Acta Scientific COMPUTER SCIENCES

Volume 5 Issue 5 May 2023

Review Article

A Brief Survey and Analysis on Satellite Mobile Telephone and Networks

Tathagata Roy Chowdhury* and Sakhaul Haque

Assistant Professor, Department of Computer Science and Engineering, S t. Mary's Technical Campus, Kolkata, India

***Corresponding Author:** Tathagata Roy Chowdhury, Assistant Professor, Department of Computer Science and Engineering, S t. Mary's Technical Campus, Kolkata, India.

Received: March 21, 2023

Published: April 06, 2023

Abstract

Satellite communication has grown highly essential in recent years as a result of its uses. The many types of satellites and their orbits are explained in this study paper. It has also been explained how satellite phones can be used to communicate. With all of the benefits and drawbacks of satellite communication, satellite systems are a viable option for providing communication services to mobile users in sparsely inhabited areas, emergency situations, and aboard aircraft, trains, and ships. Satellite systems offer unique advantages in terms of robustness, wide-area coverage, and broadcast/multicast capabilities in all of these scenarios. This study examines contemporary mobile satellite networks and services from a variety of perspectives, including research concerns and recent standardization developments.

Keywords: Satellite; Communication; Result; Communicate; Network; Broadcast; Multicast; Satellite Survey

Introduction

Satellite networks are a promising option for providing communication services in locations where existing terrestrial infrastructure is inadequate. There are numerous sectors (e.g., land-mobile, aeronautical, maritime, transportations, rescue and disaster relief, military, etc.) that require mobile communication services and for which satellites are the only viable option. This is why there is renewed interest in and market opportunities for Mobile Satellite Systems at this time (MSSs) [7]. Using S, L, and more recently Ku and Ka bands, technologies for multi-spot-beam antennas, low-noise receivers, and on-board processing have enabled compact, portable, or even handheld terminals to get direct access to the satellite [1].

Satellites that are either stationary or rotating are used in "mobile satellite communications systems." With a geostationary system, the satellite maintains a fixed position in regard to a specific geographical location (the satellite is truly in a fixed orbit and moves in a consistent connection to the Earth) [2]. With this type of system, the satellite can receive and broadcast signals to any transmitter or transceiver inside the set geographical area visible to the satellite at all times [2]. A communication system based on geostationary satellites may contain multiple satellites to cover a larger area of the Earth's surface [3]. A communications satellite in orbit moves in such a way that it passes over a specific geographical region at regular intervals [1].

The transmitter can store messages until the satellite comes within range. Messages can be stored in the satellite until it comes into range of a receiving earth station when they are broadcast to the satellite. Unlike geostationary satellites, a single spacecraft may cover the whole Earth's surface [7]. When the satellite is not visible, however, there may be time gaps in coverage of certain geographic places.

The satellite is in proper orbit around the earth. Because of their height, they can It is classified into geosynchronous orbit (GEO) and non-GEO as described below [6].

The GEO satellite is at an altitude of about 35,800 km on the equatorial plane of the earth. A considerable distance. This results in very high signal propagation delay and attenuation. Typical GEO satellite communications use high frequencies (eg S, L, as well as Ku and Ka Band), thereby exacerbating the path loss experienced by the signal. For these reasons, GEO Satellites are suitable for fixed-line communication services that allow large antennas. Used by the Earth Station. Still, there are some GEO systems that offer this A service for mobile users [6]. The NonGEO satellite uses two possible orbit types. Low Earth orbit (LEO) at one altitude Medium Earth orbit (MEO) at altitudes of 500-2000 km and altitude Altitude 8000 ~ 12000km. For NonGEO satellites, Close to Earth from a GEO perspective, enabling far lower end-to-end Data transmission delays and better link budget conditions [4]. Unfortunately not GEO systems require multiple satellites (ie constellations) to cover a region or the whole Since it is the Earth, switching links from links requires frequent handover procedures. From satellite antenna beam to another satellite, from one satellite to another, and even from the ground Gateway to another [5].

