Message Aggregation and Fragmentation in Wireless Sensor Networks using Dynamic Packet Length Control

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Abstract **- Wireless Sensor Networks (WSNs) comprising of battery-powered sensor nodes is being used in a wide range of applications. Packet size optimization is an important issue in energy constrained in wireless sensor network. Dynamic Packet Length Control scheme provide a dynamic adaptation scheme to achieve performance improvements in dynamic, time-varying sensor networks. DPLC more efficient in terms of channel utilization, incorporate a lightweight and accurate link estimation method. It provides two accessible services, i.e., small message aggregation and large message fragmentation, to make easy upper-layer application programming. DPLC should incorporate an accurate link estimation method that can capture physical channel conditions. DPLC should provide easy-to-use services to facilitate upper-layer application programming. DPLC should be lightweight for resource constrained sensor nodes. The feasibility of dynamic packet length optimization in WSNs is to demonstrate its performance improvement by integrating it into CTP, a widely used data collection protocol.**

Keywords: Dynamic Packet length scheme, Aggregation service, Fragmentation service, Wireless sensor networks.

I.INTRODUCTION

A wireless sensor network (WSN) consists of a collection of nodes that have the facility to sense, process data and communicate with each other via a wireless connection. Wireless sensor networks (WSN's) which improves in sensor technology has made it possible to have very small, low powered sensing devices equipped with programmable compute, multiple parameter sensing and wireless message capability [1]. Also, the low cost makes it possible to have a network of hundreds or thousands of these sensors, thereby enhancing the consistency and accuracy of data and the area coverage [2]. Wireless sensor networks offer information about isolated structures, wide-spread environmental changes, etc. Wireless sensor network (WSN) is a network system comprised of spatially distributed devices using wireless sensor nodes to monitor physical or environmental situation, such as sound, temperature, and motion.

A sensor network is designed to perform a set of high-level information processing tasks such as detection, track, or categorization [2]-[6]. Measures of performance for these tasks are well defined, including discovery of false alarms, classification errors, and track quality.

A trade-off exists between the will to cut back the header overhead by creating packet massive, and also the got to scale back packet error rates (PER) within the shouting channel by exploitation little packet length [8], [9]. Though there are many studies on packet length optimizations within the literature, existing approaches typically need that a collection of parameters to be fastidiously tuned such it will higher match the extent of dynamics seen by any explicit information trace. However, any fastened set of parameters won't adapt to the dynamic conditions since one parameter set doesn't work all conditions [4], [5]. Moreover, the update method would need user intervention, additional information assortment and reprogramming the parameters. This is often exactly what needs to avoid in our case, and one in all the strengths of exploitation dynamic packet length improvement theme. Results show that DPLC achieves the simplest performance in terms of transmission overhead and energy potency [9]. The contributions of our work area unit highlighted as follows.

- To implement a dynamic packet length improvement theme within the context of WSNs. To incorporate an accurate link estimation technique that captures wireless characteristics.
- To supply two easy-to-use services, i.e., little message aggregation and huge message fragmentation, to make easy upper-layer application programming.
- Evaluate DPLC extensively to demonstrate the feasibility of dynamic packet length optimization in WSNs, and show its performance improvement by integrating it into CTP [7], a widely used data collection protocol.

II. RELATED WORK

In [21] flush provides end-to-end dependability, reduces transfer time, and adapts to time-varying network conditions. It achieves these properties victimization end-to-end acknowledgments, implicit snooping of management data, and a rate-control algorithmic rule that operates at every hop on a flow. victimization many real network topologies, show that Flush closely tracks or exceeds the utmost sensible place realizable by a hand-tuned however mounted rate for every skip a large vary of path lengths and ranging network conditions. Flush is scalable; its effective information measure over a 48-hop wireless network is some tierce of the speed realizable over one hop.

In [19] K. Jamieson and H. Balakrishnan say Bit errors occur in wireless communication once interference or noise overcomes the coded and modulated transmission. Current wireless protocols could use forward error correction (FEC) to correct some tiny range of bit errors, however usually channel the entire packet if the FEC is light. Observe that current wireless mesh network protocols channel variety of packets which most of those retransmissions find you causing bits that have already been received multiple times, wasting network capability to beat this unskillfulness, we develop, implement, and valuate a partial packet recovery (PPR) system.

