

ENSC 427

Communication **Networks**

Evaluation of Zigbee Remote Sensor Networks

Group 1

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Overview

Introduction

ZigBee Protocol

Project Overview

Design Methodology

Results & Conclusion

Related Works

Introduction

- What is Zigbee?
 - Protocol suite for low power wireless personal area network (WPAN)
 - Builds on top of IEEE 802.15.4 standard
 - Maintained by ZigBee Alliance
 - <http://www.zigbee.org/>
- Applications
 - embedded applications with limited power supplies
 - Agricultural networks
 - Medical data collection
 - Building automation

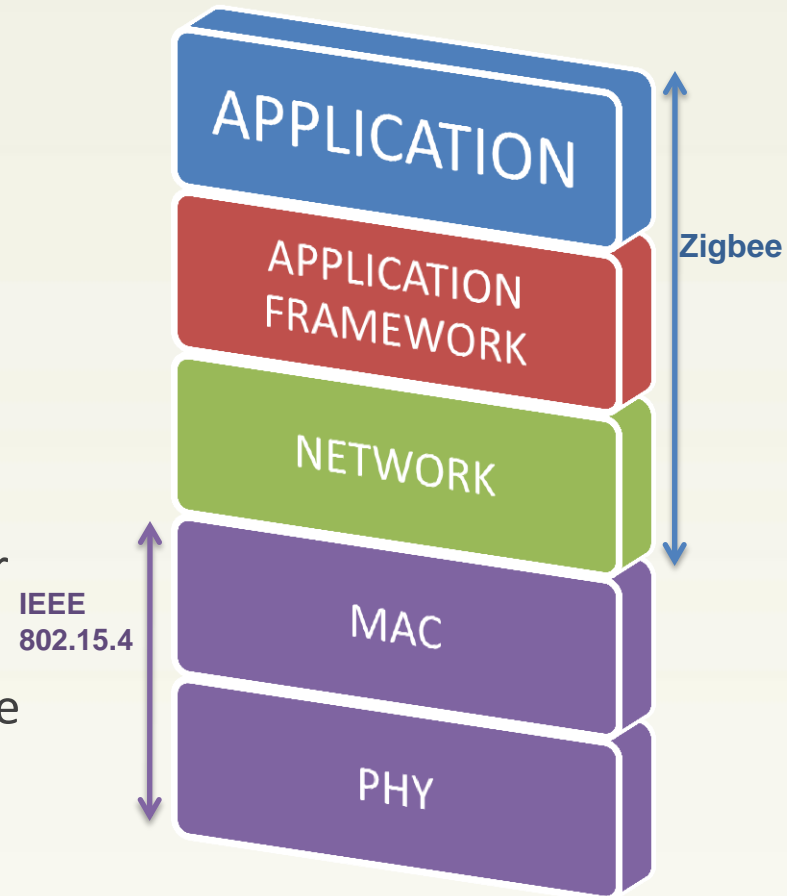
Introduction

- Why ZigBee ?

	ZigBee	Wi-Fi (802.11n)	Bluetooth
Data Rate	20,40 and 250 Kbps	up to 150Mbps	1Mbps
Range	10-3000m	70-250m	10-100m
Frequency	868MHz, (EU) 900-928MHz, (NA) 2.4GHz (WL)	2.4 & 5 GHz	2.4GHz
Complexity	Low	High	High
Battery Life (days) [3]	100 to > 1000	1 to 5	1 to 7

ZigBee Protocol

- Application and Application Framework Layer
 - User defined application specific protocol
- Networking Layer
 - Ad-hoc, Peer to Peer, Mesh and Star topologies
 - Co-ordinator sets up and defines the topology

