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DOWNLINK COCHANNEL INTERFERENCE MITIGATION IN WIRELESS CELLULAR NETWORKS

A.V.R. MAYURI

Assistant Professor, Santhiram Engineering College, Andhra Pradesh, India

ABSTRACT

Severe co-channel interference in wireless cellular networks significantly affects users at cell edges. We propose a cost-effective Downlink Co-channel Interference Mitigation (DCIM) scheme to improve network performance. For DCIM, base stations judged as severe interferers transmit randomly and transmission is controlled by wireless channel states to optimize the overall network performance while maintaining proportional fairness amongst users. The DCIM scheme requires low signaling overhead and only minor changes to the existing mobile systems. Simulation results show that the proposed scheme, DCIM, significantly outperforms traditional networks through avoidance of severe co-channel interference as well as exploitation of multiuser diversity through cross-layer design.

KEYWORDS: Co-channel Interference, Fractional Frequency Reuse, Downlink, Automatic Relay Stations

INTRODUCTION

Cellular networks are becoming increasingly interference limited as more users need to share the same spectrum to achieve high-rate multimedia communication. In typical cellular systems, co-channel interference (CCI) is one of the major factors limiting system capacity, especially as these systems move towards aggressive frequency reuse scenarios. While the overall system spectral efficiency may improve with aggressive frequency reuse, the performance of cell-edge users degrades substantially.

REVIEW OF LITERATURE

A commonly used method to avoid CCI is to assign different sets of channels to neighbouring cells and a good summary of channel assignment can be found in [1]. One recent popular approach to reducing interference for cell edge users is through *fractional frequency reuse* (FFR) [2], [3]. With FFR, a lower frequency reuse is specified for users at the cell edge, while full frequency reuse is applied for cell-centre users. This improves the throughput performance of cell-edge users since they experience lower levels of interference. In order to further improve frequency reuse efficiency, CCI can be mitigated by advanced digital signal processing techniques [4], [5]. However, these techniques usually have high complexity and therefore, result in high costs for *mobile equipments* MEs. For downlink transmission, CCI can be mitigated by joint pre-processing and encoding techniques among *base stations* (BSs) [6], [7], or avoided by using cooperative scheduling among BSs [8], both of which require a lot of instantaneous information exchange. Recently, contention based schemes are also developed for CCI avoidance in addition to an intracellular centralized *medium access control* (MAC) protocol. In [9], each ME or BS keeps on broadcasting busy-tone signals located at the mini-slot of every data frame to prevent potential interferers from transmitting and every BS or ME must listen to the mini-slots before transmission. With a large amount of signalling overhead, this scheme effectively avoids CCI without considering fairness amongst users and a group of greedy users may keep on broadcasting busy-tone signals, which always prevent others from transmitting.

ANALYSIS

We will focus on cellular systems where each BTS is controlled by a mobile switching center (MSC). Major differences between BTSs and the proposed Automatic Relay Stations (ARS) are as follows. Once a BTS is installed, its location is fixed since it often has a wired interface to an MSC (and a backbone network). An ARS, on the other hand, is a wireless communication device deployed by a network operator. It has much lower complexity and less functionality than that needed for a BTS. In addition, it may, under the control of an MSC, have limited mobility (in order to adapt to varying traffic patterns) and communicate directly with a BTS, another ARS, or an MH through the appropriate air interfaces.

An example of relaying is illustrated in Figure 1, where MH X in cell B (congested) communicates with the BTS in cell A (or BTS A, which is non congested) through two ARSs (there will be at least one ARS along which a relaying route is set up). Note that each ARS has two air interfaces, the C interface (for cellular communications) with a BTS and the R interface (for relay communication) with an MH or another ARS. Also, MHs should have two air interfaces; the C interface for communicating with a BTS and the R interface for communicating with an ARS. In the following discussion, we will assume that the C interface operates at or around 1900 MHz (PCS), and the R interface uses an unlicensed band at 2.4 GHz (in the ISM band), even though our concept also applies when different bands are used (for example, 850 MHz for the C interface as in 2G systems or 2 GHz for 3G systems). The R interface (as well as the medium access control (MAC) protocol used) is similar to that used in wireless LANs or ad hoc networks. Note that because multiple ARSs can be used for relaying, the transmission range of each ARS using its R interface can be much shorter than that of a BTS, which implies that an ARS can be much smaller and less costly than a BTS. At the same time, it is possible for ARSs to communicate with each other and with BTSs at a higher data rate than MHs can, due to limited mobility of ARSs and specialized hardware (and power source).

