

T.R.
GEBZE TECHNICAL UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES

ACCESS TO COMMUNICATION WITH LOW EARTH ORBIT
SATELLITES AND PROVIDE TELEMEDICINE

Tugay KARA
MASTER THESIS
DEPARTMENT OF BUSINESS ADMINISTRATION

GEBZE
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Thesis Advisor
Assoc. Prof. Dr. Mehmet Şahin GÖK

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SUMMARY

Communication is a critical component of humanity for their existence. The communication technology experience commencement with shouting and smoke continued with telegraph, telephone, and satellite. Communication is possible at short distances by telegraph and telephone, but satellites outpaced these limits. Satellites are of great significance in order to provide worldwide communication.

In the afterward 2000s, various companies have launched satellites to space to ensure global communication with Low Earth Orbit (LEO) Satellites. LEO satellites provide a high-speed internet connection with low latency. As the number of satellites launched into space and rivalry increments, the cost of satellite services lessening. People who do not have access to the internet connection and those who have low-speed internet have become capable of utilizing this service as the satellite internet connection prices have diminished.

In this study; satellite and communication history was scrutinized, the significance of providing worldwide communication with the LEO satellite is highlighted, information on telemedicine history and telemedicine types of equipment was yielded, the importance of LEO satellite on telemedicine has been explicated. It has been expressed that even in the distant corner of the world, the community can access primary health care services remotely as a consequence of telemedicine. Telemedicine application has been analyzed in terms of economic and technical requirements for Turkey and the World with diseases map affecting mortality rates. The feasibility of telemedicine was made, the use of telemedicine during the outbreak was explained by case studies.

Key Words: Low Earth Orbit Satellites, Mobile Health Services, Primary Health Care Services, Telemedicine, Outbreak

ÖZET

Haberleşme hayatımızın önemli bir parçasıdır. Bağırarak ve dumanla başlayan haberleşme serüveni telgraf, telefon ve uydu ile devam etmiştir. Telgraf ve telefon ile kısa mesafelerde haberleşme sağlanırken, uydularla bu sınırlar aşılmıştır. Bu nedenle global bir haberleşmeyi sağlayabilmek için uyduların önemi büyüktür.

2000'li yıllar itibariyle, çeşitli şirketler Alçak İrtifa Yörüngesi (AİF) Uyduları ile küresel iletişim sağlamak için uzaya uydular fırlatmışlardır. Bu uyduların oluşturdukları konsorsiyumlarla birlikte dünyanın her bölgesinde yüksek band genişliği ve düşük gecikmeyle haberleşme sağlanabilmektedir. Bu uydu hizmetleri, önceki yıllarda olduğu gibi pahalı değildir, aksine son kullanıcıların bu hizmetleri kullanabileceği bir hale gelmiştir.

Dünya Sağlık Örgütü ve Dünya Bankası'nın ortak çalışmasıyla ortaya çıkan rapora göre, dünya nüfusunun en az yarısı temel sağlık hizmetlerinden faydalanamamaktadır(WHO and The World Bank, 2017).

Bu çalışmada; uydu ve iletişim geçmişi incelendi, LEO uydusu ile dünya çapında iletişim sağlamanın önemi vurgulandı, teletıp geçmişi ve teletıp ekipman türleri hakkında bilgiler verildi, LEO uydusunun teletıp üzerindeki önemi açıklandı. Dünyanın en uzak köşesinde bile teletıp sayesinde toplumun birinci basamak sağlık hizmetlerine uzaktan erişebileceği ifade edildi. Ölüm oranlarını etkileyen hastalık haritası ile Türkiye ve Dünya için Teletıp, ekonomik ve teknik gereklilikler açısından analiz edildi. Teletıp fizibilitesi yapıldı, salgın sırasında teletıp kullanımı vaka çalışmaları ile açıklandı.

Anahtar Kelimeler: Alçak İrtifa Yörünge Uyduları, Mobil Sağlık Hizmetleri, Temel Sağlık Hizmetleri, Teletıp, Salgın

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LIST of ABBREVIATIONS

<u>Abbreviations</u>	<u>Descriptions</u>
LEO	: Low Earth Orbit
MEO	: Middle Earth Orbit
GEO	: Geostationary Earth Orbit
AİF	: Alçak İrtifa Yörünge
WHO	: World Health Organization
HZ	: Hertz
GPS	: Global Positioning System
USA	: United States of America
ITU	: International Telecommunication Union
TV	: Television
USSR	: Union of Soviet Socialist Republic
VSAT	: Very Small Aperture Terminal
MSS	: Mobile Satellite Services
FSS	: Fixed Satellite Services
BSS	: Broadcast Satellite Services
ICI	: Iridium Communications Incorporation
SOTM	: Satcom on the Move
NASA	: National Aeronautics and Space Administration
INMERSAT	: International Mobile Satellite Organization
Covid-19	: Coronavirus Disease
BC	: Before Christ
CAPEX	: Capital Expenditures
OPEX	: Operational Expenditures

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1. INTRODUCTION

Communication is the act of relocating information from one position, individual, or group to another. It has indispensable importance for security, health, defense, communal, personal, corporate, and commercial demands.

The communication experience commenced in ancient times with cave paintings, shouting, and smoke. The development process of communication progressed telegraph, telephone, and satellite. Communication is possible at short distances by telegraph and telephone, but satellites outpaced these limits. Satellites are of great significance in order to provide worldwide communication.

Health is mental, spiritual and physical prosperity. A healthy society comprises healthy individuals. Individuals are the major component of society, and they combine to compose society. The health of individuals is of significant value for the confidence and future of society. A vigorous individual can consummate his or her familial and social tasks, and he or she can be salutary to humankind.

Access to primary health care services is alembicated guarantee a healthy life. It is laborless to access primary health care services in metropolises and cities with high-level hospital utility, but access to primary health care services is arduous in territories distant from the city center. It is substantial to realize distant health care services for distant regions that can not perform from high-level hospital services.

Satellite is the unique route to communicate all over the world. Satellite services are indispensable for affording distant health care services.

1.1. The Intent of the Research

The intent of our research is to specify the contribution of LEO satellites to worldwide communication, to declare LEO satellites' impact on the provision of primary distant health care services for humanity, and to demonstrate telemedicine is advantageous and applicable in Turkey and World.

1.2. Contributions of This Research

- The importance of satellite communication for humanity.
- The significance of affording distant primary health care services.
- The value of global communication with LEO satellites.
- Contribution of affording telemedicine distant primary health care services to the frugality, efficiency, and public health.
- The contribution of telemedicine to outbreak diseases such as coronavirus (Covid-19).

1.3. The Scope of the Research

- The progression of communication technology.
- The importance of satellite communication for humanity.
- The significance of LEO satellites for communication.
- Access to primary health care services with LEO satellites.
- An elaborated explanation of telemedicine pieces of equipment.
- Cost calculation of telemedicine and feasibility analysis.
- According to mortality caused by the diseases, implementing telemedicine in Turkey and in the World.
- Telemedicine on the outbreak.

2. THE HISTORY of COMMUNICATION

2.1. Communication in Ancient Times

The oldest symbols utilized for communication are cave paintings. In Chauvet Cave in France, around 30,000 Before Christ (BC) the oldest cave paintings were discovered (Chauvet, Deschamps et al., 1996). Figure 2.1 demonstrate summarizes the chronological table of cave art.

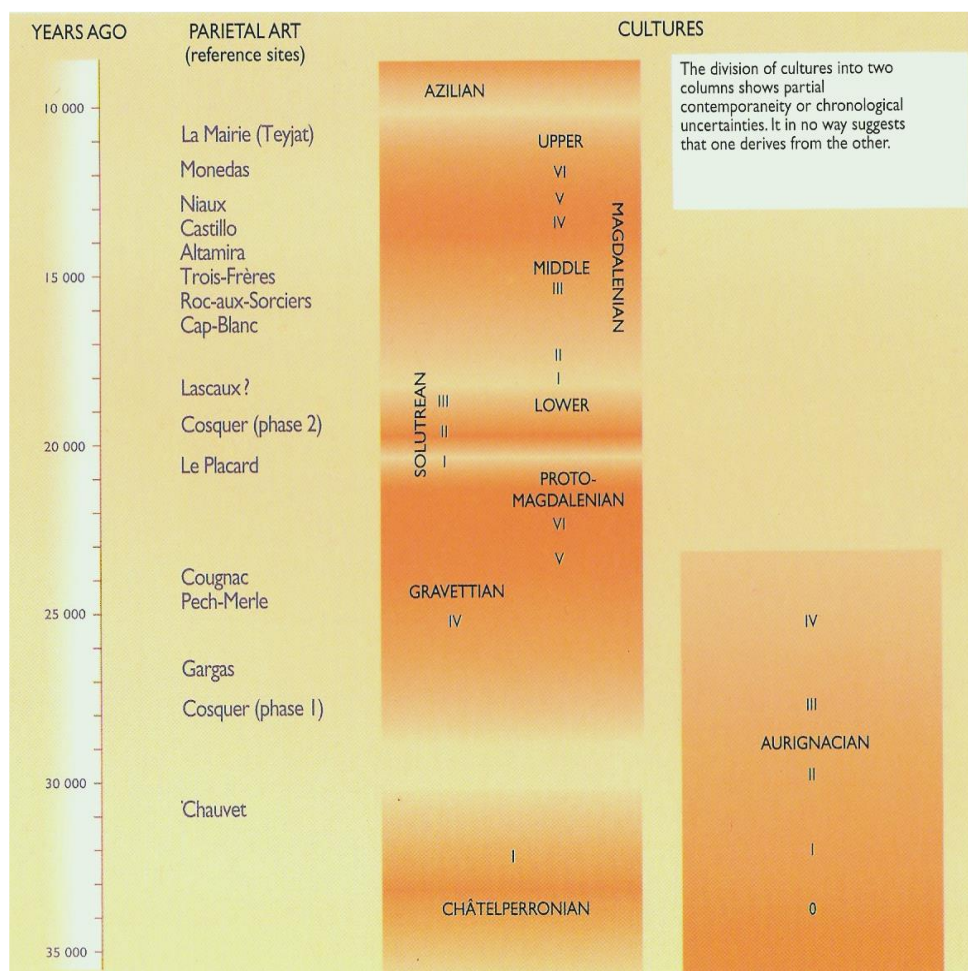


Figure 2.1 Chronological table of cave art (Clottes and Lewis-Williams 1998)

Smoke signals were first exploited in China for communication. Smoke signals were utilized for military communication between the towers of the Great Wall.

Animals such as pigeons were also used to convey messages. The Romans used pigeons 2000 years ago to communicate in their armies. Julies Cesar utilized pigeons for communication to conquer Gaul (Levi, 1977). The Greeks used pigeons to dispatch the names of the winners of the Olympic games they organized (Blechman, 2007)

Postal systems were first used in India, China, Egypt, Rome, and Iran.

The printing press was invented by Johannes Gutenberg in 1450. In addition, Johannes Gutenberg developed lead alloy letters, and it has also produced a suitable oil-based ink. Thus, wood printing was replaced by metal letters, a material that is more resistant to heat and wear (Man, 2009). The invention of the printing press marked a milestone for literary communication. The first newspaper was "Fürnemmen und gedenckwürdigen Historien", edited in 1605 by Johann Carolus in German. (Johannes, 2006).

2.2. Telegraph, Radio and Telephone

Telegraph is a system that facilitates the transmission of messages with a coded signal across distant areas. Numerous telegraph systems have been used for centuries. Telegraph technology started with optical telegraphs (Burns, 2004). They were built for the governments; the first was the visual semaphore of Mr. Claude Chappe (Gökoğlu, 1935).

Figure 2.2 shows that a block diagram of the communication system.

