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An Efficient Approach towards Recovery from Node Failure in Wireless Sensor Network

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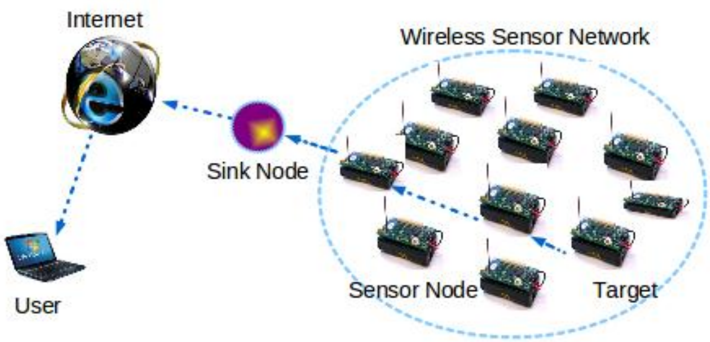
Abstract

Wireless Sensor Networks often serve mission-critical applications in inhospitable environments such as battlefield and territorial borders. Wireless sensor and actor networks are the collection of heterogeneous elements linked by wireless medium to perform distributed sensing and acting tasks. The Actor nodes may fail for many reasons such as due of battery exhaustion, message overhead, hardware failure due to hash environment and these failures may convert the connected network into several disjoint networks that reduce the capability of network. Wireless sensor networks consist of widely distributed sensor nodes. These nodes have short energy because of its limited battery size. This low energy in turn decreases the life duration of network. The declined lifespan of network perhaps distress the application to run in-efficiently. For these reasons, many algorithms and protocols designed for wireless sensor networks which considered the energy consumption in their conception. The node failure becomes more critical when data aggregation is performed along routing paths as the data packets with aggregated data contain information from various sources and whenever one of these packets is lost a considerable amount of information will also be lost. To understand this challenges a comparative study need to done on various algorithm proposed over it.

Keywords: Wireless Sensor Networks, Route Repair Mechanism, ACK

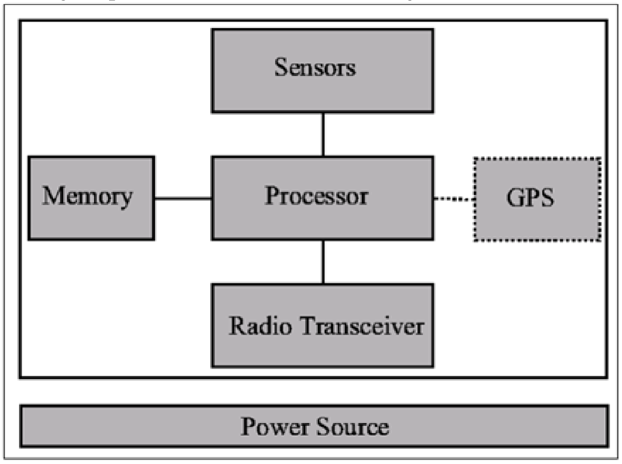
I. INTRODUCTION

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs measure environmental Conditions like temperature, sound, pollution levels, humidity, wind speed and direction, pressure, etc. Wireless sensor networks (WSNs) are composed of several small-size sensors that have various features, such as low cost, light weight, high mobility, and capabilities for sensing, computing, and communications. The sensor has the same capabilities as the machine does. In fact, WSNs are one of typical application of machine to machine communications. A wireless sensor device has a battery-operated mechanism capacitated with sensing, processing and communicating capabilities. In addition, a power source supplies the energy needed by the device to perform the task that is programmed. This power source often consists of a battery with a limited energy budget. It could be also impossible or inconvenient to recharge the battery because nodes may be deployed in a hostile or unpredictable environment. On the other hand, the sensor network should have a lifetime long enough to full fill the application requirements. In many cases lifetime may be in the order of several months or even years are required