There are three basic relaying strategies.

Primary Relaying

In an existing cellular system, if MH X is involved in a new call (as a caller or callee) but it is in a congested cell B, the new call will be blocked. In the proposed system with integrated cellular and relaying technologies, the call may not have to be blocked. More specifically, MH X which is in the congested cell B can switch over to the R interface to communicate with an ARS in cell A, possibly through other ARSs in cell B (see Figure 1 for an example).We call this strategy primary relaying. With primary relaying, MH X can communicate with BTS A, albeit indirectly (i.e., through relaying). Hereafter, we will refer to the process of changing from the C interface to the R interface (or vice versa) as switching-over, which is similar to (but different from) frequency hopping. Of course, MH X may also be relayed to another nearby non congested cell other than cell A. A relaying route between MH X and its corresponding (i.e., caller or callee) MH X may also be established (in which case, both MHs need to switch over from their C interfaces to their R interfaces), even though the probability that this occurs is typically very low.

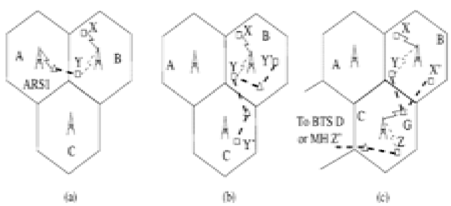

Figure 1: (a) Primary Relaying (b) Secondary Relaying (c) Cascaded Relaying

Secondary Relaying

If primary relaying is not possible, because, for example in Figure 1, ARS 1 is not close enough to MH X to be a proxy (and there are no other nearby ARSs), then one may resort to secondary relaying so as to free up a dynamic channel from BTS B for use by MH X. Two basic cases are illustrated in Figure 2(a) and (b), respectively, where MH Y denotes any MH in cell B which is currently involved in a call. More specifically, as shown in Figure 2(a), one may establish a relaying route between MH Y and BTS A (or any other cell). In this way, after MH Y switches over, the DCH used by MH Y can now be used by MH X. Similarly, as shown in Figure 2(b), one may establish are laying route between MH Y and its corresponding MH Y in cell B or in cell C, depending on whether MH Y is involved in an intra-cell call or an inter-cell call. Note that congestion in cell B implies that there are a lot of on-going calls (involving candidates like MH Y); hence, the likelihood of secondary relaying [refer to Figure 2(a) and (b)] should be better than that of primary relaying (refer to Figure 1). In addition, although the concept of having an MH-to-MH call via ARSs only (i.e., no BTSs are involved) is similar to that in ad hoc networking, a distinct feature(and advantage) of the proposed integrated system is that an MSC can perform (or at least assist in performing) critical call management functions such as authentication, billing, and locating the two MHs and finding and/or establishing a relaying route between them, as mentioned earlier. Such a feature is also important to ensure that switching-over of the two MHs (this concept is not applicable to ad hoc networks) is completed fast enough so as not to disconnect the on-going call involving the two MHs or not to cause severe quality of service (QoS) degradation(even though the two MHs may experience a “glitch” or jitter).

