

# Presentation Scrutiny of Portable Information Off-Load During Wide Band Telecommunication System

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**ABSTRACT:** In this paper we recommend a queueing analytic mannequin that can be used to understand the efficiency improvements workable through WiFibased data offloading, as a function of WiFi availability and performance, user mobility and traffic load, and the insurance policy ratio and respective rates of one of a kind cell technologies to be had. We validate our concept in opposition to simulations for realistic scenarios and parameters, and provide some initial insights as to the offloading positive factors expected in apply. This paper is the first to endorse a framework for efficient allocation of periodic feedback channels to the nodes of a wi-fi network. A couple of imperative optimization issues are outlined and efficient algorithms for solving them are provided. A scheme for deciding when the base station (BS) should invoke every algorithm is also proposed and proven by means of simulations to participate in very well.

**KEYWORDS:** Channel state information, wireless networks.

## I. INTRODUCTION

An enormous growth in the cell knowledge site visitors has been suggested. This increase in traffic demand is due to a tremendous penetration of smartphones and drugs out there, as good as internet 2.Zero and streaming applications which have high-bandwidth specifications. Furthermore, Cisco reviews that via 2019 the cellular information visitors will increase by way of 10 occasions in comparison with 2014, and will climb to 24.3 exabytes per month. Mobile video traffic will include seventy two% of the total traffic, in comparison with fifty five% in 2014 .This increase in visitors demand is overloading the cellular networks (chiefly in metro areas) forcing them to operate practically their capacity limits inflicting a big degradation of person experience. Possible options to this drawback would be the complete upgrade to LTE or LTE developed, as well as the deployment of extra network infrastructure .Nonetheless, these solutions might not be fee-potent from the operators point of view: they suggest an multiplied price (for vigour, place rents, deployment and upkeep), without similar revenue increases, due to flat rate plans, and the fact that a small quantity of customers consume a gigantic quantity of traffic (3% of customers devour forty% of the site visitors). Hence, LTE has simplest been sporadically deployed, and it's uncertain whether providers will decide upon to upgrade their current deployments, and if in fact the additional capability would suffice A more fee-strong way of alleviating the problem of totally congested mobile networks is with the aid of offloading one of the most traffic via Femtocells and WiFi. To attain excessive throughput in wi-fi networks, the transmitter desires to acquire up to date knowledge about the channel nice located through the receiver. To this finish, evolved wireless specifications require each cellular station (MS) to periodically transmit to the bottom station (BS) its Channel nice Indicator (CQI). CQI is a measure of the downlink mobile channel and is used by the BS to adapt the modulation and coding parameters to the channel fame of the corresponding node. These measurements additionally play a foremost role within the BS's scheduling algorithm. When multiple-input-multiple-output (MIMO) technological know-how is integrated into 4G wi-fi networks, the quantity of suggestions that must be transmitted from the MSs to the BS increases dramatically. Within the MIMO closed-loop spatial multiplexing mode, for illustration, this feedback includes the Rank Indicator (RI), the Precoding Matrix Indicator (PMI), and the CQI. The BS makes use of the PMI reports to assess how the precoding matrix must be configured for transmission. The RI experiences point out the quantity of

MIMO transmission layers on hand to the reporting MS. All these indicators require quite a few highly-priced uplink bandwidth, most likely because they're despatched periodically as lengthy as there's transmission on the downlink channel. This high priced bandwidth is very most often viewed as a predominant difficulty to the deployment of MIMO and other advanced closed-loop wi-fi applied sciences. Consequently, the uplink bandwidth to these warning signs ought to be allotted very carefully, whilst reaching special optimization goals.

The rest of this paper is organized as follows. In Section II, we discuss related work. In Section III, we show how to allocate slots to CSI channels using a complete binary tree, in order to guarantee an efficient collision-free allocation, and describe the considered CSI channel allocation model. Section IV is the core of the paper. It defines the CSI allocation problems and presents efficient algorithms for them. In Section V, we study the performance of the various algorithms and present a complete BS scheme for the allocation of CSI channels. Finally, Section VI concludes the paper.

## **II. RELATED WORK**

Prior works have addressed aspects of the trouble rather than the one we tackle here. For illustration, except for and previous works have now not attempted to adjust the periodicity of the CQI reports to the exact needs of each and every MS. Alternatively, they've tried to lessen the rate of the CQI stories by means of:

- 1) no longer sending CQI reviews if the channel has no longer drastically changed
- 2) sending a single CQI report to a bunch of MSs or

3) sending a single CQI report for a subset of OFDM subchannels All these works are Orthogonal to the scheme and algorithms offered in this paper.

