MANAGING INTERFERENCE IN COLLABORATIVE NETWORKS BY FLOW CONTROL AND SIGNAL POWER CONTROL BASED PRIORITY

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Abstract—The performance of wireless sensor network (WSN) can be effect by interference. The many devices in network capable of causing interference and this can cause dropping packets or block the transmission channel. In this paper we study how manage the interference in WSN. This managing can be done by flow control and power level control. We used heterogeneous collaborative network nodes like PIC microcontroller, ARM microcontroller and Personal Computer (PC) to build our network. Also we assign priority level for each node to allow the node with high priority to manage the flow and power level of other node within same network and same used channel. The time synchronization required due to different nodes used. The protocol used for time synchronization is Timing-sync Protocol for Sensor Networks (TPSN).

Key Words: WSN, PIC, ARM, PC and TPSN.

I. INTRODUCTION

A Wireless Sensor Network (WSN) of spatially distribution autonomous sensors to observe physical or environmental activities, like temperature, sound, pressure, etc. and then these sensor nodes pass their data through the network to a destination location. A lot of new networks are bidirectional, also enabling management of sensing activity. The development of WSN was motivate by military applications like battlefield surveillance, nowadays such networks are employed in several industrial and client applications, such as observance activity, management, machine health monitoring and so on.

The WSN is constructed of "nodes" from a few to hundreds or even thousands nodes, where every node is connected to a minimum of one or many sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery. The design of the sensor network is effect by many factors including scalability, operation system, fault tolerance, network topology, hardware constraints, transmission media, congestion, interference and power consumption. In this paper we concern on congestion and interference as well as saving power consumption.

High-rate streaming in WSN is required for future applications to produce high-quality information of an application. The recent advances have enabled large-scale WSN to be deployed supported by high-bandwidth backbone network for high-rate streaming, the WSN remains the shortcoming in service due to the low-rate radios used and also the effects of wireless interferences. The potential sources of interference will occur in collaborative network when other nodes send data in high rate or in high power level signal.

We build our network as a collaborative network. A collaborative network is the collection of businesses, individuals and other organizational entities that possess the capabilities and resources needed to achieve a specific outcome as shown in Fig 1.



Fig. 1. Collaborative network

The Congestion is one of the main reasons of interference because congestion means that there are huge data in channel that increase the probability of interference with other data that sent from other devices.

There is other factor effect on channel interference e.g. signal strength of other devices. So if we need to avoid interference in our network we need to take in consideration the speed of sending data as well as control the power level signal of other nodes. One of the main characteristic in WSN is power consumption constraints for nodes using batteries or energy harvesting so we need to take in consideration the saving power.

The interference leading drop packet or block the channel therefor we need to retransmit the lost packet or retrieve the channel. The retransmitting packet means consuming time as well as consuming energy. So we need to managing interference to saving time and saving power in the collaborative network.

The collaborative network that we used in our experiment has many types of node so in collaborative network all nodes starts at different time instants. The WSN need to be time synchronized. The protocol used for time synchronization is Timing-sync Protocol for Sensor Networks (TPSN).

In this paper, we propose two parameters (flow control and power level) to manage interference in WSN. We evaluate our algorithm by design collaborative network with following devices:

- PIC microcontroller node [1].
- ARM microcontroller node [2].
- PC node.
- Wireless device used to attach with these above nodes [3].

The reminder of the paper is organized as follows: in section 2 we provide a background of interference solution as a related work. In section 3 we describe the motivation behind the manage interference. In section 4 we describe the methodology and nodes design and the pre-algorithms used for design the network. In section 5 we discuss the synchronization protocol that used in our network. Section 6 show us the interference control algorithm. The results obtain after execution in section 7. The result's evaluation discussed in section 8 and concludes our paper in Section 9.

II. RELATED WORK

Wireless sensor networks will play an important role in many applications; these applications typically fall under sensor-based systems and autonomous systems. For example, many wireless sensor networks monitor some aspects of the environment and relay the processed information to a central node. Many different wireless communication technologies, such as ZigBee and Wi-Fi, have been witnessed recently to be deployed in more and more applications. Thus, the cross technology interference has drawn attention of the researchers. Now, the WSN community has acknowledged the impact of Wi-Fi interference on WSN applications in various settings. www.ijtra.com Volume 2, Issue 4 (July-Aug 2014), PP. 218-224 Most research work done on benefit of multichannel available in 2.4 GHz band. Some study work on interference-aware channel assignment algorithm and protocol for multi-radio wireless mesh networks that address this interference problem. The proposed solution assigns channels to radios to minimize interference within the network co-located wireless networks. It utilizes a novel interference estimation technique implemented at each mesh router as done in [4]. Simple localbalancing and interference-aware channel allocation algorithms for reducing the overall interference in the network studied [5]. Also some study don on evaluate the relative performance of an algorithms using actual implementations on a multichannel, multi-radio test bed. Using overall network throughput as a metric, we show through experiments that the channel allocation that is aware of the node's transmission activity performs better than the simple local balancing algorithm, irrespective of the number of channels used for allocation as discussed in [5].

