Review Of Radio Propagation Properties And Applications In Different Frequency Bands

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ABSTRACT:
Radio waves are basically frequencies that travel at the speed of light and deliver information to transmitters and receivers. Radio waves can easily suffer from interference due to natural causes such as stars and gases that emit radio waves. They can propagate from millimeters to thousands of miles, also the frequency ranges from 3KHz to 300GHz. Radio waves can propagate through different ways such as being bounced between earth and the atmosphere or being reflected and find their way to a receiver. There are many forms of radio communication in use today. Many of these have proved vital in the progression and safety of the human race. Some of these forms of communication are not tradionally associated with radio waves, but that is where they hold the basis of their function. Many forms of radio communication will continue to be used in the future, with their use proving necessary in current and future technologies.

KEY WORDS: *Radio waves, Electromagnetic Specrum, Radio propagation, Frequency bands*

INTRODUCTION:

In general the radio communication services within the VLF, LF, MF, HF, VHF, UHF, SHF and EHF frequency bands are currently used to a limited extent for commercial civil purposes. The technology has been analogue and over the past years the use of the LF, MF and HF frequency bands decreased and this decrease seems to continue. With the introduction of digital technologies and frequency adaptive systems these bands will experience a revitalization [1].

Radio frequencies are generally considered to be that portion of the electromagnetic spectrum below the infrared frequencies [2]. Day to day uses of the radio waves ranges from VLF, LF, MF, HF, VHF, UHF, SHF and EHF bands. The uses include Television, Internet, Mobile phones, GPS systems, Garage door openers, Wireless clocks, Police radios, Radio controlled toys and others. Due to dissimilar propagation properties of different frequencies traveling over the worlds' sphere, it is logical to assign separate spectrum allocations to different applications [3].

MF and HF bands has been facing some decrease over the past years but a number of national operators are now using MF as well as HF bands for radio broadcasting.

It is expected that the development of a global digital standard (DRM) with higher quality and new markets and services will further support and accelerate the development of the Broadcasting Service in particular in the LF and MF bands but also in the slightly longer term in the HF bands [4].

It may be expected that the digital technology within the broadcasting service could be adapted by other commercial radio communication services such as the Fixed and Mobile services and the Maritime Mobile service.

The civil Fixed and Land Mobile Services have decreased over the past years and there is

no indication that these services will develop further in Europe in future. There are, however, particular applications such as low data rate services, which might be developed in the LF and MF bands.

It is important that this use of digital technology and new applications as well as market developments are not in any way troubled by interference from other sources and technologies such as ADSL, xDSL, cable communications and power line transmissions [3]

THE ELECTROMAGNETIC SPECTRUM:

Different frequencies of electromagnetic radiation are better suited to different purposes. The frequency of a radio wave determines its propagation characteristics through various media. The Radio spectrum has many sub-bands, grouped by frequency as in table 1 below. Relationship between frequency, speed and wavelength

$$c = f.\lambda \text{ ----------1}$$

Where; f is frequency, λ is wavelength, c is speed of light

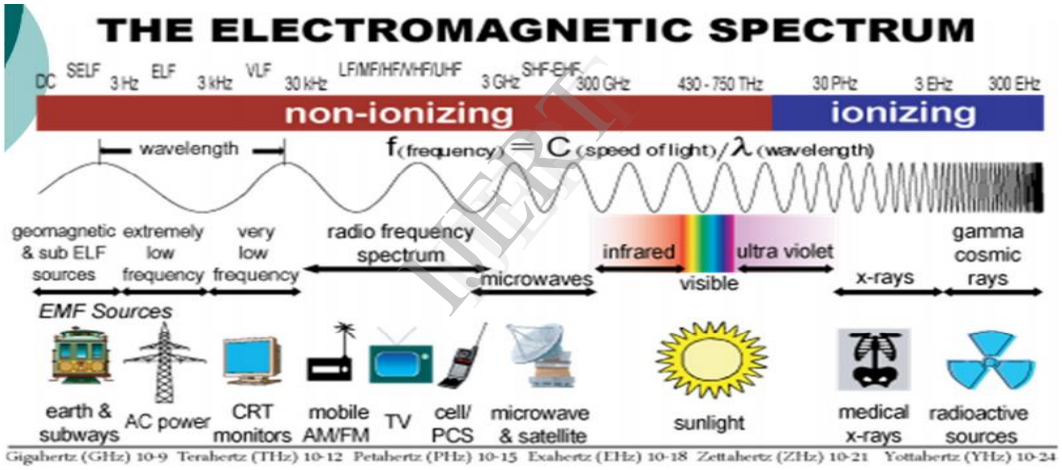

Figure 1: The electromagnetic spectrum [3]

