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INVESTIGATION OF THE SATELLITE MOBILE TELEPHONE PERSPECTIVES IN LIBYA

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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

1. 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, transportation, rescue, 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). Using S, L, and more recently Ku and Ka bands, technologies for multi-spot-beam antennas, low-noise receivers, and onboard processing have enabled compact, portable, or even

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handheld terminals to get direct access to the satellite. 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). 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. A communication system based on geostationary satellites may contain multiple satellites to cover a larger area of the Earth's surface. A communications satellite in orbit moves in such a way that it passes over a specific geographical region at regular intervals.

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. 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. 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 (e.g., 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. The Non-GEO 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 Non-GEO satellites, Close to Earth from a GEO perspective, enabling far lower end-to-end Data transmission delays and better link budget conditions. Unfortunately, not GEO systems require multiple satellites (i.e., 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.

Satellite networks can be used for communication in areas where existing infrastructure is not sufficient [1]. Disaster relief, military, maritime, transportation, and rescue are just some of the sectors. For those who require mobile communication, and for the areas where only satellites are viable, these are the only viable options. [2] “This is what had renewed interest in and market opportunities for Mobile Satellite Systems at this time”. As well as the advantages of using S and L bands, there are a lot of other benefits to getting direct access to the satellite [5]. Satellites that are either stationary or rotating are used in "mobile satellite communications systems." There is a fixed position for the satellite, in which it can only move in a consistent way between Earth and a specific geographical location. [4] Through this method of system, the satellite can receive signals from Transmitters outside of the geographical map at the same time as they’re being broadcasted to the Satellite. Multiple satellites may be used to cover a larger area of the Earth’s surface utilizing a communication system based on geostationary satellites. [6] While using portable Terminals a satellite can move in a certain manner that it

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can return to a different region many times a year [7].

The satellite can come within range of the transmitter. Messages can be stored in the satellite until they reach a receiving earth station. A single satellite can cover the Earth's surface. It can also provide coverage gaps when it's not visible [8]. The satellite is in a proper position. Because of their height. They can. It is classified into two categories, geosynchronous and non-geo [8]. The Earth Station uses it. There are some systems that offer this service. The non-geo satellite has two possible types. The LEO is at altitudes of 500-2000 km and altitude of 8000 12000 km. Close to Earth from a GEO perspective allows for lower end-to-end Data transmission delays and Bett [9]. The Earth Station uses it. There are some systems that offer this service. The non-geo satellite has two possible types. The LEO is at altitudes of 500-2000 km and altitude of 8000 12000 km. Close to Earth from a GEO perspective allows for lower end-to-end Data transmission delays and better link budget conditions. Multiple satellites are not required for the GEO systems to cover a region. Since it is the Earth, frequent handover procedures are required. From the ground gateway to another satellite, and from one satellite to the other [12].

MSS can be affected by non-LoS propagation conditions. The 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 similar to solve these problems. However, you can take a variety of innovative design approaches. (I) Hybrid network, and (II) Integrated network. In the first case, it can be broadcast locally using a non-LoS Ground Gap Filler (Repeater) satellite signal. In addition, the Return link is a terrestrial cellular system that simplifies power management for mobile devices. You can use local WIFI to extend satellite coverage (indoors, in cities, etc.). A system in which a base station converts satellite signals to radio and vice versa [10].

2. DESIGN ISSUES FOR SATELLITE MOBILE TELEPHONE

Frequency bands and regulations. Frequency bands are allocated at the World Radio communication Conference (WRC), which is regularly held by the International Telecommunication Union-Radio communication 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. 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. 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). At present, Ku-based MSSs are available to provide broadband services in many mobile environments, such as trains, boats, planes, and cars. However, Ku-band satellites, as opposed to L/S-band satellites, do not provide good coverage overseas, because antenna spot beam footprints are focused on landmasses. In fact, Ku-band satellites are mainly intended for fixed

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users, so there are not enough Ku/Ka-band satellites to provide coverage over oceans. Hence, a tradeoff has to be achieved between the need for increased bandwidth and coverage issues.