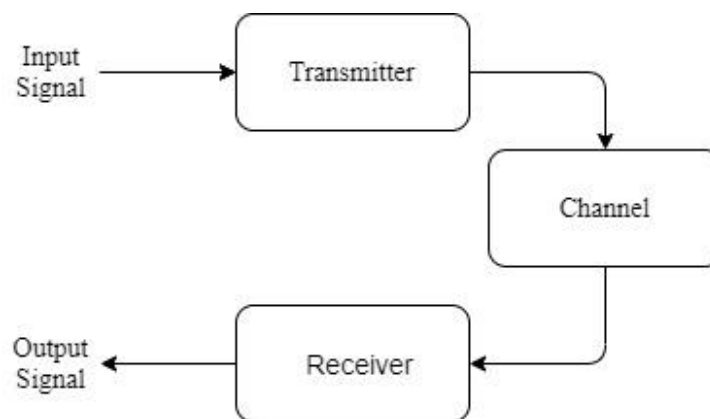


Figure 2.2: A Block diagram of the communication system

After the invention of optical telegraphs, electrical telegraphs are invented. The transmission of messages over electrical cables was made possible by the invention of the battery by Alessandro Volta in 1799 (Web1, 2019). Electric current can be stored and used in controlled environments with this invention. Physicist Hans Christian Oersted, who managed to deflect a magnetic needle with an electric

current, demonstrated the connection between electricity and magnetism(Becker, 2013).

The first electrical telegraph was made by Gauss and Weber in 1833 in the 1-kilometer area between the Gottingen Observatory and the Physics Institute (Pohl, 1924). The first commercial telegraph was made between London and Birmingham Railway in 1837 by William Cooke and Charles Wheatstone (Guarnieri, 2019).

The Morse alphabet, which is used to denote the Latin alphabet using coding, was invented by Samuel Morse. This transmission is carried out by sound, light and click. In 1830, Samuel Morse integrated these codes into the telegraph. The first telegraph message using Morse codes was sent in 1944 (Beechey, 1876).

After a series of electrical and magnetic experiments, the magnetic induction theory was formulated by M. Faraday and E. H. Lenz (Ulaby, 2007). In addition, James C. Maxwell published the theory of electromagnetic radiation in 1873 (Bruce, 1991). It was determined by this publication that electromagnetic waves travel in space at the speed of light. Heinrich Rudolf Hertz proved James C Maxwell's electromagnetic radiation theory because of the experiments (Baird, Davis et al, 1998). Therefore, frequency units in radio technologies are uttered in hertz (Hz).

The first tests with electromagnetic waves for the transmission of radio signals were carried out by Aleksandar Popov in 1894. After an array of tests and studies, Popov developed the world's first radio receiver, delineated in the Image 2.1 (Ilcev, 2005).



Image 2.1: The Radio receiver developed by Popov (Web2, 2009)

The telephone was invented subsequently, technological advancements associated with electricity. The modern telephone is the consequence of the endeavors of many groups (Lewis, 1995). Nevertheless, Alexander Graham Bell was the first to patent the phone as "a device for transmitting voices or other sounds by telegraph". Bell is often considered the inventor of the first practical phone. Figure 2.3 shows that Alexander Graham Bell's presentation about the telephone (Evenson, A. Edward, 2000).

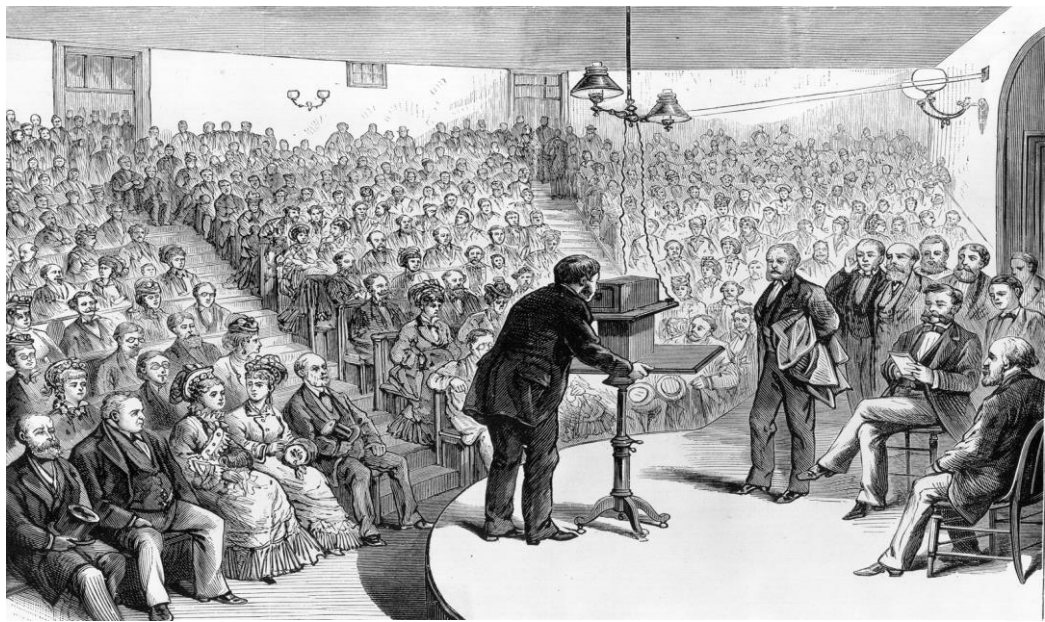


Figure 2.3: Alexander Graham Bell's presentation about telephone (Web 3, 1887)

2.3. Satellite

A satellite is an article that revolves around a sizeable substance. The earth and other planets circumference the sun are the satellites of the sun. The Moon is the Earth's satellite, as the Moon gyrates around the Earth. Earth, other planets, and the moon are described as natural satellites (Web, 4, 2014).

Fabricated machines produced for certain intents are termed artificial satellites. These kinds of satellites are launched to foreordained orbits in space by rockets. Satellites take pictures for meteorologists to foretell weather forecasts, hurricanes, and blizzards. Some satellites take pictures of black holes and the sun, and these photos help scientists analyze the universe better. There are also satellites that

enable communication and television signals to be received from Earth. Global communication can be provided in the world with these satellites. Furthermore, your rigorous location can be ascertained by Global Positioning System's (GPS) satellites and GPS receiver.

Figure 2.4 shows that the satellite communication network scheme.

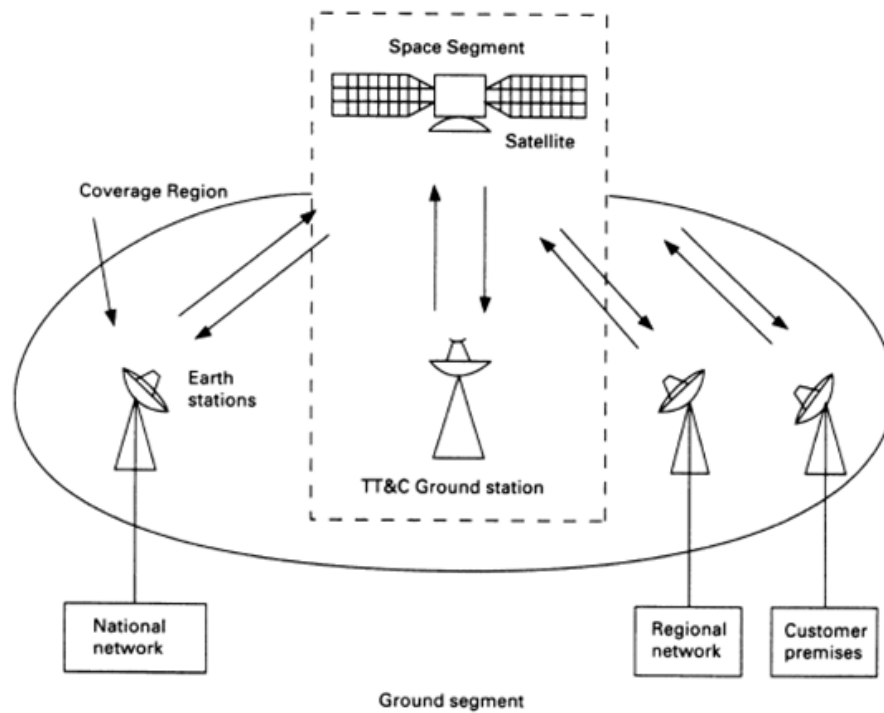


Figure 2.4 Satellite communication network (Richharia, 2009)

3. THE SATELLITE COMMUNICATION

3.1. The History of Satellite Communication

The history and milestones of satellite communication:

1232

- During the Kai-Keng war, the Chinese repulsed the Mongolians with "flying fire arrows" bombardment. These fire arrows are an elemental form of a solid propellant rocket (Web 5, 2014).

1903

- Russian teacher and engineer Konstantin E. Tsiolkovsky came up with the idea of spaceflight. He told that "Earth is the cradle of humankind, but one can not persist in the cradle endlessly." (Web 6, 2010)

1926

- The first liquid-fuel rocket launched by R.H. Goddard in Auburn, Massachusetts, the United States of America(USA) on March 16, 1926. (Web 7, 2010)

1929

- Hermann Oberth and Herman Noordung (Herman Potocnik) explained the concept of the GEO (Oberth, 1929).

1942

- The first successful space rocket was launched in Germany in 1942. Dr. Wernher von Braun and his team operated a laboratory at Peenemünde after 1937. The rocket was exploited during World War 2 (Web 8, 2017).

1945

- Arthur C. Clarke promulgated her perceptions on GEO satellites for the worldwide communication and broadcast system in an article. (Arthur, 1945).

1957

- The world's first artificial satellite, Sputnik-1, was launched into space by the Union of Soviet Socialist Republics (USSR) (Terry, 2013).
- The world's first radio signals sent to Earth by Sputnik-1 satellite were perceived (Ralph, Oleg et al., 2007).
- Image 3.1 and Image 3.2 demonstrate that Sputnik-1.

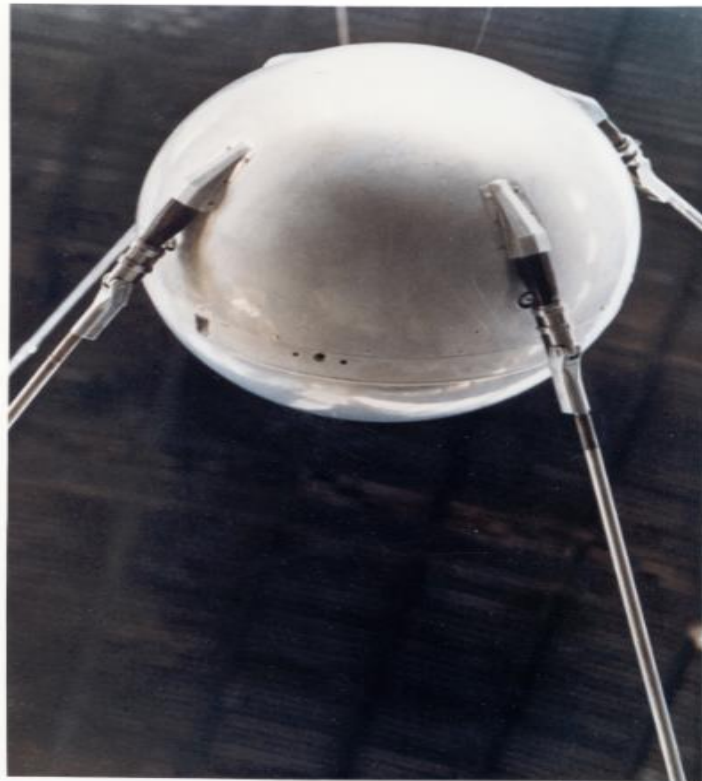


Image 3.1: Sputnik1 (Web 9, 2009)

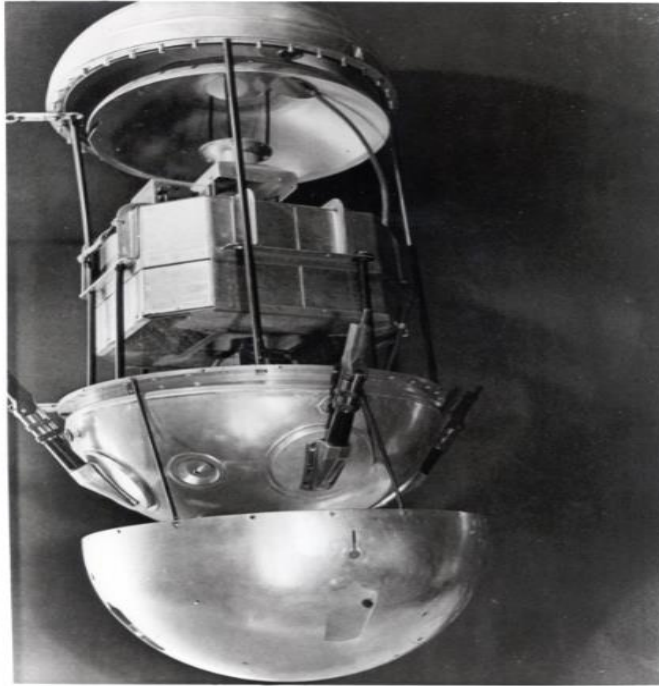


Image 3.2: Sputnik1 (Web 10, 2009)

1958

- The first artificial communications satellite Explorer-1 was launched by the United States (Web 11, 2018).
- Image 3.3 shows that Explorer-1.



