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Mobile Sinks in Wireless Sensor Networks: Challenges

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Abstract – **Drastic development in wireless technology increased the demand for Wireless Sensor Network (WSN) applications for monitoring areas of interest. The revolution of mobile sink in WSNs, draws the attention from diversified fields like smart homes, environment, and military applications etc. The life time of the WSNs get extended with the use of the mobile sinks. In this paper we analyzed the challenges in wireless sensor networks, with the deployment of mobile sink on data gathering, network life time, security etc.**

Keywords – **Wireless sensor networks, Mobile sink, Data gathering, Sink security, Challenges.**

1. INTRODUCTION

The physical world data is crucial for monitoring areas like industrial automation, defense application, habitat monitoring etc. Wireless sensor networks consists of resource constrained sensor devices with limited communication capability, limited battery and memory. Multi hop communication is a must phenomenon for wireless sensor networks with limited transmission power. The sensor devices near the base station will be always busy with data transfer. Due to continuous data transfer these end nodes near the base station suffer with resource exhaustion. Data gathering became a challenge in WSNs. The revolution of mobile sink introduction in to the wireless sensor networks balance the load on the end nodes, by distributing the load with large number of nodes in the networks. Mobile sink travels through the network and collect the information from the nodes. With reduced multi hop communication (major resource utilized), mobile sinks will save the resources in the WSNs and increases the life time of the WSNs.

Mobile sinks are equipped with huge resources, with which it can travel entire network and collect sensed information from the sensor nodes. The nodes in the traditional WSNs as in figure 1, invest huge energy resources to forward the data to the base station. The WSNs with mobile sink deployment as in figure 2, eases the data aggregation process and the increases the life time of the network. The nodes within the communication range of the mobile sink are called as access points. The access points forwards its own data and also the data from the nodes which are away from the mobile sink.

Deployment of mobile sink in the WSNs leads to new challenges, which are been addressed by researchers in the recent years. Effective utilization of mobile sinks is challenging and drawing much attention from the researchers.

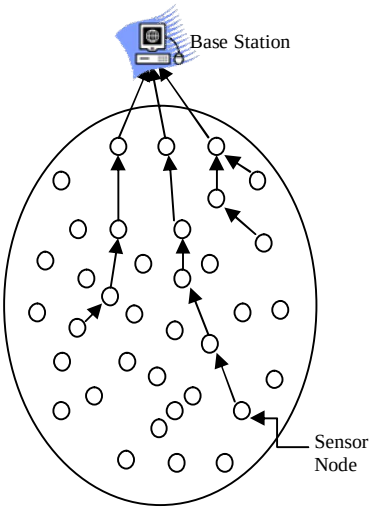

Figure. 1. Traditional WSN with sensor nodes and fixed base station

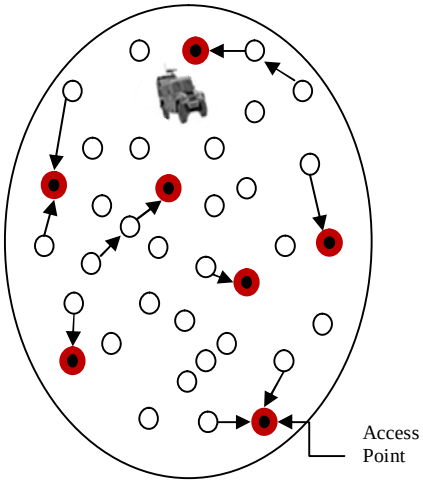

Figure. 2. WSN with mobile sink and access points

2. CHALLENGES

1) *Location Identification*: The sensor nodes require the location of the mobile sink to forward the sensed data. The mobile sinks follow the broadcast schemes in [1][2] to forward its location towards nodes in the network. However, these schemes require huge resources in periodically broadcasting the location information, from the sink to the network. Every node in the network need to forward large number of messages, which contradicts

with the effective resource utilization. Overhearing mechanism in [3] will reduce the number of broadcast messages, to identify mobile sink location. The mobile sink will generate beacons consists of new location information and forwards to the neighboring access points. The access points within the communication range of the mobile sink will hear the beacon and modifies their message headers that are directed toward the mobile sink. On overhearing the modified header the remaining nodes in the networks will identify the new location of the mobile sink. Footprint based scheme in [4] uses few fixed points. Fixed points are used by the sensor nodes to identify the communication path towards mobile sink. Based on the fixed points, nodes will calculate its logical coordinates and finds its route towards the mobile sink. To avoid unnecessary broadcast message forwarding and also to increase the network life time, the overhead incurred by the location identification protocol has to be minimized.

