

Green Wireless Communication-Need & Approaches for Energy Efficient Wireless Communication

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Abstract: With increasing demand for speedy communication and industrial services, huge amount of energy is consumed in Wireless Communication Systems to maintain the efficiency in terms of both qualitative and quantitative aspects, that is, more bits of data per second should be transferred from one end to other without minimum BER and maximum accuracy. Hence, nowadays much attention is paid to energy efficiency in communication with limited energy requirements & environment friendly behaviour. Energy consumption and greenhouse pollution are main concerns which triggers research on green wireless communication due to need of evolution in technology in harmony with nature. Recent statistics have pointed out that the content of polluting greenhouse gases in atmosphere has grown more speedily than the expected rate which led to a push towards “Green” Wireless Communication to preserve the nature. The idea is to promote energy efficient eco-friendly technology guaranteeing QoS and coverage for users ensuring capability for evolution.

Keywords: Green wireless communication, greenhouse gases, energy efficient communication, environment friendly technology.

Introduction

Technical sector dealing with IT services is playing a leading role in greenhouse gas emissions worldwide and is responsible for about 2-2.5% of harmful greenhouse emission with the growing service demands. The total energy consumption of wireless communication systems & networks and the web is about more than 2.5% of the total energy expenditure these days and the amount will obviously increase more tremendously in future. Therefore, maintaining energy efficiency is a recent trend to be followed for designing future wireless communication equipment. Energy expenditure in wireless networks at both infrastructure level and among battery operated wireless nodes is one major concerned issue in industrial or technical organisations. As a result, effort is made to resolve the issue by suggesting tools and equipment that improve energy efficiency of communication networks. ICT causes 2% of worldwide CO₂ emissions. The concept of green wireless communication expects a wide number of paradigm shifting advanced technical approaches such as optimization techniques, energy efficient network architecture, efficient networking protocols, better transmission and reception techniques and spectrum sharing(as emphasized by cognitive radio, that is ,Secondary users could use the spectrum without interfering with the activities of primary users) implementing the idea of green spectrum. Increased energy consumption for future requirements will lead to increase in CO₂ emissions which leads to climatic changes, rising pollutant content, natural disasters and sea level alterations, thus disturbing the nature’s ecological balance. Main sectors contributing to total emissions include PCs & Monitors(40%), Data centers(23%) and Mobile telecommunications(24%). Hence, the need of the hour is to use eco-friendly renewable resources of energy and reduction in carbon emissions to reduce the level of pollutants in environment. To maintain ecological harmony to ensure a balance in nature and prevent carbon emissions into the air, promotion of green industrial development is a major aspect to provide energy efficiency in wireless communication, leading to economical production levels without compromising with the quality of service.

Green Communication

Green wireless communication

Green Wireless Communication is a explanation in itself. Basically, it uses eco-friendly techniques and approaches in communication networks to minimize wastage of energy and effects of technological advancements on natural balance. Increase in telecommunication demands and equipment requires increasing amount of electricity to operate it. Thus, there is a need for shifting from non-renewable sources of energy to environment friendly renewable energy sources. It will result in a reduction of CO₂ emissions due to burning of fossil fuels as well as saving of operating expenses for telecommunication companies.

Green Telecommunication Networks

In telecommunication networks, greening promotes the idea of energy efficient wireless communication using eco-friendly energy alternatives and technologies like renewable energy resources.

Green Manufacturing

The process of manufacturing should be carried on while taking care of its effects on environment by using eco-friendly and energy efficient technology & equipment and manufacturing equipment, Recycling and proper disposal of electronic and mechanical wastes, minimum use of toxic materials like lead and mercury by industries that are difficult to decompose causing soil pollution, banning the use of plastics, and reduction of harmful radio emission into atmosphere to avoid air pollution. All steps causing harm to nature should be replaced by alternative methodologies.

Waste Disposal

Disposal of electronic and mechanical waste (e-waste disposal) equipment should be done in an eco-friendly manner so that any hazardous substance used during production process should not pollute the environment's air, water or soil. All the types of pollution caused due to technological evolution should be minimized to attain sustainable development, that is, development should take place without disturbing the nature's balance, preserving the environment and without compromising with the needs of future generations. Conservation of resources should be done so that they could be available for use by future generations.

Methods to Reduce Carbon Footprints

Recent research has shown that noticeable reduction in the carbon emissions due to telecommunication industry is possible through a number of preventive measures by taking into consideration the mother Earth. The Kyoto protocol has stated that 6 major gases that are contributing to the global warming effect and are known as GHGs (GreenHouse Gases). It consists of carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), sulfur hexafluoride (SF₆), HFCs, and PFCs. They have different levels of affecting the Earth and cause accumulation of carbon into layers of atmosphere.

