CAPACITY ENHANCEMENT IN CELLULAR SYSTEM - A REVIEW

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Abstract: Cellular communication has a tremendous growth in recent years. Capacity enhancement becomes an important topic of discussion. Both researchers and academicians have been recognized the need of capacity enhancement of cellular system in a sustained manner. In this paper, various techniques to enhance the capacity of cellular system have been discussed. The various performance metrics like cell planning, frequency reuse, cell splitting, cell sectoring, Handoff Strategy, propagation factors are explored to capacity enhancement to fulfill the demand of users.

1. INTRODUCTION

A Cellular Telephone system provides a wireless connection to the PSTN for any user location within radio range of system. Cellular system accommodates a large numbers of users over a large geographical area, with in a limited frequency spectrum. Cellular system provides high quality service than landline phones. The objective of efficient system is to provide good speech quality, compatibility with ISDN, efficient use of bandwidth; and support for Handoff etc, with low cost. Digital systems are used in the cellular communication system to transmit both voice and data using single technology. Various algorithms are developed for efficient speech compression to make small bandwidth operated system. The encryption is also done for the security purpose.

Figure 1 shows the cellular system geographical area is divided into cells. Each cell uses the different frequency to avoid inference. Cellular system is based on the concept of low power transmitter and small cells. The distance between cells using same frequency kept at sufficient distance to prevent interference. The reuse of frequency increases the overall capacity of system in term of possible number of users. The cells are usually circular; but are modeled as Hexagonal. Usually seven cells are used in a cluster with an efficient distance with different frequency as in Figure 1. A number of channels in each cell are reserved for signaling information the cells are usually roughly circular, but are easier to model as hexagons. There is an approximate two-cell buffer between cells using the same set of frequencies, giving good separation and minimizing interference. In areas that are densely populated with users, the transmitted power is reduced and the cells are smaller. At the centre of each cell is a base station consisting of a computer-controlled transceiver connected to an antenna, which communicates with all of the mobile devices in the cell. In a small system, all of the base stations are connected to a single mobile telephone switching office (MTSO) or mobile switching centre (MSC). In larger systems, several MTSOs may be required, all of which will be connected to a second level MTSO, and so on MTSOs are connected to at least one exchange in the Public Switched Telephone System (PSTN). MTSOs communicate with each other via the PSTN using a packet switching network as shown in Figure 2.
At any given time, each mobile device is under the control of the base station for whatever cell it happens to be in. When the device leaves the cell, the base station detects the fact that the received signal strength is fading and asks the surrounding base stations to report the power levels they are receiving from the device. Control is transferred to the cell whose base station is receiving the strongest signal, and a message is sent to the device informing it that it is now under the control of a different base station and must switch to a new channel. This process is called handoff, and takes approximately 300 milliseconds.

Figure 3 shows tremendous growth in the demand of wireless subscriber, so our resources are getting limited. Frequency spectrum is limited. So to fulfill this demand, the different techniques have been used to enhance the capacity. The constraints like path loss reduction, frequency analysis, algorithms, quality of service, cell planning, Handoff, propa-gation factors effect are studied. The remaining part of this paper is organized as follows. In Section 2 various Techniques to Enhance the Capacity efficiency is presented in Section 3. In Section 4 conclusion and future scope is discussed.

2. TECHNIQUES TO ENHANCE THE CAPACITY

1. Cellular Planning: Radio coverage associated with fixed-location cellular system that is interconnected with other cells. To provide radio coverage to a larger geographical area. The cell’s are often ally hexagonal block and a group of cell is are called cluster. Cell planning means to cell dimensioning and base station placement. But it is tough practice. Many other constraints like location, power, antenna height and tilting, path loss, switching etc. affect the efficiency. So here different method of cell planning with constraints is discussed.
Chamaret B. et al. [1] proposed that due to increase in demand radio network planning and optimization becomes a problem. So a mathematical model was proposed to discuss the Base-Station location, transmitted power, antenna height diagram and tilting. The objective of paper to achieve large coverage of traffic demand area (TDA) a large Base-Station set is needed and to achieve low cost network. A Base-Station set as small as possible is also needed. This creates a conflict. A model addressing to this conflict has been proposed. To keep the idea of number of required Base-Station (BS) to minimal level with a large coverage of TDA is done by minimizing the no. of cells that cover any point of TDA. An experiment was performed in test area of 73 x 76 km² was considered. Test area was divided in to 150 equal strips. At each potential site BS with an antenna height of 30m was located and a cell according to a maximum path loss 110db at 900 MHz is computed with a multiple diffraction propagation model with SUN SPARC 10. Hence it was concluded that the mean coverage per BS which is the relative coverage of the selected network divided by the number of selected BS. This provides an idea of efficiency of the radio network. Inverse of it, if the radio network cost was considered proportional to the number of BS represents the evolution of coverage cost of an area unit.

Margaret H. Wright et al. [2] elaborated in this paper to predict quantitative measurement of system performance as a function of the system parameter and to optimize predicted overall performance by choosing the best value for the parameter that can be controlled by provider or maintainer. Direct methods are suited to find the optimal placement of base station, since they require only the value of the function to be optimized. In numerical testing they proposed the customize variant of Nelder-Mead method”, a simplex method to be reasonably efficient and reliable at finding local optima. The Nelder-Mead method is conceptually simple, The NM method attempts to minimize a scalar value non-linear function of n real variable using only function values, without and derivation information Many of most well known direct search method including NM maintain at each step a non-degenerate simplex, geometrically defined by (n + 1) vertices. It was concluded that N-M method is highly effective for the base station optimization.