In most paper the solution of interference either select channel that have less use from other network or balancing the interference among the channels. Other paper when detect the interference simply change the channel with other.in our solution is depend on solve the interference without depend on changing channel, when interference occur in the collaborative network the node with high priority take responsibility to remove the interfacing while this node need to send data.

III. MOTIVATION

Performance of a deployed Wireless Sensor Network (WSN) is greatly influenced by the interference it is subject to during operation. Degradation happens because of interference leading to packet drops, retransmissions, link instability and inconsistent protocol behavior. Therefor to save time, save energy and increase the Quality of Service (QoS) in network (such as increase the throughput) we need to eliminate or reduce the effect of interference. We have conducted experiments that highlight the fact that interference caused by same channel used by other devices and/or co-channel contention significantly degrades the network performance of protocols, especially when these devices send data in high rate or in high power level signal. These potential sources of interference must therefore be accounted for during the design stage of a WSN in order to achieve acceptable network performance. Based on these observations one solution for increasing the network throughput of a WSN is managing interference.

IV. METHODOLOGY AND IMPLEMENTATION

A. Network design

We designed collaborative network and these network contain PIC, ARM and PC as a node attached with them wireless device we assume:

- 1) Each node in network is known to each other.
- 2) Each node has own priority.
- 3) Two nodes (Node 1 & Node 2) communicate with each other as shown in Fig 2.

4) The distance between these two nodes is 10 meter.

5) Node 3 work as interference and send packet in same channel of Node 1 & Node 2 as shown in Fig 3.

As shown in Fig 3, the Node 3 send data on same channel of Node 1 & Node 2.



Fig. 2. Two nodes in collaborative network without interference



Fig. 3. Two nodes in collaborative network with interference from other node

B. PIC Wireless Node

In Fig 4 show the PIC microcontroller interface with Wireless device connects either directly or use RS232C to create PIC Wireless Node.



Fig. 4. PIC Wireless Node

C. ARM Wireless Node

In Fig 5 show the ARM microcontroller interface with Wireless device connects either directly or use RS232C to create ARM Wireless Node.



Fig. 5. ARM Wireless Node

D. PC Wireless Node

In Fig 6 show the PC with Wireless device connects together to present the PC Wireless Node the RS232C used to connect between them.



Fig. 6. PC Wireless Node

V. THE NEED FOR SYNCHRONIZATION IN SENSOR **NETWORKS**

There are several reasons for addressing the synchronization problem in sensor networks. First, sensor nodes need to coordinate their operations and collaborate to achieve a complex sensing task. Data fusion is an example of such coordination in which data collected at different nodes are aggregated into a meaningful result. For example, in a vehicle tracking application, sensor nodes report the location and time that they sense the vehicle to a sink node which in turn combines this information to estimate the location and velocity of the vehicle. Clearly, if the sensor nodes lack a common time scale (i.e., they are not synchronized) the estimate will be inaccurate.

Second, synchronization can be used by power saving schemes to increase network lifetime. For example, sensors may sleep at appropriate times, and wake up when necessary. When using power-saving modes, the nodes should sleep and wake-up at coordinated times, such that the radio receiver of a node is not turned when there is some data directed to it. This requires a precise timing between sensor nodes. Scheduling algorithms such as TDMA can be used to share the transmission medium in the time domain to eliminate transmission collisions and conserve energy. Thus, synchronization is an essential part of transmission scheduling.

Timing-Sync Protocol for Sensor Networks (TPSN):

A network-wide time synchronization protocol for sensor networks, which they call Timing-Sync Protocol for Sensor Networks (TPSN) [6]. Their protocol works in two phases: "level discovery phase" and "synchronization phase". The aim of the first phase is to create a hierarchical topology in the network, where each node is assigned a level. Only one node is assigned level 0, called the root node. In the second phase, a node of level i synchronize to a node of level i-1. At the end of the synchronization phase, all nodes are synchronized to the root node and the network-wide synchronization is achieved.

