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UHF Communication Studies in Urban Areas

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***Abstract**:*

This project attempts to provide some insight into the nature of UHF communication in urban areas and how communication varies depends on the terrain and obstructions. Ultra high frequency (UHF) is the ITU designation for radio frequencies in the range between 300 MHz and 3 GHz, also known as the decimeter band as the wavelengths range from one meter to one decimeter. Radio waves with frequencies above the UHF band fall into the SHF (super-high frequency) or microwave frequency range. Lower frequency signals fall into the VHF (very high frequency) or lower bands.

They are used for UHF are FM radio broadcasting, television broadcasting, emergency, business, private use and military. Cell, satellite communication including GPS, personal radio services including Wi-Fi and Bluetooth, walkie-talkies, cordless phones, and numerous other applications. UHF is widely used by public service agencies for two-way radio communication.

The Global Positioning System also uses UHF. The Global Positioning System consists of 24 satellites, which circle the globe once every 12 hours, to provide worldwide position. GPS makes it possible to precisely identify locations on the earth. GPS allows you to record or create locations from places on the earth and help you navigate to and from those places. In the project path UHF communication signal strength are made in urban area-Hyderabad and the results are analyzed and interpreted to understand the UHF Urban area communications and the factors affection communications.

Keywords

Ultra high frequency (UHF), Global Positioning System (GPS); UHF communication; Urban-area communications...

1. Introduction

Ultra high frequency (UHF) is the ITU designation for radio frequencies in the range between 300 MHz and 3 GHz, also known as the decimeter band as the wavelengths range from one meter to one decimeter. Radio waves with frequencies above the UHF band fall into the SHF (super-high frequency) or microwave frequency range. Lower frequency signals fall into the VHF (very high frequency) or lower bands. UHF radio waves propagate mainly by line of sight; they are blocked by hills and large buildings although the transmission through building walls is high enough for indoor reception. They are used for television, cell phones, satellite communication including GPS, personal radio services including Wi-Fi and Bluetooth, walkie-talkies, cordless phones, and numerous other applications.

UHF television broadcasting fulfilled the demand for additional over-the-air television channels in urban areas. Today, much of the bandwidth has been reallocated to land mobile, trunked radio and mobile telephone use. UHF channels are still used for digital television. UHF spectrum is used world-wide for land mobile radio systems for commercial, industrial, public safety, and military purposes. Many personal radio services use frequencies allocated in the UHF band, although exact frequencies in use differ significantly between countries. Major telecommunications providers have deployed voice and data cellular networks in UHF/VHF range. This allows mobile phones and mobile computing devices to be connected to the public switched telephone network and public Internet. UHF radars are said to be effective at tracking stealth fighters, if not stealth bombers.

To receive radio signals an antenna must be used. However, since the antenna will pick up thousands of radio signals at a time, a radio tuner is necessary to tune into a particular frequency (or frequency range). This is typically done via a resonator in its simplest form, a circuit with a capacitor and an inductor form a tuned circuit. The resonator amplifies oscillations within a particular, frequency band while reducing oscillations at other frequencies outside the band. Another method to isolate a particular radio frequency is by oversampling (which gets a wide range of frequencies) and picking out the frequencies of interest, as done in software defined radio. The distance over which radio communications is useful depends significantly on things other than wavelength, such as transmitter power, receiver quality, type, size, and height of antenna, mode of transmission, noise, and interfering signals. Ground, troposphere and sky waves can all achieve greater ranges than line-of-sight propagation. The study of radio propagation allows estimates of useful range to be made.

High frequency (HF) is the ITU designation for the range of frequency electromagnetic (radio waves) between 3 and 30 MHz it is also known as the decameter band or decameter wave as its wavelengths range from one to ten decameters (ten to one hundred meters). Frequencies immediately below HF are denoted medium frequency (MF), while the next band of higher frequencies is known as the very high frequency (VHF) band. The HF band is a major part of the shortwave band of frequencies, so communication at these frequencies is often called shortwave radio. Because radio waves in this band can be reflected back to Earth by the ionosphere layer in the atmosphere – a method known as "skip" or "sky wave" propagation – these frequencies are suitable for long-distance communication across intercontinental distances. The band is used by international shortwave broadcasting stations (2.310 - 25.820 MHz), aviation communication, government time stations, weather stations, among other uses.

