Survey on optimization techniques of wireless networks

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Received: July 17, 2018 Accepted: October 04, 2018

ABSTRACT *The mobile communication is now a essential part of life. With the increase in population and wireless devices demand of network is continuously increasing. With the advent of Internet of Things, demand of wireless and mobile will certainly increase tremendously. The availability of radio spectrum is already in scarcity and with the increasing demands from Internet of Things devices the scarcity of radio spectrum will further increase. The usable radio spectrum is limited so optimization is necessary. Initially this has been achieved by using frequency division multiplexing and space division multiplexing but with increasing government regulation and demand these two are not sufficient.*

Keywords: *RF spectrum, Wireless network, Optimization.*

1. INTRODUCTION

The radio spectrums are most widely used medium for communication. These spectrums are limited so various techniques like multiplexing etc has been employed initially. Mobiles and wireless devices are the main consumers of radio spectrums. To reduce the consumption mobile operators used techniques like frequency division multiplexing and frequency reuse concepts. But these concepts are very old and they cannot bear the load of load. As the demands grows further the operators tries to accommodate more subscribers by Pico cell structure and intelligent cells. But reduction in size also leads to interference in nearby cells as well as increased need of handoffs so we cannot reduce the size beyond limit. But all these techniques have limitations and beyond the limit these techniques become inefficient so some more techniques has been suggested by the researchers like digital code division multiplexing, time to space division multiplexing etc. and many more may be suggested in future. While optimization of a radio network is done some points should always be considered

(i) Planning
(ii) Network parameters for optimization

Planning is normally considered as one time work means networks are planned in the starting but in wireless/mobile networks things are changing very fast so we have to change the plan repeatedly or in other words we can say it is a dynamic process rather than static.

Parameters should be chosen very carefully because this will not only affect performance but may increase cost as well. Some of the parameters are listed below.

(i) Location of base station
(ii) Allocation of channel
(iii) Radio wave transmission power control
(iv)Data rate
(v) Antenna angle etc.

2. TECHNOLOGY USED FOR RADIO SPECTRUM OPTIMIZATION

There are various technologies which are used for the conservation of frequency spectrum.

(i) Multiplexing:

This is the most common technique used for spectrum conservation. This is a technique which allows multiple devices to use a common resource. This sharing can be done on the basis of Time, Frequency or space. This can be used independently or use of two or more technique at same time is also possible.

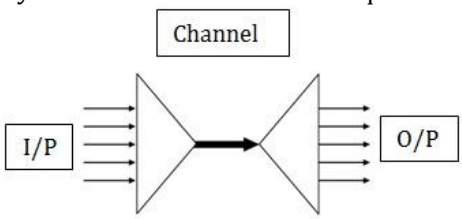

Fig1: General block diagram for multiplexing

(ii) Repeated use of frequency spectrum:

This system can also be assumed as a type of multiplexing. In this system license for a particular frequency is given for smaller areas, means a company can use a particular spectrum only in limited area. After that area any other company/ user can use this spectrum. However these two technologies are not sufficient

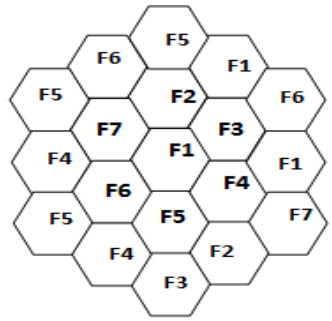

Fig2: Frequency spectrum

(iii) Use of Orthogonality:

Multiplexing can be made more reliable, secure and error free by using orthogonality. Orthogonal frequency division multiplexing is most widely used orthogonal multiplexing. Orthogonality has following advantages

(a) Less effect of Interference
(b) Higher efficiency of spectrum utilization
(c) Reduced effect of narrow band effect
(d) Reduced effect of inter symbol efficiency
(e) Simple equalizers can be used
(f) Reduced frequency dependent fading

