

Radio Division, TEC

Satellite Earth Stations on Vessels and on Aircraft

Radio Division, TEC

1. Introduction

Owing to the growing user demand for on-the-move global broadband communications, a new type of satellite terminal has emerged, known as Earth stations on moving platforms (ESOMPs). ESV (Earth Station on Vessels) and AES (Aircraft Earth Stations) are two main types of ESOMPs deployed. ESOMP terminals use small antennas with tracking systems and advanced modulation and coding schemes that allow them to provide two-way, high-speed communications from aircraft, maritime vessels, trains, or land vehicles. Various types of satellite terminals have been used onboard vessels (maritime and air) since the 1980s. Initially operating over mobile satellite service (MSS) systems at the L-band, these terminals provided modest narrowband services (voice and low data rates). New technology capabilities, adopted by satellite designers and terminal equipment manufacturers, have allowed the development of more spectrally efficient, ultra-small terminals that can provide broadband communications to support voice, video, high-speed data, and access to the Internet. In addition to Ku-band implementations, work is being done in the Ka-band, with several Ka-band satellite operators and service providers developing systems that will carry ESOMP traffic over GSO (Geostationary Orbit) and non-GSO FSS systems. Figure 1 illustrates various types of ESOMP terminals operating with a GSO FSS system.

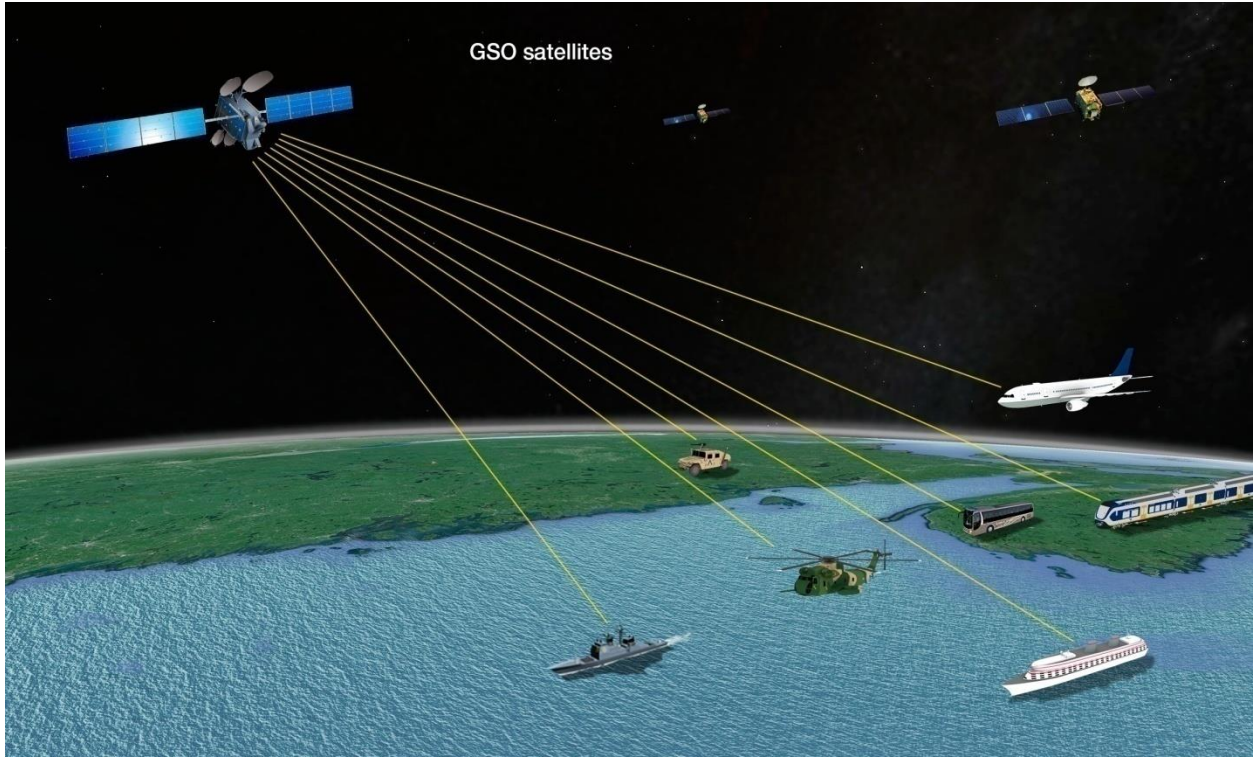


Figure 1 ESOMP network on different mobile platforms

The current regulatory scenario in India allows the use of fixed VSAT terminals to be operated by acquiring the CUG-VSAT licence from DoT. The fixed VSAT terminals work in the FSS band, the transponder bandwidth for which is provided by Department of Space. The mandatory technical requirements required for operating such services has been

framed by TEC and is conformed to by the licensee. In order to evolve the regulatory framework to allow VSAT based mobility services like AES and ESV, the technical requirements, keeping in view the standardization and global regulatory landscape, needs to be developed.