Image 3.3 Explorer1 (Web 12, 2017)

1960

- The first passive communications satellite ECHO-1 was launched into space (Web 13, 2010).
- The first active relay communication endeavor was made by the Courier-1B satellite utilization a delayed relay communication at 2 GHz (Senn, 1960).

1962

- The first active communication satellite is TELSTAR-1 launched (Martin, Anderson et al., 2007).
- The Relay-1 satellite was launched (Martin, 2000).

1963

- The first international legal prescripts on satellite communication were condemned by the International Telecommunication Union.
- SYNCOM-2, the first fixed satellite was launched (Henry, McDonald et al., 1965).
The satellite has telephone communication and TV channels.

1965

- INTELSAT-1, which is The Early Bird, satellite the first commercial ground fixed communication satellite, was launched. The satellite has telephone and TV channels. The first time, communication was established between the Federal Republic of Germany, England, the USA, and France via satellite (Web 14, 2017).
- MOLNIYA-1 satellite was launched (Martin, 2000).

1967

- INTELSAT-2 was launched for utilization in the Pacific and Atlantic (Web 15, 2020).

1968

- INTELSAT-III satellite was launched. INTELSAT has initiated global business activity (Web 16, 2019).

1971

- INTERSPUTNIK is a global satellite communications services establishment founded on 15 November 1971 (Web 17, 2021).

1972

- INTELSAT IV satellite was launched (Web 18, 2017).

1974

- WESTAR 1 satellite has been launched successfully on 13 April 1974. The first domestic satellite communications have started in the USA (Web 19, 2019).
- SYMPHONIE-1 satellite was launched (NASA, 1974).

1975

- It was the first successful direct television broadcast between the US and India. The broadcast remained active for 1 year (Krige, Long et al., 2013).

1976

- MARISAT, the first communication satellite for maritime was launched (Ilcev, 2019).
- PALAPA-1 satellite was launched in 8 July 1976. It is the first communication system in a developing country like Indonesia (Web 20, 2019).

1977

- European Telecommunications Satellite Organization, EUTELSAT has been established (Web 21, 2021).
- SIRIO, the Italian satellite, was launched. It is the first satellite to attempt exceeding 15 Gigahertz (Web 22, 2021).

- World Broadcast and Satellite Administrative Radio Conference was organized in Geneva by the International Telecommunication Union (Web 23, 1977).

1978

- The BSE, the first Japanese satellite, was launched (Web 24, 2017).

1979

- International mobile satellite organization (Inmarsat) has been established for global maritime satellite communications (Sagar, 1999).

1981

- The first reusable American Space Shuttle was improved (Web 25, 2017).
- Satellite-based marketing phases initiated in the USA. Teleports, Very small aperture terminal (VSAT) etc.

1982

- International maritime communication has developed into operational.

1983

- Japan's CS-2 satellite was launched (Web 26, 2019).
- EUTELSAT's first satellite, ECS, was launched (Web 27, 2021).

1984

- The first direct-to-home (DTH) broadcasting system started in Japan (Web 28, 2011) .
- Experiments of mobile communications for ground have been prosperous by INMERSAT.
- The receive and transmit operations of VSAT systems have started to be wholly functional.
- TELECOM 1, France's first satellite, was launched (Web 29, 2019).

1985

- The first symposium in the world was organized by ITU regarding the use of GEO.

1987

- Global mobile satellite communications on ground and aviation have been launched by Inmarsat.

1989

- INTELSAT VI satellite was launched (Web 30, 2021).

1992

- Spain's first satellite, Hispasat-1, was launched. The system was used for Satellite News Gathering (SNG), Television Receive Only (TVRO), VSAT, governmental communications (Web 31, 2021).

1994

- The Turkey's first successful satellite Turksat 1B was launched (Web 32, 2021).

1995

- The largest annual growth has been accomplished in the number of VSATs.
- Spectrum allocations for GEO have commenced.
- Tests have begun for ORBCOM, the first commercial LEO satellite with low data rate.

1997

- LEO satellites have been launched by Iridium to facilitate voice communication with handheld terminals. Besides, voice communication services with desktop phone-sized devices have been inception by Inmarsat.

1998

- LEO and MEO satellites have been launched. Assorted satellite services were launched, including Mobile Satellite Services and Fixed Satellite Services. Satellite companies yielding these services are : Teledesic, Iridium, Skybridge, Globalstar (Web 33, 2015).

1999

- The transition to the direct audio broadcasting system has begun.

2000-2005

- Broadband communication has been pioneered.
- Ka-Band systems enhanced.

2005-~

- LEO satellite constellations are launched to assure global communication. Iridium, SpaceX, OneWeb (Web 34, 2019).

3.2. The Orbits of Satellite

The structure of the orbit is important in the design of satellite communication systems. Satellites can be situated in certain orbits around the earth because of the structure of the earth. Orbits can be examined subordinate to two main headings, circular and elliptical. But elliptical orbits are utilized merely in the world to watch some television broadcasts. Hence, it is less important than the circular orbit. The orbits are shown in Figure 3.1. Circular orbits are investigated under 3 main headings:

- 1. Geostationary Earth Orbit (GEO)**
- 2. Middle Earth Orbit (MEO)**
- 3. Low Earth Orbit (LEO)**

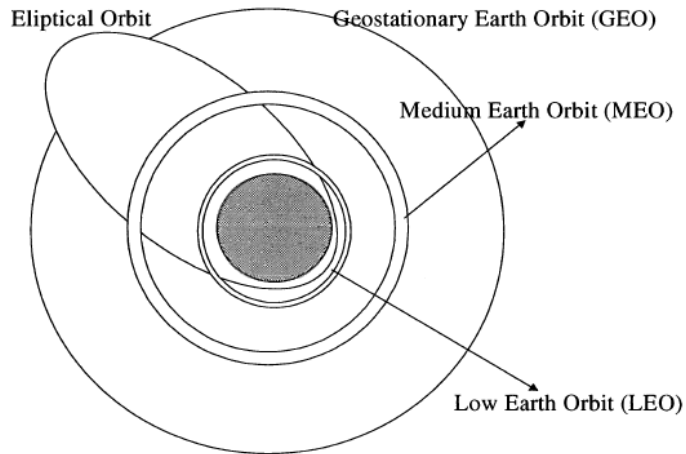


Figure 3.1: The Earth Orbits (Wood, 2000)

3.2.1. Geostationary Earth Orbit (GEO)

The geostationary orbit is located 35.768 kilometers from Earth. It appears to stand according to the Earth's law of gravity at this altitude. Thus, satellites can consistently broadcast to specific locations in the world. For illustration, Türksat 4A can merely broadcast to Europe, Asia, and Africa. But the satellite can get out of orbit from north to south. This issue is restored by guiding satellites through ground stations.

The geostationary orbit is uttered as a geosynchronous orbit. Television broadcasting satellites and communication satellites are in this orbit.

Some GEO Satellites:

- Türksat 4B
- Eutelsat KA-SAT 9A
- Arabsat 5C
- Astra 3B

3.2.2. Middle Earth Orbit (MEO)

The distances of the middle earth orbit satellites to the Earth are from 2000 kilometers up to 10.000 kilometers. Global Positioning System (GPS) satellites are in this orbit (Web 35, 2021). This orbit also includes the orbit Molniya. It was invented

by the Russians (Kolyuka et al.,(2009). It is peculiarly efficacious for observing high latitudes and view for distant north and south locations.

Some MEO Satellites:

- Viasat
- SES O3b

3.2.3. Low Earth Orbit (LEO)

Its distance from the world is between 500 and 2000 km. Many scientific satellites and meteorological satellites are in this orbit. In recent years, satellite constellation projects that have been operating in low orbit have been launched to assure global communication.

3.2.4. Comparison: GEO, MEO, LEO

Table 3.1 Comparison GEO, MEO, LEO

	GEO	MEO	LEO
Distance from the World	35768 km	2000-10000 km	500-2000 km
Latency	400 ms	130 ms	50 ms
Capacity	50-100 Mbps	100-800 Mbps	1-5 Gbps
Period of Orbit	24 Hours	2-8 hours	10-40 minutes
Lifetime	3-7 Years	10-15 Years	10-15 Years
Gateway Cost	Cheap	Expensive	Very Expensive
Propagation Loss	Large	Medium	Short
Satellite Cost	Maximum	Medium	Minumum
Antenna Size	Large	Medium	Small
Transmitter Power	Large	Medium	Small

3.3. Frequency Bands for Satellite Communication

Radio frequencies are used for inter-satellite communications and communication between satellites and ground stations. Figure 3.2 shows the frequency chart used to provide satellite communication.

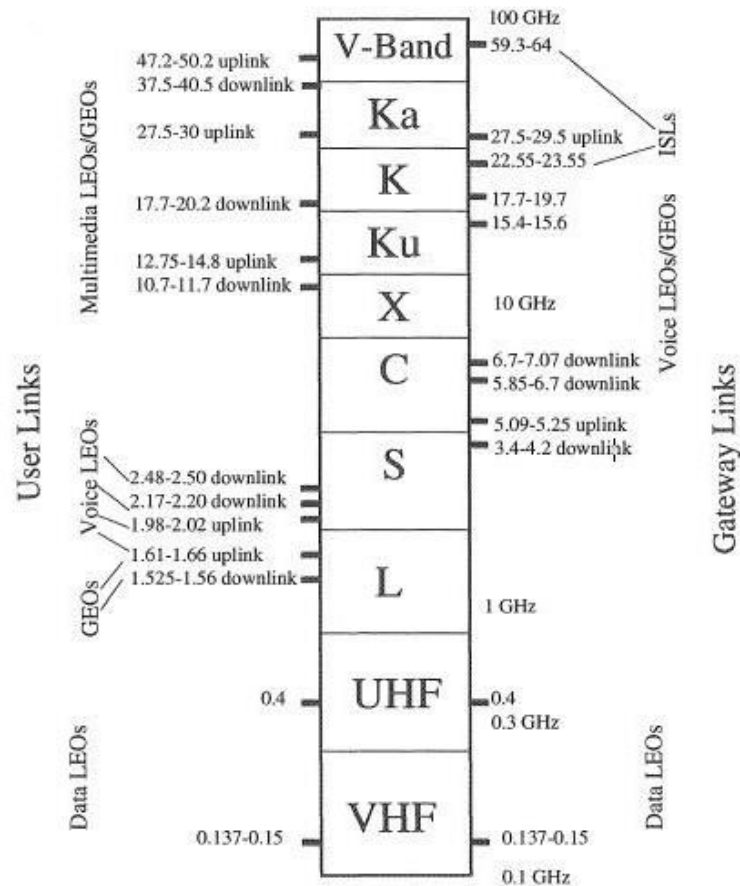


Figure 3.2: Frequency bands for satellite communication (Lutz et al., 2002)

3.4. Satellite Services

Satellite services are categorized reporting to their area of utilization. These services are:

1. Fixed Satellite Services,
2. Broadcast Satellite Services,
3. Mobile Satellite Services.

3.4.1. Fixed Satellite Service (FSS):

It is a satellite service used for satellite ground terminals that can connect to one or more satellites. It is used for sending video, audio, and IP data.

