Optimal Link Scheduling with Delay Minimization in Wireless Sensor Networks

Dilipkumar Jang Bahadur[1], Deepak C. Mehetre[2]

Dept. of Computer Engineering, K.J College of Engineering & Management Research, Pune University, Pune, Maharashtra, India

Dept. of Computer Engineering, K.J College of Engineering & Management Research, Pune University, Pune, Maharashtra, India

Abstract: ***In wireless sensor network we observe a optimal link scheduling and delay in data transmission. In this paper we implemented optimal link scheduling to minimize the delay in wireless sensor networks with different methods. In our approach, the Node to send data to a sink node 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 transmitted data then we are used the TDMA and FDMA to access those nodes which are ready to transmitted data to minimize delay. Here we are projected the iterative algorithm based on column generation and delay column generation to search the suboptimal solution to the problem.***

Keywords: optimal Link scheduling, delay constraint, TDMA, FDMA, column generation, delay column generation

1. Introduction

A sensor is consists 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 required limited 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) 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.

2. Related Work

1) WiMAX schedulers under triple play services
   Under the triple play services, the WiMAX schedulers evaluate the performance which may be real time or non real time. MAC layer scheduler satisfied the QOS on the basis of real time and non real time. This is useful to manage the handoff and buffer, increase the QOS. But it is invalid for cross layer and support only single layer.

2) Scheduling in time dependent priorities
   To QoS systems a time dependent priorities scheduling is used. It is useful to transmit an asynchronous data network and provide guarantee to the connection of minimum bandwidth, jitter delay, packet delay. Switch working and admission control are determined by this algorithm. It is used to improve packets but support only small queue priorities.

3) Novel resource scheduling algorithm
   This algorithm is used to improve a TCP performance in 3GPPLTE. In IP network the QOS long term evaluation

affects the packet loss, network congestion, latencies, jitter and other issues. So these are improved by using this algorithm. In this paper a radio scheduling algorithm over semi continuous algorithm also used for VoIP data packet mapping TCP and ACK packet into higher priority channel. Jitter constraint in real time applications are supported in centralized scheduling. It also provides a call admission controlled. But RTPS needs extra bandwidth.

4) TCP .1²NC
This mechanism is used to incorporate network coding into TCP in multi-radio multi-channel wireless mesh network. TCP .1² NC several encoding blacks worked simultaneously to utilized bandwidth propagation delay and wireless scheduling control, a black pressure algorithm is used. For applicable to control it optimize end-to-end delay and delay jitter is small. It also uses to improve the QOS and maximize the bandwidth control and downloading but it is invalid for cross layer.

5) The asymmetric best-effort service
It is used to provide ultra throughputs delay jitter service for IP by marking best packet either green or blue and sending by real time application and blue service are best efforts. Jitter constraint in real time applications are supported in centralized scheduling. But RTPS needs extra bandwidth.

6) RPR scheduling
Resilient packet ring with single transit buffer are used to improve the Quality of service in the MACK architecture. And also increase the bandwidth control and downloading data. But it is invalid for cross layer.

7) Wireless Multimedia Sensor Networks
In Wireless Multimedia Sensor Networks we used an Adaptive Synchronization Control with Multi-level buffer to verify the effectiveness of WMSN platform to maintain synchronization, analyze the buffer state to prepared packet scheduling scheme to reduce delay and Evaluate current network state and adjust number of buffer to balance delay and jitter delay. By combining stream transmission path prefer synchronization central reduce constraint of wmsn.

8) Mixed-Traffic OFDM Systems
Mixed-Traffic OFDM Systems are used to allocating Bit QoS-Aware Resource. The characteristics of OFMD is vary the QOS needs of channel conditions and publish work in RRM to exploit multi users & multi channel divert to take advantages of QOS needs optimize features. Jitter constraint in real time applications are supported in centralized scheduling. But RTPS needs extra bandwidth and also it gives call admission control. But RTPS needs extra bandwidth.

9) OCGPR Technique
OCGPR that is output controlled grant based round robin is a latest technique used to support difference secure traffic in router. To prevent starvation for low priorities class are adjust by Grant. It is also used to improve QOS and increase the bandwidth control and downloading data. But it is invalid for cross layer.

10) Jitter controlled packet scheduling
It is fair and class based and used for managing buffer and handoff occupancy for 4G wireless access systems. The advantage of scheduler is increasing QOS and managing handoff and buffer.

3. System Approach

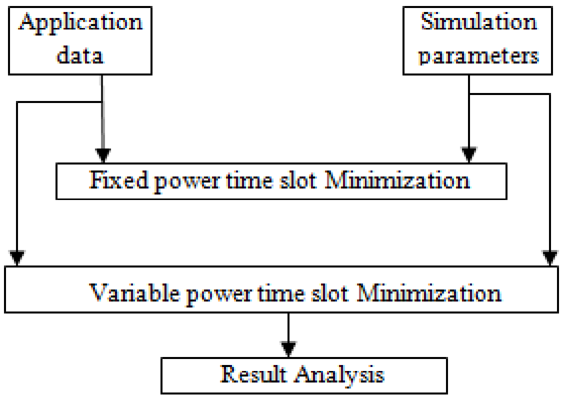


Figure 1: System Architecture Diagram

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.

