Volume 4, Issue 5, May 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Real Time Routing Protocols In WSN:A Review

Abhimanyu Dalal*
M.tech Scholar, ECE Department
Vaish College of Engineering

Pawan Kumar
Asstt. Proff. In ECE Department
Vaish College of Engineering

Abstract— Wireless sensor networks (WSNs) are revolutionizing the way people interact with the physical world. A large volume of sensor nodes are deployed to collect data from the environment, perform local processing, and communicate their results either with a base station (BS) which people may access via Internet or directly with actuators which conduct actions in response. Although energy efficiency is usually the primary concern in WSNs, the requirement of low latency communication is getting more and more important in emerging applications. Real time (RT) sensor systems have many applications especially in intruder tracking, medical care, fire monitoring and structural health diagnosis. In this paper, the state of the art in real-time routing protocols for WSNs is surveyed.

Keywords— Wireless sensor networks, real-time, routing protocol, Rap, Speed, Rpar

I. Introduction

Sensor networks have emerged as a promising tool for monitoring (and possibly actuating) the physical world, utilizing self-organizing networks of battery-powered wireless sensors that can sense, process and communicate. In sensor networks, energy is a critical resource, while applications exhibit a limited set of characteristics. Thus, there is both a need and an opportunity to optimize the network architecture for the applications in order to minimize resource consumed. The requirements and limitations of sensor networks make their architecture and protocols both challenging and divergent from the needs of traditional Internet architecture [1].

Real-time (RT) wireless sensor systems have many applications especially in intruder tracking, fire monitoring, medical care and structural health diagnosis [2,3]. In intruder tracking, surveillance may require the position of an intruder be reported to a command center within 15sec so that pursuing actions can be initiated in time [4]. Data in the same system may have different deadlines due to different requirements. For example, locations of tanks have shorter update deadlines than those of pedestrians [4]. On the fire monitoring side, applications of sensor networks are numerous.

WSNs have gained an immense attention for their ability in meeting the real time QoS guarantee in many time critical scenarios. In general, real time packet communication guarantee can be categorized as i) Hard Real Time (HRT) ii) Soft Real Time (SRT) [11]. HRT should support a deterministic dead time. That implies, delivery of a message after the dead time is considered as a failure, sometime it may lead to a catastrophic effect. On the other hand, SRT supports probabilistic dead time, which allows some sort of latency in message delivery. Providing a real time communication in case of WSNs is a challenging task because of the highly unpredictable nature of wireless links, variable data packets relaying and energy, bandwidth constraints [11].

For instance, in a monitored forest area, the message of rapid temperature increasing should be transferred to the sink with timing constraints in the form of end-to-end deadlines. Therefore, sensor network protocols should support real-time communication by minimizing the packet deadline miss ratio, i.e., the percentage of packets that does not meet their end-to-end deadlines. There are significant research results on RT communications in single-hop wired LANs, multi-hop wired LANs, and the Internet. However, WSNs differ dramatically from the traditional RT systems due to its wireless nature, limited resources (power, processing and memory), low node reliability and dynamic network topology [2]. Thus, developing RT applications over WSNs should consider not only timeliness constraints, but also finding methods of energy efficient route setup and relaying of data from the sensor nodes to the sink so that the lifetime of the network could be maximized. RT routings in sensor networks is very challenging due to several characteristics that are distinguished from contemporary communication and wireless ad-hoc networks. Very little prior work can be applied directly. First of all, a global addressing scheme is hard to build for the deployment of sheer number of sensor nodes. Second, sensor nodes are tightly constrained in terms of transmission power, on-board energy, processing capacity and storage and thus require careful resource management. Third, new designs of RT routings are necessary for offering RT QoS in WSNs with guaranteed end-to-end delivery time, delay jitter and other QoS metrics[2].

II. REAL TIME ROUTING PROTOCOLS DESIGN ISSUES

End-to-end delay is mainly affected by the applied routing scheme. Therefore, some design issues must be considered in the design of routing protocols. These issues are as follows:

- *Energy consumption*: Sensor node lifetime shows a strong dependence on the battery lifetime. Each sensor in a WSN can act as a relay unit, hence energy consumption become as an important issue. If energy consumption is not managed properly, some node's batteries may exhaust. These malfunctioning nodes can cause topological changes and might require rerouting of packets and reorganization of the network [5]. It is to note that reorganization and rerouting processes increase the end-to-end-delay.

