International Journal of Engineering Science Invention Research & Development; Vol. IV, Issue III, SEPTEMBER 2017
www.ijesird.com, E-ISSN: 2349-6185

OPTIMIZING LOAD BALANCING AND DATA-LOCALITY WITH DATA-AWARE SCHEDULING IN MANET

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Abstract: **Load balancing techniques (e.g. work stealing) are important to obtain the best performance for distributed task scheduling systems that have multiple schedulers making scheduling decisions. In work stealing, tasks are randomly migrated from heavy-loaded schedulers to idle ones. However, for data intensive applications where tasks are dependent and task execution involves processing a large amount of data, migrating tasks blindly yields poor data-locality and incurs significant data-transferring overhead. This work improves work stealing by using both dedicated and shared queues. Tasks are organized in queues based on task data size and location. Implement our technique in MATRIX, a distributed task scheduler for many-task computing. We leverage distributed key-value store to organize and scale the task metadata, task dependency, and data-locality. We evaluate the improved work stealing technique with both applications and micro-benchmarks structured as direct acyclic graphs. Results show that the proposed data-aware work stealing technique performs well.**

I. INTRODUCTION

A MANET is a self-organizing set of mobile devices that communicate with one another across multiple hops in a distributed manner. Because of the widespread use of cheaper, smaller, and more powerful portable devices, MANETs have become a promising and growing technique. With recent advances in information and communication technology (ICT), MANETs are able to support high network capacity and proliferating multimedia services, such as video on-demand, surveillance, remote education, and health monitoring, etc. MANET traffic produced for ubiquitous access and multimedia applications with quality of service (QoS) requirements considerably increase energy exhaustion of mobile devices. Energy is a scarce resource for mobile devices, which are typically driven by batteries with limited capacities. Further, progress in battery technology is slow and expected to improve little in the near future. Under such critical conditions, optimal EE design that concentrates on the most economical ways of utilizing mobile device energy while ensuring proper network operations is an urgent requirement for MANETs. EE optimization of mobile communication systems has received much attention in the literature. For instance, in the authors optimized link-level EE of the wireless network under static and time-variant fading channels. In the authors studied link-adaptive transmission for maximizing the EE of the orthogonal frequency division multiplexing (OFDM) system by presenting an energy efficient water-filling power allocation algorithm. In the authors introduced channel selection and power allocation mechanisms to optimize the EE of a distributed cognitive radio network where the transmitter directly sent data to the receiver (i.e., a single-hop network). In the authors used game theory to develop multiuser detection and power control methods to optimize EE for each user in a wireless network. On the scheduling side, a number of solutions have been devised, including selection of transmitting MTs, adaptation of transmission rates, and selection of cooperating BSs. With regard to the selection of transmitting.[1][2][4]

OBJECTIVE

- To resolve the transmission collisions with the help of backhaul rate.
- Improving throughput value in topology.
- Comparing the parameters.
- To control the utilized power effectively with the help of power adaptation algorithm.

II. EXISTING SYSTEM

Consider a SC-FDMA cellular system using CoMP with a rate-limited backhaul. Received signals are first quantized on a per-subcarrier basis and then forwarded on the backhaul to other BSs. In particular, to save backhaul rate, different BSs may use the same received signal quantized with different bits. Hence, an efficient method for sending various bit representations of a given signal is proposed. By combining reconstructed signals through a minimum mean square error (MSE) beamformer, the BS serving a given MT is able to increase the desired MT signal strength relative to ICI. With the aim of maximizing the network throughput we a) design the quantizers, and b) propose a greedy algorithm for the backhaul rate allocation. By observing that the received signal on each subcarrier is modeled as a complex Gaussian random process, we consider a non-uniform Gaussian quantizer and quantization noise is modeled as additional white Gaussian noise. We derive a closed-form expression of the network throughput, including the impact of residual ICI. In order to solve the problem of the backhaul rate allocation that maximizes the network throughput, we propose an iterative greedy approach. At each iteration we determine the number of bits required to quantize each signal not yet shared on the backhaul, and then we select the signal providing the maximum network throughput increase per backhaul bit. Regarding the number of quantization bits, two criteria are compared: static where the number of bits is fixed for all the signals, and *dynamic* where the number of bits is optimized ensure a predetermined network percentage throughput loss with respect to the case of unquantized signal. The iterative procedure is repeated until the backhaul is full. With respect the proposed solution introduces quantization, thus requiring a different backhaul occupation for each subcarrier signal shared by the BSs. Besides being more practical, this approach also modifies the backhaul rate allocation problem, introducing further flexibility on the amount of information shared among BSs. Numerical results for an uplink LTE scenario confirm that the proposed method adapts to channel and backhaul conditions very well.[7][8][9]

