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RESEARCH ARTICLE

Design of Power and Rate Adaptation with Scheduling In Wireless Networks Based On SIC

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Abstract— To properly evaluate the usage of SIC, a joint design of power and rate adaptation algorithm with scheduling in wireless networks is to be analyzed.SIC (Successive Interference Cancellation) is an effective way of multiple packet reception (MPR) to fight with interference in wireless networks. Power management and high data rate is an important problem in wireless networks. With the help of SIC these problems are investigated. The link scheduling and power adaptation will minimize the total transmission power in a network and rate adaptation algorithm will minimize the high data rate in a network. The main objective is o improve the performance (QoS) of a network topology. Joint design of power and rate adaptation with scheduling has great potential to increase the throughput gain and successful delivery of packets and capacity in wireless networks. Performance of proposed scheme has been verified using network simulator to show that the approach is efficient

Keywords— Link Scheduling; Multiple Packet Reception; Power Adaptation; Rate Adaptation; Successive Interference Cancellation; Throughput

I. INTRODUCTION

Wireless networks are interference limited in which the performance depends on the success in managing the interference. Due to the broadcast nature, what arrives at the receiver is a composite signal consisting of all near-by transmissions. However, the receiver tries to decode only one transmission by regarding all the others as interference and noise. When the arrivals of multiple transmissions overlap, collision occurs and the reception fails multiple packet reception (MPR) is a promising technique at the physical layer to combat the interference. When the links interfering with each other transmit simultaneously, a receiver node can separate the collided signals with the MPR capability. MPR can significantly increase the capacity of a Wireless network shown in [1], [2], and [4]. SIC is an effective way of MPR to combat interference in wireless networks. To resolve the transmission collision in MPR, the successive interference cancellation is an effective way [3].Dealing with interference is one of the major problems in wireless networks.

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There are two major interference models such as layered protocol model and the physical model introduced in [5].SIC in wireless networks mainly focus on link scheduling is nothing but process of deciding how to commit packets between the variety of possible nodes and also presenting joint design of power and rate adaptation with scheduling in wireless networks to properly evaluate the usage of SIC. Power and rate adaptation is important in wireless networks for at least three reasons: (1) improving the performance of a network topology in terms of successful delivery of packets and throughput. (2) To minimize the power consumption in network topology and maximizing the capacity of a network and reducing the interference. (3)To minimize the high data rate, to improve the throughput and reducing the packet loss

The overview of this paper can be stated as follows: Division II overviews of the related work and division III describe the present work. Division IV analyses the simulation results and finally, we conclude the research in Section V.

II. RELATED WORK

It is a fundamental issue to handle the interference and power, rate adaptation in wireless networks. Here we summarize only some of the works closely related for our research.

MPR: for characterizing the influence of sic, in the literature there are two interference models proposed in [5]. MPR is deals with these protocol models by increasing the number of permitted interferers, at that same time the physical model is enriched by allowing the reception with lower SINR threshold. The earliest MPR technique is multi-user detection [6], which attempts to extract all involved transmissions from the composite received signal.

Interference: interference is anything which alters, modifies, or disrupts a signal as it travels along a channel between a source and a receiver. The term typically refers to the addition of unwanted signals to a useful signal. There are several different ways to perform interference cancellation (IC) [7]: parallel, successive, and hybrid. The parallel IC iteratively detects all signals at once, while the successive IC detects the signals sequentially. The hybrid IC is a combination of the two. Among them, successive interference cancellation (SIC) is the simplest one, whose effectiveness in ad hoc networks has been already, verified experimentally [8].

Scheduling and power, rate adaptation: interference-aware scheduling is a major issue [8]. The famous link interference models are protocol and physical models in [5], are proposed originally for networks with single packet reception. Joint power adaptation and scheduling in wireless networks are discussed in [9].Auto-Selecting the Rate Adaptation Algorithm in Wireless Networks [11].

III. PRESENT WORK

A. SYSTEM MODEL: Consider a wireless network of N stationary nodes, labelled by the integers 1,2,……..,N [9]. A set of transmission links L, among the possible N(N-1) links between nodes, make a network topology. These active links are chosen based on the distance between the nodes, signal to interference noise ratio (SINR). For simple understanding in this paper analysing that two nodes constitute a link if the distance between them is less than a threshold. The given link L = (u,v) , here the transmission node u, uses a signal power P(L).

