**CHAPTER 1**

**INTRODUCTION**

* 1. **OVERVIEW OF WIRELESS COMMUNICATION**

Wireless communication is among technology’s biggest contributions to mankind. Wireless communication as thousands or even millions of kilometers for deep-space radio communications.

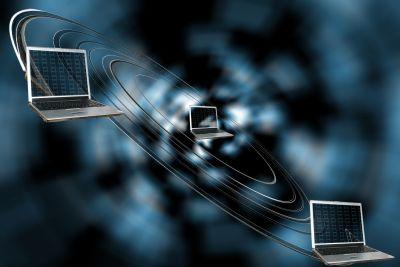
It encompasses various types of fixed, mobile, and portable applications, including [two-way radios](http://en.wikipedia.org/wiki/Two-way_radio), [cellular telephones](http://en.wikipedia.org/wiki/Mobile_phone), [personal digital assistants](http://en.wikipedia.org/wiki/Personal_digital_assistant), and [wireless networking](http://en.wikipedia.org/wiki/Wireless_network).

Somewhat less common methods of achieving wireless communications include the use of other [electromagnetic](http://en.wikipedia.org/wiki/Electromagnetism) wireless technologies, such as light, magnetic, or electric fields or the use of sound.

It involves the transmission of information over a distance without help of wires, cables or any other forms of electrical conductors. The transmitted distance can be anywhere between a few meters and thousands of kilometers .

Some of the devices used for wireless communication are cordless telephones, mobiles, GPS units, wireless computer parts, and satellite television.

Wireless communication is the [transfer of information](http://en.wikipedia.org/wiki/Telecommunication) between two or more points that are not connected by an electrical conductor. The most common wireless technologies use [radio](http://en.wikipedia.org/wiki/Radio). With radio waves distances can be short, such as a few meters for television or as far.



**Figure 1.1 Wireless Communication**

# Wireless operations permit services, such as long-range communications, that are impossible or impractical to implement with the use of wires. The term is commonly used in the [telecommunications](http://en.wikipedia.org/wiki/Telecommunications) industry to refer to telecommunications systems which use some form of enter to transfer information without the use of wires. Information is transferred in this manner over both short and long distances.

Wireless is used for short and medium-range communications and security control.  For wireless communication to work, the systems mostly operate inline-of-sight mode which means that there must be no obstruction between the transmitter and receiver. In the electromagnetic spectrum, infrared radiation lies between microwaves and visible light, therefore, they can be used as a source of communication.

A photo LED transmitter and a photodiode receptor are required for successful IR communication. The LED transmitter transmits the infrared signal in the form of non-visible light, which is captured and retrieved as information by the photo receptor. In this way, the information between the source and the target is transferred.

# 1.1.1 Advantages

# Wireless communication has the following advantages

* Communication has enhanced to convey the information quickly to the consumers.
* Working professionals can work and access Internet anywhere and anytime without carrying cables or wires wherever they go. This also helps to complete the work anywhere on time and improves the productivity.
* Doctors, workers and other professionals working in remote areas can be in touch with medical centers through wireless communication.
* Urgent situation can be alerted through wireless communication. The affected regions can be provided help and support.

**1.1.2 Wireless Technology Development**

The convergence of wireless communications and mobile computing is bringing together two areas of immense growth and innovation. This is reflected throughout the journal by strongly focusing on new trends, developments, emerging technologies and new industrial standards.

Recent analysis by manufacturers and network operators has shown that current wireless networks are not very energy efficient, particularly the base stations by which terminals access services from the network. These huge numbers of wireless terminals, together with the access network equipment necessary to serve them, consume an enormous amount of energy.

Green radio technology describes one of the most promising research directions in reducing the energy consumption as well as the carbon emissions of future base stations. The Green Radio program sets the aspiration of achieving a hundredfold reduction in power consumption over current designs for wireless communication networks. This challenge is rendered nontrivial by the requirement to achieve this reduction without significantly compromising the quality of service experienced by the network’s users.

The cellular network operators feel an impetus towards reducing the energy consumption of their networks in order to decrease the expense of operating a network. Due to competition in the market the operators try to reduce their network operation cost while still keeping high Quality of Service (QoS) for the customers. From a system-level point of operators’ focus is shifting from optimizing the network deployment schemes towards developing techniques, such as intelligently switching unnecessary BSs off in order to further reduce the energy consumption of already optimally deployed cellular networks, more than two-thirds of the energy in a mobile communication network are consumed by the part responsible for radio access, mainly Base Stations .

