WIRELESS SENSOR NETWORK

Pankaj Gupta, Ravi Sangwan
IT Department, mdu university

***Abstract*- The availability of low-cost hardware such as CMOS cameras and microphones has fostered the development of Wire-less Multimedia Sensor Networks (WMSNs), i.e., networks of wirelessly interconnected devices that are able to ubiquitously retrieve multimedia content such as video and audio streams, still images, and scalar sensor data from the environment. The problem we consider is to select a set of BS locations, a set of relay locations, and an association of sensor nodes with the selected BS locations, so that the number of hops in the path from each sensor to its BS is bounded by h_{max}, and among all such feasible networks, the cost of the selected network is the minimum. The hop count bound suffices to ensure a certain probability of the data being delivered to the BS within a given maximum delay under a light traffic model. Placement algorithm proposed in our earlier work, along with a modification of the greedy algorithm for weighted set cover. We have analysed the worst case approximation guarantee for this algorithm. We have also proposed a polynomial time heuristic to improve upon the solution provided by Smart Select. Our numerical results demonstrate that the algorithms provide good quality solutions using very little computation time in various randomly generated network scenarios.**

***Index Terms*—Wireless sensor network design; Multiple sink and relay placement; QoS-aware network design**

I. INTRODUCTION

Recently there has been increasing interest in replacing wireline industrial sensor networks with wireless packet net-works ([1], [2], [3]). Owing to the small communication range of the sensing nodes (typically a few tens of meters), usually multi-hopping is needed to communicate to the control centre. The practical problem that we consider in this paper is the following: there are already deployed, static sensors (also referred to as sources) from which measurements, encapsulated into packets, need to be collected. Additional relays and base stations (BS) need to be placed in the region in order to provide multi-hop paths from each of the sources to at least one BS. The sources can also act as relays for the packets from other sources. The network so obtained needs to provide certain quality-of-service (QoS) to the packets flowing over it, in terms of, e.g., delivery probability, or packet delay.

Existing solutions and open research issues at the application, transport, network, link, and physical layers of the communication protocol stack are investigated, along with possible cross-layer synergies and optimizations.

Wireless sensor networks (WSN) have drawn the attention of the research community in the last few years, driven by a wealth of theoretical and practical challenges. This growing interest can be largely attributed to new applications enabled by large-scale networks of small devices.

In most practical applications, due to the presence of obstacles or taboo regions, we cannot place relays and sinks anywhere in the region, but only at certain designated locations. This leads to the problem of constrained node placement in which the nodes are constrained to be placed at certain potential locations.

In wireless networks, the actual link qualities are unknown a priori, and can only be ascertained by field measurements; designs based only on approximate stochastic RF propagation models cannot be guaranteed to work when deployed on field. This motivates iterative algorithms that explore the field by making partial deployments and link quality measurements. Efforts from several research areas will need to converge to develop efficient and flexible WMSNs, and this in turn, will significantly enhance our ability to interact with the physical environment. These include advances in the understanding of energy-constrained wireless communications, and the integration of advanced multimedia processing techniques in the communication process.

Some multimedia sensors, in particular video sensors, have larger sensing radii and are sensitive to direction of acquisition (directivity). Furthermore, video sensors can capture images only when there is unobstructed line of sight between the event and the sensor.

This general problem is of interest for scalability of the network design, i.e., when we want to deploy a network over an area so large that a single sink based solution fails to meet the desired QoS

requirements.

II. THE NETWORK DESIGN PROBLEM

Formally, we define "light traffic" as follows: at any point of time, there is at most one packet flowing in the network.

This requires new architectures for collaborative, distributed, and resource-con-strained processing that allow for filtering and extraction of semantically relevant information at the edge of the sensor network. This may increase the system scalability by reducing the transmission of redundant information, merging data originated from multiple views, on different media, and with multiple resolutions. The first cloud on the left shows a single-tier network of homogeneous video sensors. A subset of the deployed sensors have higher processing capabilities, and are thus referred to as processing hubs.

This light traffic assumption facilitates the conversion of QoS objectives into simple graph constraints. The designs based on lone-packet model can be used as a starting point for network design with more general arrival processes. Packet level simulation results reported in suggest that such lone-packet model based designs suffice up to some small (but useful) positive arrival rates. For a more detailed discussion on the applicability and justification of the lone-packet model. Most proposals for wireless sensor networks are based on a flat, homogenous architecture in which every sensor has the same physical capabilities and can only interact with neighbouring sensors.

Where we have considered the practical situation of slowly fading links, and packet losses due to random channel errors. Thus, there is a random delay at each hop due to packet retransmissions, and packets could be dropped if a retransmission limit is reached. Note that as a consequence of the lone packet assumption, the delay along a path is additive, i.e., it is simply the sum of the delays on each hop along the path. Since computing an optimal solution is NP-Hard, we obtain a lower bound on the optimum cost of a problem instance by solving the LP relaxation of an ILP formulation for the MSSN-MC-HC problem. See [4] for details of the ILP. We compare the performance of our algorithms against this LP-based lower bound on the optimum cost.

