Wireless Sensor Network &Perishable food Monitoring:

Wireless Sensor Nodes Lifetime Prediction

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Introduction

Food Export industry is worth approximately $30,633 million NZ dollar [1]. To maintain food quality during transportation environmental factors like temperature and humidity need to be closely monitored. More direct quality related measurement like pH or water content offers better precision for monitoring the quality[2]. Wireless Sensor Network (WSN) offers the ability to constantly monitor these food items during the various post harvesting stages[3]. WSN nodes are small and battery operated. Powering WSN nodes with battery, constraints its duration of operations. The power consumption of the node depends on its state of operation (Transmit, Receive, Idle, Sleep).

This research looks at the possibility of increasing the node longevity through finding a balance between the process requirements and node's operational capability. Different Off the shelf nodes are tested here. Data aggregation is also being investigated to optimise the transmission duration and save power.

Applications

Fruits and Vegetables

Meat

Milk Products Monitoring

Sea Food

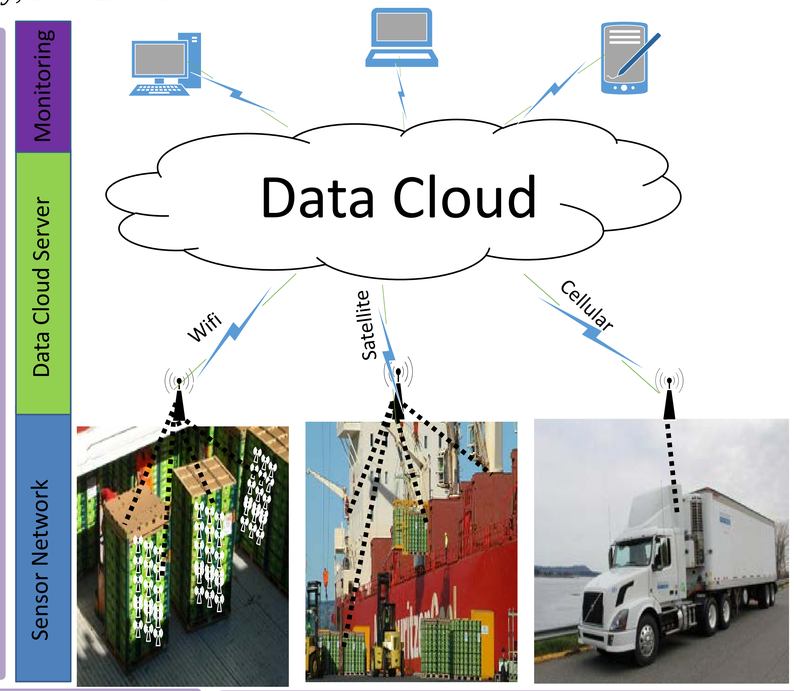
Potential industrial application are fresh fruits and vegetables, meat, milk and sea food. WSN is used to detect any early decay by monitoring temperature, pH, humidity, water loss and other environmental and chemical parameters. The product storage life varies from few days to few months. Supplier are alerted such that the product that has gone bad can be isolated.

Research objectives

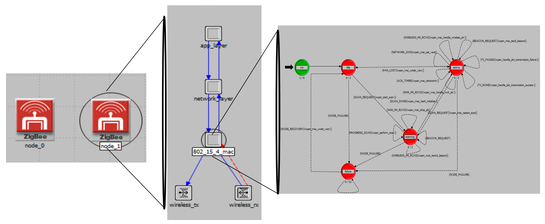
This research aims at extending the node lifetime in providing periodic update on the c the food condition and related environment.

The research objective are:

- ❑ Characterise Power modes for Off the shelf nodes such as Microduino and TI CC2538.
- ❑ Characterise the radio transmission through the specific food product to configure radio power and determine battery life of node.
- ❑ Create physical and virtual simulated sensor network to establish a low power transmission protocol for periodic data collection.
- ❑ Big data aggregation scheme for data transfer to the cloud for analysis.



