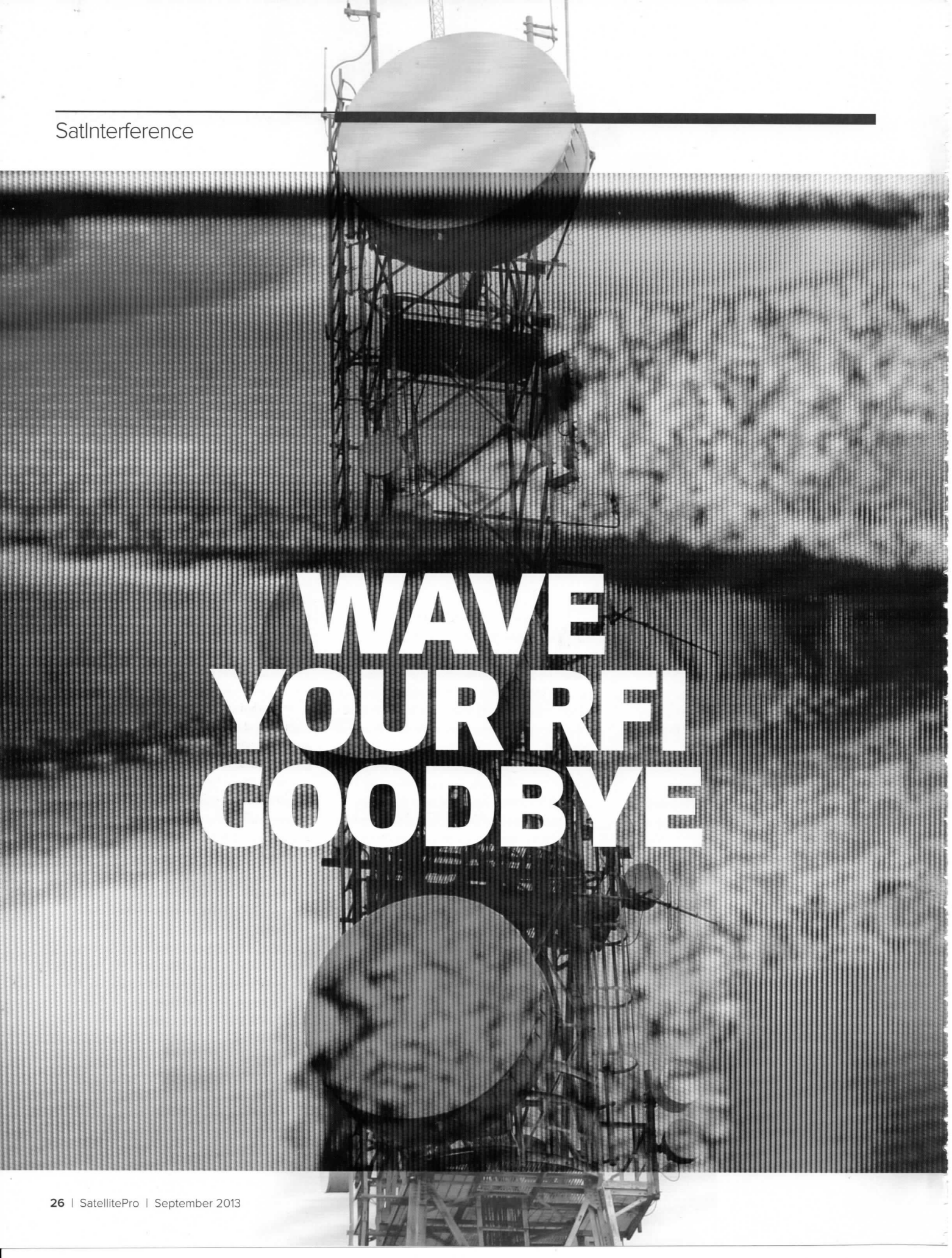
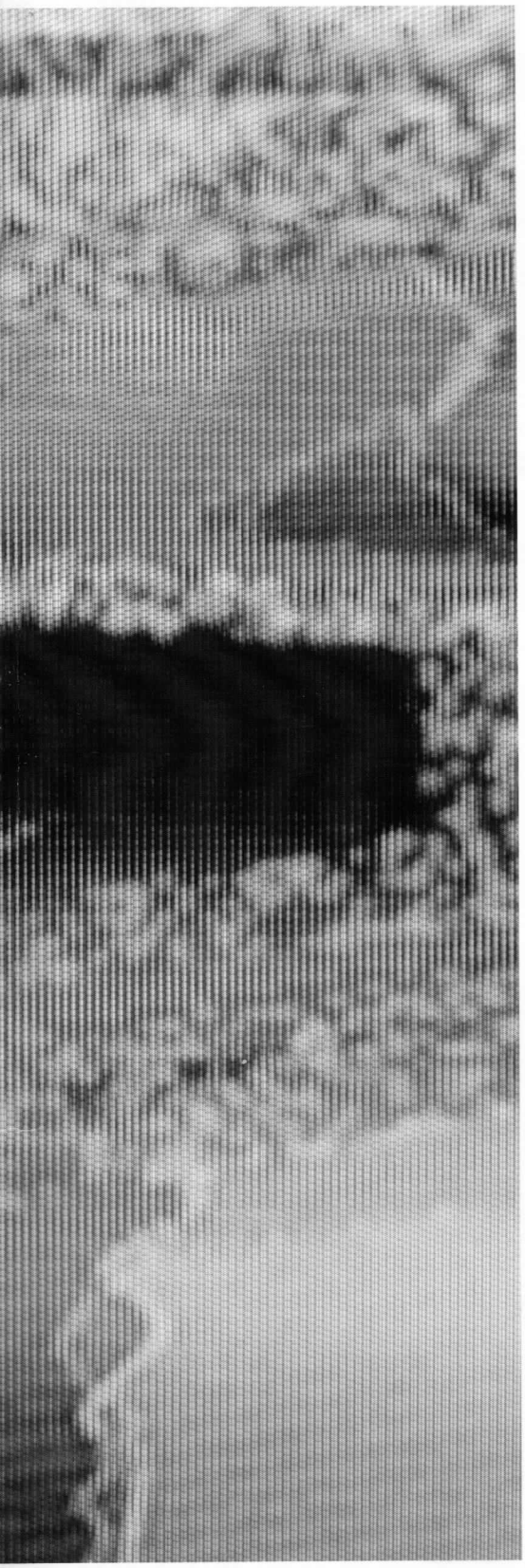