3.4.2. Broadcast Satellite Service (BSS):

This is a service that endows televisions and radios to be received from satellites in a predestined frequency band. Service is operated from one point to numerous points. Anyone inside the satellite coverage region can watch TV broadcasts via satellite. Users can watch these broadcasts with small antennas under 1 meter.

Figure 3.3 shows that Broadcast Satellite Services scheme .

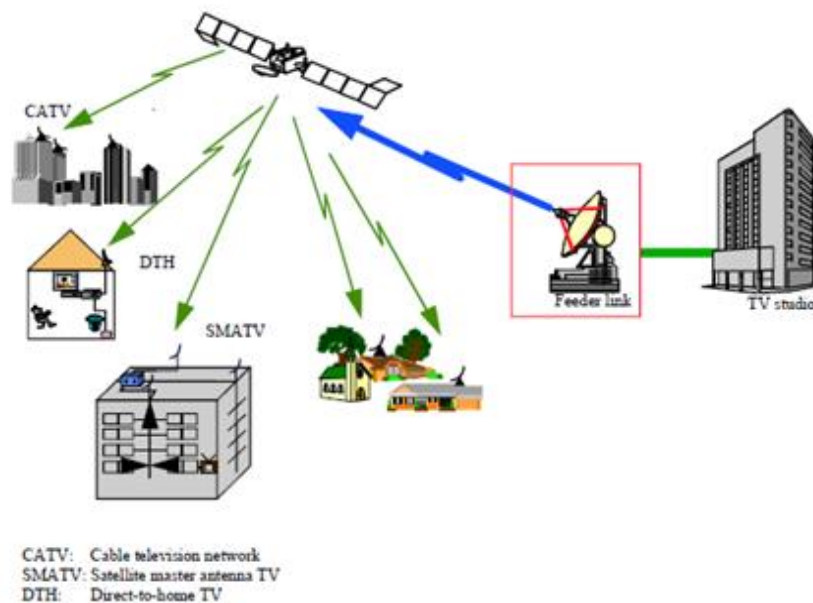


Figure 3.3: Broadcast Satellite Services (ITU 1, 2002)

3.4.3. Mobile Satellite Service (MSS):

This service provides satellite communication of land, sea, air vehicles, and mobile platforms while in motion. Uninterrupted communication can be provided with these services during in motion.

Figure 3.4 shows that Mobile Satellite Services.

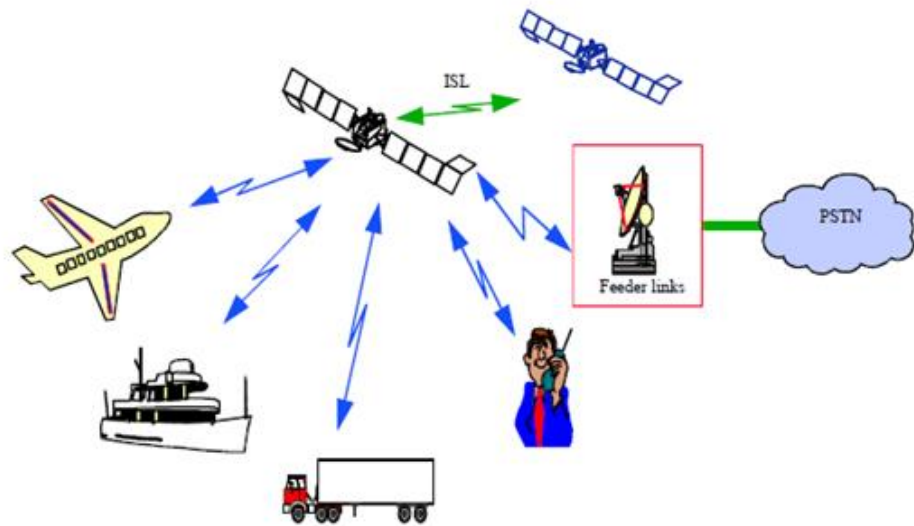


Figure 3.4.: Mobile Satellite Services (ITU 2,2002)

4. LEO SATELLITE CONSTELLATIONS

GEO satellites are utilized for both communication and television broadcasts. There are currently over 2500 GEO satellites (Web 36, 2019). Using GEO satellites for communication is utterly pricey because of the high investment cost of the satellite. In addition, it is not appropriate for many applications because of the high latency and low bandwidth.

Various companies have been launching the LEO constellations since 1990. These constellations are proposed to be used for worldwide communication. In the next 10 years, there will be approximately 50,000 LEO satellites in space (Web 37, 2021). These satellites submit internet connection with low latency and cater overmuch bandwidth than GEO satellite's.

Companies such as Globalstar and Iridium have created various LEO projects. Nonetheless, companies other than Iridium relinquished their satellites because of excessive expenditure and inadequate requisition. User capability has accrued due to developing satellite technology and modifying requirements in recent years. These satellites are of considerable importance, peculiarly for the 5th Generation Mobile Telecommunication Service (5G).

The COVID-19 outbreak as well influences the perspective of the satellite market. Internet capacity requisite is expanding gradually because of the pandemic. Meeting and education sessions by way of remote video conferencing likewise increment the necessity for bandwidth. This emphatically impinges on the futurity of LEO satellites.

4.1. Why Low Earth Orbit?

LEO Satellites are situated at an interval from the Earth turning from 500 kilometers up to 2000 kilometers. Its vantages over geosynchronous satellites are its low latency and low operating expenditure.

Latency in satellite systems refers to the time that passes during the transmission and receives of data. The latency in geosynchronous satellite systems is at the grade of 600 milliseconds. It can not be a substitute for many communication systems because of the high latency.

LEO satellites are in low orbit, thus the latency is inferior. Confer to the analysis conducted by OneWeb, one of the LEO constellation companies, in July 2020, the delay time was measured as 32 milliseconds (Web 38, 2019). This delay grade makes it conceivable to operate LEO satellites as a substitute for some communication systems.

4.2. Cost Calculations for LEO Constellation Satellites

The cost of LEO satellites is much lower than GEO satellites. GEO satellite per kilogram is 30.000 US Dollars (Web 39, 2021). Starlink expenditure of the 12.000 system will be 10 Billion US Dollars (Baylor, 2018). The system is designed to improve global internet access by utilizing thousands of satellites in Low Earth orbit (Web 40, 2018). According to this calculation, Starlink's target per kilogram is 1850 US Dollars.

4.3. LEO Projects

- **SpaceX Starlink**

42,000 satellite plans (Web 41, 2020).

- **OneWeb**

Planning a constellation of 2000 satellites. They plan to offer full global commercial coverage by 2021 (Web 42, 2017).

- **Iridium Next**

A constellation project involving 66 satellites was initiated by Iridum Next in 2017 (Web 43, 2019).

4.3.1. SpaceX Starlink

Starlink is a constellation satellite project contrived by SpaceX for low earth orbit. The endeavor of the project is to yield a high-speed and low latency internet connection with worldwide communication. The owner of the company is Elon Musk. Figure 4.1 shows the Starlink logo.

Starlink evolve into an alternative to cable communication and fiber communication, as it propounds bandwidth up to 1 Gigabit/s with delays of 25 milliseconds and 35 milliseconds (Web 44, 2015).

Image 4.1 shows the SpaceX Starlink logo.



Image 4.1 : SpaceX Starlink logo (image credit: SpaceX)

Some technical parameters:

- Ka Band frequency,
- Phased array antennas,
- A solar panel,
- 227 kilogram spacecraft,
- Navigation system,
- It will be located at a distance of 550 km. SpaceX rockets will spread the constellation over 24 orbital planes with a 53° inclination.

Conform to the approval received from the Federal Communications Facility (FCC) for SpaceX, Starlink satellite constellation, roughly 1 million ground station antennas will be installed (Web 45, 2020).

Image 4.2 shows the first launch of SpaceX.



Image 4.2: First launch of the SpaceX (image credit: Satnews Daily)

The aim of SpaceX is to provide conveniently approachable communication at all points that will surround the world like a spider web. The artist demonstrated this in Figure 4.1.

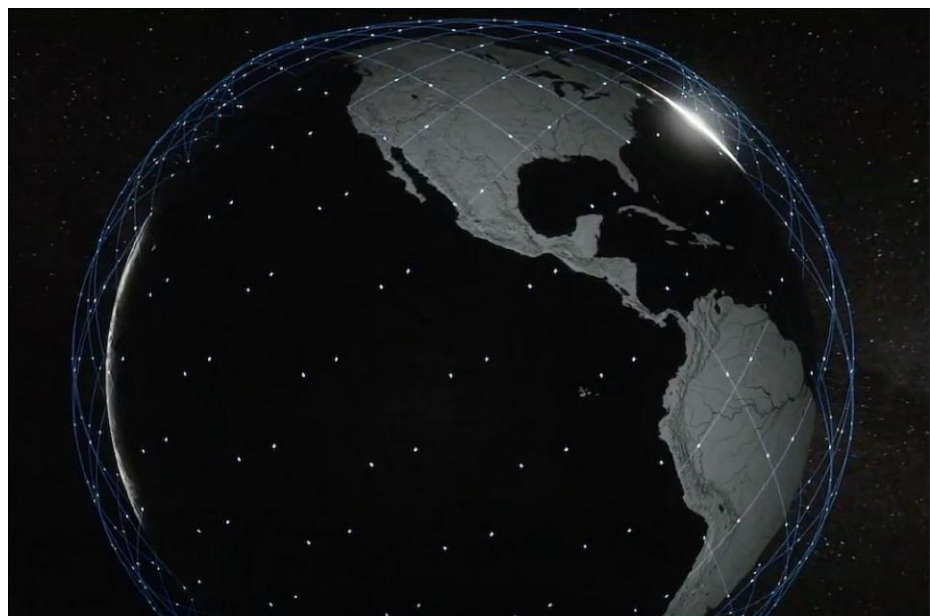


Figure 4.1: SpaceX Starlink Satellites view around the world (image credit: SpaceX)

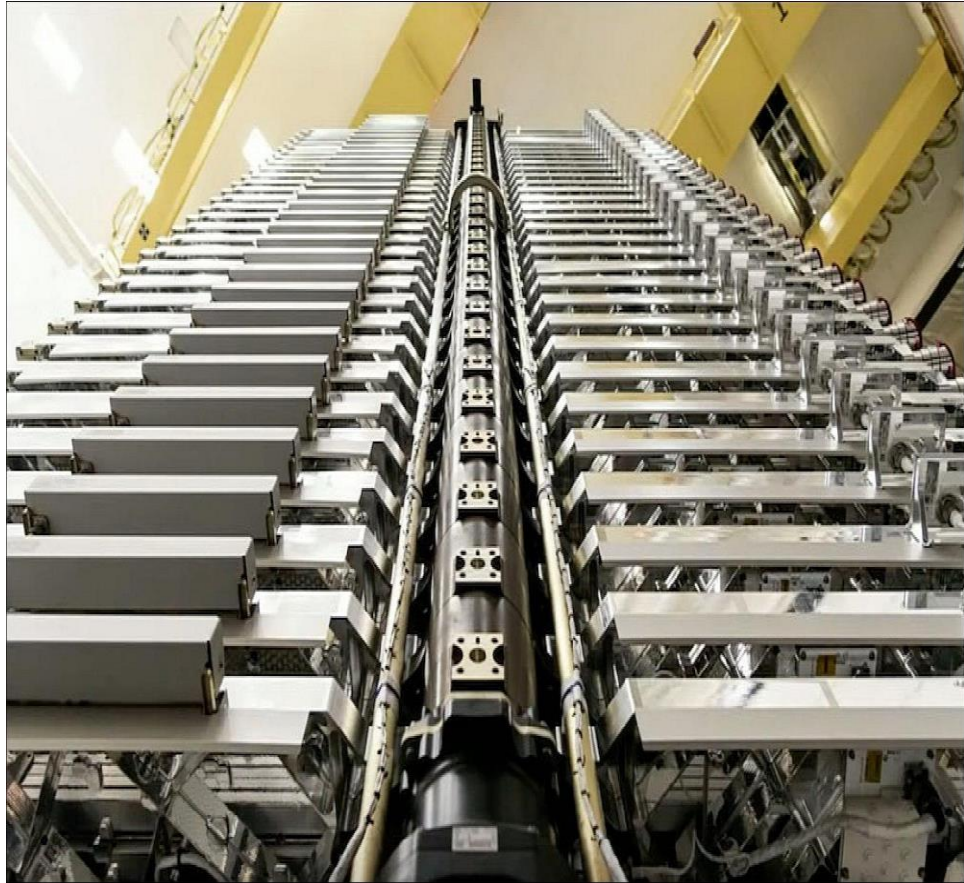


Image 4.3: Starlink Satellites before launch(image credit: SpaceX)

4.3.2. Oneweb

OneWeb has endorsed a concurrence with Airbus Defense and Space for the design, production, and development of the satellite constellation. This satellite program is funded by Bharti Enterprises, Virgin Group, Intelsat, Qualcomm, Airbus Group, and Hughes Network Systems. The constellation comprises 900 satellites in total and weighs 150 kilograms separately. According to the preceding data, it was planned to commence service in 2018, but it is awaited to serve in 2021 because of the coronavirus pandemic. (Web 46, 2015; Web 47, 2015; Web 48, 2015).