Frequency Band	Frequency Range (Wavelength)	Propagation Modes
ELF (Extremely Low Frequency)	Less than 3 KHz ($\lambda > 100$ km)	Ground wave
VLF (Very Low Frequency)	3-30 KHz (10 km $\leq \lambda <$ 100 km)	Earth-Ionosphere guided
LF (Low Frequency)	30-300 KHz (1 km $\leq \lambda <$ 10 km)	Ground wave
MF (Medium Frequency)	300 KHz-3 MHz (100 m $\leq \lambda <$ 1 km)	Ground/sky wave for short/long distances.
HF (High Frequency)	3-30 MHz (10 m $\leq \lambda <$ 100 m)	Sky wave, but limited, short-distance ground wave also.
VHF (Very High Frequency)	30-300 MHz (1 m $\leq \lambda <$ 10 m) 30-60 MHz (5 m $< \lambda <$ 10 m)	Space wave Space wave
UHF (Ultra High Frequency)	300 MHz-3 GHz (10 cm $\leq \lambda <$ 1 m)	Space wave
SHF (Super High Frequency)	3 GHz-30 GHz (1 cm $\leq \lambda <$ 10 cm)	Space wave
EHF (Extremely High Frequency)	30 GHz-300 GHz (1 mm $\leq \lambda <$ 10 mm)	Space wave

Table 1: Radio frequency bands

GENERATION, TRANSMISSION AND RECEIPTION OF RADIO WAVES:

Accelerating charges radiate EM energy and the charges oscillating back and forth, get time-varying fields. A transmitter is an electronic device, with the aid of excited antenna by the AC current, produces radio waves [4]. A carrier wave transmits information through space as an EM wave used in radio communication. The receiver contains conductors that receive EM waves. .

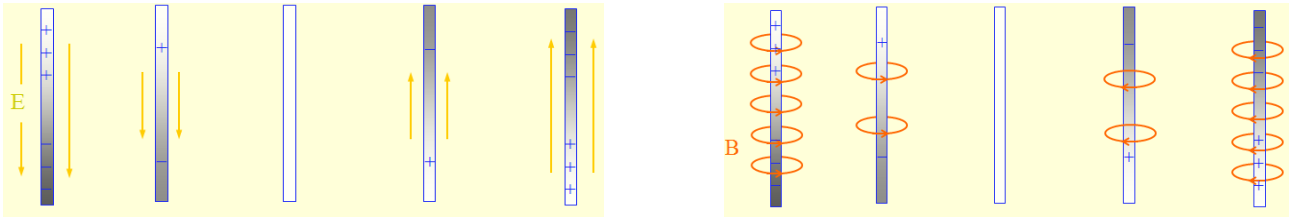

Figure2 : Generation of radio waves

Note that the magnetic fields are perpendicular to the electric field vectors. Receiving antenna works best when 'tuned' to the wavelength of the signal, and has proper polarization. Electrons in antenna are vibrated by passage of electromagnetic wave. The Optimum antenna length is λ/4: one-quarter wavelength. The radio waves can be transmitted over thousands of miles by following the curvature of the earths' surface, skywards or space waves.

The atmospheric medium most relevant to terrestrial radio propagation may be specified as troposphere and ionosphere. The troposphere is the first layer above the surface of the earth, and contains approximately half of the earth's atmosphere. This is the layer at which weather takes place. The ionosphere is where ions and electrons exist in sufficient quantities to reflect and/or refract the electromagnetic radio waves. Consider two types of electromagnetic waves; ground waves and sky waves. The ground wave is the portion of the transmitted signal that propagates along the contour of the earth. Understandably, such waves are directly affected by the earth's terrain. Ground waves are the dominant mode of propagation for frequencies below 2 MHz[5]