- *Data Reporting Model*: This issue affects the delivering latency of a data packet. The data delivering method can be categorized as either time-driven, event-driven, query-driven, and hybrid. Event-driven and time-driven (with low period) approaches can be considered in real time routing protocols.

- *Fault Tolerance*: Some sensor nodes may fail because of internal or external reasons such as power exhaustion or environmental factors. In addition to MAC layer, the routing protocols have to find new forwarding choices in order to relay the data timely or in a low latency bound. So while designing a real time routing protocol fault tolerance techniques must be determined.

- *Scalability*: With the increase of the network size, the management would become more complicated. A real time routing protocol should be scalable enough to respond to events in the environment timely. In order to relay a delay-constraint data time-synchronization techniques may be while coordinating a huge network.

- *Network Dynamics*: It is to note that a network is a dynamic form which can adjust themselves according to environmental factors and needs. For example the location of nodes or the amount of data can change in time. These changes may cause some delay while transmitting a data. The real time routing protocol must consider such as network dynamics [5].

III. REAL-TIME ROUTING PROTOCOLS

- *RAP*

RAP is a Real-time communication Architecture for large-scale WSNs [6,7]. For distributed micro-sensing applications, RAP provides a convenient, high-level query and event-based services, which is based on a novel location-based addressing model supported by a lightweight protocol stack.. Sensing and control applications interact with RAP through a set of APIs. A Query/ event service layer submits desired query or event registration to the physical environment. The occurrence of the event will automatically trigger the query and communicate the query results to the base station via local coordination and sensor-base communication.

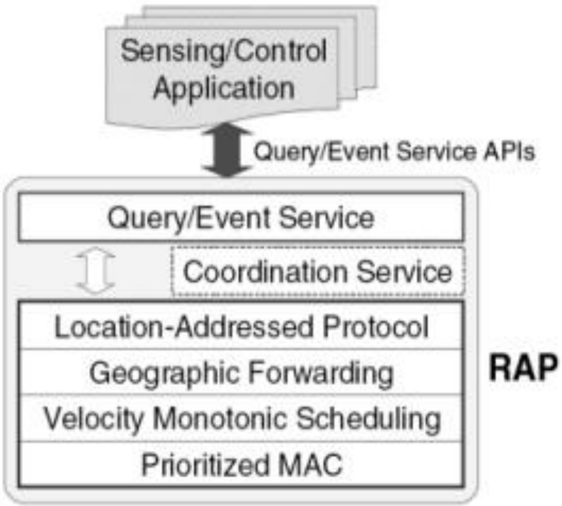

Fig 1: RAP Communication architecture model [6]

The coordination service provides the local area coordination among the sensors in the sensed area by dynamic group management and aggregates data to generate the reliable data for the sensor-base communication. A bottom four layered network stack of the RAP architecture shown in Fig 1 supports the sensor-base communication.

Location-Addressed Protocol (LAP) is a connectionless transport layer protocol where all the messages are adressed by location rather than IP address. The proposed LAP provides three types of communication namely unicast, area multicast and area any cast. The proposed Geographic Forwarding (GF) routing protocol, make a greedy decision in forwarding a packet to a neighbor node. A novel packet scheduling policy named Velocity Monotonic Scheduling (VMS) is been proposed, which is both deadline-aware and distance-aware. VMS is based on the notion of packet requested velocity i.e. the priority of the packet is assigned based on its requested velocity.VMS assigns highest priority to those packets having high requested velocity and lowest priority to those packets having less requested velocity which leads to the decrease in packets deadline miss ratio. Two priority assignment policies namely Static Velocity Monotonic (SVM) and Dynamic Velocity Monotonic (DVM) are been investigated in the proposed protocol. SVM assigns a fixed requested velocity for a packet on each hop, which is based upon the distance from the current node to the destination and deadline (D). DVM dynamically re-calculates the requested velocity of a packet at each node, which is based upon the distance between the current node to the destination, deadline (D) and elapsed time of the packet. If the incoming packet velocity is less than the desired velocity, DVM dynamically increases the required velocity so that the packet can reach the destination within dead time. A prioritized MAC layer provides a distributed prioritization on packets from different nodes that helps in meeting global prioritization of packets. Simulation results showed that the RAP is get successful in achieving low Deadline Miss Ratio (DMR). However, RAP is depending upon the notion of velocity, which is not sufficient to provide high throughput in wireless communication, especially in case of real-time communication applications [6].