The 'path gain' from node u to node v is given by G(u,v). The transmitting and receiving nodes of a link L are denoted by T(L) and R(L) respectively. The received signal power at the node R(L) from T(L) is given by P(L)G(T(L),R(L)). However the signals entering from other transmitters appear the receiver R(L) as interference or noise is cancelled by SIC (successive interference cancellation). The SINR (signal to interference noise ratio) of a link L is defined as,

$$\gamma(L) = \frac{G(T(L),R(L)P(L)}{\sum_{k \neq 1} P(k)G(T(k),R(L)) + nR(L)} \qquad (1)$$

Where n_u is the noise power at node v. Next assume that the efficient bandwidth of channel L is W(L).Assuming gaussian noise plus interference, the maximum mutual information of link L will be X(L) = W(L).$\log_2(1+\gamma(L))$. In a low power activity, the SINR value γ(L) is very small.for that using the linear approximation for log function and obtain

$$X(L) = W(L).\ \gamma(L) \quad (2)$$

1) SCHEDULING:

Performing the scheduling between the nodes are considered as a link. In which each link is divided into several time slots with each of equal duration and the transmission is starting and ending on slot boundaries. Introducing the notation , let as X_t(L) and P_t(L) be the data rate for link L in slot t, the transmission power for the transmitter T(L) for link L in slot t, respectively. Figure 1 shows the scheduling based on successive interference cancellation.

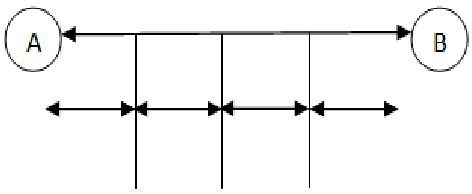

FIGURE 1 : **Scheduling**

2) POWER ADAPTATION:

To properly evaluate the usage of SIC power adaptation is important in wireless network.The main objective of our work is to find the solution for minimum power consumption. So, to minimize the power consumption, the maximum power of each node has to be fixed and have to calculate the total transmission power of a link between the nodes. Let,

$$Pt=(Pt(1),Pt(2),\ldots.,Pt\ (L_\varepsilon)). \quad (3)$$

Pt be the network power vector for slot t. Let $P^{\max(u)}$ be the maximum transmission power for node u. also let ε (u) be the linkks in ε that initiate at node u. Always the total transmission power of a link should be less than the maximum power of each node.In case of greater power between the nodes there will be wastage of power, to overcome this power wastage power adaptation algorithm is analyzed. Each node must conform to the peak transmission power constraint in each slot:

$$0 \le \sum_{L\in\varepsilon(u)} P_t(L) \le P^{\max(u)}$$

$$0 \le P_t(L)\ ,\ \text{for all } t \ge 1 \text{ and } L \in \varepsilon \quad (4)$$

The above constraints form a polytope in $\vec{P}$ Space. Let us denote this polytope by $\mathbf{P}$. Using (1) and (2), the maximum achievable data rate for link L in slot t is

$$X_t(L) \quad =W(L)\ \frac{G(T(L),R(L))P(L)}{\sum_{k\ \neq 1} P(k)G(T(k),R(L)) + nR(L)} \quad (5)$$

The average rate of link L is than defined as X_{avg}(L)=$\liminf t \to \infty \frac{1}{t}\sum_{k=1}^{t} X_k(L)$. For each link L,let C(L) be a given minimum required average data rate is,

$$X_{avg}(L) \ge C(L),\ \text{for all } L \in \varepsilon \quad (6)$$

Define the required minimum average rate vector as $\vec{C}$=(C(1),C(2),…….. ,C(L ε)). The average power consumed by the transmitter of link L is then

$$P_{avg}(L) = \limsup t \to \infty \frac{1}{t}\sum_{k=1}^{t} P_k(L)$$

Define the average power vector as,

$$\overrightarrow{Pavg} = (Pavg(1), Pavg(2), \ldots\ldots, Pavg(L\varepsilon)).$$

There may or may not exist a sequence of network power vectors P1, P2… that satisfy (2) and (6). If there does exist a sequence of such network power vectors, our aim is to minimize a linear function of Pavg. An example of such a linear function is simply the total average power, $h(avg) = \sum_{L \in \varepsilon} Pavg(L)$ (7)

The scheduling and power adaptation problem is then defined as, min h(avg) subject to (2) and (6) . Let us define the value of this cost function as $\vec{C}$ denoted by $H(\vec{C})$. The potential function is,

$$V(\vec{P}, \beta) = h(\vec{P}) + \sum_{L \in \varepsilon} \beta(L)[C(L) - X(L)] \quad (8)$$

From literature using duality methods,

$$H(\vec{C}) = \max_{\beta \geq 0}\{\min_{\vec{P}} V(\overrightarrow{Pavg}, \beta) \text{ subject to } (2)\} \quad (9)$$