Minseok Jeong et al. [5] explained path loss models. In the mobile communication path loss is the main constraints for the system efficiency. Main models are Okumura-Hata Model, Cost-231 Hata, ITU-R model studied. The problem of model is that the predicted expressions were based on qualitative propagation environments such as urban, suburban and open area. From these models the Cost 231-Walfisch-ikegami model was a result of effort to use a quantative description of propagation enviroment. In addition to height of Transmitting and Receiving antenna, the quasi-uniform building height and the width of street are considered. Objective was to compare the Okumura Hata and Cost-231 model. It was concluded that Cost-231 is extension of Okumura Hata Model to cover the frequency up to 2000 MHz and Cost 231-Hata is close to Okumura when building group Height is a bout half of street width. Also at the frequency more than 2000 MHz ITU-R are based on Okumura, suburban area.

Samuel Pierre et al. [6] proposed this paper for cell assignment to switches with the Taboo Search Algorithm. Thus, the problem of cell assignment could be summarized as follows: for a set of cells and switches (whose positions are known), assign the cells to the switches in a way that minimizes the cost function. The cost function integrates a component of link cost and a component of handoff cost. The assignment must take into account the switch’s capacity constraints that make them capable to host only a limited number of calls. The pressure to reduce costs adds new urgency to the search for optimized or quasi-optimized network designs which can minimize the number and cost of required facilities. Two types of Handoff discussed simple handoff and complex handoff.

In this paper a heuristic approach has been discussed based on taboo search to solve the problem of assigning cells to switches in cellular mobile networks. The implementation of that approach was consisted of defining a series of moves for short-term and middle-term memory components. These moves allow for improving the cost of a solution or re-establishing its feasibility. This has led them to define a gain structure with update procedures to efficiently choose at each iteration, the best solution in the current neighborhood. The implementation of long-term and middle-term memory components has required a choice for intensification areas and a definition of
a diversification policy. On comparing with simulated annealing (SA) it was proposed that TS algorithm performance is better than the SA algorithm. In particular, for large-size problems, TS-found solutions that are twice as good as those of SA.

Shine-Ming Tsai et al. [7] proposed a HCN channel assignment scheme called repacking on demand (RoD). RoD was originally proposed for wireless local loop networks. They expend this work to accommodate mobile HCN. A simulation model is proposed to study the performance of HCN with RoD and some previously proposed schemes. The important issues is capacity planning. Especially when the number of cellular subscribers grows rapidly, it was required that the cellular service provider increases its network capacity effectively. One possible solution was to deploy the hierarchical cellular network (HCN) the HCN consists of two types of base stations (BSs): micro BSs and macro BSs. A micro BS with low power transceivers provides small radio coverage (referred to as micro cell), and a macro BS with high power transceivers provides large radio coverage (referred to as macro cell). The micro cells cover mobile subscribers (MSs) in heavy telegraphic areas. A macro cell is overlaid with several micro cells to cover all MSs in these micro cells.

A basic scheme called no repacking (NR). In this scheme, when a call attempt (either a new call or a handoff call) for an MS arrives, the HCN first tries to allocate a channel in the micro cell of the MS. If no idle channel is available in this micro cell, the call attempt over-flows to the corresponding macro cell. If the macro cell has no idle channel, the call attempt is rejected. Call blockings and force-terminations of NR can be reduced by repacking techniques. If a call attempt for a micro cell BSi that has no idle channel. In NR this call attempt is served by the corresponding macro cell. If radio channels are available in later, this call can be transferred from the macro cell to again. The process of switching a call from the macro cell to micro cell is called repacking. Repacking increases the number of idle channels in a macro cell so that more macro cell channels can be shared by the call attempts where no channels are available in the micro cells. The study develops a simulation model to investigate the performance (i.e. the call blocking, force-termination, and incompletion) for NR, AR, and RoD. System Parameters, Traffic Parameter, Mobile Parameter are discussed in this paper.

It was concluded that on increasing the Macro channel C significantly improves the Probability of Blocking, Probability of force-termination, Probability of new call.

M.Al-Akaidi et al. [9] explained HCS which used for the multimedia traffic in 3-G system. In this type of network an efficient cell assignment scheme is required to improve Quality of Service (QoS) of the system in terms of dropping probability blocking probability and channel utilization. In this a new channel assignment scheme which exploits the delay insensitive property of non real-time data service to admit user to preferred cell layer. This scheme is anticipated to improve the QoS of real time voice user for both blocking probability and channel utilization parameter.

Problem is to provide efficient cell planning technique to improve quality of service (QoS) of the system in terms of dropping probability. So objective is to design of wireless network using Hierarchical (multi-tier) cellular structure (HCS) to provide high coverage and capacity. HCS has two layers i.e. over flow scheme and speed-sensitive assignment Speed sensitive assignment scheme is required to classify according to their speed in macro cell and micro cell. It was concluded that increase in outage as the data service were introduced and there is an increase in the traffic offered to each micro cell.

Stuart Allen et al. [10] presented a paper for 3g network deployment. The location and configura-tion of transmission of infrastructure problem has mentioned. A cell planning is a challenging due to inherent complexity, which stems from requirement concerning radio modeling and optimization. Factor, cell coverage, service quality and capacity are interdependent with the cell planning. So the CDS Smartplan optimization tool for automatic Cell Planning. This is an optimization engine which is capable of finding highly efficient cell plans. Goal is to steer the network configuration towards achieve the best key performance indicators (KPI). These KPI could be set to represent coverage, traffic, cost, dominance/interference or any other variables in any combination to cover 95% coverage; site cost to be minimized; cell isolation to be optimized. The required coverage 95% was achieved on different KPI structure.

S.M. Allen et al. [12] described the Automated Cell Planning Technique for the improvements of
network quality and cost. This paper describe an optimization algorithm for cell planning based on simulated annealing which is used to investigate the effect of several strategies for planning, the staged rollout of cellular network. The objective of this paper is to reducing the cost of network infrastructure maximizing the coverage maximizing the traffic capacity of network and keeping interfaces below acceptable levels. Each potential cell plan is devalued by considering of large no. of reception test points (RTP) distributed over network area. Each RTP has associated signal and traffic requirement that are used to calculate the coverage, traffic capacity and potential interface of cell plan.