1. For several years HF radio has provided reliable communication services throughout the world. Today, it may be regarded as outdated due to the development and deployment of modern communication means such as VHF/UHF, microwave, satellites and optical fibers, but it will still be used in particular situations for a long time. As with other technologies, there are disadvantages and advantages with the use of HF SSB radio communication. The most obvious disadvantages are associated with interference due to the congested spectrum and the effects of atmospheric noise and fluctuations. These normally affect the quality and reliability of the communication.

2. There are, however, many advantages. In many cases the use of HF radio communication is the most appropriate solution due to the possible coverage of large areas by fixed or mobile stations. It provides more direct control to the owner of the network and once the infrastructure is in place there will be no monthly bill from the telecommunication companies or national communication authorities. In some countries, for the registration of the frequencies and the use of the corresponding spectrum, a license fee is charged once a year for each station.

3. Recent technological advances have significantly overcome some of the problems inherent to HF communications. New HF systems are now able to select the most appropriate channel to establish and maintain communications, keep the quality of voice and transmit data and facsimile, while their operations have been considerably simplified.

4. Real networks can be implemented today with HF radios, using techniques that resemble the modern mobile or cell phone networks. Complete management of the network can be provided, including updates of link qualities and reconfiguration of the network databases in case of addition of new stations. Depending on the user requirements, e-mail services can be implemented through Internet access from remote areas. Complete telephone system with standard interfaces to PSTN can also be implemented.

5. HF SSB radios may still be the most reliable alternative to solve data collection problems in some regions of the world. Sparse areas in RA I may still be potential candidates for such systems. Not in direct competition with more recent technologies, but integrated with them until adequate replacements are available and cost-effective. A combination of HF and VHF/UHF is also possible. Some application examples are included in the Annex.

6. Several WMO Members in almost all Regions are still using HF SSB radio systems to collect meteorological and hydrological data. The replies to a questionnaire sent to all RA I Members will indicate the extent to which this type of technology is effectively being used in Africa. The analysis of the replies will be provided in a separate document.

7. Technical information concerning the design, installation and maintenance of HF SSB systems and networks will be included in the programmed of the technology seminars organized by WMO in Africa.

8. The meeting is requested to consider the information provided in this paper with a view to including modern HF SSB radio communication networks as potential solutions for meteorological and hydrological data collection, in particular situations, in selected areas of Africa.

LIMITATION OF HF COMMUNICATION

1. HF Communication is rather difficult for the range of 50Kms to 250Kms and normally, the planning of fixed-to-fixed services is not done for such distances.

2. Variation in Levels: The ionosphere characteristics vary diurnally, seasonally and yearly. The communication during sunrise and sunset is always subjected to great Fluctuations in levels, due to changes in ionosphere layers.

3. Choice of Frequencies: A reliable HF communication depends on the correct choice of frequencies and proper type of aerials. A minimum of three frequencies per station is required for round the clock operation. Based on the ionosphere information provided by the committee of Council of

Scientific and Industrial Research, as published by National Physical Laboratory New Delhi, the working frequencies for the wireless links can be computed.

4. Reliability: The reliability of an HF communication circuit depends on the working frequency and the take off angle of the beam.

5. Optimum Working Frequency: The optimum, working frequency is normally 85% of the maximum usable frequency.

The maximum usable frequency regularly drops below 10 MHz in darkness during the winter months, while in summer during daylight it can easily surpass 30MHz. It depends on the angle of incidence of the waves; it is lowest when the waves are directed straight upwards, and is higher with less acute angles. This means that at longer distances, where the waves graze the ionosphere at a very blunt angle, the MUF may be much higher. The lowest usable frequency depends on the absorption in the lower layer of the ionosphere (the D-layer). This absorption is stronger at low frequencies and is also stronger with increased solar activity (for example in daylight); total absorption often occurs at frequencies below 5 MHz during daytime. The result of these two factors is that the usable spectrum shifts towards the lower frequencies and into the Medium Frequency (MF) range during winter nights, while on a day in full summer the higher frequencies tend to be more usable, often into the lower VHF range.