Image 4.4 shows the OneWeb logo.



Image 4.4 : OneWeb constellation logo (image credit: OneWeb)

648 of the 900 satellites will be allocated in low orbit, encompassing 1200 kilometers from the Earth. The leftover satellites will be kept as substitutes, both in orbit and at the factory.

The intention of the constellation is to supply both worldwide communication and an affordable high-speed internet connection to rural and underdeveloped areas. Also, the constellation work with Intelsat's Ku Band satellites. This caters to uninterrupted high-speed and low latency internet in mobile systems such as ships, planes, trains, oil, gas exploration platforms, and land vehicles (Web 49, 2015).

The artist demonstrated OneWeb satellites in Figure 4.2.

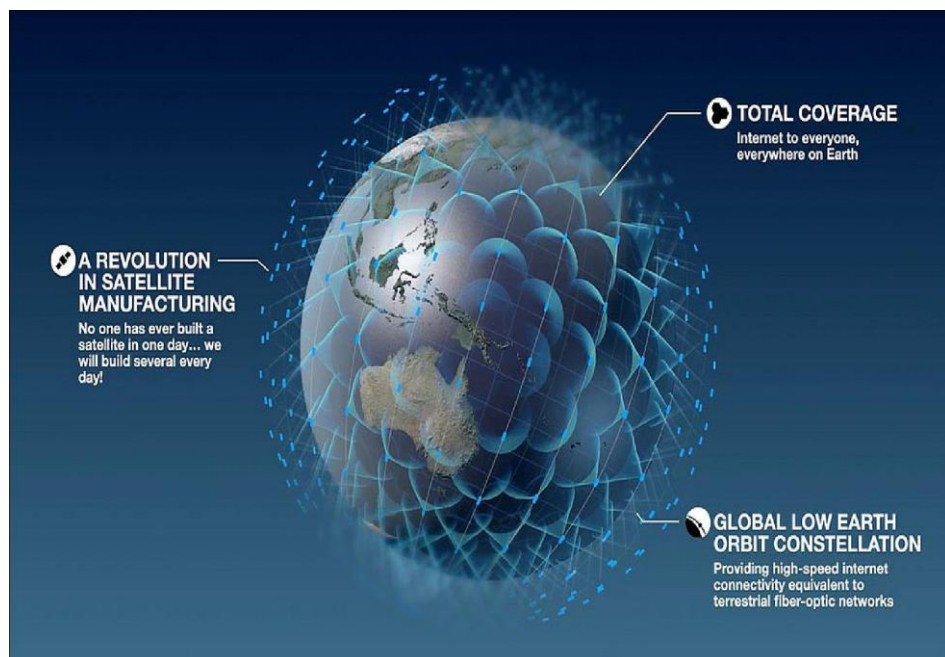


Figure 4.2: OneWeb Satellites view around the world(image credit: Airbus DS)

Figure 4.3 shows the OneWeb system architecture.

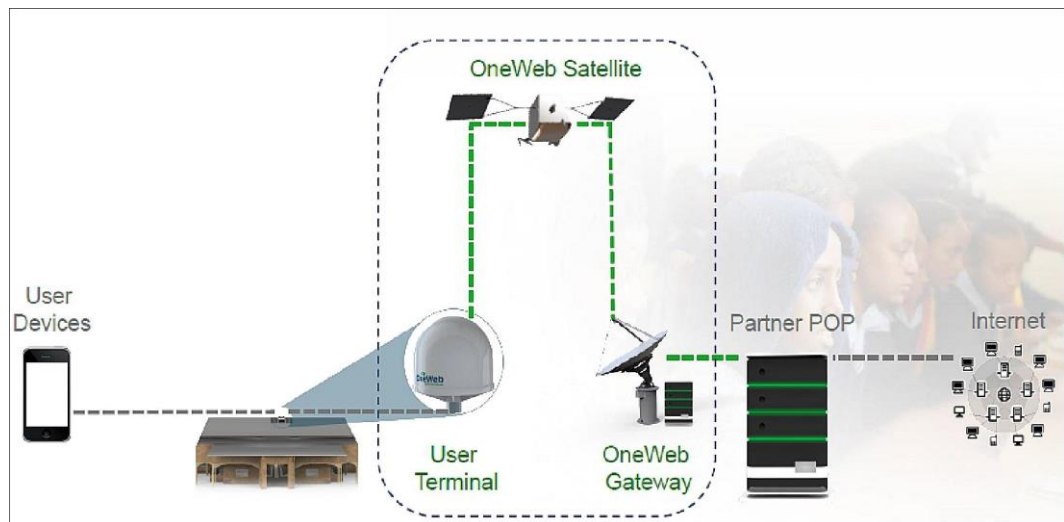


Figure 4.3: OneWeb communication system architecture (image credit: OneWeb)

Figure 4.4 shows the OneWeb system overview.



Figure 4.4 : OneWeb communication system overview (image credit:OneWeb)

Some technical parameters:

- A industrial plant investiture of 85 million dollars for the production of satellites,
- 13,900 square meters manufacture area.
- The endmost technology assembly, integration, and test lines.
- A state-of-the-art factory, producing satellites at about 1/50 of the cost of a conventional satellite manufacturer.
- 150-kilogram spacecraft.
- 60-kilogram payload.
- The lifespan of the produced satellites will be over 5 years in 1200 kilometers orbit, and over 7 years in 500 kilometers orbit.
- 1m x 1m x 1.3m size.
- 2 external solar panels.
- Ku Band for users, Ka Band for gateways.
- OneWeb satellites will function in compliance with the Inter-Agency Space Debris Coordination Committee (IADC) regulations. It will automatically depart orbit when the lifespan of the satellite remnant (Web 50, 2021).

Figure 4.5 shows the rendering of OneWeb satellite.

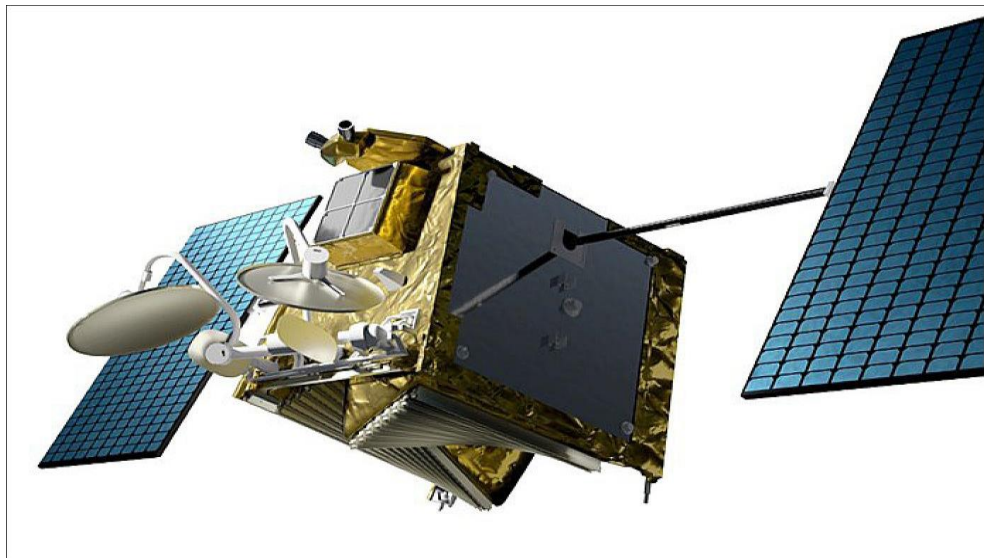


Figure 4.5: Drawing of the satellite (image credit: Airbus)

Figure 4.6 shows the deploy the satellites from the rocket.



Figure 4.6: Illustration of OneWeb satellites on Launch (image credit: RUAG Space)



Image 4.5: Oneweb satellites at the Airbus Facility (image credit: Airbus, Oneweb)

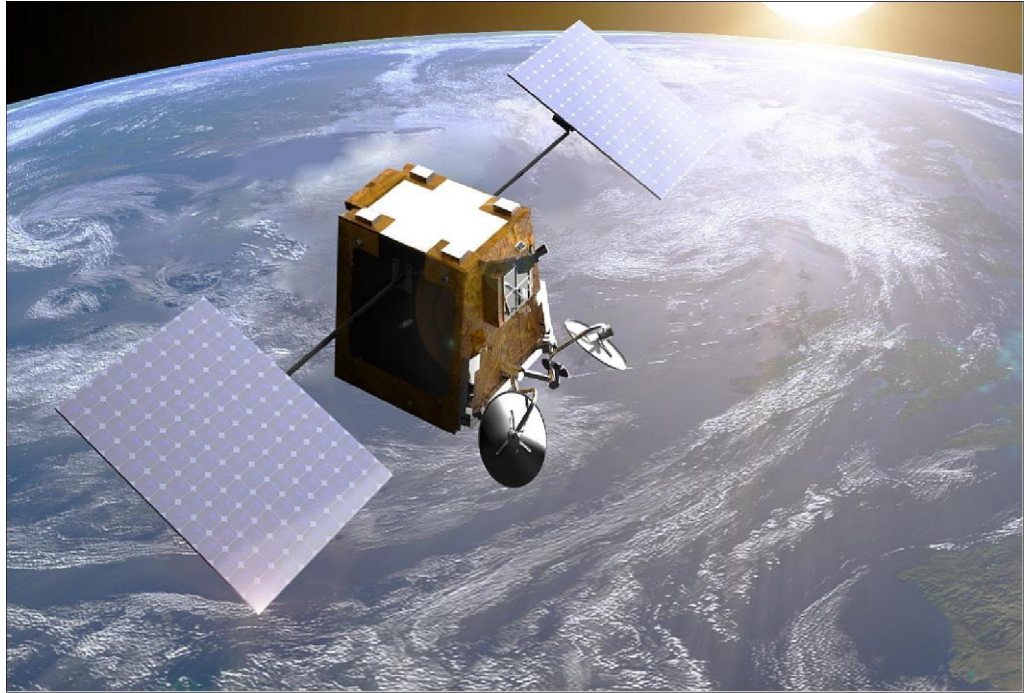


Image 4.6: OneWeb satellite deployed in orbit (image credit: OneWeb)

4.3.3. Iridium NEXT

Iridium Communications Incorporation (ICI) is a mobile satellite services organization that endeavors global voice and data coverage. The organization is the operator and proprietor of the constellation. Figure 4.7 shows the Iridium global coverage.