II. SYSTEM MODEL AND PROBLEM STATEMENT

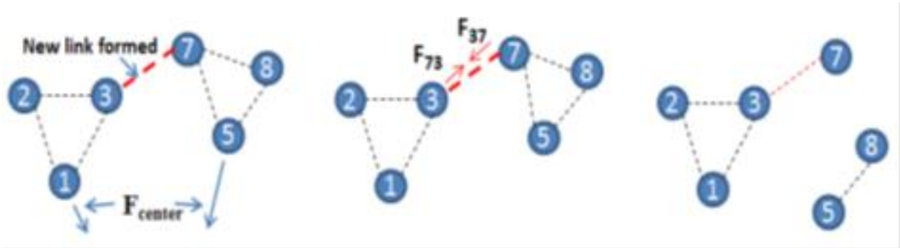
As mentioned earlier, a WSAN involves two types of nodes: 1) sensors and 2) actors. Sensors detect and report events of interest to one or multiple actors. Actors obtain reports from sensors, process and collaborate with each other to plan an optimal coordinated response. It is thus necessary for actors to rely mostly on contemporary terrestrial radio links for coordination among themselves. Both sensors and actors are deployed randomly in an area of curiosity. After deployment, actors are assumed to discover each other and form a connected inter-actor network using some of the existing techniques. An actor is assumed to be able move on demand and such relocation does not affect sensor actor connectivity. The action range of an actor refers to the maximum area in which an actor can cover and is assumed to be equal for all actors. Each actor maintains a list of direct (1-hop) neighbors and exchanges heartbeat messages with them to update its status. DCR and RAM are suited for applications in which line-of-sight links are available between actors that fall in the communication range of each other. The impact of an actor's failure depends on the position of that actor in the network topology. A node is said to be serious, cut-vertex in graph theory terminology, if its removal partitions the network into disjoint segments. The failure of one or multiple critical actors not only affects the actor coverage but significantly impacts inter-actor connectivity. [1]



The proposed AuR approach can be applied to networks that include mobile sensor nodes. We undertake that each mobile node is aware of the size and center of the deployment area and its position, e.g., using contemporary localization schemes. All nodes are assumed to have the same transmission range that is significantly less than the size of the deployment area. Node failure may result in a loss of connectivity and coverage. AuR focuses on re-establishing connectivity and as a secondary objective tries to restore some of the lost coverage through optimized node self-spreading.

Node failures impact a network in different ways depending on their importance to network connectivity and the scope and scale of failure. The loss of a leaf node does not affect connectivity, though failure of a cut-vertex or multiple collocated nodes will split the network into multiple disjoint segments and undermine the network operation. In Figure 1 the loss of leaf nodes, e.g., S3, S4 or S16 does not impact the network connectivity. The same applies for some non-leaf nodes, namely, S12 and S14, as alternate paths exist among neighboring nodes. Failure of S1 or S9 however results in two or more disjoint blocks. Numerous published approaches deal with connectivity restoration after the failure of one critical node like S9 and S12, as pointed out in the previous section.

On the other hand, multi-node failures pose unique challenges since the extent of failure can be vast and surviving nodes do not know the location of other live nodes. Therefore a strategy has to be devised to ensure that nodes in disparate locations can be mobilized and reconnected. In a centralized approach the general area can be mapped and the surviving nodes can communicate via satellite to determine the location of other live nodes and chart a re-connectivity strategy based on the current location of all nodes. This though has considerable messaging and resource overhead to keep the relocation in sync. In addition, availability of satellite links cannot be guaranteed due to line of sight issues or simply because nodes do not have modems or sufficient power.[4]



III. ROUTE REPAIR MECHANISM

The route used by the algorithm is unique for data transmission, which maximizes the data aggregation along with the overlying routes. Any failure in one of its nodes will cause disturbance, avoiding the transport of several gathered event data. In the conventional methods, flooding of the message is used for identifying the failure nodes. In our proposed method, ACK based repair mechanism is used to identify the node failure. When a node sends aggregated data packet to its Next Hop, the receiver node should transmit an ACK to its sender. If the gainer does not obtain the ACK, it has to find an alternate Next Hop to forward the packet. Thus a new route will be established excluding the repaired node. This ensures the reliable data routing in the network. [2]

IV. CONCLUSION

In WSNs, simultaneous failure of multiple nodes may leave the network fragmented into disjoint segments. In this paper we have presented AuR, a novel distributed algorithm that enables a network to restore connectivity by only local coordination amongst nodes in the individual segments. The idea is to self-spread nodes and to move them toward the center of the deployment area. AuR models motion as electrostatic forces of attraction and repulsion and leave the decision making and coordination in the hands of a node and its 1-hop neighbors. The simulation results have confirmed that AuR outperforms contemporary schemes for recovering from multi-node failure in terms of the average node degree, travel overhead and coverage. As future work we are planning to study the implications of increasing the state information that a node maintains, e.g., 2-hop neighbors, on performance.

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