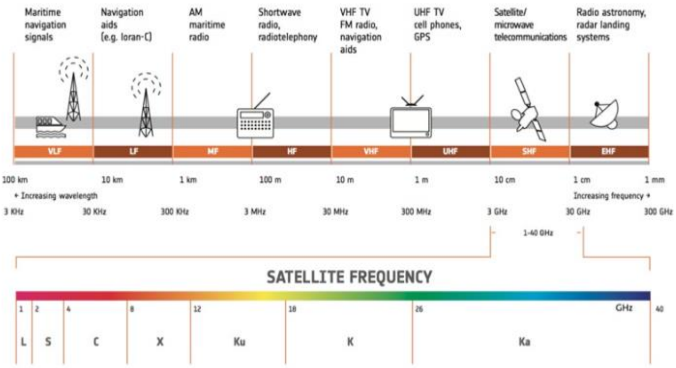

Figure 1: Satellite Frequency Table

3. MOBILE TERMINAL ANTENNA

The first and most serious drawback of GEO is that it is only available in English. Round trip delay for satellites the cost of GEO schemes is the second imitation. Because the bit is 36,000 kilometers above the equator, a large satellite is required, with large antennas, strong transmitters, and high-performance receivers.

4. GEO's DRAWBACKS INCLUDE

The first and most serious drawback of GEO is that it is only available in English. Round trip delay for satellites the cost of GEO schemes is the second imitation. Because the bit is 36,000 kilometers above the equator, a large satellite is required, with large antennas, strong transmitters, and high-performance receivers.

- Affecting the quality of hardware's potential
- Failure is on the rise.
- In the polar areas, there is a lack of performance.

5. SATELLITE TELEPHONY IN LIBYA (THURAYA SATELLITE TELEPHONE)

Thuraya has begun operations in Libya. This extremely adaptable satellite phone is the first on the market to support all three major navigation systems: GPS, Beidou, and Glonass. This satellite phone has the largest display of any satellite phone on the market and is made of toughened glass to withstand the roughest conditions. The screen is glare-resistant, allowing for optimal visibility in direct sunshine, and a brightness sensor adjusts the illumination of your display automatically [7].

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Figure 2: Thuraya Telephone

Thuraya is known for having the most stable satellite network, and the Thuraya XT-sophisticated PRO's omnidirectional antenna ensures an unbroken connection whether walking or moving, allowing for a complete walk-and-talk functionality [6].

Even if the satellite connection is too weak to receive the call itself, the Thuraya allows it to receive a call notice [7]. This is especially beneficial when the Thuraya is in your pocket and the antenna is stowed, ensuring that you are always connected.

When you're on, you'll have an unbroken connection, thanks to Thuraya's stable satellite network and an innovative omnidirectional antenna [8]. Even if the satellite signal is too weak to receive the call, it will send a call notification. When the antenna is stowed, this is especially handy.

Table 1: Comparison Table for All Communication

Geo	Utilize	Efficiency	Density
Geo Thuraya	0.1	20	0.03
Leo Globalstar	0.8	10	0.01
Leo Iridium	0.2	50	0.02
Geo BGan	0	40	0.08

6. DESIGN ISSUES FOR SATELLITE MOBILE TELEPHONE

There are some specific types of different aspects that work in a satellite network which leads in a different way:

A. Frequency Bands

There are Frequency bands and regulations. The International Telecommunication Union-Radio Communication Sector organizes the World Radio Communication Conference. [10] FMobile services are suitable for the low L and S frequencies assigned by the World Administrative Radio Conference. L / S band technology has been used by MSS. Due to the limited number of L / S band resources, smaller onboard antennas are possible. The need for high-speed broadband services is forcing the use of Ka and Ku bands.10] “ITUR has a Ka-

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band frequency share of 29.9% for Earth-to-space links and 20.1-21.3 GHz for space-to-Earth links. The band frequencies are assigned secondarily to the MSS in all regions'. [8]

In many portable locations, KubasedMSSs are able to provide broadband services. L/S band satellites offer good coverage overseas, but the antenna spot-beam footpaths are concentrated in the tropics. There aren't enough Ku / Ka-band satellites that can provide coverage over the ocean for non-convertible users. There is a tradeoff to be made [8].