- *SPEED*

SPEED, a QoS routing protocol for sensor networks that provides soft real-time end-to-end guarantees is presented in [8]. The protocol requires each node to maintain information about its neighbors and uses geographic forwarding to find paths. In addition, SPEED strives to ensure a certain speed for each packet in the network so that each application can estimate the end-to-end delay for the packets by dividing the distance to the sink by the speed of the packet before making the admission decision [2]. Moreover, SPEED can provide congestion avoidance when the network is congested and efficiently handles voids with minimal control overhead. The routing module in SPEED is called Stateless Geographic Non-Deterministic forwarding (SNFG) and works with other four modules at the network layer, as shown in Fig 2, [8]. The beacon exchange mechanism is used to collect information about nodes and their location. Delay estimation at each node is basically made by calculating the elapsed time when an ACK is received from a neighbor as the response to a transmitted data packet. By looking at the delay values, SNGF selects the nodes which meet the speed requirement. If such a node cannot be found, the relay ratio of the node is checked. The Neighborhood Feedback Loop (NFL) module is responsible for providing the relay ratio which is calculated by looking at the miss ratios of the neighbors of a node (the nodes which could not provide the desired speed) and is fed to the SNGF module. If the relay ratio is less than a randomly generated number between 0 and 1, the packet is dropped. And finally, the backpressure-rerouting module is used to prevent voids when a node fails to find a next hop node, and to eliminate congestion by sending messages back to the source nodes so that they will pursue new routes.

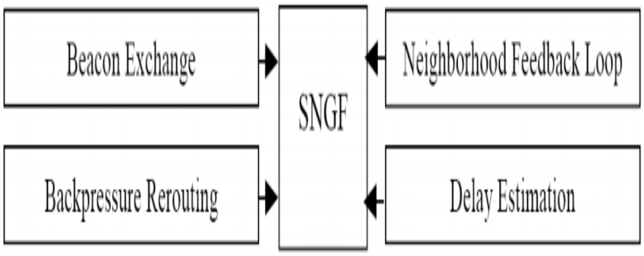

Fig 2: Routing components of SPEED [8]

- *MM-SPEED*

MM-Speed [6,9] is a Multi-path and Multi-speed real-time routing protocol which provides multiple probabilistic QoS guarantee in wireless sensor networks based on the work of SPEED[7]. MM-SPEED provides QoS in terms of two distant domains namely timeliness and reliability, so that the packets can choose the anyone of the QoS or both depending upon their requirement. Unlike the SPEEED, MM-SPEED provides multiple network wide speed options instead of single network-wide speed *guarantee* to address the Qos in terms of timeliness. For achieving the QoS in terms of reliability, MM-SPEED uses the probabilistic multipath forwarding. For achieving Qos guarantee in terms of timeliness, MM-SPEED provides multiple layers of network wide speeds augmented by two novel techniques namely; virtual isolation and dynamic compensation. By using a virtual isolation technique, classification of incoming packets according to their speed classes takes place and placed them in an appropriate queues, which aid in minimizing the effect of lower speed packets on the delays experienced by the high-speed packets. The packets in the highest priority queue are served first in FIFS fashion. Virtual isolation in a node avoids intra-node priority inversion only. Therefore, in order to provide the distributed prioritization, which minimizes the inter-node priority inversion, a network layer takes the support from the MAC layer. It uses a notion called dynamic compensation, which compensates for inaccuracy of local decisions in a global sense as a packet progress towards its destination. I.e. when a packet arrives to a node with the speed less than the desired speed, dynamic compensation enhances its speed to required speed, which ensures high probability of meeting end-to-end deadlines. In order to provide the service differentiation in terms of reliability, MM-SPEED used the principle of redundancy i.e. the more paths to deliver, the higher the probability that the packet reaches its final destination. Performance results showed that the MM-SPEED performs well in providing Qos in terms of timeliness and reliability or both for the various traffic types. Like that of SPEED, energy metric is not considered in the protocol design [6].