A. BS RECEIVED SIGNAL

In SC-FDMA, the bandwidth available for transmission is divided into N subcarriers. In turn, these subcarriers are grouped into S adjacent frequency sub-blocks (FSBs), each comprising M subcarriers, i.e., $N = SM$. Let $N = \{0, 1, . . ., N − 1\}$ be the set of available subcarriers, and $Ns = \{sM, sM + 1, . . . , sM + M − 1\}$ the set of subcarriers associated to FSB $s = 0, . . . , S − 1$. With reference to MT $k \in K$, we indicate with $N(k)$ the set of subcarriers allocated to MT k. Then, indicate with Kn =_ $k \in K : n \in N(k)$_ the set of MTs transmitting on subcarrier n.

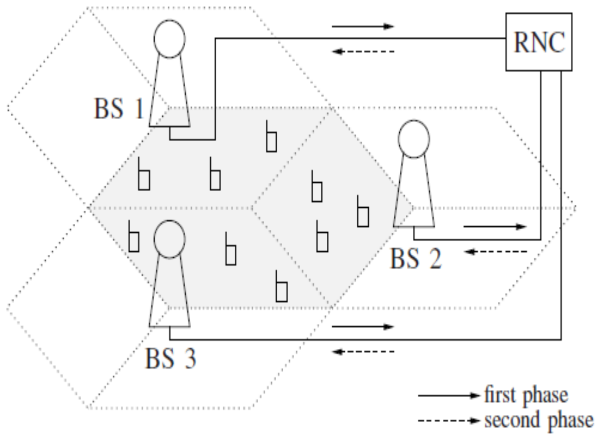

Figure 1. Considered cellular setup with 3 BSs.

As we are assuming single antenna devices, at most one MT is transmitting within each cell (i.e., for each set $K(j)$) on a given subcarrier: hence, no interference arises among the MTs anchored to the same BS.

B. BACKHAUL INFRASTRUCTURE

Cooperation among BSs is allowed thanks to a RNC which is connected to each BS by a zero latency and error free backhaul link as in Fig.3. 1. Hence, there is no direct connection between BSs. Assume that detection and decoding are distributed, i.e., BS $j \in J$ decodes all and only the messages sent by the MTs in $K(j)$. The exchange of received signals among the BSs on the backhaul follows a two phase scheme. In the first phase, BS j quantizes $Y\ (j)\ \ n$ for the subcarriers belonging to a subset of $k \in K(j)\ N(k)$ and a representation of the quantized values is forwarded to the RNC. In the second phase, the RNC sends the bits to the intended BSs.