When all factors are at their optimum, worldwide communication is possible on HF. At many other times it is possible to make contact across and between continents or oceans. At worst, when a band is 'dead', no communication beyond the limited ground wave paths is possible no matter what powers, antennas or other technologies are brought to bear. When a transcontinental or worldwide path is open on a particular frequency, digital, SSB and code communication is possible using surprisingly low transmission powers, often of the order of milli watts, provided suitable antennas are in use at both ends and that there is little or no man-made or natural interference.[2] On such an open band, interference originating over a wide area affects many potential users. These issues are significant to military, safety and amateur radio users of the HF bands.

Applications

The Commander Naval Telecommunications Command (COMNAVTELCOM) controls the specific frequencies used by the Navy and Marine Corps. This section provides a general overview of the Navy uses in the lower frequencies.

ELF - This is the only band that can penetrate hundreds of meters below the surface of the ocean. The US Navy transmits ELF messages using a huge antenna in Wisconsin and Michigan created by several miles of cable on towers in conjunction with the underlying bedrock. This band is used to send short coded "phonetic letter spelled out" (PLSO) messages to deeply submerged submarines that are trailing long antenna wires. The communication is only one way; therefore it is used primarily for prearranged signals or to direct the submarine to come closer to the surface for faster communications. Environmental factors do not have a strong influence on changing the signal and therefore it is quite reliable.

ULF - This band can also penetrate through the earth and sea water. It is used for communications in mines. It is rarely used for military purposes.

VLF - This band can penetrate several meters below seawater and can transmit much more information than ELF, therefore it is useful for submarine communications when the submarine cannot surface, but can come close to the surface. It can be affected by salinity gradients in the ocean, but these usually do not present problems for near-surface submarines. There are natural sources of VLF radiation, but in general, like ELF, it is not strongly influenced by changes in environmental conditions therefore it is useful for reliable global communications. The transmission antennas need to be large; therefore it is primarily used for one-way communications from shore-based command centers to surface ships and submarines. It can also be used to broadcast to several satellites at once, which can in turn relay messages to the surface. The Navy's VLF systems serve a a back-up for global communication use during hostilities when nuclear explosions may disrupt higher frequencies or satellites are destroyed by enemy actions. VLF is also used for aircraft and vessel navigation beacons and for transmitting standard frequencies and time signals.

LF - The Navy uses this band primarily as an alternative to other bands that are often crowded. It is particularly useful in Polar Regions where ionosphere disturbances can affect higher frequency transmissions. A primary use for LF systems is for airport and vessel navigation. For example, the LORAN navigation system uses 100 kHz. It is also useful for long range communications. The Navy now uses eight LF channels for the Fleet Multichannel Broadcast System using radio teletypewriters. A drawback to LF is that large antennas must be used and many frequencies are susceptible to atmospheric noise, particularly in tropical regions.

MF - Commercial AM radio stations use the central part of this band, therefore the military uses are restricted to the high and low ends. This band is used for communications, international distress frequencies and for search and rescue. This is a useful band for moderate distance transmissions because the coverage usually extends further than VHF and UHF (discussed next module), but is not as affected by ionosphere disturbances as HF. The reception distance over ocean is considerable greater than over land, making it particularly useful for naval use. Like all the lower frequencies, transmission in this band is usually ground waves, which limits the transmission distance, but makes them less susceptible to ionosphere disturbances than HF.

HF - The Navy makes extensive use of this band for communications. It is also used for long range ("over-the-horizon") radar. Due to the sky wave transmission mode, HF radiation can travel great distances, sometimes to the other side of the earth. Due to its versatility and large coverage area, this is a very crowded band and the military can only use a few frequency regions scattered throughout this band. The most efficient transmissions require fairly large antennas; therefore it is most useful when at least one of the stations is on shore. The antenna size limits its use on aircraft. It cannot be used for satellite communications since it is reflected by the ionosphere. Many of the former uses of HF by the Navy are now being taken over by satellite communication systems.

