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STRATEGIC ANALYSIS OF MOBILE ADHOC NETWORKS IN ROUTING PROTOCOLS USING WSNs

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ABSTRACT

The vision of ubiquitous computing requires the development of devices and technologies, which can be pervasive without being intrusive. The basic components of such a smart environment will be small nodes with sensing and wireless communications capabilities, able to organize flexibly into a network for data collection and delivery. The constant improvements in digital circuit technology, has made the deployment of such small, inexpensive, low-power, distributed devices, which are capable of information gathering, processing, and communication in miniature packaging, a reality. Realizing such a network presents very significant challenges, especially at the protocol and software level. Major steps forward are required in the field of communications protocol, data processing, and application support. Although sensor nodes will be equipped with a power supply (battery) and embedded processor that makes them autonomous and self-aware, their functionality and capabilities will be very limited. The resource limitations of Wireless Sensor Networks (WSN), especially in terms of energy, require novel and collaborative approach for the wireless communication.

Therefore, collaboration between nodes is essential to deliver smart services in a ubiquitous setting. Current research in this area generally assumes a rather static network, leading to strong performance degradation in a dynamic environment. In this thesis we investigate new algorithms for routing in dynamic wireless environment and evaluate their feasibility through experimentation. These algorithms will be key for building self-organizing and collaborative sensor networks that show emergent behaviour and can operate in a challenging environment where nodes move, fail and energy is a limited resource.

KEYWORDS: Sensors, WSN, Networks, Wireless Processing.

I. INTRODUCTION

A Wireless Sensor Network (WSN) is a network of wireless embedded system elements, which consists of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants at different locations [1]. WSNs belong to the Low-Rate Wireless Personal Area Network (LR-WPAN) type. Here, the word “personal” means short range communication. Every device in the network is called a sensor node. It includes the processing unit (micro controller), the radio unit (low-power transceiver) and the sensing unit (a board with sensors).

Nodes may communicate in ad-hoc way in order to extend the communication range and maintain network scalability. The main WSN limitations are battery capacity, bandwidth and computing power. Hence, packet routing techniques [2] must be applied to provide long-range and large-scale communication in WSNs. Routing in ad-hoc networks selects the optimal path to send a message from a source to a sink. The shortest routing path does not always refer to an optimal routing. Plenty of routing algorithms are available today and each of them tries to solve the routing task, with different requirements and parameters. Most of the algorithms are valid in static networks or allow only limited node mobility. Network mobility and node mobility introduce a new challenge into the research area. The deployment of sensor nodes changes frequently and a routing algorithm must adapt to these conditions. It should take into account the information about the packet routing opportunity in each case. Opportunistic routing is aware of the communication context information. It adapts to the current conditions and predicts the future behaviour. In order to extend the maximum network lifetime, the context information must play the most important role.

Wireless sensor networks have their own unique characteristics which create new challenges for the design of routing protocols for these networks. First, sensors are very limited in transmission power, computational capacities, storage capacity and most of all, in energy. Thus, the operating and networking protocol must be kept much simpler as compared to other ad hoc networks. Second, due to the large number of application scenarios for WSN, it is unlikely that there will be a one-thing-fits-all solution for these potentially very different possibilities. The design of a sensor network routing protocol changes with application requirements. For example, the challenging problem of low-latency precision tactical surveillance is different from

that required for a periodic weather-monitoring task. Thirdly, data traffic in WSN has significant redundancy since data is probably collected by many sensors based on a common phenomenon. Such redundancy needs to be exploited by the routing protocols to improve energy and bandwidth utilization. Fourth, in many of the initial application scenarios, most nodes in WSN were generally stationary after deployment. However, in recent development, sensor nodes are increasingly allowed to move and change their location to monitor mobile events, which results in unpredictable and frequent topological changes [21],[22].

Due to such different characteristics, many new protocols have been proposed to solve the routing problems in WSN. These routing mechanisms have taken into consideration the inherent features of WSN, along with the application and architecture requirements. To minimize energy consumption, routing techniques proposed in the literature for WSN employ some well-known ad hoc routing tactics, as well as, tactics special to WSN, such as data aggregation and in-network processing, clustering, different node role assignment and data-centric methods. In the following sections, introduce to current research on routing protocols have been presented.