## **III. PRELIMINARIES**

### **A. CSI CHANNELS**

Resolution-making schemes that might make a decision to not ship special CSI reports e.G., if the channel condition has no longer modified mainly, can't without problems take knowledge of the unused slots. That is considering that these slots are too quick for ordinary packets and considering the MS cannot depend on their availability. The procedure taken via our paper is unique in the feel that the BS allocates exclusive bandwidth to special CSI channels in response to each and every channel's individual revenue operate. Making use of the scheme we recommend, the BS views the CSI bandwidth (i.E., the uplink bandwidth dedicated to the CSI channels) as a shared useful resource, to be dynamically allocated to the MSs. The BS may alter the size of this useful resource. A perfect-channel consists of one slot in every uplink frame [Fig. 1(a)].

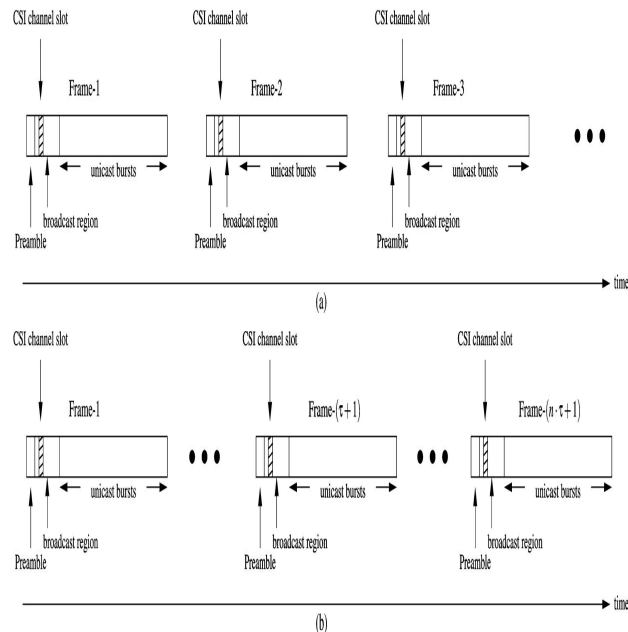


Fig. 1. (a) CSI super-channel consists of the same slot in every uplink OFDMA frame. (b) CSI channel consists of the same slot in every  $r=2i$  frames.

$r$  frames [Fig. 1(b)]. This paper presents algorithms for the division of an ideal-channel into more than one channels and for the allocation and deallocation of these CSI channels. To allocate a CSI channel, the BS sends to an MS a control message with the following parameters:

- 1) the sequence quantity of the first frame that includes a slot of this channel;
- 2) the number of frames between two consecutive slots of this channel;
- 3) the time throughout which this CSI channel is allocated to the MS. The BS might also allocate the channel and not using a expiration time, and then explicitly request it back. A CSI channel is  $C_j$  denoted  $\alpha_j \tau_j$ , where  $\alpha_j$  is the  $\alpha_j$  sequence number of the first body that includes a slot of this channel and  $\tau_j$  is the periodicity of the slots. A smaller value of  $\tau_j$  method more prevalent CSI studies, which CSI stories, which furnish the BS with more correct expertise concerning the channel state of the corresponding MS. Nonetheless, if  $\tau_j$  is just too small, the BS is more likely to acquire too many identical CSI reviews. For this reason, the highest quality value of  $\tau_j$  is dependent upon the steadiness of the channel, which is littered with many reasons equivalent to MS mobility velocity, bodily boundaries, climate conditions, interference from other BSs/MSs, or different wi-fi networks.

### B. POWER-OF-2 ALLOCATION

A vigour-of-2 allocation is an allocation of CSI channels for  $\tau = 2^i$  Which holds for every channel, the place  $i$  is an integer between 0 and  $C$ . Such an allocation is useful because it may hinder collisions between slots of two unique CSI channels.

*Definition 1* Two or extra CSI channels are stated to collide in the event that they include the identical slot. In other phrases, a collision occurs between  $\alpha_1 | \tau_1$  and  $\alpha_2 | \tau_2$  if for some integers  $x > 0$  and  $y > 0$ ,  $\alpha_1 + \tau_1 \cdot x = \alpha_2 + \tau_2 \cdot y$ .