Therefore, the Moreover, as the BSs in a telecommunication network consume a major portion of the total network power.

The power consumption reduction of BSs may be viewed as a definite direction towards green communication at the system level. Furthermore, in the technological domain, operators have started to incorporate new features in their infrastructure equipment allowing network elements to be remotely controlled, and even switched off under certain circumstances.

Taking such advancements as motivation, I propose in this paper a network energy saving scheme which switches off the middle BS in a linear configuration of a network with three micro-cells when the traffic intensity in the corresponding cell is below a threshold level. Correspondingly, the users of the switched-off BS are covered by increasing the transmission power of a sector antenna from each of the two neighbouring cells when their respective traffic intensities are sufficiently low as well.

The assumption that some cells in the access network can be switched off when traffic is low implies that radio coverage and service provisioning can be taken care of by the cells that remain active, which requires a, possibly small, increase in the emitted power, and some adjustment in other network parameters, such as antenna tilting; moreover, some switch-off patterns result unfeasible due to specific site positioning that require some cells to be always on to provide full coverage. Main Objective is to reduce the energy consumption in base stations and reduce the amount of CO2 emission. To keep controlling system in every base station for switching purpose.

To have complete control over base station to prefer to use PC. In this technology, the mobile communication tower in an area is turned ON, based on the frequency of users present in that area. In general, within a pre-defined control area, there will be multiple towers operating. And each tower has predefined user-strength capacity, up to which it can operate. Thus, based on the user strength in a region, the number of towers in that particular region is turned ON and remaining towers are kept in IDLE state.

**1.2 BHARAT SANCHAR NIGAM LIMITED**

Bharat Sanchar Nigam Limitedis an Indian [state-owned](https://en.wikipedia.org/wiki/State-owned) [telecommunications](https://en.wikipedia.org/wiki/Telecommunications) company headquartered in [New Delhi](https://en.wikipedia.org/wiki/New_Delhi). It was incorporated on 15 September 2000 and assumed the business of providing telecom services and network management from the erstwhile Central Government Departments of Telecom Services (DTS) and Telecom Operations (DTO) as of 1 October 2000 on a going-concern basis. It is the largest provider of [fixed telephony](https://en.wikipedia.org/wiki/Telephony) and [broadband](https://en.wikipedia.org/wiki/Broadband_Internet_access) services with more than 60% market share, and is the [fifth largest](https://en.wikipedia.org/wiki/Mobile_network_operators_of_India) [mobile telephony](https://en.wikipedia.org/wiki/Mobile_telephony) provider in India. However, in recent years, the company's revenues and market share have plummeted resulting in heavy losses as a result of intense competition in the [privatizing](https://en.wikipedia.org/wiki/Privatizing) Indian telecommunications sector. BSNL is India's oldest communication service provider and had a customer base of 93.29 million as of June 2015. It has footprints throughout India, except for [Mumbai](https://en.wikipedia.org/wiki/Mumbai) and [New Delhi](https://en.wikipedia.org/wiki/New_Delhi), where telecommunications are managed by [Mahanagar Telephone Nigam](https://en.wikipedia.org/wiki/Mahanagar_Telephone_Nigam" \o "Mahanagar Telephone Nigam) .

**1.3 SERVICE**

[BSNL Mobile](https://en.wikipedia.org/wiki/BSNL_Mobile) is a major provider of GSM cellular mobile services under the brand name Cell one. BSNL provides a complete telecom services solution to enterprise customers including MPLS, P2P and Internet leased lines. It provides fixed line services and landline using CDMA technology and its own extensive optical fiber network. BSNL provides [Internet access](https://en.wikipedia.org/wiki/Internet_access) services through dial-up connections as prepaid, Net One as Postpaid and [Data One](https://en.wikipedia.org/wiki/BSNL_Broadband) as BSNL Broadband.