2) *Routing and Mobile sink trajectory*: Mobile sink trajectory plays a vital role in the routing of sensed data. Mobile sink can visit all the nodes in the network to gather the sensed information, which is not feasible in the case of large scale WSNs. Random walks based scheme in [5], decouples the mobile sink trajectory with the sensor nodes using special nodes. These special nodes are of smaller number when compared with the total number of nodes in the network. Mobile sink can move freely and can gather the information from limited number of nodes (which act as a sub sinks or access points). Sensor nodes find the location of the mobile sink by location identification algorithms. The trajectory and routing path selection are vital in extending the life time of the WSNs. The trajectory of mobile sink must ensure the availability of the sink throughout the network with minimum routing overhead.

3) *Transmission scheduling*: The node in the WSNs waits for the mobile sink to enter their communication range, and forwards the sensed data to the sink. WSN are resource constrained networks, tries to reduce the energy consumption for disseminating the data to the mobile sink. Transmission scheduling scheme in [6] will not allow the nodes to forward its data, until the mobile sink reaches the closest point in the communication range.

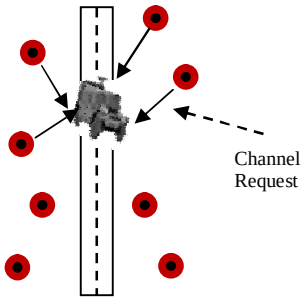

Figure. 3. Multiple nodes request for transmission channel at the same time.

WSNs with densely deployed sensor nodes find difficulty in data transmission, when more than one node identifies the mobile sink in its communication range. Data scheduling algorithms in [7], addressed the selection of transmission channel by the mobile sink in a densely deployed WSNs as shown in figure 4. The mobile sink allocated the channel based on the remaining power on the node and the amount of data to be transferred. A robust scheduling algorithm is required for effective data dissemination in the WSNs.

4) *Speed and Distance travelled:* Tradeoff between the effective data aggregation and the availability of the mobile sink to the entire network is a challenging task. Mobile sink has to stay in the communication range of sensor nodes, until the nodes transmission completed. The applications of WSNs require immediate response from the base station to handle the areas of interest. Using transmission scheduling and routing algorithms the mobile sink moves along the trajectory with a regulated speed, which makes the sensor nodes to forward its sensed data to the sink. Trajectory with minimum travelling distance and maximum network coverage has to be selected for increased lifetime of the network. The model proposed in [8] related the increases the performance of the network with speed and distance travelled by the mobile sink in the network.

5) *Security:* Mobility of the sink makes the WSN prone to various attacks. Traditional security algorithms are not suitable for the WSN with mobile sinks. Compromising a mobile sink will reveal entire information about the network. If the wireless sensor networks deploy multiple mobile sinks, capturing a mobile sink compromise major portion of the network to the attacker. Key management scheme in [9], generates two separate key pools, one for connection establishment between the sensor node and access point, other for mobile sink and access point connection establishment. The complexity to provide security, increased with the mobility of the sink. The scenario of an access point being compromised and a replicated mobile sink introduced in the network by an attacker is shown in figure 4. WSN security has to get much attention from researchers.

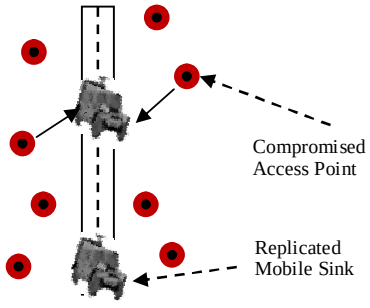

Figure. 4. WSN with compromised access point and replicated mobile sink

6) *Network maintenance:* Before deployment of the mobile sink, the privilege level of the mobile sink has to be specified, this makes the base station control the network. Under serious security attacks the mobile sinks are used for the node revocation and also broadcast sensitive control messages to the entire network as shown in figure 5.

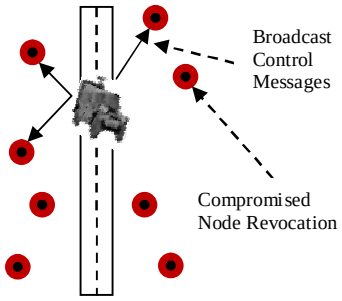

Figure. 5. Mobile sink isolate compromised node and broadcast control messages to the network.

3. CONCLUSION

The demand for mobile sink in wireless sensor networks was increasing drastically. The deployment of mobile sink in WSNs brings new challenges for the network. The challenges in deploying the mobile sink in the WSNs are identified and few existing schemes were discussed in this paper. The wireless sensor networks are still suffering from resource exhaustions with the existing mechanisms. More focus from the researchers towards WSN with mobile sinks was required, to address the challenges discussed in this paper.

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