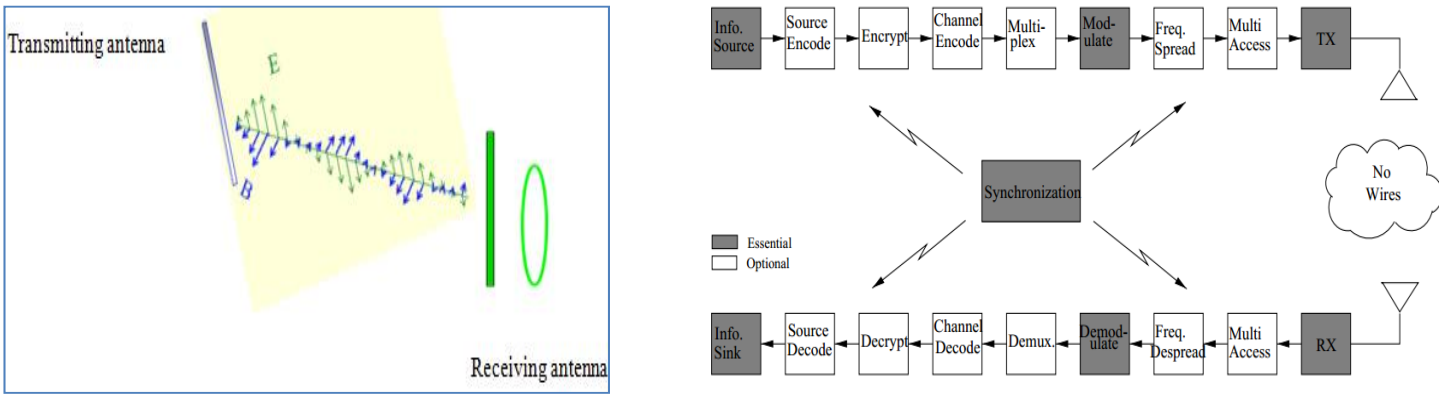

Figure 3: Transmission and receiption of radio waves

FREQUENCY ALLOCATION

The frequency allocations for auxiliary services may change from time to time as the needs of various services for radio frequencies change and as technology for equipment improves. The most common frequency bands are AM/FM and Television stations

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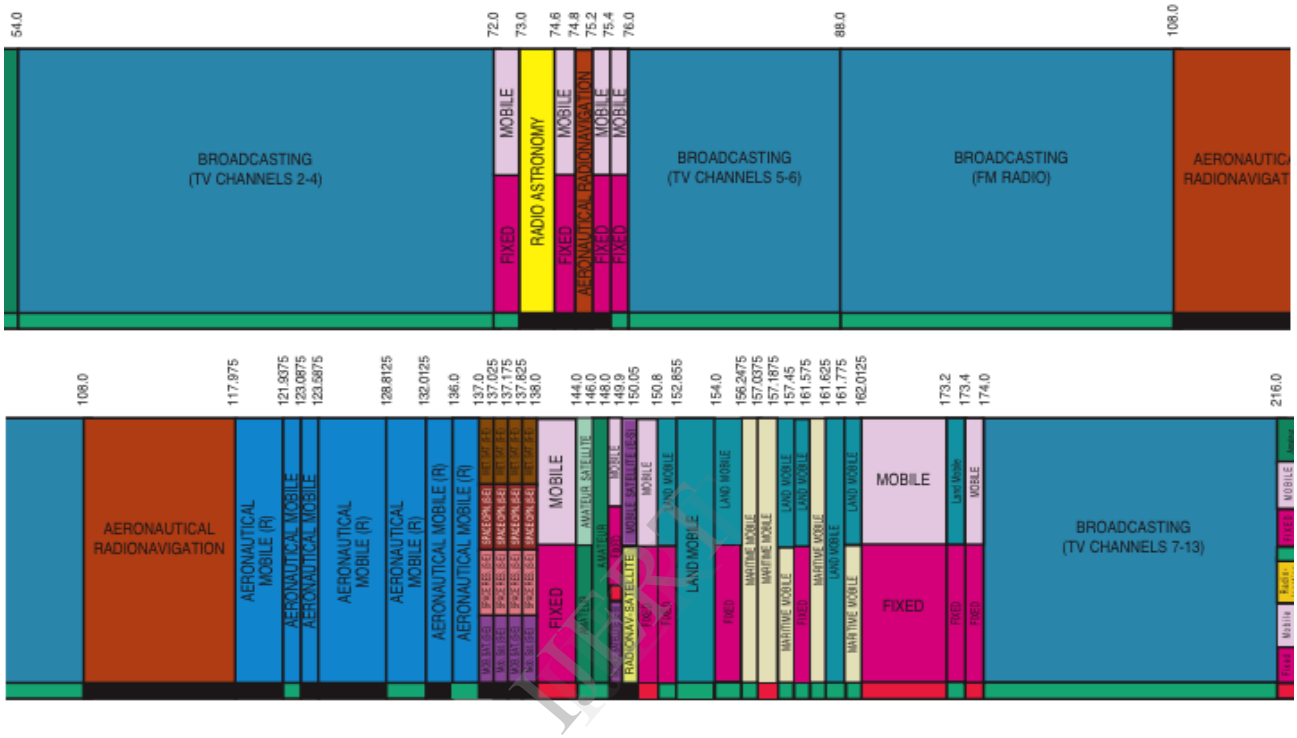

