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Microwave and Advance Telecommunication

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Abstract: *Connectivity is about to undergo a transformation thanks to emerging developments in microwave communication. Technological developments will increase data transfer rates and decrease latency, which will benefit high-demand applications. Connectivity to individuals will be further enhanced by integration with 5G networks.*

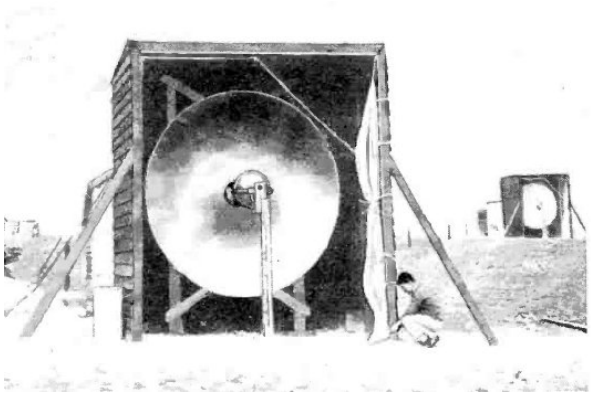
Keywords: Data transmission, latency, Integration with 5G networks, capabilities to connect to people

I. INTRODUCTION

Information transmitted by electromagnetic waves with wavelengths in the 300 MHz to 300 GHz microwave frequency range (1 m to 1 mm wavelength) of the electromagnetic spectrum is known as microwave transmission. Since microwave transmissions are typically only able to travel within line of sight, a network of repeaters known as a microwave relay network is necessary for long-distance transmission of these signals. Using tropospheric scatter, microwave signals can be used for over-the-horizon communications; however, these systems are costly and are only employed in specialized tasks.

- Typical range of microwave is 3GHz to 300GHz
- Wavelength ranges from 10cm to 1mm
- Microwave frequency can send enormous amount of information from point to point in absences of any physical obstacles
- Mainly used in point to point communication
- Two types of microwave transmission are terrestrial and satellite:

The origins of microwave telephony may be traced back to World War II, when secure military communication was the primary use for microwave relay systems. Johann Mattausch published the first article on radio relay transmission in the Austrian magazine Zeitschrift für Elektrotechnik in 1898. However, his suggestion was rudimentary and unsuitable for real-world application. The development of radar during World War II gave the technology for the practical use of microwave communication, even though an experimental 40-mile (64-kilometer) microwave telecommunication link across the English channel was shown in 1931.



The British Army deployed the Wireless Set No. 10 during the war, multiplexing eight telephone channels over vast distances using microwave relays. The English Channel was connected, enabling General Berneard Montgomery tomust maintain constant communication with his group's London headquarters. Many transcontinental microwave

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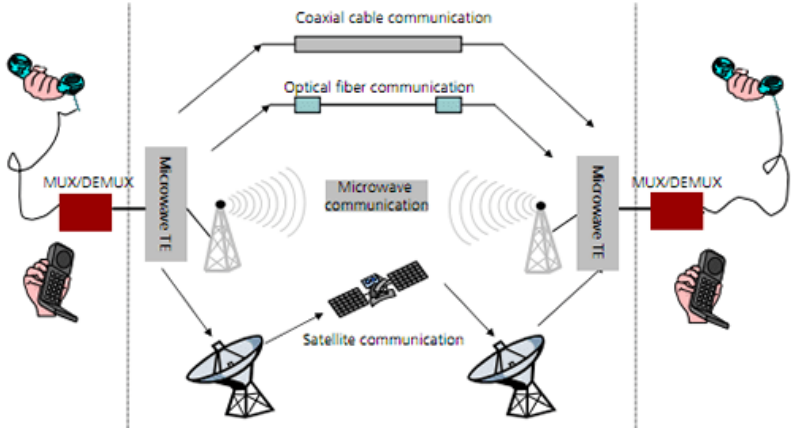
relay networks were built in North America and Europe as a result of the post-war era's significant advancements in microwave technology. These networks were used to transmit television signals for cross-country broadcasts, thousands of phone calls at once, and later computer data. The market for television broadcasting was dominated by communication satellites in the 1970s and 1980s, and the deployment of long-distance fiber optic systems in the 1980s and particularly the 1990s caused the relay networks to rapidly degrade, with the majority of them being abandoned. New telecommunications devices have used the microwave spectrum at an exponential rate in recent years, including technology like wireless networks and direct-broadcast satellites, which send radio and television straight to consumers' homes.

Working Principle

Microwave link is a communications system that transmits data, audio, or video between two locations—which may be a few feet or meters apart or several miles or kilometers away—using a beam of radio waves in the microwave frequency range.



The two types of microwave transmission are terrestrial and satellite: Terrestrial microwave transmissions are sent between two microwave stations on the earth (earth station). It is the most common form of long-distance communication.