Table 2: Satellite Frequency Table

Band	Name	Wavelength
1	Blue light (B)	0.45–0.52 μm
2	Green light (G)	0.53–0.60 μm
3	Red light (R)	0.63–0.69 μm
4	Near-Infrared (NIR)	0.76–0.90 μm
5	Shortwave Infrared Channel 1 (SWIR1)	1.55–1.75 μm
6	Thermal Infrared (TIR)	10.4–12.5 μm
7	Shortwave Infrared Channel 2 (SWIR2)	2.08–2.35 μm

B. Terminal Antenna Based on Mobile Devices

It is an important point for mobile devices to have an effective mobile antenna. The considerations include antenna size, cost, and technology. In addition, antenna systems need to be reliable and efficient [5].

The difference between fixed and mobile services is important. Fast-tracking is used to improve links, instead of omnidirectional antennas, which are used for fixed terminals [5]. It can be equipped with a phased array directional antenna (budget). The phone can send and receive signals. As a result, cell phones interfere with other satellite networks can be interfered with.

There are issues of interference between fixed and mobile satellite services. The author describes interferences [7]. Considering the different application environments when designing the terminal antenna. 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". [9]

Figure 3: Mobile Antenna

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C. Elevation Angle

"The minimal topographic angle at which the mobile terminal may see the satellite on the MSS" is another key factor in increasing network density.

Although the angle requirement is less rigorous for FSS, MSS situations (particularly those involving land-based users) should avoid low minimum elevation values. Signal occlusions and attempts to block events caused by trees, facilities, elevations, and other obstacles can occur often elsewhere. [10] Unless there are obstacles that prevent ships or planes from reaching the satellites' coverage, these issues are less relevant to maritime and aviation users. The elevation angle of the satellites affects their signal quality and cost. A good scenario in the future would be for mobile users on land to have a minimum elevation of about 200 [11]. In the first generation of MSSs, the elevation angle values p101 have been adopted. These are required for the number of satellites that can be used for a constellation. Also, since there is no chance of using geosynchronous satellites to orbit Polar Regions, the elevation angle is also considered for design limits. The 66 satellites are organized into six orbital planes, each with 11 operational satellites. The satellite is in a circular orbit at a height of 66 kilometers.

- 783 kilometers above the earth's surface
- The corotating mince 49
- The ling-plane of 310 Recounters is 22 degrees.

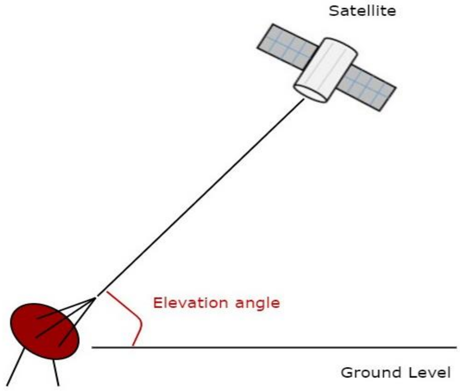

Figure 4: Elevation Angle to the Ground

On November 1, 1998, the Iridium communications service was established, and on August 13, 1999, it filed for bankruptcy [14].

Al Gore, then-Vice President of the United States, made the first Iridium call using Motorola process technology and significant financial backing.

D. Channels Models

"ESA conducted a measurement campaign in the Ku and Ka bands, allowing for the creation of a channel model for MSSs". In

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"GSM is currently the world's most popular standard for cellular communications and supports packet-switched data with General Line Radio Service (GPRS)". Although the GSM standard is mainly used for terrestrial communication, there are other extensions that can be used for this purpose. [1]

The air interface that is used for mobile services is known as the Geo Mobile Radio Interface (Gr). Two sets of specifications have been created for this type of Telecommunication. The specifications are called GMR1, GMR2 and they correspond to the characteristics of GEO systems.