The optimization algorithm used is based on Simulated Annealing, an iteration process that involve making small changes to network at each step like adding site changing the power of single sector, moving site. The resulting cell planning at each iteration is evaluavated and either accepted or system based on assessment of network Simulated annealing uses a probabilistic mechanism to avoid the algorithm convert to solution which are locally but not globally optimal.

In this paper site selection, site configuration, downlink field strength, optimization algorithm, coast function Neighborhood etc was studied. It was concluded that increase of traffic and decrease in cost with this algorithm.

T Reza et al. [28] presented a new cell planning is based on active contour theory. The structure of proposed method lets several parameters be applied in cellular mobile communication network design simultaneously. In this paper iterative optimization algorithm is proposed to optimize the parameter set of contour. The optimization criteria include the maximum overlap coverage area as well as minimum number of cell and Cell overlaps. Active Contour Theory is an Image Processing and Machine Vision algorithm to extract the minimum area surrounding contour for a two dimensional object. The main thing is to shrink and expand the outer contour of object in any iteration. The ides is also known as snake theory or gradient vector Flow (Guf) optimization algorithm. In this no. of base station is initialize in first stage based on the dimension of area and the cell radius. In next stage the location of base station are initialized based on the greedy algorithm. The location of base station are tuned using net stage and the fitness function is calculation for all cells in area. If the requirements are not met, the number of based station is checked and corrected based on overlap of neighbor cells and corrected based on overlap of neighbor cells and the coverage of each cell. For optimization the cell radius a gradient based approach has been deployed to adjust the cell radius. It was concluded 99.23% and 97.23% overall coverage in uniform and non-uniform traffic situation respectively revealing a great improvements with respect to genetic algorithm.

2. Frequency Reuse: It is a technique of reuse frequency and channel in communication system to improve the capacity and efficiency. Frequency reuse means that frequency allocated to cell are reused in regular pattern of cells is called cluster. Each cell is designed to use radio frequency only with in its boundaries, the same frequency can be reuse in another cell not far away without interference. These cells are called co-channels. So different method is used to maximize the traffic load. These are discussed here.

Antonio Capone et al. [3] proposed the planning of reuse of available frequency in efficient way. In this paper author proposed the Tabu Search Algorithm. Its objective is to maximize the sum of traffic load offered by the region in which the ratio between the received power and the sum of power received from interfering transmission is above threshold valuve. In this paper they present an algorithm based on Tabu Search Technique to solve the problem In this model Channel Assignment Problem (CAP) is given narrowband cellular network. Proposed model describe the CAP problem in narrowband cellular network which accounts for the cumulative effect of interferes. In this model the service area was portioned into region and propagation characteristics are assigned by means of levels received in each region by consider B.S. Their objective is to keep the long term C/I above capture ratio through out service area. Here TS approach is used. The ability of receiver to detect signal in the presence of interference noise is known as Capture Effect. It is based on load search and initiation procedure the basic moves are defined as the swaps of used frequency with a used one for one B.S. At each iteration it associated with the current solution the following attributes; the BS and the couple of frequencies involved. The adopted algorithms have been developed using C++ languages and SUN Sparc 10 workstation have been used to obtain numerical results. Hence it was estimate that the tuning of 'T'
(iteration) may be a key issue for the efficiency of algorithm. So they used TS approach. The result are equal very close to the maximum value achievable with fixed TS.

**Klas Johansson et al. [18]** has explained two capacity expansion strategies as Multi-access network and hierarchical cell structure. Cost can be minimized for a cell structure; cost can be minimized for asset of available radio access technologies given heterogeneous requirement on area coverage, capacity and quality of service. In this paper they quantify the infrastructure cost for a multi-access network composed of macro cellular HSPA base station and IEEE 802.11 WLAN access point. The network is dimensioned for an urban environment using stochastic model for heterogeneous traffic density.

This paper treats cost efficient deployment strategies for network composed of HSPA macro cellular base station (BS) and IEEE-802.11g access point (A.P). These represent system with long range for wide area coverage and low cost, short range access point suitable for hot spot.

Two problem had addressed first is the tradeoff between no. of macro cellular BS and complementary WLAN APs needed another is to find parameter which is most important to improvement in each system in order to reduce the cost. The objective is to contribute to a better understanding of the role of multi-access as capacity expansion strategy and for this reason a stochastic spatial distribution of traffic is assumed.

A macroscopic model is used to capture key technical and economical parameter that influence the infrastructure cost for a typical mobile network dimensioning and capacity analysis like interference, propagation etc. This explains how operator could exploit WLAN in the short run instead of building a dense macro cell network if traffic suddenly increases. There is fulfillment during transition period increasing capacity from 5 to 10 Mbps/km² with WLAN instead of deploying more macro sites, as increases the cost. In long run increasing capacity in macro cell is more cost efficient. A graph shows that decrease in cost coefficient of HSPA, 802.11. Increase in HSPA BS capacity and AP coverage in 802.11.

**Mohmoud Al-Ayyoub et al. [33]** explained the self management technology. As the cellular network technology that allows an operator to fully use all its licensed spectrum in every base station are very attractive. These co-channel frequency reuse among neighbor base station increases interference in overlapping cell-edge area and degrade then performance. Solution to this problem is proposed to configure the base station to use different parts of spectrum to serve edge user. Such fractional frequency reuse and associated intercell interference coordination (ICIC). Self management technology are fully automated in task of managing (configure, monitoring, optimization) a cellular network are emerging as an important tool in reducing service provider OPEX and CAPEX and has distinguish feature of LTE. Main objective of LTE are computation efficiency controlled cascading and stability and optionally of solution. But reality this is not possible to achieve all. Method is Spectrum is divided into a set of orthogonal Channels ‘k’.