MSS can be affected by non-LoS propagation conditions. Existence of reverse link budget failures or limitations due to low power and small size. antenna size that can be used with portable terminals. Two similars to solve these problems. However, you can take a variety of innovative design approaches. (I) Hybrid network and (ii) Integrated network [7]. In the first case, it can be broadcast locally using a non-LoS Ground Gap Filler (Repeater) satellite signal. In addition, Returnlink is a terrestrial cellular system that simplifies power management for mobile devices. You can use local WiFi to extend satellite coverage (indoors, cities, etc.). A system in which a base station converts satellite signals to radio and vice versa.

Design issues for satellite mobile telephone

There are some specific types of different aspects works in a satellite network which leads in different way.

Frequency bands

Frequency bands and regulations. Frequency bands are allocated at the World Radiocommunication Conference (WRC), which is regularly held by the International Telecommunication Union-Radiocommunication Sector (ITUR). Fixed services use the high C and K frequency bands, while mobile services are suitable for the low L and S frequency bands assigned by the World Administrative Radio Conference (WARC) 92. MSS has long used L/S band technology [8]. L/S band systems allow for smaller onboard antennas due to less signal attenuation and less atmospheric impact. However, the need for broadband services and the limited amount of L/S band resources available are driving the use of Ku and Ka bands in MSSs [3]. ITUR is primarily equipped with MSS and fixed satellite systems (FSS) in all regions and has a Ka band frequency share (29.9-30 GHz for Earth-to-space links and 20.1-21.3 GHz for space-to-Earth links.) And Ku-The band frequency share secondarily assigned to the MSS in all regions (14 to 14.5 GHz for Earth-to-space links, 10 to 12 GHz for space-to-Earth links) [4]. At present, Kubased MSSs are available to provide broadband services in many mobile environments, such as trains, boats, planes, and cars. However, Kuband satellites, as opposed to L/Sb and satellites, do not provide a good coverage overseas, because antenna spotbeams footprints are focused on landmasses [9]. In fact, Kuband satellites are mainly intended for fixed users, so that there are not enough Ku/Ka band satellites providing coverage over oceans. Hence, a tradeoff has to be achieved between the need of increased bandwidth and coverage issues.

Figure 1: Satellite Frequency Table.

Mobile terminal antenna

Antenna design is an important point for mobile devices. Important considerations are antenna size, cost, and technology used. In addition, antenna systems need to be reliable and efficient in terms of sensitivity, gain, and interference [4]. It is important to emphasize the difference between fixed and mobile services. Fixed terminals use directional antennas, but mobile terminals can also use omnidirectional antennas (in either case, instead of omnidirectional antennas, fast tracking algorithms are used to improve links. It can be equipped with a phased array directional antenna (budget) [10].

Mobile devices can typically send in all directions and can also receive signals from all directions. As a result, mobile devices can interfere with other satellite networks. There is some research in the literature that addresses the issue of interference between fixed and mobile satellite services. The author describes the interference characteristics between non-GEO-MSS and GEO-FSS. The author analyzes the constellations of fixed and mobile non-geostationary satellite services and makes some suggestions on regulations (in terms of maximum transmit power and elevation) to avoid interference between them [8].

You can further consider the terminal antenna design for different application environments. For example, railroad scenarios are well handled by Ku-band satellites (covering land), but train antennas need to be small (low directional gain). This will increase the level of interference of adjacent satellites. In aerospace and ocean scenarios, aircraft and boats can be at the edge of spot beam coverage and require proper antenna design [1].

Elevation angle

Another important point for improving communication quality is the minimum elevation angle at which the mobile terminal can see the satellite on the MSS. This angle requirement is less stringent for FSS, but MSS scenarios (especially land-based users) should avoid low minimum elevation values. Otherwise, signal shadowing and blocking events due to trees, buildings, hills, etc. can occur frequently [5].

Such issues are less relevant to aviation and maritime users unless there are obstacles, unless the plane or ship is near the limits of satellite coverage. The higher the elevation angle, the better the signal quality (reduced shadowing/blocking effect), but the higher

Figure 2: Mobile Antenna.

the system cost (more satellites in the constellation) [2]. For this reason, a good choice for future MSS minimum elevation for mobile users on land is about 201. However, in first generation MSSs, also elevation angle values p101 have been adopted. The necessity for a minimum elevation angle implies appropriate design limits for the number of satellites in a constellation, as well as the fact that GEO satellites cannot service Polar Regions [4].