Wireless Sensor Network

The concept of wireless sensor networks is based on a simple equation: Sensing + CPU + Radio = Thousands of potential applications

As soon as people understand the capabilities of a wireless sensor network, hundreds of applications spring to mind. It seems like a straightforward combination of modern technology. However, actually combining sensors, radios, and CPU's into an effective wireless sensor network requires a detailed understanding of the both capabilities and limitations of each of the underlying hardware components, as well as a detailed understanding of modern networking technologies and distributed systems theory. Each individual node must be designed to provide the set of primitives necessary to synthesize the interconnected web that will emerge as they are deployed, while meeting strict requirements of size, cost and power consumption. A core challenge is to map the overall system requirements down to individual device capabilities, requirements and actions. To make the wireless sensor network vision a reality, architecture must be developed that synthesizes the envisioned applications out of the underlying hardware capabilities.

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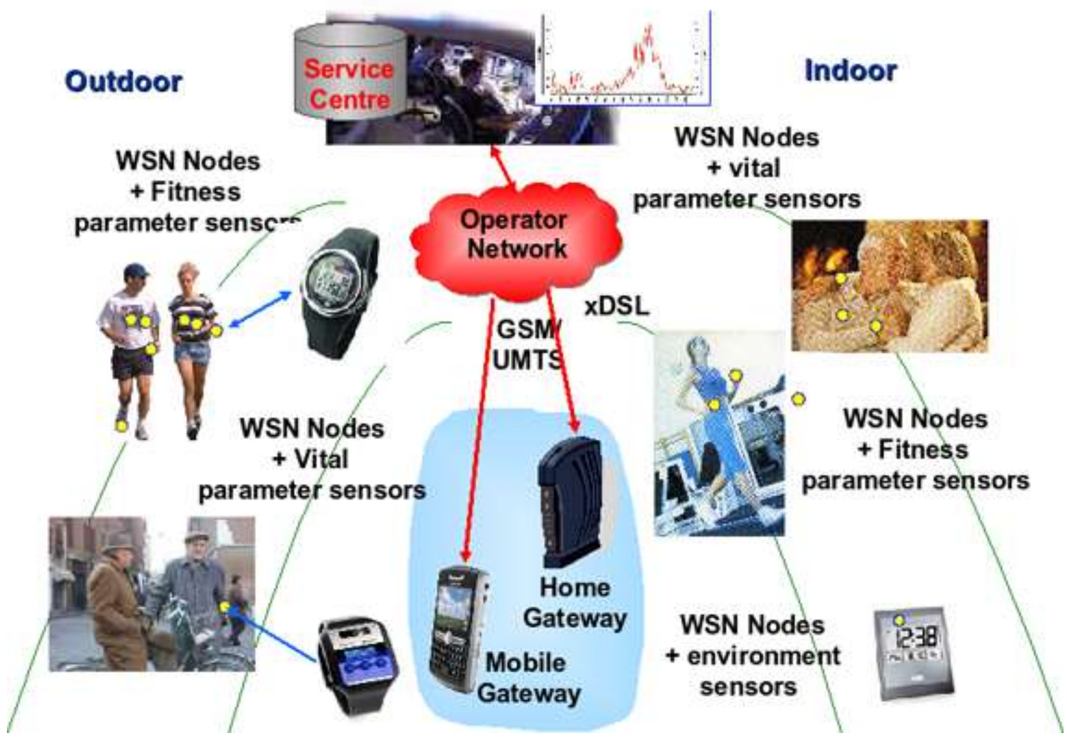

Figure: Example of wireless sensor network.

Wireless Sensor Networks (WSN) is large scale networks of sensor nodes. The number of wirelessly communicating nodes can reach thousands of separate devices including sensor equipment and data collection tools. The initial motivation for WSNs was battle field surveillance for military purposes. Now WSNs are applied for monitoring of the environment in local and wide areas in the context of temperature, humidity and other metrics. This provides a possibility to have precise statistical data about any changes during time. WSNs are also applied in automotive control, inventory tracking, surveillance, security, health monitoring and other civil tasks, etc.

Routing in wireless sensor networks

The basic purpose of a wireless sensor network is to monitor the physical environment, and provide this information in an appropriate fashion to applications when needed. Each node is equipped with one or more sensors, whose readings are transported via other network nodes to a data sink. This section gives an introduction on the communication types, operation modes and communication patterns of wireless sensor networks.