We now show how a power-of-2 allocation may also be performed when the bandwidth of each tremendous-channel is maintained making use of a whole binary tree  $T_c$  whose height is  $C$ . We Consult with this type of tree as a CSI allocation tree. Then, we will see how such an

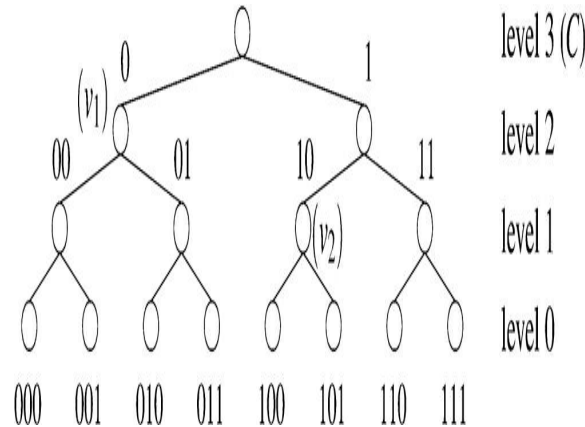


Fig. 2. Example of a labeled CSI allocation tree for a super-channel.

Allocation can also be guaranteed to be collision-free. The leaves of  $T_c$  are in degree 0, their parents are in level 1, and so forth. We assign a label to every tree node within the following way. For a node in level  $l$ , the assigned label consists of  $C-l$  digits from which the first  $C-l-1$  are the same as of the node's parent and the last digit is set to 0 for a left child or to 1 for a right child. Fig. 2 gives an example.

Let  $r$  be the reversed label of node  $v$  in the tree, and  $d(r)$  be the decimal value of  $r$ . Then, node  $v$  is the root of a subtree whose height is  $l$  associated with the CSI slots  $d(r)|2^{C-l}$ . For example, node  $v_1$  in the tree of Fig. 2 is the root of a subtree whose height is 2 associated with the CSI slots  $0|2^2$ , while node  $v_2$  is the root of a subtree whose height is 1 associated with the slots  $1|4$ . We now prove that if each root-to-leaf path in the allocation tree has at most one allocated node, then the CSI channels represented by the tree do not collide. For instance, consider the two trees in Fig. 3 and suppose that the black nodes indicate allocated slots. In both trees, there is at most one allocated node on every root-to-leaf path. By Lemma 1, this indicates that the CSI channels represented by the allocated tree nodes are collision-free. The fraction near every black node indicates the fraction of the super-channel bandwidth assigned to the corresponding CSI channel.

**Lemma 1:** Two nodes of a CSI allocation tree are on the same root-to-leaf path if and only if their corresponding slots collide.

*Proof:* Consider node  $v_1$  in level  $l_1$  and node  $v_2$  in level  $l_2$  of the tree. Without loss of generality, let  $l_1 > l_2$ . Recall that

the corresponding CSI slots of  $v_1$  and  $v_2$  are  $d(r_1)|2^{C-l_1}$  and  $d(r_2)|2^{C-l_2}$  and

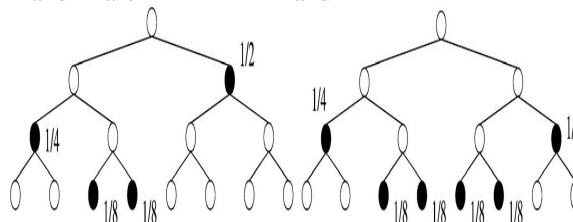


Fig. 3. Examples for two collision-free allocations.

frame# 1 1+1 1+2 1+3 1+4 1+5 1+6 1+7 1+8 1+9 1+10 1+11 1+12 1+13 1+14 1+15

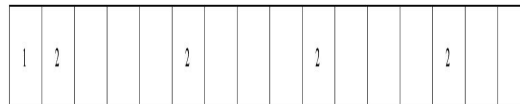


Fig. 4. Fragmentation of a CSI channel.

$d(r_2) | 2^{C-l_2}$ , where  $r_1$  and  $r_2$  are the reverse labels of  $v_1$  and  $v_2$  respectively.

