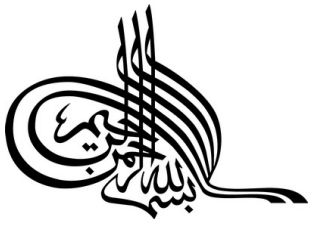
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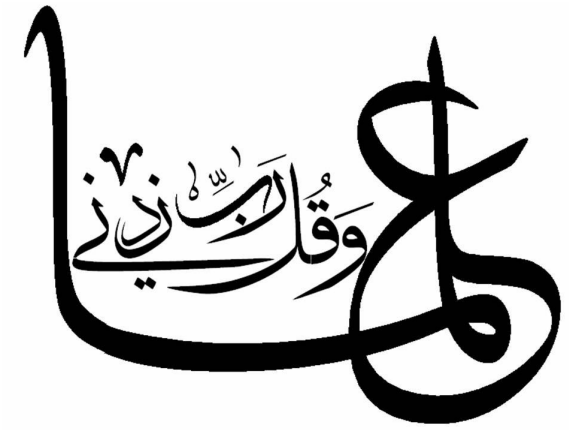
وقل رب زدني علما

Computer Science Department
Faculty of Computer & Information Sciences
Ain Shams University

INTEGRATING WIRELESS SENSOR NETWORKS WITH IP-BASED NETWORK

This thesis submitted to the Department of Computer Science, Faculty of Computer and Information Sciences, Ain Shams University, in partial fulfillment of the requirements for the degree of Master of Computer and Information Sciences.

BY

Karim Ahmed Awad El Sayed Emara

Approved by the discussion committee:

Prof. Dr. Yasser Dakroury Member
Professor of Computer and Systems Engineering ,
Faculty of Engineering, Ain Shams University.

.....

Prof. Dr. Gamal Darwish, Member
The Dean of Faculty of Computers and Information Technology
Ahram Canadian University

.....

Prof. Dr. Mohammad Hashem Member and Supervisor
Head of Information Systems Department,
Faculty of Computer and Information Sciences, Ain Shams University

.....

Computer Science Department
Faculty of Computer and Information Sciences
Ain Shams University
Cairo - 2009

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Faculty of Computer & Information Sciences
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a thesis submitted as a partial fulfillment of the requirements for the degree of Master of Science in Computer and Information Sciences.

By
Karim Ahmed Awad El Sayed Emara
B.Sc. in Computer and Information Sciences,
Demonstrator at Computer Systems Department,
Faculty of Computer and Information Sciences,
Ain Shams University.

Under Supervision of
Prof. Dr. Taha El Areef
Prof. of Computer Science,
Computer Science Department,
Faculty of Computer and Information Sciences,
Ain Shams University.

Prof. Dr. Mohammad Hashem
Head of Information Systems Department,
Information Systems Department,
Faculty of Computer and Information Sciences,
Ain Shams University.

Dr. Mohammad Abdeen
Lecturer,
Computer Science Department,
Faculty of Computer and Information Sciences,
Ain Shams University.

Cairo 2009

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Abstract

Wireless sensor networks (WSN) envision a ubiquitous computing future in many fields, like environmental monitoring, military surveillance, and inventory tracking. Wireless sensor networks are composed of large numbers (up to thousands) of tiny radio-equipped sensors. Every sensor node has a small microprocessor with enough power to allow the sensors to autonomously form networks through which sensor information is gathered. Sensor nodes in such networks are ad hoc deployed, self-configurable and battery powered. A set of special protocols are developed for such networks to fit their specific characteristics.

Many wireless sensor network applications cannot run in complete isolation; the sensor network must be connected to monitoring and controlling entities through known wireless/wired networks like IP-based networks. Such interconnection achieves many advantages and increases sensor networks benefits such as:

- Controlling and monitoring sensor networks remotely.
- Integrating data collected from sensor networks into data repositories.
- Ability to collapse multiple remote sensor networks into one virtual sensor network.

A few approaches recently manipulate this issue and they are categorized into two main approaches: gateway-based and network overlay. The first approach uses a gateway node to interconnect both networks and bring data from WSN to the IP network. It so allows choosing WSN communication protocols

freely. The second approach overlays the protocol stack of one network by the protocol stack of the other network. Overlaid nodes become an intersection area among both networks through which they are integrated.

In this thesis, an integration technique is proposed. This technique supports both address-centric and data-centric WSNs. It uses a low-level gateway node to translate packets from one network to the other. Thus, it allows choosing WSN communication protocols that are most suitable for the sensor network application. Furthermore, it depends on a simple translation operation and does not require modification to be made in protocols running in either network. Therefore, it can be used in different applications with no need to modify the gateway logic. Moreover, this technique provides transparent communication between both networks which allows interconnection with no need to know details about the protocols of the other side.

The proposed technique is implemented on the OMNeT++ simulator for both address-centric and data-centric paradigms. Experimental results show that it supports accessing individual sensor nodes from IP hosts with high request rates without significantly influencing the network performance. For example, when an IP host sends requests to sensor nodes up to 150 requests per second, the average of overhead delay is about 0.25 milliseconds with 0.5% average increase in the packet loss. On the other hand, it also supports accessing data-centric WSN with different sizes and through simultaneous queries (interests). For example, when an IP host propagates up to 20 simultaneous

interests, the median overhead delay is about 4.3 milliseconds with 6.5% decrease in the delivery ratio at maximum. The proposed integration technique, however, suffers from bottleneck and single point of failure problems which should be investigated in future work.

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List of Abbreviations

µIP	A light weight TCP/IP protocol stack
6LoWPAN	IPv6 over Low power Wireless Personal Area Networks
ADC	Analog to Digital Converter
BS	Base Station
CPU	Central Processing Unit
DTC	Distributed TCP Caching
DTN	Delay Tolerant Networking
EIA	Extensible Interworking Architecture
EML	EIA Management Layer
EQL	EIA Query Layer
ETL	EIA Tunneling Layer
GPS	Global Positioning System
HVAC	Humidity, Ventilation, Air Conditioning
IETF	Internet Engineering Task Force
IP	Internet Protocol
NGN	Next Generation Network
OGN	Overlay Gateway Node
OSN	Overlay Sensor Network
PDA	Personal Digital Assistant
QoS	Quality of Service
SIP	Session Initiation Protocol
VIP Bridge	Virtual IP Bridge
VSN	Virtual Sensor Node
WSN	Wireless sensor network

List of Publications

Karim A. **Emara**, Mohammad Abdeen, Mohammad Hashem, "*A gateway-based framework for transparent interconnection between WSN and IP network*", EUROCON 2009, IEEE, 18-23 May 2009, Pages: 1775 – 1780, St. Petersburg, Russia

Karim A. **Emara**, Mohammad Abdeen, Mohammad Hashem, "*Generic Technique for Interconnection between WSN and IP Network*", International Journal of Intelligent Computing & Information Science (IJICIS), Vol. 10, No. 2, Faculty of Computer and Information Sciences, Ain Shams University, Cairo, Egypt, July 2010 ***(To be appeared)***