A new Balanced and QoS-based Multipath routing protocol for Healthcare Monitoring in WSNs

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Introduction

Wireless Sensor Networks (WSNs) are increasingly invested revolutionizing the way we acquire information in various fields such as healthcare, environmental, civil, military and many more domains.

Routing phase plays an important role in network performance. In fact, it is considered as one of the major challenges in WSNs since it represents a key process to consider for dealing with QoS requirements and influences directly on delay, reliability, packet delivery ratio, network lifetime, etc [1].

Nowadays, multipath routing approach is widely used in WSNs and has viewed a tremendous expansion to improve network performance through efficient utilization of available network resources; this has allowed it to become one of the most important actual directions in wireless and mobile networks.

In this work, we propose a novel hospital-monitoring multipath routing protocol that offers an efficient scheme for both real time and non-real time data communication, called BFEQM (Balanced and Flexible Energy Efficient and QoS based Multipath routing protocol).

Motivation

In hospitals, many patients suffer from clinical damage such as cardiac or respiratory arrest whereas up to 70% of such cases could have been prevented [2][3]. Hence, proposing a reliable, energy efficient and balanced routing protocol for such an application is very interesting.

Furthermore, in the literature, the presence of WSNs in healthcare domain is restricted to intra-body communication and data management of sensors in the same body. However, in this work, we propose to go beyond local BAN (Body Area Network) communication to manage communications from the BANs to the monitoring service of the hospital (from the coordinators in all patient rooms to the medical monitoring service).

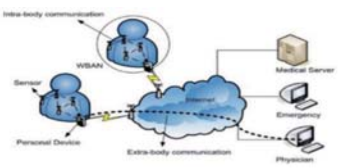

Figure 1: Intra-body and Extra-body communication in WBSNs

Therefore, our WSN will replace the second and third tiers of the BSN already used frequently. Indeed, this could improve reliability, security, and cost implementation comparing with the old methods.

To do so, Each patient body is equipped with body sensor nodes forming together a BAN. So, to connect all the BANs in the hospital with our WSN, which is responsible for communicating their vital data to the monitoring service, we have realized that it is necessary to use another node that has more performance in terms of resources than a simple sensor one. This node would be constrained to manage the data flows generated from all the BANs in a room and then send them through our designed network to reach the monitoring service.

Protocol details

Figure 2: Illustrative diagram of the network architecture in a wing of the Fleurimont CHUS hospital [4].

Path discovery phase

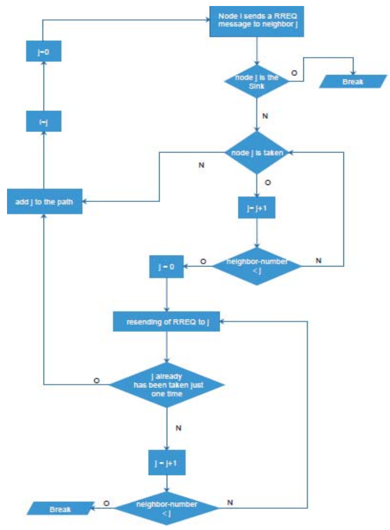

Figure 3: Functional diagram of next node selection procedure in paths construction.

The process presented in the diagram is repeated for each source node in the network in order to construct paths connecting every source-sink couple in the network.

When all RREQ messages reach the Sink node, this latter will take an adaptive decision and check for the most appropriate path according to the required data packet performance. Then, it will send a RREP message via the reverse path to the source node. After that, the Sink will generate RREP packets for all the other received RREQ packets and send them to the source node. Consequently, the source node will receive at first the best path responding to the current alert message requirements, and then the other RREP packets to form a routing table of all constructed paths with their residual performance to be used for non real time traffic transmission.

Data communication phase

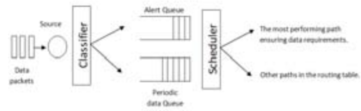

Figure 4: The functional diagram of a source node.

Our model promotes real time traffic by using the best resources in the network to satisfy the QoS requirements of urgent packets. However, to make the model more flexible and standard for any type of applications, either real time or non-real time application, we have realized that when the non-real time traffic exceeds real time traffic in a given period of time, it is preferable to transmit non-urgent packets within better performance, since the best paths are free, i.e. the first queue is empty. By doing so, we ensure fairness and load balancing between all paths, and consequently extend the network lifetime.

To accomplish its task, when a non-real-time packet arrives, the classifier checks whether the Alert queue is empty, then it enqueues the packet to be transferred through the best performing path. When an Alert packet arrives and finds Periodic packets in the queue, it will be put at the head of the queue to keep always priority for real time traffic.

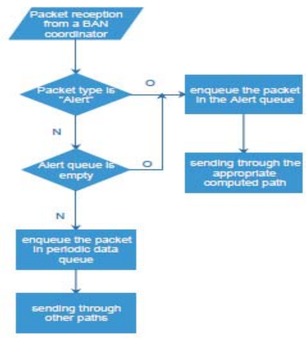

Figure 5: Functional diagram of data processing in BFEQM protocol.

Conclusion

In this work, we have proposed a QoS-based Multipath routing protocol namely BFEQM for healthcare monitoring in WSNs. The proposed protocol combines the proactive and reactive approaches in designing the paths conception to connect the source nodes placed in hospital rooms and the Sink node placed in the monitoring service. In BFEQM, we consider a WSN comprising a set of video source nodes placed in hospital rooms, communicating with their destination in the monitoring service using multiple routes. The BFEQM protocol objectives are: 1) maximizing the packets reception ratio, 2) minimizing the end-to-end delay, and 3) prolonging the network lifetime.

Références

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