III. PLATFORMS

One major challenge in a WSN is to produce *low cost* and *tiny* sensor nodes. There are an increasing number of small companies producing WSN hardware and the commercial situation can be compared to home computing. Many of the nodes are still in the research and development stage, particularly their software. Also inherent to sensor network adoption is the use of very low power methods for radio communication and data acquisition. In many applications, a WSN communicates with a Local Area Network or Wide Area Network through a gateway. This enables data to be stored and processed by devices with more resources, for example, in a remotely located server. It gives solutions of very good quality in extremely reasonable computation time. We have also provided worst case bound on the performance of the algorithm.

Lifetime maximization: Energy/Power Consumption of the sensing device should be minimized and sensor nodes should be energy efficient since their limited energy resource determines their lifetime. To conserve power the nodes normally turn off the radio transceiver when not in use.

Some of the important topics in WSN (Wireless Sensor Networks) software research are:

Operating systems
Security
Mobility
Usability
Maintenance

Firefly is a low-cost wireless sensor network platform capable of data acquisition, processing & multi-hop mesh communication. Each battery-operated node functions with scalable & economical global time-synchronization and delivers a lifetime of 1.5-2 years. Firefly supports both hardware-based global time synchronization and in-band software-based sync. (a) Shows the TDMA schedule generated to support both high-speed voice streaming and low-speed sensor probing. (b) Shows the hybrid time sync with hardware sync along the mine backbone and software sync everywhere else.

TinyOS is perhaps the first [7] operating system specifically designed for wireless sensor networks. TinyOS is based on an event-driven programming model instead of multithreading. TinyOS programs are composed of *event handlers* and *tasks* with run-to-completion semantics. Event handlers can post

tasks that are scheduled by the TinyOS kernel some time later.LiteOS is a newly developed OS for wireless sensor networks, which provides UNIX-like abstraction and support for the C programming language.

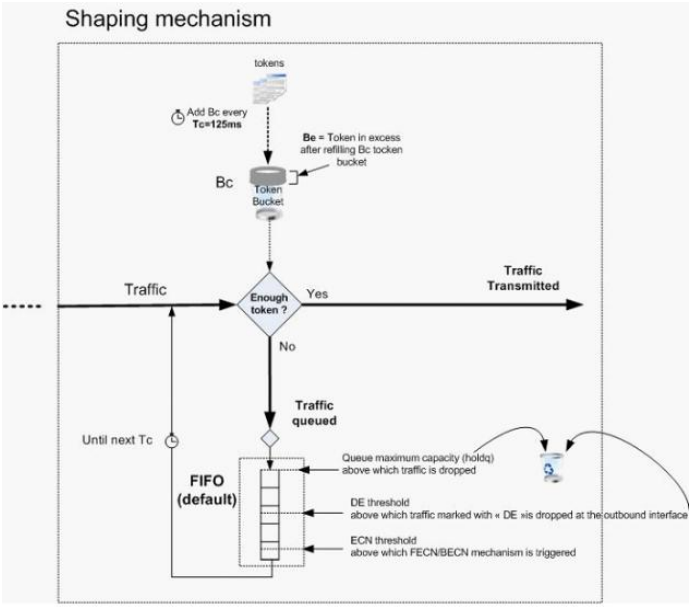
Contiki is an OS which uses a simpler programming style in C while providing advances such as 6LoWPAN and Protothreads.

RIOT implements a microkernel architecture. It provides multithreading with standard API and allows for development in C/C++. RIOT supports common IoT protocols such as 6LoWPAN, IPv6, RPL, TCP, and UDP.[8]ERIKA Enterprise is an open-source and royalty-free OSEK/VDX Kernel offering BCC1, BCC2, ECC1, ECC2, multicore, memory protection and kernel fixed priority adopting C programming language.

IV. FRAME RELAY

A large part of Frame Relay documentation is focused on the configuration of end devices more than the FR cloud, which can make practicing Frame Relay quality of service very confusing and frustrating without an organized approach, this begins by setting a FR lab for testing and deployment; this is the purpose of the current post .R2 and R1, customer devices, connected to FRS the frame Relay switch through back-to-back serial cables, a traffic generator is connected to R2 will generate traffic, through the FR cloud at different rates, destined to the receiver station connected to R1.

1) Frame Relay connectivity
   1-a) FR End-device
   1-b) FR switch
2) Shaping queue and congestion on FR end device
   2-a) Traffic rate:
   2-b) Shaping queue size:
   2-c) Shaping parameters:
3) Shaping queue and congestion on FR Switch
4) FR Congestion management, FECN/BECN
5) FR Congestion management, Discard Eligible bit



Frame relay is based on the older X.25 packet-switching technology which was designed for transmitting analog data such as voice conversations. Unlike X.25 which was designed for analog signals, frame relay is a fast packet technology, which means that the protocol does not attempt to correct errors. When an error is detected in a frame, it is simply "dropped." (Thrown away). The end points are responsible for detecting and retransmitting dropped frames. (However, the incidence of error in digital networks is extraordinarily small relative to analog networks.)