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.

When signals are not available, mobile devices can use the satellite interface or even the terrestrial interface (integrated network approach) [3].

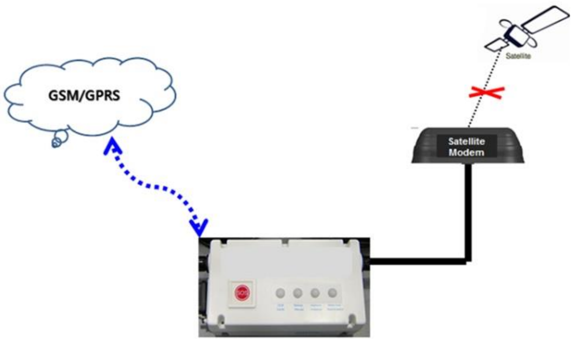

Figure 5: GSM Network Hybrid Connections

E. S-Umts or Universal Mobile Telecommunication Systems

There was a pause within ETSI to extend the status of UMTS in the satellite context, SUMTS. "UMTS is one of the 3G terrestrial cellular technologies; here we refer to the UMTS version based on the Wideband — Code Division Multiple Access (WCDMA) and Frequency Division Duplexing (FDD)" [8].

The goal of the SUMTS Family specification was to achieve the satellite air interface with the Wireless based UMTS system. SUMTS is intended to add extra coverage to places where the coverage is impractical and also provide new coverage when it isn't economically viable. The 2 GHz band is like those used by 3G networks. SUMTS supports user bit rates. Up to 100 kbit /s [4].

This is usually an acceptable value for multimedia services for mobile users with small devices.

SUMTS is widely analyzed in the literature. For example, a study conducted 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 [7] Consider. 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 [8].

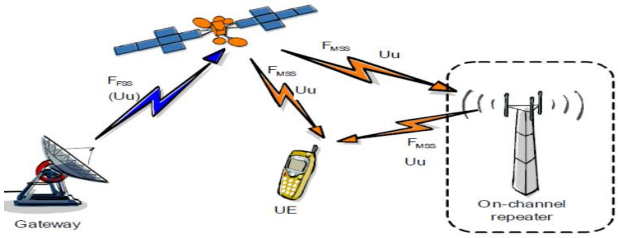

Figure 6: UMTS System

7. FUTURE TRENDS OF SATELLITE TELEPHONES

It is very important that the MSSs industry identifies the various challenges that it must face in order to provide its customers with the best possible service. One of these is the development of next-generation satellite networks that can deliver end-to-end Quality of Service (QoS); [6]

One of the most important factors that the industry must consider when it comes to developing next-generation satellite networks is the availability of reliable and high-quality services to mobile users. This can be achieved through the use of hybrid satellite and terrestrial networks; [6].

User movement management through appropriate delivery processes. New broadband services and the acquisition of small-sized smart terminals are some of the initiatives that will help improve the efficiency of batteries. As of June 30, 2007, Iridium Satellite LLC claims to have 203,000 customers.

- In the second quarter of 2007, revenue was 866.7 million dollars, with a $20.2 million EBITDA
- The Department of Defense has superextensivity Iridium uses a baud rate of 2200 to 3800. For its 'direct internet' service, Iridium boasts data speeds of up to 10 kilobits per second.

Woefully inadequate demand for the service, as well as a high initial investment cost. The growth of roaming agreements and the expansion of terrestrial cellular networks (e.g., GSM). Mismanagement has also been identified as a significant contributor. Moreover, "the novel approach based on cross-layer air interface design could permit an optimization of the whole protocol stack, thus improving capacity and QoS" [13].

