Competition: Multimodal Reactive-Routing Protocol to Tolerate Failure

Tiong Hoo Lim
Electrical and Electronic Engineering
Institut Teknologi Brunei
Brunei
lim.tiong.hoo@itb.edu.bn

Iain Bate
Department of Computer Science
University of York
United Kingdom
iain.bate@york.ac.uk

Jon Timmis
Department of Electronics
University of York
United Kingdom
jon.timmis@york.ac.uk

Abstract

Link failure and unreachable nodes due to interference from external devices are common in WSNs. These interferences can be a major inhibitor to node performance and network stability. In order to tolerate these failures, we propose a distributed Multimodal Routing Protocol (MRP) that automatically switches between routing protocols in real time to overcome interference in a noisy environment. By incorporating timing-based route selection mechanism has reduced the numbers of routing packets generated. Results from TelosB motes have shown significant performance improvement on packet delivery ratio and lower power consumption in MRP in noisy environments

1 Introduction

Wireless Sensor Networks (WSNs) are commonly used in an environment they co-exists with other devices using the same frequency range. In real world implementations, WSNs may experience transient network failures caused by interference as they share the same radio frequency band with other radio emitting and home devices such as portable phones, Bluetooth devices, and Wi-Fi networks.

Existing literatures have revealed that no single routing protocol on its own can perform and handle all types of network anomalies [4, 5]. Each routing protocol has specifically been designed to tolerate specific network failure, and has shown better performance than others in a specific network condition. Perkin and Royer proposed the Adhoc On-demand Distance Vector (AODV) [6] to tolerate permanent node failure where no alternative route is available. However, if the networks are susceptible to sporadic frequent link failures, the control packet overhead may increase dramatically. Gomez et al. applied retransmission in Not So Tiny-AODV (NST-AODV) [2] to tackle failure caused by sporadic radio interference. However, this single retransmission can only handle short sporadic failures and may not be able to handle failures with different durations.

We have proposed the use of a distributed Multimodal Routing Protocol (MRP) to be implemented in individual nodes that can switch between two or more routing algorithms in real time depending on the type of anomalies. The motivation behind re-using the existing known protocols is that we do not want to design a whole new protocol that is not supported by existing hardware. In contrast, what is proposed in this paper can be supported using commonly available hardware, e.g. MICAz and TelosB and new routing protocol can be added if required. To handle dynamic transient failure, we have incorporated stop and wait protocol [1].

The rest of this paper is organised as follows: Section 2 provides a detailed description of our proposed solution, and the results from preliminary evaluation on both simulation and real hardware under the influence of transient failure with different failure durations and frequencies are presented in section 3.Finally, we summarise our conclusions.

2 The Design of MRP-AODV

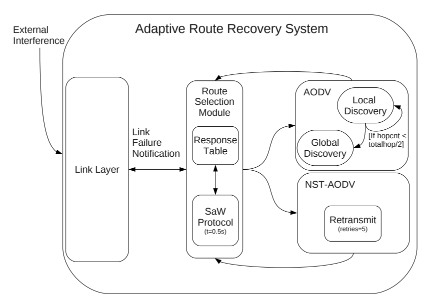

Figure 1. The proposed MRP architecture

To tolerate different types of interference sources, we integrate the best existing features from various AODV protocols and operates in one of the feature modes depending on the characteristics of the network anomalies, and traffic conditions. It consists of Route Selection Module (RSM) and a set of routing protocols as illustrates in Figure 1. During link failure, the self-switching route mechanism in RSM enables intermediate nodes to make effective localised decisions whether to switch RD in AODV or retransmission

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in NST-AODV. Once a routing decision has been made, the RSM module will wait, and evaluate the effectiveness of that decision. Based on the evaluation, it updates its response table and timeout parameter appropriately. This approach allows more effective and efficient routing strategy to be executed and reduces the number of redundant RREQs generated during transient failure.