In general, two types of nodes are logically recognized: nodes that mainly sense the physical data and transmit their own sensor readings (sensor nodes) and nodes that mainly relay messages from other nodes (relay nodes). Sensor readings are routed from the source nodes to the sink via the relay nodes, thus creating a multi-hop topology. This logical organization implies four types of communications types as shown in Figure 1.2 that must be accounted for, especially on lower communication levels such as the MAC protocol.

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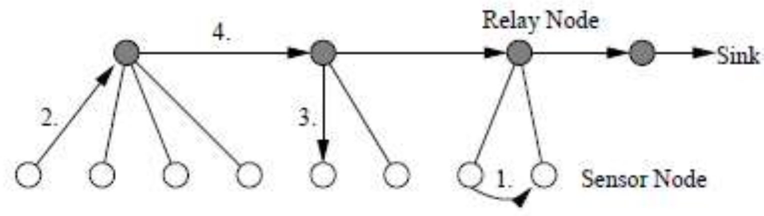

Figure: WSN Communication Types

1. Sensor node to sensor node communication - This direct type of communication is used for local operations, for example, during the clustering process, or the route creation process.
2. Sensor node to relay node communication - Sensor data is transmitted from a sensor node to a relay node. This type of communication is often unicast.
3. Relay node to sensor node communication - Requests for data and signalling messages (often multicasts) to reach a subset of the surrounding nodes at once, are spread by the relay nodes.
4. Relay node to relay node communication - The relay nodes form the backbone of the network. Communication between these nodes is mostly unicast. Note that every node is equipped with a wireless transceiver and thus is able to perform the duties of a relay node.

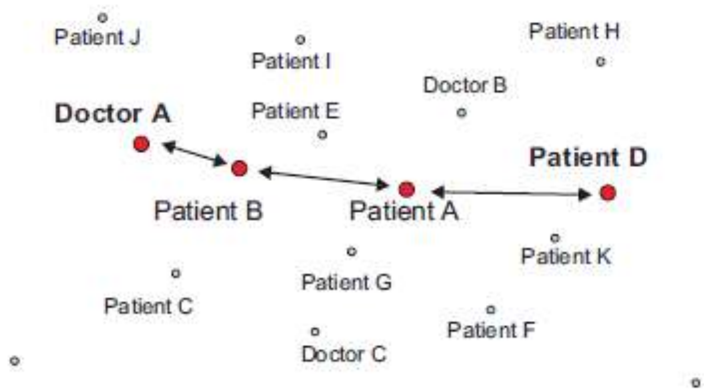

Figure: The point-point communication between Doctor A and Patient D

For a sensor node, there are two operational modes to fit the possible applications arising from the WSN: 1) active polling and 2) passive detection and notification. To get the reading of a sensor, the node acting as sink can actively ask for the information from a specific node or a group of nodes (active polling), or request to be notified when an event is detected by one of the nodes, e.g., if a pre-determined threshold on a sensor reading is passed (passive notification).
On the routing level, two types of communication patterns exist between data sink and data source in the wireless sensor network, which are:
1. Point-point communication - In the point-point communication, the data sink is only interested in sensing the data from an individual sensor node and needs to communicate with this particular sensor via a routing protocol. For example, in a patient tracking application, the doctor needs to know the monitored data from a specific patient, who is attached with a sensor node

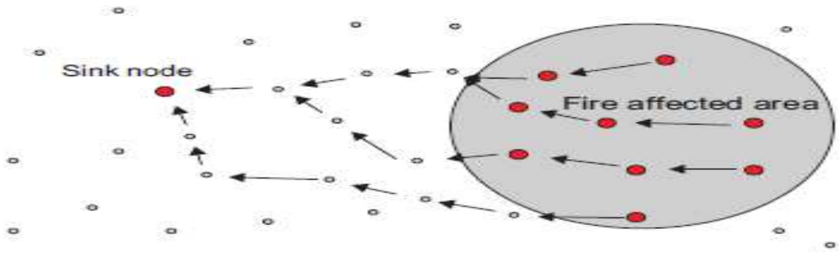

Figure: The point-multipoint communication in a forest fire detection application

And might move around inside the hospital. A point-point communication should be setup between the doctor node and the patient node to track the status of the individual patient as shown in Figure 1.6.