In [13] S. Ganeriwal, I. Tsigkogiannis, H. Shim, V. Tsiatsis, M. B. Srivastava, and D. Ganesan “Estimating clock uncertainty for efficient duty-cycling in sensor network”**,** propose connect grade uncertainty-driven approach to duty-cycling wherever a model of long-run clock drift is employed to attenuate the duty-cycling overhead. First, use long-run empirical measurements to judge and analyze in-depth the interaction between 3 key parameters that influence long-run synchronization - synchronization charge, the earlier period of past synchronization beacons and also the estimation theme. Second, use this measurement-based study to style a rate-adaptive, energy-efficient long-run time synchronization algorithmic rule which will adapt to dynamical clock drift and environmental conditions whereas achieving application-specific exactness with terribly high likelihood. Finally, integrate uncertainty-driven time synchronization theme with a Macintosh layer protocol, BMAC, and by trial and error demonstrate one to two orders of magnitude reduction within the transmit energy consumption at a node with negligible impact on the packet loss rate. In theory, sensing element nodes deployed for these applications ought to use the radio only the rare events square measure discovered, hence, radio energy consumption ought to be stripped-down.

In [12] X. Liu, Q. Wang, W. He, M. Caccamo, and L. Sha presents the characteristic of a multi-hop Real- paper presents solutions to each of the new challenges. The primary answer to the optimum rate allocation may be a centralized answer which will handle the additional general sort of constraints as compared with previous analysis. The second answer may be a distributed version for giant sensing element networks employing a rating theme. it's capable of progressive adjustment once utility functions modification. This paper additionally presents a replacement sensing element device/network backbone design period of time freelance Channels (RICH), which may simply notice multi-hop period wireless sensing element networking. RTWSN presents new challenges for period resource allocation.

In[11]I.F.Akyildiz,W.Su,Y.Sankarasubramaniam, and E. Cayirci says that realization of those and alternative sensing element network applications need wireless accidental networking techniques. Though several protocols and algorithms are projected for ancient wireless accidental networks, they're not compatible for the distinctive options and application necessities of sensing element networks. Several researchers square measure presently engaged in developing schemes that fulfill these necessities. During this paper, gift a survey of protocols and algorithms projected to this point for sensing element networks. Our aim is to supply a stronger understanding of the present analysis problems during this field. We have a tendency to additionally try associate degree investigation into pertaining style constraints and description the utilization of bound tools to satisfy the look objectives.

III.SYSTEM DESCRIPTION

In this section, present DPLC’s design. The major design goals are

- Dynamic adaptation. DPLC ought to give a dynamic adaptation theme to realize performance enhancements in dynamic, time-varying sensing element networks.
- Correct link estimation. DPLC ought to incorporate associate in correct link estimation methodology which will capture physical channel conditions.
- Simple programming. DPLC ought to give easy-to-use services to facilitate upper-layer application programming.
- Light-weight for implementation. DPLC ought to be light-weight for resource affected sensing element nodes.

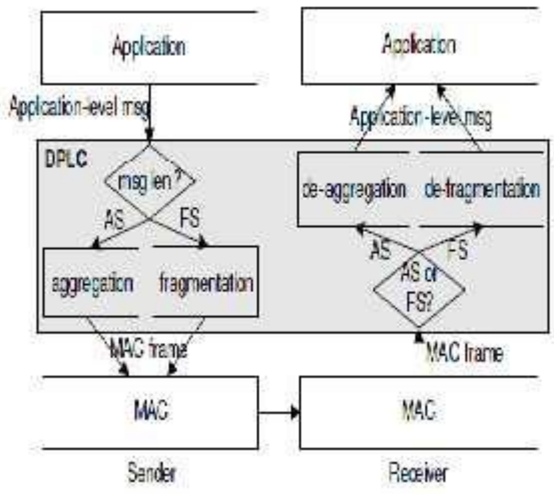

Fig. 1: DPLC overview.

A. Overview

The application passes associate in application-level message for communication. The DPLC parts at the sender decide whether or not to use the aggregation service (AS, if the message length is small) or the fragmentation service. The link among DPLC dynamically estimates the acceptable packet length for transmission as shown in fig 1. Supported this, the DPLC module at the sender decides what number messages ought to be mass (for AS), or what number frames the message ought to be fragmented into (for FS). Once a frame is prepared for transmission (enough messages are mass or time is come in AS), DPLC transmits it out via the waterproof layer. Once the DPLC module at the receiver receives a waterproof frame, it American state aggregates or defragments the in close order to get the original message. Once the message is prepared (all frames within the message are received or the receive buffer is packed in FS), the DPLC part at the receiver notify the higher layer for any handling.

The DPLC theme provides two services for upper-layer applications, i.e., the aggregation service (AS, for little messages) and therefore the fragmentation service (FS, for big messages). AS is beneficial for little knowledge assortment, e.g., CTP.