Terrestrial Microwave Transmission System	Satellite Microwave Transmission System
The frequency range needed is from 4 GHz to 6 GHz.	The frequency range used in this system is between 11 GHz to 14 GHz.
In this system, attenuation mainly depends on the frequency and signal strength	Attenuation is generally affected by frequency and power.
Installation of terrestrial microwave transmission systems is fairly challenging due to signal requirements.	It is quite difficult to place satellites in satellite microwave transmission systems.
Terrestrial microwaves are utilized for point-to-point communication.	Satellites in space can communicate with satellites via satellite microwaves.
Line of sight and concentrated signals are necessary for the physical path.	Antennas on earth stations must be properly aligned.
In these systems, long-distance systems are nearly always expensive, whereas short-distance systems can be quite cheap.	Due to the high cost of development and launch, these systems are highly costly.
Signals are extended by relay towers.	Signals are expanded by the utilization of satellites.

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Terrestrial microwave systems are used for short-range communications or as an addition to fiber-optic networks.	In places where communication would otherwise be impossible, satellite systems offer connectivity.

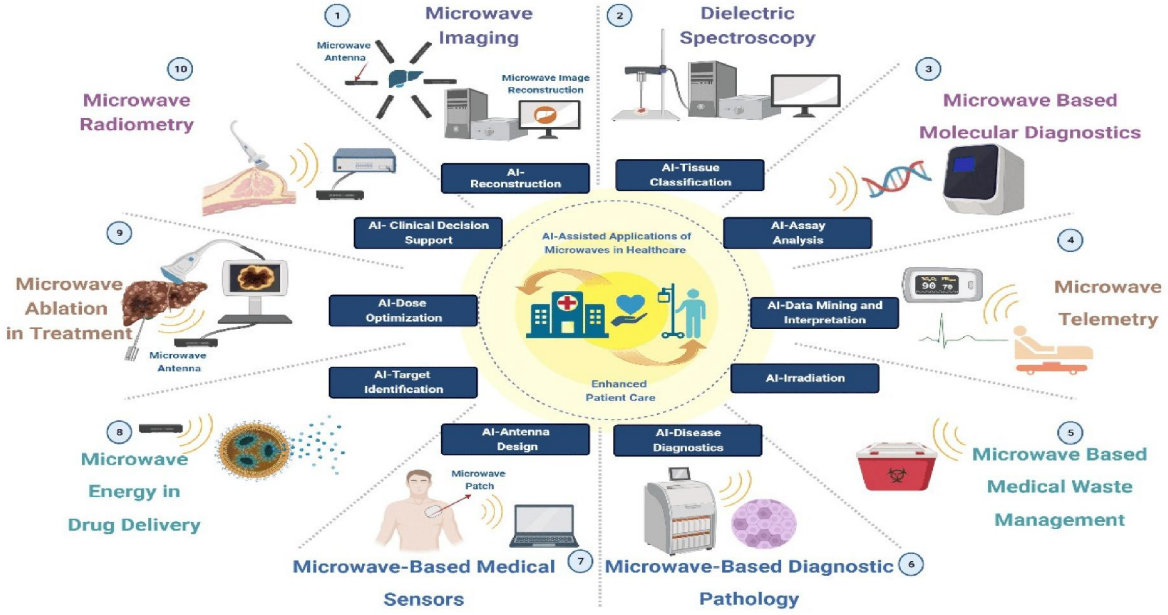
Application

A common technique in the 1950s and 1960s was microwave radio relay, which employed a narrow microwave beam to send information between two terrestrial locations, including television shows and long-distance phone conversations. A microwave transmitter and directional antenna create a fixed radio connection between two points by sending a narrow beam of microwaves with numerous channels of information along a line-of-sight path to another relay station, where it is picked up by a directional antenna and receiver. In order to send data in both directions, the link was frequently bidirectional, with a transmitter and receiver at either end. Due to the necessity of a line of sight, stations are only separated by the visual horizon, which is roughly 30 to 50 miles.

(48 to 80 km). For longer distances, the receiving station could function as a relay, retransmitting the received information to another station along its journey. Chains of microwave relay stations were used to transmit telecommunication signals over transcontinental distances. Microwave relay stations were often located on tall buildings and mountaintops, with their antennas on towers to get maximum range.

Networks of microwave relay lines, such the AT&T Long Lines system in the United States, began transporting television shows and long-distance phone calls between cities in the 1950s.[1] In 1947, AT&T constructed the first system, known as TDX, which used a network of eight radio relay stations to link New York and Boston.[1] They spread TD2, a somewhat enhanced variant, throughout the United States until the 1950s. Among these were lengthy daisy-chained connections that crossed continents and geographical ranges. A less expensive option was made available by the introduction of communication satellites in the 1970s. Although satellites and optical fibers now carry a large portion of transcontinental traffic, microwave relay is still crucial for shorter distances. Data transmission is made possible via the microwave medium.

in the contemporary communication technologies, over long distances. TV, radio, phone, and internet networks may all be broadcast thanks to satellites, microwaves, and transmission towers. The ability of massive data carriers to operate at faster rates has been shown to be essential for enhancing communication on a global scale.