However, we expect that the Navy will continue to use HF for quite some time in the future. The primary drawback to HF use is that it is highly susceptible to changes in the ionosphere and therefore several frequencies must be available for use. There are a wide variety of military uses for electromagnetic radiation in the HF and lower frequencies. These frequencies have the advantage of being able to travel long distances. The VLF and lower frequencies can penetrate the ocean surface and are generally not affected by environmental changes, making them a reliable one-way communication tool. HF and lower frequencies are limited by the need for large antennas, especially the very low frequencies. HF is strongly affected by changes in the ionosphere. The rest of this module will examine how the ionosphere affects HF transmission and how to predict these effects.

The main users of the high frequency spectrum are:

- Military and governmental communication systems
- Aviation air-to-ground communications
- Amateur radio
- Shortwave international and regional broadcasting
- Maritime sea-to-shore services
- Over the horizon radar systems
- Global Maritime Distress and Safety System (GMDSS) communication.

The high frequency band is very popular with amateur radio operators, who can take advantage of direct, long-distance (often inter-continental) communications and the "thrill factor" resulting from making contacts in variable conditions. International shortwave broadcasting utilizes this set of frequencies, as well as a seemingly declining number of "utility" users (marine, aviation, military, and diplomatic interests), who have, in recent years, been swayed over to less volatile means of communication (for example, via satellites), but may maintain HF stations after switch-over for back-up purposes. However, the development of Automatic Link Establishment technology based on MIL-STD-188-141 for automated connectivity and frequency selection, along with the high costs of satellite usage, have led to a renaissance in HF usage in government networks.

The development of higher speed modems such as those conforming to MIL-STD-188-110C which support data rates up to 120 kilobit/s has also increased the usability of HF for data communications and video transmission. Other standards development such as STANAG 5066 provides for error free data communications through the use of ARQ protocols. Some modes of communication, such as continuous wave mores code transmissions (especially by amateur radio operators) and single sideband voice transmissions are more common in the HF range than on other frequencies, because of their bandwidth-conserving nature, but broadband modes, such as TV transmissions, are generally prohibited by HF's relatively small chunk of electromagnetic spectrum space.

Noise, especially man-made interference from electronic devices, tends to have a great effect on the HF bands. In recent years, concerns have risen among certain users of the HF spectrum over "broadband over power lines" (BPL)Internet access, which has an almost destructive effect on HF communications. This is due to the frequencies on which BPL operates (typically corresponding with the HF band) and the tendency for the BPL signal to leak from power lines. Some BPL providers have installed notch filters to block out certain portions of the spectrum (namely the amateur radio bands), but a great amount of controversy over the deployment of this access method remains. Other electronic devices including plasma televisions can also have a detrimental effect on the HF spectrum.

In aviation, HF communication systems are required for all trans-oceanic flights. These systems incorporate frequencies down to 2 MHz to include the 2182 kHz international distress and calling channel. The upper section of HF (26.5-30 MHz) shares many characteristics with the lower part of VHF. The parts of this section not allocated to amateur radio are used for local communications. These include CB radios around 27 MHz, studio-to-transmitter (STL) radio links, radio control devices for models and radio paging transmitters. Some radio frequency identification (RFID) tags utilize HF. These tags are commonly known as HFID's or High Fid's (High Frequency Identification).

2. UHF Communication Propagation in Different Areas

The nature of packet radio is changing. As access to the Internet becomes cheaper and faster, and the Applications offered on the "net" more and more enticing, interest in the amateur packet radio network which grew up in the 1980s steadily wanes. To be sure, there are still pockets of interest in some places, particularly where some infrastructure to support speeds of 9600 bps or more has been built up, but this has not reversed the trend of declining interest and participation. Nevertheless, there are still lots of interest in packet radio out there - it is simply becoming re-focused in different areas. Some applications which do not require high speed, and can take advantage of the mobility that packet radio can provide, have found a secure niche - APRS is a good example. Interest is also high in high-speed wireless transmission which can match, or preferably exceed, landline modem rates. With a wireless link, you can have a 24-hour network connection without the need for a dedicated line, and you may also have the possibility of portable or mobile communication operation.

