A Multi-Path Dynamic Routing for the Fulfilment of QoS Requirements in Wireless Sensor Networks

Shantanu P
Engineering Student
Department of ISE
AMC Engineering College, Bangalore

Sukhil
Engineering Student
Department of ISE
AMC Engineering College, Bangalore

Varsha M
Engineering Student
Department of ISE
AMC Engineering College, Bangalore

Kashyap
Engineering Student
Department of ISE
AMC Engineering College, Bangalore

Vidya Rao
Asst Professor,
Department of ISE
AMC Engineering College, Bangalore

Abstract: **Amongvarious Quality of Service (QoS) requirements in Wireless Sensor Network (WSN) domain, less delay and high data integrity are of critical issue. In most situations, these two provisions cannot be satisfied at the same time due to definite bandwidth and limited buffer space. To resolve the above conflict, (Integrated Delay Differentiated Routing) IDDR a multi-path dynamic routing algorithm which uses the concept of potential in physics is proposed. A virtual hybrid potential field is created which separates packets of applications with various QoS provisions. This is done by assigning weight to each packet, and routing them towards the sink through different paths to improve the data fidelity for integrity-sensitive applications as well as reduce the high delay for delay-sensitive ones. Simulation results demonstrate that IDDR provides data integrity and delay differentiated services.**

Keywords: Data integrity, delay differentiated services, dynamic routing, potential field, Wireless sensor network.

I. INTRODUCTION

Wireless Sensor Network (WSN) is a network structure where each other nodes are connected to several other nodes without using any physical mode. Wireless Sensor Network has several ample applications such as monitoring system, environment monitoring system, healthcare centre etc. Because of their uniformity and simplicity [1] the WSNs has given us an easier environment. They are getting to be basic part of our lives. QoS in WSN can be understood as a measurement metrics that measures delay, integrity, bandwidth, accuracy, packet drop etc. of the end-user's or application's network. User only concentrates on the service that the network gives to improve the QoS of the application and not really concentrate on how the network is going to grant.

The development in wireless sensor network technology has possible methods to realize the wireless sensor network (WSNs) in a wide range of situations. WSNs consists thousands of small sensor nodes are effective in a physical environment for examination of interested events. The sensors in the area of an event examine and account back to the sink. A sink sensor node connects with outside world like laptop, base station. Sensor nodes [2] are used as an effective part in traffic control, battlefield, habitat monitoring and intruder tracking. The legacy target tracking methods for Wireless Sensor Networks utilizes the centralized approach. Since the number of sensors increases in the network, more messages are not sent to the sink and uses extra bandwidth.

The QoS requirements can be either application specific or network specific. This work aims to simultaneously improve the data integrity and decrease the end-to-end delay. IDDR [4] is able to provide the following two functions:

Increases fidelity for high-integrity applications: The maximum buffer space available is found from the idle and/or under-loaded paths to cache the extra packets that might be dropped on the shortest path. Therefore, the first job is to find these paths, then the next is to cache the packets efficiently for the following transmission.

Decrease delay for delay-sensitive applications: Each application is given a weight, which represents the absolute sensitivity to the delay. Through building local dynamic potential fields with different slopes according to the weight values carried by packets, IDDR allows the packets with larger weight to choose shorter paths.

Existing systems cannot accomplish low delay and high integrity services at the same time. Since delay sensitive packets have definite bandwidth and buffer space. High integrity packets restrict the shortest path thus delay sensitive packets to travel additional hops and these packets dwell in buffers that will increase the queuing delay for the delay sensitivity packets

The rest of the paper is catalogued as follows. Section 2 describessome of the related work is discussed. Section 3 presents the details and design of IDDR. Section 4shows the system analysis and experimental results. Finally, Section 5 presents conclusion**.**

II. RELATED WORK

There are many routing protocols like RAP, SPEED and EDF that are proposed whichprovides real-time service and rules like AFS, ReInforM and LIEMRO are proposed to have a hold on the stability.

Hassanein, *et al*.,[3] proposed Reliable energy aware routing in wireless sensor networks. It reduces energy wastage basically. The reliability is achieved by sending packets across multiple paths. Source node starts the routing procedure and the path discovery process packets are over loaded by sink node. It is used to decrease buffering and data loss in case of broken connection.

E. Felemban, *et al*.,[6](Multipath Multi SPEED)MMSPEEDa development ofSPEED and this procedure provides many route and multi speed for data. The QoS essentials like stability and timeliness are provided. Here routing is confined, which allows different types of packet to go through the network. By taking decision between each node it achieves both QoS essentials that was considered. But it devours a lot of power in doing so. The protocol suffers from wastage of the energy and data dismissal problem.

