



ع
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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

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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.

Table of Contents

Acknowledgement	I
Abstract	II
Table of Contents.....	V
List of Tables.....	VII
List of Figures	VIII
List of Abbreviations	XI
List of Publications.....	XII
1 Introduction.....	1
1.1 Overview.....	1
1.1.1 Wireless Sensor Network (WSN).....	1
1.1.2 Applications.....	3
1.1.3 Sensor Node Architecture	7
1.1.4 WSN Protocols.....	11
1.2 WSN and IP network Integration.....	18
1.3 Motivation.....	23
1.4 Objectives	24
1.5 Thesis Outline.....	24
2 IP-WSN Integration Techniques.....	27
2.1 Application Level Gateway	28
2.2 Virtual IP (VIP) Bridge.....	31
2.3 WSN Overlays TCP/IP network.....	36
2.4 TCP/IP network Overlay	42
2.5 Delay Tolerant Network (DTN).....	48
2.6 Discussion	51
3 Proposed Integration Technique.....	55
3.1 Design Considerations.....	55
3.2 The Design of Proposed Technique	58
3.2.1 Direct Access to Sensor Nodes	60
3.2.2 Data Centric WSN.....	64
3.3 Gateway Architecture	67
3.3.1 Direct Access to Sensor Nodes	68
3.3.2 Data Centric WSN.....	72

3.4	Discussion	75
4	Implementation.....	79
4.1	Simulators Review.....	79
4.1.1	NS-2.....	80
4.1.2	GloMoSim.....	82
4.1.3	OPNET	83
4.1.4	OMNeT++	84
4.1.5	Simulator Selection	86
4.2	Simulation Environment	87
4.3	Direct Access to Sensor Nodes	101
4.3.1	Generic Node Module	102
4.3.2	Application Module	103
4.4	Data-centric WSN.....	104
4.4.1	Directed Diffusion Protocol.....	104
4.4.2	Generic Node Module	106
4.4.3	Application Module	108
5	Experiments and Evaluation	111
5.1	Evaluation Methodology.....	111
5.2	Evaluating Direct Access to Sensor Nodes.....	112
5.3	Evaluating Data Centric WSN	123
6	Conclusion and Future Work.....	131
6.1	Conclusion.....	131
6.2	Future Work.....	132
Appendix I: OMNeT++ Simulator.....		136
I.1	Compiling OMNeT++ 3.3.....	135
I.2	Compiling INET Framework.....	137
I.3	Porting and Compiling Castalia 2.1.....	138
I.4	Introduction to OMNeT++.....	141
References		147
Arabic Summary		\

List of Tables

Table 1.1: Key differences between traditional IP-based networks and wireless sensor networks.....	19
Table 2.1: Comparison among the integration approaches.....	54
Table 3.1: Virtual address mapping tables for the network shown in Figure 3.1.....	61
Table 3.2: The mapping table of a data-centric network.....	64
Table 3.3: Comparison between proposed technique and the related work	78
Table 5.1: Direct access to sensor nodes in different request rates (traffic within sensor network only).....	114
Table 5.2: Direct access to sensor nodes in different request rates (traffic across IP and sensor networks).....	115
Table 5.3: Direct access to sensor nodes vs. number of requesting nodes (sensor network only).....	119
Table 5.4: Direct access to sensor nodes vs. number of requesting hosts (IP and sensor networks).....	119
Table 5.5: Experimental results for data-centric WSN in several network sizes	124
Table 5.6: Experimental results for data-centric WSN with multiple interests	127

List of Figures

Figure 1.1: Wireless sensor network - collaborative sensor nodes	2
Figure 1.2: The components of sensor node	7
Figure 1.3: Sensor node Mica mote (evolved out at the University of California at Berkeley).....	11
Figure 1.4: The sensor network protocol stack	12
Figure 1.5: Internetworking between sensor nodes and user through Internet or satellite network.....	16
Figure 1.6: Wireless sensor network connected with Internet through a gateway	18
Figure 2.1: Integration approaches taxonomy	27
Figure 2.2: Application-level Gateway	29
Figure 2.3: Communication Architecture using a gateway	29
Figure 2.4: A WSN identified by a single IP address	30
Figure 2.5: Packet mapping in single IP framework	31
Figure 2.6: The VIP Bridge packet format and translation operations	33
Figure 2.7: WSN Overlay TCP/IP network.....	38
Figure 2.8: EIA Protocol stack.....	41
Figure 2.9: Using TCP/IP within and outside sensor networks	43
Figure 2.10: Architecture of tiny TCP/IP protocol stack.....	45
Figure 2.11: The bundle layer overlay in DTN.....	50
Figure 2.12: DTN Gateway architecture.....	50
Figure 3.1: The proposed interconnection technique between WSN and IP network	59
Figure 3.2: (Top) A TCP/IP packet originating from Host A to Node X as in Figure 3.1. (Bottom) The same packet after packet translation	63
Figure 3.3: (Top) A WSN packet originating from Node X to Host A as in Figure 3.1. (Bottom) The same packet after packet translation	64

Figure 3.4: The interconnection technique with data-centric WSN	65
Figure 3.5: Virtual IP address request for a given Interest	66
Figure 3.6: (Top) A TCP/IP packet originating from Host A querying about an interest as in Figure 3.4. (Bottom) The same packet after translation	67
Figure 3.7: (Top) A WSN data message. (Bottom) The same packet after packet translation.....	67
Figure 3.8: Gateway Architecture for direct access mode	68
Figure 3.9: Protocol stack for the gateway in direct access mode ..	69
Figure 3.10: Packet translation for direct access to a sensor node.	71
Figure 3.11: Gateway architecture in data-centric WSN	73
Figure 3.12: Protocol stack for the gateway in data-centric WSN...	73
Figure 4.1: The simulation network topology using OMNeT++ simulator	87
Figure 4.2: The IP host structure in INET framework.....	89
Figure 4.3: The internal structure of sensor node in Castalia.....	95
Figure 4.4: The modified structure for sensor nodes and gateway	96
Figure 4.5: An example of interest diffusion in sensor network.....	105
Figure 5.1: Simulation environment.....	111
Figure 5.2: Average delay versus requests rate - direct access to sensor nodes.....	116
Figure 5.3: Packet loss percentage versus request rate - direct access to sensor nodes.....	117
Figure 5.4: The total throughput versus requests rate - direct access to sensor nodes.....	118
Figure 5.5: Average delay versus number of nodes - direct access to sensor nodes.....	120
Figure 5.6: Packet loss percentage versus number of nodes - direct access to sensor nodes	121
Figure 5.7: Total throughput versus the number of nodes - direct access to sensor nodes	122

Figure 5.8: Average delay versus number of nodes - data centric WSN	125
Figure 5.9: Distinct event delivery ratio versus number of nodes - data centric WSN	126
Figure 5.10: Average delay versus number of interests - data centric WSN	128
Figure 5.11: Median delay versus number of interests - data centric WSN	129
Figure 5.12: Distinct event delivery ratio versus number of interests - data centric WSN	129

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

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