Until recently, most people have considered it to be just too difficult to do high-speed digital. Two-way radios can operate on many different frequencies, and these frequencies are assigned differently in different countries. Typically channelized operations are used, so that operators need not tune equipment to a particular frequency but instead can use one or more pre-selected frequencies, easily chosen by a dial, a pushbutton or other means. For example, in the United States, there is a block of 5 channels (pre-selected radio frequencies) are allocated to the Multiple Use Radio System. A different block of 22 channels are assigned, collectively, to the General Mobile Radio Service and Family Radio Service. The Citizens Radio Service (""CB"") has 40 channels. In an analog, conventional system, (the simplest type of system) a frequency or channel serves as a physical medium or link carrying communicated information. The performance of a radio system is partly dependent on the characteristics of frequency band used. The selection of a frequency for a two-way radio system is affected, in part, by government licensing and regulations.

- Local congestion or availability of frequencies.
- Terrain, since radio signals travel differently in forests and urban view sheds.
- The presence of noise, interference, or intermediation.
- Sky wave interference below 50–60 MHz and troposphere bending at VHF.
- In the US, some frequencies require approval of a frequency coordination committee.

A channel number is just a shorthand notation for a frequency. It is, for instance, easier to remember "Channel 1" than to remember "26.965 MHz" (US CB Channel 1) or "462.5625 MHz" (FRS/GMRS channel 1), or "156.05 MHz" (Marine channel 1). It is necessary to identify which radio service is under discussion when specifying a frequency by its channel number. Organizations, such as electric power utilities or police departments, may have several assigned frequencies in use with arbitrarily assigned channel numbers. For example, one police department's "Channel 1" might be known to another department as "Channel 3" or may not even be available. Public service agencies have an interest in maintaining some common frequencies for inter-area or inter-service coordination in emergencies (modern term: interoperability). Each country allocates radio frequencies to different two-way services, in accordance with international agreements. In the United States some examples of two-way services are: Citizen's Band, FRS, GMRS, MURS, and BRS. Amateur radio operators nearly always use frequencies rather than channel numbers, since there is no regulatory or operating requirement for fixed channels in this context. Even amateur radio equipment will have "memory" features to allow rapidly setting the transmitter and receiver to favorite frequencies.

For example, the WA4DSY 56 Kbps RF modem has been available for ten years now, and yet only a few hundred people at most have put one on the air. With the new version of the modem introduced last year, 56 Kbps packet radio has edged closer to plug 'n play, but in the meantime, landline modem data rates have moved into the same territory. What has really sparked interest in high-speed packet radio lately is not the amateur packet equipment, but the boom in spread spectrum (SS) wireless LAN (WLAN) hardware which can be used without a license in some of the ISM bands. The new WLAN units are typically integrated radio/modem/computer interfaces which mimic either Ethernet interfaces or landline modems, and are just as easy to set up. Many of them offer speeds which landline modem users can only dream of. TAPR and others are working on bringing this type of SS technology into the amateur service, where it can be used on different bands, and without the Effective Radiated Power (ERP) restrictions which exist for the unlicensed service. This technology will be the ticket to developing high-speed wireless LANs and MANs which, using the Internet as a backbone, could finally realize the dream of a high-performance wide-area AMP net which can support the applications (WWW, audio and video conferencing, etc.) that get people excited about computer networking these days.

