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Carrier Sense Jitter Constrained Optimal Link Scheduling with Delay Minimization in Wireless Sensor Networks

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Abstract-

In wireless sensor network we observe a delay in data transmission. In this paper we approach a Jitter constrained optimal link scheduling to minimize the delay in wireless sensor networks. In our approach, the users who want to send data to a different user in that same instant and same path to minimize the delay, delay bound in data rate, jitter that is variation of delay, delay bound violation, have assigned the time slot under the optimal link scheduler. For optimization purpose, a carrier sense jitter constrained optimal link scheduler used an effective capacity model. The fading model and signal to noise ratio (SINR) also studied in this problem. If it is not free and number of nodes are fascinated to transmitted data then we are used the TDMA and FDMA to access those nodes which are engrossed to transmitted data to minimize delay. Here we are projected the iterative algorithm based on column generation to search the suboptimal solution to the problem. In wireless sensor network, we implement the optimal link scheduling for delay minimization with the help of Media access control that is MAC protocol.

Index Terms - *Link scheduling, Jitter, delay constraint, TDMA, FDMA, column generation.*

I. INTRODUCTION

A combination of a transceiver radio, transducer (sensor), small power source, generally batteries and small microcontroller is nothing but a wireless sensor. It is an ad-hoc network which not required any infrastructure to work. Limited data processing, short distance communication and environmental data sense are the characteristics of the wireless sensor network (WSN). It used in many applications like health care, haunt monitoring, volcano monitoring, military surveillance, structural health monitoring, industrial process control, land seismicity monitoring etc.

The sensor has three services that is Sensing, Processing and transmission. They should be in low cost and light weight with limited communication range. The deployment of wireless sensor network is either inside or nearer to the process or object monitored. Here we projected two mattes. First is increase the sensor node life and second is jitter that is delay variations, delay minimization for a rapid response of sensor node. Here we do a sensor node scheduling to increase the sensor lifetime. Here we use delay scheduling, sleep scheduling, wakeup scheduling where some nodes are in sleep state and some are in active state. We use optimal link scheduling to perk up the response of sensor node. But it is a NP-hard difficulty due to this reason an optimization model is use where we achieve the goal by deeming parameters like jitter end to end delay, data rate, overhead of network, violation packets loss bound delay. With the help of channel model we intend a scheduling link. The meddling characterize of channel model are

1. COLLISION MODEL

It is also called a Disk model. Here conjecture range occurs if the distance between two nodes that are node A and node B found less than the fixed distance.

2. PHYSICAL MODEL

If SINR that is signal to noise ratio at node A go beyond the specified threshold then physical model node K can communicate with a node A.

In physical model optical scheduling is NP-hard that is mixed integer problem which is solved with the help of delay column generation, interior point based algorithm, column generation algorithm to solve the problem under transmit power which is fixed. The integer or linear programming problem solved by using a column generation method algorithm reduce variable which approaches zero during each iteration. But it is valid only for integer. In the case of logarithmic variable value, the column generation algorithm is not valid. In that situation we use an interior point method which is valid for logarithmic variable value.

II. RELATED WORK

In wireless multihop networks, the link scheduling problem is very jump topic. The TDMA schedule persuade the needs of power efficiency, robustness of routing, and interference constraints, admissible link rates, fairness. In this paper some representative related works are given.

1. Scheduling for WiMax mesh network

With strict QoSguarantee WiMax mesh network used a scheduling and Call Admission Control algorithm [2]. These algorithms have the advantages like it provides call admission control and in real time applications, the jitter constraint supported by centralized scheduling. But RTPS needs an additional bandwidth and this is a disadvantage of the algorithm.

2. Scheduling for broadband wireless access system

A jitter controlled packet delay algorithm which is fair, efficient, class based and used in a 4G broadband wireless access system [1]. In this paper contained a method for civilizing QOS that is Quality of service. Increasing uploading and downloading data and improving QOS for mobile IP are the advantages of the algorithm and disadvantage is it invalid for cross layer and support only single layer.

3. Guaranteed Rate Internet Traffic Delivery

Here we see about the delivery of guaranteed rate internet traffic with very low delay jitter [6]. Over the internet traffic flows delivered with a low jitter delay and provide to the each IP router which have capacity to buffer small number of switch flow. Increasing QOS, reducing delay and managing traffic flow are the advantages of the algorithm and disadvantage is support only specified IP address.

4. Packet scheduling Scheme

This scheme is use for 4G wireless access systems aspiring to capitalize on income in the telecom carriers [4].This is use in telecom operators for maximizing the profit. Increasing uploading and downloading data and improving QOS for mobile IP are the advantages of the algorithm and disadvantage is it invalid for cross layer and support only single layer.

