Traffic Management– Framework for Sensor Networks with Sink Mobility

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***Abstract*– Sink Mobility is a imminent growth sensing environments promotes the increasing number of event based, sensor network applications including rescue missions, intrusion detection and smart buildings. Most of critical challenges supporting quality of service is effective in distributed congestion avoidance in these setting. In this paper the problem of traffic management in the sensor networks with a mobile sink, under sink mobility various novel challenges arise need to be addressed. We first analysis the sink mobility on traffic load in sensor networks, then propose adaptive routing, agile and load estimation techniques that effectively adapt to sink mobility relocations. A novel aspect of our technique is that it jointly considers the network load as well as path quality variations to facilitate intelligent, mobility-adaptive rate regulation at the sources. We provide a thorough study of the trade-offs induced due to persistent path quality variations and conduct extensive real MICA2-based test bed experiments to study the performance of the sensor network under sink mobility.**

***Keywords*–** Wireless Sensor Networks, Mobility and Congestion Control

I. INTRODUCTION

Sensor network applications become increasingly more pervasive, an inherent need or requirement for mobility of the event-collecting sink becomes apparent. The benefits of sink mobility can be showcased in several user-centric application scenarios and include extensive coverage, inspection, and evaluation of reported events, facilitating task-specific mobile patrols as well as receiving proximity-based personalized reports. In such event-based applications, events can appear in unpredictable spatiotemporal coordinates and have to be delivered to an observer whose location varies in time. Examples of this class of applications include rescue missions (where, e.g., the rescuer or a robot roams the disaster site while receiving sensor reports of activity in the area) and intrusion detection (where, e.g., a guard moves around a camp periphery while receiving reports of movements within or outside the periphery).

Wireless Sensor Networks (WSNs) comprises of a large number of sensor nodes that are densely deployed either inside the phenomenon or very close to it. In sensor networks, a source is defined as a sensor node that detects a stimulus, which is a target or an event of interest, and generates data to report the stimulus. A sink is defined as a user collecting these data reports from the sensor network. In many sensor network applications such as military, homeland security or environmental surveillance, it is necessary for users (sinks) to access sensor networks while they are moving. For example, in a battle- field a soldier with a PDA in hand might continuously collect an enemy tank's movement information while he is moving. Sink mobility brings new challenges to secure routing in large-scale sensor networks. To maintain a dissemination rout, a mobile sink has to constantly propagate its current location information to all sensor nodes. That introduces significantly communication overhead. Furthermore, intermediate nodes on the new rout have to discover their neighbors and exchange secret information to establish a secure communication. That also introduces more computation and communication overhead.

Wireless sensor network (WSN) consists of spatially distributed autonomous sensors nodes to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. Basically, each sensor node comprises sensing, processing, transmission, mobilizer, position finding system, and power units. These nodes collect and transmit the information. Under light load the data traffic in the network is light. When an event has been detected, the load becomes heavy and the data traffic also increases. This might lead to congestion.

The most predicament issues that happen in WSN is Congestion. There are many sources for congestion. They are buffer overflow, concurrent transmission, packet collision and many to one nature. Congestion causes packet loss, which in turn reduces throughput and energy efficiency. Therefore congestion in WSN's needs to be controlled for high energy-efficiency, to prolong system lifetime, improve fairness, and improve quality of service (QoS) in terms of throughput (or link utilization) and packet loss ratio along with the packet delay. A WSN consists of one or more sinks and perhaps tens or thousands of sensor nodes scattered in an area.

Congestion restraint generally follows two steps: congestion detection and congestion control. Accurate and efficient congestion detection plays an vital role in congestion control in sensor networks. Congestion detection is the methodology in which that abnormality in the normal traffic is been made out, i.e., when a packet is been transferred from one node to other [1] predicament events can happen. Congestion is controlled by various techniques like Congestion Detection and Avoidance, Event to Sink Reliable Transport, Congestion Control and Fairness

II. SENSOR NETWORKS

A sensor network is a group of specialized transducers with a communications infrastructure intended to monitor and record conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensively, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels and vital body functions.