Point-multipoint communication - In the point-multipoint communication, data sink cares about a certain type of data. Multiple sensor nodes might process this type of data and all of them send their data to the sink. A typical application scenario is found in forest fire detection, where the administration node needs to know the status from all the fire affected areas. This involves a large amount of sensors. All of these sensors should send their data through point-multipoint communication to the sink node as shown in Figure 1.4. In Table 1.1, we identify some of the typical wireless sensor applications and their corresponding communication patterns.

Problem Statement

Not with standing many similarities between wireless sensor networks and wireless ad hoc networks, sensor networks have their own unique characteristics which create new challenges for the design of wireless sensor networks. Routing in WSNs is very challenging due to the inherent characteristics that distinguish them from other wireless networks. To illustrate this point, the differences between sensor networks and existing ad hoc network concepts are outlined below:

Application	Category	Mobility	Comm. Patterns	Examples
Habitat Monitoring	Environmental Application	Static	Point-Multipoint	Great Duck Island, Great Barrier Reef
Glacier Monitoring	Environmental Application	Static	Point-Multipoint	Glacsweb at Briksdalsbreen
Patient Tracking	Healthcare Application	Mobile	Point-Point	Mote Track
Smart Home	Home Application	(Partly Mobile)	Point-Point	Residential Laboratory
Intrusion detection	Military Application	Mobile	Point-Multipoint	Sniper Localization
Battle Field Surveillance	Military Application	Static	Point-Multipoint	Self-Healing Mine Field
Herd Monitoring	Commercial Application	Mobile	Point-Multipoint	Networked Cows

Avalanche victim rescue	Commercial Application	Mobile	Point-Point	Wearable Sensor for Avalanche Rescue
Power Monitoring	Commercial Application	Static	Point-Point	Office Power Monitoring

Table: Typical wireless sensor network application and its communication patterns

Structure of Protocol Stack of DSDV Protocol

The DSDV algorithm is written on the Prospeckz IIK described in Section 3.5.2. The SpeckMAC algorithm [31], or to be more specific, the SpeckMAC-D variant of the same, is used in the MAC layer. The SpeckMAC-D algorithm was select because [31] indicates that it performs better than SpeckMAC-B. The reader is therefore requested to note that in the rest of this section, the word SpeckMAC is used to refer to the SpeckMAC-D variant unless explicitly mentioned otherwise. Figure 5.1 summarises the protocol stack within which the implementation of the DSDV algorithm resides.

The DSDV algorithm uses the sending and receiving primitives and the packet format defined in the SpeckMAC algorithm. In this section, I describe the primitives and structures used from the lower layers, as well as the structures defined in the network layer.

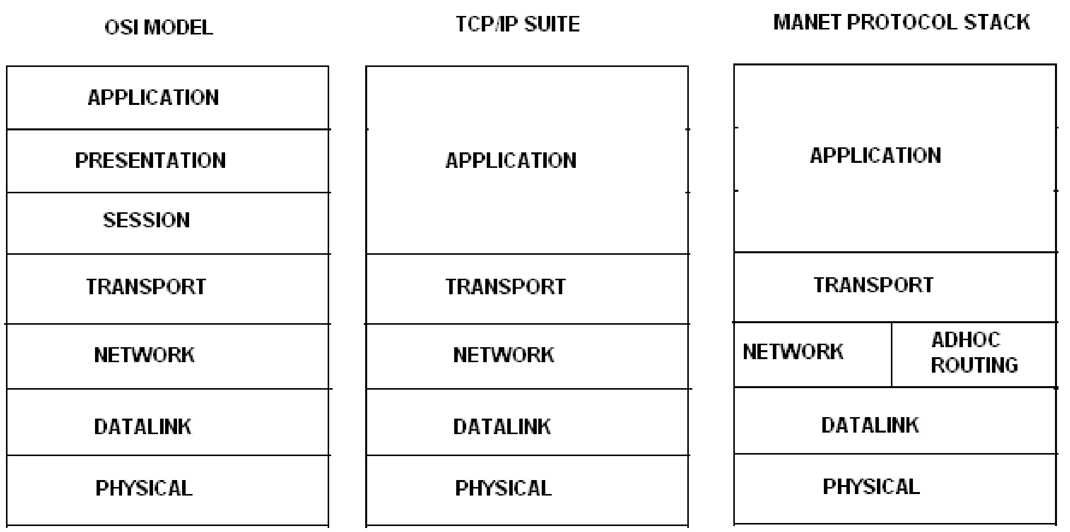

Figure: DSDV protocol stack with three models

Design Goals Of Dsdv

The Bellman Ford Routing Algorithm is computationally efficient and easy to implement. This algorithm can cause routing loops that can occur if the internetwork's slow convergence on a new configuration causes inconsistent routing entries. Another problem that cannot be handled by this algorithm is counting to infinity. This condition continuously loops packets around the network, despite the fundamental fact that the destination network is down. While the routers are counting to infinity, the invalid information allows a routing loop to exist. Modifications eliminate the problem of loops but need some inter-nodal coordination mechanisms which imply few topological changes. Now, this algorithm is not designed to handle rapid topological changes.

