Dimensioning Cellular Wimax Networks

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Abstract
WiMAX networks are designed to cover diverse geographic region. WiMAX data range and throughput are higher as compared to 2G/3G networks. A major challenge for wireless network communication is to provide broadband services efficient to everyone. They can cover-up urban areas as well as rural areas. Tx and Rx antennas require for Line of Sight (LOS) conditions.UL and DL Carrier to Interference Ratio (CINR) are observed. However, in every network it is demanding factor to cover-up the whole region. Relays are introduced within multihop scenarios. Relays are working in different as well as similar time slots. Adaptive antennas are also introduced in wireless networks for reducing the interference. A worst case analysis in important explanations for dimensioning cellular networks within different scenarios. In terms of capacity, performances of single and multihop deployments are compared. The main emphasis is to enhance the coverage area of base station in terms of throughput and coverage. This paper discusses an analytical dimensioning and feasible planning techniques for a cellular OFDM based WiMAX networks.

Keywords
WiMAX, CINR, UL, DL, Frame format, SINR.

I. Introduction

One of the crucial demanding factors for WiMAX wireless networks is to provide broadband services all over the geographic region. With an increase in distance the achievable carrier to interference Ratio (CINR) declines which point to non line of sight (NLOS) and decrease the signal. This paper discusses an analytical dimensioning approach and feasible planning techniques. Cell planning features (Clustering and sectorization) [1] has been considered to upgrade the certain criteria e.g. coverage, capacity or cost. Relays are used to enhance the link quality in terms of throughput and coverage area [2]. These has been the used in multi hop scenario.

Based on estimated signal to interference plus Noise Ratio (SINR) value, the mean cell capacity of single and multi hop WiMAX networks has been calculated in[1]. For dimensioning WiMAX networks, the worst case CINR with in a cellular 802.16 is important. In downlink (DL) of singlehop, the central base station(BS) broadcasts to the most isolated subscriber station(SS) which is positioned at the cell border but in multihop the central BS first transfers to the relay and then it re-transfers the data to the most isolated SS. In uplink (UL) of singlehop, SS at the cell border broadcasts to the central BS but in multihop network the SS at the cell border broadcasts to the relay and it further re-transfer the data to the central BS. Interference is induced by co-channels in single hop and by BS or relays in multihop that uses the similar frequency channel. [1, 2] Frequency division duplex (FDD) or fully synchronized time division diplex (TDD) schemes are used to separate the DL and UL in the examined networks. [4]

II. Celluar Single-Hop And Multihop

Clustering and sectorization: To avoid interference cells are combined into clusters in which there is uniquely channel slot for each cell. Applying a cluster order K, the distance to co-channel cells D. R is radius of cell [6]:

D=R√3K.

Carrier to interference Ratio (CIR) at a central BS receiving a signal from a SS at a cell border is increasing with increase in cluster order. According to [7], the UL rely on the cluster order and noise is ignored. The worst case CIR can be calculated. γ is pass-loss component.

$$\frac{C}{I} = \frac{1}{6}\left(\frac{D}{R}\right)^{\gamma} = \frac{1}{6}(3k)^{\frac{\gamma}{2}}$$

For further decreasing the interference in cellular network, the cells are splitting into sector. Accepted UL CIR in a sectorized and cluster cell is derived by following equation, m is the number of sector [7].

$$\left(\frac{C}{I}\right)_{sector} = \frac{m}{6}\left(\frac{D}{R}\right)^{\gamma} = m\left(\frac{C}{I}\right)_{non-sector}$$

These equations computes only UL CIR.

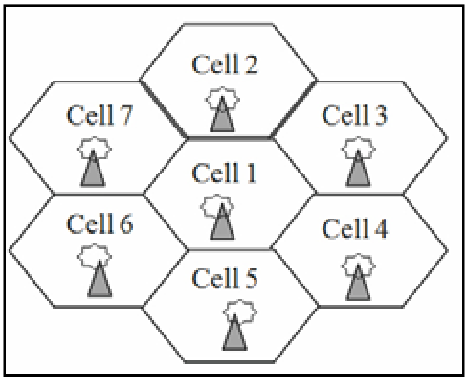

Fig. 1 : Cellular network cluster

For dimensioning, the multihop network, the hexagonal cells are noticed that clustered according to a given cluster order. Inter cell interference is induced by the six co-channel cells of the first tier. The network performs in the 5GHZ spectrum using a channel band width of 20 MHZ. Multihop network design allowed MAC frame and expected that transmission on the first and second hop are perfectly partitioned in time [9].

The broadcast power of all station is limited to the equivalent isotropic Radiated Power (EIRP) i.e. BS, SS and relays are transmitting with 1W line of sight (LOS) and non line of sight (NLOS) propagation conditions are considered into account.

Two different scenarios for locating of relay station.

- Throughput scenario - Locating relays with BS's coverage, the CINR and the link capacity can be increased.
- Coverage scenario - In order to expand the coverage of the cell, relays are located at the border of the BS's transmission range.

$$A_{multi\ hop} = 3\frac{3}{2}\sqrt{3}R^2 = 3 * A_{single\ hop}$$

In order to increase the cell capacity, relays operates in time division multiplexing (TDM), they do not get involved into each other. However, the distribution of resources to relays result in disorganized utilization of available bandwidth. Relays that perform in space division multiplex (SDM) interfere each other. Directive antennas are used to reduce the interference.