Starting from the manufacturing of electronic components employed in the communication network to the various steps involved in designing the network infrastructure equipment and to the operation life span of the network and ultimately network failure & e-waste disposal, there are certain activities that emit greenhouse gases directly or indirectly and cause injurious impacts on nature and human health which can be prevented and controlled using following attempts:

1. Careful cellular planning so that a wide coverage can be achieved by employing lesser number of antennas.
2. Infrastructure sharing should be allowed in order to minimize hazardous impacts on nature.
3. Replace air-conditioners that emit CFCs into air with alternative cooling methods.
4. Employing HFC free cooling systems.
5. Outdoor base-stations should be preferred.
6. Designing energy efficient tools and equipment that can operate well consuming less power and use of renewable sources of energy like solar, tidal, hydal and wind energy.

Causes of Inefficient Energy Consumption

Network entities

Inefficient energy expenditure by some network entities and subsystems.

Hardware Design

Poor design of power amplifiers and inefficient power consumption by wireless nodes are the main causes. To overcome this hardware inefficiency will require complete redesign of the wireless network infrastructure and equipment, which is very hard, expensive and time consuming process.

Routing protocols

Inefficient routing protocols use leads to congestion and improper routing consuming more time, energy and efforts.

Other factors

Improper planning of current deployments and cell structures cause energy wastage due to increased traffic densities, interference caused by coverage overlapping and due to the co-existence of different technologies simultaneously as if 802.11 WLANs and Bluetooth are coexisting in a network, then it would result in lack of harmony between the two standards causing interference and collisions.

Approaches To Improve Energy Efficiency

Relay Transmission

The use of relay in wireless communication networks offers alternative method to improve system performance & reliability and provides energy efficiency. So, by using relay nodes, multiple connections between two wireless nodes is possible and hence data from the source node to the destination can be delivered through multiple wirelessly transmitted paths which improves diversity gain, energy efficiency and spectrum efficiency by saving energy and reducing the transmission time.

Closed loop MIMO

MIMO stands for Multiple Input-Multiple Output. Key MIMO aspects such as beam forming and precoding enhance SE efficiently. But the CSI feedback required will need overhead which will consume additional resources and energy, thus increasing time, bandwidth, and power requirements.

Energy efficient MIMO systems

It can be used to achieve energy efficiency by reducing interference and using spatial resources but can lead to added complexity in multi-cellular systems.

Energy efficient MIMO-OFDMA systems

Combination of MIMO and OFDM is a solid combination as it combines the advantages offered by them. Since OFDM is an energy efficient multiple access scheme much robust to noise and narrow band interference, immune to frequency selective fading and offers multipath delay spread tolerance with high spectral efficiency and efficient modulation & demodulation. MIMO offers greater efficiency, high data rates & enhanced reliability with greater range and increased number of users. Use of OFDM increases the hardware complexity, so effective simple algorithms must be developed to achieve a trade-off between complexity and performance.

Cooperative relay systems

Cooperative relay systems are still in research but it has been found that user cooperation can help a lot in implementing energy efficient schemes.

Four different scales of energy saving algorithms in time domain are used to improve energy efficiency:

Frame: Its variables include frame length, modulation and encoding schemes and mapping of data which must be taken care of to ensure energy efficient systems.

Super frame: It is used to regulate several transmissions through algorithms & protocols. It includes parameters like scheduler for scheduling tasks, enabling the power saving mode of the wireless system and other variables.

Flow: It regulates the flow in network by controlling the network load and reconfigure the resources available to best serve the traffic load. It includes adaptive routing algorithms or the use of multiple technologies.

Usage pattern: It dynamically configures the network deployment. The main feature of these mechanisms is on demand infrastructure as per user requirements, keeping only certain nodes in active state and switching off the unrequired nodes, thus saving total energy consumption.

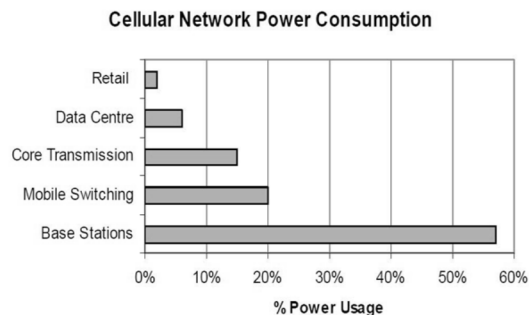


Fig.1 Power consumption

Green Technologies

Green Base station transceiver antennas

Today due to gradually increasing energy requirement and vanishing non-renewable non-regenerative conventional energy sources, the need of hour is to find alternative methods of providing base station transceivers with continuous power supply.