WAVE YOUR RFI GOODBYE



The majority of unwanted radio-frequency interference (RFI) plaguing commercial satellite systems is caused by equipment malfunction or human error. Guido Baraglia, of the satellite Interference Reduction Group, discusses the most common RFI generated by a combination of these two causes

An intermediate frequency (IF) pick-up describes radio-frequency interference (RFI) generated by satellite ground terminals, of whatever size and purposes, which are affected by local terrestrial transmissions and in one way or another, retransmits those terrestrial signals towards the satellite they are pointing at.

The impact of such an anomaly to the communication networks available on the affected satellite largely depends on the nature of the terrestrial disturbance and the type of satellite ground terminal that retransmits it.

A VSAT ground terminal is more likely to be the source of this type of RFI either through a bad grounding or a damaged IF cable. In both cases, the effects on the affected satellite will be equal.

The most common type of IF pick-up is generated by satellite ground terminals that are located near FM radio distribution stations that retransmit parts or the entirety of the FM radio broadcast. This happens because the CCIR FM radio frequency allocation between 87.5 and 108.0 MHz, with all the known exceptions, falls within the IF range of the satellite ground terminal, when this is 70 or 140 MHz in value. A different scenario opens for more recent terminals that use L band as IF, but it doesn't mean these will not generate RFI; *on the contrary*, it will be a different type of interference, which actually has a bigger impact than the FM radio pick-up.

Unintended aerials

A damaged cable, a non-terminated input connector and a bad or missing ground assembly can transform the IF cabling between the indoor modulator (modem) and the outdoor frequency conversion and amplification system, or the entire installation into a perfectly functional aerial that will "receive" and "inject" the FM radio stations in the air into the transmit path to the satellite.