A. Comparison of Singlehop and Multihop Network

Based on performance & evaluation, comparing single hop and multi hop scenario in terms of capacity. In throughput scenarios, observed that under LOS and NLOS conditions, the multihop capacity is less or equal to the singlehop capacity. In order to compare singlehop and multihop in coverage scenarios, singlehop deployments seem to be effective because their mean cell capacities are larger and their coverage areas are lower [5]. Relays are used concurrently in Space Division Multiplex for increasing the mean cell capacity. For further increasing the cell capacity relays in LOS-NLOS use directive antennas. The real advantage of multihop deployments is the cost effective roll out.

III. Network Capacity Optimization

An analytical approach to estimate the average data throughput of a cellular radio communication is derived. Carrier to interference Ratio (C/I) inside a radio cell is calculated [10]. At first, analytical formula are calculated for a cellular system with no power control and adaptive modulation or coding. And further formula is calculated in the presence of adaptive modulation and power control. By using modulation/coding obtained better C/I distribution. The analytical Approach is assigned to HIPER-LAN/2 and is used to optimize network capacity. Various modulation and coding schemes are used in HIPER-LAN/2.Orthagonal Frequency Division Multiplexing (OFDM) is used by all modulation schemes.

IV. Smart Antenna and MAC Frame Structure

The main emphasis on smart antennas and MAC frame structure [8] that consists of two parts DL and UL sub frames. DL consists of PDUs that are scheduled for transmission.UL consists of contention intervals scheduled for ranging and bandwidth request. The MAC protocol holds up a frame based transmission. The sub frames appear consequently on the identical channel, when operating in time division duplex (TDD) and in frequency division duplex (FDD) operate on different frequency channel. During unicast transmission phase, only adaptive antenna can be proposed. Still an omnidirectional pattern has to be proposed for broadcast messages. By using smart antennas, interference can be decrease of a cellular system during unicast transmission phase. An adaptive space time sectorzation scheme is promoted to decrease the interference during critical transmission. Two WiMAX MAC frame structures were developed that admit for space-time sectorzation.

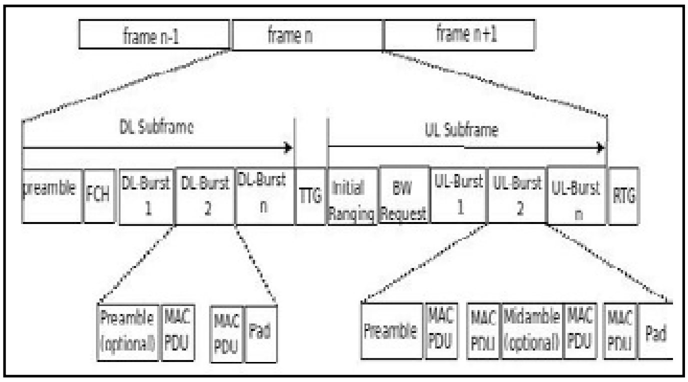

Fig. 2 : MAC Frame Format [14]

Beside clustering and sectorization various another features may extend the CINR, UL and DL coverage:

- In a non- saturated system not all Co-channel BSs and cells are consistently active transmission. This heads to a lower level of interference [1].
- During the DL sub frame, a BS with adaptive antennas may directs its broadcast antenna to the receiving SS so the BS broadcast antenna gain upgrades the signal quality and during UL sub frame, the BS may target its receive antenna to the transmitting SS so that BS receive gain upgrades the signal quality[11]. Due to limited power is radiated in unwanted directions, inter-cell interference is reduced. If regulations admit to surpass the EIRP by targeting the transmission power and extending the spectral density, the received signal power at the SSs is extended. This is effective in noise limited systems.
- The flexibility amendment of IEEE 802.16 extends subchannelization to the DL data transmission. If BSs transfer on a subset of sub carriers only, the number of interferer per subcarrier may be decreased [12]. The spectral density and thus the transmission range stay stable. This feature is effective in interference-limited systems.
- UL subchannelization is described for initial ranging, for Bandwidth (BW) requests and for UL data transmission. If the transmit power per subcarrier stays stable during UL data transmission, interference-restricted systems gains from subchannelization: if all SSs are utilizing a subset of the feasible sub carriers, the number of interfering stations per subcarrier is decreased. Subchannelization during ranging and BW request procedures permits to target the transmit power onto a subset of sub carriers. This extends the spectral density by 12 dB and enhances the transmission range [13]. This feature extends the carrier signal and decreases interference, it is effective in both interference and noise limited systems.

The remarked features to extend the CINR level are only credible during the schedule DL and UL data transmission.

V. Conclusion

This paper presents the various features to enhance the coverage area in terms of throughput and coverage and discusses feasible planning techniques. Noise and interference are the critical components that restrict the range. Clustering, sectorization, sub channelization features are used to reduce the interference. UL focus on power and in DL, the critical part is broadcast phase that consider dimensioning approach. For increasing the coverage area in multihop networks, relays are used. Directive antenna decreases the interference and thus enhances the capacity of cell. Further uses smart antennas to focus the transfer energy into assured direction, so that interference level is decreases.

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