**3. Interference and capacity:** Interference problem are associated with the mobile communication. These are due to congestion. The interference occurred from clash with another mobile in the same cell due to adjacent cells. These are of two types: co-channel inference and adjacent channel interference. Co-channel occurs between two cells present in different clusters. Adjacent interference occurs in between two cells in same cluster. So various techniques are used to control them. These techniques are discussed here.

**Nasreen Badruddin et al. [11]** Presented paper to presents an approach that uses relaying to increase CDMA cellular capacity (spectral efficiency). The key Insight is that, since the power received by the mobile falls off rapidly, as a function to distance to the base station, relaying could potentially be used to eliminate the out-of-cell interference, thus increasing the cellular capacity. However, as the paper shows, achieving the increase in capacity require a specific relaying architecture, which can successfully control the interference at the relay stations. The main challenge to increase capacity or number of user served simultaneously and to increase the data rate capabilities to support the growing demand for high data rate application. Objective is to solve the problem of “dead spots” and increase system coverage. In this paper however, the potential capacity gains (as measured by the spectral efficiency) from implementing relaying in a Code Division Multiple Access (CDMA) system are investigated. Instead of transmitting directly to the base station (BS), a mobile station (MS) in a CDMA system will transmit to relay
station (RS), which will then relay the signal to the BS. By placing a RS in between the MS and the BS, the transmission power is reduced due to the smaller distance between MS-RS and RS-BS compared to MS-BS. Since a CDMA system’s capacity is interference-limited. It is hoped that by reducing the transmit power, and thus the out-of-cell interference, through relaying, the energy-per-bit to noise ratio, $E_b/N_0$ at the BS can be increased, thereby increasing the capacity of the system. The effect of relaying on interference is investigated by calculating the $E_b/N_0$. A higher $E_b/N_0$ at the BS can be translated to an increase in capacity. It was concluded that the overall interferences experienced by the center BS has reduced by 34%. Thus they deduce that capacity can be increased by 51%. The overall decrease in interferences at BS of about 12%. Taking the inverse of new interference it can deduce that $E_b/N_0$ at the center BS increased by 14% which translate in to an increase in capacity by the same percentage.

Hakan Bolukbasi et al. [13] proposed paper that presents as the demand of high data rate is increasing so conventional cellular network with wireless fixed relay to enable multihop communication is being considerate for beyond 3-G network in order to provide high data coverage in cost effective manner.

In this paper author considered a Cellular Relay Network (CRN) where a large no of low complexity and low power wireless fixed relay are deployed around the central node (BS) in each cell. Each relay and central node covers only a small area with a small amount of power enabling the reuse of frequency time resources. Objective of this paper was to evaluate the cell capacities in CRN which enables to make the conventional cellular network. The paper shows that cell capacity of CRN doesn’t depend on the cell size or the total number relays in the cell, but it rather depends up number of nearest relays to the central node. Pico cell network idea is one of remedies to high data rate demand as the resources “Frequency and time” are very scare, by splitting macro cells into much smaller size calls namely Pico cells, spectrum efficiency can be improved significantly. Although the cost of base station in Pico-cellular network may be much less than conventional base station the very fact that each Pico cell would still required the high speed connection to the internet makes the architecture not as cost effective. Due to low power feature when there is sufficient electromagnetic separation, it is possible to reuse the channels (time frequency recourses) even in the same cell.

Therefore the system performance can be improved from both reduced propagation loss and reusing the available channels. It was concluded that use an equation which follows as cell capacity in CRN is directly proportional to the no. of root node. If increase the no. then the capacity of cell would increase and accordingly either the no. of user in cell or the amount of bandwidth for user would increase.

Saurbh Chhabra et al. [14] Proposed paper that presents the result of development of user friendly software tool that can be used to calculate co-channel Interference. Both are uplink and downlink of mobile communication due to reuse of frequencies in spot beam or coverage cell. The cells or beam was defined in angular domain as measured from satellite or the elevated platform and cells are arranged in Hexagonal Lattice and overlap to provide complete coverage. Interference is inherently detrimental to a communication system. There are two type of interference as intrasystem and intersystem.

Out of band emission of one system that interferes with another system in an adjacent band is intersystem, Co-channel interference is intra-system interference. This paper focus on co-channel interference. So if co-channel interference is calculated the designer will be able to manage their link budget calculation and optimize the design. It was concluded that for same side lobe level (db) the reuse no. increases the overall co-channel interference; power decreases since $C/I$ increases. Same reuse number as side lobe level of spot beam antenna pattern decreases. Thus co channel interference is proposed to decrease.

Mark DeFaria et al. [19] illustrated that in a multihop cellular network, the physical layer of mobile terminals is modified so that in addition is being able to transmit to base stations and mobile terminals are able to transmit directly to other mobile terminals. So it allows mobile terminals to lower their maximum transmission power and use other terminals as repeaters to forward their packets to the base station. Multihop cellular networks have a higher capacity than traditional cellular networks due to their potential of lower intercell interference. Intercell interference is lower because the maximum transmission power of terminals is decreased. The effects of intercell interference in a multihop cellular...
network investigated in this paper. Previous simulation results of a one-cell system show that the SNIR of a multihop cellular network is slightly lower than that of a traditional cellular network. Simulations of a network with many cells show that the overall SNIR of a multihop cellular network is in fact higher than in a traditional cellular network because of lower intercell interference. In a multihop cellular network, the physical layer of mobile terminals is modified so that they can transmit packets not only to base stations but to other mobile terminals as well. Therefore, a mobile terminal would able to decrease its maximum transmission power and use other mobile terminals as repeaters to allow its transmissions to reach a base station. Mobile terminals require smaller amount of transmission power so interference decreased. The decrease in intercell interference in a multihop cellular network gives a potential of higher Signal to Noise and Interference Ratios (SNIR) than traditional cellular networks. Second the coverage in a multi hop cellular network increased because mobile terminals that are too far away from a base station are still able to communicate with one by allowing transmissions forwarded to a base station by other mobile terminals. The coverage also improved if any mobile terminal that is caught in a deep shadow fade with respect to the base station would still be able to communicate with it by relaying its data to a nearby mobile terminal that is not caught in a deep fade. It was concluded that the multihop cellular network has a larger SNIR and smaller transmission consumption than traditional system.