Let us denote with $b(i,j)\ n \in$ N, $n \in N$, $i \in J$, $j \in J$, $i = j$, the number of bits used to represent at BS i signal $Y\ (j)\ n$ (2) received by BS j on subcarrier n, _$b(i,j)\ n$ /2_ for the real part and _$b(i,j)\ n$ /2_ for the imaginary part. The corresponding quantized signal received at BS i from the RNC is denoted by $Y\ (i,j)\ n$. Cooperation is limited by considering a constraint on the maximum rate that can be exchanged through the RNC on the backhaul. For simplicity, we assume that the same backhaul bandwidth is allocated to each of the two phases and denote with b(BH) the maximum number of bits that can be sent in the first phase and received in the second phase by each BS and for each SC-FDMA block.[10][11]

C. COMPOSITE BIT REPRESENTATION

An important backhaul rate reduction results if a suitable composite representation of the quantized signals is used. In fact, BS j may quantize the signal on subcarrier n for two BSs $i1$ and $i2$ using $b(i1,j)\ n$ and $b(i2,j)\ n$ bits. However, considering that both quantized signals are sent to the RNC and are obtained from the same signal $Y\ (j)\ n$, we can provide both quantization representations with fewer bits than $b(i1,j)\ n + b(i2,j)\ n$. For instance, if $b(i1,j)\ n = b(i2,j)\ n$, only one of the two signals is sufficient to reconstruct both and thus only one can be sent to the RNC. Note that if we were to represent a given signal with the maximum number of bits required by the other BSs, I would increase the backhaul rate in some links during phase two. In this section we illustrate this composite representation. With reference to subcarrier n, instead of simply sending $i \in J \setminus \{j\}\ b(i,j)\ n$ bits to the RNC, BS j defines a new composite quantizer that still allows the RNC to a) reconstruct each quantized signal $Y\ (i,j)\ n$, $i \in J \setminus \{j\}$, and b) send the corresponding bits to each cooperative BS in the second phase.[3][4]

D. STATIC BIT ALLOCATION (SBA)

With SBA, we assume that each subcarrier signal is quantized with a fixed number of bits b(sba). Therefore, we add the following constraint to

$$b = b^{(SBA)}$$

E. DYNAMIC BIT ALLOCATION (DBA)

With DBA, b is optimized with the aim of limiting the impact of quantization. In detail, we take as a reference the network throughput $\hat{R}$ $(\zeta t(+\infty))$ obtained with unquantized sharing of the signal of the tuple $(\bar{s}, \bar{i}, \bar{j}) \in Tt$. Then, we select the minimum number of bits that limits the loss on the network throughput to a maximum percentage α(dba) of the reference value. In formulas, we add the following constraint to

$$b = argmin\ b\_\hat{R}(\zeta t(b))$$

$$R(\zeta t(b)) - \hat{R}\ (\boldsymbol{b}t-1) \geq (1 - \alpha(\text{dba}))\times \$\ \hat{R}\ (\zeta t(+\infty)) - \hat{R}\ (\boldsymbol{b}t-1)$$

Moreover, when backhaul constraints and are not met, we assign to b the maximum integer value that satisfies both backhaul constraints. this a non linear integer optimization in only one variable and can be solved efficiently by employing the bisection method. However, the complexity of SBA is definitely lower than DBA by simply applying The algorithm stops when either the network throughput does not increase over two iterations, which denotes that no more bits can be allocated on the backhaul, or all the FSB signals have been shared among all the BSs after $SJ(J - 1)$ iterations.

III. PROPOSED SYSTEM

In uplink communication, a channel model for two mobiles cooperating to send their information to the base station is shown in Figure 4.1 This channel is quite similar to the full duplex user cooperative diversity channel. However, in cellular networks, the mobiles work in a half duplex mode. Hence, we consider a half-duplex transmission using time division where each transmission block is divided into 3 phases. While the base station

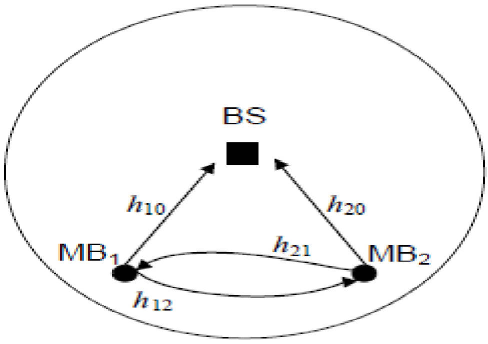

Figure 2. Channel model for two mobiles cooperating base station

is always in receiving mode, each mobile either transmits or receives during the first two phases and both transmit during the 3rd phase. The discrete-time channel model for this half-duplex uplink transmission can be expressed as follows.

