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Wireless Sensor Network (WSN): A Reliable Data Transfer Using Spaced Hop by Hop Transport

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ABSTRACT: In wireless sensor network reliable data transfer is one of the most important issues. There exist a number of protocols which provide reliability when packet is send over the network. The two most important transports are end-to-end and hop-by-hop. In this paper we proposed a framework for transferring the data which is based on the spaced hop-by-hop transport. Spaced hop-by-hop provide the best output in an intermittently connected-path in comparison to end-to-end and basic hop-by-hop transport.

Index Terms*—Wireless sensor network, end-to-end, hop-by-hop, Spaced hop-by-hop.*

I. INTRODUCTION

Wireless sensor network is a distributed network which is self organized along with significant number of tiny devices. These tiny devices have a minimum cost. The main drawback of that tiny devices on which wireless sensor network rely has limitation in processing, memory, communication and energy capabilities. The problems which are related to the WSNs are energy–conservation, reliability and congestion control .These problem are related to the several layers as application layer to physical layer as congestion control may be related to the transport layer and energy conservation is related to the data link layer, network layer or any other high level layers. We basically focus on the transport layer's issues in which transport layer protocols and reliability are important points. Transfer Control Protocol (TCP) [13] and User datagram Protocol (UDP) [14] are the popular transport protocols which are extensively used in the Internet and may not be a good choice for wireless sensor networks. The cross layer optimization is not very good in all these protocols means interaction and communication between the lower layer and upper layer protocols are not so easy and it is effect the system performance .In wireless sensor networks, sensor nodes have different capacity of communication and computation at each end of a particular connection.

Data transfer in wireless sensor networks affected by the loss in comparison to wired networks in the Internet. This is because in wired network only congestion is the reason of the data loss but in wireless sensor networks there are many reason for data loss as node failure, system environment etc. So overcome the problem of data loss in wireless sensor networks reliability is the only option while sending the data. Thus reliability is the only option to measure the performance of the wireless sensor networks. Reliability is not only good for the transport layer but it also provides the cross-layer optimization all over the network. So the reliable data transfer is the main issue in wireless sensor networks. There exist a number of reliability protocols for upstream (sensor-to-sink) and downstream (sink-to-sensor) data transfer.

II. TRANSPORT CONTROL PROTOCOLS

According to [1] the main characteristics of the transport layer protocols are reliable message delivery, congestion control and energy- efficiency. There exist a number of protocols as reliability protocols, congestion control protocols and some protocols which provide both congestion and reliability controls. According to [3] only Sensor control transmission protocol (STCP), Asymmetric and reliable transport (ART), Event to sink reliable transport (ESRT) and DTC are protocols which support both reliability and congestion control. Reliability in transport layer divided in two ways as upstream (sensor-to-sink) and downstream (sink-to-sensor).

III. RELATED WORK

There are a number of transport protocols which are already used in wireless sensor network (WSN). The related works on these protocols are presented here. These protocols are differentiated by some categories: Upstream reliability, downstream reliability, Congestion control and Congestion-Reliability Control

A. Upstream Reliability

Upstream reliability means data is transfer sensor node to sink node through those particular protocols as Reliable Multi-Segment Transport (RMST) [2], Reliable Bursty Converge cast (RBC) [2], and Energy

Efficient and reliable Transport protocol (ERTP) [2]. These protocols provide the unicast transmission. Basically if we left the two protocols PSFQ [7] and GARUDA [8] then all the protocols communicate through the upstream reliability.

B. Downstream Reliability

Downstream reliability means data is transfer sink node to sensor node through the Pump Slowly Fetch Quickly (PSFQ) [7] and GUARDA [8] .There are only two protocols which provide downstream reliability. These protocols only broadcasting the message rather than unicasting, means it has
only single sender node (sink node). It successfully sends all the packets and queries from sink to sensor (source).

C. Bidirectional Reliability

Some protocols which offer both side reliability means sensor node to sink node as well as sink node to sensor node. This type of reliability called the bidirectional reliability. Piggybacking is used in that type of reliability. It reduces the complexity and energy consumption of the network. It is better that uses bidirectional reliability in spite of using two unidirectional protocols.

Congestion occur in the wireless sensor network due to interference between sensor to sink, addition n removal of the nodes, high data rates, use of different type network topologies and collision in physical channel [12]. Traditional UDP [14] does not offer any congestion control mechanism in spite of TCP [13] offers only window based approaches [1]. The protocol which offers congestion control and fairness are Code Detection and Avoidance (CODA) [12], Sen.TCP [6], Fusion [9], congestion Control and Fairness (CCF) [10], Priority-based congestion Control Protocol (PCCP) [5]. But all these protocol only provide the congestion control and not provide the reliability mechanism.

