Modelling and Performance Study of Large Scale Zigbee Based Green House Monitoring and Control Network

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Abstract

Zigbee wireless sensor networks, known as IEEE 802.15.4 standard, have become quite popular in recent years due to its low power consumption, long battery life and security management. Academic and networking industries have taken interest in Zigbee (IEEE 802.15.4) due to its capability for multiple applications. In this thesis, we have studied Zigbee wireless sensor networks in geographically distributed greenhouses, which are a vital component in agriculture industry today. However due to the complexity and scattered nature of the proposed large scaled network, we only simulate the scenarios in an industry standard and powerful simulator called OPNET to achieve the perfect design and high percentage success. We investigate the performance parameters such as throughput, end-to-end delay, packet loss, traffic sent and traffic received depending on the network topology under various layouts and node conditions based on specific features and recommendations of the IEEE 802.15.4/ZigBee standards.

Since the network delay is the most important characteristic, we investigate this parameter first. We find that the delay increases as the number of greenhouses increases e.g. the delay for 20- greenhouse (GH) scenario is higher than 50- GH scenario. This is contrary to generally perceived understanding however our initial delay was also greater for 50- GH scenario but later due to many un-joined nodes, the delay fell suddenly. The next parameter we investigate is MAC throughput which is seen as increasing when there is communication between maximum nodes. The 20- GHs scenario is shows maximum MAC throughput whereas the scenario with 50- GHs stays way below 20- GHs. We also observe that the number of packets drops significantly in case of 50- GHs. This is attributed to the possibly of the routers dropping the joining or relay requests from end devices while they are too busy in processing requests from other end devices. We can conclude from the above that if the setup is as big as 50 GHs, we can't rely on single coordinator setup as it is too far for the nodes to hop all the way.

On the other hand, the traffic sent in scenario with 20- GH reaches the IEEE 802.15.4 industry specification of 250 kbps showing that the data is being sent at maximum possible rates in this scenario. So, real life implementation of this setup is possible for small number of GHs like 20-

GHs. The scenario with 20- GHs and nodes spaced at 20 m has shown favorable results for all the parameters such as throughput, delay and traffic even for a single coordinator.

Though our simulations worked and have been able to get reasonable results there are many challenges that need be met to improve the outcome of this as well as any other study involving simulation of the geographically dispersed very large scale Zigbee-based wireless sensor networks. Another challenge in this design is that the simulation of 50- GH with nodes close to 1000 takes large amount of time execute. Nonetheless, based on the findings from this work, it will be helpful to design the GH/nodes layout of the implementation in OPNET.

The most important achievement of the work is that we have been able to develop a simulation model for the geographically dispersed very large scale Zigbee-based wireless sensor network representing networked greenhouses. Considering the results of throughput, end-to-end delay, packet loss, traffic sent and traffic received it looks the network can support optimally a 20- GH setup for remote monitoring and control application.

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