A. Level Discovery Phase

This phase is run once at the network deployment. First a node should be determined as the root node. The root node is assigned level 0, and initiates the level discovery phase by broadcasting a level discovery packet. This packet contains the identity and level of the sender node. Upon receiving this packet, the neighbors of the root node assign themselves level 1. Then each level 1 node broadcasts a level discovery packet with its level and identity in the packet. Once a node is assigned a level, it discards further incoming level discovery packets. This broadcast chain goes on through the network, and the phase is completed when all nodes are assigned a level.

B. Synchronization Phase

The basic building block of the synchronization phase is the two-way message exchange between a pair of nodes. The authors assume that the clock drift between a pair of nodes is constant in the small time period during a single message exchange. The propagation delay is also assumed to be constant in both directions.

Consider a two-way message exchange between nodes A and B as shown in Fig 7. Node A initiates the synchronization by sending a synchronization pulse packet at T1 (according to its local clock). This packet includes A's level number, and the value T1. B receives this packet (according to its local clock) at $T2 = T1+\Delta+d$, where Δ is the relative clock drift between the nodes, and d is the propagation delay of the pulse. B responds at time T3 with an acknowledgement packet, which includes the level number of B and the values T1, T2, and T3. Then, node A can calculate the clock drift and propagation delay as in formula, and synchronize itself to B.



Fig. 8. Two way message exchange between a pair of nodes

$$\Delta = \frac{(T_2 - T_1) - (T_4 - T_3)}{2}$$
$$d = \frac{(T_2 - T_1) + (T_4 - T_3)}{2}$$

VI. INTERFERENCE CONTROL ALGORITHM

ALGORITHM:

Setting parameter of nodes (Baud rate, buffer size, delay, pin selection, I/O directions, register selection, port initialization)

Assign: when two nodes start sending data to each other

- Assign priority to all nodes one of these two node as a master node
- flow=TRUE , power=TRUE
- size = No. of packet need to send

While (sending packet < size)

- Two nodes start sending data
- Master node monitors the throughput of transmission

If (drop packets occur) THEN

$$If (flow = = FALSE \& \& power = = TRUE)$$

- Master node send notification packet with its priority value to inform other nodes in network to reduce the power level of packet
- > Power=FALSE
- If(interference node priority < master priority)</p>

Reduce the level power of receive node }

}

Else if (flow==TRUE)

- {
- Master node send notification packet to inform other nodes in network to reduce the flow rate of packet
- ➢ flow=FALSE
- If(interference node priority < master priority)</p>

Reduce the flow speed of receiver node

} Else

Lise

- Change Channel
- }

}

}

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5	· · ·		
PL=18 dBm RO=4 ms	10 dBm	0	98%
	18 dBm	0	71%
	10 dBm	1	98%
	18 dBm	1	98%

Where:

Γ

RO: Speed of flow data

PL: Power level of sending signal

1)	Setting	nodes fo	or communication.
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- 2) Assign priority to all nodes.
- 3) Assign master node (Node 1).
- 4) Node 1 & Node 2 start sending data.
- 5) Monitor the throughput between these two nodes from master node.
- 6) If there is drop packet discovered that mean the interference occurred as shown in Fig 3.
- 7) The master node start send notification packet to all nodes within range telling them to reduce the speed of sending data.
- 8) If the drop packets still the master node start send notification packet to all nodes within range telling them to reduce the power level of sending data.
- 9) If packet drop remain then change channel.

VII. RESULT

In this section we read the result of our experiment after design the collaborative network as shown in Fig 2 and Fig 3. These results show the effect our algorithm on interference and how improve the throughput during communication. We collect these results when Node 1 and Node 2 have two cases:

- High power level for sending signal as shown in Table (1).
- 2) Low power level for sending signal as shown in Table (2).