If  $v_1$  and  $v_2$  are on the same root-to-leaf path, the last  $C - l_1$  digits of  $r_1$  and  $r_2$  are identical. Therefore, there exists an integer  $x$  such that  $d(r_1) + 2^{C-l_1} \cdot x = d(r_2)$ , implying that

the corresponding CSI slots of  $v_1$  and  $v_2$  collide. If  $v_1$  and  $v_2$  are not on the same root-to-leaf path, the last  $C - l_1$  digits of  $r_1$  and  $r_2$  are different. Therefore, for every two integers  $x$  and  $y$ ,  $d(r_1) + 2^{C-l_1} \cdot x \neq d(r_2) + 2^{C-l_2} \cdot y$  holds.

### C. CSI ALLOCATION FRAMEWORK

Following the discussion above, we now describe our requirements from a CSI allocation framework:

R1) Collisions and fragmentation of CSI channels are not allowed. Therefore:

- a) a super-channel is divided into multiple CSI channels using a complete binary tree;
- b) each CSI channel consists of at most one tree node, which is the root of a subtree;
- c) subtrees allocated to different CSI channels are mutually disjoint.

R2) For each tree level  $l$  and  $MS_j$ , a profit function  $P_j(l)$  indicates the “profit of the system” from allocating

this CSI channel to this MS. While our framework is general enough to address every  $P_j$  function, throughout the paper we focus on the following specific one:

$$P_j(l) = \begin{cases} E_j \cdot 2^{(l_j^{MAX})}, & \text{if } l > l_j^{MAX} \\ E_j \cdot 2^{(l)}, & \text{otherwise.} \end{cases}$$

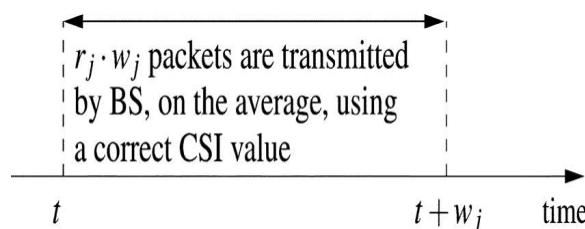


Fig. 5. Consecutive packets transmitted to using correct CSI value.

#### IV. ALGORITHMS FOR CSI ALLOCATION

##### A. OPTIMIZATION CRITERION

In this section, we address the following problems related to the CSI allocation framework described in Section III:

- 1) how to allocate bandwidth to CSI channels when a tree (super-channel) is empty;
- 2) how to reallocate the bandwidth of a released CSI channel;
- 3) how to allocate a CSI channel to a new MS when the available CSI bandwidth is fragmented;
- 4) how to change the bandwidth of a CSI channel in order to take into account changes in the profit function of some MS(s), e.g., due to a new mobility pattern.

We first present algorithms for the various cases and then combine them into a scheme that indicates when each algorithm should be executed by the BS.

##### B. CSI ALLOCATION WHEN THE TREE IS EMPTY

We start with the basic problem, where we assume that the tree is empty and the goal is to find the best allocation for a given set of active MSs. This problem is referred to as Collision-Free CSI allocation in an Empty tree (CF-CSI-E) and is formally defined as follows:

###### Problem 1 (CF-CSI-E):

**Instance:** The height of the allocation tree and the profit function for every active .

**Objective:** Find an allocation of CSI channels to the active MSs such that the total profit is maximized.

**Algorithm 1:** (An algorithm for CF-CSI-E)

- 1) Reduce the CF-CSI-E instance to an MCKP instance as described above.
- 2) Run an algorithm, , that finds a solution to the MCKP instance.
- 3) Translate the solution returned by to a solution for CF-CSI-E, such that a CSI channel is allocated a tree node in level if item in class is chosen for the MCKP solution.

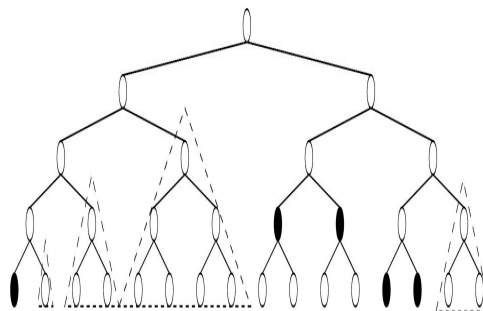


Fig. 6. CSI tree with its four max-free subtrees (black nodes are occupied).

###### Problem 2 (CF-CSI-NC):

**Instance:** The height of the allocation tree , the profit function for every active , and information about already allocated CSI channels.