Aggregation Service is beneficial for little knowledge assortment. The Aggregation Service assembling the tiny message from detector nodes. Aggregation Service sends the info to base station. The fragmentation rule adaptively matches channel failure characteristics. The work of uses an easy freelance bit error model for packet length adaptation. The work needs the sender to live the channel convenience amount for adaptation. The fragmentation service is beneficial for bulk knowledge transmission. FS provides reliable transmissions as an oversized message is sometimes vital for upper-layer applications. FS doesn't essentially rely upon L2 ACKs. As mentioned higher than, in addition give the AggAck mechanism to mitigate the ACK overhead,

B. Description of DPLC

Individually, DPLC tunes the packet length on each leaving link. A link is originally set to pass on at its default granularity. DPLC monitors all packet receptions by keeping a sliding window of size w. When the window is full, DPLC computes the metric and tries to increase (or decrease) the small package extent by the granularity. Use a gradient variable (g) to decide whether to increase the packet length or decrease the packet length. DPLC uses a small piece vector to documentation each packet's receptions and use it to calculate the packet reception percentage. Originally, the gradient variable is put to 1 and DPLC stay in the INIT state as shown in fig 2.

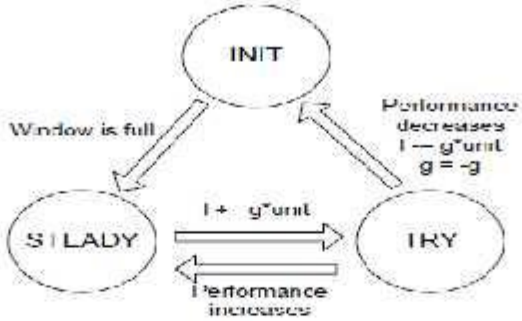

Fig. 2: DPLC state transition diagram

C. Metrics for Dynamic Adaptation

For a path 1 → $k + 1$, the normalized path transmission overhead $TO_{1\to K+1}$ is the number of total transmitted bytes at nodes 1… .. k divided by the number of received useful bytes at node k + 1. We use $dr_{i\to i+1}$ to denote the data delivery ratio over the link $i \to i+1$. It can seen from equation (1) that the data delivery ratio differs from link PRR in that link layer retransmissions can improve the data delivery ratio . It relates to PRR and the link layer retransmission threshold m as follows,

$$dr_{i\to i+1} = 1 - (1 - p_{i\to i+1})^{m+1} \qquad (1)$$

When the threshold of retransmissions is 0 (i.e., there is exactly one transmission), *dr* equals to *p*, i.e., the packet delivery ratio equals to the link PRR. Note that both *dr* and *p* are functions of the packet length.

Metric for Single-Hop Transmission

It can be seen from equation (2) that for a flow traversing a link $i \to i + 1$, we decide the transmitted packet length at node i in order to minimize the single hop metric which is,

$$TO_{i\rightarrow i+1}(l)=\frac{l+H+O}{l.p(l)} \qquad (2)$$

Where l is the packet payload length (bytes) over the link, p (l) is the PRR from i to i+1 given the packet payload length l, H is MAC header overhead, and O is the additional header overhead introduced by DPLC.

Metric for Multi-Hop Transmission

For a flow traversing a path 1 → k + 1, we decide the transmitted packet length at node k as follows. It can be seen from equation (3) and (4) that the calculation is different because in this case node k is not the source node (the source node is k−1 hops away from node k). The normalized transmission overhead $TO_{1\rightarrow k+1}$ is the sum of the transmission overhead over the link k → k+1 and the transmission overhead over the path 1 → k for node k + 1 to receive 1 useful byte. For receiving one useful byte at node $k + 1$, node k must receive $\frac{1}{dr_{k\rightarrow k+1}}$ bytes.

For receiving $\frac{1}{dr_{k\rightarrow k+1}}$ useful bytes at node k, the transmission overhead over the path 1 → k is $\frac{1}{dr_{k\rightarrow k+1}}.TO_{1\rightarrow K}$. So the normalized transmission overhead over the entire path 1 → k + 1 can be recursively calculated as follows,

$$TO_{1\rightarrow K+1}=TO_{k\rightarrow K+1}+\frac{1}{dr_{k\rightarrow k+1}}.TO_{1\rightarrow K} \qquad (3)$$

The multi-hop metric can be openly expressed as a function of l as follows,

$$TO_{1\rightarrow K+1(l)}=TO_{k\rightarrow K+1(l)}+\frac{1}{dr_{k\rightarrow k+1(l)}}.TO_{1\rightarrow K} \qquad (4)$$

Where,l is the packet length over the link k → k +1.