- *RPAR*

Real-time Power-Aware Routing protocol (RPAR) [10] is proposed to support energy-efficient real-time communication in WSNs. RPAR achieves this by dynamically adapting transmission power and routing decisions according to packet deadlines [2]. RPAR is based on the hypothesis that there is an inherent trade-off between transmission power and communication delay. The authors also perform a set of experiments using XSM motes to demonstrate that transmission power control may be an effective mechanism for controlling communication delays under the light workloads by improving link quality and reducing the number of transmissions needed to deliver a packet. So trade-off can be made between energy consumption and communication delay by specifying packet deadlines. Since RPAR adjusts the transmission power from time to time to meet the end-to-end delay requirement, there's no need to predefine various delivery speeds like the Set Speed layers in MMSPEED. (Both SPEED and MM-SPEED use fixed transmission power.) Moreover, a novel on-demand neighborhood management mechanism is proposed to reduce energy consumption in contrast to periodic beacon exchanging scheme adopted by SPEED and MMSPEED. The neighborhood manager is invoked only when there are no eligible forwarding choices in the neighbor table for forwarding a packet. Simulations show that the forwarding policy and neighborhood management of RPAR together can introduce significantly reduction in energy consumption with desired real-time guarantee. However, the reaction time of the neighbor discovery is a potential problem to the real-time performance [2].

- *Akkaya et al.*

Akkaya and Younis, 2003 propose an energy-aware QoS routing protocol that will find energy-efficient path along which the end-to-end delay requirement can be met. It is assumed each node has a classifier to check the type of incoming packets and divert RT and non RT traffic to different priority queues. The delay requirement is converted into bandwidth requirement. To support end-to-end guarantee, their approach however does not take into account the delay that occurs due to channel access at the MAC. Moreover, the use of class-based priority queuing mechanism is too complicated and costly for resource limited sensors [3].

Table 1: A Summary of the real-time routing protocols in WSN

Routing Protocol	**Routing type**	**Hierarchical**	**Location based**	**Scalability**	**Energy efficiency**	**Link reliability**
RAP	SRT		✓	GOOD	N/A	N/A
SPEED	SRT		✓	GOOD	N/A	N/A
MMSPEED	SRT		✓	GOOD	N/A	High
RPAR	SRT			GOOD	High	High
AKKAYA	SRT	✓		LOW	High	Moderate

• Conclusions

• Real-time routing is playing an important role n providing real time communication in case of WSNs operating in the real world. Because of having an implicit or explicit time constraints, non deterministic nature of links, and resource constrained environment of WSN, real time routing is quite exciting and at the same time extremely challenging to meet the real-time demands. In this paper, we present a review of real time protocols along with their key features.

- **References**

- Biradar, Rajashree V., et al. "Classification and comparison of routing protocols in wireless sensor networks." Special Issue on Ubiquitous Computing Security Systems, UbiCC Journal 4 (2009): 704-711.
- Zhan, An-dong, et al. "A survey on real-time routing protocols for wireless sensor networks." Proceedings of The 2nd China wireless sensor network conference. 2008.
- LI Y, CHEN C and SONG Y et al., "Real-time QoS support in wireless sensor networks: a survey," in the Proceedings of 7th IFAC Int Conf on Fieldbuses & Networks in Industrial & Embedded Systems (FeT'07) [C], Toulouse, France, Nov 2007.
- LU C, BLUM B and ABDELZAHER T et al., "RAP: A Real-time Communication Architecture for Large-Scale Wireless Sensor Networks," in the Proceedings of the Eighth IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS' 02) [C], 2002
- Mujdat Soyturk, Halil Cicibas and Omer Una, "Real Time Data Acquisition in Wireless Sensor Networks", www.intechopen.com, Nov. 2010.
- Pradeep Chennakesavula, Jemimah Ebenezer, S.A.V Satya Murty, "REAL-TIME ROUTING PROTOCOLS FOR WIRELESS SENSOR NETWORKS: A SURVEY".
- T. He, J. Stankovic, C. Lu, and T. Abdelzaher." SPEED: A stateless protocol for real-time communication in sensor networks," In ICDCS, 2003.
- E T, STANKOVIC J and LU C et al., "SPEED: A stateless protocol for real-time communication in sensor networks," in the Proceedings of International Conference on Distributed Computing Systems [C], Providence, RI, May 2003.
- E.Felembane, C. Lee and E. Ekicie, R.Boder, S.Vural "MMSPEED: Multipath multi-SPEED protocol for QoS guarantee of reliability and timeliness inwireless sensor networks," IEEE Transactions on Mobile Computing [J], 5(6), pp. 738-754, 2006.
- CHIPARA O, HE Z and XING G et al., "Real-time Power-Aware Routing in Sensor Networks," in the Proceedings of the 14th IEEE International Workshop on Quality of Service (IWQoS 2006) [C], New Haven, CT, June 2006.

  S.Bansal, D.Juneja, S.Mukherjee " An analysis of real-time routing protocols for the wireless sensor networks" in International journal of Engineering Science and Technology (IJEST), Vol.3, no.3, pp 1797-1801, march 2011