BSNL offers value-added services such as Free Phone Service, India Telephone Card, Account Card Calling , Virtual Private Network, Tele-voting, Premium Rate Service and Universal Access Number. BSNL also offers the IPTV which enables customers to watch television through the Internet and Voice and Video Over Internet Protocol. In 2007, BSNL announced plans to provide 5 million broadband connections and secured 80% of the INR 25 billion rural telephony project of the Government of India. On 20 March 2009, BSNL launched blackberry services across India. BSNL paid Rs. 101.87 billion for [3G](https://en.wikipedia.org/wiki/3G) spectrum in 2010. As of 2011, BSNL offered coverage in over 800 cities across India. BSNL launched in 2012 a 3G wireless pocket-sized router called Winknet Mf50. BSNL 3G provides service with a top speed of 21.1 Mbit/s downlink and 5.76 Mbit/s uplink.

After providing it for 160 years, BSNL discontinued its telegraph service on 15 July 2013. It began delivering telegrams to the public in February 1855; this service was upgraded to a web-based messaging system in 2010 and had been offered through 182 telegraph offices across India.

Bharat Sanchar Nigam Limited, a Public Sector Enterprise, also provides fiber plans for the home, which are generally known as BSNL FTTH broadband service. This is the fastest broadband service provided by BSNL, offering speeds up to 100Mbit/s to home-based Internet users.

According to a Telecom Regulatory Authority of India Report dated 19 February 2016, at the end of 2015, BSNL's 14.54% share of the broadband market placed it 4th in market share. As a wireless provider, it ranked 6th with an 8.16% share of that market.

BSNL launched linguistic email service using the DATAMAIL app in eight Indian languages. On 8 June 2017 BSNL signed a memorandum of understanding with the Universal Service Obligation Fund to have 25,000 Wi-Fi hotspots in rural exchanges within the next six months.

**1.4 SPECTRUM MANAGEMENT**

Spectrum management is the process of regulating the use of [radio frequencies](https://en.wikipedia.org/wiki/Radio_frequency) to promote efficient use and gain a net social benefit. The term [radio spectrum](https://en.wikipedia.org/wiki/Radio_spectrum) typically refers to the full frequency range from 3 kHz to 300 GHz that may be used for wireless communication. Increasing demand for services such as mobile telephones and many others has required changes in the philosophy of spectrum management. Demand for [wireless broadband](https://en.wikipedia.org/wiki/Wireless_broadband) has soared due to technological innovation, such as 3G and 4G mobile services, and the rapid expansion of wireless internet services.

Since the 1930s, spectrum was assigned through administrative licensing. Limited by technology, signal interference was once considered as a major problem of spectrum use. Therefore, exclusive licensing was established to protect license signals. This former practice of discrete bands licensed to groups of similar services is giving way, in many countries, to a [spectrum auction](https://en.wikipedia.org/wiki/Spectrum_auction) model that is intended to speed technological innovation and improve the efficiency of spectrum use. During the experimental process of spectrum assignment, other approaches have also been carried out, namely, [lotteries](https://en.wikipedia.org/wiki/Lotteries), unlicensed access and privatization of spectrum.

Most recently, the President's Council of Advisors for Science and Technology advocated the sharing of federal radio spectrum when unused at a place and time provided it does not pose undue risks.

PCAST's recommendations, President Obama made shared spectrum the policy of the United States on 14 June 2013 [Shared Spectrum](https://en.wikipedia.org/w/index.php?title=Shared_Spectrum&action=edit&redlink=1). As of Dec 2014 the FCC was extending the limited success of television band spectrum sharing into other bands, significantly into the 3550-3700 MHz US Navy radar band via a three tier licensing model while Europe has been pursuing an authorized shared access licensing model.

**1.4.1 Frequency Allocation:**

A band of radio frequencies identified by an upper and lower frequency limit kept for use by one or more of the 38 terrestrial and space radio communication services defined by the [International Telecommunication Union](http://www.wirelesscommunication.nl/reference/chaptr07/itu.htm) under specified conditions.

The designation of portions of an allocated frequency band to individual countries or geographical areas for a particular radio communication service; for a satellite service, specific orbital positions may also be allotted to individual countries.

**1.4.2 Frequency Assignment:**

Authorization given by a nation's government for a station or an operator in that country to use a specific radio frequency channel under specified conditions. In the U.S., the [FCC](http://www.wirelesscommunication.nl/reference/chaptr07/fcc.htm) handles frequency assignments. Increasingly, [economic mechanisms](http://www.wirelesscommunication.nl/reference/chaptr02/specfee.htm) are used to assign frequencies.