Figure 3: Elevation angle to the ground.

Channels models

ESA conducted a measurement campaign in the Ku and Ka bands, allowing for the creation of a channel model for MSSs. In the land-mobile example, a three-state Markov chain model with LoS, shadowing, and blocking (non-LoS) conditions can be used to describe the channel at both Ku and Ka bands. Each state has a Rice (Loo) distribution when it comes to the Ku (Ka) band. At lower L frequency bands, multipath, shadowing, and blockage effects are also evident [4].

However, for the L-band channel, a two-state (good–bad) Markov model is a common choice. The parameters of these models are determined by the location of the mobile terminal (city centre, suburban area, or rural area) as well as the elevation angle.

Figure 4: Channels types.

Medium access control (MAC) configuration

From what is known, many handover scenarios can be considered. For non-GEO, user mobility is dominated by satellite constellation mobility. For GEO, mobility only exists for users who access the service from planes, trains, and ships. Resource allocation at the MAC layer (Layer 2) should provide appropriate priorities for handover management. Handover traffic usually suffers from additional switching delays (and in some cases rerouting delays if gateway changes are involved), so proper prioritization Layer 2 prioritization is required on reception. Resources in the target cell. Otherwise, the associated session may be terminated by the upper tier [5].

Satellite standard for telephone

There are two categories of mobile communication systems exist, one GSM or Global Systems for Mobile Communications and second one is UMTS or universal mobile telecommunication systems.

GSM or global system for mobile communications

GSM is currently the world's most popular standard for cellular communications and supports packet-switched data with General Line Radio Service (GPRS). Although GSM is a terrestrial system, there are extensions on the market that allow for the "form" of GSM via satellite. In particular, you can consider the GEO Mobile Radio (GMR) air interface used for mobile services via GEO satellites. The European Telecommunications Standards Institute (ETSI) has created two GSM-derived specification sets for GMR. These specifications are called GMR1 and GMR2 and include compliance with GSM standards to meet the characteristics of GEO systems [3].

GMR makes it possible to access GSM core networks via satellite. In addition to the concepts of cellular coverage and frequency reuse on Earth, there are other similarities between GSM and GMR, especially with respect to the protocol layer above the physical layer. Mobile devices can be in dual mode and can use either the terrestrial GSM interface or the GEO satellite interface when terrestrial signals are not available (integrated network approach) [8].

Figure 5: GSM network hybrid connections.

S-UMTS or universal mobile telecommunication systems

There has been a standardization activity within ETSI for the extension of the UMTS standard to the satellite context, SUMTS. UMTS is one of the 3G terrestrial cellular technologies; we refer here to the UMTS version based on the Wideband—Code Division Multiple Access (WCDMA) air interface with Frequency Division Duplexing (FDD). The ETSI TC SES group has defined the SUMTS Family G specification set, aiming at achieving the satellite air interface fully compatible with the terrestrial WCDMA based UMTS system [3].

SUMTS is not only intended to complement the terrestrial UMTS coverage, but it is also conceived to extend UMTS services to areas where the terrestrial coverage would be either technically or economically unfeasible. SUMTS uses frequency bands around 2GHz that are close to those used by terrestrial 3G systems. SUMTS supports user bit rates up to 144 kbit/s. This is usually an acceptable value for multimedia services for mobile users with small devices [5].

SUMTS is widely analyzed in the literature. For example, a study conducted at suggests a SUMTS system architecture in which satellite segments may be connected to an IP-based core network. SUMTS "Phase 1" is called a WCDMA system that implements a forward path over a satellite at 2 GHz to support broadcast and multicast services, and returns to interactive services (hybrid network approach) over the 3G ground segment. You can use the path. Next, SUMTS "Phase 2" also enables a satellite return path with a link budget optimized for mobile phones, providing an OFDMA (Orthogonal Frequency Division Multiple Access) based air interface operating at 5 GHz. Consider [8]. This is in line with the recently launched activities of the ITUR Working Group 4C, which focuses on multi-carrier air interfaces for satellite components. This is for compatibility with terrestrial systems evolving into 4th generation (4G) cellular networks such as UMTS Long Term Evolution (LTE) and WiMAX [6].