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Although the dream as stated above is somewhat controversial, the author believes it represents the best hope of attracting new people to the hobby, providing a basis for experimentation and training in state-of the- art wireless techniques and networking, and, ultimately, retaining spectrum for the amateur radio service. One problem is that most of the people attracted to using digital wireless techniques have little or no background in RF. When it comes to setting up wireless links which will work over some distance, they tend to lack the necessary knowledge about antennas, transmission lines and, especially, the subtleties of radio propagation. This paper deals with the latter area, in the hopes of providing this new crop of digital experimenters with some tools to help them build wireless links which work. The main emphasis of this paper is on predicting the path loss of a link, so that one can approach the installation of the antennas and other RF equipment with some degree of confidence that the link will work. The focus is on acquiring a feel for radio propagation, and pointing the way towards recognizing the alternatives that may exist and the instances in which experimentation may be fruitful. We'll also look at some propagation aspects which are of particular relevance to digital signaling.

GPS and field navigation is vital to the safety of any field expedition. When combined with the necessity of fixing a location's co-ordinates for scientific research, the need for accurate, rapid and cost-effective navigation tools becomes paramount. Increasingly GPS receivers are becoming a standard some would say essential item of expedition equipment. Determining the co-ordinates of a point in the field can be achieved in a number of ways. The most common traditional approach involves triangulation with a map and magnetic compass. Triangulation (see Chapter 10) is often very accurate but relies on accurate maps and navigable objects. The Ordnance Survey of Great Britain produces very reliable maps but even they admit.

The result is that any triangulation achieved is relative to the map, which may in fact be quite inaccurate. Lines on navigation charts have accuracy on paper of ±1.5 mm. On a 1:10,000 chart that could be an error of 75 m. In addition, when drafting, the tools used may introduce additional errors. Triangulation is also time consuming and of limited use outside of areas of human influence i.e. those areas with manmade objects surveyed to an acceptable accuracy. Other methods have been employed to determine location but they are either difficult in the field or rely on expensive equipment, examples include sextants for astronomical positioning and various types of the dolomites for astronomical triangulation. There has for some time been a move to establish Global Navigation Systems (GNS) that are quick, cost effective and reliable. GPS has been the most successful of these systems.

GPS technology allows soldiers to find objectives, even in the dark or in unfamiliar territory, and to coordinate troop and supply movement. In the armed forces, commanders use the Commanders Digital Assistant and lower ranks use the Soldier Digital Assistant. Even this technology has been widely used to locate soldiers who may get lost in the middle of forest areas or army vehicles that may get confused in foreign territories. A navigation system is a (usually electronic) system that aids in navigation. Navigation systems may be entirely on board a vehicle or vessel, or they may be located elsewhere and communicate via radio or other signals with a vehicle or vessel, or they may use a combination of these methods.

Navigation systems may be capable of:

- containing maps, which may be displayed in human readable format via text or in a graphical format
- determining a vehicle or vessel's location via sensors, maps, or information from external sources
- providing suggested directions to a human in charge of a vehicle or vessel via text or speech
- providing directions directly to an autonomous vehicle such as a robotic probe or guided missile
- providing information on nearby vehicles or vessels, or other hazards or obstacles.

