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Downlink Throughput Enhancement of a Cellular Network Using Two-Hopuser Deployable Indoor Relays

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ABSTRACT:

Wireless relaying is essential to provide reliable transmission, high throughput and broad coverage for wireless networks. Due to several penetrations Indoor signal strength is poor and leads to less SNR .In this project, the two-hop user-deployable indoor relays are proposed for CDMA systems. The concurrent relaying techniques are used to transmit when a relay is forwarding. The two-hop indoor relay is studied using a generalized model for outdoor-to-indoor communication in a frequency-selective channel in the presence of co-channel interference is studied.

The proposed equalize-and-forward relay employs multiple-antenna interference-aware equalization before forwarding signal. It presents a unified solution to minimize interference at the relay-served destination and the BS-served destination, using power control. Simulation results in the context of High Rate Packet

Data (HRPD) CDMA network shows that the ATs served through the indoor relays experience throughput improvement by at least a factor of two, whereas the ATs served by the BS experienced a gain of around 6% in spite of concurrent relaying. The results also show an overall system throughput gain upto 30% when compared to the existing network with only single hops.

INTRODUCTION:

The throughput improvement for indoor access has been a subject of research in academia and standards bodies. Indoor reception is poor due to additional wall-penetration losses leading to poor Signal-to-Interference-plus Noise Ratio (SINR) compared to outdoor reception. One approach that is being actively pursued to overcome this problem is to place an additional low-power base station (BS) within the indoor premises, commonly referred to as a Het Net solution. Generally, such a solution consisting of femto and/or pico base station requires an extensive and dedicated backhaul (e.g DSL, fiber or microwave) network. In contrast, repeater and relay-based approaches do not need such a backhaul.

In CDMA systems, repeater-based solutions have been widely studied and deployed to primarily resolve coverage holes and extend macro coverage. Such repeaters usually need a favorable Line-of-Sight (LoS) location to mount the outdoor unit and sufficient RF isolation from the retrans-mission unit. Unlike repeaters, relays introduce sufficient delay before retransmission and can operate in half-duplex mode.

They can be deployed as needed without depending on the LoS availability (for e.g., indoor premises). Moreover, it is feasible to performadvanced signal processing at the relays to suppress interference before forwarding, thereby improving the SINR. two-hop relay-based communication involves two phases of operation - 1) the relay receives from the source and processes the signal and 2) the relay forwards the signal to the destination. Often, assumptions made in this context are interference-free reception at the relay and destination over a channel free of inter-symbol-interference (ISI).

However, these assumptions are unlikely to be valid in the downlink of a cellular network, especially in a reuse-1 deployment. One must therefore undertake careful investigation of three aspects related to

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interference, in addition to the impact of ISI due to the channels, on the two-hop link in a cellular network

Contribution of the Paper The main contribution of the paper lies in the analysis of two-hop indoor relaying in the presence of interference for the downlink of a CDMA system. In this work, we have made assumptions which are valid in a practical multi-cell CDMA system, such as frequency-selectiveness of the channel, which was not considered in previous works. In addition, we analyse the two-hop indoor relaying scheme when the relay and relay served AT are in proximity. The key contributions in this paper are the following:

1) A generalized model for outdoor-to-indoor relaying for CDMA systems in an interference-limited, frequencyselective channel.
2) Use of a multi-antenna relay receiver to perform interference-aware processing and an "Equalize-and-Forward" relaying scheme to address the issue described in Section I-A.
3) A power control solution, which exploits the proximity of the relay and relay-served AT in order to minimize the interference generated due to relaying.
4) A scheduling-based solution to address the interference related issues described in Sections I-B and I-C for concurrent relaying in a cellular network.
5) An approach for integrating the proposed relaying solution in an existing CDMA network, without any additional requirements imposed on the existing AT capabilities.
6) Through system-level simulations of High Rate Packet Data (HRPD) network, it is demonstrated that concurrent relaying in indoor scenarios provides significant system gain, unlike the case of outdoor relays where the gains were shown to be limited [16].
7) Demonstration that, in spite of inband concurrent relaying, there is no loss in the spectral efficiency of the ATs served directly by the macro base stations. We do not consider in this paper the uplink from indoor ATvia the indoor relay. The throughput of this link can also be increased by using a relay. We note, however, that even if the throughput were to remain unchanged, the transmit power of the AT is much lower when it communicates via a relay in its proximity, and the relay is therefore beneficial.

II. TWO-HOP RELAY MODEL:

In a typical CDMA transmitter, the data symbols for the intended receiver are modulated and spread using orthogonal spreading codes which are then scrambled with a specific PN sequence. We assume synchronous transmission from all sources and the relays. The received signal at a receiver comprises of sum of signals transmitted from all the sources through a frequency-selective channel.