5. Jitter compensation scheduling scheme

To support the real time communications, a jitter compensation scheduling schemes is used [3]. This algorithm used in a real time service like packet switched network. On the basis of virtual block scheme and first come first serve packet by packet we compare the delay in jitter compensation scheme.

6. Jitter controlled packet scheduling

It is fair and class based and used for managing buffer and handoff occupancy for 4G wireless access systems [5]. The advantage of scheduler is increasing QOS and managing handoff and buffer. And disadvantage is it invalid for cross layer and support only single layer.

7. Scheduling in real-time packet-switched network

Here the delay jitter controlled by a RFWRR and WRR gives priorities to packets in order to meet delay needs. It also provides a constant buffer space. But it supports only packet switch network.

8. Analysis in Jitter Buffer

Real time services are generally used by a voice over IP that is [8] VoIP which have a serialization effect, queuing, scheduling and routing which cause a loss in jitter delay. To analysis the performance in jitter delay we used VoIP. But it does not support a more number of queuing.

9. HUHG Algorithm

Due to the upstream bandwidth in EPON, efficiency in a solution for high speed broadband occurs in network is minimizing [11]. This problem is solved by a high utilization and hybrid granting which is minimize the packet delay and jitter delay and gives a good performance and improve the packet loss.

10. Admission control strategy

To downlink packet transmission in WCDMA [10] is done by using admission control strategy and two scheduling algorithms having class's real time and non real time which is based on mean power and mean traffic load in target based station. And gives the results in terms of packet rate, jitter delay and grade of service and improve the admission strategy. But it support only small queue priorities.

11. Scheduling in time dependent priorities

To QoS systems a time dependent priorities scheduling is used [12]. It is useful to transmit an asynchronous data network and provide guarantee to the connection of minimum bandwidth, jitter delay, packet delay. It is used to improve packets but support only small queue priorities.

III. SYSTEM APPROACH

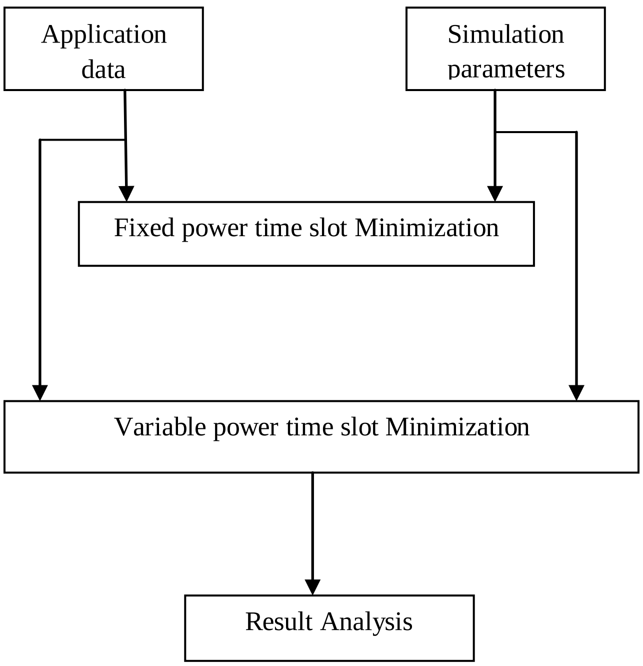

Fig: System Architecture Diagram

To solved the problem under fixed transmit power, we used column generation method, interior point method, delay column generation method to solved the NP-hard which is mixed integer problem under physical model which is optimal scheduling physical problem. So in that situation we use an interior point method which is valid for logarithmic values.

IV. REVIEW OF EFFECTIVE CAPACITY THEORY

Wireless link modeled by two EC functions in EC connection layer model that is $\gamma(\mu)$ a nonempty buffer probability and $\theta(\mu)$ QoS exponent connection. Both have rate μ source traffic. If source traffic delay communication bound D_{max} then ϵ is tolerate the delay-bound violation probability. That's why we need maximum source data rate μ. Here $\alpha(.)$ is the EC original function.