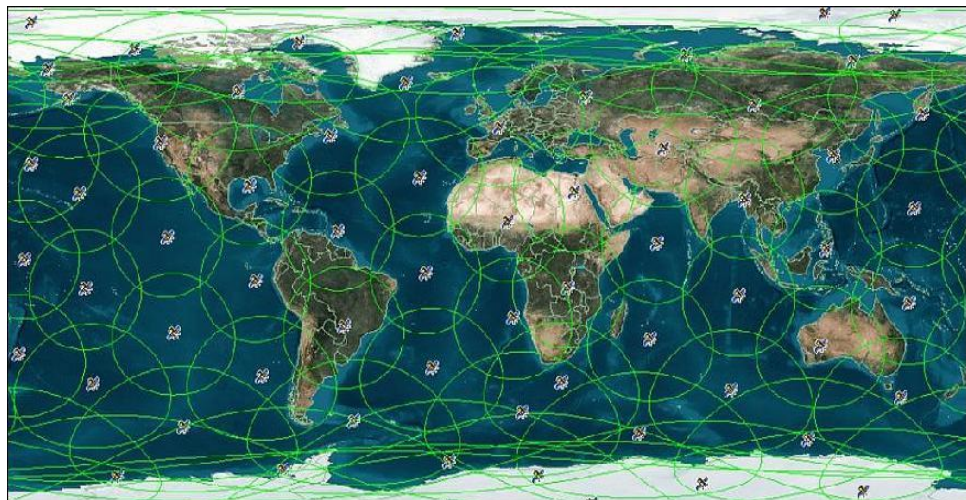


Figure 4.7: Constellation global coverage (image credit: Iridium)

The Iridium NEXT Constellation comprises 66 satellites. The constellation operates 780 kilometers from Earth and an inclination of 86.4 °. The satellite's lifespan is over 10 years (Web 51, 2019).

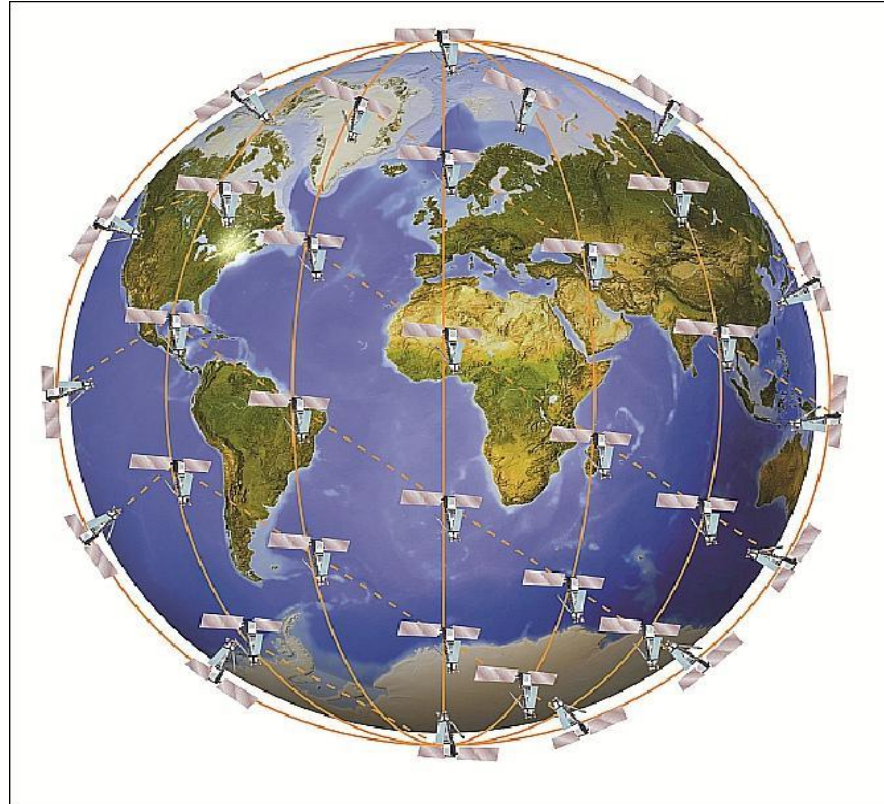


Figure 4.8: Iridium NEXT constellation view around the world(image credit: Iridium Satellite)

Figure 4.9 also shows the deployed satellite.



Figure 4.9: Deployed Iridium NEXT satellite (image credit: Thales Alenia Space)

Some technical parameters:

- 66 satellites,
- 780 kilometers from Earth
- 86.4° inclination,
- 50-kilogram payload,
- 40 cm x 70 cm x 30 cm size,
- 50 Watt-200 Watt power,
- Operation life 15 years,
- Missions:
 - ✓ There are altimeters to analyze sea surfaces and waves and to monitor the level of the ice.
 - ✓ GPS Radio Occultation is available to gauge temperature, atmospheric humidity, and weather data in space.
 - ✓ There are Broadband Radiometers to gauge the radiation stage of the Earth.
 - ✓ Multispectral Imagers are available to scrutinize land and ocean.
 - ✓ Vector sensors that pursue the cloud movement are available. These sensors find out forest fires and polar winds.
- 860-kilogram spacecraft,
- 3.1 m x 2.4 m x 1.5 m spacecraft size,
- Radio Frequency Communications:
 - ✓ Phased array antenna with 48 beams,
 - ✓ 2 pieces, 20/30 Gigahertz steerable feeder links to terrestrial gateways
 - ✓ 20/30 Gigahertz links via Omni antennas

(Web 52, 2021)

Image 4.7 shows the Iridium NEXT satellite's view at the facility.



Image 4.7: Iridium NEXT satellite's view at the facility (image credit: Iridium)

4.4. LEO Satellite Terminals

4.4.1. Satcom on the Move Antenna

Satcom is the descriptor for satellite communication. SOTM (Satcom on the move) is an antenna system used to yield uninterrupted satellite communication on the moving sea, land, and air conveyances. The systems function with GEO, MEO, and LEO satellites.

Türksat SOTM Antenna empowers internet connection at sea via satellite. The system caters to communication in expanses where there is no internet infrastructure. A roaming infrastructure is established with other satellite operators over the SOTM antenna in areas which has not covered by Türksat communication satellites. SOTM antenna has been designed and manufactured with indigenous competencies. Solutions of the SOTM antenna for conveyances such as buses will be overtured to the marketplace.

Image 4.8 shows that the Türksat SOTM Antenna technical specifications.



Image 4.8: Turksat SOTM Antenna for Maritime(Image Credit: Turksat)

SOTM antenna systems for the terrestrial are designed and produced by Turasis İletişim Teknolojileri A.Ş. Image 4.9 and Image 4.10 demonstrate this antenna system. This system is used in conveyances (automobiles, trucks, trains, military conveyances) for communication on the move. The system locks the satellite automatically on the move.



Image 4.9: Turasis Communication Technologies Inc. SOTM Antenna for Land
(Image Credit: Turasis)



Image 4.10 : Turasis Communication Technologies Inc. SOTM Antenna for Land (Image Credit: Turasis)

4.4.2. VSAT Autopoint Antenna System

VSAT is is the descriptor for a very small aperture terminal. It yields satellite communication with small size (0.7 meters to 2.4 meters) satellite terminals. Autopoint antenna is the system that provides satellite communication by automatically finding the satellite of VSAT systems in motionless platforms.

Autopoint Antenna is designed and produced by Turasis İletişim Teknolojileri A.Ş and Ms Satcom Uydu Haberleşme Ltd. Satellite communications can be provided

uninterruptedly using the antenna and Ka, Ku, and C band frequencies. It can be easily mounted at any conveyance or place with the mounting table. It takes only a few minutes to turn on and picking the satellite. It countenances users to access the web, e-mail, and many important applications.

Image 4.11 shows a VSAT Autopoint antenna.



Image 4.11: VSAT Autopoint Antenna (Image Credit: Turasis)

4.4.3. Flyaway Antenna

It is a system comprising carbon fiber or aluminum reflector, elevation and azimuth alteration mechanism, an application for showing satellite route in hand-operated altering, and a tripod. The antenna is packaged in a knapsack or container for effortless transporting.

The antenna can be installed with 1 personage in a supreme of 5 minutes, and satellite communication can be provided within 2 minutes. There are no limitations regionally, and the antenna works independently from the conveyances.

Image 4.12 demonstrate a flyaway antenna.



Image 4.12: Turasis Communication Technologies Inc. Flyaway Antenna
(Image Credit: Turasis)

5. TELEMEDICINE

5.1. What is Telemedicine ?

Telemedicine is the detection and treatment of the patient's trouble distantly. It can be used in all geographies through communication via satellite and yield to contribute treatment for patients. According to the World Health Organization report, information and communication technologies are used for the exchange of information required for the diagnosis, treatment and prevention of diseases and injuries in rural and remote areas where health opportunities are limited (WHO, 2017).

5.2. The History of Telemedicine

Telemedicine has been used in our lifetimes since the 19th century in collateral with the alterations in technology.

Some milestones about Telemedicine:

- **1600s - 1700s**

Consulting with correspondence because of the lack of access to doctors in several regions, or frequently get sentiment from a famous doctor (Louis-Courvoisier and Mauron, 2002).

- **1700s**

Patients who sent urine samples to distant physicians were examined by uroscopy (Fine, 1986).

Prescriptions were written and comprehensive instructions on treatments were sent by telegraph (Wild, 2000).

- **1874**

Evidence proposes that the telegraph was utilized in Australia to care for a wounded human and to reunite a deceased man with his wife 2000 kilometers distantly (Eikelboom, 2012).

- **1879**

A mother had the doctor observe the baby's cough by phone to delimitate if her baby had croup (Aronson, 1977).

- **1905**

Electrocardiograms were transferred electronically by Willem Einthoven (Shannon, 2009).

- **1910**

Cardiologists proclaimed that electrocardiograms (ECG) were transmitted distantly to analyze "hypertrophy and arrhythmia." (James, 1910).

Engineer Sidney Brown illustrious that by phone, it is conceivable to precisely comprehend the sounds of a stethoscope that a patient holds miles distant and make an accurate diagnosis (Bashshur et al., 2014).

- **1920s**

Haukeland Hospital in Norway commenced bestowing two-way radio communications with vessels to direct treatment and doctors (Bashshur and Shannon, 2009).

- **1925**

The hypothetical perception of "radio doctor" granting distant care using sound was vindicated in an article frequently adduced in Science and Invention magazine (Gernsbeck, 1925).

- **1950**

The cognitive content of distant diagnosis was delineated in the medical literature by the term telegnosis, which originated regarding the telephone transmission of radiological images between Philadelphia, Pennsylvania (Gershon-Cohen and Cooley, 1950).

Teleradiology has been repeated at the Jean-Talon Hospital in Montreal (Allen, 1994).

- **1959**

Sending of fluoroscopic figures was accomplished in Canada (Jutra, 1959).

Neurological scrutinies were transmitted to the University of Nebraska to be utilized in the education of medical students (Benschoter et al., 1972).

- **1960s**

In the 1960s, articles were promulgated on cardiac monitoring, wireless transmission of ECGs, and X-ray images (Monnier et al., 1965).

Nebraska Psychiatry Institute has entrenched a closed-circuit television system for psychiatric deliberations (Brown, 1998).

NASA used satellite technology to appraise the health of astronauts during space travel. As part of improving services using satellite supported telemedicine, NASA and Lockheed cooperated in a project to provide medical services to Papago Indians in Arizona (Institute, 1996).

- **1967**

The cardiac data was sent to emergency physicians in Miami,USA with radio transmission (Nagel et al., (1968).

- **1968**

Nurses employed at Logan Airport were affiliated to Massachusetts General Hospital through a microwave relay in order to contribute emergency medical services. Nurses provided emergency and primary medical services to travelers and airport personnel (Murphy and Bird, 1974).

- **1970**

A telepsychiatry link has been established between Massachusetts General Hospital and Veterans Administration Hospital (Crump and Pfeil, 1995).