We assume that all the sources transmit with equal power, however the large-scale channel losses (such as path loss and shadowing) determine the quality of the signal and interference received at a receiver. The two-hop communication involves two phases of transmission in non-overlapping time slots m1 and m2 with retransmission delay τd= (m2 −m1)Tslot, where Tslotis the slot duration.

WORKFLOW:

Algorithm 1 Self-organization by each relay in the network

1: **procedure** SOP(χ_{max}, χ_{min})
 ▷ χ_{max}, χ_{min} are respectively max. and min. data rates supported by the network
2: Estimate the average received power from each BS i.e, $(P_s \times \beta_{sr})_i, \quad i \in [0, K]$
3: Connect to the BS with strongest link
4: Estimate I_K based on measurements
5: Estimate $\bar{\sigma}_e^2$ from measurements and pilot estimates
6: Calculate β_{rd} for the desired coverage $\check{r}_d$ (in meters).
7: Estimate/obtain γ_{direct} and $\gamma_{cc,EF}$.
8: **if** γ_{direct} is sufficient for χ_{max} **then**
9: De-activate relay
10: **go to** 20
11: **end if**
12: **if** $\gamma_{cc,EF}$ is not sufficient for χ_{min} **then go to** 9
13: **end if**
14: With $P_r = P_{r_{max}}$, calculate Γ as in (17)
15: **if** $\Gamma \leq 1$ **then go to** 9
16: **else**
17: Find P_{opt} as in (19) for a control parameter ϵ.
18: Set transmit power $P_r = max\left(min(P_{r_{max}}, P_{opt} + \Delta P), P_{r_{min}}\right)$.
19: **end if**
20: **end procedure**

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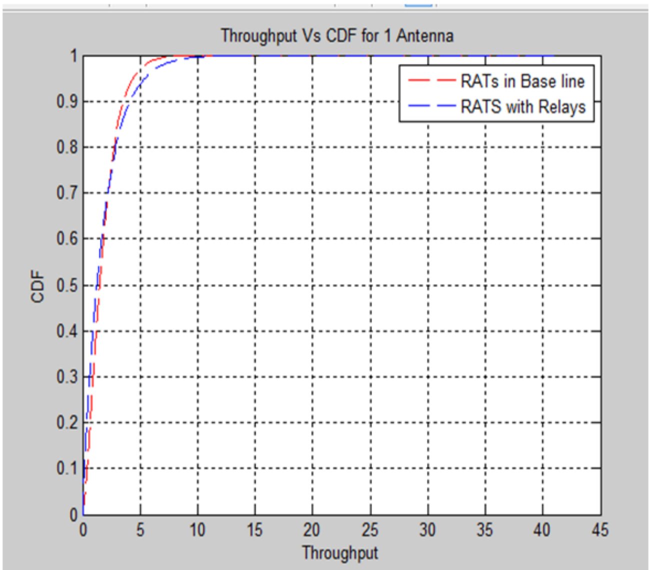
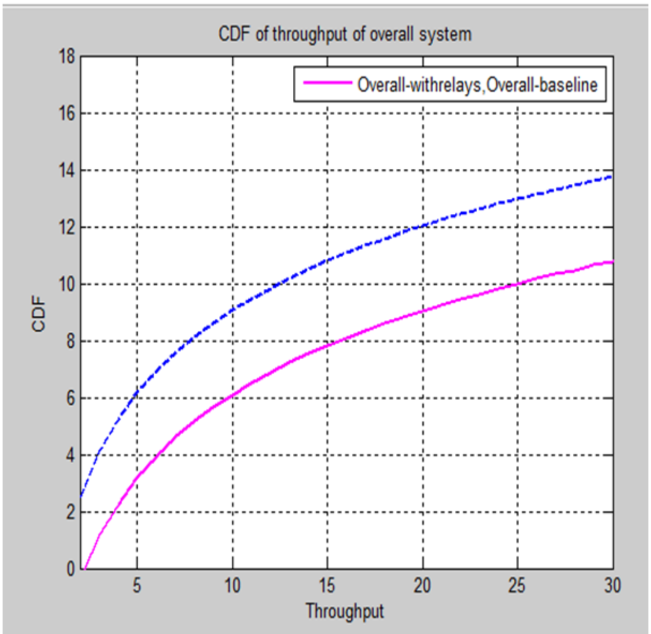
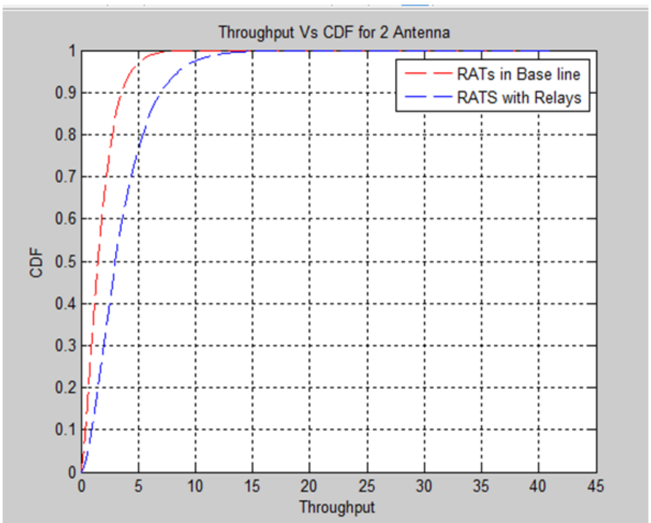
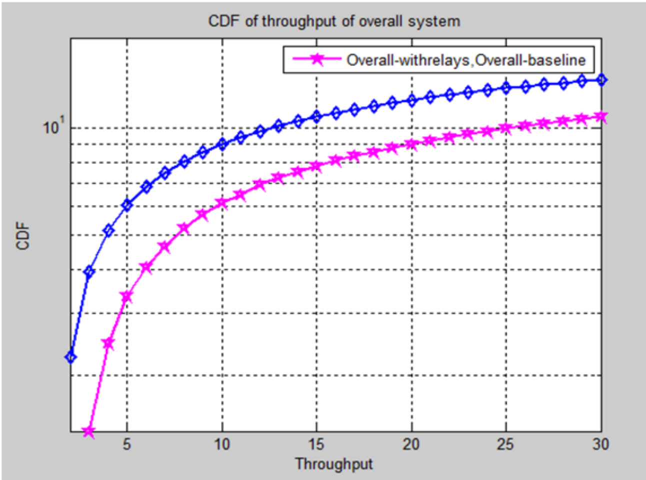
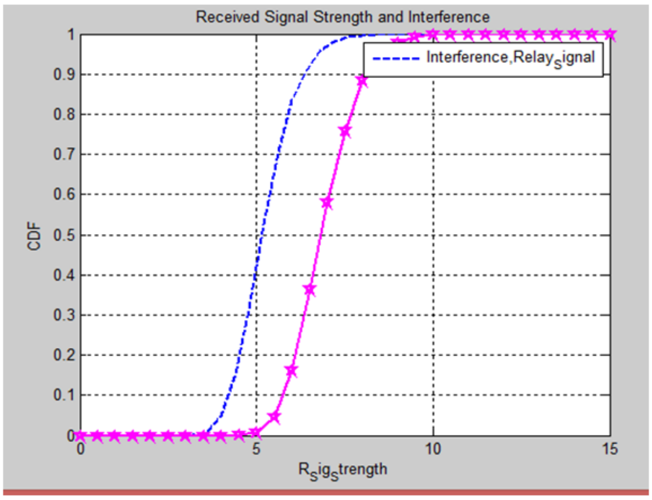
SIMULATION RESULTS