phase 1 : $Y12 = h12X11 + Z1$, $Y1 = h10X11 + Z31$,
phase 2 : $Y21 = h21X22 + Z2$, $Y2 = h20X22 + Z32$,
phase 3 : $Y3 = h10X13 + h20X23 + Z33$,

where Yij , (i, j) 2 {1, 2}, is the signal received by the j^{th} mobile during the i^{th} phase; Yk, k 2 {1, 2, 3} is the signal received by the base station during the k^{th} phase; and all the Zl, l 2 {1, 2, 31, 32, 33}, are complex Gaussian noises with zero mean and unit variance. X11 and X13 are the signals transmitted from mobile 1 during the 1st and 3^{rd} phases, full receiver knowledge of the channel coefficient, the base station knows h10 and h20, mobile 1 knows h21 and mobile 2 knows h12. Moreover, each mobile knows the phase of its link to the base station which allows the mobiles to perform coherent transmission. We also assume each mobile knows if its link to the base station is weaker or stronger than the link to the other mobile. We assume block fading where the channel coefficients stay constant in each block through all 3 phases and change independently in the next block.[3][5][6]

A. FLOW CHART

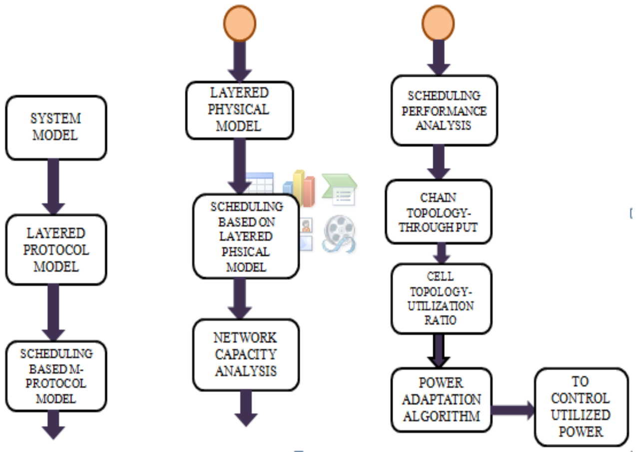

Figure 3. Flow chart

B. LAYERED PROTOCOL MODEL

- LPM is also called the M-protocol model. here M is a predefined system parameter.
- Performing packet transmission, to measure the performance of a scheduling scheme.The objective of a scheduling scheme is to allocate each link at least one slot.

C. SCHEDULING BASED M-PROTOCOL MODEL

- Allocating set of links.
- based on the M-protocol model, defining the IN difference of a link.
- The scheduling scheme has two major procedures are,
  - ➢ Link ordering
  - ➢ Slot allocation

D. LAYERED PHYSICAL MODEL

- Scheduling based on layered model, consist two major steps are
- Partitioning the plane.
- Feasible schedule is constructed

E. TRANSMISSION SCHEME AND ACHIEVABLE RATES
AN UPLINK COOPERATIVE MOBILE-TO-MOBILE SCHEME

Propose a mobile-to-mobile transmission scheme applied directly to the half-duplex uplink communication. The proposed scheme is based on rate splitting, superposition coding and partial decode-forward (PDF) relaying techniques. Each transmission block is divided into 3 phases with relative durations α1, α2 and α3 = 1 ρ α1 − α2. In each block, mobile 1 splits its information into a cooperative part (indexed by i) and a private part (indexed by j).

(i) *Quantifying the Delays from Adaptive Channel Switching Single-channel networks*.