Cascaded Relaying

If neither primary relaying, nor basic secondary relaying [as shown in Figure 2(a) and (b)] works, the new call may still be supported. More specifically, assume that there is a relaying route, which can be either primary or secondary relayed, between MH X and ARS, say G (for gateway),in a nearby cell C which unfortunately is congested. As shown in Figure 2(c), one may apply any of the two basic secondary relaying strategies described above in the congested cell C (i.e., in a cascaded fashion) to establish a relaying route between an MH (say MH Z) in cell C and either another BTS in a non-congested cell or MH Z . In this way, ARS G can be allocated the DCH previously used by MH Z in cell C, and, in turn, MH X can be allocated the DCH previously used by MH Y in cell B_{if} the route between MH X and ARS G is set up by secondary relaying.

In addition to the above relaying strategies, one critical design issue is the number and placement of ARSs. We have discussed the maximum number of relaying stations needed to ensure that a relaying route can be established between any BTS and an MH located anywhere in any cell. In the case where only a limited number of ARSs is available, an approach called seed growing, whereby one seed ARS is placed on each edge can be used (note that additional ARSs may be placed around these seeds to increase the ARS coverage). Consequently, traffic in the ARS coverage area in one cell can be relayed to a neighboring cell covered by the same seed ARS (provided that it will not be blocked in that neighboring cell). It has been shown that, for an cell system, the maximum number of seed ARSs needed is 2. In the following analysis and simulations, we assume that the seed growing approach is used and denote the ARS coverage in terms of the percentage of a cell covered by ARSs, by $0<p\leq 1$.

On Downlink Capacity of Cellular Data Networks

With WLAN/WPAN Relays Augmenting a cellular network with relays is not a novel concept. Suppose that mobile nodes cannot relay and introduce dedicated relays which use unlicensed frequencies in order to improve the capacity. We assume mobile nodes themselves dispose of WLAN interfaces, and provide a routing protocol that finds and maintains relay routes. In, small networks with 1-hop relays are considered. Scheduling algorithms for relay networks and more advanced scheduling techniques are considered. It is supposed that the BS and the relays use the same frequency band. Consequently, the BS transmits only to the nearest nodes, and the others receive relay traffic only. It is common for all the proposed relay protocols is that none of them is based on the objective to maximize a certain network-wide performance criterion. Instead, they are based on a simple local heuristic that considers relaying only for those nodes whose direct communication with the BS is of very low quality. That way one node will never receive traffic from both relay and direct links. Typically, closer nodes will receive traffic only directly, and distant nodes only over relay links.

PROBLEM STATEMENT AND OUR CONTRIBUTIONS

The main objective of this work is to characterize the optimal resource allocation that maximizes the capacity of a densely populated cellular network with relays. This capacity defines the maximum amount of traffic the network can support given a spatial distribution of traffic demand and is hence crucial for dimensioning purposes. We characterize the optimal resource allocation scheme policies using different heuristics. We find that the optimal resource allocation scheme divides a cell into two regions. The first region, around the BS, is such that the relay channel is fully saturated. Nodes in this region may receive traffic both from relays and directly from the BS. In the other region, the relay channel is never saturated, and there is no direct traffic to users in this region.

From the optimal resource allocation, we deduce the capacity of a cell with relays, which can be easily used for dimensioning purposes. We show that the capacity remains constant, independent of the cell size, which is in contrast with cellular networks with no relay where the capacity decreases exponentially. We also show a significant improvement in the capacity as compared to when the direct traffic is scheduled only to the nodes nearest to the BS. The results are based on the assumption that all relays links use the same routing policy (i.e. relay link length).

We consider the downlink of a single cell whose transmission resources (power and bandwidth) are shared by a dynamic population of data flows. Flows are randomly generated by users and leave the network once the corresponding data transfer has been completed. Flows are characterized by their sizes but also by the position of the corresponding users in the cell. We assume here that users remain still during the entire duration of the data flows. We will consider both 1D linear or 2D cells.

Traffic Characteristics

We denote by C the set of locations in the cell (this set might be discrete or continuous). The traffic model may be very general. We just assume that data flows are generated at location x ϵ C according to a stationary erotic process of intensity λ(x). These flows have arbitrary distributed sizes of mean σ(x). The traffic intensity at location x in then defined by $p(x) = \lambda(x) \times \sigma(x)$ (in bit/s). We further define p(x) as the proportion of traffic generated at location x: p(x) = p(x) / p, where p is the total traffic generated in the network, i.e., $\boldsymbol{p = \int_c^n p(x)dx}$

Radio Resources - Scheduling and Relay Policies

We next describe the two radio interfaces we shall use.