The term frequency assignment is also used for the action of an operator assigning a channel to a particular user. For instance in dynamic frequency assignment ([DCA](http://www.wirelesscommunication.nl/reference/chaptr04/cellplan/dca.htm)) the cellular operator optimizes the resources available in all cells to optimally adapt to the changing needs from its subscribers. Confusingly, DCA is often called dynamic frequency allocation.

**1.5 CELLULAR CONCEPT**

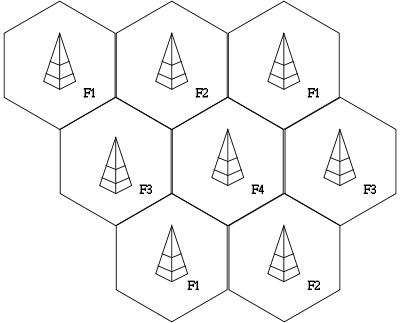
In a [cellular radio](https://en.wikipedia.org/wiki/Cellular_radio) system, a land area to be supplied with radio service is divided into cells, in a pattern which depends on terrain and reception characteristics but which can consist of roughly hexagonal, square, circular or some other regular shapes, although hexagonal cells are conventional. Each of these cells is assigned with multiple frequencies (*f*1 – *f*6) which have corresponding [radio base stations](https://en.wikipedia.org/wiki/Radio_base_station). The group of frequencies can be reused in other cells, provided that the same frequencies are not reused in adjacent neighboring cells as that would cause [co-channel interference](https://en.wikipedia.org/wiki/Co-channel_interference).

If there is a single plain transmitter, only one transmission can be used on any given frequency. Unfortunately, there is inevitably some level of [interference](https://en.wikipedia.org/wiki/Co-channel_interference) from the signal from the other cells which use the same frequency. This means that, in a standard [FDMA](https://en.wikipedia.org/wiki/Frequency-division_multiple_access) system, there must be at least a one cell gap between cells which reuse the same frequency.

In the simple case of the taxi company, each radio had a manually operated channel selector knob to tune to different frequencies. As the drivers moved around, they would change from channel to channel. The drivers knew which [frequency](https://en.wikipedia.org/wiki/Frequency) covered approximately what area. When they did not receive a signal from the transmitter, they would try other channels until they found one that worked. The taxi drivers would only speak one at a time, when invited by the base station operator. This is, in a sense, [time-division multiple access](https://en.wikipedia.org/wiki/Time-division_multiple_access).

**1.5.1 Cellular Architecture**

Time Division Multiplexing technique is used to share eight full-rate or sixteen half-rate speech channels per radio frequency channel. There are eight radio time slots grouped into a TDMA frame.

[](https://en.wikipedia.org/wiki/File:Frequency_reuse.svg)

**Figure 1.2 Cellular Architecture**

A cellular architecture containing 9 cores in the processor which in the base station. Cellular architecture follow the low level programming.

**1.6 GSM SYSTEM**

Global System for Mobile Communications(GSM) is the standard for mobile telephone systems in the world. In GSM, the signalling and speech channels are digital, therefore GSM is considered a 2G system. This helps wide-spread implementation of data communication applications. There are five different cell sizes in a GSM network These are macro, micro, pico, femto and umbrella cells.

Macro cells are cells where the base station antenna is installed on a mast above average roof top level. Micro cells are cells whose antenna height is under average roof top level. Pico cells are small cells whose coverage diameter is a few dozen metres. These are mainly used in indoors applications. Femto cells are cells designed for use in residential or small business environments and connect to the service provider’s network via a broadband internet connection.

Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells. Horizontal radius of the cell varies depending on the antenna height, antenna gain and propagation conditions. Maximum distance the GSM supports is 35 kilometres. Most 2G GSM networks operate in the 900 MHz or 1800 MHz bands while 3G GSM in the 2100 MHz frequency band.