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8. SCOPE OF THE COMMUNICATIONS IN SATELLITE MOBILE SYSTEMS

Mobile satellite communication can take numerous forms. Communication can be done from one phone to another through another phone or a satellite phone [7]. This includes;

I. The caller dials the number and then presses SEND to give the desired number. The phone needs to process and send the call location and information to the nearest satellite. [8]

II. Because of the communication services, the gateway is where the call is to be transferred from the satellite. The gateway does the patching of calls. 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 [8].

III. 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].

IV. When dialing a satellite 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 [5].

V. 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”.

VI. Voice, data, and fax are all available in real-time using the Global Star 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” [7].

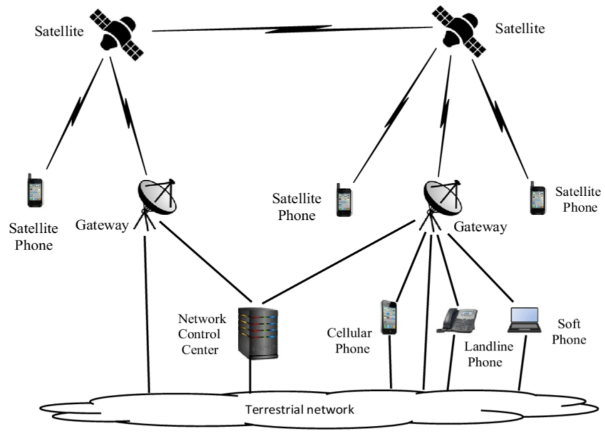

Figure 7: Communication Paradigm in Satellite Telephone

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9. FINDINGS

This changes depending on the service. Service calls from a Globalstar phone to another Globalstar phone within the same footprint of the service gateway, for example, accomplish the satellite from the Globalstar phone, reach the gateway, and then return to the Globalstar satellite. It will then be transmitted to the Globalstar phone that is expecting to receive it [9]. In this case, the payphone is not utilized. When each call is made from one Globalstar phone to another Globalstar phone that is beyond the calling gateway's range, the call works. Calls are routed through the satellite, the service connection, and finally to payphones through the PSTN or T1 line. The mechanism connecting the receiving Globalstar phone to the gateway is down. Even if the payphone system is down, the Global Star Satellite Service will continue to operate [10].

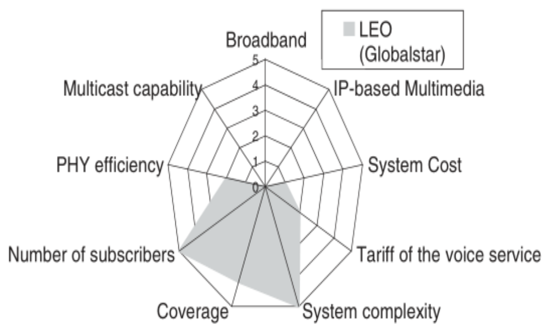

Figure 8: Globalstar Broadband Paradigm

The numerous L / Sband MSSs are shown below with respect to several key factors. The Globalstar approach's system cost, the supply of IP-based multimedia services, telecommunications prowess, multicast capabilities, and physical layer efficiency are all factors to consider (i.e., efficiency associated with the modulation, and coding schemes adopted). We can observe through Figure 8.1 that Leo Globalstar works well for internet telephony.

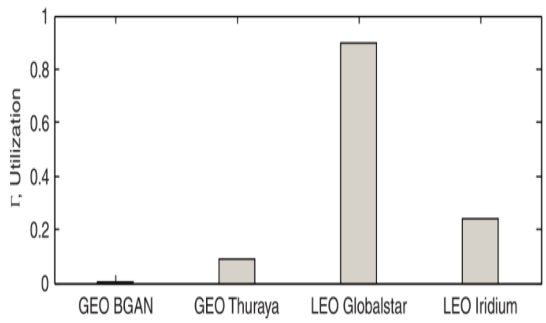

Figure 9: Utilization Comparison

Figure 8.2 shows BGAN, Globalstar, Iridium, And Thuraya, using the author's theme.