We generated random unit-disk graphs with varying sizes, and varied the number of random connections for a network topology. For each choice of network size, number of connections and _ value, we perform 500 iterations of random topology and connection generation, plus LP formulation. Figure 3 shows numerical tradeoff curves under the same interference model. Figure 3a features a fixed network size of 100, and Figure 3b features a fixed number of flows equal to 8. Intuitively, as _ values increase, thereby loosening the delay constraint, the optimal throughput will rise; as the number of random connections increases, the optimization process gets more exploration space, yielding greater optimal network throughput. The saturation of the curves happens where the interference plays a major role through the constraint for stability in the LP.

(II) MULTI-CHANNEL NETWORKS.

The optimal throughput calculated by solving the LP's for grid topologies with 2-hop interference model on grid topologies. As expected, the total throughput increases as additional channels are equipped and delay bound is loosened. Saturation points are observed in both plots. Addition of channel resources alleviates the severance of interference, thus yielding a slower saturation process. Also, loosening the delay bound produces similar effects and the addition of channels make the optimization process to explore more of the delay bound.

F. REAL-WORLD IMPLEMENTATION AND PERFORMANCE

The previous sections have addressed the theoretical performance of cooperative networks, including some non-ideal assumptions such as limited backhaul bandwidth and channel uncertainty. In this section, we discuss these and other topics related to the real-world implementation of cooperative techniques in cellular networks. We discuss the practical aspects of system implementation and present system-level simulations and prototypes which hint at the potential and problems of real-world cooperative cellular networks.

G. PROTOTYPES AND TESTBEDS

The feasibility of cooperative techniques has been demonstrated in "over-the-air" networks of limited size. The proposed system showed significant gains in mean sum-rate capacity (as a function of measured SINR) compared to a conventional time-multiplexed baseline. Two outdoor testbeds for implementing network coordination have been developed under the EASY-C project (Enablers for Ambient Services and Systems Part C- Cellular networks), a collaboration between academia and industry for the research and development of LTE-Advanced technologies. One testbed in Berlin, Germany, consists of four base station sites (seven sectors) connected through a high-speed optical fiber network. An even larger testbed consists of ten base station sites (28 sectors) distributed in downtown. Network coordination has been recently demonstrated over limited portions of each testbed. Using two distributed base antennas and two users, the Berlin testbed demonstrated downlink network coordination for an FDD LTE trial system. It accounted for many practical implementation aspects including synchronization.[7][8][9]

IV. NETWORK SIMULATOR

A. INTRODUCTION

A network simulator is a software program that imitates the working of a computer network. In simulators, the computer network is typically modeled with devices, traffic etc and the performance is analyzed. Typically, users can then customize the simulator to fulfill their specific analysis needs. Simulators typically come with support for the most popular protocols in the use today, such as Wireless LAN, Wi-Max, UDP, and TCP.

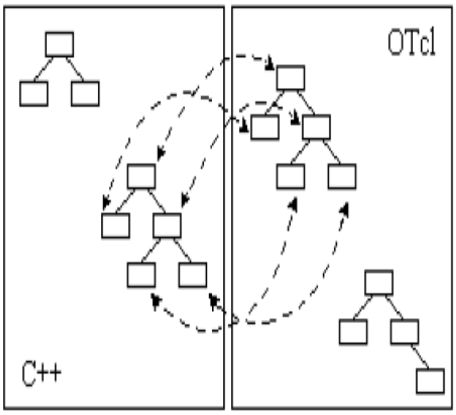

Figure 4. Flow chart for C++ and OTcl

A network simulator is a piece of software or hardware that predicts the behavior of a network, without an actual network being present. NS is an object oriented simulator, written in C++, with an OTcl interpreter as a frontend. The simulator supports a class hierarchy in C++ and a similar class hierarchy within the OTcl interpreter. The two hierarchies are closely related to each other; from the uses perspective, there is one-to-one correspondence between a class in the interpreted hierarchy and one in the compiled hierarchy. The root of this hierarchy is the class Tcl object. Users create a new simulator objects through the interpreter; these objects are instantiated within the hierarchy. The interpreted class hierarchy is automatically established through methods defined in the class Tcl object. There are other hierarchies in the C++ code and OTcl scripts; these other hierarchies are not mirrored in the manner of Tcl object.