**1.7 MOBILE TECHNOLOGY**

Mobile technology is the technology used for cellular communication. Mobile [code division multiple access](https://en.wikipedia.org/wiki/Code_division_multiple_access) technology has evolved rapidly over the past few years. Since the start of this millennium, a standard mobile device has gone from being no more than a simple two-way [pager](https://en.wikipedia.org/wiki/Pager) to being a [mobile phone](https://en.wikipedia.org/wiki/Mobile_phone), [GPS navigation device](https://en.wikipedia.org/wiki/GPS_navigation_device), an embedded [web browser](https://en.wikipedia.org/wiki/Web_browser) and [instant messaging](https://en.wikipedia.org/wiki/Instant_messaging) client, and a [handheld game console](https://en.wikipedia.org/wiki/Handheld_game_console).

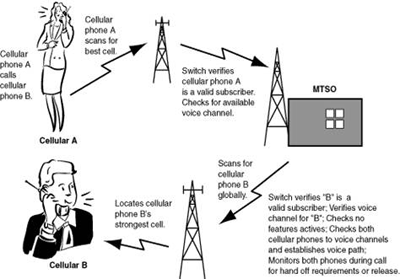
Many experts believe that the future of computer technology rests in [mobile computing](https://en.wikipedia.org/wiki/Mobile_computing) with [wireless networking](https://en.wikipedia.org/wiki/Wireless_network). Mobile computing by way of tablet computers arise becoming more popular.



**Figure 1.3 Mobile Technology**

**1.8 MOBILE NETWORK**

Mobile phone converts voice, text, multi-media messages or data calls into Radio Frequencies . Mobile phone base stations transmit and receive these RF signals and connect callers to other phones and other networks. Mobile phone network is divided into thousands of overlapping, individual geographic areas or ‘cells’, each with a base station. The size of a cell depends on the area of coverage and the number of calls that are made in that area. The smallest cells are in crowded urban areas with large buildings and heavy population density, while the biggest cells are in rural areas, where people are dispersed.

**[](http://www.electroschematics.com/wp-content/uploads/2010/03/Mobile-Communication.png)**There are two types of channels used in GSM. These are Control channels and Traffic channels.

**Figure 1.4 Mobile Network**

**1.8.1 Control Channels**

These are responsible for housekeeping tasks such as telling the mobile when a call is coming in and which frequency to use. To ensure this handover works, the phone constantly monitors the broadcast control channel of up to 16 neighbouring cells.

In normal operation, phones continually adjust the power of the radio waves they send out to be the minimum needed for the base station to receive a clear signal. If a phone moves far away from its base station and if the signal is weak, the network consults the list and triggers a handover to a neighbouring cell with best signal.

**1.8.2 Traffic Channels**

It is used to carry calls or other data from the mobile phone to the base station and vice versa. In the Traffic channel, voice or text data is carried in bursts. Each burst comprises two consecutive strings of bits, each 57 bits long.

**1.8.3 Range**

The range within which mobile devices can connect is not a fixed figure. It depends on a number of factors like the frequency of signal in use, the transmitter’s rated power, the transmitter’s size etc.

**1.9** **MOBILE PHONE COMMUNICATION**

A mobile phone is an electronic device used for mobile telecommunications over a cellular network of specialized base stations known as cell sites. A cell phone offers full Duplex Communication and transfer the link when the user moves from one cell to another. As the phone user moves from one cell area to another, the system automatically commands the mobile phone and a cell site with a stronger signal, to switch on to a new frequency in order to keep the link.

Mobile phone is primarily designed for Voice communication. In addition to the standard voice function, new generation mobile phones support many additional services, and accessories, such as SMS for text messaging, email, packet switching for access to the Internet, gaming, Bluetooth, camera with video recorder and MMS for sending and receiving photos and video, MP3 player, radio and GPS.

**1.9.1 Signal Frequency in Cell Phone**

The cellular system is the division of an area into small cells.  
This allows extensive frequency reuse across that area, so that many people can use cell phones simultaneously. Cellular networks has a number of advantages like increased capacity, reduced power usage, larger coverage area, reduced interference from other signals etc.

**1.9.2 FDMA and CDMA Systems**

Frequency Division Multiple Access and Code Division Multiple Access were developed to distinguish signals from several different transmitters. In FDMA, the transmitting and receiving frequencies used in each cell are different from the frequencies used in the neighbouring cells. The principle of CDMA is more complex and the distributed transceivers can select one cell and listen to it. Other methods include Polarization Division Multiple Access and Time Division Multiple Access. Time division multiple access is used in combination with either FDMA or CDMA to give multiple channels within the coverage area of a single cell.