Direct Transmissions from the BS

We assume that the BS transmits at full power and serves only one user at a time. The service rate of a user at location x is denoted by $C_d(x)$. This rate is a function of the SINR at the receiver and can be well-approximated by Shannon formula:

$$C_d(x) = W_1 \log_2(1 + \frac{P^{\mathrm{BS}} x^{-\alpha^{\mathrm{BS}}}}{N_1}), \quad (1)$$

where P^{BS} is the BS's transmission power, α^{BS} is the attenuation exponent and N1 is the white noise power.

Relay Capabilities

We assume the relay channel is based on the design principles of 802.11 MAC/PHY. It supports variable transmission rates. If a signal, coded for a given rate, is received at an SINR below the corresponding threshold, the packet is lost. We assume that more advanced techniques, like incremental redundancy coding, are not available at the physical layer. In order to control the interference at a receiver, we use the idea of the RTS/CTS signaling. When a node wants to receive a packet, it sends a CTS signal. All nodes in an area around a destination that hear the CTS signal have to refrain from sending.

We denote the radius of this area, assumed circular, by D, and it depends on a power of the transmitted signal and the attenuation function. Note that in our case there is no need to exclude nodes that hear the RTS signal. This is typically done to ensure ACK reception. However, the signaling consumes a small fraction of bandwidth and we suppose that it is performed over the direct link, thus by omitting RTS, we avoid unnecessary exclusions and increase the capacity of the network. To simplify the analysis and the practical implementation of relay policies, we consider that the exclusion area D will be the same for all relay nodes. Furthermore, we assume that relay nodes transmit at full power (denote by PRELAY) when transmitting. PRELAY is assumed to be identical for all nodes. For a given link we need to choose coding rate C_r as a function of link length l. Loosing and resending a packet is expensive hence it is important to choose a rate sufficiently low to avoid packet errors. We will choose

$$C_r(l) = W_2 \log_2\left(1 + \frac{P^{\mathrm{RELAY}} l^{-\alpha}}{N_2 + k P^{\mathrm{RELAY}} D^{-\alpha}}\right), \quad (2)$$

Where k is a security factor guaranteeing low packet error rate. This factor basically quantifies the maximum interference generated by other active relay nodes such that the packet error rate on the considered link is negligible. The exclusion principles can be enforced and acknowledgments can be transmitted by the BS, using the direct channel. These packets are short, unlike data packets, hence the overhead is low. Consequently, there is no need for distributed protocols (like sending RTS/CTS); we can emulate the principles of such protocols by a centralized scheduler implemented at the BS.

Scheduling and Relay Policies

We now provide a model to describe how radio resources can be shared by active users. We fix the number of active users and their positions in the cell. Denote by $N \subset C$ the set of locations of active users and by $L \subseteq N^2$ a set of possible relay links (those whose rate is larger than some minimum). Without loss of generality we may assume that two users cannot be at the same position.

Scheduling BS Resources

The BS shares its power in time between active users. We denote by $T(x)$ the proportion of time the BS serves a user at position $x \in N$

A feasible scheduling policy is such that:

$$\sum_{x \in N} T(x) \leq 1 \tag{3}$$

Relay Policies

To describe a relay policy, one first has to define a notion of transmission profile. A profile j is a set of simultaneously active relay links: j = {(s_1, d_1), . . . , (s_p, d_p)}. Profile j is feasible if and only if the distance between any pair of positions (s_m, d_n) is greater than D for all m 6= n. Denote by J is the set of all possible profiles. A relay policy consists in activating the links from profile $j \in J$ for transmission a proportion of time $T_r(j)$ The relay constraint then reads:

$$\sum_{j \in J} T_r(j \leq 1) \tag{4}$$

SYSTEM MODEL

Locations of Nodes

The model we study is that of a network with multiple nodes. Each of these nodes represents a BS serving subscribers in a given region, which we shall call a cell in analogy to conventional cellular wireless systems. Some of these BSs, called access points (APs), are assumed to have a wired connection to the backhaul network. The remaining BSs correspond to so-called extension points (EPs) in the sense of extending the range of the wired BSs (APs) over a wider area. All APs are assumed identical, and all EPs are also assumed identical.