Figure 6: UMTS system.

Scope of communications in satellite mobile systems

Mobile satellite communication can take numerous forms. This can be communication from a satellite phone to a cellular phone or from a satellite phone to another satellite phone. They are, in a nutshell, as follows:

- The caller dials the desired number and then presses the send key. The phone then does some processing before locating and transmitting the call information to the nearest orbiting satellite [3].
- The point at which the satellite transfers the call to the nearest ground receiver is known as the gateway. The process of patching the calls through is done by the gateway. The gateway will not be able to patch a call to UAE using the existing phone network if it originates in America. The gateway will then broadcast the call to the closest satellite, which will assist in passing the call onward until it reaches one that can assist in connecting to the receiver [5].
- The call is received by the receiver's network and arrives from the satellite. The call's format must be changed so that it can be received on a regular phone or a cell phone. The call is termed to be connected once the received call has been converted and the link has been established [3].
- When dialing a satellite phone (such as a Globalstar phone) from a cellular phone or landline, the same rules apply. Calls are routed through one of the Globalstar gateways, which then route the call to a relay satellite and then back to the Globalstar satellite phone user. This is referred to as "bent pipe technology" by Global star [6].
- Globalstar now employs a DS-CDMA PHY method with a spreading factor of G5128. Path diversity combining is used by Globalstar to alleviate shadowing and obstruction effects by combining signals from up to three visible satellites for a single call. Voice, data, and fax are all available in real time using the Globalstar system. Depending on the background noise level, voice is encoded at a configurable bit rate (2.4, 4.8, or 9.6kbit/s). The maximum data rate supported is 9.6kbit/s [9].

Conclusion

The many types of satellites and their orbits are explained in this study paper. It has also been explained how satellite phones

Figure 7: Communication paradigm in Satellite telephone.

can be used to communicate. With all of the benefits and drawbacks of satellite communication, satellite systems are a viable option for providing communication services to mobile users in sparsely inhabited areas, emergency situations, and aboard aircraft, trains, and ships. Satellite systems offer unique advantages in terms of robustness, wide-area coverage, and broadcast/multicast capabilities in all of these scenarios. This study examines contemporary mobile satellite networks and services from a variety of perspectives, including research concerns and recent standardization developments [2].

Also this paper concludes all the details of Satellite network and also different scopes so that we can implement Communication Paradigm based on Satellite.

Bibliography

1. Höyhtyä M., *et al*. "Sustainable satellite communications in the 6G era: A European view for multi-layer systems and space safety". *IEEE Access* (2022).

2. Tropea M and De Rango F. "A comprehensive review of channel modeling for land mobile satellite communications". *Electronics 11*.5 (2022): 820.

3. Arumugam S., *et al*. "High gain wide band grid array antenna for short range radar and vehicle-to-satellite communications". *AEU-International Journal of Electronics and Communications* 147 (2022): 154157.

4. Flannigan L., *et al*. "Mid-wave and long-wave infrared transmitters and detectors for optical satellite communications—a review". *Journal of Optics* 24.4 (2022): 043002.

5. Kim MG and Jo HS. "Problem and solution for NB-IoT uplink in Low Earth Orbit satellite communication". In 2022 International Conference on Electronics, Information, and Communication (ICEIC) (2022): 1-3.

6. Abdrabou M and Gulliver T A. "Authentication for satellite communication systems using physical characteristics". *IEEE Open Journal of Vehicular Technology* 4 (2022): 48-60.

7. Khan W U., *et al*. "When RIS meets GEO satellite communications: A new sustainable optimization framework in 6G". In 2022 IEEE 95th Vehicular Technology Conference (VTC2022-Spring) (2022): 1-6.

8. Chen Q., *et al*. "Joint Satellite-Transmitter and Ground-Receiver Digital Pre-Distortion for Active Phased Arrays in LEO Satellite Communications". *Remote Sensing* 14.17 (2022): 4319.

9. Al-Hraishawi H., et al. "A survey on non-geostationary satellite systems: The communication perspective". IEEE Communications Surveys and Tutorials (2022).

10. Tedeschi P., *et al*. "Satellite-based communications security: A survey of threats, solutions, and research challenges". *Computer Networks* (2022): 109246.