**1.9.3 Codes in the Mobile Phone**

Mobile phones have special codes associated with them. These include:

* Electronic Serial Number -Unique 32-bit number programmed in the phone
* Mobile Identification Number– 10 digit number derived from the phone’s number.
* System Identification Code – unique 5 digit number that is assigned to each carrier by the FCC.
* ESN is a permanent part of the phone while MIN and SID codes are programmed in the phone when a service plan is selected and activated.

Mobile phone is a Duplex device. When we use one frequency for talking, a second separate frequency is used for listening.

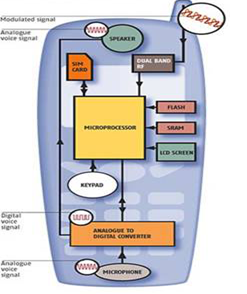
So that both the people on the call can talk at once. The Mobile phone can communicate on 1,664 channels or more. The Mobile phones operate within the cells, so that it is easy to switch on to different cells as they move around.

A person using a cell phone can drive hundreds of kilometers and can maintain a conversation during the entire time because of the cellular approach.

**1.9.4 Inside the Mobile phone**

Mobile phone is a sophisticated device using SMD components, Microprocessor, Flash memory etc. In addition to the Circuit board, Mobile phone also has Antenna, Liquid Crystal Display , Keyboard, Microphone, Speaker and Battery.

The circuit board is the heart of the Mobile phone. It has chips like Analog-to-Digital and Digital-to-Analog conversion chips that translate the outgoing audio signal from analog to digital and the incoming signal from digital back to analog.



**Figure 1.5 Inside the Mobilephone**

**1.9.4.1 Digital signal processor**

It is generally rated as having 40 MIPS (millions of instructions per second) to conduct calculations of signal manipulation at high speed. This chip deals with both compression and decompression of the signals.

**1.9.4.2 Microprocessor**

It handles all the housekeeping tasks for the keyboard and display. It also deals with command and control signalling with the base station, and coordinates the rest of the functions on the board.

**1.9.4.3 Mobile Microprocessor and Flash Memory**

The Flash memory and ROM Chips of the Mobile phone act as a storage location for the phone. These chips store the customizable options of the cell phone, as well as the entire operating system. The power and radio frequency sections of the phone, phone recharging and power management are controlled by this chip. It also controls several hundred FM channels. The RF amplifiers focus on signals that go in and out of the phone’s antennae.

**1.9.5 SIM Card**

SIM card is a type of Smart cardused in mobile phone. The SIM is a detachable smart card containing the user’s subscription information and phone book. This allows the user to retain his or her information even after switching off the handset. Alternatively, the user can also change service providers while retaining the handset simply by changing the SIM. SIM card Securely stores the services.

The digits of the key are :

* First 3 digits – Mobile country code
* Second 2 digits – Mobile network code
* Third 10 digits – Mobile station identification number

**[](http://www.electroschematics.com/wp-content/uploads/2010/03/SIM-CARD.png)**

**Fig 1.6 SIM Card**

When the Mobile phone is used for the first time, it sends a number called International Mobile Subscriber Identity – IMSI present in the SIM card to the network, which looks it up in a database to ensure the card is registered. If the IMSI is recognized, the network creates another number called a Temporary Mobile Subscriber Identity , which is encrypted and sent back to the phone. In all subsequent calls, the phone identifies itself by broadcasting the TMSI.

**1.9.6 Make a call**

* When we switch on the mobile phone, it tries for an SID on the Control channel. The Control channel is a special frequency that the phone and base station use to talk to one another.
* If the Mobile phone finds difficulty to get link with the control channel, it displays a no service message.
* If the Mobile phone gets the SID, it compares the SID with the SID programmed in the phone. If both SID match, the phone identifies that the cell it is communicating is the part of its home system.
* The phone also transmits a registration request along with the SID and the MTSO keeps track of your phone’s location in a database. MTSO knows in which cell you are when it wants to ring the phone.
* The MTSO then gets the signal, it tries to find the phone. The MTSO looks in its database to find the cell in which the phone is present. The MTSO then picks a frequency pair to take the call.
* The MTSO communicates with the Mobile phone over the control channel to tell it what frequencies to use. Once the Mobile phone and the tower switch on those frequencies, the call is connected.
* When the Mobile phone move toward the edge of the cell, the cell’s base station will note that the signal strength is diminishing. At the same time, the base station in the cell in which the phone is moving will be able to see the phone’s signal strength increasing.