**Objective:** Allocate the unused CSI bandwidth such that the gained profit is maximized.

**Algorithm 2:** (An algorithm for CF-CSI-NC)

- 1) Reduce the CF-CSI-NC instance to an MC-MKP instance as described above.
- 2) Run an algorithm, , that finds a solution for the MC-MKP instance.
- 3) Translate the solution returned by to a solution for CF-CSI-NC, such that a CSI channel is allocated a tree node in level of subtree if item in class is packed in knapsack of the MCKP solution.

**Lemma 3:** If is an  $\epsilon$ -approximation to MC-MKP, Algorithm 2 is an  $\epsilon$ -approximation to CF-CSI-NC.

**Algorithm 3:** (A 2-approximation greedy algorithm for MC-MKP)

- 1) For each class with items, create new items,



the first of which is the first item from . For each item , the weight and profit are and, respectively. From now on, the algorithm relates to the new generated items.

2) Sort the new items in decreasing order of their efficiencies (profit divided by weight).

3) Go over the knapsacks in increasing order of capacity. For each knapsack, try to pack items in decreasing order of their efficiencies (only items whose weight is smaller than the current knapsack capacity are considered). The first item that does not fit into knapsack is called the split item for and denoted .

4) Return the maximum between the items packed so far and the solution obtained by packing of in knapsack .

*Lemma 4:* Algorithm 3 is a 2-approximation to MC-MKP.

*Proof:* Consider the linear relaxation of a given MC-MKP instance. The total profit of the optimal solution for the linear relaxation is not smaller than that of the MC-MKP instance. Therefore, proving that Algorithm 3 is a 2-approximation with respect to the linear relaxation will complete the proof.

## V.SIMULATION STUDY AND A COMPLETE BS SCHEME

We now present Monte Carlo simulation results of the various algorithms introduced in the paper. The goal of this section is twofold:

- to investigate the performance of these algorithms;
- use the simulation results to develop a complete BS allocation scheme that indicates when the BS should invoke each algorithm.

### A.Performance of Algorithms 1 and 2

We first compare Algorithm 1 to an algorithm that allocates only level-0 CSI channels (i.e., only tree leaves). As far as we

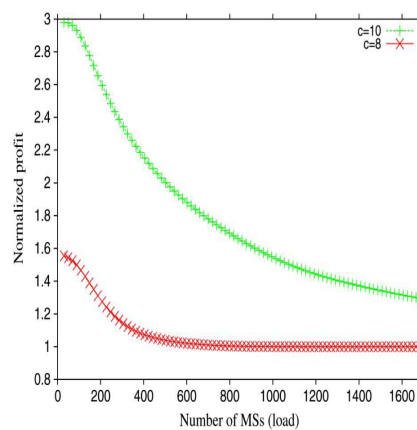


Fig. 7. Normalized profit of Algorithm 1 versus the number of MSs (load).

know, this is the common scheme used today by BS. We consider up to 1600 active MSs. For each number of MSs, we repeat the simulation 1000 times with different seeds and average the results. In Fig. 7, the x-axis indicates the number of active MSs (load), and the y-axis indicates the normalized profit obtained by Algorithm 1, i.e., the profit obtained by Algorithm 1 divided by the profit obtained by an algorithm that allocates only level-0 CSI channel to each MS

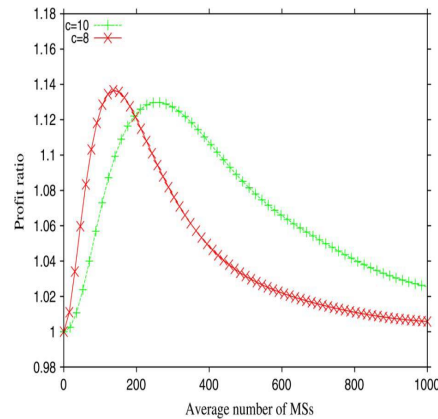


Fig. 8. Total profit of Algorithm 1 divided by total profit of Algorithm 2 versus the number of MSs (load).

**B.COMPLETE BS SCHEME**

We now combine Algorithms 1 and 2 into a complete allocation scheme for the BS. An action is required from the BS in the following cases:

- 1) a new MS becomes active;
- 2) an active MS leaves the cell or becomes inactive;
- 3) the profit function of an active MS changes (e.g., due to a change in the user mobility speed). Algorithm 2 allows an increase in the profit without the overhead associated with the removal of existing CSI channels.