Md. Rezaul et al. [23] elaborated in paper that major current thrust for cellular communication system is improved economics through enhance coverage early in life cycle of a network and high spectrum efficiency later in life cycle. An attractive approach for economical, spectrally efficient and high quality digital cellular and personal communication services (PCS) is the use of spread spectrum modulation with Code Division Multiple Access technology. This paper deals this comparative parametric analysis for propagation path loss considering macro cell region using different models and contains comparatives study with real measurement obtained from Pacific Bangladesh Telecom Limited. In cellular system reusing each frequency at several region of service area increases the capacity. Also cell corresponds to cell where the B.S. is placed on top of tall building or towers and transmission enough power to cover several miles. Macrocells can be classified into different channel type, urban, surban, and rural. Main issue of interference into microwave system is line of sight. Most common occurrence of this will be a subscriber unit located in a high rise building or on a balcony and in this case path loss figure approaching free space loss. It is possible for this the unit is interfering signal will be strong than aggregate power of many base station at receiver. In urban environments the probabilities of elevated subscriber unit is greater. Thus the impact of subscriber unit interference source on microwave receiver will be more substantial than in residential areas. Performance depends upon following factor like Path loss variation versus distance models, Hata Okumura, Walfisch Ikegmi Models, Random slow shadowing, Random Multipath fading, Intersymbol Interference, Background Noise. It is concluded that Walfisch –Model is more close to standard value as compared to Hata Models so in order to maximizing the spectral efficiency of cellular System. It also advised to use Walfisch Model with approximation factor.

Georgies S. et al. [27] analyzes a two-hop extension to the coverage of IEEE 802.16 cell. As the natural degradation in cell capacity due to multihop communication which can be mitigated by spatial reuse, adaptive modulation and coding. The available capacity can be estimated by analyzing the random geometry related to location of Base Station, the sponsor node and mesh subscriber situated two hops away from Base Station.

The IEEE 802.16 standard leaves undefined the central schedule located a B.S. Mesh networking is a part of IEEE 802.16 specification. There is numerous application of mesh network Infrastructure relay nodes are proposed for the coverage extension. This extension is useful in case of shadowing, are even cost efficiently in perimeter of its metropolitan network. Further in this paper a scheduling strategy when exploit spatial reuse for mesh node. This can apply on top of another scheme. The extra capacity due to capacity loss resulting from multihop communication. In this model adaptive modulation and coding is done by an ideal Shannon Channel. The capacity of each link is then related to its distance, analogously to WIMAX network. It is suggested that this scheme can be used by a network operator to estimate the impact of coverage extension in WiMax deployment. At out of perimeter nearby customer grows in no.
a new BS can be installed and SN can be moved to
the new boundary area. This area provides smooth
infrastructure expansion for cellular network.

*M.Godarzvand-Chegini et al. [31]* explained the
interference reduction capability of cell sectoring
and power control algorithms have been considered
separately as mean to decrease the interference in
CDMA. In this paper Rota table equal sectoring
method for CDMA in 2D urban environment (RES).
In this method the equal sector of base station is
rotating together to decrease the inter cell and intra
sector interference. Also use central power control to
overcome the near far problem. Simulation results
indicate that the proposed method considerably
increase the CDMA capacity compared to ordinary
equal sectoring (E.S.) method. Problem discussed
is to enhance the capacity limited multifading,
shadowing and near far effect that cause the
fluctuation of received power at the base station.
Paper is focused on RES method i.e. able to rotate
the sector bases on slow variation of user distribu-
tion with in a cell. Methodology is used by the
interference between users is to sectoring the cells
using directional antenna. This approach utilize
spatial domain to introduction orthoganalization
to system it is fundamentally different than
beamforming. Beamforming method combines the
received signals from multiple antenna in a unique
way for each user to suppress the interference that
the user sees. Sectoring employs directional antennas.
Sectoring increases the no. user admissible in system
However under highly non-uniform traffic load,
conventional sectoring i.e. ES method fails to bring
much capacities. To increase the capacity of CDMA
cellular system the RES is proposed to reduce
rejecting of call request in situation like traffic jams
and crowded hour entertainment places. It was
conclude that by simulation RES and Es method’s
result is compared. Active user in different hours
of day and night in a day off RES and ES method is
compared. In such a day assumed ,user are
spending their spare time in places such as park,
cinema, sport club and also gathered in two
different places and around different hour (around
17 and 22 hours) As this time faces crises so
increasing capacity is increasing is neccesary. By
using this method there is increase of 25% capacity.

*Ihsan UlHaq et al. [34]* proposed that Hand off
management is to ensure quality of service for
wireless connection. Here by QoS mean to reduce
the probability of forced termination during
handoff. This paper proposed algorithm helps in
successful group handover and thus guarantees QoS
by making the resources available in target cell. The
objective of this article was to present a resource
allocation algorithm to prevent Cell Breathing and
facilitate Proactive for CDMA Access This enhances
the cell capacity in terms of density of mobile station
as the MS at edge will not disconnected due to cell
breathing. To keep the interference a minimum it
is important user that are far from Node-B (BTS)
have to transit signal with more power than closer
to Node B. It is due to user get disconnected so the
area of coverage area of cell get reduced. The
disconnection of call at edge is called cell breathing.

There are multiple user so it is called Group. In
this proposed paper location information of user
to allocate or free resources in target cell in advance
while keeping the interference level with in the
threshold value. The algorithm prevents cell
breathing, resulting in increasing networking
capacity and coverage. It was concluded that
prevention of cell breathing and enhancement in
cell capacity and cell remain connected to system
and thus quality of service (QoS) is maintained.