So, the design goals of DSDV are: Keep the simplicity of Bellman Ford algorithm. Avoid the looping problem.

Therefore, the approach that is followed to attain these goals is: Model each host as a router. Tag each routing table entry with a sequence number.

Primitives and Data Structures of the DSDV

The sending and receiving primitives (defined in the MAC layer) used in the network layer are explained. This is followed by a description of the MAC layer packet structure used, the mechanisms used for packing the network layer data structures into the MAC layer packet format, and the packet structures defined in the network layer.

MAC Layer Primitives

The SpeckMAC algorithm described in it provides several primitives to allow for the transmission and reception of data from other nodes over the CC2420 radio. The primitives used in the implementation of the DSDV algorithm are described in this section.

SpeckMAC Blocking Send Primitive

The blocking send primitive does not return until the packet passed to it as an argument has been successfully sent. Since this reduces the complexity of the code in the network layer, this primitive was extensively used in the implementation of the DSDV algorithm.

The implementation characterised herein does not use a scheduler to schedule the transmission of multiple packets from the network layer. It is, however, worthwhile, noting that the implementation of the ZRP algorithm uses a scheduler.

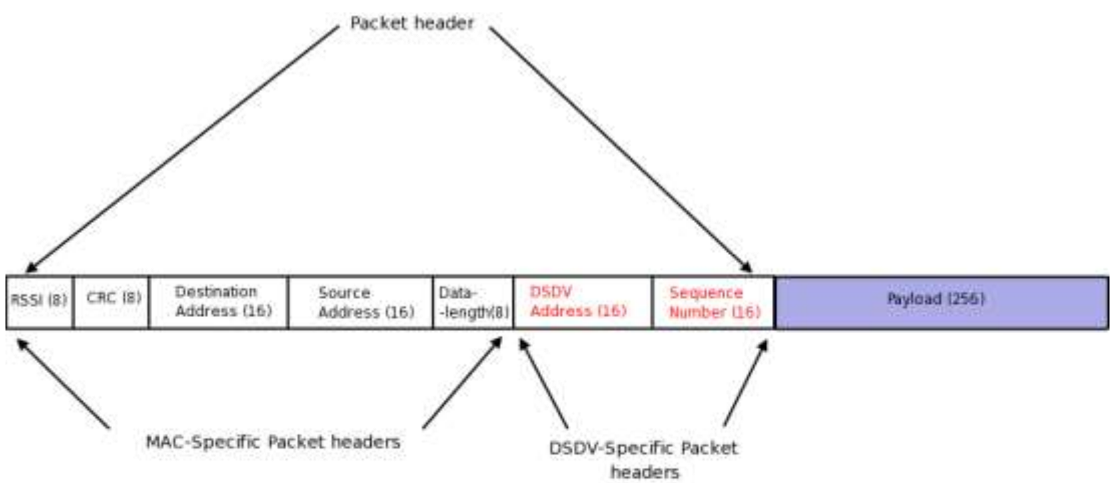

Figure: Basic Packet Structure (with DSDV-specific extensions)

Receiving Packets using SpeckMAC

The SpeckMAC algorithm periodically switches the node radio on. When the radio senses activity in the medium1, it listens in until it has received a whole data packet.

Upon completion of reception, an interrupt which handles the received packet and checks for errors is triggered. The packet handler for the DSDV algorithm is called from within the SpeckMAC Interrupt Service Routine (ISR).

Packet format

The packet format used in the MAC layer of the implementation is summarised in Figure 4.2. To maintain separation between the layers, it would have been necessary to encapsulate the entire network layer packet inside the data field of the MAC layer packet. However, the design decision was taken to sacrifice modularity in favour of performance. Hence, the packet header was modified to include DSDV-specific headers. This is because the size of the data field is limited. Therefore, using the data field to store DSDV-specific information would be a waste of valuable space, and would also result in an increase in the transmission time for the packet2.