IV. DATA TRANSFER IN TRANSPORT LAYER

Reliable data transfer is one of the most important issue in transport layer .When packet is send over the network then it reached successfully (with no congestion or data loss) to the sender and find the acknowledgement that packet is send successfully. The process by which acknowledgment is send to the sender is called the retransmission policy of the transport layer and with the help of this policy we get to know that data is send successfully or not. In the transport layer two types of transport used for sending the packets these are end-to-end and hop-by-hop transport. In [4], SimonHeimlicher et al proposed a one transport that is spaced hop-by-hop and it is better from the both end-to-end and basic hop-by-hop transport.

A. End-to-End Transport

In the end-to end transport data transfer sensor to sink and no any intermediate node take part in that type of transport. So it causes the delay and minimum throughput. So this type of transport is only useful when connected path is available and not good for intermittently –connected networks. In the long disruption periods the end-to-end perform better in comparison to hop-by-hop, so we can say that the loss data recovery is very difficult in the end-to end transport and it is not good for wireless sensor networks. If we consider that a source to destination pair is communicating with the help of the H links (hops) and these links appear for a q fraction of time for wireless communication and node mobility. So end-to-end transport is established when all the links are connected .Then according to SimonHeimlicher et al [4] if the throughput is T^c
and it is bounded by the link capacity C and link loss is given that is q then we can write $T^c \leq q^H.C$ for all $0<q<1$.

B. Hop-by-hop Transport

In the hop-by-hop intermediate nodes are used for sending the data rather than final node. So it is not necessary that path is fully connected for sending the data. It is also helpful in the intermittently-connected networks. Due to this it is more energy efficient in comparison to end-to-end transport. As end-to-end transport is good in long disruption periods as well as hop-by-hop transport is good in short disruption periods. If we consider that a source to destination pair is communicating with the help of the H links (hops) and these links appear for a q fraction of time for wireless communication and node mobility According to SimonHeimliche et al [4] throughput is bounded by the fraction of hops that is T^h that are available over the length written as $T^h \leq q.C$ for all $0<q<1$ and finally it holds that $T^h \geq T^c$.

C. Spaced hop-by-hop Transport

As we already told that end-to-end transport is good in large disruption periods and hop-by-hop is good in small disruption periods. So we need a mechanism which works well in both the situation. So a mechanism which work well in both the situations are called spaced hop-by-hop transport. It is different from the end-to-end and basic hop-by-hop transport. In [4] SimonHeimlicher et al prove that spaced-hop-by-hop is better from end-to-

end and basic hop-by-hop transport. According to the SimonHeimlicher et al slightly variation in basic hop-by-hop protocol introduce a new scheme called spaced hop-by-hop

In the spaced hop-by-hop we introduce an idle period between the successive transmission attempts by increasing the retransmission periods. We select the retransmission timeout considerably longer than the minimum value of $T^{h}_{RTO} = 1$ for the spaced hop-by-hop scheme. Set is equal to the end-to-end scheme which we used in the basic hop-by-hop scheme i.e. $T_{RTO} = T_{RTT} = 2H$ time slot where RTO is retransmission time out , RTT is round trip time and H links (hops). For applying these rule transmission periods of the spaced hop-by-hop transport is equal to the end-to-end transport. The number of transmission is infinite and limited to the L, so the maximum number of the link transmission is upper bound to the *H.L.* Here h is number of links and L is the length of the path.

So SimonHeimlicher et al [4] numerically, analytically and by simulating prove it that spaced hop-by-hop is better than both of the schemes as end-to-end and basic hop-by-hop transport in the context of the delivery ratio , number of link transmission and energy efficiency (due to lower interference). The number of link transmission is lower in the spaced hop-by-hop transport in comparison to basic hop-by-hop when correlation is negative in the wireless sensor network. Wireless sensor network has a number of tiny nodes that called sensors. Due to these tiny nodes, node mobility problem is occur in the wireless sensor networks, so spaced hop-by-hop can be a good choice for transferring the reliable data.