Channel Model

While our analysis is applicable to any model of path loss between a transmitter and receiver, for concreteness, we assume the Erceg–Greenstein model. Since the EPs and APs are all stationary, there is no fast fading on the links. Thus, the maximum rate that can be supported on a given wireless link is a function only of the transmit power, distance between transmitter and receiver, shadow fading on the link, and interference power at the receiver from neighboring node transmissions. However, in the simulations, we have set the transmit power to be equal at all EPs and at all APs, but different between EPs and APs. The shadow fading model is the customary log-normal model.

Traffic Model

In the present section, we focus on the downlink, i.e., the transfer of information from the APs to the EPs, and assume for simplicity that all traffic for all subscribers in the cell arrives at only one AP. Note that we are only interested in the aggregate traffic per cell and, thus, the locations of the individual subscribers in each cell are irrelevant to our analysis, so long as we make the assumption that the aggregate traffic demand per cell is constant over time. Thus, when we write "traffic intended for an EP," we mean "traffic intended for all subscribers served by that EP." Note that in practical systems, transmission intervals are usually divided into time slots, and information is transmitted in the form of packets. However, if the time slot duration is sufficiently small, and a transmission interval can comprise multiple time slots, then the duration of a transmission interval is effectively arbitrary, and we can employ the above approximation of focusing only on individual bits of the packets, rather than the packets themselves. B.

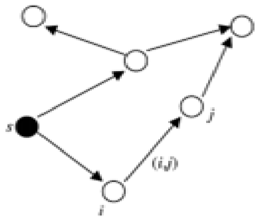

Figure 2: Network with 6 Ep, 1APand Several Links

Statement of the Wireless Network Flow Problem

All traffic intended for a particular destination EP arrives in a continuous stream of bits at a specific AP and is transmitted to other EPs en route to the destination EP. The bits intended for the destination EP reside in buffers at the intermediate EPs on the path between the AP and the destination EP. These buffers are assumed to be of infinite length, so that bits are never lost due to queues over flowing. We assume that the buffers in the intermediate nodes are never empty since the focus is on the average throughput achievable and by appropriate scheduling of transmissions, buffers can be maintained to be nonempty just before transmission. This makes the movement of data through the network analogous to the flow of fluid through a network of pipes. By analogy to the fluid flow problem, the portion of the total number of bits that travels through a given link (edge of the graph) is called the flow on that edge. The traffic intended for each EP is called a commodity and indexed by the label of the EP. The throughput to each destination EP is simply the ratio of the total number of bits it receives in a certain time interval to the total transmit time allocated for these bits at the AP and at the various intermediate EPs.

Solution to the Single-Hop Network Flow Problem

The single-hop strategy corresponds to having transmission scenarios where there is exactly one active link in each scenario, namely with the AP as the transmitter and one EP as the receiver. Thus, there are exactly as many transmission scenarios as there are EPs, or $N = n$ If the rate from the AP s to the EP i is R_{si} (note that there is no interference as this is the sole transmission), then the time required for EP i to receive its demanded number of bits f is $T_i = f/R_{si}.$ Since the AP transmits to each EP one by one, the total time required for all the EPs to receive their demanded number of bits is which is the harmonic mean of the rates from the AP to the individual EPs.

Description of the Numerical Parameters Used in the Problem

We assume a bandwidth of 10 MHz, log-normal shadow fading with a standard deviation of 8 dB, and several possible choices for the radius of the hexagonal cells containing the AP and EPs. The cell containing the AP is assumed to be of the same size as the cells containing the EPs.