Figure 4: Radio Frequency allocations

FREQUENCY BANDS AND TECHNOLOGIES:

Radio waves are extremly important and have made many things possible. Without them, many progress in technology would have not been done, not only in persons' lives but also in professional and even in wars. Most of us use radio waves every day to communicate whether in the same road or on the other side of the world.

Low Frequency (LF)

Low frequency is the frequency which can travel in very long distance. Used in Long-range navigation (LORAN) which is a terrestrial radio navigation system that enables ships and aircraft to determine their position and speed from low frequency radio signals transmitted by fixed land based radio beacons using a receiver unit. Also used in Marine communication and radio beacons.

Medium Frequency (MF)

Medium Frequencies are used in AM radio broadcast (550-1600 KHz) and Maritime radio, Direction Finding (DF) which refers

to the establishment of the direction from which a received signal was transmitted. DF can refer to radio or other forms of wireless communication. By combining the direction information from two or more suitably spaced receivers (or a single mobile receiver), the source of a transmission may be located in space via triangulation. [6]

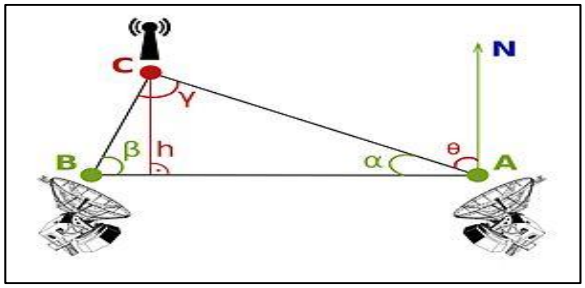

Figure 5: Direction Finding

High Frequency (HF)

Sky wave is the main mode of propagation, but also Ground wave is used for communication over shorter distances. HF's single greatest value is its ability to provide reliable short and long-range Beyond Line Of Sight (BLOS) communications.[7] HF is generally available, rapidly and readily deployable – requires very little infrastructure and can be made extremely reliable. The typical techologies that employ HF includes International broadcasting, Long distance aircraft and ship communication and citizen band (CB) radios.

Very High Frequency (VHF)

Diffraction and reflection give rise to propagation beyond the horizon. Propagation at large distance, propagates well within buildings. Few applications are FM Radio (88-108 MHz), Broadcast TV, Radio beacons for air traffic and AM aircraft communication.

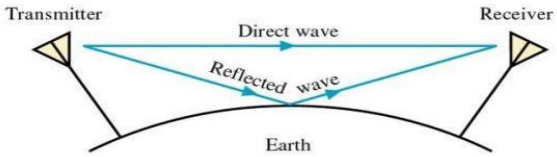

Figure 6: Radio signals at VHF band

Ultra High Frequency (UHF)

These frequency band travels in a very short distance, or in a long distance where the Line Of Sight (LOS) is considered. If the signal reaches the obstacle it might not reach the receiver side where the signal is intended to reach. Used in the technologies of Global Positioning System (GPS),Microwave links, Wireless personal communication systems: Cellular, PCS, 3G, Unlicensed band communication and Bluetooth, 802.11b, LMDS (500 Mbps).[8]

Super High Frequency (SHF)

Propagation distances become limited due to absorption by atmosphere (i.e. rain, clouds)[8]. The applications are Satellite services for telephony and TV, LEO and GEO satellite systems and Possible future mobile communication services.

Extremely High Frequency (EHF)

Basically all particles become obstacles due to very small wavelengths. Absorption effects greatly limit range/distance. High losses due to water, vapor, oxygen in atmosphere. EHF band is used for Short-distance communication (LOS required). Currently being proposed for HDTV and Satellite communication.[9]

CONCLUSSION:

Radio waves can be used for many different applications in a quick and effective way. Without radio waves, the media would be a lot more sparse and information would travel a lot slower. However, the use of radio waves for AM,FM radio and television could soon be on the decline due to the digitalisation of radio and television and the help of online links that make people use the original formats of these devises less and less.

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