SOMAP

Comms-On-The-Move Interference

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Under Comms-On-The-Move (COTM) we understand a service which involves a satellite antenna system on a moving object. This can be a ship, a train, a vehicle or an airplane/drone. There are systems that only receive the signal from the satellite while moving, but there are also systems that, also while moving, transmit back to the satellite to establish a duplex link.
It is the transmit/receive antenna systems which demand specific attention from satellite operators.

Interference may occur on the targeted satellite known as cross-pol, but antenna systems with a very small aperture, which goes along with a very wide beam-width, are likely to cause interference on adjacent satellites if the environment in which they operate is not thoroughly controlled by all satellite operators.

The appearance of the interference caused by a COTM service is fundamentally different from the interference caused by a conventional fixed antenna service, for example an SNG carrier which causes significant interruption to another service when accidentally activated in the incorrect polarization. The determination of the source of any interference is not an easy task and requires substantial analysis and experience by the involved technicians in the operations departments. COTM interferences pose an additional challenge, as they have the tendency to occur at random and intermittently. This can be caused by the specific movement of the vehicle, ship, train or aircraft the COTM antennas are situated on, but COTM interferences may also occur due to irregularities in the system feed-back mechanism, faults in sensor reading or errors in the deployed algorithm which calculates the look angles towards the satellite. Additional inaccuracy could induce accumulated errors, due to misalignment between the coordinate systems of the moving object and the antenna coordinate system.

COTM services generally operate in a relatively low powered service configuration. These services will always operate with significant back-off, to prevent adjacent satellite interference in the context of satellite operator's coordination constraints. In case of a fault, they are not likely to produce a complete service outage, but appear as intermittent glitches. This makes it extremely difficult to detect their origin, considering their permanent change of transmit location and transmission times in TDMA operation. A special type of that is the MF-TDMA service, which is frequently used in COTM systems. The terminal will hop from slot to slot and may cause brief intermittent Adjacent Satellite Interference over a frequency range much wider than the single channel it occupies at any instant in time. This makes troubleshooting even more difficult, as the terminal is only on a specific slot for a fraction of the overall time. It is also noteworthy to point out that interferences from COTM systems may not immediately be recognized as such. Users may tend to investigate their own equipment set-up first, unsure whether the disturbances originate from their own systems or a third-party source, before they report the problem to the operations department of their satellite operator. Hence significant time may pass by before the problem is addressed.

A thorough examination of the antenna systems which will support COTM services and a responsible link-budget analysis by satellite operators is essential to control an interference environment which may become more complex in the future, as technology advances and the mobility sector will use larger percentage of capacity in space. Transponder capacity which is influenced by this type of service will be difficult to be used by other applications, for Fixed Satellite Services (FSS) or for mobile applications.

To avoid interference, the maximum permissible spectral E.I.R.P. density of a given COTM terminal must be determined in accordance with the performance of the RF-front-end. In this context the related key parameters are:

1) Off-Axis Spectral E.I.R.P. Density under consideration of radome effects and beam pointing accuracy.
2) Polarization Discrimination under consideration of radome effects.
3) Out-of-Band Radiation.

Due to the small aperture size, the dominating E.I.R.P. constraint is in most cases originating from the antenna pattern i.e. item 1) above. In addition to the traditional examination of the antenna diagram, the approval of COTM terminals require that special attention is given to the following aspects:

a) Antenna patterns and cross-polar isolation used for the determination of the maximum permissible spectral E.I.R.P. density must always be measured with the corresponding radome in place.
   In addition to the standard test program including pattern cuts, raster scans via both polarizations at a number of different frequencies are highly recommended. The measurements shall be repeated for a reasonable number of different look-angles of the antenna relative to the radome.
b) The evaluation of the resulting antenna pattern must be performed while taking into account the maximum antenna misalignment which may occur before Transmission-Mute. Principal sources of antenna misalignment to be assessed are:
   a. Tracking errors in conjunction with the adequate movement profile.
   b. Beam squint in case of the reception of the tracking signal via the orthogonal polarization.
   c. In case of open-loop tracking:
      i. Beam refraction in the radome.
      ii. Offset between the inertial unit and the antenna.
      iii. Flexing of the plane’s body leading to mechanical misalignment between the inertial unit and the antenna.

Taking into account all above contributions the maximum permissible spectral E.I.R.P. density will be determined. The closer a given COTM meets the required specification, the higher will be the allocated maximum permissible spectral E.I.R.P. density. This implies that the use of marginal terminals will be restrained by the need for more bandwidth. On the other hand, the higher price for good quality hardware will rapidly pay back by the need for less bandwidth during operations. In view of both interference mitigation and fairness in the SATCOMS market, the strict application of maximum permissible spectral E.I.R.P. density levels are of highest priority.