Here let r (t) = instantaneous capacity channel at time t

$S(t) = \int_0^t r(r)dr$

Then EC function of r (t) define as

$$\alpha(u) = \frac{-\wedge(-u)}{u} \qquad \forall u > 0 \qquad (1)$$

Where

$$\wedge(-u) = \lim_{t\to\infty} \frac{1}{t} \log E[e^{-uS(t)}]$$

We can find the QoS exponent function with the help of derived EC function according to $\theta(\mu) = \mu\alpha^{(-1)}(\mu)$. In this way D_{max} and ϵ estimate the $\gamma(\mu)$ and tune source rate μ assurance its QoS needs. Now we learn the EC model as a triplet of data rate, delay bound, and delay bound violation probability that is (μ, D_{max}, ϵ). Another useful form derived by author [10] is that P_{err} is nothing but a packet error probability, and relation among them is a u = -log $P_{err}/(\mu \cdot D_{max})$. We select this model to formulate and solve the link scheduling problem because it is capture the effect of channel fading on the queuing behavior of the link.

V. FORMULATION OF THE LINK SCHEDULING PROBLEM FOR THE FIXED POWER CASE

Here the paper model the N node sensor network denoted by $\mathcal{N}$, ε as a directed links set. Assume that node simultaneously cannot transmit and received, node I communicate only node j ($j \neq i$). And assume that each link {i, j} $\in \varepsilon$ and the transmitting node i directly communicate with receiving node j with QoS. Let transmission power $P_i(t)$ for node I at time j, $G_{ij}(t)$ gain of fading channel from I to j and nj variance of thermal noise at receiver j. The SINR at receiver *j* due to transmission from node *i* is given by

$$SINR_{ij}(t) = \frac{Pi(t)Gij(t)}{nj + \sum_{l\neq i,j} Pl(t)Glj(t)} \qquad (2)$$

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VI. COLUMN-GENERATION-BASED SOLUTION TO THE OPTIMAL SCHEDULING PROBLEM

It is an iterative algorithm to use solving linear or integer programming problems. Experience tell that in the optimal solution only small subsets of variables found and the rest of these variables will be non basic and always take a value of zero in the optimal solution. And here the problem solved by using column-generation-algorithm because it generate only those variables that have the potential to improve the objective function. Let i∈ {i, j}∈ S, transmitt power $P_i^{(k)}$ $(\forall k)$ is equal to P_0, therefore,

$$\min_{\{wk\}} \sum_{k=1}^{|S|} w_k$$

s.t. $w_k \in (0,1)$ $\forall k \in \{1, \ldots\ldots, | S |\}$

α_{ij}, $\{P_i^{(k)}\}$, $\{w_k\}$ $(u^*_{ij}) \geq r_s^{(ij)}$ $\forall \{i, j\} \in S$

Until now, in section IV we formulated the basic optimal link scheduling problem in sensor networks with QoS needs and learn the column-generation based algorithm to solve the original complex optimization problem for a fixed power case.

Algorithm

Step1: Each node which wants to sense the carrier sends data.

Step2: Node use greedy approach to keep sensing carrier until it's free, if carrier is busy.

Step3: Using column generation method Link optimize the collision among multiple nodes.

Step4: Solved the equation using Column generation method, interior point method, delay column generation method and using TDMA explanation do scheduling.

VII. PERFORMANCE ANALYSIS

In terms of throughput gain and admission region of QoS-assured flows, we analyze the performance of our SINR-EC scheduler. One-hop flows are easy to analyze the admission region that's why we consider One-hop flows. Also we consider system under study admission control module [31] to ensure that the admitted one-hop flows have their requested QoS satisfied. Assume that $[N_1, N_L]$ the Pareto-optimal vectors identifies a point on the admission region under the NI-TDMA, and the 100%. percentage of channel use under the NI-TDMA. Let all these flows simultaneously supported by the SINR-EC scheduler. N_l one-hop flows for QoS class l (l = 1,…. L) and the percentage of channel use under our SINR-EC scheduler is $\sum_{k=1}^{S} w_k$ <1. Then,

$[N_1 \times \lfloor 1 \;\; \sum_{k=1}^{S} wk], \ldots\ldots, [N_1 \lfloor 1 \;\; \sum_{k=1}^{S} wk] \quad]$ is within the admission region under our SINR-EC scheduler, where $\lfloor x$ is the largest integer that is less than or equal to x.

VIII. DISTRIBUTED PROTOCOL TO IMPLEMENT OPTIMAL LINK SCHEDULING

Here we study the MAC protocol design for implementation of projected optimal link scheduling. Here cluster of node is used where each cluster elect a cluster head which is used to coordinate the transmission initiation by periodically transmitting a beacon signal so that all the other nodes can set up their networking parameters. The MAC is a TDMA-like protocol based on a well-defined superframe similar to that in IEEE 802.15.3. it consist of a management channel time allocations (MCTAs), and channel time allocations (CTAs), beacon, a contention access period as shown in fig. a contention free period is formed by the MCTAs and CTAs combine. Based on the preamble in the beacon from the cluster head, all nodes in a cluster will synchronize to the cluster head.