In addition, we study two possible combinations of antenna transmit heights and transmit powers for the AP and the EPs, which we call Situation 1 and Situation 2, respectively.

Single-Hop

AP transmits with 43 dBm power with antenna height of 20 m, and all EPs transmit with 30 dBm power with antenna height of 10 m. Multihop: AP and all EPs transmit with 30 dBm power, and AP and all EP antennas are 10 m high.

Single-Hop and Multihop

AP and all EPs transmit with 30 dBm power, and all EP antennas are 10 m high.

Situation 1 corresponds to the case where the AP is on a taller tower than the EPs and also can transmit with more power. This should lead to higher rates to EPs and, therefore, increase the throughput for the single-hop case over Situation 2.

Multihop With Omni directional Antennas Versus Single Hop

In Figure, we plot the throughput versus range curves for several choices of the cell size for the two situations defined above. It is clear that for Situation 1, where the AP transmits with significantly higher power and from a greater height, the single-hop scheme has greater throughput for a given range compared with the multihop routing scheme. Thus, if the power available to a wired BS is large enough to cover a given area, there is no advantage to be gained in terms of throughput by introducing EPs without wired backhaul access into that area. In Situation 2, on the other hand, multihop routing is clearly superior to single-hop routing, though the advantage is not overwhelming.

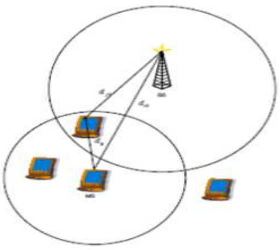

Figure 3: Multihop Transmission Via Relay

Downlink Capacity of Cellular Data Networks with Relays

We consider the downlink of a cellular network supporting data traffic. In addition to the direct traffic from the base-station, each user is equipped with the same type of 802.11-like WLAN or WPAN interface that is used to relay packets to further users and hence to improve the performance of the overall network. We are interested in analyzing what are the design guidelines for such networks and how much capacity improvements can the additional relay layer bring, in comparison to cellular networks. We consider a realistic dynamic setting where users randomly initiate downloads and leave the system upon transfer completion. A first objective is to provide a scheduling/relay strategy that maximizes the network capacity, which is the traffic in bit/s/cell that the network can support. We find that, regardless of the spatial traffic distribution, when the cell approaches saturation (the number of active users is large), the capacity-achieving strategy divides the cell into two areas: one closer to the base-station where the relay layer is always saturated and some nodes receive traffic through both direct and relay links, and the further one where the relay is never saturated and the direct traffic does not exist. We further give a simple algorithm to calculate the cell capacity.

The obtained capacity is shown to be independent of the cell size (unlike in traditional cellular networks), and it is 20%-60% higher than already proposed relay architectures. We consider the downlink of a single cell whose transmission resources (power and bandwidth) are shared by a dynamic population of data flows. Flows are randomly generated by users and leave the network once the corresponding data transfer has been completed. Flows are characterized by their sizes but also by the position of the corresponding users in the cell. We assume here that users remain still during the entire duration of the data flows.

Application of Multihop Relaying

The multihop relaying technology provides a significant flexibility in design and operation of cellular networks. In multi hop cellular network, MS may choose to utilize multi hop relaying instead of single-hop direct transmission. As an example of an application that could benefit from the multi hop extension of cellular network, we present the improvement in fairness and robustness in the presence of variability of traffic distributions

Fairness Improvement

One of the concerns in the design of cellular networks is the tradeoff between throughput and fairness. System throughput can be maximized by allocating more radio resources to a user with higher SIR; e.g., a user that is close to BS. However, a user with lower SIR will experience higher latency. If more resources are assigned to the lower SIR user to achieve better fairness, the total system throughput will decrease. Therefore, it is not easy to provide QoS fairly over the whole service area and, at the same time, to maximize the system throughput. This tradeoff caused by the location-dependent SIR is an inherent feature of the cellular network.