**1.10 SIGNAL TO NOISE RATIO**

Signal-to-noise ratio is a measure used in [science and engineering](https://en.wikipedia.org/wiki/Science_and_engineering) that compares the level of a desired [signal](https://en.wikipedia.org/wiki/Signal_(electrical_engineering)) to the level of background [noise](https://en.wikipedia.org/wiki/Noise_(signal_processing)" \o "Noise (signal processing)).SNR is defined as the ratio of signal power to the noise power, often expressed in [decibels](https://en.wikipedia.org/wiki/Decibel). A ratio higher than 1:1 (greater than 0 dB) indicates more signal than noise. While SNR is commonly quoted for electrical signals, it can be applied to any form of signal.

The signal-to-noise ratio, the [bandwidth](https://en.wikipedia.org/wiki/Bandwidth_(signal_processing)), and the [channel capacity](https://en.wikipedia.org/wiki/Channel_capacity) of a [communication channel](https://en.wikipedia.org/wiki/Channel_(communications)) are connected by the theorem. Signal-to-noise ratio is sometimes used metaphorically to refer to the ratio of useful [information](https://en.wikipedia.org/wiki/Information) to false or irrelevant data in a conversation or exchange. For example, in [online discussion forums](https://en.wikipedia.org/wiki/Internet_forum) and other online communities, [off-topic](https://en.wikipedia.org/wiki/Off-topic) posts and [spam](https://en.wikipedia.org/wiki/Spamming) are regarded as noise that interferes with the signal of appropriate discussion.

**1.10.1 Improving SNR**

All real measurements are disturbed by noise. This includes [electronic noise](https://en.wikipedia.org/wiki/Electronic_noise), but can also include external events that affect the measured phenomenon wind, vibrations, gravitational attraction of the moon, variations of temperature, variations of humidity, etc., depending on what is measured and of the sensitivity of the device. It is often possible to reduce the noise by controlling the environment. Otherwise, when the characteristics of the noise are known and are different from the signals, it is possible to [filter](https://en.wikipedia.org/wiki/Filter_(signal_processing)) it or to process the signal.

For example, it is sometimes possible to use a [lock-in amplifier](https://en.wikipedia.org/wiki/Lock-in_amplifier) to modulate and confine the signal within a very narrow bandwidth and then filter the detected signal to the narrow band where it resides, thereby eliminating most of the broadband noise.

**1.11 ENERGY EFICIENCY**

With the fast development of wireless networking in the world, the energy efficiency of wireless networking protocols becomes a concern of many wireless networking stakeholders. They have interests on the energy efficiency in wireless networking protocols for various reasons such as design problem, green technology policy, cost and final user satisfaction.

Different wireless networks protocols take one or several energy efficiency measures to reduce the power consumption according to their payload, cover area, and the demand for energy. Therefore, the protocols integrate the energy efficiency characteristics into applications to achieve balances of power consumption between the energy efficiency and functions.

When the signal is constant or periodic and the noise is random, it is possible to enhance the SNR by averaging the measurement.

In this case the noise goes down as the square root of the number of averaged samples.

Additionally, internal noise of electronic systems can be reduced by amplifiers. The three route selection schemes to enhance the network performance of Cognitive Radio network, and investigate them using a real test bed environment.

It can be achieve the better performance and also achieve the close to the performance achieved by the SL approach.Particularly the hardware and software processing delays, can affect the network layer performance.

Simulation result conformaly reduce the end-to-end delay and achively dependable communication for cognitive radio network. This technology enhance the spectrum efficiency by creating the transmission links.

Introduce the concept of correlated equilibrium for the cooperative spectrum sensing game among non-cooperative secondary user and formulate the optimization problem.

Finial we propose the neighbor based learning algorithm and show that it achieves better performance than the no-regrant algorithm. Secondary user are allowed to opportunistically access the spectrum on the basis of no-interference to the primary user.