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Routing Metric Enhancement for Multi-Purpose WSN on MATLAB Platform

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Abstract:-Routing effectively and efficiently is an important task for all networks, especially for wireless networks. WSN based application make the use of WSN (wireless sensor network) generated data which has force to the design of WSN architectures and systems. Numerous Quality of Service requirements by discrete applications focus on the use of appropriate routing metrics to decide the amend data path [12]. The Network performance is directly linked to the routing protocol in place and the metric it uses to optimize specific network performance aspects [2].

Wide literature study on routing metric pageant that WSNs are still not affective due to lack of affective routing and shortage of power backups. In this paper we tried to reinforce the routing metric by testing one of the combination approaches. By practicing in this way the effectiveness of the routing protocol also get increased. Now, the new enhanced combined routing metric giving better result than existing routing metric.

Keywords:-Multi-hop wireless sensor networks; Routing metrics; Routing protocol and Routing metrics compositions.

I. INTRODUCTION

A wireless sensor network here refers to a group of sensors, or nodes that are linked by a wireless medium to perform distributed sensing tasks. Connections between nodes may be formed using such media as infrared devices or radios. Wireless sensor networks will be used for such tasks as surveillance, widespread environmental sampling, security and health monitoring. They can be used in virtually any environment, even those where wired connections are not possible, where the terrain is inhospitable, or where physical placement is difficult. They may also be used as enabling infrastructure for new sensing/computational paradigms such as those described in [3]. Wireless sensor networks are part of a growing collection of information technology constructs which are moving away from the traditional desktop wired network architecture towards a more ubiquitous and universal mode of information connectivity [2].

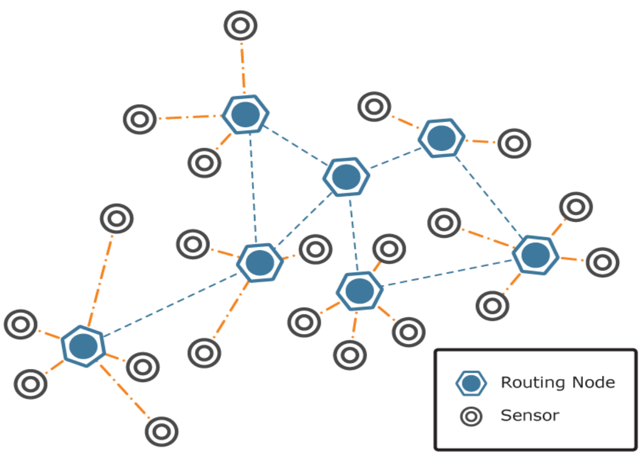

Figure:- 1 Framework of Wireless sensor network

The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting[13].

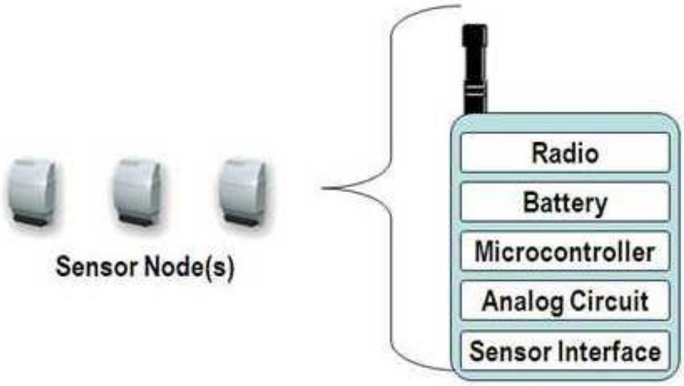

Figure:- 2 component of sensor node

A **routing protocol** specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network. Routing algorithms determine the specific choice of route. A routing metric is a unit calculated by a routing algorithm for selecting or rejecting a routing path for transferring data/traffic.

Metrics are assigned to each different route available in the routing table and are calculated using many different techniques and methods based on the routing algorithms in use. To achieve the required QoS, the path should be selected based on appropriate criteria or routing metrics. The selection of (primary) routing metrics and their combination is neither an arbitrary nor a trivial task because combining routing metrics of different properties may lead to routing instabilities or selection of non-optimal paths [14].

Some of the parameters used for calculating a routing metric are as follows:-

- **Hop count**
- **Path reliability**
- **Path speed**
- **Load**
- **Bandwidth**
- **Latency**
- **Maximum transmission unit**

Over recent years, wireless sensor networks (WSNs) have received considerable attention in environmental and industrial monitoring and control applications. Being one of the main building blocks in ambient intelligence, WSNs provide significant advantages both in cost as well as in distributed intelligence.

On the other hand, installation and maintenance expenses are reduced because of the use of cheap devices which do not require wiring. It is for this reason that WSN technology has been attracting rapidly growing attention both from academia and in industry [16].

The purpose of this paper is to provide groundwork for specifying the routing metrics that can be adopted to optimize more specific performance aspect(s) and provide convergence to optimal loop-free paths, when applied to specific routing protocols. This work provides the prospective system designers/implementers with guidelines for selecting the appropriate routing metrics and quantification rules and combining them also with tools to check the convergence of the produced routing protocol to optimal loop-free paths.

The rest of this paper is organized as follows. First, in Section II, the routing metrics composition approaches are presented, along with practical guidelines for producing composite routing metrics that lead to protocols which converge to optimal paths. In Section III, a brief of routing metrics composition approaches is presented in MATLAB simulation. Finally, Section IV, concludes the paper and outlines future work [12].

II. ROUTING METRIC COMPOSITION APPROACHES AND GUIDELINES

To cover a wide variety of application-dependent QoS requirements and efficiently face the network intricacies more than one routing metrics are often required. In the literature, there are two distinct approaches to follow, regarding the combination of multiple routing metrics into one composite routing metric, namely the lexical metric composition and the additive metric composition [12].