Potential applications of sensor networks include:

1. Industrial automation
2. Video surveillance
3. Traffic monitoring
4. Medical device monitoring
5. Air traffic control

A. Wireless Sensor Networking for Industrial Automation

Wirelessly networked sensors are ideal complements to sophisticated machinery, providing real-time signals for predictive maintenance, real time monitoring and precision instruments. For example, Meshscape system is ideally suited for industrial automation applications. Hardware modules are easily integrated with sensor and control devices and can be installed quickly and easily. The robust networking protocol provides redundant and scalable wireless mesh network

B. Wireless Sensor Network for Video Surveillance

In a video surveillance system, one of the biggest problems is minimizing the rate of communication between video sensors and the base station, where the images are aggregated and decisions are made. Information theory provides compression bounds that can be achieved. Video sensors observing the same area of interest have lot of common information to send to the base station. Such sources can be modeled as correlated random processes. The correlation among the sources can be exploited to compress the images generated by the sources or sensors.

Fig. 1 illustrates two sources modeled as two random variables X_1 and X_2 sending data to a common destination. The source information is encoded (U_1 and U_2) in such a way as to minimize the overall rate (bits) spent in transmitting the input data to the destination. If we encode the sources in such a way that U_1 - X_1 - X_2 - U_2 form a Markov chain is achieved. In a Markov chain only consecutive elements are directly correlated to each other, the other elements are correlated via the elements in between. For example, U_1 and X_1 are directly correlated, but U_1 and X_2 are only correlated via X_1. In other words, if the information content of X_1 is removed from at least one of U_1 or X_2 they become uncorrelated. The above

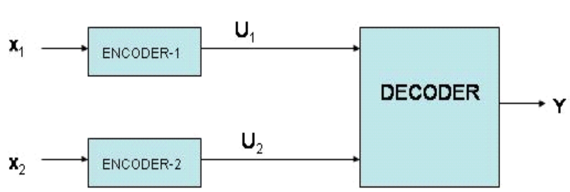

Fig. 1. Two sources modeled

Markov chain implies that U_1 does not have any information about X_2 which is not present in X_1, and U_2 does not have any information about X_1 which is not present at X_2. It is previously shown that when we apply the above Markov chain to our system at hand, we get rid of the excessive rate, and we end up with the least possible sum rate.

C. Wireless Sensor Networks for Traffic Management

Sensor nodes detects vehicles by change in earth's magnetic field, transmit data to access point via radio. Access point reports to signal controller or TMC, low cost non-intrusive, flexible, easy to install.

III. CONGESTION CONTROL

A. Types of Congestion Control Schemes

Open Loop Congestion Control Schemes identifies traffic Filtering Schemes uses accept or reject rules and traffic Scheduling Schemes Closed Loop Congestion Control Schemes identifies Uni-Variable Feedback based schemes and Multi-Variable Feedback based schemes.

B. Congestion Metrics

- Average/Mean Queue Length
- Average number or percentage of lost/discarded packets
- Number of retransmitted packets those had to be sent again because of Transmitter's Timeout
- Average/Mean Delay in Packet Delivery

C. Congestion Control Strategies

- Congestion control by regulating admission of Packets/Cells
- Congestion control by regulating traffic based on traffic Type/traffic-rate (packet rate/cell rate/bit rate etc) analysis
- Congestion control by admission-time resource reservation
- Congestion control by threshold monitoring and message passing
- Congestion control by preferential restraint (in research stage)

By incremental deploy ability on the current Internet: Only sender needs modification; sender and receiver need modification, only router needs modification; sender, receiver and routers need modification. By the aspect of performance it aims to improve: high bandwidth-delay product networks; lossy-links; fairness, advantage to short flows; variable-rate links by the fairness criterion it uses: max-min, proportional, "minimum potential delay".