TABLE 1.Percentage read the	interference experiment	(HIGH POWER
	LEVEL)	

Node1 & Node2	Node 3 (interference)		Throughput
HIGH POWER			
	PL	RO in (ms)	
	10 dBm	0	98%
PL=18 dBm RO=1ms	18 dBm	0	60%
	10 dBm	1	98%
	18 dBm	1	98%
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	10 dBm	0	97%
PI –18 dBm	18 dBm	0	43%
$P_{D}=10$ uBill $P_{D}=2$ ms	10 dBm	1	97%
KO=2 IIIs	18 dBm	1	97%
PL=18 dBm RO=3 ms	10 dBm	0	97%
	18 dBm	0	57%
	10 dBm	1	97%
	18 dBm	1	97%
	•	•	•

TABLE 2.Percentage read the interference experiment (LOW POWER			
LEVEL)			
Node1 & Node2	Node 3 (interference)	Throughput	

	1104000 (1	()	Throughput
	LOW PO	OWER	
	PL	RO in (ms)	
	10 dBm	0	72%
$\mathbf{D}\mathbf{I} = 10  \mathrm{d}\mathbf{P}\mathbf{m}$	18 dBm	0	0%
$P_{D-1}$ ms	10 dBm	1	96%
KU=1 IIIS	18 dBm	1	95%
	10 dBm	0	30%
$\mathbf{D}\mathbf{I} = 10  \mathrm{d}\mathbf{P}\mathbf{m}$	18 dBm	0	21%
PL=10 uBill PO=2 ms	10 dBm	1	97%
KO-2 IIIS	18 dBm	1	97%
	10 dBm	0	19%
$\mathbf{PI} = 10  \mathrm{dBm}$	18 dBm	0	0%
RO=3 ms	10 dBm	1	93%
	18 dBm	1	98%
	10 dBm	0	19%
PI = 10 dBm	18 dBm	0	0%
PL=10  dBm	10 dBm	1	95%
10-7 115	18 dBm	1	97%

Table (1) and (2) show the percentage values of throughput in two cases above with different values of flow speed. Also the Node 3 has different value of power level as well as different values of flow speed.

#### VIII. EVALUATION

As a result of execute the interference algorithm we can manage the interference in our network we use the reading in table (1) and (2) as shown in figures below. International Journal of Technical Research and Applications e-ISSN: 2320-8163,



Fig. 8. Effect of Node 3 on Node1 & Node2 when high power with different data speeds

In Fig 8 the interference node (Node 3) use different value of power level and value of the speed of flow data, and the Node1 & Node2 use high power (PL=18 dBm) and different flow speed. The Fig 8 can show us the ratio of the throughputs during communication.

In Fig 9 the interference node use different value of power level and value of speed the deliver data, and the Node1 & Node2 use low power and different flow speed. Also as Fig 8 the Fig 9 show us the throughputs.



data speed

As we can see in Fig 8 the effect of interference is less when comparing in Fig 9. The different due to the Node1 & Node2 use high power in Fig 8 and reverse in Fig 9. Because of Node 1& Node 2 use high power level the effect of interference node less than when Node 1& Node 2 use low power level, as shown in Fig 8 the minimum value of throughputs we got is 42% when interference Node use high power level and high flow speed (PL=18dBm & RO=0 ms).but when Node 1& Node 2 use low power level we got 0% of throughputs when interference Node use high power level and high flow speed (PL=18dBm & RO=0 ms).

The Fig 10 show comparison between two value *case 1* when Node 1& Node 2 = (PL=18 dBm & RO=1 ms) means high power with speed 1ms of data flow and the *case 2* Node

www.ijtra.com Volume 2, Issue 4 (July-Aug 2014), PP. 218-224 1& Node 2 = (PL=10 dBm & RO=1 ms) this value means low power used by Node 1& Node 2.

We can recognize from the Fig 10 the *case 1* give best result then *case 2*. We can see the node 3 effect much more when sending packet in high rate and high power signal so the result is block the channel as we see 0% of throughput in *case 2* when Node1 & Node2 use low power and in *case 1* that interference effect about 60% when Node1 & Node2 use high power signal but in *case 2* we are consuming the energy by sending signals with high power level. To save energy in our network we need to work on *case 2* low level of power for Node1 & Node2 and at same time avoid the interference so to solve this problem we can reduce the flow of packet or reduce the power level of sending data from interference node (Node 3) as we can see in Fig 10 when the Node 3 values (PL=10 dBm & RO=0 ms) and (PL=18 dBm & RO=1 ms) we get around 98% of throughput.



power

This interference algorithm work on priority of node if the high priority suffering from interference then the low priority reduce the flow of packet or reduce the power level of sending data from interference node. In case that all interference nodes have high priority then master node then the best solution to avoid the interference is by changing channel. So by applying our algorithm we eliminate the interference as well as saving the energy.

#### IX. CONCLUSIONS

As we can see the interference effect on the performance of network as reduce the throughput or may block the channel. As we need to eliminate the retransmission to save energy by applying our algorithm we can avoid the interference and increase the throughput also we saved energy by allow Node1 & Node2 sending the packet in low level energy.

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