3. PROJECT EXPERIMENTATION

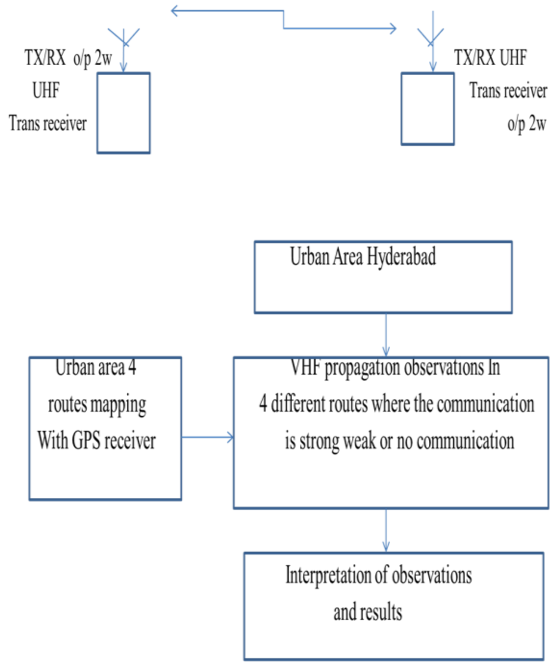

Figure 1: Project block diagram

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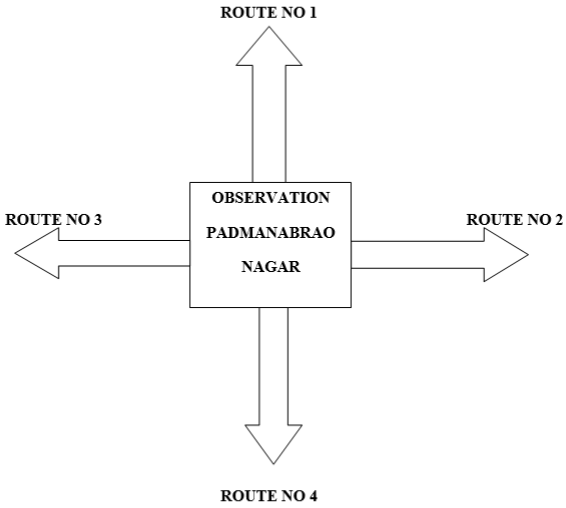
Project Experimentation Routes 4 for UHF Communication:



Route No 1: padmanab rao nagar to after RTC cross road.

Route No 2: padmanab Rao Nagar – Sithaphal Mandi – Sangeeth Theater.

Route No 3: padmanab rao nagar to via musheerabad to ambedhkar bhavan.

Route No 4: padmanab rao nagar to via sithapal mandi to IETE.

HARDWARE REQUIREMENTS:

Figure 2: GPS receiver

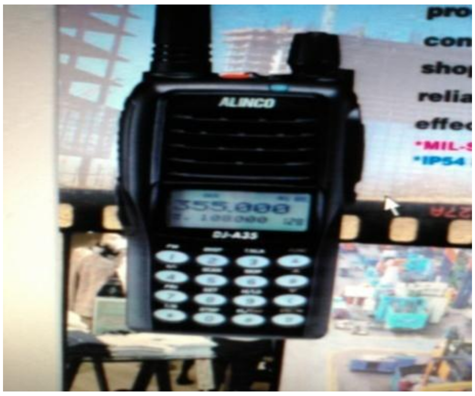


Figure 3: UHF transceiver

4. Results and Discussion

In this project UHF communication observations are planned in the Urban areas of Hyderabad Four different routes are chosen. It consists of low linking area, strong signal, weak signal, and no signal areas with a lot of obstructions.

The routes of observations are

- PADMANAB RAO NAGAR to after RTC cross road.
- PADMANABRAO NAGAR to SANGEETH THEATER
- PADMANABRAO NAGAR to AMBEDHKAR BHAVAN
- PADMANABRAO NAGAR to IETE

Obstructions such as terrain, buildings, and trees reduce UHF communication we had notice the communication range increases with less number of obstructions.

Route no1: PADMANAB RAO NAGAR to after RTC cross road.