4. 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) = $\int_0^t r(\tau)\, d\tau$
Then EC function of r (t) define as

$$\alpha(u) = \frac{-\Lambda(-u)}{u} \quad \forall u > 0 \tag{1}$$

Where

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

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 derivd 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.

5. 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

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

6. 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 $i \in \{i, j\} \in S$, transmitt power $P_i^{(k)}$ $(\forall k)$ is equal to P_0, therefore,

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

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

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

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.

7. 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,

$[N_1 \times \lfloor 1\ \sum_{k=1}^{S} wk], \ldots\ldots, [N_l \lfloor 1\ \sum_{k=1}^{S} wk]\ ]$ 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*.

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

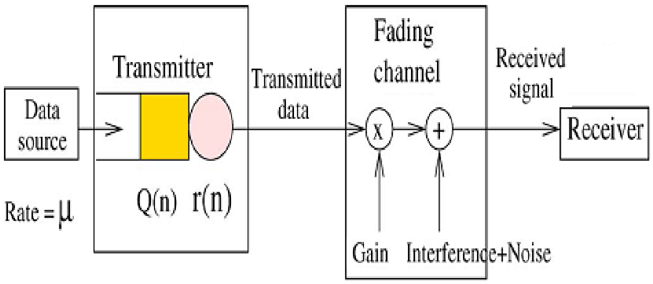


Figure 2: Queuing system model used in our simulation.

9. Results and Discussion

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

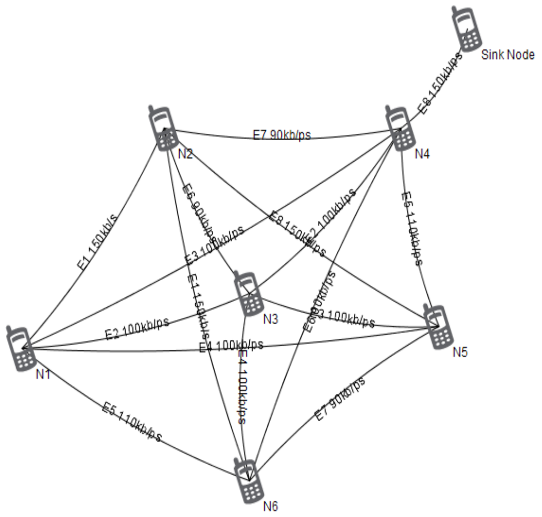


Figure 3: Topology and traffic load of six node network

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.

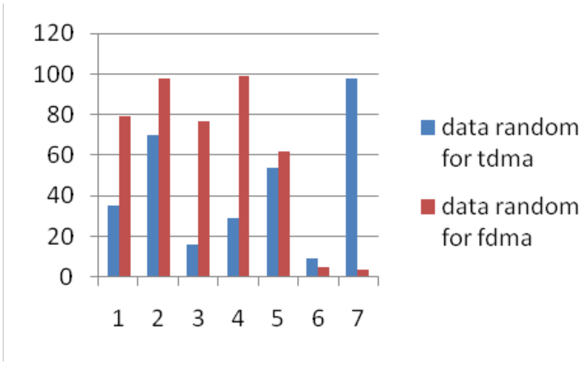


Figure 4: Graph User vs packets

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.