D. Congestion Control Techniques

The congestion control techniques studied under the assumption of a static sink, mobility introduces a number of additional challenges: When the sink is moving, the rate of path reconfigurations becomes considerably higher compared to a static network. Modifying these routing techniques to efficiently accommodate sink relocations is a *Non trivial* task [8].

Path reconfigurations can result in sudden load changes along the paths. This may happen during a transition of the sink between areas with different node density and traffic redirected in a denser area may eventually result to increased contention. These effects call for load estimation techniques.

Throughout the sink's itinerary, alternating paths may experience considerable reliability fluctuations over small periods of time, in contrast to fixed networks, where significant changes are less likely to occur. With varying link, and consequently, varying path quality we are faced with an important trade-off: Packets injected during transient periods [9] of reduced path quality might unnecessarily detain critical channel resources before they are eventually lost.

In order to maintain mobile sink node in sensor networks fallowing are consider

1) Mobility-Aware Routing: Routes need to be established between the sources and the sink while it relocates in order to maintain reliable packet delivery. The two challenges that the routing scheme needs to address are

i) Keeping up with the high degree and often unpredictable movement of the sink

ii) Consider the variability of the link quality due to mobility

2) Collective Load Estimation: Load estimation technique that considers the observed conditions of nodes collectively in a region. By collectively considering the conditions in the regional proximity of the sink, can provide a more accurate indication of the current congestion condition.

Intelligent Rate Control to minimize the effects of mobility, we can instead exploit mobility to the benefit of traffic control by learning from previous theoretical analyses. The work has to be report through improvements attributed to mobility based on the premises of multiuser diversity [9].

IV. DYNAMIC TRAFFIC CONTROL SYSTEM

A. Dynamic Traffic Control System Based on Wireless Sensor Networks

Traffic control signal is a wireless sensor based preset gathers the traffic information and control the traffic flow (Fig. 2).

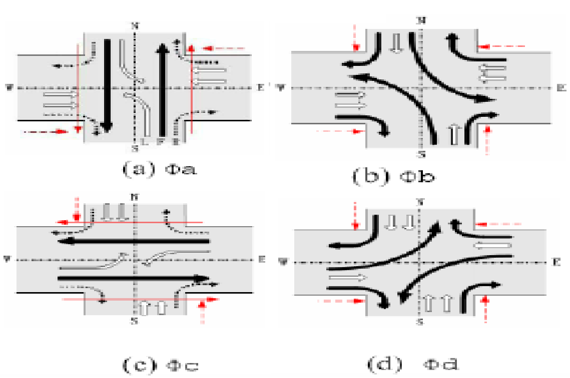

Fig. 2. Model of intersection

Model of intersection assume the right turn is always permitted in each direction there are two waiting queues including parking and running vehicles. The goal is to gather the information of incoming vehicles through wireless sensor networks and set phase time [4] dynamically.

B. Wireless Sensor Network for AST System Analysis

WSN based AST systems consist of a number of sensor nodes, several cluster head nodes and additional optional wireless router nodes that help with data aggregation and transmission via wireless multi-hop each cluster head node associates some sensor node to create its own subnet for AST implementation in a certain area of the specimen (Fig. 3). The monitoring and control of the WSN measurement system must be simultaneous with the AST loading facility. The next sections prove that this WSN framework could completely support low-power, multi-point, and heterogeneous operations with a distributed synchronization mechanism.

In order to design an efficient WSN system based AST, it is important to understand the critical parameters and design requirements [5] such as testing reliability, timeliness, scalability and energy efficiency.

V. PROBLEM DEFINITION

Wireless sensor networks environment promotes sink mobility in an increasing number of event based applications like rescue missions, intrusion detection and smart building to avoid the most critical challenges towards quality of service is effective congestion avoidance. Problem of traffic management in the context of sensor networks with a mobile sink, which requires to solve sink mobility with agile as well as load estimation techniques.