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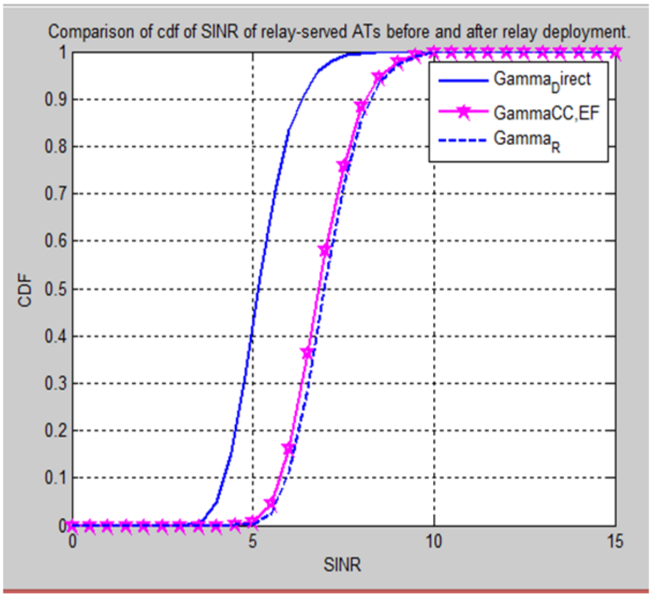

CONCLUSION:

The performance of a two-hop Equalize-and-Forward indoor relay in the presence of co-channel interference is observed.By examining the results it is observed that interference-aware equalize-and-forward indoor relays with multiple antennas which implement concurrent relaying are showing better results in terms of doubling the throughputof the relay-served ATs, and the overall system-level throughput is also increased by 30%. The key to this performance gain is minimization of the transmit power at the relay and interference management by the base station. Comparison between the relay-based solution and the repeater-based solution shows that the relay-based solution offers significant gain.

FUTURESCOPE:

The proposed model can be implemented both in indoor and outdoor relay, further the throughput rate can be increased by adopting multiple antenna and thus saving the power.

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