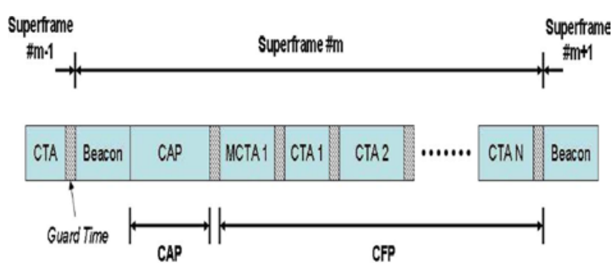

Fig.: Superframe structure of the proposed MAC protocol.

IX. SIMULATION

Here we stimulate the discrete time system depicted in fig. for estimating the EC-Function. Where source data goes through transmitter at the rate μ without any interference and the transmission rate r (n) is equal to the instantaneous. And this transmitted data

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entered the fading channel where optimal link strategy is implemented with gain and interference.

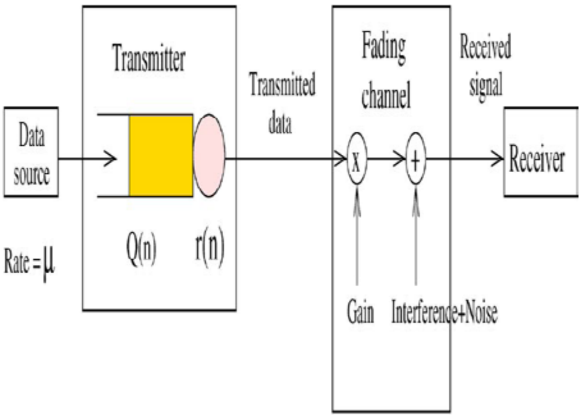

Fig.: Queuing system model used in our simulation.

Comparison of the QoS in the literature is shown below.

NAME	ENERGY EFFICIENCY	SCALABILITY
SINR-EC	High	Good
TDMA	High	Good
MAC	N/A	Good

X. Results and Discussion

For implementation of the proposed work, we used the following network topology with six nodes i.e. from N1 to N6.

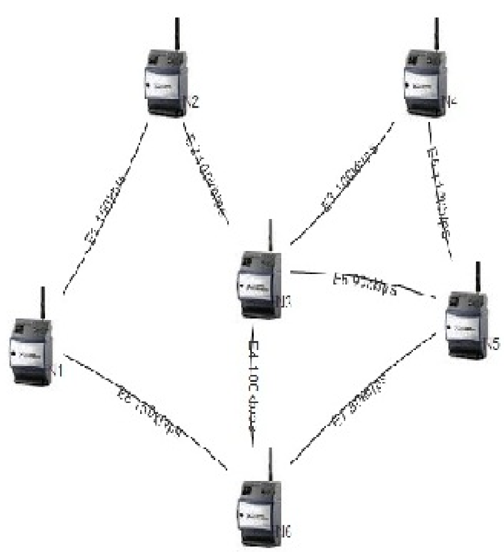

Fig. Topology and traffic load of six node network

Now we will discuss about the implementation result of the proposed work. Here we are given random data of 100 bytes which is divided randomly to all the users in TDMA and FDMA.

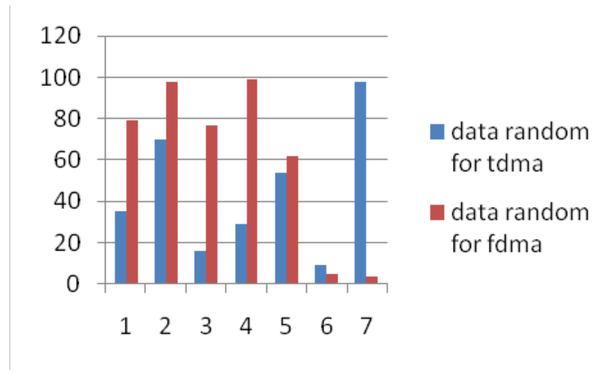

Fig: Graph User vs packets

Here we have implemented average channel gain G with jitter and without jitter in TDMA and FDMA mode in column generation method and delay column generation method. In topology we consider six nodes and we selected source node N1and destination node N5 with user 7 and find out the average channel gain for FDMA and TDMA with considering quality of service parameter which are data rate, delay, delay bound violation and jitter.