D. Performance Evaluation

The collection reliability in terms of data delivery ratio. The data delivery ratio is the number of packets received at the sink node divided by the number of generated packets. Note that use a maximum link-layer retransmission threshold of 4 in this experiment. This means if a packet transmission fails, the sender would retry at most 4 times before it gives up. With link-layer retransmission, the packet delivery ratio keeps high, e.g., above 95%. Then see that the CTP-max scheme is less stable than the other schemes. The reason is due to the fact that larger packets are more suspect able to wireless loss.

CTP is a data collection protocol that dynamically selects the best route to the sink according to a hybrid link estimation algorithm DPLC is an iterative algorithm that increases or decreases the packet length based on the TO metric.

IV.IMPLEMENTATION

The major goal of the simulation is to demonstrate DPLC's possible enhancements in terms of the transmission overhead per helpful computer memory unit (TO). Use thoroughgoing search to seek out the best packet length order to validate the DPLC algorithmic program. The thorough going search procedure merely iterates over every double packet length. In every iteration, it calculates the TO metric outlined supported the already far-famed simulation parameters. The search procedure finally returns the packet length that minimizes the TO metric.

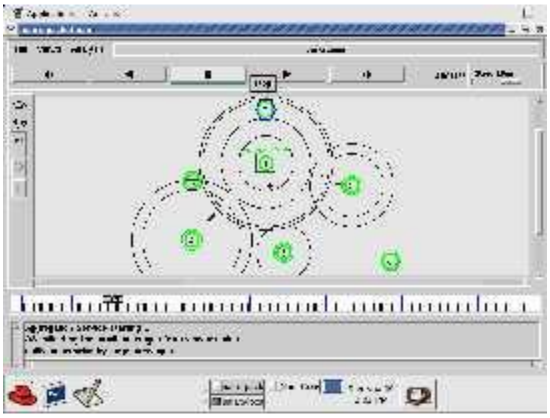

Fig.3: Data Aggregation Service

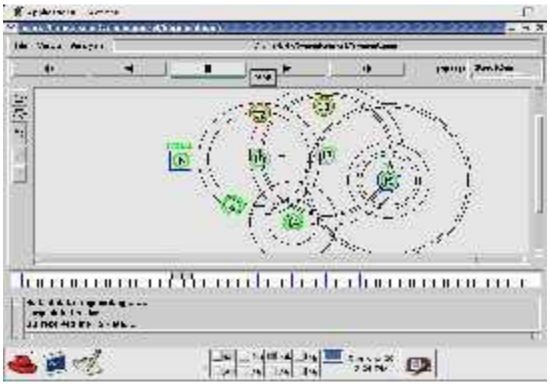

Fig.4: Data Fragmentation Service

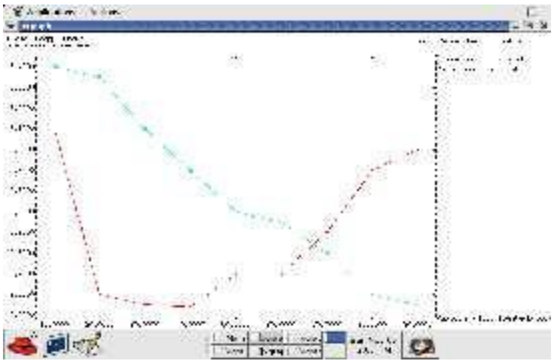

Fig.5: Impact of Packet Payload Length On TO and PRR with Power Level=3, Distance=8m.

DPLC severally tunes the packet length on every outgoing link. A link is at the start set to transmit at its default graininess (which equals to the message payload length for AS and ten bytes for FS in our current all packet implementation).

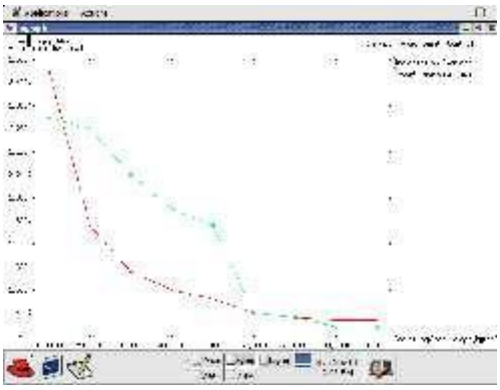

Fig.6: Impact of Packet Payload Length On TO and PRR with Power Level=4, Distance=8m.