Example

When lengthy fiber optic is not a practical choice, microwave networks are frequently utilized to link a base station in a remote or isolated location with the main cellular network. Microwave links could serve as an example of a cost-

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effective way to extend network coverage in hard-to-reach places under this topic. The foundation of satellite communications technology is the use of microwave waves to transmit data from satellites to ground stations placed throughout the world. Air to ground is achieved in this way. phone, video, and data services that are available worldwide, as well as mission-critical theater communication.

Characteristics of Microwave Transmission and telecommunication

Microwaves only go in one direction.

The line-of-sight (LOS) communication technology is used in microwave transmission.

• Significantly impacted by environmental elements such as rain fade.

• Because of their high frequency, microwaves are unable to pass through obstructions like hills, buildings, and trees.

• During solar proton events, signals may deteriorate.

• Microwave transmissions can be scattered by atmospheric disturbances like rain and snow.

Microwaves only go in one direction. Microwaves can be sharply focused using an antenna. This indicates that alignment of the sending and receiving antennas is necessary.

The propagation of microwaves is line-of-sight.

• Because of its extremely high frequency, microwaves are unable to pass through walls.

•At about 299 GHz, the microwave band is associatively vast. As a result, a high data rate is achievable and wider subbands can be approved.

Advantages of Microwave Communication

The advantages of microwave communication are as follows: ➡ Because the microwave spectrum has a larger bandwidth, it can transport a lot of data.

The radio frequency spectrum is becoming more and more crowded every day. Using high-selective receivers, modulation (SSB, PSK, QAM, etc.), spread spectrum techniques, data compression, etc., microwave technology aids in the management of crowded spectrum.

According to its intended use, the microwave spectrum is separated into many channels. These channels' core frequencies are distributed with spaces between them to prevent channel overlap and interference with neighboring channels.

Since ancient times, microwave communication has been utilized as a Line of Sight communication method in hilly, isolated locations where other wired communication methods are not feasible.

Radar systems, efficient satellite and terrestrial communications, and a wide range of uses across several frequency bands are all made possible by microwaves. Microwave technology, on the other hand, requires more expensive installation, has larger parts, and may be susceptible to electromagnetic interference or changes in dielectric properties.

Disadvantages of Microwave Communication

As is well known, microwaves are employed for communication. The following are the drawbacks of microwaves:

Standard circuit analysis can be used for frequencies lower than 30 MHz. E-H wave analysis. Lumped components, such resistors, inductors, and capacitors, are known to exhibit different properties at microwave frequencies compared to lower frequencies. As a result, using these components at microwave frequencies is challenging.

A significant portion of the actual signal is lost due to the longer travel time of the current carrier, or electron, at microwave frequencies. Because of this, conventional transistors perform worse at microwave frequencies than at lower frequencies.

Future scope

Microwave planning's future. In addition to networks being denser, efforts are being made to increase capacity and lengthen hops. Using spectrum more effectively and modernizing microwave planning will be crucial to reaching Wireless communications is about to undergo a transformation thanks to 6G technology. Unmatched speeds, cutting-

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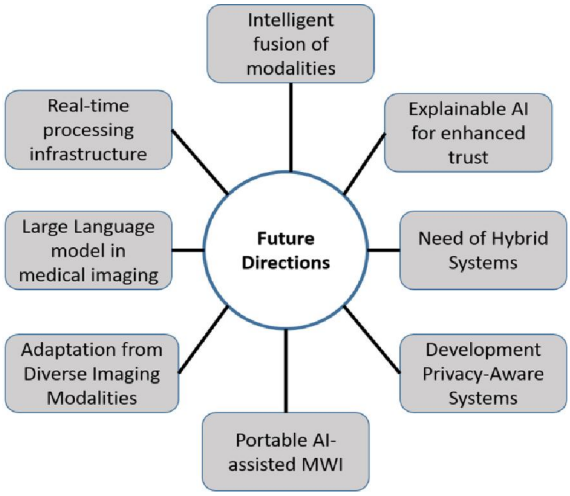
edge connectivity, and minimal latency are anticipated. 6G networks, which use AI and ML in conjunction with higher frequencies, have the potential to greatly increase network penetration, security, and capacity.



II. CONCLUSION

All things considered, microwave communications technology is essential to contemporary society. Radio frequency connectors (RF connectors) are essential components of many technologies, including Drone technology, military radar systems, satellite communications, and 5G networks.

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