The fields in Figure 4.2 that are marked in red are DSDV-specific fields, whereas those marked in black are the MAC layer-specific fields. The purpose of the fields in the structure are as described below:

• MAC Layer-specific fields:

Cyclic Redundancy Check (CRC): CRC is an error detection method which typically involves the calculation of a two-byte checksum of a data block, and is used to detect the accidental alteration of data during transmission or storage. The Least Significant Byte (LSB) of the CRC is loaded into this 1 byte field. Received Signal Strength Indicator (RSSI): RSSI is a measure of the strength (and not necessarily the quality) of the received signal strength in a wireless network . The Most Significant Byte (MSB) of the two-byte CRC is loaded into this 1 byte field by the MAC layer whenever a packet is transmitted. Destination Address: This field holds the ID of the node that is the packet's final destination. This field is 16 bits long, and thus, the implementation of the DSDV theoretically allows for 65,536 distinct nodes in the network. However, in practice, only 13 of these bits are used, thereby restricting the number of nodes to 8191.

Source Address: This field, which is also 16 bits long, holds the address of the source of the packet, i.e., the node that constructed the original packet.

Results

The results obtained are shown in Figure 5.4. The average proportion of time the transmitter remained switched on was found to be an extremely small 1.1 seconds per minute, which corresponds to 1.83% of the time. The receiver remains, on average, switched on for a slightly larger proportion of time; approximately 1.6 seconds per minute, which corresponds to 2.67% of the time.