A. Comparative Study

Sensor network applications become increasingly more pervasive, an inherent need or requirement for mobility of the event-collecting sink becomes apparent. The benefits of sink mobility can be showcased in several user centric application scenarios and include extensive coverage, inspection, and evaluation of reported events, facilitating task-specific mobile patrols as well as receiving proximity-based personalized reports. However, in such event-based applications, events can appear in unpredictable spatiotemporal coordinates and

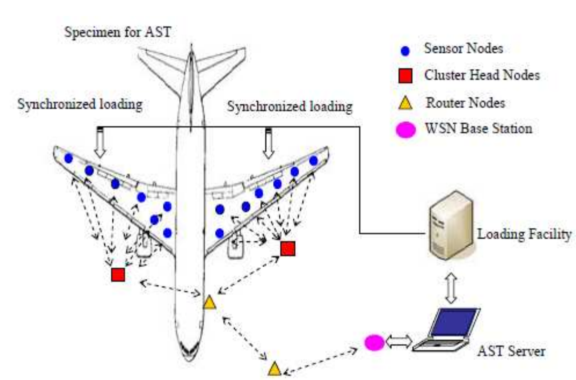

Fig. 3. AST System Analysis

have to be delivered to an observer whose location varies in time. Examples of these lass of applications include rescue missions (where, e.g., the rescuer or a robot roams the disaster site while receiving sensor reports of activity in the area) and intrusion detection (where, e.g., a guard moves around a camp periphery while receiving reports of movements within or outside the periphery).

In our proposed study identifies the problem of traffic management in the context of sensor networks with a mobile sink. Under sink mobility, various new challenges arise that need to be effectively addressed. Adaptation to sink mobility requires agile as well as effective load estimation techniques. We then propose adaptive routing as well as load estimation techniques that effectively adapt to sink relocations, a novel aspect of our approach is that it jointly considers the network load as well as path quality variations to facilitate intelligent, mobility-adaptive rate regulation at the sources. We provide a thorough study of the trade-offs induced due to persistent path quality variations and conduct extensive real MICA2-based test bed experiments to study the performance of the sensor network under sink mobility.

Sensor networks are tightly bound to congestion control. Additive Increase/Multiplicative Decrease (AIMD) has been widely used in real implementations. However, these techniques assumed a static sink. In such a case, local node conditions such as queue size were shown to be rather accurate congestion indications due to longer traffic persistence along a path. Unfortunately, this is not the case when path rate changes are higher. Furthermore, changes to the paths reliability is a consideration that has not been addressed in previous rate control schemes. We design a rate allocation technique implemented at the sources stemming from the intuitions of rate-limiting schemes [11] to avoid congestion. While securing congestion avoidance, we simultaneously attempt to distribute the available resources in a way that exploits beneficial sink locations.

B. Load Estimation

Congestion is an artifact of the interferences between multiple nodes, potentially belonging to multiple flows. Thus, observing the traffic traversing a spatial region within which flows interfere can provide a better understanding of the congestion level in a dynamic environment. Extending this idea, when the sink moves, it can be expected to be within a region of its neighboring nodes (*e.g.* between two different locations along its itinerary) for sufficient time to allow information exchange that will allow us to better estimate the traffic conditions.

VI. CONCLUSION

We have studied a set of techniques to address the challenges of congestion and rate allocation under the assumption of mobile sink, conduct the effects introduced by mobility and the need for explicit intelligent rate control. We provide a new wireless sensor routing and congestion control techniques to fast reliability which identifies the trade-off between global and local maximization with variant path quality aware rate allocation. Our analysis observes throughout expose challenges pertaining to sink mobility and explains that our techniques can be applied in practice to achieve effective congestion avoidance and significantly improves the performance network utilization under sink mobility.

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