This paper tries to provide an overview of the VSAT based mobility services, its related ITU, ETSI standards and some examples of the regulatory framework existing in other countries for such services.

2. Chief characteristics of ESOMPs

ESOMPs exhibit some technical and operational characteristics that are different from those of fixed (stationary) VSATs. These are:

- The small antenna size that is necessary to operate from a moving aircraft, or maritime vessel. Must keep antenna beam within off-axis e.i.r.p. density mask. Inhibit transmission if antenna pointing error exceeds threshold.
- The tracking system that is required to maintain accurate pointing to the target satellite at all times.
- Meet the off-axis e.i.r.p. density mask in the plane of the GSO under all motion conditions or inhibit transmission. Resume transmission only when emissions will be back under the mask.
- Co-ordination between satellites/ satellite constellation.
- Operate under control of a network management system.

3. Aircraft Earth Stations (AES)

The Radio Regulation 2016 in its Article 1.84 defines AES as;

“A mobile earth station in the aeronautical mobile-satellite service located on board an aircraft.”

Aircraft Earth Station (AES) installed on board aircraft, is intended to provide non-safety related broad-band data communication services (e.g. internet and other type of data services) to users on board aircraft using their own data equipment (e.g. laptop computer or PDA) or one provided by the airline.

3.1. Architecture of AES

Figure 2 depicts a typical architecture of AES system.

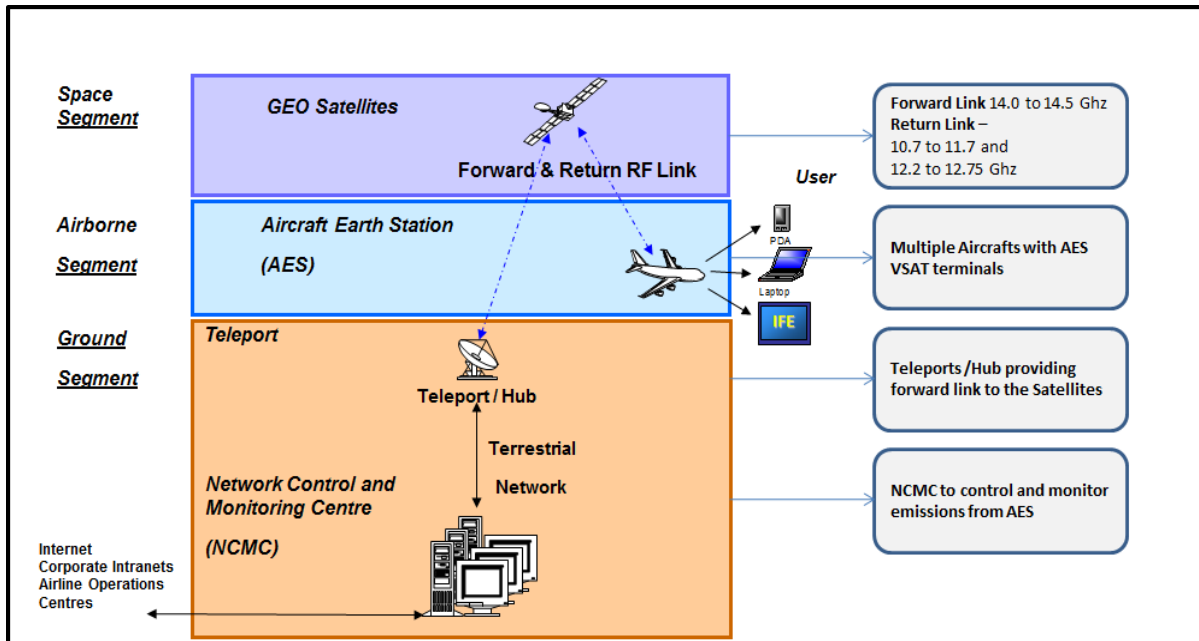


Figure 2 : Typical Architecture of AES system

The AES system can be broadly divided into three main segments, which are:

- Space segment, which comprises of the satellite system
- Airborne segment or the AES which comprises of the equipment hosted on the aircraft like antenna, VSAT equipment, Wi-Fi APs etc.
- Ground segment consisting of the Hub Earth station for the network which controls the remote mobile earth stations (in star configuration) and also hosts the network control center.