Damaged cables or installations gone awry are by far the most common sources of IF pick-up. Unqualified VSAT installers, with no knowledge of RF systems, can be the cause of serious anomalies that affect several MHz of transponder bandwidth. Extending an IF coaxial cable by sticking two pieces together with scotch tape seems like a horrifying thing to do to those familiar with satellite communication. However, it is apparently completely acceptable to some VSAT installers (as I've sadly witnessed!).

There has been a case where VSAT modems were accidentally left on in a cupboard being used by a cleaner for

"FM radio interference is usually easy to detect and characterise, first and foremost, because with appropriate spectrum analysers, it's possible to demodulate the FM radio broadcasts"

detergents. While this is causing absolute havoc, the end user, in this scenario a convenience store at a petrol station, has no clue of the existence of such equipment, even less how it works or to whom it belongs. Then there is also the fact that in some countries, registering VSAT terminals is not mandatory and this hampers the policing of such events.

The frequencies at which this interference will be visible on the satellite vary depending on a number of factors: the original FM radio broadcasting frequencies, the IF used (70 or 140 MHz), or the set-up of the ground station frequency conversion system. Sometimes this could generate interferences that are detected on adjacent transponders from the one used by the ground station.

FM radio interference is usually easy to detect and characterise, first and foremost, because with appropriate spectrum analysers, it's possible to demodulate the FM radio broadcasts. Not that this solves all problems, but it generally provides great insight of the country of origin of the FM radio and, thus of the ground station generating the anomaly at hand.

These interferences are often characterised by a triangular shaped signal, or group of signals, with a bandwidth of around 200 kHz and a seemingly bursting behaviour. Setting the spectrum analyser at the centre frequency of the rogue signal at zero span allows the operator to visualise the analogic nature of the signal. Adding specific instrument settings for the resolution bandwidth and the video bandwidth of the spectrum analyser with FM demodulation capabilities, the operator will also be able to "tune" the radio station and listen to the broadcast, normally with very good quality.

As mentioned before, this will only partially help the troubleshooting of such anomalies, simply because chances are the radio station will broadcast in an unknown or obscure language.

If it is possible to demodulate and listen to the radio station broadcasting name, hence country of origin, there are numerous online databases that list all known and registered FM radio channels around the world, including those radio networks that use different frequencies according to the part of the originating country they are covering.

If and once the country of origin can be established, it will be, theoretically, possible to filter all registered ground

"It will be also possible to attempt a reverse engineering calculation of the frequency used by the offending ground station to transmit its legitimate carrier, even if this will require a number of assumptions that could mislead the search"

stations or network providers that are operating from the origin, and report the anomaly. It will be also possible to attempt a reverse engineering calculation of the frequency used by the offending ground station to transmit its legitimate carrier, even if this will require a number of assumptions that could mislead the search. In particular, not all ground terminals have their uplink frequency converters set to the centre frequency of the transmitted signal, and those that are transmitting more than one carrier are often set to the centre frequency of the transponder or, even worse, to an arbitrary frequency that best fits the knowledge of the installer.

If this procedure cannot be applied, or if this procedure does not provide the necessary clues to solve the anomaly, the last resort would be the geolocation of the interfering signals.

Geolocation of such type of interferences are quite common and quite often successful thanks to the often small aperture of the faulty ground terminal. On the other hand, the identification of the malfunctioning ground station can be far more challenging. This depends on the fact, especially if the target is a VSAT terminal, that there will be several terminals within the search ellipse defined by the geolocation result.

Contacting each installation isn't practical; the person that uses the terminal often doesn't have a clue where it is or how it works, and they are not keen to take any action on the basis of a phone call from an unknown entity (the satellite operator control centre).

Going through the service provider is often as challenging as the end users, so satellite operators resort to the last-mile search using a specifically equipped helicopter. PRO

Guido Baraglia is the SAT Corporation Sales Director for EMEA and a Board Member of the satellite Interference Reduction Group. Considered a leading expert in carrier monitoring and interference geolocation, he has almost 20 years' of experience in combating RFI.

Terms & References

A zero span setting on an angle analogic spectrum analyser allows visualising the signal in the time domain, using the analyser as an oscilloscope.

A recommended online database that lists all known and registered FM radio channels from around the world can be accessed at: www.fmlist.org