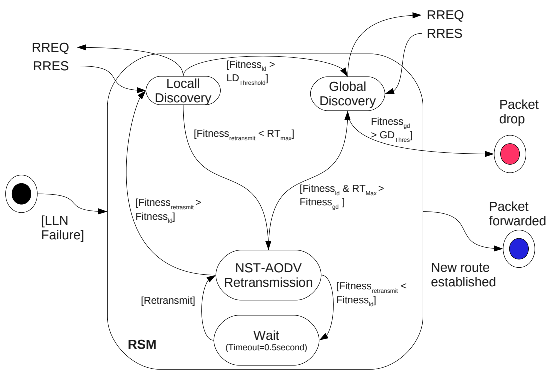

Figure 2. Different states of MRP

We modelled our MRP using a state diagram as shown in Figure 2, highlighting different recovery states based on AODV and NST-AODV routing protocols. When a link failure notification is received, sensor nodes can either immediately send the packet, or delay its transmission depending on the current network condition and availability of next hop neighbouring node. Initially, the forwarding node waits for a short interval of 0.5s. After timeout, the node switches its routing mode to the routing algorithm with the lowest cost, in this case NST-AODV, to transmit the packet queueing in the buffer. This delays the RD, and increases the probability packet transmission as the network condition returns to normal. This wait and retransmit procedure is repeated until it reaches an initial retransmit threshold of 3 retries. Once this threshold level is reached, MRP will switch to dual mode where local repair in AODV is initiated to allow the node to determine an alternative backup route. It will further operates dual mode until it reaches a total retransmit threshold of 5 retries, where it will switch to full AODV mode. If both local RD and retransmission are not successful, a route error packet will be send to source and the packet will be dropped. The maximum number of retransmissions and retries timeout parameters are configured based on commercially available network troubleshooting tools, such as Ping [3], where the default settings are between 3-5 for retries and 0-1 second for timeout. Based on these two parameters, each intermediate node can reconfigure its own packet retransmission with different interval and frequency.

3 Preliminary Experiments and Result

MRP has been tested in real hardware. A small network of 6 TelosB motes in a grid topology as shown in Figure 3 was used to evaluate the MRP in hardware. Node 1 in the network is configured to collect temperature reading from the sensor and transmit the packet to node 6 using multihop routing protocol. To control the environment from any interference generated from other radio devices, Channel 26 is used. An interference signal generated at irregular random interval from another TelosB node is placed near to the nodes to evaluate the performance of MRP. Table 1 provides a comparison of the performance improvement between MRP, NST-AODV and AODV and has shown that MRP can delivery more packets than AODV and NST-AODV with smaller routing overhead at lower delay.

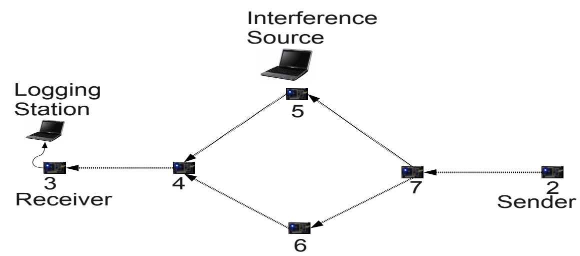

Figure 3. The topology of the WSN. Node 2 periodically send packets to node 3 via node 5 or node 6. At random intervals, Wi-Fi traffic are introduced near node 5

Table 1. Comparison between MRP, AODV and NST

Protocol	MRP	AODV	NST
PDR	90%	82%	88%
Delay	270ms	300ms	285ms
Routing Load	24	30	25

4 Conclusion

For this competition, we have proposed the MRP to be evaluated against other protocols. Preliminary results have shown that MRP can achieved a higher Packet Delivery Rate than AODV and NST-AODV. Results from the simulation also showed that MRP has used the least energy. We believe MRP can outperform single routing protocol in the noisy environments as proposed for the competition as it has the ability to toggle between routing protocols based on the failures condition.

5 References

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