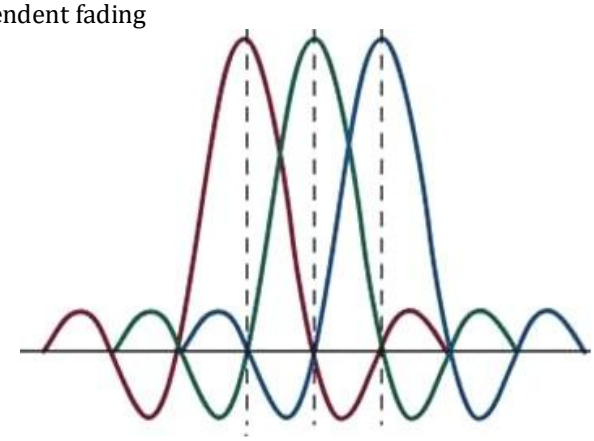

Fig3: OFDM representation

(iv) MIMO (Multiple Input Multiple Output):

The radio wave follows the multipath phenomenon in transmission from one place to another place. The total energy transmitted from a transmitter is divided in no of waves transmitted through no of paths. So the power received at destination is just a fraction of total power transmitted. To increase the amount of received power MIMO system can be used. The multiple input multiple output system uses multiple antennas for transmission of signal. These antennas transmitted same signal at different gain and phase so that receiver can get maximum power. Here the locations of transmitting antennas are very important; they should be placed carefully so that the receiver can add up the entire signal transmitted from different transmitter. However practically all the signals cannot be received at receiver so we try to add as much signal as we can. The entire process can be divided into three parts

(a) Beam forming
(b) Multiplexing
(c) Coding

(a) Beam forming:

As the name suggest in this stage a single radio signal is divided into multiple radio signals. These signals are transmitted using different transmitting antennas. These antennas transmit signal at different phase and gain however the data rate by each transmitted signal will less than the original data rate.

(b) Multiplexing:

The multiplexing used in this system is also known as spatial multiplexing. Since all the transmitting antennas are sending part of a single signal so it is very necessary to add up all these signals to construct the original signal. These transmitted antenna should have a unique identity so that they received signal can be identified and processed accordingly.

(c) Coding:

From the above discussion it is very clear that same data is being transmitted through no of channels. This type of system has more probability of receiving correct data at receiver. That means the entire data is divided in time as well as in space and thus provides them coding as well as diversity gain.

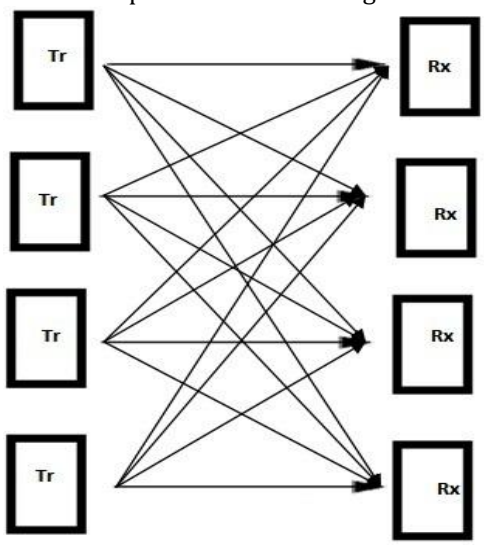

Fig:4 Block Diagram of MIMO

(v) Cell Range Expansion:

Initially cell size of cellular network has been kept equal, but with increase in demand it has been established that demand of spectrum is not equal everywhere. The demand for spectrum varies on no of users in that area. This demand in spectrum may vary with time also. So the planner introduced micro and pico cell concept. These micro/pico cells are used whenever load increases and as the load decreases the load again shifted to the macro cell. From the fig it is very clear that a macro cell has been divided into micro and pico cell and whenever the load decreases the range of pico cell is increased to micro cell and service is provided by base station of pico cell. But it is applicable only if the power received from macro cell base station is below threshold value.