3.2. Frequency of operation:

The frequency of operation of AES (as per ITU and deployment in other countries) is generally in the following bands:

- 14.00 - 14.50 GHz (Earth-to-space);
- 10.70 - 11.70 GHz (space-to-Earth);
- 12.50 - 12.75 GHz (space-to-Earth);
- 19.7-20.2 GHz (space-to-Earth);
- 29.5-30.0 GHz(Earth-to-space).

4. Earth Station on Vessels (ESV)

ITU refers to ESVs or Earth station on Vessels as terminals used to provide broadband access on board which require high communications bandwidth which cannot be met by the other maritime systems.

Example applications are:

- Large data transfer requirements for scientific research ships
- Passenger telephone and internet service for ferries and cruise ships
- Extension of the corporate LAN to the ship's bridge.

4.1. Architecture of ESV

Figure 3 below depicts typical architecture of ESV system;

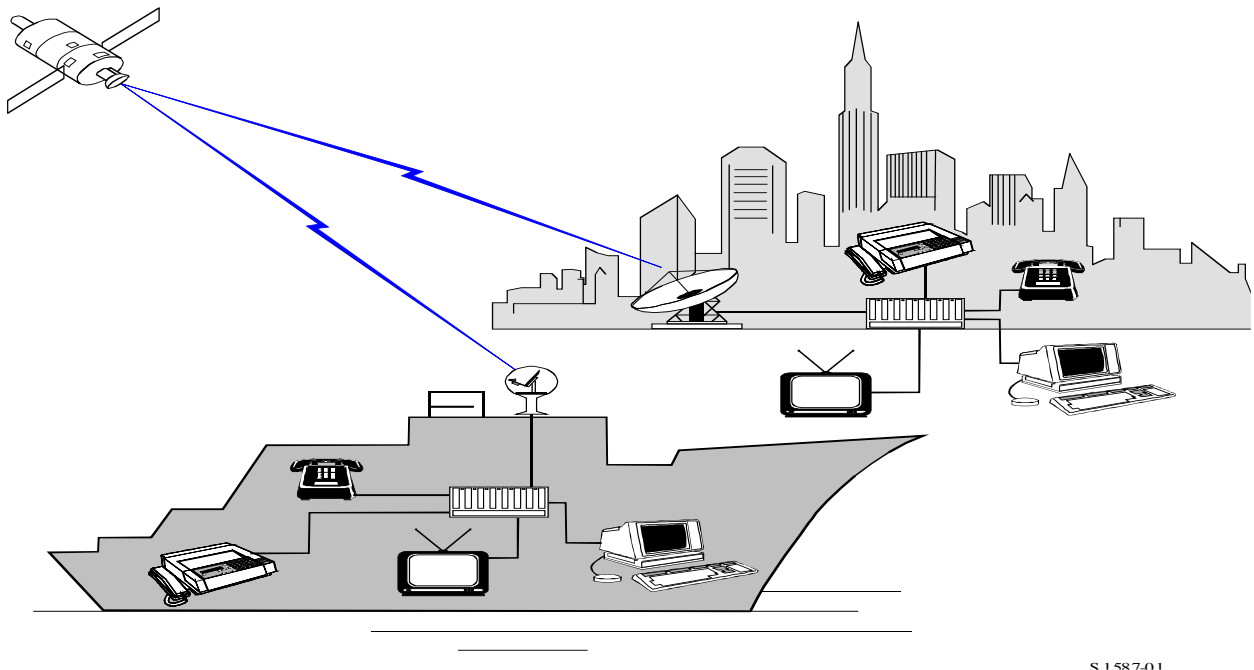


Figure 3 ESV Architecture (Source: ITU REC S.1587)

- Space segment, which comprises of the satellite system.
- ESV comprises of 3 components -
 - Antenna Subsystem -
 - Stabilized Platform and reflector antenna
 - Mounted above deck and covered by rigid radome
 - RF Subsystem -
 - Standard transmitters and receivers mounted above deck in rigid radome of antenna
 - Modem Subsystem -
 - Located below decks in the radio room
 - Includes Antenna Control Unit (ACU) and VSAT IDU
 - Integration of the GPS on Vessel with the Antenna / ACU subsystem

- Ground segment consisting of the Hub Earth station for the network which controls the remote mobile earth stations (in star configuration) and also hosts the network control center.