We showed that the throughput gain achievable with the multi hop relaying increases as the MS is closer to the cell boundary. This implies that the degraded QoS due to low SIR can be compensated for through the use of the multi hop relaying. This can be confirmed through the comparison of two distributions of the effective data rates for the multi hop system and for the conventional system.

DESIGN

Algorithm for DCIM Protocol

```
Begin
Construct nodes;
Construct downlink to transmit PKT from BS;
REQ sent →BS;
if(true)
{
for i =1 to k do
{
PKT→n i for all direct links
PKT→ARS→ n i for all indirect links
}
while (time =T)
{
break;
Print throughput, PKT_DEL_SUCC;
}
```

}

else

{

Select CCIC;

for i =1 to k do

{

PKT→n $_i$ for all direct links

PKT→ARS→ n $_i$ for all indirect links

}

while (time =T)

{

break;

Print throughput, PKT_DEL_SUCC;

}

}

Compare the simulation result

End

Downlink co-channel alleviation (DCIM) Algorithm

OBJECTIVE: maximize $\sum_m a_m(t)$

INPUT VARIABLES

1: MS index m;

2: frame index t;

3: frame duration T;

4: Under transitive situation the calculation of relay stations r;

5: RS node $i's$ queue status $Q_i^m(t)$;

6: RS node $i's$ queue status under transitivity

$\sum_{r=1}^{tc} Q_{i_r}^m\ (t)$

7: a set of simultaneous transmission scenarios, S_k $1 \le k \le K$

8: power used from node i to j,p_{ij} ;

9: distance between node I to j, d_{ij};

OUTPUT VARIABLES

1: $x_{ij}^{m}(k,t)$, scheduled packets transmitted from node i to j in s_k at frame t, which are destined for MS node m;

2:$T_k(t)$, scheduled time portion for scenario S_k

Constraints

$1. S_{sm} = \sum_{s,k-1}^{K} x_{sm}(k,t)$

$a_m(t) = \sum_{k-1}^{K} S_{sm}(k)$

where S is MS node m's upstream node' index;

$\sum_{r=1}^{k} Q_{i_r}^{m}(t) + \sum_{k=1,s}^{K} x_{si}^{m}(k,t) =$

$\sum_{w,r=1}^{k} x_{iw}^{m}(k,t) + \sum_{r=1}^{k} Q_{i_r}^{m}(t+1)$

Where 'i' is RS index and r is transitive RS index and t_c is transitively associated relay station count. 's' and 'w' stands for node $i's$ upstream and downstream node, correspondingly;

$\sum_m x_{ij}^{m}(k,t) \le w_{ij}(k,t) \times T_k(t)$

$w_{ij}(k,t) = \omega log_{\delta 2}\left(1 + \frac{p_{ij}/d_{ij}^{\alpha}}{N_0 + \sum(x,y)\epsilon S_k,(x,y) \neq (i,j)\; p_{ij}/d_{ij}^{\alpha}}\right)$ where α is the path defeat advocate, and N_0 is sound power;