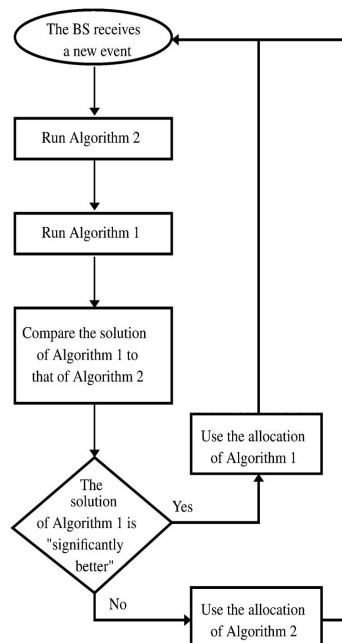


Fig. 9. Complete BS scheme (scheme 1).



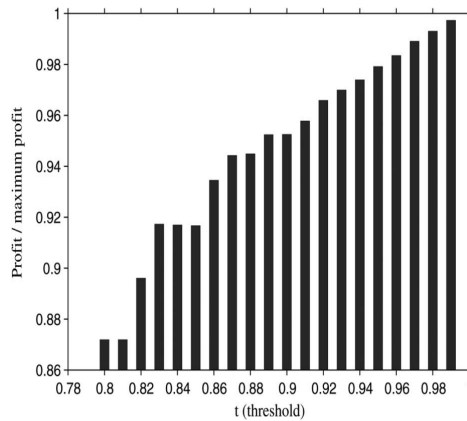


Fig. 10. Profit achieved by the proposed scheme divided by the maximum profit that can be achieved using Algorithm 1, as a function of the threshold .

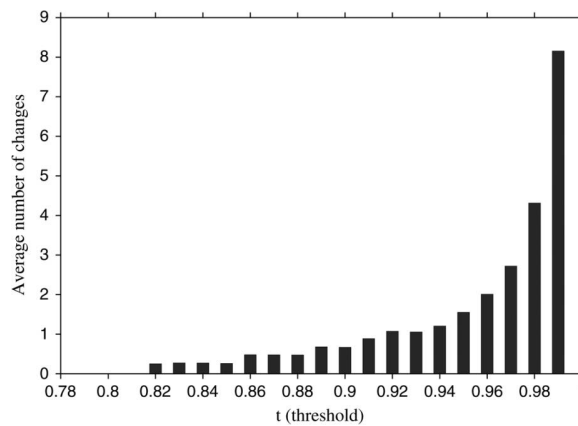


Fig. 11. Average number of changes per event of the proposed scheme as a function of the threshold .

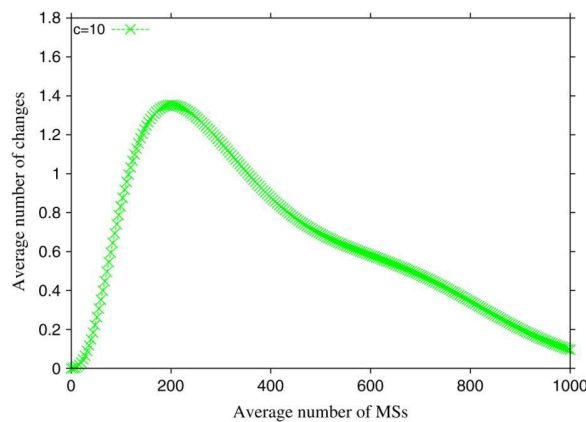


Fig. 12. Average number of changes per event of the proposed scheme as a function of the average number of MSs for .

Given an allocation tree, we define the *fragmentation index* as the number of leaves in the biggest max-free subtree divided

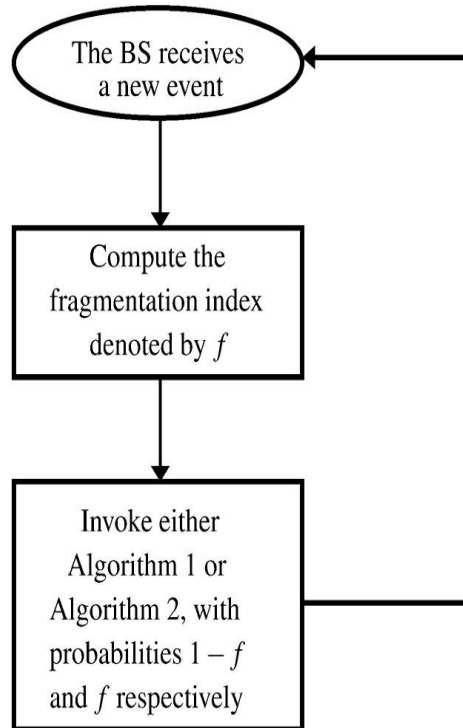


Fig. 13. Adapted BS scheme (scheme 2).