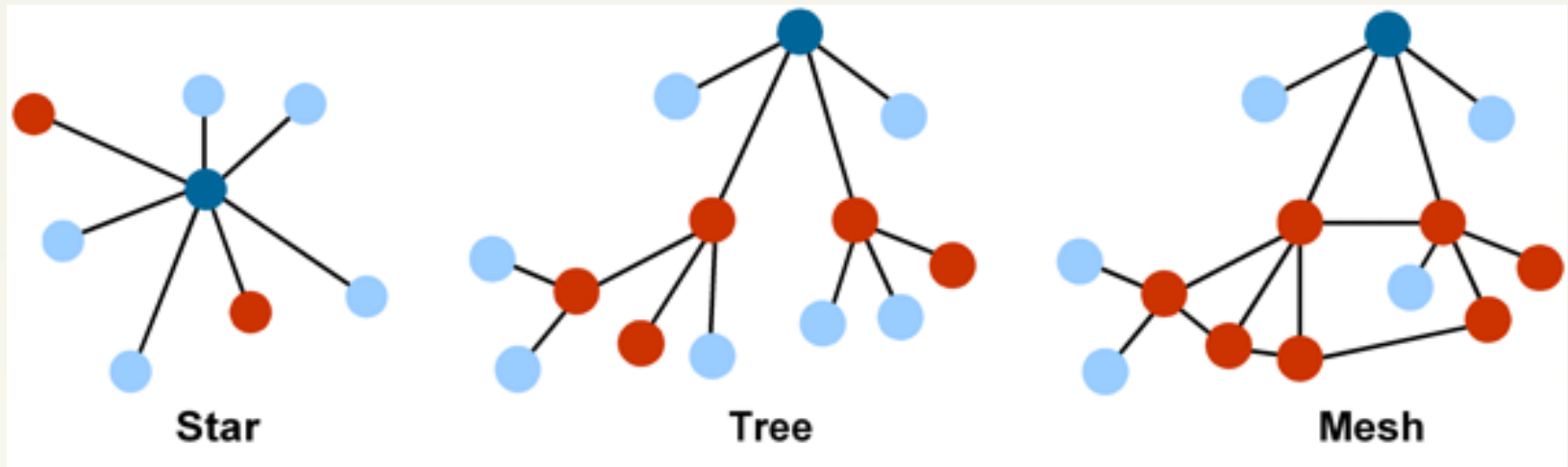


ZigBee Protocol

- IEEE 802.15.4 Medium Access Control(MAC) Layer
 - Provides channel access via CSMA/CA
 - Transmits/Receives frames
- IEEE 802.15.4 Physical Layer
 - 2.4GHz/900-928MHz/868MHz Radio
 - Offset Quadrature Phase Shift Keying (OQPSK) modulation for 2.4GHz
 - Binary Phase Shift Keying (BPSK) modulation for others
 - 250 Kbits/s transmission rate per channel for 2.4GHz band
 - 120m range based on 2mW transmitter power [6]

ZigBee Protocol

- Topologies: Star Topology, Mesh Topology, Tree Topology



- End Device (Sensor)
 - ❖ Router
 - Coordinator

Project Overview

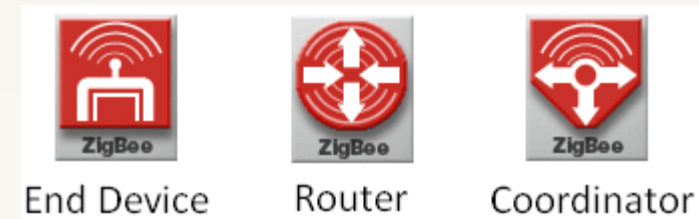
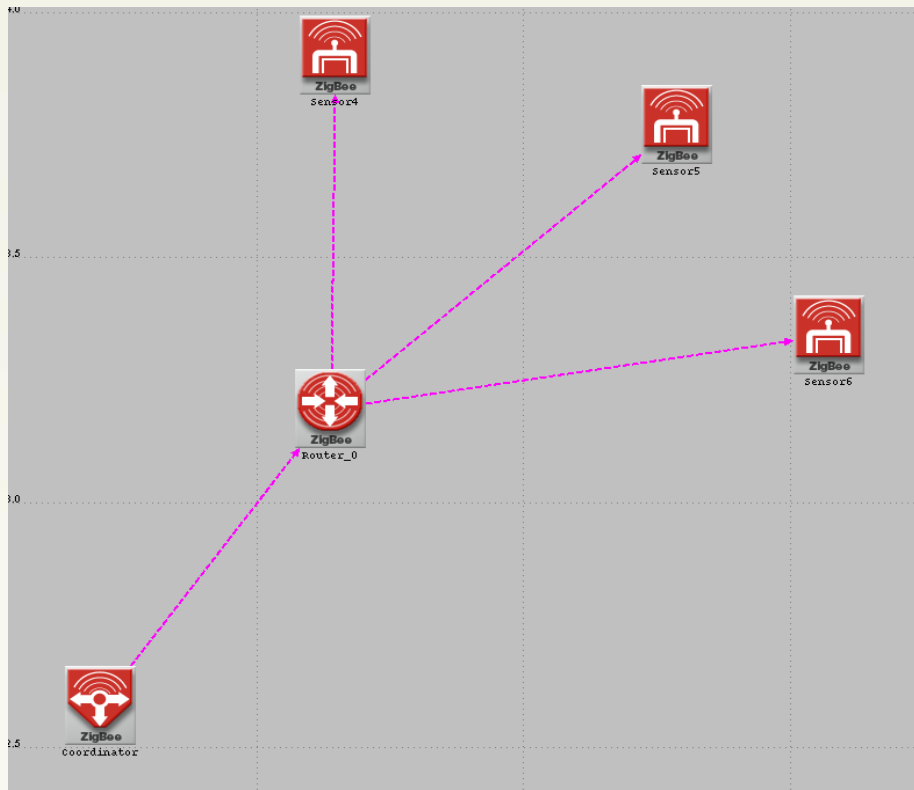
- Analyze the performance of cluster and star topology with OPNET 16.0
- Compare and contrast the two topologies under different scenarios
 - Network coverage
 - Transmission rate
 - Additional sensors
- Parameters of interest
 - End to End Delay (ETED)
 - Throughput
 - Packet Loss (PL)