Stankovic*et al*.,[9] *SPEED* isQoS aware protocol in WSN. Every single hub will have the particulars of the hubs around them and Geographic Forwarding is used as a routing algorithm to gain the path. Mobbing can be lessened using this. However, packet drop ratio is high when network is mobbed.

P. T. A. Quang*et al.*,[10]Gradient routing information with two-hop for industry required wireless sensor networks to increase energy efficiency with real-time performance.

B. Deb*et al.*, [12]ReInForM, a routing algorithm which provides wanted fidelity at proportional cost. This procedure makes copies of the packet and transfers them through various paths. Reliability or stability is achieved by the above routing. But lack in resources like energy and bandwidth usage and the global topology of the network that is to be known.

M. Radi, B. Dezfouli*et al*.,[13]The existing multipath algorithms for wireless sensor networks depict the efficacy of traffic distribution over various paths to fulfil the Quality of Service (QoS) requirements of various applications. However, the performance of these protocols suffers from the essentials of the wireless channel and may be even affect the performance of single-path approaches.

J. Ben-Othman *et al.*,[14]The hype for real-time applications in Wireless Sensor Networks (WSNs) has changed the Quality of Service (QoS) based communication protocol. Fulfilling Quality of Service (QoS) requirements (e.g. integrity and bandwidth) for the variousQoS based applications of WSNs raises notable challenges.

EQSR protocol for wireless sensor networks to recover from node failure is needed. The protocol divides the traffic and routes through disjoint node paths along the network to achieve efficient load balancing. The real time and non-real time queuing model is deployed to distinguish between real time and non-real time data traffic. But this protocol will be affected with control overhead.

.D. Djenouri*et al*.,[16]proposed aQoS aware routing for Wireless Sensor Network. In network having various data traffic types, it is used to distinguish among theQoSessentials in accordance to the data type, which empowers to give different customized QoS metrics for per barter type.

C.-Y. Wan *et al*.,[18**]** Event-driven sensor networks work with idle or less load and then all of a sudden become active in return to a detected or monitored task. CODA (Congestion Detection and Avoidance) that consists of three mechanisms: (i) based on receiver congestion selection; (ii) open-loop backpressure; and (iii) closed-loop regulation.

III. IDDR ALGORITHM

To improve fidelity for data integrity applications and to decrease end to end delay for delay sensitive applications,a novel potential based routing protocol, and integrity and delaydifferentiated routing (IDDR) was introduced.

The potential field is created by calculating the potential depth and queue length of each node using Euclidean Distance rule. Clusters [7] are formed by accounting energy and position. Cluster head is chosen for individual cluster which is formed based on energy and potential depth value.To route the packets from one cluster toanother until it reaches the sink, cluster head issued. The implication of the absolute delay sensitivity is done by assigning weights to packets. Delaysensitive [11] packets are the ones whose weights are not zero and which should be travelled through shortest path to escape end to end delay. Withzero weights considered, data integrity packets are encrypted to manage the integrity. The integrity and delay differentiated routing (IDDR), potential based routing algorithm is used to route distinguish different packets according to their weight.

Let ‘c’ be the weight of the packet which helps in distinguishing between the delay-sensitive applications and integrity-sensitive applications. It is given in the packet header. Let 'P' be the packet, 'Q' be the queue length, CH be the cluster head and D_{ij} be the distance between the clusters. Firstly the packet weight is checked and then the criteria is known. And next CH with the minimum distance and with the empty queue is found. If the packet is a integrity-sensitive one then the packet is sent to the above CH else sent to the present CH. Through this algorithm we route packets with delay-sensitivity in a shortest path and the integrity-sensitive ones in the longest path in order to avoid drop leakage and achieve the purpose.

Algorithm 1: IDDR Algorithm

```
Begin
1.   Input c
2.   If (c!=0)
3.      A=delay-sensitive
4.   Else
5.      A=integrity-sensitive
6.   End if
7.   If((CH==min[Dij])&&(Q!==0))
8.      While(Q==0)
9.     P=CH(Pos[Dij+1])
10.     End while
11.  Else
12.     P=CH, Goto 1
13.  End if.
End
```

IV. SYSTEM ANALYSIS

Execution of potential-based routing algorithm of legacy wireless networks did not neither fulfill the Qos requirements nor attract widespread attention because of its complex management overhead. To build an exclusive virtual field it is upscale for each destination where numerous destinations might be distributed randomly in legacy networks. On the other end of the spectrum, the potential-based routing algorithm is much suitable for the many-to-one traffic pattern in WSNs.