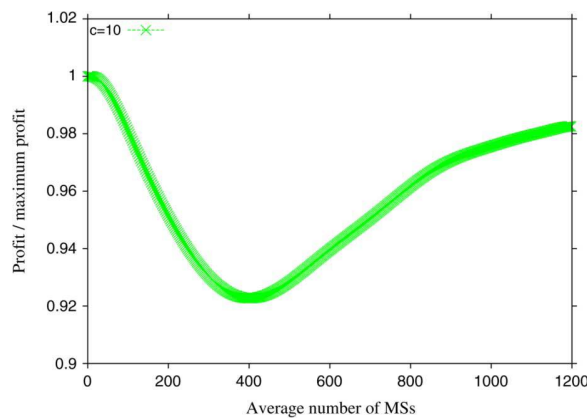


Fig. 14. Normalized profit achieved by scheme 2 versus the average number of MSs (load). by the total number of leaves in all max-free subtrees. For example, if there are max-free subtrees, and each of them is a leaf, then the fragmentation index is . The adapted scheme computes the fragmentation index and invokes Algorithm 1 with probability that is inverse proportional to this index. The modified scheme is shown in Fig. 13, which now replaces Fig. 9.

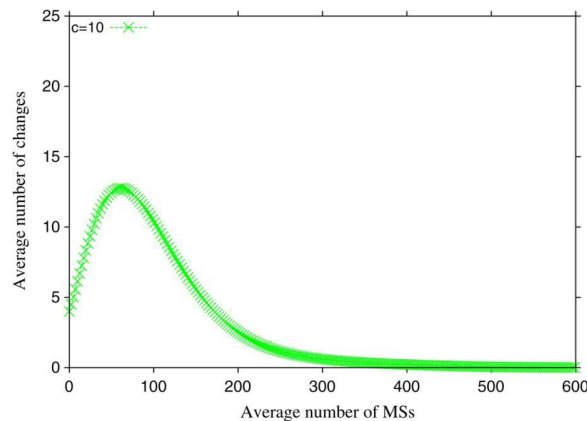


Fig. 15. Average number of changes per event of scheme 2 versus the number of MSs (load).

Thus, we see that the normalized profit decreases. As the load increases further, we are more likely to have many pending MSs with high values. Therefore, the tree is unlikely to be fragmented (in most cases only one node is free), and the profit ratio increases. A comparison between Figs. 15 and 12 reveals that the average number of changes for scheme 2 is bigger than for scheme 1 when the load is light (less than 175 MSs in this concrete example). However, it is important to note that under light load, both Algorithms 1 and 2 are very fast because their running times are linear with the load. Therefore, scheme 1 can be invoked for light loads, and scheme 2 for heavy loads.

#### IV. CONCLUSION

We presented a formal framework for the allocation of periodic CSI channels. In the proposed framework, the allotted bandwidth is maintained as a tree. Every MS is related to a revenue operate that suggests the “profit of the system” from allocating a CSI channel of precise bandwidth to this MS. We defined two optimization issues for this framework and proposed foremost polynomial-time algorithms for them. Our simulation be trained shows how the proposed algorithms may also be mixed into a unified scheme, to be invoked by using the BS when a new event takes position. Some of the important points of the proposed scheme is the definition of the revenue operate to be optimized by way of the BS.

On this paper, we used a operate whose intention is to maximize the quantity of packets sent utilising the correct CSI value. We feel that other features with different parameters should even be studied, and we go away this for future work.

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**International Journal of Innovative Research in Science, Engineering and Technology***An ISO 3297: 2007 Certified Organization**Volume 6, Special Issue 2, February 2017***National Conference on Recent Advancements in Engineering & Technology and Management 2017 (NCRAETM 2K17)****18<sup>th</sup> February 2017****Organized by****Sree Rama Engineering College (SRET), Tirupati- 517 507, India**

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