4.2. Frequency of operation:

The frequency of operation of ESV(as per ITU and deployment in other countries) is generally in the following bands:

- 5925-6425 MHz (Earth-to-space);
- 3700-4200 MHz (space-to-Earth);
- 14.00 - 14.50 GHz (Earth-to-space);
- 10.70 - 11.70 GHz (space-to-Earth);
- 12.50 - 12.75 GHz (space-to-Earth);
- 19.7-20.2 GHz (space-to-Earth);
- 29.5-30.0 GHz(Earth-to-space).

5. Global standards and regulations

The table below provides a brief overview of the standards from ITU, ETSI and regulations of some of the countries in the world pertaining to VSAT based mobility services like ESV and AES.

Type of Service	ITU	ETSI	FCC	ECC
AES	<ul style="list-style-type: none"> i. RR No. 4.4 ii. ITU-R S.1643 iii. Resolution 156 (WRC-15) (For C band, Ku band and Ka band)	<ul style="list-style-type: none"> i. EN 302 186 ii. EN 303 978 (For Ku band) (For Ka band)	<ul style="list-style-type: none"> i. §25.222 (For Ku band)	<ul style="list-style-type: none"> i. ECC Decision (05)11 (For Ku band)
ESV	<ul style="list-style-type: none"> i. RR No. 4.4 ii. ITU-R S.1587 iii. Resolution 902(WRC-03) iv. Resolution 156 (WRC-15) (For C band, Ku band and Ka band)	<ul style="list-style-type: none"> i. EN 301 447 ii. EN 302 340 iii. EN 303 978 (For C band) (For Ku band) (For Ka band)	<ul style="list-style-type: none"> i. §25.227 (For Ku band)	<ul style="list-style-type: none"> i. ECC/DEC/(05)09 ii. ECC/DEC/(05)10 (For C band) (For Ku band)

6. Security considerations for operation of VSAT based mobility services

In this section, some basic security considerations for operation of mobile VSAT terminals are described. The security regulations may include these considerations but may not be limited to only these requirements and may be enhanced depending on the deployment and usage scenario.

- **Prevention of unauthorized usage over VSAT**
 - **Security on VSAT Network**
Configuring VSAT by Unique Identification Number
 - **Data Traffic monitoring**
All the traffic will pass through Hub and can be monitored. *Monitoring may be extended for AES / ESV traffic as well*
- **Monitoring the location of the terminal**
 - VSAT integrates with the GPS to get Lat/Long information and passes the details to the NMS
 - The NMS logs and stores the location details with time stamps
 - The NMS access can be extended to the regulatory for online monitoring
- **Restricting the services to country's exclusive economic zone / Airspace**
 - The Maps server allows to define the area contours of operation
 - Flexibility to define geopolitical constraints
 - Configure areas as per regulations where the AES / ESV is allowed to operate

7. Conclusion

With the growing demand for broadband and seamless connectivity, the adoption of VSAT based mobility solutions like AES and ESV is imminent. However, to successfully deploy such solutions, it is imperative to have appropriate standards and regulations to enable proper operation of these terminals. To meet this goal, several technical and regulatory challenges will need to be addressed by the standards and regulatory bodies.

TEC is in the process of developing the Interface Requirements (IR) to lay down the technical requirements for operation of VSAT based Mobility solutions. This paper has tried to provide a brief overview of such solutions mainly AES and ESV and the regulations and standards pertaining to them. This study will further be helpful in framing the IR document for VSAT based Mobility solutions.

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9. ETSI 302 186 Satellite Earth Stations and Systems (SES); Harmonised Standard for satellite mobile Aircraft Earth Stations (AESs) operating in the 11/12/14 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU`
10. ETSI 302 340 Satellite Earth Stations and Systems (SES); Harmonised Standard for satellite Earth Stations on board Vessels (ESVs) operating in the 11/12/14 GHz frequency bands allocated to the Fixed Satellite Service (FSS) covering the essential requirements of article 3.2 of the Directive 2014/53/EU
11. ETSI 303 978 Satellite Earth Stations and Systems (SES); harmonised Standard for Earth Stations on Mobile Platforms (ESOMP) transmitting towards satellites in geostationary orbit, operating in the 27,5 GHz to 30,0 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU
12. ETSI 301 447 Satellite Earth Stations and Systems (SES); Harmonized EN for satellite Earth Stations on board Vessels (ESVs) operating in the 4/6 GHz frequency bands allocated to the Fixed Satellite Service (FSS) covering essential requirements of article 3.2 of the R&TTE directive