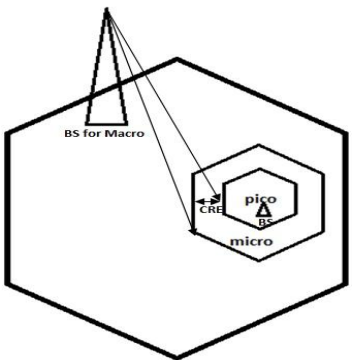

Fig5: Diagram for cell range expansion.

(vi) Dynamic Network Planning

This type of network planning can be divided in two parts

(a) Self organizing

(b) Data based organization

(a) Self organizing

These types of networks continuously monitor the parameters of network and optimized them. This system can be done centrally or distributed manner. This system also include software based network planning architecture so whenever a new base station is added, it includes this new base station in plug and play

manner. This software includes the feature to recover from network failure. These type of networks are made intelligent enough for following parameters
(1) Network optimization
(2) Automatic configuration
(3) Automatic recovery

(b) Data Based Organization

With the advent of 4G services data generation is increasing very rapidly and with the rolling out services of 5G and internet of things the data generation will increase many folds. So this type of network organization has been proposed. This type of network uses the data generated by users and network for regularization of network that includes deployment, optimization and automatic configuration of newly installed base station. This system uses machine learning technology. These base stations will be made intelligent so that they can take decisions on the basis of past history. These decisions can be modified on the basis of current situations.

3.TECHNOLOGIES FOR MOBILE BACKBONE OPTIMIZATION

Mobile backbone is the system which carries data from data generator to data receiver. The mobile backbone networks can be divided in two parts
(i) Stable or fixed network
(ii) Movable node network
(iii) Mixed network

(i) Fixed Network Hierarchy:

These networks are the conventional type of networks. Complete geographical area is divided in small cell and each cell is served by fixed base stations. These base stations are connected to main switching centers. These switching centers are used to provide all types of control and support needed by base stations and mobile nodes. In this type of network all other nodes except mobile nodes, are connected by fixed cables like copper cable or optical fiber. These types of networks are costly but can provide greater support and stability to the mobile networks. But these networks cannot be changed easily after installation.

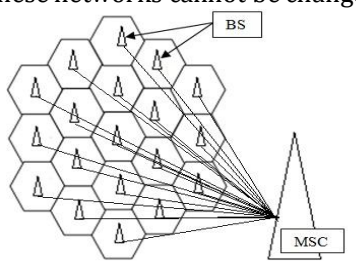

Fig6: Network hierarchy for fixed network

(ii) Movable node network:

In this type of system all backbone supports are provided by movable nodes like mobile itself. Every mobile not only generate data but also work as switching center for transfer of data packets. These systems are also known as adhoc network or Mobile Adhoc Network.

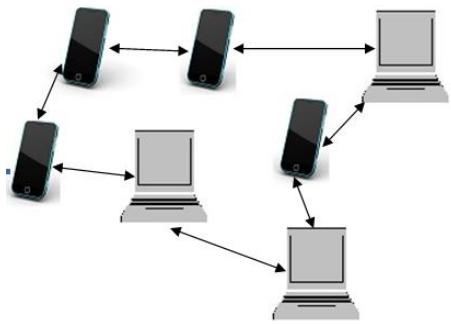

Fig7: Movable node network

(iii) Mixed Network

This type of network is a combination of both fixed and movable type of network. This is also known as cooperative communication. In this system a mobile can share network it is receiving. So if a mobile is outside the coverage area of mobile network then it can request to nearby mobiles to share the network.

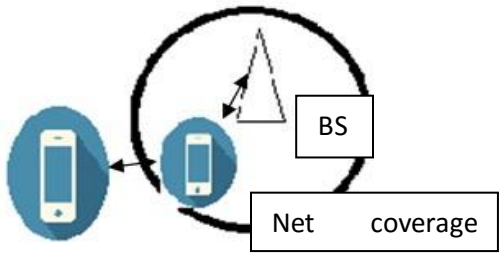

Fig8: Mixed network

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