- **1972**

The National Aeronautics and Space Administration (NASA) has afforded a link between communities and hospitals in Alaska through the ATS-1 satellite to provide health care services (Hudson and Parker, 1973).

- **1984**

The Australian Government has established a satellite network for telemedicine. The project describes North West Telemedicine Project. Health services have been provided to communities in the north of Australia (Watson, 1989).

- **1989**

After the earthquake in Armenia in 1988, a telemedicine network was established under the guidance of NASA with the attendance of the University of Utah, Texas University, LDS Hospital, Maryland Emergency Medical Service Systems Institute, and Uniformed Services Health University (Web 53, 1991).

- **1993**

The American Telemedicine Association was established (Web 54, 2021).

- **1996**

The H.323 protocol provides audio and video communication over a computer network. It has been promulgated by the International Telecommunication Union (Davidson et al., 2000).

- **2000**

Sentara Healthcare in Virginia was the first to execute the tele-intensive care (tele-ICU) conceptualization. Research on the literature, mortality repercussions, and cost-effectiveness has been affirmative (Wilcox and Adhikari, 2012).

- **2003**

The pertinency of telemedicine technology to neonatal intensive care unit has been testified to by the Prenatal and Neonatal Guidelines Education and Learning System (ANGELS) developed in Arkansas. This program is corroborated by periodic telemedicine symposiums and 24/7 telemedicine consultations (Bronstein et al., 2011).

- **2005**

According to the research conducted on telemedicine, promising results have been obtained in patient gratification, conformity with treatments, emergency room utilization, and hospital bed day (Schofield et al., 2005; Darkins et al., 2008).

- **2010**

Tele-ICU daubed over 5,000 intensive care units in almost 250 hospitals (Kumar et al., 2013).

According to the research conducted in PubMed, over 11,000 articles published from 2010 to 2016 comprise the keywords "telemedicine" and "tele-health" (Web 55, 2021).

- **2011**

A telemedicine application was set up by The University of Texas Medical Branch to provide healthcare services for prisoners in order to establish healthcare services in prisons. Although Texas had the highest prisoner numbers in the US, medical care

exemptions were 60% of the national average. This is an indicator of the efficiency achieved through telemedicine (Web 56, 2016).

- **2016**

The Time magazine cited "telemedicine" as one of these reasons in its issue of "240 reasons to celebrate America." (Time Magazine, 2016).

5.3. The Benefits of the Telemedicine

Telemedicine improves the quality of health care in rural and distant areas. It accommodates rapid and snug health care with no patients to be conveyed.

Telemedicine diminishes the expenditure of health care services. It obviates the expenses incurred when physicians, medical specialists, employees, and patients indigence to travel. Consultation with telemedicine is accommodated instead of the medical specialist traveled to the region in rural areas where medical specialists not acquirable. In some cases, if the disease is diagnosed at a beforehand phase with telemedicine, treatment expenditures are also ablated because the disease does not reach progressive periods.

A physician is living in rural regions be bestowed distance instruction with telemedicine, and they have effortless access to up-to-date content. In this way, the diagnosis and treatment operation of physicians are perfected.

5.4. Telemedicine Services and Medical Usage Areas

Telemedicine services:

1. Medical Specialist's Recommendation Services
2. Medical Education

1. Medical Specialist's Recommendation Services:

Professionals transmit the patient's data such as radiology, pathology, dermatology, cardiology to a physician through telemedicine for consultation. The most veracious process to treat the patient is revealed by scrutiny of his/her personal diagnosis with the diagnosis of the specialist physician.

2. Medical Education:

Telemedicine is utilized for physician's education. Image 5.1 shows the video conference for medical education.



Image 5.1: Low cost video conferences for medical education

(Image Credit: www.telemed.org.ua)

Telemedicine medical usage areas:

1. Tele-radiology
 2. Tele-psychiatry
 3. Tele-dermatology
 4. Tele-ophthalmology
 5. Tele-obstetrics
 6. Tele-oncology
 7. Tele-pathology
 8. Tele-ECG
-
1. Tele-radiology: Tele-radiology endeavors to dispatch a patient's x-rays and dossiers to a well-qualified radiologist in another location and get an expeditious consultation on the patient's circumstance.
 2. Tele-psychiatry: Tele-psychiatry and telepsychology diligences are equivalent to a tralatitious face-to-face conversation. The consequences are exceedingly

prosperous as a routine consultation. Psychiatry consents qualified psychiatrists to provide distant counseling to patients, since it rarely compels a corporeal examination.

3. Tele-dermatology: It is ensured the images of skin lesions are sent to a qualified dermatologist with telemedicine for communities living in rural regions and people who can not get support from qualified dermatologists. Treatment processes are complied with according to this diagnosis.
4. Tele-ophthalmology: It reckons ophthalmologists to examine patients' eyes or distantly control treatments (diagnosis and treatment of an eye infection).
5. Tele-obstetrics: It empowers obstetricians to control pregnant women distantly. A consultation is specified by sending the heart rate of the baby, blood and hormone values of the mother to a qualified specialist.
6. Tele-oncology: It obviates cancer patients from moving to hospitals and fatigue. The test consequences are appraised remotely by qualified specialists, and treatment datum is served by video conferencing with the patient.
7. Tele-pathology: It enables qualified pathologists to diagnose diseases and use them for the research and education of medical students.
8. Tele-electrocardiogram: Electrocardiogram data in intensive care units are dispatched to specialists to assess the condition. Thus, a prosperous and expeditious intervention can be made in exigency situations. Image 5.2 shows the Tele-electrocardiogram instance.



Image 5.2: Tele-electrocardiogram for neonatal intensive care units
(Image Credit: www.telemed.org.ua)

5.5. Telemedicine via Satellite

Communication can be provided with satellites all over the world, land, sea, and air without interruption. It is mandatory to utilization satellites in telemedicine to ensure global communication.

GEO Ku-Band satellite capacity services price is costly, so its utilization rate for telemedicine minimal. The prices are diminishing with the GEO Ka-Band satellites and LEO satellites in recent years, consequently these services utilizable. Capacity is also broadband in these services. Broadband is indispensable in emergency situations in telemedicine. The broadband affords a continuous HD video conference with the GEO and LEO satellites created with the technological progressions in recent years.

On the other hand, the utilization of satellite communication is compulsory for aircraft and ships that can not use telephones line and base station. These conveyances use telemedicine through satellites.

Traveling at sea can take months before reaching the destination. If a crew or passenger were to fall ill during those months, instantaneous treatments would be unachievable, and the ship might have to make a halt at a closer port for the patient to get access to health care. This is time-wasting and can cause the corporations to lose millions of dollars in the long term. Thus, it is crucial to utilize satellites for telemedicine in the sea.

6. A TELEMEDICINE APPLICATION

The succeeding components are germane to Telemedicine Application:

6.1. A Vehicle

The vehicle should be entirely equipped to assist people who can not welfare from primary health care services and to yield telemedicine services that can be used in emergency conditions. Image 6.1, Image 6.2, and Image 6.3 demonstrate the instance vehicle manufactured by Ms Satcom for the Libya project. The vehicle anchors to the ground with the plungers and the lateral cases open. In this way, it functions at maximal capability and provides services further.



Image 6.1: Ms Satcom Van for Telemedicine (Image Credit: Ms Satcom)



Image 6.2: Ms Satcom Van for Telemedicine (Image Credit: Ms Satcom)



Image 6.3: Ms Satcom Van for Telemedicine (Image Credit: Ms Satcom)

6.2. A Satellite Antenna

There should be an antenna system on the vehicle in order to yield satellite communication. The antenna system is used motionless or motion according to application necessities. It caters to communication all over the world through LEO satellites, even in remote and rural areas. Data transmitted instantaneously and uninterrupted from point to point with low latency and broadband, and even video conferences conduct between patients and physicians.

6.3. An Encoder

An encoder is an equipment that grants video or audio data files to be dispatched to the desired place in peculiar formats in accordance with the internet bandwidth.

Bandwidth perpetually changes according to user density and weather conditions at the satellite internet. The crucial factor on the encoder is no diminution in the file transmitted, although internet bandwidth changes. Image 6.4 shows the encoder that works with the satellite connection produced by Ctech Bilişim Teknolojileri A.Ş.



Image 6.4: An Encoder (Image Credit: CTech Bilisim)

6.4. Information and Data Security Programme

The program is utilized to forestall any data loss during the recording and sharing of patient data in the Personal Data Protection Law (KVKK). It encrypts patient data and guarantees that only accredited people access these data.

6.5. Computer and Camera

There necessity be a computer in the vehicle in order to insert data by the data entry operator. In some cases, a camera system should as well be in the vehicle to effectuate video conferencing between patient-specialist and physician-specialist.

6.6. Data Entry Operator

It refers to the personnel in charge of ingress patient data, sending data, and devising video conferencing.

6.7. Medical Devices

Medical devices such as Auto-analyser, Ultrasound Machine, Blood Pressure Machine, Anthropometric Measuring Equipment, Radiology Devices requisite be conceived. The diagnosis of the disease is made by analyzing the examinations made with these devices. Image 6.5 and Image 6.6 show noteworthy medical devices for telemedicine.



Image 6.5: Medical devices, Ms Satcom Van for Telemedicine
(Image Credit: Ms Satcom)



Image 6.6: Laboratories, Ms Satcom Van for Telemedicine (Image Credit: Ms Satcom)

6.8. Examination Bed

An examination bed is sustaining for patient scrutiny in the vehicle. Furthermore, an eligible operating table is obtainable for an exigency operation. Image 6.7 and Image 6.8 show assorted examination beds.



Image 6.7: Patient examination coach, Ms Satcom Van for Telemedicine (Image Credit: Ms Satcom)



Image 6.8: Patient examination coach, Ms Satcom Van for Telemedicine (Image Credit: Ms Satcom)

6.9. A Physician

A physician must endure in the vehicle to diagnose the disease and analyzing the patient's data.

7. REASEARCH PROPOSAL: TELEMEDICINE FEASIBILITY

7.1. Cost Calculations for Telemedicine

Businesses, governments, and nonprofits have various expenditures for the conservation, growth, and services of their assets. In order to simplify these expenditures, arrangements were made under 2 headings: Capital Expenditures (CAPEX) and Operational Expenditures (OPEX).

CAPEX is a type of expense incurred by businesses, governments, and nonprofits to purchase, maintain or improve fixed assets such as buildings, vehicles, equipment, or land (Hayes, 2003). OPEX is an in-progress cost to running a service, merchandise, or business (David, 2008). The CAPEX and OPEX of the telemedicine vehicle demonstrated in Image 6.1 are beneath.

Capital Expenditures (CAPEX): 260.000 US Dollar

CAPEX is calculated based on the vehicle's manufacturing in Turkey. The price may vary by country. The vehicle includes Antenna, Medical Devices, Computer, Encoder, etc. shown in Picture 6.1 produced by Ms Satcom company.

Operational Expenditures (OPEX): 12.000 US Dollar/ month

OPEX is calculated according to the economic conditions in Turkey. The price may vary by country. It includes internet price, physician, nurse, operator and driver salary, fuel, vehicle maintenance, etc.

7.2. Telemedicine Feasibility in Turkey

Turkey is a Eurasian country bridging Asia and Europe (Immerfall, 2009). Population by the end of the year 2020, 83,614,362 has been (Web 57, 2021). The acreages of the country is 783,562 square kilometers (Bilgin, 2014). Turkey is in the class of developing countries. Advancement and meliorations in the field of health care services compose consequential socio-economic contributions to the development of the country. It is indispensable to the utilization of telemedicine in

order to ensure everyone to benefits from health services and to increase development because of the high population density and the large surface area.

Notable metropolises in Turkey (Istanbul, Ankara, Izmir, Kocaeli, Bursa, etc.) have competent physicians in health care. People living in these cities effortlessly retrieve these services. Notwithstanding, people do not retrieve these services in provinces (East, Southeast, Black Sea Region) that do not have proficient physicians in health care.

Many expert physicians do not prefer to employ in an undeveloped region. For this reason, health services are disrupted and practising physicians are usually employed in underdeveloped regions. These physicians yield amended prime health care service by receiving consultancy from qualified physicians with telemedicine.