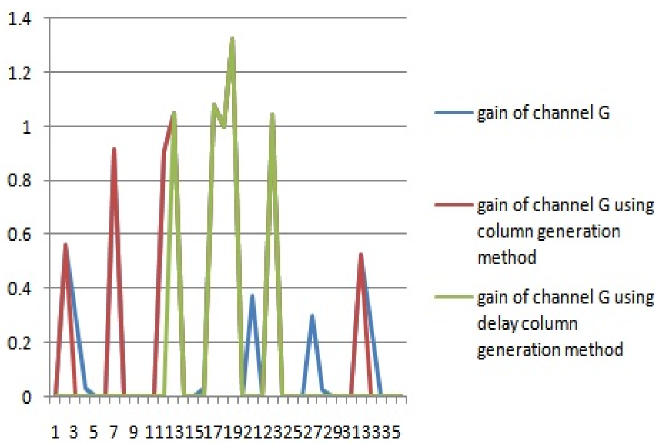


Figure 5: TDMA without jitter

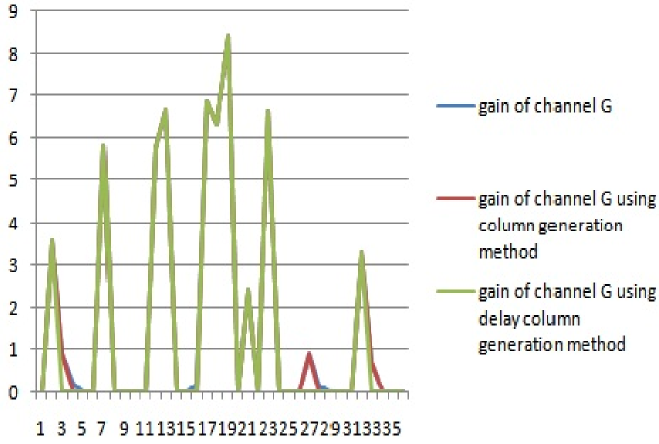


Figure 6: TDMA with jitter

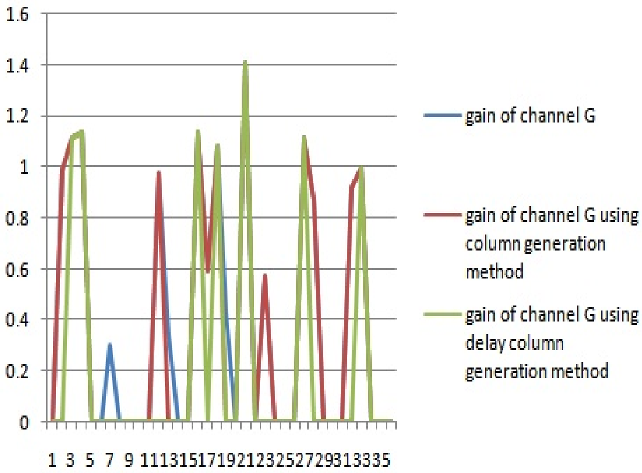


Figure 7: FDMA without jitter

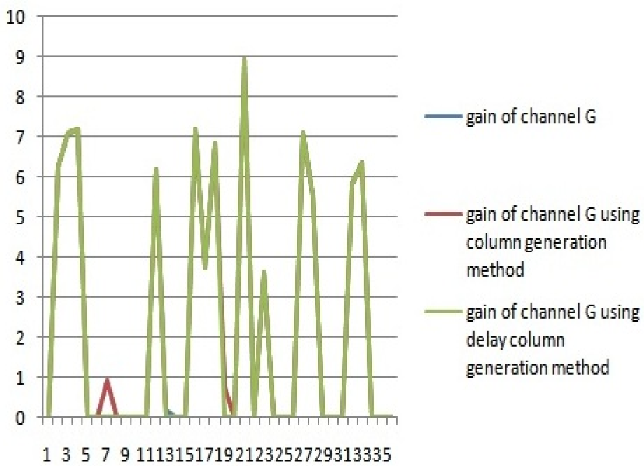
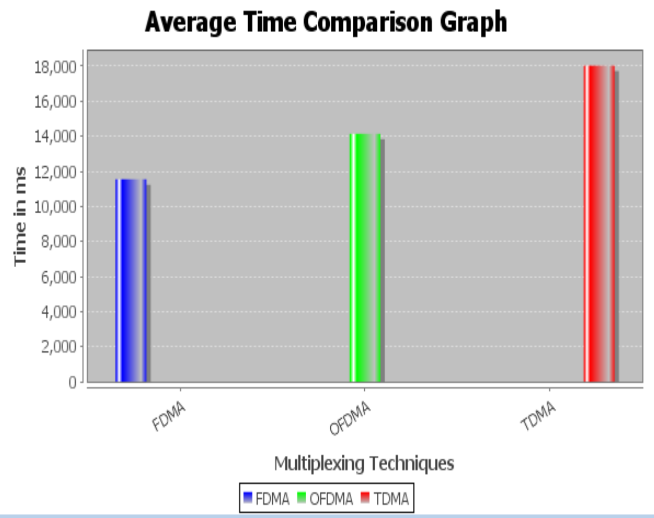
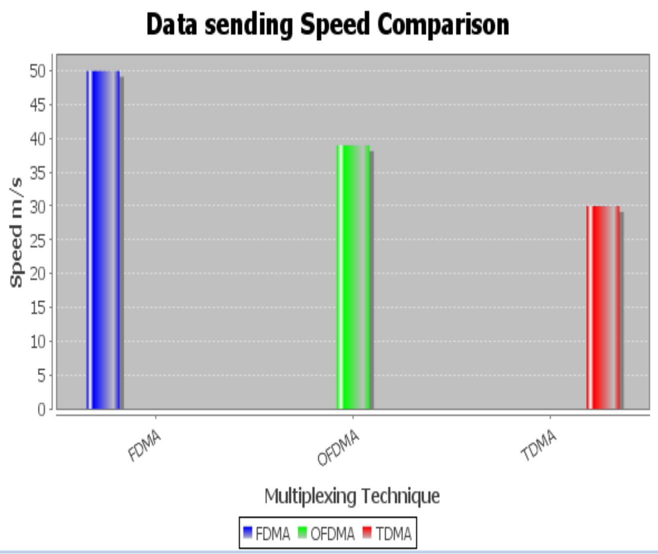


Figure 8: FDMA with Jitter





10. Conclusion and Future Scope

10.1 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.

10.2 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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