According to the routing algebra, routing protocol convergence, loop-freeness and optimality are mapped into the isotonicity and monotonicity properties. Briefly speaking, monotonicity means that the weight of a path does not decrease when prefixed or suffixed by another path. Thus, if the algebra is monotonic, then every network can be made free of loops, thereby ensuring convergence of the routing protocols. On the other hand, the isotonicity property essentially means that a routing metric should ensure that the order of the weights of two paths is preserved if they are appended or prefixed by a common third path. So, if the algebra is isotonic, then the paths onto which routing protocols converge are optimal.

The composite routing metric must hold monotonicity and strict isotonicity properties, so that the protocol convergence to loop-free optimal paths is ensured

Metrics must be orthogonal and not antagonistic:-

- Orthogonality means that no redundant information is carried within different
- Antagonistic metrics eliminate the effects of one another.

Scalability and path stability issues:-

In large network deployments, (such as the ones in logistics enterprise premises or vehicular networks) scalability becomes an important issue and depends a) on the path computation complexity, since the complexity of the path computation is determined by the composition function and b) on the routing traffic (messages exchanged for communicating routing information).

III. COMPARISON OF THE EXISTING AND NEW ROUTING METRIC

To provide insight on the performance achieved based on the additive composition rules, computer simulations have been performed for the routing protocol using Dijkastra and Bellman-ford algorithm[15] in the MATLAB simulation platform and for different routing metrics. The network topology consisted of 100 nodes with one node acting as sink node. Several tests have been conducted with different configurations and parameters in order to capture many network characteristics. Tests have been performed for 5, 10 and 15 sessions (number of nodes generating sensing data and sending them to the sink node).

This provided the ability to check the network performance under low and high traffic conditions. In all tests, the sensing nodes were kept the same (mainly positioned on the perimeter of the network topology), while the rest of the nodes were randomly placed for each set of tests. Moreover, different tests have been conducted for several numbers of faulty nodes (5, 10, and 15) which are mentioned as attackers in the figures, uniformly distributed over the network. Each individual test has been run for 20 times. The performance metrics considered were latency and packet loss.

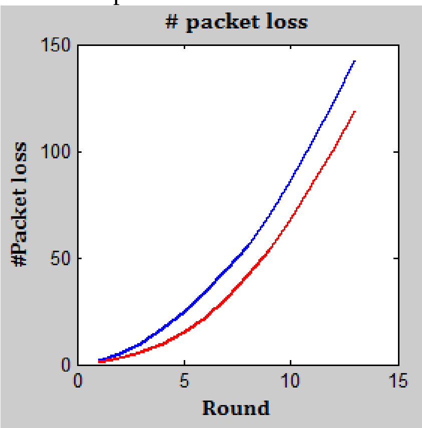

Figure:-3 packet loss in WSN due to attacker

The simulation results are included in Fig. 3 and 4. Blue line represents the existing metric while red line represents the new enhanced metric. Rounds are session in data transfer from source to destination. It is evident that the performance depends mostly on the number of "attackers", i.e. nodes that do not forward traffic than on the exact weight allocation in the additive composite routing function or between the additive and lexical composition. As expected, the packet loss is higher for higher attacker penetration values. For the same network topology (including attackers penetration), the selection of the weights for the additive composite routing metric does not dramatically affect performance. Namely, when 50 attackers exist, the differences are very small, while the case slightly changes for 150 attackers. So, from the packet loss perspective, since the penetration of misbehaving nodes is never known in advance, an additive composite routing metric with balanced weights is preferable. Based on this metric, a node can detect failure of forwarding packets either due to malfunction or malicious behavior.

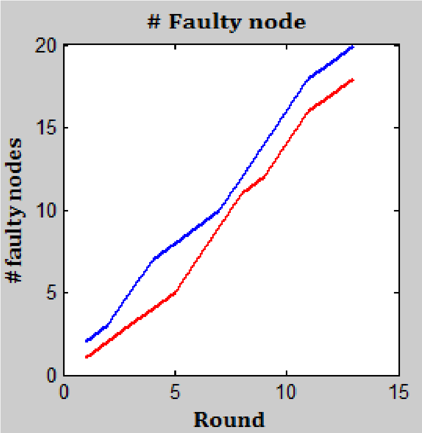

Figure:- 4 lower faulty node in WSN due to new metric

Figure 4 shows that new composite routing metric give less faulty node than existing metrics. Fig 3 and 4 shows that new composite routing metric are better than existing one. Red line show new metric whereas blue line show existing metrics.

IV. CONCLUSIONS

Modem WSN exceeds the role of environmental condition monitoring and their use in a variety of critical application domains mandates the satisfaction of specific QoS (Quality of service) requirements while respecting the network intricacies. Given that the adopted routing metric determines the performance aspect that will be optimized, we anticipate that a system designer (or user if allowed to) may need to decide the routing metric to be used by a specific routing protocol to fulfill the requirements of the application at hand. Towards facilitating this decision, we explained that each routing protocol can be classified in one (out of four) routing protocol types and presented the necessary properties (strict or not, left or right monotonicity and/or isotonicity) of a routing metric which ensure the routing protocol convergence to optimal loop-free paths. Additionally, we discussed two ways to combine multiple primary routing metrics so as to optimize multiple performance aspects and provided practical guidelines for this composition. Examples illustrating the impact of this composition on the monotonicity and isotonicity of the (composite) routing metric were provided and finally the performance difference between existing and new composite routing metrics was evaluated using computer simulations.

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