$\sum_{k-1}^{K} T_k(t) = T$ observed for time frame T

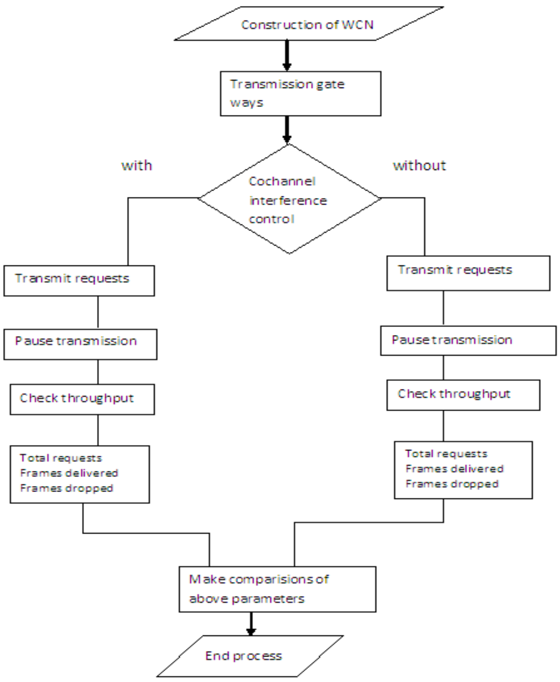

Figure 4: Flow- Diagram of DCIM Protocol

SIMULATION RESULTS

The Downlink Co-channel Interference Mitigation (DCIM) under transitive connection considerations has been implemented using mxml and action script. The accomplishment is based on multi-hop relay based wireless cellular network routing functions that are added. In additional to building MAC, the protocol also establishes a best schedule plan when it learns such obligation. The best-effort scheduling is used to enhance the throughput.

A distributed protocol which dynamically generates and updates broadcast schedules among the nodes has been used. Assumed transmission rate is 1 Mbps. The model detects all simultaneous transmissions, and responds by invoking scheduling behavior as suitable. The relay station queues that are transitively associated to BS also be measured to end the relies in middle between BS and transitive relay station. We apply greedy search technique to recognize simultaneous relations of the replication.

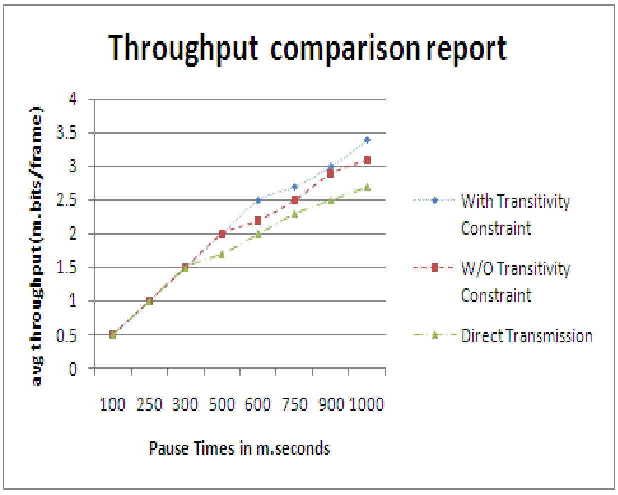

Figure 5: Throughput Comparison Report

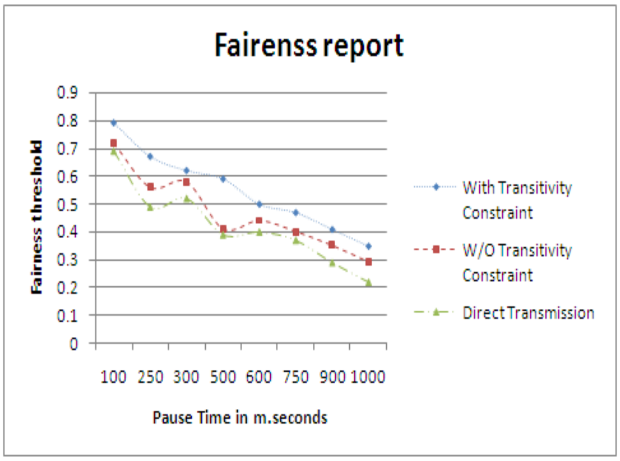

Figure 6: Fairness Comparison Report

CONCLUSIONS

This paper provides a low-cost solution to improve performance for cell-edge MEs that are experiencing severe CCI in wireless cellular networks. The proposed DCIM requires semi-static information exchange amongst BSs and automatically randomizes transmission to improve QoS for severely interfered MEs. The proposed scheme significantly improves communication performance for MEs experiencing severe CCI because of intelligent recognition of severe interferers and corresponding interference avoidance.

For simplicity, we have not considered traffic characteristics yet, which influence MAC buffer status and thus its transmission probability. Hence, thresholds need to be redesigned to incorporate traffic characteristics in our future research.

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