Project Overview

- Scope of the design and interest
 - Simulating a sensor network
 - Fixed nodes
 - Fixed packet size 1024 bits
 - Transmission rate 0.1 packets/sec
 - 6mWatts transmission power
- Assumptions
 - Transmitter power is fixed at 6mW
 - Transmitter Packet size is constant and small (1024 bits)
 - Transmitter packet interval is periodic

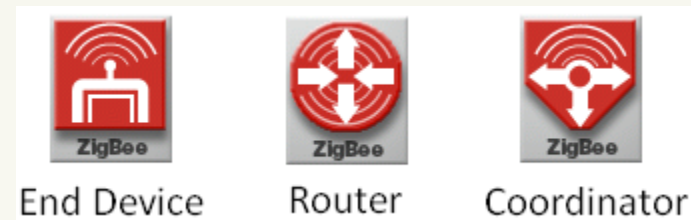
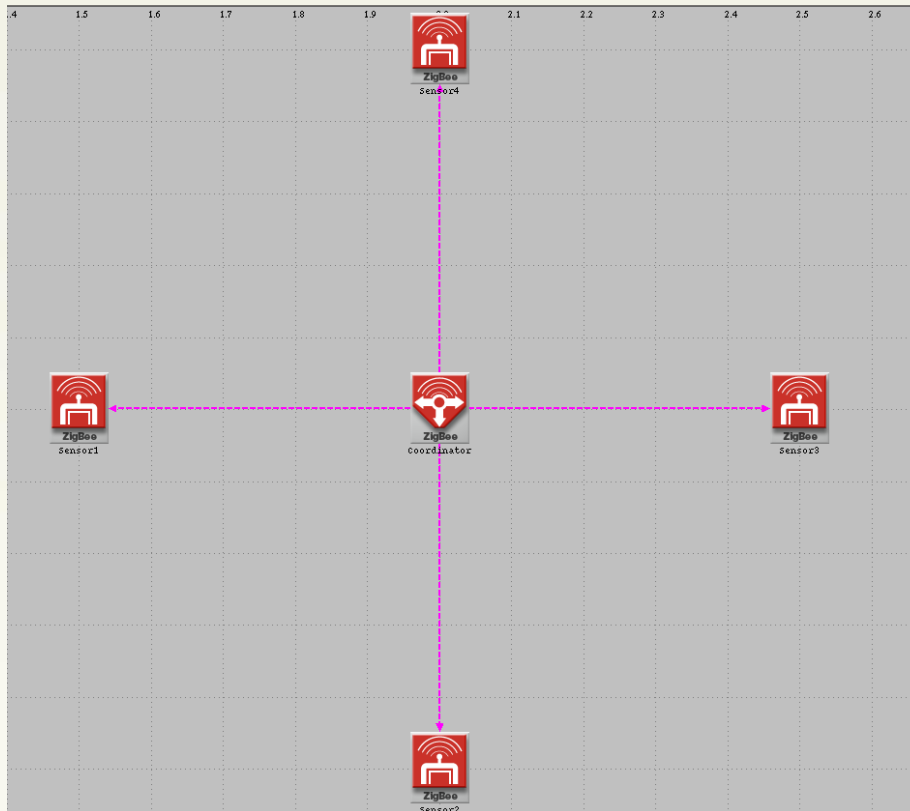
Design Methodology