*Dong Zhang et al. [35]* proposed a ubiquitous
wireless access network called a cellular wireless
mesh network. A cellular wireless mesh network
is organized in multi-radio, multi-channel, multi-
rate and multi-hop radio cells, each served by a
single gateway. Maximum Channel Collision Time
algorithm, which derives an expression for a
conservative cell capacity. In future ubiquitous
wireless access networks are expected to face
increasing demand for bandwidth. Traditional
cellular (telephone) networks will have difficulty
in satisfying such increased demand, because they
cannot utilize high radio frequencies such as 5-50
GHz. Reason is when radio frequencies are so high,
even tree leaves may absorb signals; transmissions
require greater reliance on line-of-sight paths and
generally have shorter distances; and thus user
packets need to travel multiple hops before they
can reach base stations. So a cellular wireless mesh
network (CMESH) made up of multi-hop radio
cells, each served by a single gateway. CMESH cells
are distinguished from the single-hop cells in a
cellular network by having multiple hops. A CMESH
is deployed to provide “last-kilometer” broadband
Internet access for both residents and mobile clients.
A CMESH can operate on abundant high radio
frequencies (above 5 GHz), and thus can satisfy the
bandwidth required.
A city-wide CMESH may contain thousands of multi-radio multi-channel, multi-rate and multi-hop cells. Each cell has a single Internet-connected gateway and serves up to hundreds of user nodes within its coverage area. Small random cells are like GSM cells, where neighboring cells use different sets of channels to avoid inter-cell interference. Large random cells, where neighboring gateways are spaced. This is proposing that Maximum Channel Collision Time (MCCT) algorithm, which derives an expression for the achievable cell capacity in a CMESH. It concluded that the conservative cell capacity is achievable and its name is achievable cell capacity. The cell planning, designing methods are proposed in these papers. These can be used as a guide line for the designing an efficient system. The principle idea for the each method is to provide the capacity enhancement.

By using relaying in CDMA uplink; capacity improvement can be achieved through, using complicated technique to mitigate the effect of large interference in relay system. Automated cell planning also served 85% final traffic by using optimization algorithm on Simulated Annealing. In cellular relay network (CRN) has high capacity than conventional cellular network. It transmits the high data rate coverage demand of system. By using multihop cellular network the decrease in intercell inference up to 28.7 db as compare to traditional cellular networking also shown. The one third of total interference is eliminated. Average power consumption is also decreased up to 23 db than traditional network. Multihop relay has better performance as compared to the single hop system transmission having cell radius more than 1.9K.M. A Heuristic cell planning proposed the 15% capacity improvement. The capacity and coverage area up to 95% proposed to enhance by spatial reuse, adaptive modulation and coding. Using Contour based algorithm for cell Planning the optimization increased up to 99.92% overall coverage. Femto Cell System and Rotatable equal sectoring method are also used for capacity enhancement. Also the factors like handoff, path loss also play important role in the cell efficiency.

4. Cell Splitting and Femto cell Strategy: It is based on cell radius reduction cell splitting involve the process of sub-dividing a congested cells into smaller cells each with its own base station and corresponding reduction in antenna size and transmitting power. This increase the capacity of cellular system as the increase in frequency reuse. Following methods are used to enhance capacity by using cell splitting.

X.Haung et al. [4] has represented the automatic cell planning for mobile radio network design. As there is tremendous increase in mobile service so the design of modern wireless communication network gets challenged with extremely limited amount of available resources. The problem is to how to determine the no. of cells, the optimal cell sites and parameter introduce to meet the system requirement while minimizing the spectral cost and financial cost. Its objective is to provide cell dimensioning, Base-Station (BS) placement and growth planning. In this paper cell planning has proposed Three aspect are studied cell planning, Base-Station (BS) Placement and growth Planning.

Main concept was Growth Planning in which cell splitting was done i.e. reducing the existing the cell size and adding the new cells. The problem is then to find optimal B.S. site for new cells and optimized dimensions of both original cells and additional cell so that the growing demand met effectively while offering minimum disturbance to the exiting network structure. It was concluded that graph shows the coverage rate and traffic coverage is higher than threshold and financial cost gets down after planning.

Ki-Ho et al. [20] explained in this paper a basic resources reuse scheme applied that is used for cellular network to multihop cellular network. They examined the capacity gains of proposed recourses reuse scheme through mathematical analysis based in Shannon capacity. In multihop networks, several important issues are how to increase coverage, capacity and reliability (self-heal, self-configure), while taking account into data transmission delay. By multihop relaying, can enhance SNR because of the path loss reduction between a Transmitter node and a Receiver node, and therefore we can increase data rate.

The implementation of spatial reuse increased Shannon capacity for small ad hoc networks consisting of five nodes. In addition, two types of concurrent data transmission show the possibility of capacity enhancement when there are two source-destination pairs in multihop cellular networks. This was formulate not a limited or specific spatial reuse scheme, but basic spatial resource reuse schemes based on TDMA for multihop cellular networks. Then, we analyze the cell capacity gains of the formulated reuse schemes through mathematical analysis using Shannon capacity.
They assumed that nodes are distributed uniformly in cellular networks. Also, we assume that nodes have saturated traffic. In TDMA-based multihopped multi-hop cellular network, nodes which are away from a transmitting node may use the same time slot. In order to formulate the distribution of nodes using the radio resources spatially they assume that a node is surrounded by further six nodes which are located at vertices of hexagram centered at the node i.e. a cell is divided into many small hexagonal cells and node is located in the center of small hexagonal cells. Small hexagonal cell called “reuse region”. It was estimated an average cell capacity when spatial reuse is implemented in multihopped cellular networks. Graphs show that adequate spatial reuse, according to size of reuse regions improves the average cell capacity.