The Green Base Station should be introduced to provide a shift to renewable sources of energy like solar, wind and tidal energies. The utilization of solar energy, wind energy and hydrogen make the green BTS a real hybrid system and even allow one to think about off-grid solutions. Solar energy, wind energy, Hydral technologies can be used as a energy source for feeding base stations.

Green handover mechanism

Green handover mechanism for cellular networks aims at minimising harmful emissions from mobile phone radiations.

MIMO systems should be employed for multi-dimensional wireless transmissions.

Green charger

A green charger can be made using solar cells. Three solar cells can together accumulate 2 volts across them when in full sunlight. Similarly, a set of 6 solar cells puts out around 4V with no load. When this set of solar cells is connected to 3.7 volt battery, it can charge it.

The diode prevents the battery from discharging through the cells at night in absence of sunlight.

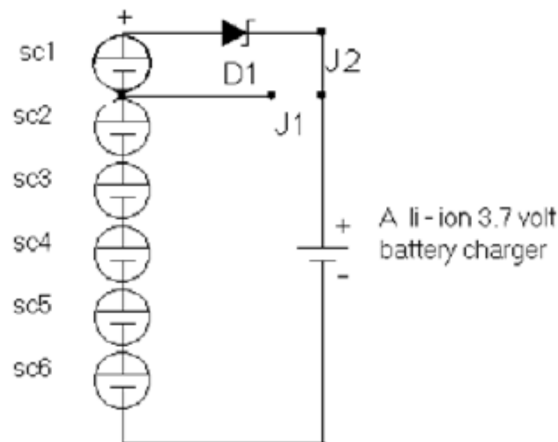


Fig.2. Lithium ion 3.7V battery charger

Smart Grid Technology

The “Smart Grid” terminology means that electric power should be distributed in an optimized way such that it continuously observe, regulate, control and optimize the operation of connected network entities in a system from central station and the distribution system, to industrial users and automation systems, to ensure energy conservation and to end-user consumer and electronic appliances and other household devices. Two-way seamless communication is the vision of smart grid. There are numerous standard wired and wireless communication technologies available for various smart grid applications. With the recent growth in wireless communication, it can be widely used to offer standardized technologies for LAN, MAN, WAN and PANs.

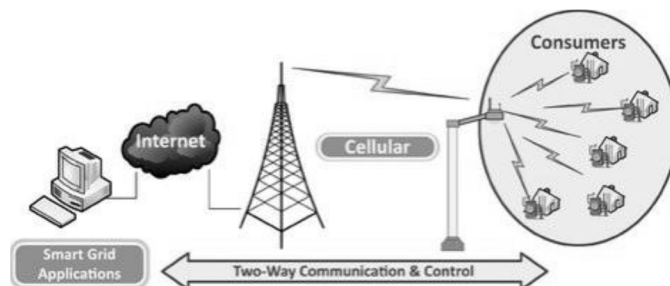


Fig.3 Smart grid technology for wireless communication

Green antennas and green electronics

Solar energy radiation is the primary source of renewable energy. Recent pieces of work have reported that solar cells can be used along with antennas. These green antennas (utilizing renewable energy) can be used for advanced wireless technologies for energy efficient green communication. Lead free electronics should be developed to promote the idea of green wireless communication and harmonious eco-friendly manufacturing.

Challenges to Green Communication

Today's wireless technologies play a primary role in the networking market but they require a re-design process, aiming at greening the wireless communication to reduce and control its hazardous impact on nature focusing on two main needs of reducing pollutant emission into atmosphere and lithosphere resources and attaining energy efficiency to minimize the cost of production and to greenify the technical platform. The use of different energy efficient technologies like Green BTS, Green manufacturing, Green Handover, Green antennas, Green electronics and Smart Grid solution will create accord between human being and nature.

Following are the challenges:

- (i) Provision of an standardized homogeneous performance framework and creating awareness regarding the alarming issue;
- (ii) development of new strategies and technologies and its study & implementation;
- (iii) employment of cognitive radios for effective utilization of unused bands in spectrum;
- (iv) provision of low-cost platforms to enable academic experimentation in the wireless field;
- (v) designing low energy consumption networks by allowing the utilization of renewable sources of energy.

Conclusion

The recent research in this area has proved that Green communication can be effectively achieved by using advanced techniques of OFDM and MIMO. The main challenges have been recognised and the aim is to focus on sustainable technical development through green methods employment in wireless as nowadays most of communication networks are connected wirelessly. The need to develop green wireless communication systems turns out to be more and more vital as wireless networks are widely employed. Green Wireless Communication will provide energy efficient communication. It will result into less radiation from devices as well as more economic solutions for service providers and subscribers. Green wireless communication is the part of social responsibility which strives to reduce carbon footprint and Greenhouse gases to provide green ICT services to customers. Future advancements should be aimed at achieving green evolution. Government should also form rules and regulations to certify a service provider as Green service provider.

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