Computation of (9) involves optimizing over all schedules of network power vectors satisfying the peak power constraint in every slot. However, since the potential function V is linear and it follows that (9) can be computed by an optimization over a single slot [1], [2]. Therefore, we can just focus on solving

$$\max_{\beta \geq 0}\{\min_{\vec{P}} V(\vec{P}, \beta) \quad (10)$$

$$\vec{P} \in \mathbf{P}$$

From above this the scheduling and power problem is sloved and max-min problem also sloved by (11),

$$H(\vec{C}) = \{\min_m V(P^m_{ext}, \beta) : 1 \leq m \leq M \quad (11)$$

The mathematical statement of the joint scheduling and power adaptation problem will be shown as,

$$\min \sum_L Pavg(L) \quad (12)$$

IV. SIMULATION RESULTS

In this division, the report investigates the simulation work that examined the network throughput and capacity using joint scheduling and power adaptation algorithm. The evaluation result shows the better performance metrics for the parameters such as utilization ratio of SIC and through put and the power consumption graph will be shown in future.

A. SIMULATION ENVIRONMENT:

Simulations were performed by using Network Simulator (NS2) environment which is a powerful platform for network research process and it is a discrete event simulator tool.

In the environment, 50 nodes are randomly deployed in a 200m × 200m area. The performance of our joint scheduling and power adaptation algorithm is designed using SIC in NAM window in NS2 software. NAM is called network animator.

B. RESULTS AND DISCUSSION :

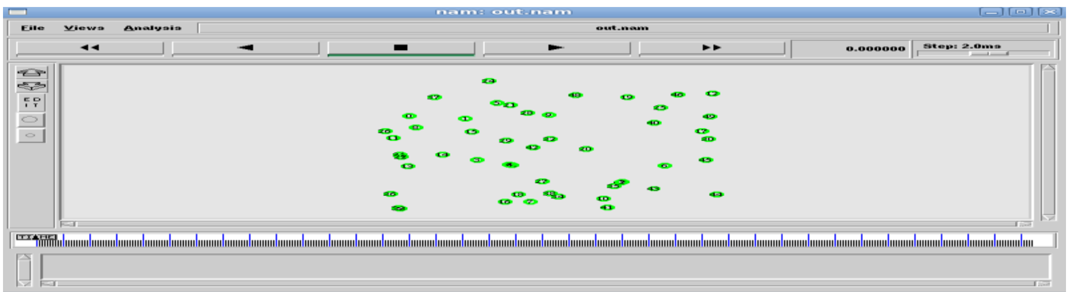

FIGURE 2 : **Creation of Network Topology**

The performance of proposed scheme has been verified using network simulator to show that the approach is efficient. The simulation results are shows in a NAM window. NAM provides a visual interpretation of the network topology. In Figure 2, totally 50 nodes are created in a network topology with green colour.

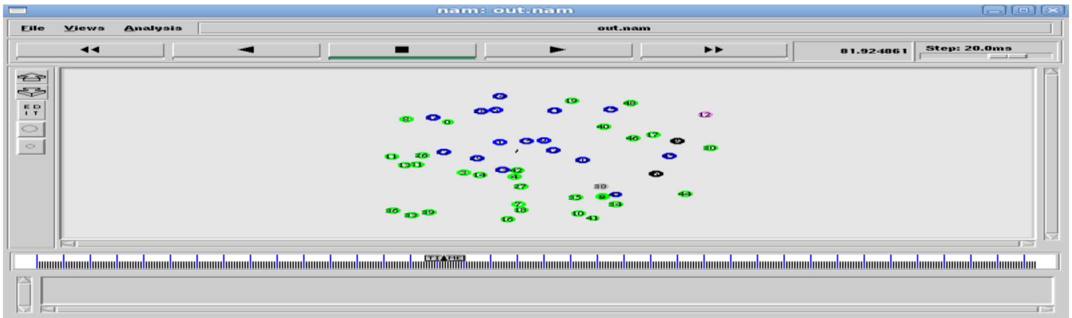

FIGURE 3: **Monitoring Node Selection using MPR Techniques**

Multiple packet reception techniques are take place in Figure 3, in that the multiple source nodes are shown in blue colour and the destination node is in violet colour.