Namgeol O. et al. [32] proposed that the current macro cellular system are used they have drawback of the user far from macro cell and the user in indoor undergo poor service relative to other. To solve the problem macro cell are required which is costly. So the femto cell are used Basically the Femto cell are home based station which are short range, low cost and low power base station called as home base station. Femto cell has a femto base station connected to core network via a wired backhaul. Through wired backhaul a downlink and uplink data packets are delivered to femto base station and the core network co-channel interference is considered between BS, and BS. So the solution to this problem the paper proposed a new Time Division Duplex frame structure called reversed pair frame. RPF consist of TDD frame with a reversed order of downlink and uplink using the RPF and a wired-backhaul-delivered downlink data. Capacity is achieved through a simple interference mitigation process. In this paper performance is analyzing with the capacity of two users than applied to multi-user. It concluded that adopting the RPF in an OFDMA femto cell system greatly enhances the uplink capacity of both macro and femto cell and even downlink capacity of them than using the conventional TDD Frame System, capacity and coverage analysis of Femto network.

This paper analyzes performance of femtocell embedded HCS network adopting more detailed radio propagation model. Considering various environmental factor such as wall structure, no. of wall, and distance between femto cell and user this paper evaluate the overall outage problem and the dynamic range of spectral efficiency of femtocell in HCS network and required separation distance from macro cell for a femto cell to guarantee the minimum required spectral efficiency. In this paper Signal to Interference noise (SINR) ratio is studied. Hence proposed method represents dynamic range of 2-40% 2.5 and 50, 200m. In term outage probability, average spectral efficiency, and required separation from macrocell, respectively. The
evaluation results indicate that system performance of embedded femto cells are significant affected by surrounding environment.

Hansung et al. [36] investigated that the effects of cell size on energy saving and system capacity and then show the effectiveness of small-cell based future mobile communication systems in terms of energy efficiency. It implies that larger cells are needed for energy saving when call generation rate is low. However, if the call generation rate and other situations are not changed, a small-sized cell topology has more advantages in the viewpoint of the energy saving and system capacity. Cell environments are categorized into macro-, micro-, Pico-, and femto-cells according to their cell sizes. In order to maintain communication coverage, a small-sized cell-based topology requires many BSs with low transmit power level. On the other hand, a large-sized cell-based topology requires a few BSs with a high transmit power level. However, the relationship between energy saving and cell size has not been investigated yet. In this paper, we investigate the effect of cell size on the energy saving of MSs and BSs in terms of energy consumption, system capacity, and per-energy capacity by evaluating system-level energy efficiency. As the cell size becomes smaller, there is significantly increase energy efficiency and system capacity.

5. Channel Assignment Strategies: On the basic of frequency reuse scheme different channel assignment strategies i.e. fixed channel and dynamic channel assignment are used. Handoff are micro cell the part of cell assignment strategies. These are discussed here.

Jordi Perej-Romero et al. [21] proposed that enhancement of different Radio access Technology allocation strategies in a heterogeneous scenario with CDMA and TDMA access technology by including path loss information. Cellular wireless system become interference limited and consequently, any engineering technique developed to either reduce interference or to improve the robustness of the system to bear interference will readily increase network capacity and operator revenue. Managing interference has been topic of interest for many years. Interference level in power-controlled system in related on one hand to propagation losses from interference source to its target receiver and on the other hand, on propagation losses from interference source to interfered destination, Path loss is lead to over all interference reduction and consequently performance and capacity improvement.

This paper focus on a heterogeneous scheme where CDMA and TDMA access technologies coexist and analysis different scheme for distribution the user between the two technologies. It was revealed that by making an appropriate use of path loss information by considering the user’s an increasing order of the measured path loss towards the cell site it is possible to improve the performance. The analysis can be used as the basic for development of new common radio resource Management (CRRM) algorithm open in long and short term. It was concluded by observing in all the cases; the use of path loss measure by means of allocating the users with low path loss to CDMA (LPC) outperforms the path loss unaware and LPT case and in TDMA performance is best at less no. of user but in CDMA best performance is for adding more user as path loss goes down. Outage also reduces is also shown on applying LPC or LPT.

Sedat Atmaca, Celal Ceken, and Ismail Erturk [22] considered limited bandwidth of wireless as a biggest drawback. As the demand is growing so there is need of capacity enhancement. Multipath and co-channel interference, limited the performance and capacity of system. These interferences are caused by a signal from a different cell occupying the same frequency band. Co-channel interference is the interference between two signals that operate at the same frequency. In cellular communication the interference is usually caused by a signal from a different cell occupying the same frequency band. Directional antennas are used for capacity enhancement. Time Division Multiple Access (TDMA) is employed together with Space Division Multiple Access (SDMA) technique. In a TDMA wireless system, the transmission time (frame) is divided into time slots assigned to the wireless terminals (WTs) and several users share the same frequency channel simultaneously in their own slots to communicate. In an SDMA system, the BS does not transmit the signal throughout the space. It concentrates power in the direction of the mobile unit. This reduces the power in the directions where other terminals are present. The same principle can be applied for reception. In order to define directional antenna pattern OPNET Antenna Pattern Editor is used. From the graphs it is concluded that directional antenna is 10 times better than the omni directional antenna.
Maan et al. [24] has studied the possibility of increasing mobile communication cell capacity through merging two communication systems in one cell. They supposed that the two systems must have interference immunity from each other, so they may work separately in the same cell and hence the overall cell capacity would be the sum of the two system’s users. The two candidates, the TDMA system and the WCDMA system have considered. The two basic base band systems have been built and simulated using MATLAB. Cell capacity through merging two communication systems in one cell. They proposed one cell model with both TDMA and WCDMA mobile station’s transmitters, and a base station which consists of two receivers; one for WCDMA and the other for TDMA users. This simulation has concerned with the uplink system only. The mobile station’s transmitters and base station receivers have been built using MATLAB SIMULINK. From the simulation results, they concluded that the two systems can work in one cell to increase cell capacity; but with partially sacrificing in the two systems’ BER.