Route No 2: PADMANABRAO NAGAR to SANGEETH THEATER

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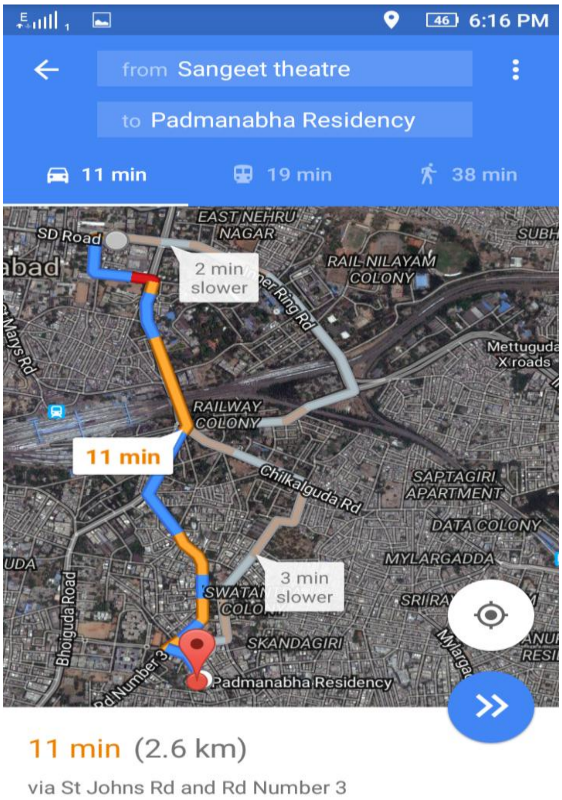
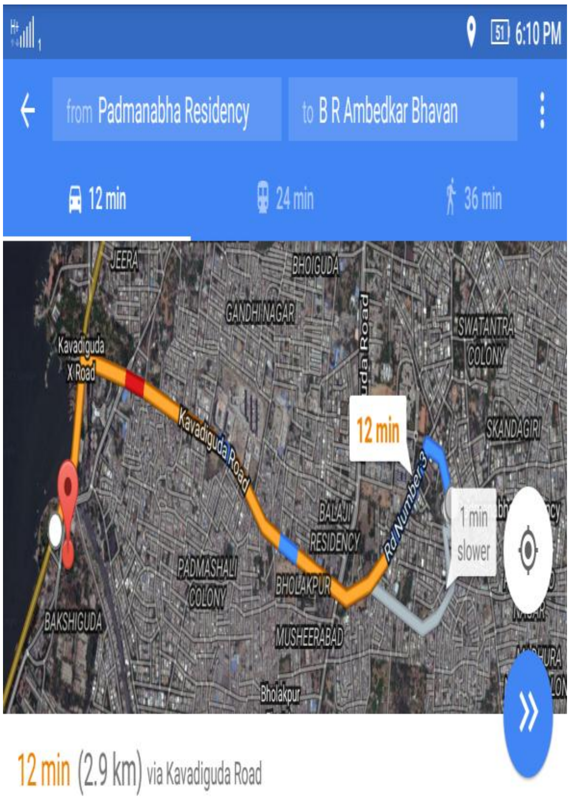
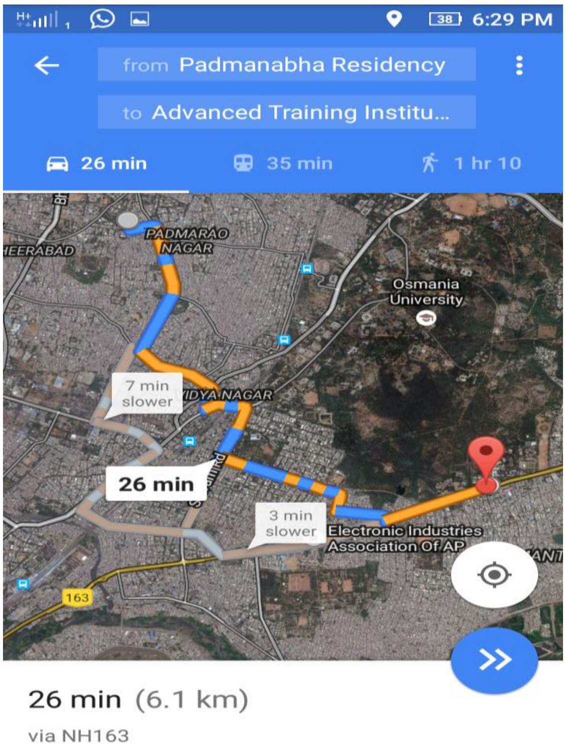


Route No 3: PADMANABRAO NAGAR to AMBEDHKAR BHAVAN



Route No 4: PADMANABRAO NAGAR to IETE



5. Conclusion

In this project UHF communication observations are planned in the Urban areas of Hyderabad. Four different routes are chosen. It consists of low linking area, strong signal, weak signal, and no signal areas with a lot of obstructions. Obstructions such as terrain, buildings, and trees reduce UHF communication we had notice the communication range increases with less number of obstructions. All routes observation points and position locations are mapped through the GPS receiver and the routes are platted with GPS co-ordinates on the digital maps.

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