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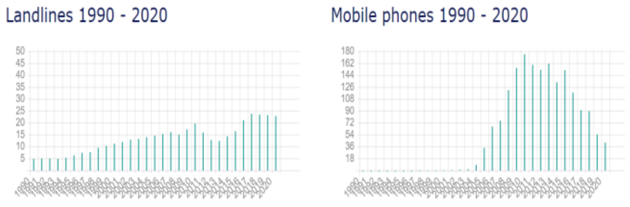
Considering that the Globalstar system has gained a large number of subscribers over the years, it can be said that it has achieved the highest G score. In addition, you can compare the total value with all phone comparisons [11]. The findings relating to the acquired data based on the specific country, Libya are stated below:



Distribution in 2020	Libya Total	Libya percent	EU Total	EU percent
Broadband users	332,000.00	4.83 %	163.72 m	36.56 %
Landlines	1.58 m	22.94 %	160.15 m	35.76 %
Mobile cellulars	2.92 m	42.52 %	540.56 m	120.71 %

Figure 10: Usage and Distribution of Satellite Mobile and Telephones in Libya (Source: World Data, 2021)

It can be analyzed that; the development of various telephone services and internet connections may carry out the percentage of the total country's population where the values above 100% clarify the average rate of usage of the services where each and every inhabitant occupies more than one connection of mobile and telephone networks. As per the analysis of the above graphs, it can be stated that the rate of landline usage in 1990-2000 in Libya shows that the highest percentage of using landline networks was in 2018, and in 2011, there was almost growing usage of using the landline network. But, using the mobile network, Libya showed the record growth of using this network by users in 2011 and in 2013 and 2016, the usage of the mobile network was slowing down. Hence, the total usage of the mobile cellular and landline network used by Libya were 1.58 and 2.92 meters where the percentage of using and applying this network was carried out by 22.94% and 42.52% respectively, thus, it is analyzed that, the usage of the mobile network is comparatively higher than that of the landline network in Libya (Worlddata, 2021). Thus, it is shown that, as compared to the European Union, Libya has massively lagged behind the thorough development of the telecommunication network, hence, a total of 4.50 million connections were developed in 2020, and among those about 2.92 million mobile phones that correspond to the average of 0.43 per individual, that demonstrates the usage of the mobile network is 1.2 per person (Libya, 2022). In mid-2020, it was imposed that around 50% reduction in the teleport services will be provided to the customers where a moderate growth of 9.9% was shown in 2019 due to the massive worldwide effect of the pandemic, the Teleperformance network became affected and collapsed in the international markets too [13].

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The key developments that have been shown in the last 4-5 years are followed below:

- The Ericsson of the LPTIC contracts were developed for maintaining and developing the telecom networks and infrastructure of the overall country, Libya.
- The Government of Libya ordered that around a 50% reduction is needed in the subscription fees of the teleport network.
- LPTIC also signed around $80 billion contracts with Arabsat for providing satellite broadband services to a large base of customers.
- The entire update of the report includes the charts of the Telecon Maturity Index for analyzing the assessment of the overall telecom sectors where the recent market development of Libya has been observed thoroughly (HAMID, 2020).

10. CONCLUSION

There is a renewed interest in research and development now that MSS can give services at any time and from any location. Researchers investigated MSS in this study by concentrating on certain aspects that set it apart from other GPS signals. Several standards have been established for the mobile satellite communications industry. One of these focuses on hybrid networks that combine satellite mixed basement components. One of the most critical components that satellite operators need to consider when it comes to improving their system efficiency is the design of multi-spot base stations for their satellites. This white paper aims to provide a step-by-step approach to optimizing these components. In military communications, this effective communication is quite valuable. She has a huge part to play both before and after the accident. It’s also a great tool for tourists. This is really necessary and beneficial, but it does have certain disadvantages. Propagation delays are common, post-launch repairs and maintenance are challenging, and launch costs and dangers are significant. Furthermore, terminals are so costly that not everyone would afford them. It heralds the dawn of a new era of global connectedness.

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