- Cluster Setup



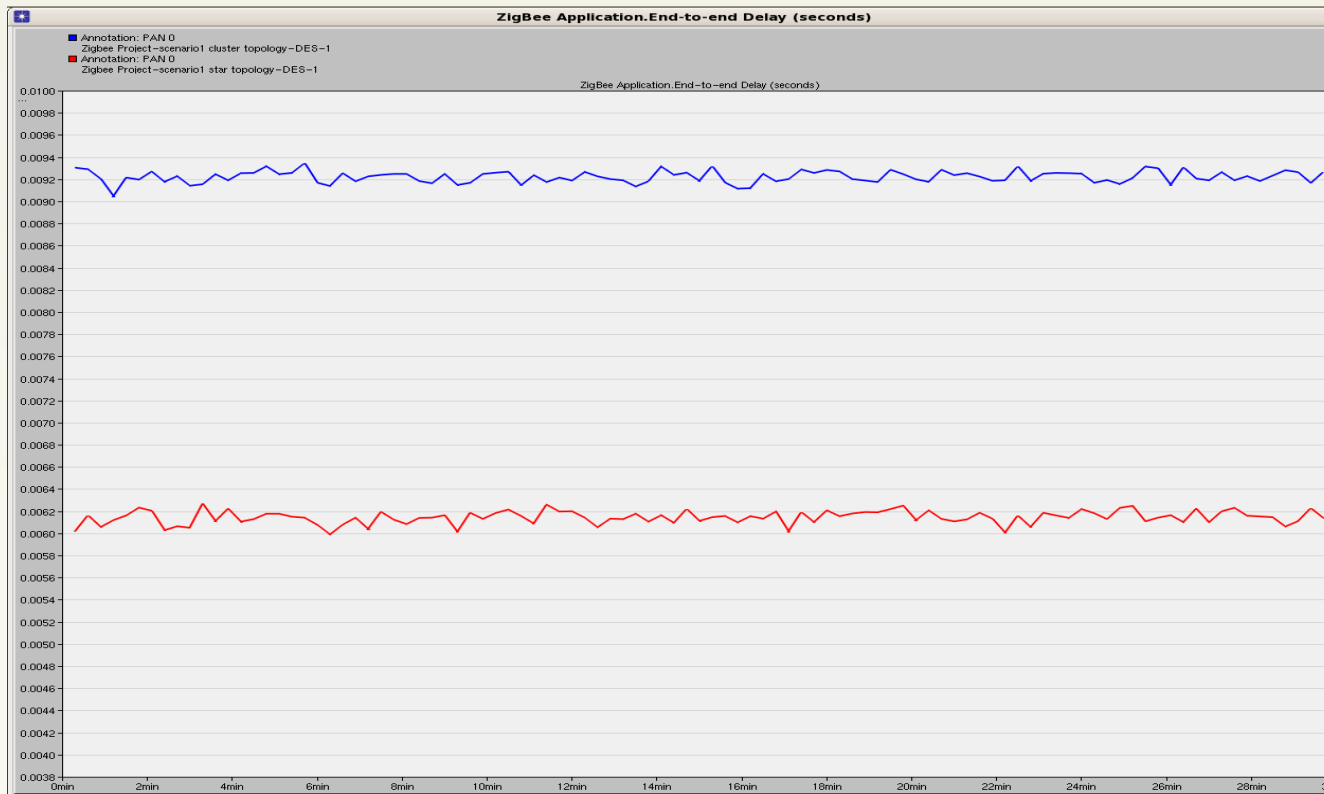
Design Methodology

- Star Network



Results

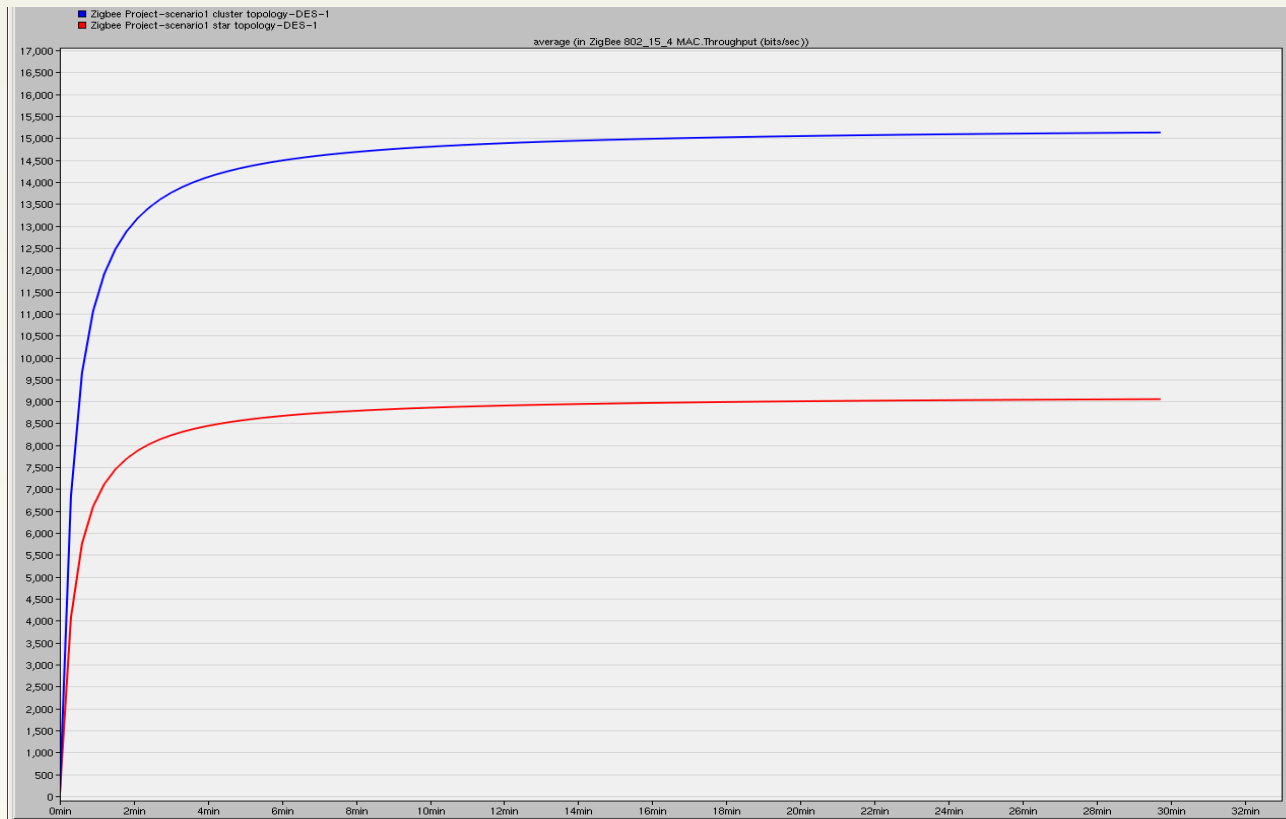
- ETED: Cluster VS Star



- Cluster
- ◆ Star

Results

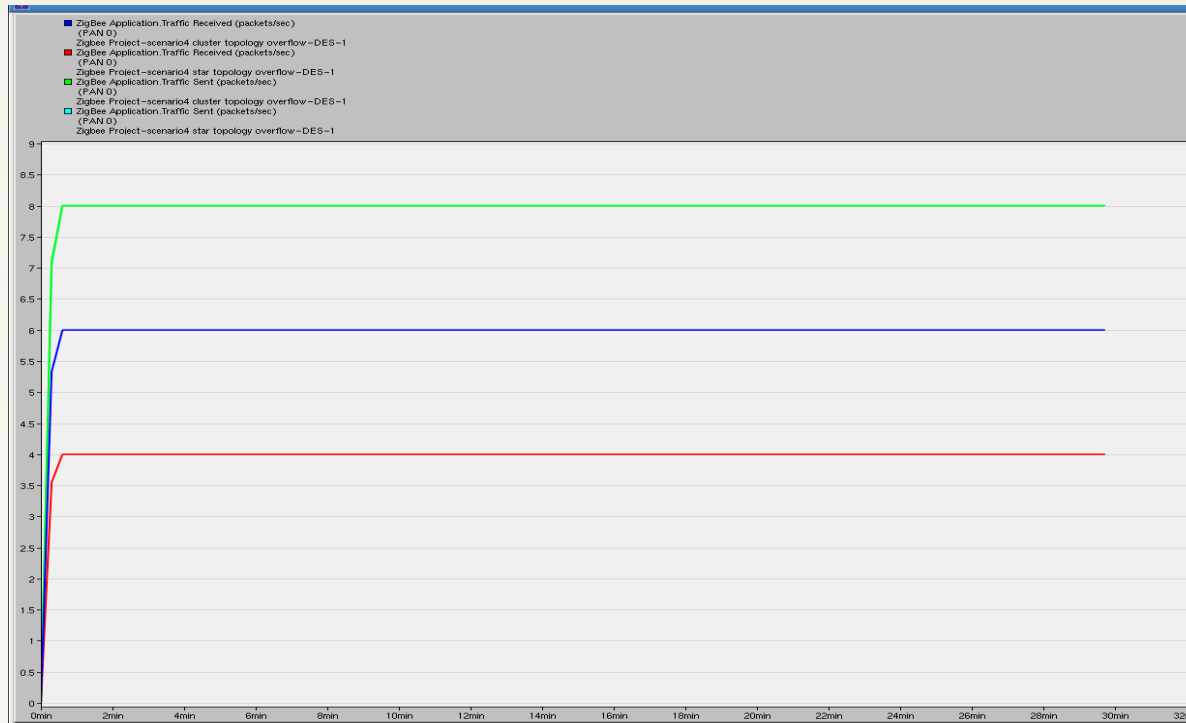
- Throughput



- Cluster
- Star

Results

- Packets lost
 - increasing packet size to 50kb



- Cluster (Received packets/sec)
- ❖ Star (Received packets/sec)
- ❖ Cluster|Star (packet send/sec)

Discussion

- What we discovered
 - ETED is smooth proportional to increase packet size/transmission rate (as expected)
 - Star topology more prone to Packet Loss (PL)
 - Throughput is higher in cluster topology
 - PL proportional to transmission rate
 - » Distance does not effect PL if the transmission rate is low

Conclusion

- Packet size are relative small