Many special applications and environments, may have the existence of more than one sink. In general, the data-centric WSNs will use only nodes to transfer their sampling data to one of them. An unique virtual potential field is built to customize a multipath dynamic routing algorithm, which finds paths for the packets to the sink with high integrity and delay requirements accordingly. Along the surface like water the data packets are sent to the bottom. In WSNs with less traffic, IDDR works same as the shortest path routing algorithm where in with high load, large backlogs will form some bulges on the bowl surface[8].

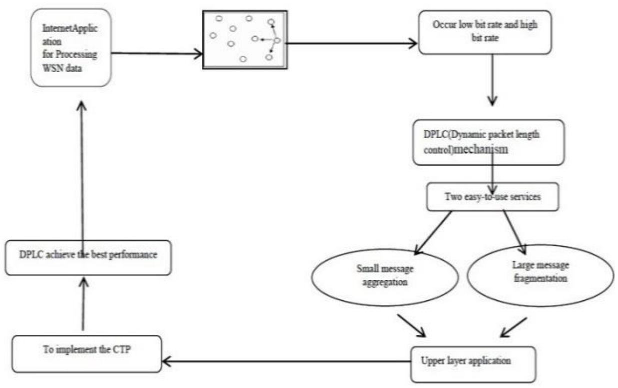

Fig. 1 System Architecture For IDDR Algorithm

V. EXPERIMENT RESULTS

Fig 2 and 3 shows the dropratio of the two applications against time with IDDR and MintRoute[17] on the testbed. Considering the two lines as the two applications, IDDR can achieve smaller drop ratio than the MintRoute in both the applications. In IDDR the first application will have high drop ratio due to the large load difference between the shortest path and the longest path. But in MintRoute both the applications has the same drop ratio.

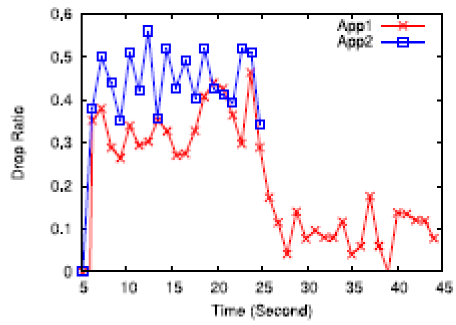

Fig. 2 Drop ratio under IDDR testbed.

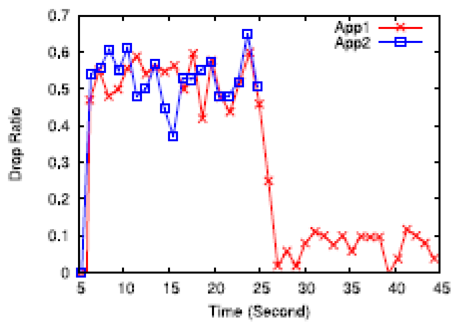

Fig. 3 Drop ratio under MintRoutetestbed.

Fig 4 and 5 shows the end-to-end delay with IDDR and MintRoute.The shortest path have three hops while the longest path has four paths and hence the end-to-end delay is decreased in IDDR. MintRoute packets of Applications have the same end-to-end delay.The reduction is caused by the smaller queuing delay between the nodes.

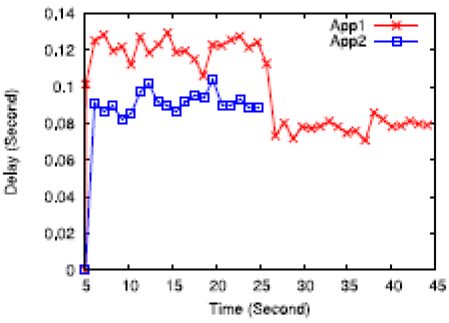

Fig. 4 Average packet delay under IDDR testbed

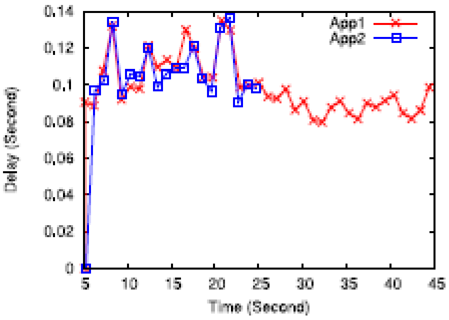

Fig. 5 Average packet delay under MintRoutetestbed

VI. CONCLUSION

A multipath dynamic routing algorithm IDDR which is based on the concept of potential in physics to fulfil the two mainQoSrequirements, high data integrity and low end-to-end delay, over the same WSN concurrently is proposed.IDDR algorithm is proved to be stable in different simulation techniques and at the same time experimental results proves to significantly improve the throughput of the high-integrity applications and decrease the end-to-end delay of delay sensitive applications. IDDR can also provide good scalability because of the local information that is provided, which simplifies the implementation with acceptable communication overhead.