B. USES OF NETWORK SIMULATORS

Network simulators serve a variety of needs. Compared to the cost and time involved in setting up an entire test bed containing multiple networked computers, routers and data links, network simulators are relatively fast and inexpensive. They allow engineers to test scenarios that might be particularly difficult or expensive to emulate using real hardware- for instance, simulating the effects of sudden bursts in the traffic or a Dos attack on a network service. Networking simulators are particularly useful in allowing designers to test new networking protocols or changed to existing protocols in a controlled and reproducible environment. various types of Wide Area Network (WAN) technologies like TCP, ATM, IP etc and Local Area Network (LAN) technologies like Ethernet, token rings etc, can all be simulated with the typical simulator and the user can test, analyze various routing etc.

C. NETWORK SIMULATOR 2 (NS2)

NS2 is an open- source simulation tool that runs on Linux. It is a discreet event simulator targeted at networking research and provides substantial support for simulation of routing, multicast protocols and IP protocols, such as UDP, TCP over wired and wireless (local and satellite) networks. It has many advantages that make it useful tool, such as support for multiple protocols and the capability of graphically detailing network traffic. Additionally, NS2 supports several algorithms in routing and queuing. Queuing algorithms include fair queuing, deficit round-robin and FIFO. REAL is a network simulator originally intended for studying the dynamic behaviour of flow and congestion control schemes in packet switched data network. NS2 is available on several platforms such as FreeBSD, Linux, Sim OS and Solaris. NS2 also builds and runs under Windows.

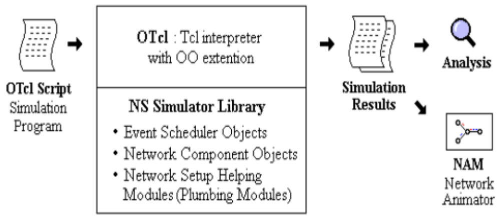

Figure 5. Simplified user's view of NS2

V. SIMULATION AND RESULTS

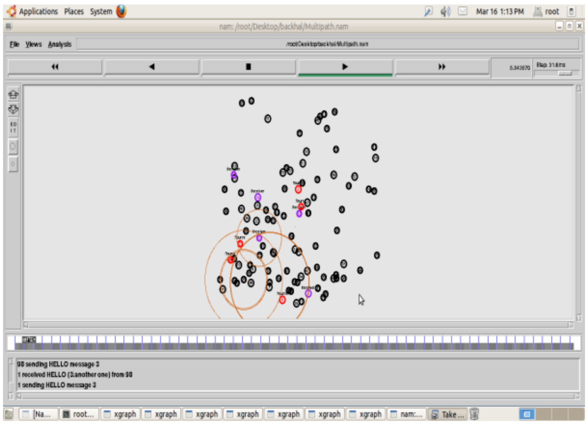

Figure 6. Communications between Different Types of Nodes

Assign to *b* the maximum integer value that satisfies both backhaul constraints. Note that is a non linear integer optimization in only one variable and can be solved efficiently by employing the bisection method. However, the complexity of SBA is definitely lower than DBA by simply applying. The algorithm stops when either the network throughput does not increase over two iterations, which denotes that no more bits can be allocated on the backhaul, In Algorithm 1, denotes the final solution. Note that the number of bits *b*(sba) used to quantize each signal in SBA (and similarly *α*(dba) in DBA) defines a trade off between the number of subcarrier signals exchanged on the backhaul and their precision.