Frame relay is often used to connect local area networks with major backbones as well as on public wide area networks and also in private network environments with leased lines over T-1 lines. It requires a dedicated connection during the transmission period. It's not ideally suited for voice or video transmission, which requires a steady flow of transmissions. However, under certain circumstances, it is used for voice and video transmission.

V. QOS REQUIREMENTS

The wide variety of applications envisaged on WMSNs will have different requirements. In addition to data delivery modes typical of scalar sensor networks, multimedia data include snapshot and streaming multimedia content. Hence, a strong foundation is needed in terms of hardware and supporting high-level algorithms to deliver QoS and consider application-specific requirements. These requirements may pertain to multiple domains and can be expressed, amongst others, in terms of a combination of bounds on energy consumption, delay, reliability, distortion, or network lifetime.

The growing demand of usage of wireless sensors applications in different aspects makes the quality-of-service (QoS) to be one of paramount issues in wireless sensors applications. Quality of service guarantee in wireless sensor networks (WSNs) is difficult and more challenging due to the fact that the resources available of sensors and the various applications running over these networks have different constraints in their nature and requirements.

Benefits of QoS

QoS mechanisms offer improved services to the end user, while reducing upgrades to the network capacity. QoS allows for better use of the existing network infrastructure, improves service to the network users and reduces the cost of providing these services, thus, increasing the ROI on network infrastructure. These mechanisms are designed for differentiating between different categories of traffic based on priority, required bandwidth, assured timing etc. One of the main goals of QoS is to provide priority including dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics. It adds predictability and controllability beyond the existing best-effort service that networks provide.

- Flexible architecture to support heterogeneous applications. WMSN architectures will support several heterogeneous and independent applications with different requirements. It is necessary to develop flexible, hierarchical architectures that can accommodate the requirements of all these applications in the same infrastructure.

Need for QoS in WLAN

A WLAN network is susceptible to all the parameters mentioned before. These parameters may cause variation in bandwidth, latency in data delivery, jitter and error rates. The adverse conditions prevailing in a WLAN network make QoS guarantees very important. An intelligent, adaptive QoS solution could be the answer to the unpredictable nature of the medium, leading to better utilization of the network resources.

The base IEEE 802.11 specification does not provide for QoS in WLANs, but an extension draft (IEEE 802.11e) provides for MAC extensions to support QoS in WLANs.

With AppQoS, there are three ways to mark DSCP values on SRX Series devices:

IDP attack action-based DSCP rewriters

Layer 7 application-based DSCP rewriters

Firewall filter-based DSCP rewriters

IDP remarking is conducted at the ingress port based on IDP rules. Application remarking is conducted at the egress port based on application rules. Interface-based remarking also occurs at the egress port based on firewall filter rules. (See the *Class of Service Configuration Guide for Security Devices* for a detailed description of Junos OS CoS features.)

The remarking decisions of these three rewriters can be different. If a packet triggers all three, the method that takes precedence is based on how deep into the packet content the match is conducted. IDP remarking has precedence over application remarking which has precedence over interface-based remarking.

The AppQoS DSCP rewriter conveys a packet's quality of service through both the forwarding class and a loss priority. The AppQoS rate-limiting parameters control the transmission speed and volume for its associated queues.

VI. CONCLUSION

We have studied the problem of determining an optimal relay and sink node placement strategy such that certain performance objective(s) (in this case, hop constraint, which, under a lone-packet model, ensures data delivery to the BS within a certain maximum delay) is (are) met. We found that the problem is NP-Hard, and is even hard to approximate within a factor of O (ln m), where m is the number of sources. We have proposed a polynomial time approximation algorithm for the problem. The algorithm is simple, intuitive, and as can be concluded from numerical experiments presented in Section IV, gives solutions of very good quality in extremely reasonable computation time. We have also provided worst case bound on the performance of the algorithm. Further, we are working on combining our algorithm. [5] To further improve the cost efficiency of our algorithm while retaining the benefits of fast running time.

Wireless technology is becoming more and more popular because of its low cost and ease-of-use. In many cases wireless has become cheaper than the wired alternative. [6] This technology allows us a faster and more convenient access to the world. From a simple domestic application of temperature control to the more complex mesh sensor networks that analyse volcano, devices are gradually becoming an industry standard in wireless communication.

REFERENCES

[1] Honeywell, "www.honeywell.com/PS/wireless."

[2] ISA100, "www.isa.org/isa100."

[3] GE, "http://www.ge.com/stories/industrial-internet."

[4] A. Bhattacharya, S. M. Ladwa, R. Srivastava, A. Mallya, A. Rao, D.G. R. Sahib, S. Anand, and A. Kumar, "Smartconnect: A system for the design and deployment of wireless sensor networks," in

5th International Conference on Communication Systems and Networks (COMSNETS), 2013.

[5] L. Lloyd and G. Xue, "Relay node placement in wireless sensor networks," IEEE Transactions on Computers, vol. 56, January 2007.

[6] J. L. Bredin, E. D. Demaine, M. T. Hajiaghayi, and D. Rus, "Deploying Sensor Networks with Guaranteed Capacity and Faul Tolerance," in MobiHoc'05, ACM, 2005