REFERENCES

[1] P. Levis, N. Lee, M. Welsh, and D. Culler, "TOSSIM:Accurate and scalable simulation of entire TinyOS applications," in Proc. 1st Int. Conf. Embedded Networked Sensor Syst., 2003, pp. 126–137.

[2] T. Chen, J. Tsai, and M. Gerla, "QoS routing performance in multihop multimedia wireless networks," in Proc. IEEE Int. Conf. Universal Personal Commun., 1997, pp. 557–561.

[3] R. Sivakumar, P. Sinha, and V. Bharghavan, "CEDAR: Core extraction distributed ad hoc routing algorithm," IEEE J. Selected Areas Commun., vol. 17, no. 8, pp. 1454–1465, Aug. 1999.

[4] S. Chen and K. Nahrstedt, "Distributed quality-of-service routing in ad hoc networks," IEEE J. Selected Areas Commun., vol. 17, no. 8, pp. 1488–1505, Aug. 1999.

[5] B. Hughes and V. Cahill, "Achieving real-time guarantees in mobile ad hoc wireless networks," in Proc. IEEE Real-Time Syst. Symp., 2003.

[6] E. Felemban, C.-G. Lee, and E. Ekici, "MMSPEED: Multipath multi-speed protocol for QoS guarantee of reliability and timeliness in wireless sensor networks," IEEE Trans. Mobile Compute., vol. 5, no. 6, pp. 738–754, Jun. 2003.

[7] C. Lu, B. Blum, T. Abdelzaher, J. Stankovic, and T. He, "RAP: A real-time communication architecture for large-scale wireless sensor networks," in Proc. IEEE 8th Real-Time Embedded Technol. Appl. Symp., 2002, pp. 55–66.

[8] M. Caccamo, L. Zhang, L. Sha, and G. Buttazzo, "An implicit prioritized access protocol for wireless sensor networks," in Proc. IEEE Real-Time Syst. Symp., 2002, pp. 39–48.

[9] T. He, J. Stankovic, C. Lu, and T. Abdelzaher, "SPEED: A stateless protocol for real-time communication in sensor networks," in Proc. IEEE 23rd Int. Conf. Distrib. Comput. Syst., 2003, pp. 46–55.

[10] P. T. A. Quang and D.-S. Kim, "Enhancing real-time delivery of gradient routing for industrial wireless sensor networks," IEEE Trans. Ind. Inform., vol. 8, no. 1, pp. 61–68, Feb. 2012.

[11] S. Bhatnagar, B. Deb, and B. Nath, "Service differentiation in sensor networks," in Proc. Int. Symp. Wireless Pers. Multimedia Commun, 2001.

[12] B. Deb, S. Bhatnagar, and B. Nath, "ReInForM: Reliable information forwarding using multiple paths in sensor networks," in Proc. IEEE Intl Conf. Local Comput. Netw., 2003, pp. 406–415.

[13] M. Radi, B. Dezfouli, K. A. Bakar, S. A. Razak, and M. A. Nematbakhsh, "Interference-aware multipath routing protocol for QoS improvement in event-driven wireless sensor networks," Tsinghua Sci. Technol., vol. 16, no. 5, pp. 475–490, 2011.

[14] J. Ben-Othman and B. Yahya, "Energy efficient and QoS based routing protocol for wireless sensor networks," J. Parallel Distrib. Comput., vol. 70, no. 8, pp. 849–857, 2010.

[15] M. Razzaque, M. M. Alam, M. MAMUN-OR-RASHID, and C. S. Hong, "Multi-constrained QoS geographic routing for heterogeneous traffic in sensor networks, ieice transactions on communications," IEICE Trans. Commun., vol. 91B, no. 8, pp. 2589–2601, 2008.

[16] D. Djenouri and I. Balasingham, "Traffic-differentiation-based modular QoS localized routing for wireless sensor networks," IEEE Trans. Mobile Comput., vol. 10, no. 6, pp. 797–809, Jun. 2010.

[17] A. Basu, A. Lin, and S. Ramanathan, "Routing using potentials: A dynamic traffic-aware routing algorithm," in Proc. Conf. Appl., Technol., Architectures, Protocols Comput. Commun., 2003, pp. 37–48.

[18] C.-Y. Wan, S. B. Eisenman, and A. T. Campbell, "CODA: Congestion detection and avoidance in sensor networks," in