Protection of VSAT in C-Band for Aviation Usage

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Objective

- To discus measures taken to protect VSAT usage in C-band in Africa

Introduction

- Very Small Aperture Terminal (VSAT) is a two-way satellite ground station equipped with a dish antenna with diameter ranging from 75 cm to 3.8 meters.
- These terminals facilitate bidirectional communication via satellites, connecting small remote Earth stations to other terminals (in mesh topology) or to a central Earth station “hub” (in star topology).
- VSATs relay data, voice, and video signals over satellite networks,

operate from 4 kbit/s to 16 Mbit/s and play a crucial role in bridging communication gaps in areas with underserved or unserved terrestrial infrastructure. VSAT technology evolved over time, with various frequency bands (C - Ku band) and applications.

Introduction

- VSATs have been in use in Aviation in Africa since the 1990s when Aerosatel was installed in West Africa.
- It transitioned into AFISNET used in ASECNA in Western and Central Africa and Madagascar. It has undergone various upgrades in line with technological developments leading to great improvements in service delivery .
- Connectivity, availability, integrity and reliability have greatly improved in all weather conditions. AFISNET, SADC and NAFISAT have been interconnected to provide coverage for most of Africa.
- SADC and NAFISAT have ATNS of South Africa as the Service Provider, whereas AFISNET is provided by ASECNA.

Overview

- Satellite component of VSATs orbit 35,000 kilometres above the earth. This physical distance leads to a delay of about 250 milliseconds as communications travel from the earth to the satellite and come back. Protocol processing adds another 300 to 500 milliseconds.
- These add up to create latency, also called ‘ping time’, which is the time lag between a signal’s broadcast and when it is received at the destination.
- C-band frequencies span from 4 GHz to 8 GHz. C-band is widely used for terrestrial microwave backhaul links due to its sub-6 GHz range being license-free in many countries.
- C-band signals are less focused compared to higher frequencies (like Ku-band) due to their longer wavelength.

Frequency bands used by VSATs

- C-band, 3.4–4.2 GHz in the downlink and 5.925–7.025 GHz in the uplink, is a critical radio spectrum for satellite communications.
- VSATs in Africa use bands 3.4-4.2 GHz and 5.85 -6.725 GHz .
- C-band satellites provide hemispherical and global coverage beams, critical for cross-continent or global service delivery.
- C-band signals are resilient in tropical climates, making them ideal for broadcasting services.
- MS introduced in these bands are often a threat as they use higher output powers and only distance or frequency separation has been found to work.

Sources of interference

- The VSATs were introduced into FSS Bands and most of them were not registered.
- They could not claim protection since the bands were for generic FSS.
- Mobile networks were at times assigned at distances too close and started interfering with the existing VSAT systems.
- This was particularly bad in West Africa and some VSAT terminals had to be moved to create distance separation as Mobile Stations had much higher power, that interfered with VSAT signals.

Protection of VSAT Systems

- In WRC 07 African States highlighted VSAT use, their importance and existing threats in Africa. The discusions led to approval of

Recommendation 724 (WRC-07) :

- Vital nature of VSAT communication in remote and rural areas
- Satellite communication systems operating in the FSS may be the only medium to satisfy the requirements of the ICAO CNS/ATM systems, where inadequate terrestrial communication infrastructure exists.
- Recommended that Administrations in developing countries be encouraged to expedite the authorization process and implement these VSATs in bands with primary satellite service allocations.
- Urgent service restoration or alternative routing in case of a disruption and ICAO was urged to assist in implementation of best practices.

Protection of VSAT Systems

In WRC 12, Resolution154 was approved as part of the Radio Regulations (RR):

- Consideration of technical and regulatory actions to support existing and future operation of FSS earth stations in Frequency band 3 400-4 200 MHz,
- Allocated globally to the FSS in the space-to-Earth direction and to the FS and MS, except aeronautical ,on a primary basis and Identified for IMT in Region 1.
- Relevant ITU Radiocommunication Sector (ITU-R) studies showed a potential for interference from fixed wireless access and IMT stations into FSS receiving earth stations at distances from less than one kilometre up to hundreds of kilometres,
- Depending on the parameters and deployment of stations of these services.
- WRC-12 decided to study technical and regulatory measures to support the FSS earth stations since several cases of harmful interference to the FSS VSATs used for aeronautical safety communications from fixed wireless access or IMT stations had been reported.

Protection of VSAT Systems

- Coordination challenges of frequencies between the fixed wireless access or IMT systems and VSATs was noted in many countries
- FSS VSAT earth stations are not subject to individual licensing and not registered as specific stations in national frequency databases and in the ITU Master International Frequency Register (MIFR) due to the work involved.
- Knowledge of the location and operational frequencies of these VSAT stations is important for ensuring compatibility with applications of other services,
- ITU-R comprehensive studies and results summarised in recommendations ITU-R SF.1486,reports ITU-R S.2199,ITU-R M.2109 and ITU-R S.2368 offer mitigation techniques employed for international coordination and at a national level and to facilitate coexistence of FSS, FS and MS systems.
- Recommendation ITU-R S.1856 has methodologies for verification of compliance with the relevant power flux-density (pfd) limit set forth in the Radio Regulations.

Protection of VSAT Systems

- WRC 15 revised Resolution 154: Administrations were to ensure compliance of IMT stations with the relevant provisions set forth in the RR and apply the relevant coordination procedures before bringing these applications into use;
- When planning and/or licensing fixed point-to-point, fixed wireless access and IMT systems, are to take into account the protection needs of existing and planned VSAT FSS earth stations within the frequency band 3 400-4 200 MHz
- Consider the possibility of licensing the FSS earth stations used for VSATs on an individual basis and registering them in the MIFR as specific earth stations;
- Employ the appropriate mitigation techniques described in the ITU-R publications
- Ensure that the application of these technical and regulatory measures to FSS and the mobile service does not limit the use of the frequency band 3 400-4 200 MHz by other existing and planned systems and services in other countries.

Current status

The Aeronautical world has tried to introduce measures stronger than a Resolution.

There has been resistance from Mobile and Fixed services that fear that such a move would limit their operation to the point that they would need to migrate.

Resolution 154 currently provides increased protection and VSAT users in Africa have phased minimum service interruption due to interferences.

Conclusion

- As 5G networks expand, protecting C-band frequencies becomes crucial. Guard bands are necessary to prevent interference.
- C-band serves critical services like national broadcasting, air navigation, meteorology, and emergency response operations.
- Most appropriate protection is through either distance separation or management of pfd limits as regulated by Radio Regulations
- Number of interference reports have gone down appreciably and where they occur are quickly resolved by relevant administrations.
- VSATs in Band C have come a long way from being unknown to being protected as safety of life services.

References

- Radio Regulations 2020
- Final Acts of WRC 23

THANK YOU