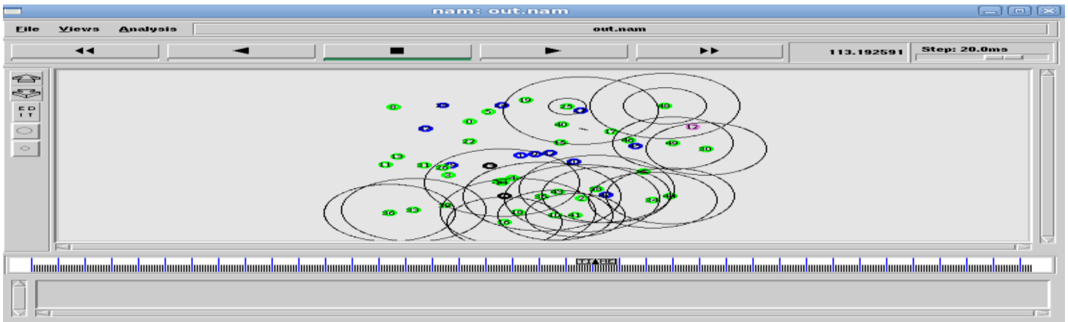

FIGURE 4 : **Packets Broadcasting Using SIC**

In Figure 4 the interfering links are shown in black colour. For packet transmission, if any interfering links occur between the source and destination means the link get failure and packet will take another link to reach their destination and the power consumption also be minimized based on joint scheduling and power adaptation algorithm with the help of SIC. Finally, the broadcasting from source to destination is done with the help of SIC. To properly evaluate the usage of SIC joint scheduling and power is introduced, based on this the utilization of SIC is increased. In Figure 5 the graph is plotted between the number of chains Vs throughput of SIC and SIC power. Based on the number of received nodes the throughput value will be increased. Compared to with SIC and with SIC power gives greater % of throughput value shown in blue color line. This paper got 81% throughput gain value.In Figure 6 shows the number of received nodes Vs power consumed in each node in a network. The design of rate adaptation algorithm and scheduling with SIC graph will be discussed in future work.

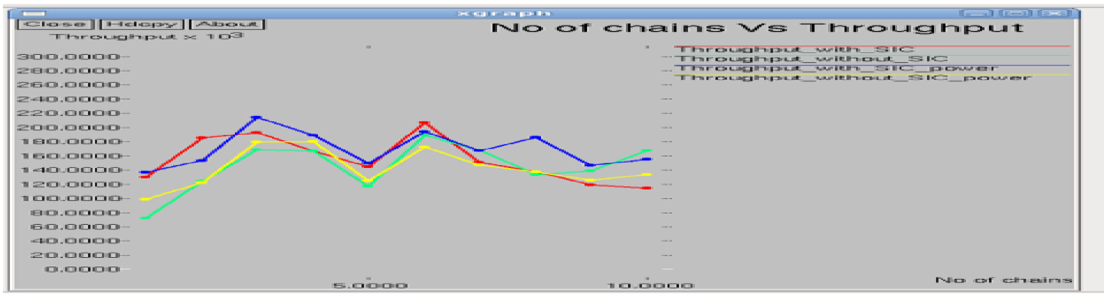

FIGURE5: **No of Chains Vs Throughput**

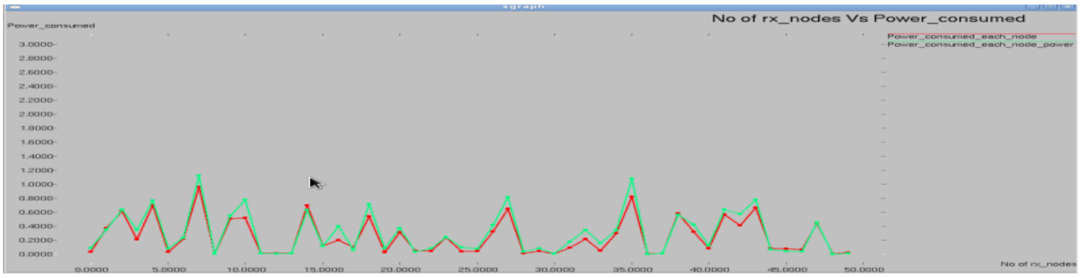

FIGURE 6: **No of Received Nodes Vs Power Consumed in each node in a network**

V. CONCLUSION

In Wireless Networks, interference and power, rate adaptation or management plays a vital role. This paper look into the performance of SIC with joint design of power and rate adaptation in wireless networks. Broadcasting from source to destination has been done with multiple nodes. Compared with existing method, the proposed scheme got increased throughput value. The total power consumption of a network topology is minimized with the help of joint power adaptation and scheduling in wireless networks.

A New global optimization algorithm is proposed for joint power adaptation and scheduling to minimize the power consumption in wireless and capacity of a network is effectively verified. There are several directions to extend the work. First, it is important to designing the algorithm for Rate adaptation. Second, one of the ongoing works to plot the graph between data rate and time for each received node in a network.

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