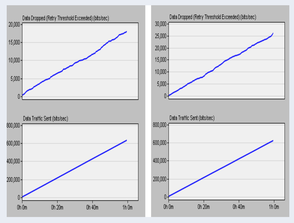
Modelling Tools and Preliminary Results



(a) A 11 node Zigbee network

(b) A 61 node Zigbee network

Zigbee Node Parameters	
Transmission Power	0dBm
Receiver Sensitivity	-85dBm
Carrier Frequency	2400MHz
Propagation Loss	Free Space Model
CSMA Channel Sensing duration	0.1 seconds
Number of Backoffs	4
Area of deployment	2m x 2m
Data Rate	250Kbps



Network Modelling tools, OPNET and OMNET++ are used for to test the deployment scenario. Virtual nodes are designed with the use of the physical nodes parameter and tested on these simulators.

Measurements of Node Power Consumption

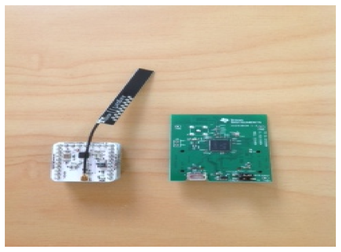


Figure 1 WSN nodes
(Left) Microduino
(Right) TI CC2538

Figure 2 Current Consumption for Microduino on Oscilloscope

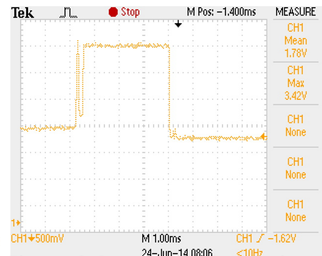


Figure 3 Current Consumption for CC2538 on Oscilloscope

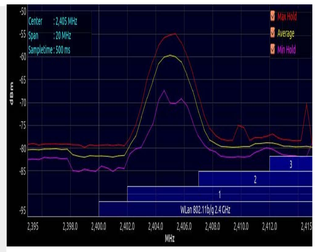


Figure 4 RSSI measurement on Spectrum Analyser – Channel Freq 2405Mhz.

Fig. 1 shows the WSN hardware that is being used for testing. Microduino is a low power node that has a very low operating current of 14mA. TI's CC2538 is an IoT enabled node. The power consumption of the nodes for different power modes is characterised on an oscilloscope as shown in Fig. 2 and 3. The power consumption data is helpful in simulating the behaviour of the node in a network and predicting the node and network lifetime as shown in fig. 5. Measurement of RSSI (fig. 4) gives an indication of the acceptable signal strength at which the complete data is received. If RSSI is below a certain threshold packet drops will occur requiring retransmission. Retransmission of data is wastage of power.

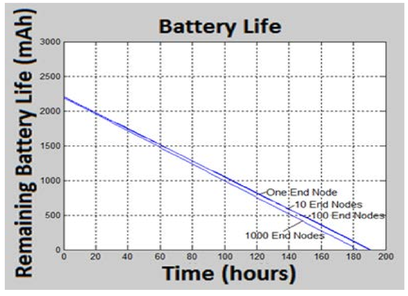


Figure 5 Power Consumption for multi-node Data collection

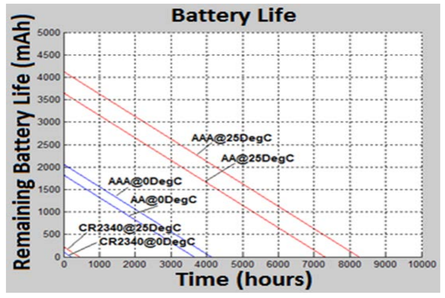


Figure 6 Comparison of different battery life

Ongoing & Future work

As part of ongoing work we are establishing a physical network and characterising the radio of the node for related media.

For future work we will be looking at the following:

- ❑ Create a scenario for 3D modelling of radio propagation on OMNET++
- ❑ Design a low power transmission protocol for periodic data collection.
- ❑ Investigate a scheme that reduces cross pallet communication
- ❑ Investigate a scheme to aggregate multi-sensor data to remove redundancy before forwarding to the cloud.
- ❑ Big data aggregation scheme to transfer to the cloud for analysis.

References

[1]http://www.stats.govt.nz/searchresults.aspx?q=food%20export
[2] N. Yamani, & A. Al-Anbuky, "neuro Wireless Sensor Network Architecture: Cool Stores Dynamic Thermal Mapping" 2011 IEEE Sensors Applications Symposium, Feb 22-24, 2011, San Antonio, Texas., USA.
[3] Gao Junxiang, Xu Jingtao, Fruit Cold Storage Environment Monitoring System Based on Wireless Sensor Network, Procedia Engineering, Volume 15, 2011, Pages 3466-3470, ISSN 1877-7058