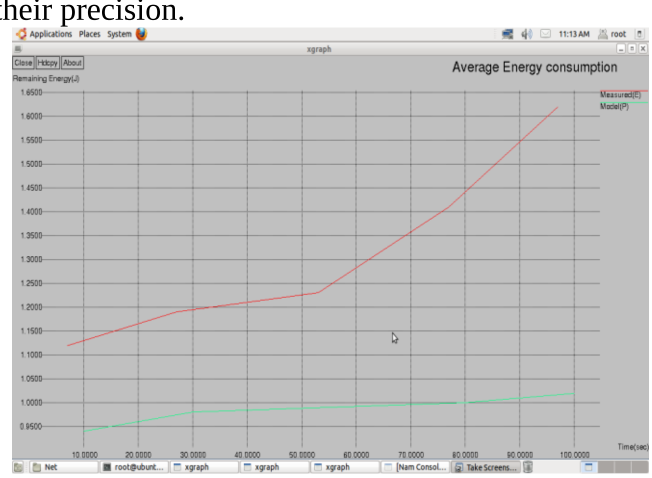

Figure 7 Comparison between and proposed and existing system in Energy value

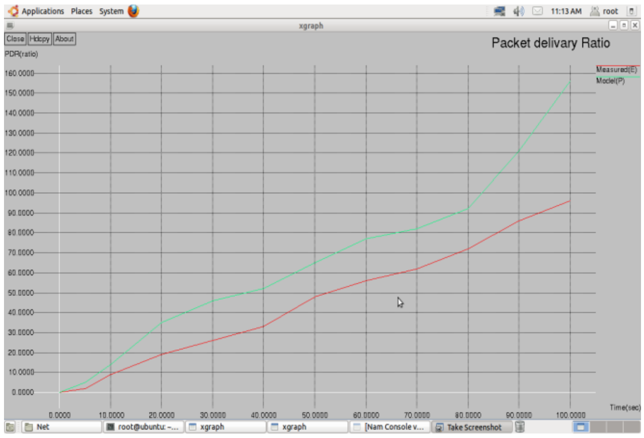

Figure 8 Comparison between and proposed and existing system in PDR

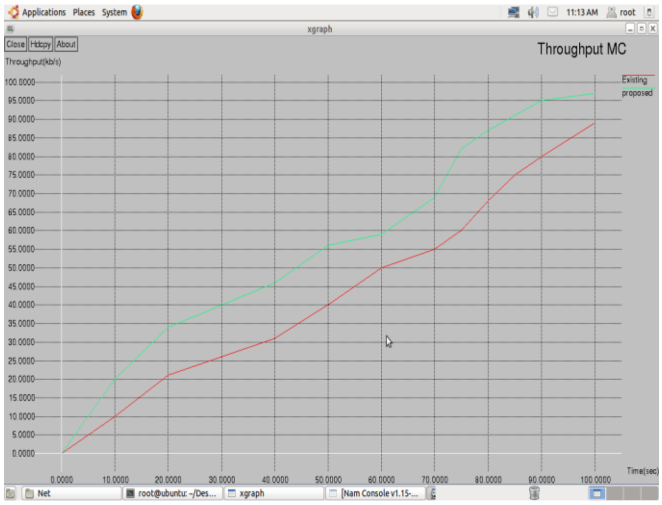

Figure 9 Comparison between and proposed and existing system in Throughput

VI. CONCLUSION AND FUTURE WORK

Uplink resource allocation strategies in modern cellular networks are studied in this thesis. With the presence of multiple antenna transmission, multiple base station (BS) coordination and multicarrier techniques, the resource allocation problem is reformulated and jointly optimized over a large set of variables. The focus is on the sum power minimization with per user rate constraints. A centralized multicarrier coordinated cellular network with multiple antennas implemented at the BS side is considered, where BSs can be adaptively clustered to detect signals from one mobile station (MS). Analyze both the common and individual outage probabilities of the proposed scheme over Rayleigh fading channels, taking into account outage at the mobiles and the base station. I provide numerical results comparing outage performance between the proposed cooperative scheme and the classical non-cooperative MAC. Results show significant improvement in outage performance for all ranges of practical interest.

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