

Chapter 6

Conclusion

This chapter summarises the work that was presented in this dissertation. The research question is also interpreted and recommendations for future work is provided.

6.1 Work Summary

The aim of the research presented in this dissertation was to compare the energy consumption characteristics of a shortest hop path routing scheme with that of a MTTPR scheme. This was achieved by making use of the scientific method presented in Chapter 1. Chapter 2 detailed the literature study that was performed. To be able to compare the energy consumption characteristics of the routing schemes, a SN designed specifically for use in an energy consumption ascertaining WSN tesbed was developed. The design and implementation of this SN was presented in Chapter 3. The testbed and experimental setup used for the experiments was presented in Chapter 4. This chapter also detailed the working of the routing framework that was used to support the shortest hop path routing and MTTPR schemes as well as the working of the SN firmware. Finally, the results of the experiments were presented in Chapter 5. The verification

and validation of the results were also presented in this chapter.

6.2 Research Question Interpretation

The research question as presented in Chapter 1 can be seen below:

How does the energy consumption of a shortest hop path routing scheme compare to that of a MTTPR scheme in a realistic environment?

This question was answered in Chapter 5. The results presented in this chapter show that the MTTPR scheme is more energy efficient than the shortest hop path routing scheme for the setup used. However the saving is significantly less than what the MTTPR scheme expects. This is because the MTTPR scheme does not take the transmission power setting dependant efficiency of the SN transceiver into account. Further investigation showed that the efficiency of the SN transceivers are significantly lower at low transmission power settings than at high transmission power settings. This means that under certain circumstances a MTTPR scheme will use more energy than a shortest hop path scheme.

6.3 Recommendations for Future Work

This section details some recommendations for future work with specific focus on the developed SN, WSN testbed and energy aware routing schemes.

6.3.1 Sensor Node and Wireless Sensor Network Testbed

By adding a support network (wired or wireless) and server to the testbed, efficient network management, precision timing protocols, in-field debugging and in-field programming can be supported. This would greatly ease experimentation and increase

the repeatability of experiments. Due to the increasing size of WSNs, experimentation on large scale WSN testbeds is important. This can be achieved by increasing the number of nodes in the testbed. The performance of routing protocols and schemes in mobile WSNs is also of importance. Mobile WSN experiments can be supported by developing a modular mobile platform which can be attached to some SNs.

6.3.2 Energy Aware Routing schemes

From the results presented in the previous chapter it is clear that the transmission power setting dependant efficiency of a transceiver has a significant effect on the working of a MTTPR scheme (as well as the numerous routing schemes based on the MTTPR scheme including: MTTCP routing, MTRTP routing and CMMBCR). A simple modification to the cost metric of the MTTPR scheme would enable it to take the transceiver efficiency into account. This could be achieved by making use of a predetermined lookup table or function. Such a lookup table or function would be unique for every type of SN transceiver.

Energy aware routing schemes provide a promising increase in the lifetime of a WSN. However to extend the lifetime of a WSN to its full potential these routing schemes need to be combined with a protocol that keeps the SNs, that form a WSN, in a sleep or idle state for as long as possible.

6.3.3 Simulation Environments

The majority of the simulation environments used to evaluate energy aware routing schemes do not take the transmission power dependant efficiency of SN transceivers into account. This has a significant effect on the energy consumption of the WSN. The simulation models can be improved by considering the transmission power dependant efficiency of SN transceivers.

6.4 Closure

The use of energy aware routing schemes in energy constrained networks shows promise. However, these routing schemes need to be adapted to fit the SN hardware used in WSNs. The MTTPR scheme can be improved by modifying the scheme to take the transceiver efficiency at different transmission power settings into account. Such a scheme would increase the lifetime of a WSN. If the SNs that form a WSN make use of sleep and idle states the lifetime of the WSN can be increased even further.

The results showed that there is still a significant difference between simulations and real life. It is simpler and cheaper to evaluate energy aware routing schemes in simulation, however, the experimental evaluation of energy aware routing schemes provides more realistic information. The simulation environments used to evaluate energy aware WSN routing schemes and protocols can be improved by taking the transceiver efficiency at different transmission power setting into account.