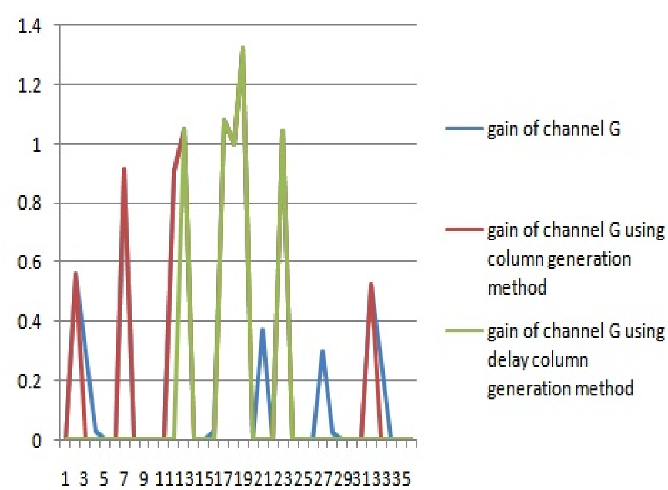

Fig: TDMA without jitter

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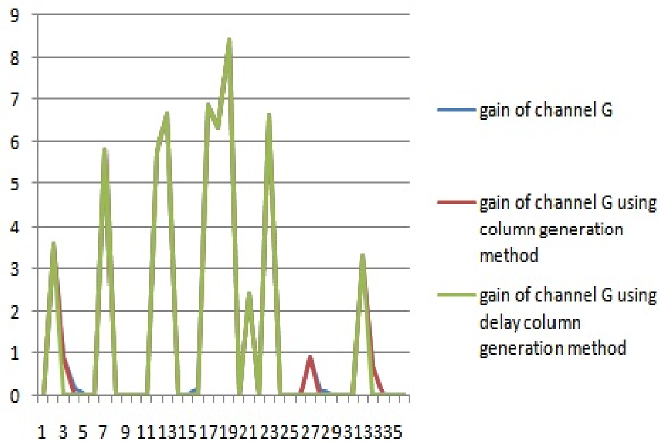

Fig: TDMA with jitter

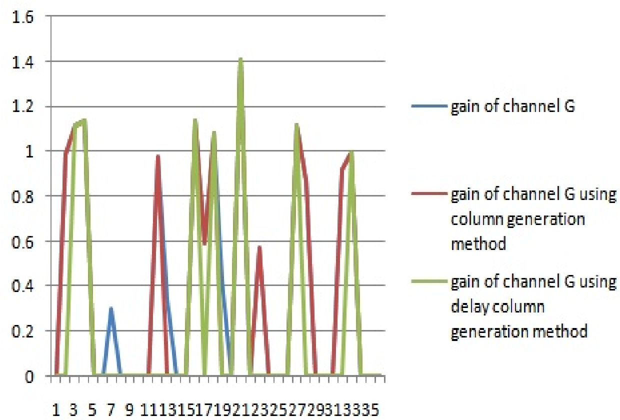

Fig: FDMA without jitter

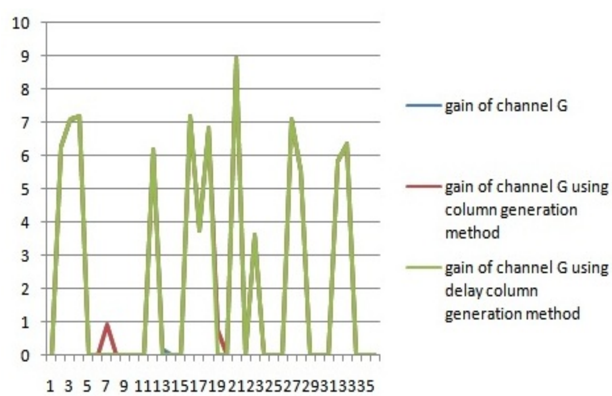

Fig: FDMA with Jitter

XI. CONCLUSION AND FUTURE SCOPE

Future Scope:

For fixed power in WSN we are applying a career jitter constraints optimal link scheduling with delay minimization. Variable power also can be implemented. We consider four specified constraints users and in future we can also consider more than four constraints. We can also improve the career sense property. And here we use TDMA to enhance the delay, but we can also use the other technology like FDMA, PDMA, and CDMA to enhance the delay.

Conclusion:

In wireless sensor network, the carrier sense jitter constraint optimal link scheduling with delay minimization are learn in this paper. With constraint on delay bound, delay violation, jitter and data rate the optimal link scheduler allocate time slot to different user to minimize channel usage. To optimize the problem we use link scheduling mathematical model. But optimization problem is NP-hard that's why we projected a column generation and delay column method based iterative algorithms to search suboptimal solution of the problem. And finally with the help of TDMA we executed the career sense jitter constraints optimal link scheduler.

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