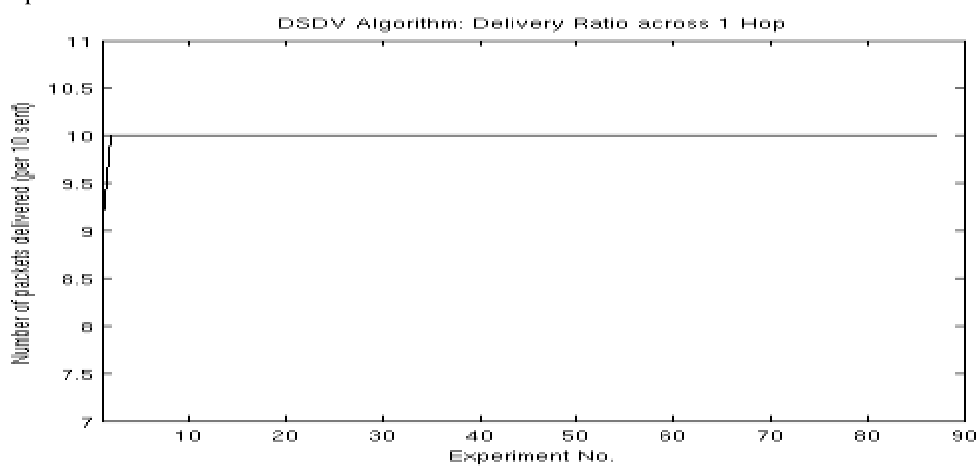

Figure : Results: Delivery Ratio across 1 hop

Figure: Results: Delivery Ratio across 2 hops

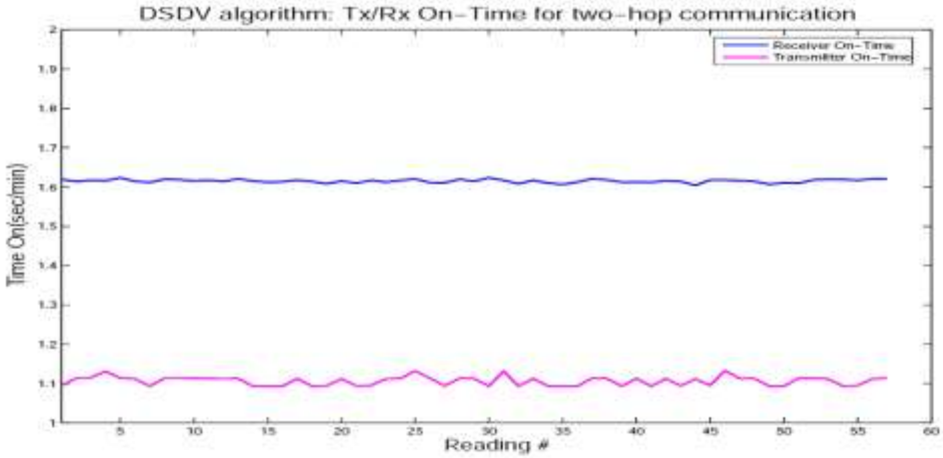

Figure: Results: Tx/Rx On-time for the DSDV algorithm

II. CONCLUSION

This work presented the implementation and characterisation of a selection of MANET routing algorithms in WSNs. It additionally attempted to explore domains wherein MANET routing algorithms could potentially be applied. The dissertation began with a review of WSNs, and a detailed discussion of the hardware and software platforms, MAC layer algorithms, and network layer algorithms used (and developed) in this work. This was followed by an in-depth presentation of the implementation of the DSDV algorithm, an application that builds upon and uses the DSDV algorithm, and the ZRP algorithm. This included descriptions of the position of the algorithm/application in the protocol stack, the primitives used from the lower layers, and the data structures and primitives defined as part of the algorithm/application. The discussion then moved to the experimental methodology used to characterise the implementations developed herein. The metrics used and the mechanisms used to measure them were presented.

This report then detailed the results obtained upon performing the experiments, and the conclusions derived from these results. The results indicated that the MANET algorithms analysed herein were suitable for use in WSNs by virtue of their power and memory conservation characteristics, and also that there exist application domains where these algorithms may be used. It is our belief that we have developed implementations on the ProSpeckz IIK (4) that could be used in the future in developing novel applications, and that we have performed a detailed analysis and comparison of two algorithms typically unused in the WSN domain.

III. REFERENCES

1. Romer K. and Friedemann M., "The Design Space of Wireless Sensor Networks," IEEE Wireless Communications, vol. 11, pp. 54-61, 2004.
2. Al-Karaki J. and Kamal A.E. "Routing techniques in wireless sensor networks: a survey," IEEE Wireless Communications, vol. 11, pp. 6- 28, 2004.
3. Akyildiz I, Su, Y W. Sankarasubramaniam, , and E. Cayirci. Wireless sensor networks: a survey. Computer Networks, 38(4):393{422, 2002.
4. Kininmonth S. Bainbridge S., Atkinson I., Gill E., Barral L., and Vidaud R. Sensor networking the great barrier reef. Spatial Sciences Institute Journal (QLD), 50(2):101{129, 2005.
5. Mainwaring, Polastre J., Szewczyk R., Culler D., and Anderson J.. Wireless sensor networks for habitat monitoring. In Proceedings of the ACM International Workshop on Wireless Sensor Networks and Applications, Atlanta, USA, pages 88{97. ACM Press, 2002.
6. Lorincz K. and Welsh M. Motetrack: A robust, decentralized approach to rf-based location tracking. In Proceedings of the International Workshop on Location and Context-Awareness (LoCA 2005) at Pervasive 2005, USA, vol- ume 3479 of Lecture Notes in Computer Science, pages 63{82. Springer, 2005.

7. Young Han Nam, Zeehun Halm, Young Joon Chee, and Kwang Suk Park. Development of remote diagnosis system integrating digital telemetry for medicine. Proceedings of the 20th Annual International Conference of the IEEE, Hong Kong, 3(4):1170{1173, 1998.
8. Simon Gyula, Maroti Miklos, Ledeczi Akos, Balogh Gyorgy, Kusy Branislav, Nadas Andras, Pap Gabor, Sallai Janos, and Frampton Ken. Sensor network- based countersniper system. In Proceedings of the 2nd international conference on Embedded networked sensor systems, 2004, Baltimore, USA, pages 1{12. ACM Press, 2004.
9. Essa I.A.. Ubiquitous sensing for smart and aware environments. IEEE Personal Communications, 7(5):47{49, 2000.
10. Calhoun B. H., Daly D. C., Verma N, Finchelstein D, Wentzlo D. D., Wang, Cho S.-H., and Chandrakasan A. P.. Design considerations for ultra-low energy wireless microsensor nodes. IEEE Transactions on Computers, 54(6):727{740, 2005.
11. BTnodes - A Distributed Environment for Prototyping Ad Hoc Networks. website. http://www.btnode.ethz.ch/.
12. Radhakrishna Hiremane. Technology@Intel Magazine, 2005. http://www.intel.com/technology/magazine/silicon/moores-law-0405.p

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