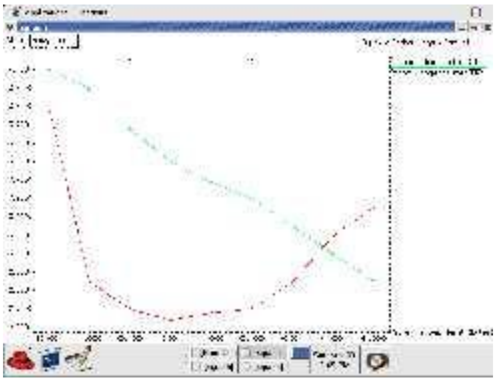

Fig.7: Impact of Packet Payload Length On TO and PRR with Power Level=4, Distance=35m.

DPLC monitors receptions by keeping a window of size w. once the window is full, DPLC computes the metric and tries to extend (or decrease) the packet length by the graininess. Results show that DPLC achieves the simplest performance in terms of transmission overhead and energy potency.

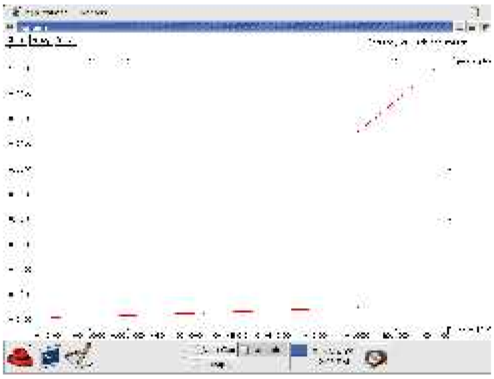

Fig.8: Accuracy of Link Estimation

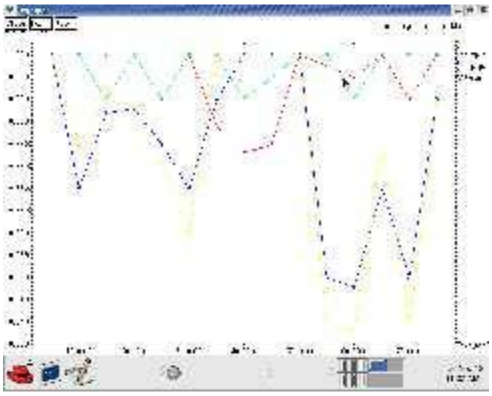

Fig.9: Delivery Rate over Time

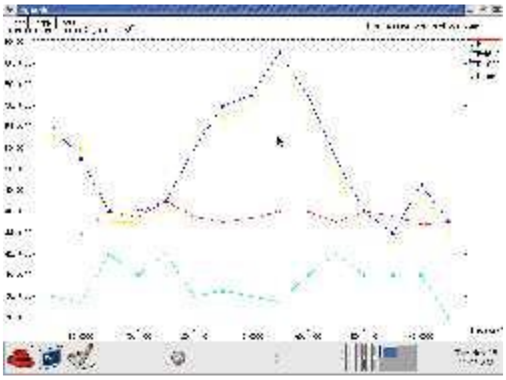

Fig.10: Transmissions Overhead Over Time

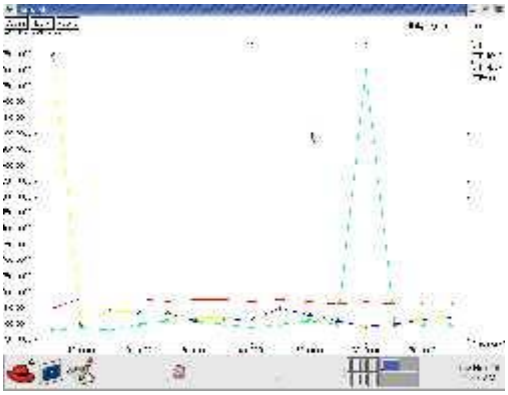

Fig.11: Duty Cycle over Time

Energy analysis and extensions: we are able to extend the energy analysis approach by considering the packet length below XMAC. Convergence analysis and extensions: DPLC needs some quantity of information traffic to converge with relevancy channel conditions.

CTP-DPLC reduces the transmission overhead compared to both CTP-max and CTPAIDA. CTP-AIDA also has a higher duty cycle than CTP-DPLC because of less aggressive aggregation. We can see that CTP-max slightly reduces the reliability while CTP-DPLC remains the high reliability of the original CTP.

V. CONCLUSION

This paper presents DPLC, a Dynamic Packet Length management theme. DPLC incorporates a light-weight and correct link estimation technique that captures physical channel conditions. Moreover, DPLC provides two easy-to-use services, i.e., tiny message aggregation and enormous message fragmentation, to make easy of upper-layer application programming. The implementation is light-weight with regard to calculation, memory, and header overhead. Our experiment employing a real indoor test bed running CTP show that DPLC achieves the most effective performance compared with previous works.

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