It is one of the telemedicine subjects to examine the causes of mortality and to make regional-based health care examinations. According to the Turkey Statistical Institute censuses, mortality ratios by cause pretended in Table 7.1 in Turkey. Regular examinations of the patients can be made and the treatment procedures can be commencement by providing pre-diagnosis with the telemedicine service. It is attained that early diagnosis and treatment will have an affirmative consequence on mortality rates in some provinces in accordance with Table 7.2 and Table 7.3.

Table 7.1: Death Rate table by diseases in Turkey (Web 58,2020)

Disease	2018	2019
Cardiovascular System Disease	%37,8	%36,8
Benign and Malignant Tumors	%19,3	%18,4
Respiratory Disease	%12,2	%12,9
Neural System and Sense Organs Disease	%4,8	%4,6

Cardiovascular System Diseases

The Cardiovascular System Diseases elicited mortality rate is the peak in Turkey. Table 7.2 demonstration the death rate because of cardiovascular systems diseases by cities.

Table 7.2: Cardiovascular Disease Death Rate Table with Cities,2019
(Web 58, 2020)

City	Death Rate (%)
Aydın	%47,2
Denizli	%47
Kırıkkale	%46,2
Çanakkale	%44,2
Çorum	%44
Afyonkarahisar	%43,5
Bursa	%42,9
Balıkesir	%42,6
Sinop	%42,5
Burdur	%42,3

Telemedicine can be utilized to diminish mortality because of cardiovascular diseases in Aydın, Denizli, Kırıkkale, Çanakkale, Çorum, Afyonkarahisar, Bursa, Balıkesir, Sinop and Burdur according to Table 7.2.

Benignant and Malignant Tumors

The Benignant and Malignant tumors induced mortalities are second in Turkey. Table 7.3 displays the death rate because of Benignant and Malignant Tumors by cities.

Table 7.3: Benignant and Malignant Tumors Death Rate Table with Cities,2019
(Web 58, 2020)

City	Death Rate (%)
İstanbul	%22,2
Tekirdağ	%22,1
Kırklareli	%21,9
Edirne	%21,9
Erzurum	%21,8
Kocaeli	%21,7
Ağrı	%21,6
Rize	%21,5
Ankara	%20,9
Bursa	%20,6

Telemedicine can be utilized to diminish mortality because of benignant and malignant tumors in İstanbul, Tekirdağ, Kırklareli,Edirne, Erzurum Kocaeli, Ağrı, Rize, Ankara and Bursa according to Table 7.3.

In addition, some of the disease with cities:

Alzheimer: Ankara, Diyarbakir, Sivas, Burdur, Çankırı, Erzurum, Aydın, Erzincan, Bitlis, Denizli, Kastamonu.

Cerebral hemorrhage: Bursa, İstanbul, İzmir, Van, Trabzon, Rize.

Heart Disease and Heart Attack: Sivas, Ordu, Şanlıurfa, İzmir, Kilis, Tokat, Gaziantep, Düzce, Kirikkale, Bursa, Siirt, Bitlis and Tunceli.

Cancer: Ankara, İzmir, Artvin, Elazığ, Gumushane, Düzce.

7.3. Telemedicine Feasibility in Developing and Least Developed Countries

The path to welfare and melioration in developing and underdeveloped countries is through the benefits of health care services to society. In developing countries, health services can be reached through hospitals. This service can be afforded virtually perfectly in developed cities, while health services can not be provided in areas far from the center that are not developed. In underdeveloped countries, almost all cities are deprived of health care services. In developing and underdeveloped countries, the foremost access to health care services is through telemedicine. The applicability of telemedicine has become possible in developing and underdeveloped countries with the advances in technology and the lessening in costs.

As in Section 7.1, telemedicine vehicles application can be made according to the cause of death in countries throughout the world. Figure 7.1 shows the map of diseases that cause the most death by country around the world (Web 59, 2014).

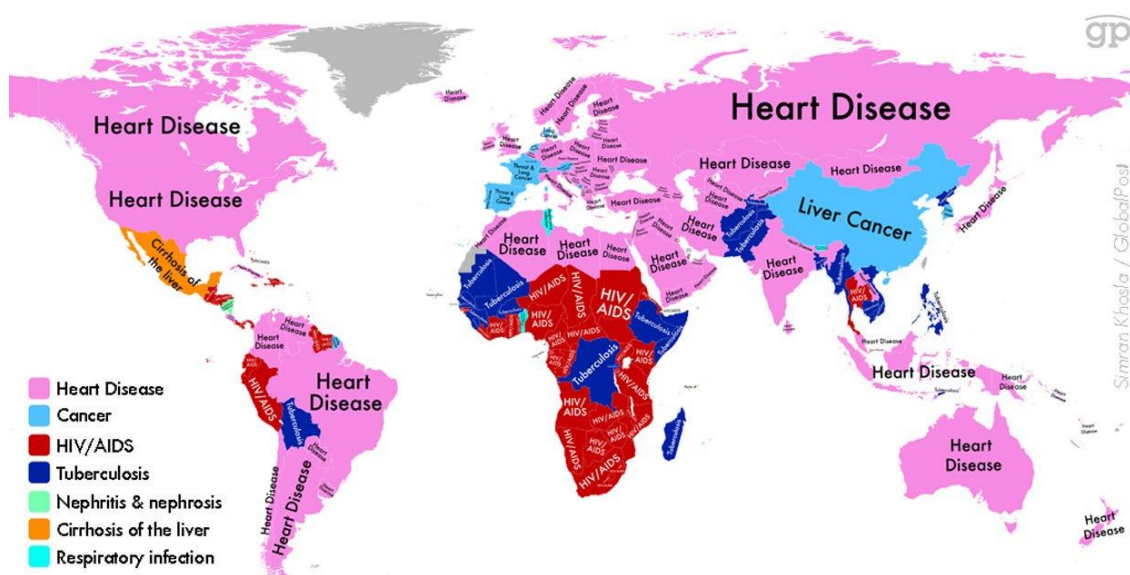


Figure 7.1: The map of diseases that cause the most death by country

As seen from the map, mortality rates of epidemic diseases and chronic diseases (cardiovascular diseases, respiratory diseases) are high. These diseases can be diagnosed with telemedicine early and both the life span can be extended and health care services can be reached more.

- The ranking of diseases with the most deaths in Africa is specified below.

1. Heart Disease
2. Cancer
3. HIV/AIDS
4. Tuberculosis
5. Respiratory of Infection

- The ranking of diseases with the most deaths in Middle East&Asia is specified below.

1. Heart Disease
2. Cancer
3. HIV/AIDS
4. Tuberculosis

- The ranking of diseases with the most deaths in Europe is specified below.

1. Heart Disease
2. Cancer
3. Respiratory of Infection

- The ranking of diseases with the most deaths in South America is specified below.

1. Heart Disease
2. Cancer
3. HIV/AIDS
4. Tuberculosis

- The ranking of diseases with the most deaths in Central America& the Caribbean is specified below.

1. Heart Disease
2. Cancer
3. HIV/AIDS
4. Nephritis & Nephrosis

5. Cirrhosis of the Liver
6. Respiratory of Infection

7.4. Telemedicine Feasibility in Covid-19 Outbreak

The COVID-19 outbreak conceived in 2019 in Wuhan, China (Web 60, 2021). Early indications of COVID-19 comprise febrility, dry cough, breathing trouble (Huang et al., 2020; Jiang et al., 2020). To trim back contagion, travel limitations have been nominated and implemented around the world, and most metropolises have been isolated (Papadimos et al., 2018).

Telemedicine during outbreak stipulations (COVID-19 outbreak) has the potential to ameliorate the scrutiny of the epidemiological, check of disease, and governance of clinical occurrences (Smith et al., 2020; Zhou et al., 2020; Ohannessian, 2015). Restaurants and shops closed, all social activities were restricted, and distance education was started instead of face-to-face because of this outbreak.

According to the advanced (23 February 2021) data of the World Health Organization (<https://covid19.who.int/>) :

Confirmed cases: 111.419.939

Confirmed deaths: 2.470.772

Countries, areas, or territories with cases: 223

Society can not access primary health care services because hospitals are full in various countries. Besides, people with nonviral diseases also pose a high risk to go to hospitals. People living in areas far from hospitals requisite to travel to observe the disease and this trip causes the virus to increase. Telemedicine turns more significant for such conditions. If examinations and treatments are provided with telemedicine vehicles, the risk of outbreaks can be reduced.

Studies conducted during the Covid-19 outbreak show telemedicine is helpful.

Some of these studies are:

1. Country: Iran (Davarpanah et al., 2020)

Key outputs:

- Patients were prevented from being sent to crowded hospitals.
- Real-time consultancy has been afforded from specialists.
- Showed the deficit of thoracic radiologists.
- Granted consultation in locations with circumscribed access to thoracic radiology expertise.

2. Country: UK, China (Zhai et al., 2020)

Key outputs:

- Afforded real-time data transmission.
- Avoided direct physical interaction.
- Diminished the danger of exposure to respiratory secretions.
- Forestalled the potential contamination of physicians and nurses.

3. Country: USA, Canada (Nicol et al., 2020)

Key outputs:

- Assisted to implement social distance.
- Applied away from high-risk regions such as hospitals.
- Decreased the utilization of public transport.
- Created inferior risk of a viral infection than face-to-face interactions.
- Delivered precise and accurate information to older adults.

4. Country: USA, UK, Italy (Simcock et al., 2020)

Key outputs:

- Lessened the risk of infection of the virus during radiotherapy.
- Eliminated workforce fatigue risks with reduced infection.

5. Country: USA, Canada (Shaker, 2016)

Key outputs:

- Provided to bounded exposure of physicians, nurses, and others to potentially infected.
- Maintained social distance.
- Diminished the demand to visit hospitals.
- It was effective in the management of patients with chronic diseases.
- Video conference was held on allergy and consultation was given.

8. CONCLUSION

Since the early eras of humanity, people have developed peculiar know-how to communicate with each other. It has commencement with cave paintings, shouting, smoke. The Telegraph, the radio, and the telephone have been invented with the progression in technology. In collateral with the evolution in rockets, worldwide communication has been qualified with developments in satellite discipline. Satellite technology (VSAT, SOTM technology) is not only significant in the rural areas but, also signed on the sea and in the air where only satellite connectivity is conceivable.

Health is indispensable because it influences the quality of life for our lives. It is significant to yield primary health care services efficiently, particularly with scarce resources and modern technology. The effectiveness and accessibility of primary health care services increase with integrating modern technology into health care science.

According to the report originated by the joint work of the World Health Organization (WHO) and the World Bank; at least half the world's population still lacks access to essential health services (WHO and The World Bank, 2017). Telemedicine is a prosperous instance generated by integrating modern technology and medical science to provide access to essential health care services. It facilitates the access of societies to health care services as it can reciprocate to dynamic health needs, adapt to up-to-date technologies, and removes geographical barriers. Its services realized by satellite connection are provided with a broadband connection, low latency, uninterrupted and worldwide communication. Especially with LEO satellites, both costs have been reduced, and global coverage has been accomplished.

The fundamental goals of telemedicine are:

1. Access to primary health care services,
2. Conserve time and money,
3. Overcome to geographical barriers,
4. Efficiency,
5. Reduce to patient transfer,
6. Motivation for physicians in rural areas,

7. It is the best solution to use in outbreak times.

According to the feasibility of telemedicine vehicles in Turkey's economic conditions, CAPEX 260,000 US Dollars, OPEX 12,000 US Dollars. Considering that this investment is an application that serves the entire country, it is seen that CAPEX and OPEX are at applicable levels.

In addition, the Covid-19 outbreak had an eminent repercussion all over the world, and hospital systems and services have collapsed. Therefore, distant health care service is of considerable value. In this research, the importance of this has been explained with case studies. Afterward the Covid-19 outbreak, countries will fund more tending to Telemedicine services to be equipped for outbreak situations.

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