- Not event based
 - Transmission is periodic
- Future Work
 - More realistic application scenarios
 - More nodes
 - Mesh topology and self healing mechanism

Related Works

- Mitsugu Terada, “Application of ZigBee sensor network to data acquisition and monitoring”, MEASUREMENT SCIENCE REVIEW ,2009
- S. Ma, M. Zhu, L. Wang, L. Shu, S. Li, S. Huang, “A Remote Monitoring System of IDC Room Based on ZigBee Wireless Sensor Networks”, Dalian University of technology, 2009

References

- [1] Zigbee Technology. Internet:
<http://www.zigbee.org/About/AboutTechnology/ZigBeeTechnology.aspx>,
Jan.2, 2012 [Feb. 09, 2012].
- [2] Sinem Coleri Ergen. “ ZigBee/IEEE 802.15.4 Summary” Internet:
<http://pages.cs.wisc.edu/~suman/courses/838/papers/zigbee.pdf>,
Sept.10, 2004 [Feb. 25, 2012]
- [3] Dusan Stevanovic. “Zigbee / IEEE 802.15.4 Standard”
Internet:<http://www.cse.yorku.ca/~dusan/Zigbee-Standard-Talk.pdf>,
Jun.20, 2007 [Feb.25, 2012]

References

- [4]Raul Morais. “A ZigBee multi-powered wireless acquisition device for remote sensing applications in precision viticulture” Internet: <http://ageweb.age.uiuc.edu/classes/abe425/Lectures/Networks/A%20ZigBee%20multipowered%20wireless%20acquisition%20device%20for%20remote%20sensing%20applications.pdf>, Dec 3, 2007 [Feb. 25, 2012]
- [5]Tuan Le Dinh. “Design and Deployment of a Remote Robust Sensor Network: Experiences from an Outdoor Water Quality Monitoring Network” Internet: <http://eprints.qut.edu.au/33774/1/33774.pdf>, Oct.11, 2009 [Feb 25, 2012]
- [6] Making Wireless M2M Easy, <http://www.digi.com/xbee/>, [Feb 25, 2012]

THANK YOU