F. Thani Alami [29] discussed the admission control of a WCDMA network is a very important task which an operator must take into account in order to avoid the in stability of mobile network due to increasing of interference level when a new mobile station appear in cell. It is based on target load factor value fixed in dimension phase. Problem described is planification and dimensioning processes of a WCDMA third generation multi-service network to increase the capacity. Main objective is studying an algorithm of admission control based on target load factor fixed in the dimensioning phase. Admission control increases the no. of simultaneous active user, guarantying a good quality of service and to minimize the call blocking rate.

A communication request of a new user is accepted if it has frequency estimated less than threshold frequency. If estimated frequency is more then the new call is rejected. To find value equation of load factor value fixed in dimension phase. Planification and dimensioning processes of a WCDMA third generation multi-service network to increase the capacity. Main objective is studying an algorithm of admission control based on target load factor fixed in the dimensioning phase. Admission control increases the no. of simultaneous active user, guarantying a good quality of service and to minimize the call blocking rate.

Anupam Shukla et al. [25] described that channels to cell in a cellular mobile communication by finding the minimum no. of channel required obtaining an interference free assignment. Objective is that to minimize the probability that the incoming calls are blocked, the probability that outgoing calls are dropped and also to minimize the probability that the carrier-to- Interference ratio of any cells below a pre specified value.

The channel assignment scheme in general, is classified into fixed channel assignment (FCA), Dynamic channel Assignment (DCA), Hybrid Channel Assignment (HCA). In FCA, a set of channel are permanently allocated to each cell based on the pre estimated traffic intensity. In DCA there is no permanently allocated to each cell based on the pre estimated traffic intensity. In DCA there is no permanent allocation of channel to cell. There entire set of available channel to cell is accessible to cells and the channels are assigned on a call-by-call basis in dynamic manner. In HCA one set of channels are allocated as per FCA scheme and another set is allocated as per DCA scheme. In this paper new algorithm by increasing the co-site channel interference to interference to assign minimum channel satisfy the demand constraints and an interference free solution.

In this method Channel Separation is more for the channels so that more channel of cells which have interference with the cell X can be assign and hence take minimum time for computation when compared to other algorithm is efficient and produces results that are very near to require bandwidth.

6. Sectoring: It is basically a technique which is used to increase the SIR without to increase in cluster size. In this method cell spited is into sector and directive antennas are used. It minimize the co-channel interference. These method are discussed here.

Ming Zhang et al. [8] elaborated frequency reuse concept used for the increasing the coverage area. Frequency reuse is one of the most important considerations for wireless radio network planning to meet the network capacity needs and provide good grade of service.

A clover Leaf cell configuration is studied. In 4 × 12 frequency review in GSM This configuration has a unique challenge due to the fact that the antenna main beam of nearest in co-channel interference and reduces the coverage area. And in the conventional cell configuration dead coverage spot are found and require the use of wide beam antenna to compensate. In this paper generic cell
configuration scheme using antenna orientation at angle of 30° degree for all system is used. A novel cell configuration, Alternate Row Rotation for 4 × 12 GSM reuse is proposed. In ARAR First and every odd row of base station have antenna rotation by 0° degree, i.e. 90°, 210°, 330°. Second and every even row of base station have antenna orientation rotation by 60° i.e. 30°, 150°, 275°. Due to the edge coverage enhanced by neighboring sector eliminating the weak coverage spot issue. The configuration is best implemented with narrow horizontal beam antenna, which reduces the co-channel interference. It has concluded that ARAR configuration results in better coverage and C/I.

3. DISCUSSION

The cell planning, designing methods are proposed in these papers. These can be used as a guide line for the designing an efficient system. The principle idea for the each method is to provide the capacity enhancement.

By using relaying in CDMA uplink; capacity improvement can be achieved through, using complicated technique to mitigate the effect of large interference in relay system. Automated cell planning also served 85% final traffic by using optimization algorithm on Simulated Annealing [13]. In cellular relay network (CRN) has high capacity than conventional cellular network. It transmits the high data rate coverage demand of system. By using multihop cellular network the decrease in intercell interference up to 28.7 db as compare to traditional cellular networking also shown. The cell planning, designing methods are proposed in these papers.

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A Heuristic cell planning, Tabu Search has been proposed with the 15% capacity improvement. The capacity and coverage area up to 95% proposed to enhance by spatial reuse, adaptive modulation and coding. Using Contour based algorithm for cell Planning the optimization increased up to 99.92% overall coverage. Femto Cell System and Rotatable equal sectoring method are also used for capacity enhancement. Also the factors like handoff, path loss also play important role in the cell efficiency.

4. CONCLUSION AND FUTURE SCOPE

The comprehensive review shows the necessity of optimization and expansion of capacity to fulfill the tremendous demand of consumers. In the literature survey various techniques have been studied. There are performance metrics like cell planning, frequency reuse, cell splitting, cell sectoring, Handoff Strategy, propagation factors on which capacity depend. These metrics are interdependent. In some technique “optimization” is discussed in literature with main objective function to satisfy all factors involved. Two factors, interference and handoffs are common in all cases so these have to study properly for cellular planning. Cell Planning Method is the basic requirement of any efficient system also it is less costly and more efficient than other methods. With the enhancement of system, quality of service (QoS) must be maintained. For the already installed system, the best enhancement techniques are to use optimization algorithm, implementation of propagation models. These show the better efficiency and easy to maintained.

From the comprehensive study, path loss reduction, Frequency analysis, Quality of Service, Cell Planning, Handoff, cell splitting, propagation factors etc are concluded as performance metrics hence there is a need to deep study of these for further capacity enhancement to fulfill the demand of users.

REFERENCES