V. PROPOSED WORK

In that present scenario we use the end-to-end and hop-by-hop scheme to transfer the data in the wireless sensor network, the main aim of the transport layer to provide reliability and congestion control. In [2] Faizah Yunus et al present a model for transport layer using hop-by-hop scheme and result is good in the context of energy-saving, congestion control and cross layer optimization. As we know that end-to-end is good in long disruption periods and hop-by-hop is good in short disruption periods. So here we present a framework using spaced hop-by-hop scheme and in [4] it is prove that spaced hop-by-hop is better from hop-by-hop and end-to-end scheme and it is good in both (long and short) disruption periods. In that framework we use a spaced-hop-by-hop scheme for transferring the data. But when the negative correlation is exist in the network then we use the basic hop-by-hop scheme for transferring the data because in negative correlation spaced hop-by-hop perform lower in the term of link transmission rate in comparison to basic hop-by-hop scheme.

When data is transfer then transport layer interact with the other lower layers. The flow of process is start from the application layer and it goes to the transport layer and there transport layer interact with the congestion control and reliability and ensure that data is transfer easily to sink node. Then process goes to the network layer and it decides the best route for the data, then process goes to the physical layer. In transport layer when it finds that congestion is occur then it send the data to the MAC layer and try to solve the problem of the congestion. In the whole scenario of the data transfer we use the spaced hop-by-hop transport.

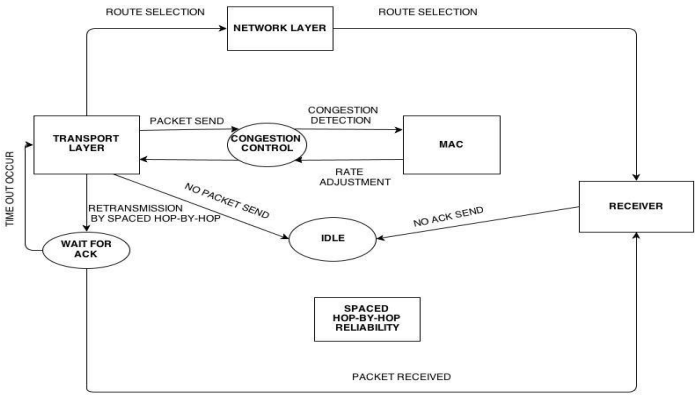

Fig 1: Reliable Data Transfer using Spaced Hop-by-hop Transport

In fig 1 we a reliable data transfer is showing with the help of spaced hop-by-hop. In that process when data is transfer then transport layer check that there is congestion or not if it find the congestion then it contact with MAC layer and that layer detect that where n why congestion is occur and send the rate adjustment information to the transport layer. Transport layer then handle that congestion and this congestion problem is solved by the spaced hop-by-hop reliability. Further when transport layer find that delay is happen for getting the acknowledgement (Ack), then it apply the retransmission policy with the help of the spaced hop-by-hop. With the help of the retransmission hop-by-hop scheme time delay is reduced and energy-saving is also efficient. After solving the problem of the congestion control data is transfer to the network layer where network layer deal with the process of the route discovery for the data.

A. Delivery Ratio

- In the context of the delivery ratio the spaced hop-by-hop is perform better in the comparison of the end-to-end.
- In the context of delivery ratio spaced hop-by-hop perform better in the comparison of the basic hop-by-hop in the positive correlation.

B. Link transmission

- In the term of link transmission spaced hop-by-hop has full dominance over basic hop-by-hop then the retransmission timeout of the network is good.
- Because of retransmission policy of end-to-end scheme is same as spaced hop-by-hop scheme, but the spaced hop-by-hop has dominance over the end-to-end scheme in the term of delivery ratio and link retransmission.

So introducing the new transport scheme as spaced hop-by-hop in the transport model for transferring the data, we can achieve the reliability when we transferring the data. So with the help of spaced hop-by hop transport we can achieve good link transmission rate. Reduced delay in retransmission of the packets and energy-saving is efficient in the network. All the layers communicate easily from lower layer to upper layer and upper layer and information can be share easily n with no delay. As example when congestion control occur in transport layer then transport layer interact with MAC layer for dealing with congestion control, then MAC layer help for detecting congestion and send the information to transport layer that which rate is required means adjust the rate for transferring the data.

VI. CONCLUSION AND DISCUSSION

Previously a model is proposed which is depending on basic hop-by-hop data transport. Here the authorsss presents a framework which is depending upon the spaced hop-by-hop transport. A reliable data transfer with the help of the spaced hop-by-hop transport better from the end-to-end and basic hop-by-hop. In all scenario spaced hop-by-hop is better but when correlation is negative then basic hop-by-hop perform better in comparison to spaced hop-by-hop and it will be our future work. We further studied to enhance the performance of the transport model and try to simulate that theory. In our next paper we present our simulation work and simulation data.

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