Toward Event Based Communication for Temperature Scheduling in an Implanted Sensor Network

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Abstract

This paper presents an analysis on the problems involved in thermal aware routing algorithms available for an implanted sensor network. It also proposes how event based communication can be suitable for temperature scheduling in an implanted sensor network.

1. Introduction

Smart implanted sensor nodes are deployed in critical and sensitive healthcare applications like artificial retina, glucose level monitoring, and organ monitoring or cancer detection. These nodes sense and transmit data to neighbor or remote nodes time to time in a medical diagnosis system. Heat caused by their sensing and transmission activities is harmful for surrounding tissues. Even recharging of these nodes involves IR (Infrared radiation, an electromagnetic radiation) that also causes tissues to be very sensitive. The more the temperature is generated, the more battery power is expired and human tissues become more sensitive for IR of recharging.

Thermal aware routing algorithms have been proposed to generate less temperature in transmitting packet in an implanted sensor network. But, these algorithms have some limitations. TARA [1] moves packet away from hotspot region but it causes high average packet delivery delay. In, LTR and ALTR [2], HPR [3] the total number of hops and total temperature of nodes become large. LTRT [4] tries to solve it but it does not consider the complexity of shortest path routing algorithm in a limited powered implanted sensor node. Sensor temperature is transmitted through every node in regular interval for the route formation and it is a huge overhead.

Event based communication [5] can be an alternative solution for temperature scheduling in an implanted sensor network. A publish-subscribe system can schedule temperature among nodes in a small cluster of implanted sensor network. This will reduce the hotspot formation, redundant multi-hops or complexity overhead of algorithms discussed above.

The paper is organized as follows: Section 2 discusses the limitation of thermal aware routing algorithms. Section 3 discusses why we need event based communications in an implanted sensor network. Performance evaluation is done in section 5. We concluded with our future plan s in section 6.

2. Limitations on Thermal Aware Routing Algorithms for an Implanted Sensor Network.

TARA is a routing protocol that sends packet by following a withdrawal strategy. If defines a hotspot region that is above a threshold value of temperature. When a node sends a packet to a hotspot, it withdraws from it and the packet is back to the sender. After the cooling period, the packet is sent again to destination. The protocol does not consider the shortest path, just only withdraws packet from hotspot. In LTR, packet is sent to next node if it is destination. Packet is generally sent to the node that has the least temperature. If the number of hops increases above a threshold value, the packet is discarded. If the next node is already visited then the second minimum temperature node is selected for packet transmission. ALTR is an advancement of LTR. Packet is sent to the least temperature node but if the number of hops is increased above threshold value, SHR is followed in packet transmission. HPR uses shortest hop routing algorithm for sending packet to the destination which does not have any hotspot. If the next hop is the destination, packet is sent to it. If the next hop has temperature below a threshold, packet is sent to it. But if the next hop is above a threshold temperature, it is assumed that there is a hotspot there. Then packet is forwarded to the coolest neighbor that is not yet visited. The problem with the HPR is that temperature information has to be propagated to other nodes and it is a huge overhead. LTRT has tried to solve the problems involved in previous algorithms. It tries to send packet through a path which creates the least temperature from the source to destination. The algorithm uses Dijkstra algorithm to determine the shortest path from the source to destination. It avoids hotspot formation and redundant multi-hops. The problem with the algorithm is that temperature information is to be propagated to every node with a regular interval. After the shortest path is created, the function of temperature schedule is established. Maintaining Djsktra algorithm is a huge overhead for an implanted sensor network.

3. Need for Event Based Communications in Implanted Sensor Network

Event based communication can be a used to solve the above problems of thermal aware routing algorithms. We can think about a publish subscribe system in an implanted sensor network. Some sensor nodes are subscribed to temperature rising event. When a node or nodes (publisher) are above a threshold value of temperature, this event is transmitted to subscriber node through broker nodes. In this way, temperature can be dissipated in that network. We can think about an implanted sensor network where nodes are partitioned into small clusters. In every cluster, publisher, subscriber, broker nodes can be involved in multi-hop communication with a remote gateway to schedule the temperature in described way. The success of this communication system depends on cluster formation and node orientation in every cluster. As long as the number of subscribers, brokers and publishers is almost the same, publish-subscribe system [6] best works in that cluster.

4. Performance Evaluation

We have performed simulation in a Java program. Figure.1 describes how event based communication (EC) works the better than existing thermal aware routing algorithms. Nodes are deployed in a 6*6 mesh topology.

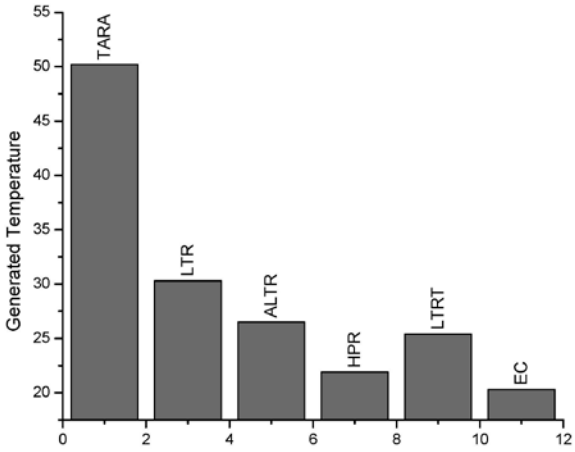

Figure 1: Performance comparison of event based communication (EC) with TARA, LTR, ALTR, HPR and LTRT. EC generates less amount of temperature than other protocols. TARA generates the maximum temperature, ALTR is better than LTR for the use of hop count threshold. HPR is better than LTR, ALTR or LTRT but EC provides the least temperature.

We consider one unit of temperature is generated for every packet transmission (send or receive) among nodes. When a node sends or receives from a gateway node, it generates 2 unit of temperature. If a node's surrounding temperature is above 7 unit, it is assumed to be in hotspot region. We assume 10 hops as max hop count for LTR and ALTR. Threshold temperature of LTRT is assumed to be 6 units. TARA generates the maximum temperature as it tries to move away packets away from hotspots and traverses more multihops. LTR and ALTR provide better performance than TARA by choosing the least temperature node. But, ALTR is better than LTR because when 10 hops are crossed, shortest hop routing algorithm works. HPR is far better than previous three by choosing the shortest hop with temperature parameter. LTRT is also better than TARA, LTR or ALTR but worse than HPR. EC is better than all other by creating 3 small clusters with publish-subscribe systems.

5. Conclusion & Future Work

In this paper, we have discussed the problems of thermal aware routing algorithms for an implanted sensor network. We have proposed how an event based communication with publish-subscribe system can be a better solution. We also have pointed out node orientation, cluster formation technique as key issues in this solution. In future, we have plan to develop approximation algorithms by which we can approximate the minimum number of nodes to be connected in a publish-subscribe system of a cluster.

Acknowledgement

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6. References

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