Ain Shams University
Faculty of Computer and Information Sciences
Computer Systems Department

MOBILITY-AWARE MAC FOR WIRELESS SENSOR NETWORKS

Thesis submitted as a partial fulfillment of the requirements for the degree of
Master of Science in Computer and Information Sciences

By

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Thesis Abstract

Mobility-Aware MAC for Wireless Sensor Networks

Recent advances in micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics have enabled the development of the wireless sensor networks (WSN). WSN can be used for various application areas (e.g., military, home, environment).

Several design challenges present themselves to designers of WSN applications. The limited resources available to individual sensor nodes imply that designers must develop highly distributed, fault-tolerant, and energy-efficient applications in a small memory-footprint.

Since power is consumed every time a networked device accesses the channel, the method by which the device accesses the channel can have a large effect on its power consumption, and on the network as a whole. The OSI stack places the responsibility for channel access in the medium access control (MAC) layer.

Most of the MAC protocols proposed for WSN assume sensor nodes to be static and therefore they usually fail or provide very bad network performance in mobile sensor networks. Since WSN mobile applications have become popular nowadays, there is a need for MAC protocols that consider mobility. In this thesis, we propose a mobility-aware MAC protocol for WSN that can work with satisfactory level of energy efficiency in both stationary and mobile sensor networks.

Besides, most of the WSN mobile applications are considered critical ones (ex., a patient assistance system which monitors patients' health via wearable bio-sensors). Such applications require very quick responses. So, in addition to handling mobility, the proposed MAC protocol considers the problem of latency as well.

In summary, this thesis proposes a WSN MAC protocol that is considered to be mobility-aware, delay-sensitive and provides satisfactory level of energy efficiency.

The thesis treats this topic in five chapters in addition to a conclusion, future work, and the list of references, as follows:

- Chapter one gives an overview on the scope of the thesis, previous work, problem definition, motivation, objectives, and the thesis outline.

- Chapter two introduces the wireless sensor networks and outlines the architecture of the wireless sensor node. It discusses the challenges that face the designers of the WSNs. A brief overview of the various domains of the WSN applications is also presented. Finally, it provides a quick view on the WSN communication model and protocol stack.
- Chapter three introduces the concept of the medium-access control stating the problems that should be solved and avoided by the MAC layer. In addition, it discusses the various methods of the medium-access control. Then, it considers the MAC for sensor networks. Firstly, it states why we need special MAC protocols for WSNs. Secondly, it provides a huge survey on several proposed MAC protocols for WSNs. Finally, it ends with a brief comparison among the surveyed WSN MAC protocols.
- Chapter four introduces the proposed MAC protocol (MD-SMAC). Firstly, it discusses the theory behind the protocol. As the protocol inherits many features from previously-proposed protocols, those protocols are discussed in details. Secondly, it discusses the modifications and the improvements presented by the proposed protocol. Finally, it describes the proposed protocol packets structure; declaring their fields and their description and describes the protocol overhead introduced.
- Chapter five provides the simulation results of the proposed MAC protocol against three previously-proposed protocols. The protocols are compared over different network scenarios. Four performance measures are used for the comparison (the disconnectivity duration, the queue delay, the end-to-end delay, the energy consumption).
- Finally chapter six summarizes the conclusions of the conducted research and presents ideas for future work.

ABSTRACT

Recent advances in micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics have enabled the development of the wireless sensor networks (WSN). WSN can be used for various application areas (e.g., military, home, environment).

Several design challenges present themselves to designers of WSN applications. The limited resources available to individual sensor nodes imply that designers must develop highly distributed, fault-tolerant, and energy-efficient applications in a small memory-footprint.

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Besides, most of the WSN mobile applications are considered critical ones (ex., a patient assistance system which monitors patients' health via wearable bio-sensors). Such applications require very quick responses. So, in addition to handling mobility, the proposed MAC protocol considers the problem of latency as well.

In summary, this thesis proposes a WSN MAC protocol that is considered to be mobility-aware, delay-sensitive and provides satisfactory level of energy efficiency.

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LIST OF ABBREVIATIONS

AEA	**A**daptive **E**lection **A**lgorithm
ACK	**A**cknowledgement
AODV	**A**d-hoc **O**n-demand **D**istance **V**ector
ARP	**A**ddress **R**esolution **P**rotocol
B-MAC	**B**erkeley **MAC**
BP	**B**ackoff **P**eriod
CBR	**C**onstant **B**it **R**ate
CCA	**C**lear **C**hannel **A**ssessment
CDMA	**C**ode **D**ivision **M**ultiple **A**ccess
CR	**C**ommunication **R**equest
CSMA	**C**arrier **S**ense **M**ultiple **A**ccess
CSMA/ CA	**C**arrier **S**ense **M**ultiple **A**ccess / **C**ollision **A**voidance
CSMA-MPS	**C**arrier **S**ense **M**ultiple **A**ccess-**M**inimal **P**reamble **S**ampling
CTS	**C**lear **T**o **S**end
CW	**C**ontention **W**indow
DMAC	**D**ata gathering **MAC**
DRAND	**D**istributed **RAND**om
DS	**D**ata **S**ending
DSDV	**D**estination **S**equence **D**istance **V**ector
DSMAC	**D**ynamic **S**ensor-**MAC**
DSR	**D**ynamic **S**ource **R**outing
ECN	**E**xplicit **C**ontention **N**otification
EMACS	**E**YE**S MAC**
FDMA	**F**requency **D**ivision **M**ultiple **A**ccess
FLAMA	**FL**ow-**A**ware **M**edium **A**ccess

FRTS	**F**uture **R**equest **T**o **S**end
FTP	**F**ile **T**ransfer **P**rotocol
GPS	**G**lobal **P**ositioning **S**ystem
HCL	**H**igh **C**ontention **L**evel
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers
IP	**I**nternet **P**rotocol
LEACH	**L**ow-**E**nergy **A**daptive **C**lustering **H**ierarchy
LCL	**L**ow **C**ontention **L**evel
LMAC	**L**ightweight **MAC**
LPL	**L**ow-**P**ower **L**istening
MAC	**M**edium **A**ccess **C**ontrol
MD-SMAC	**M**obile **D**ynamic **S**ensor-**MAC**
MLMAC	**M**obile **L**ightweight **MAC**
MMAC	**M**obility-aware **MAC**
MS-MAC	**M**obile **S**ensor-**MAC**
NAM	**N**etwork **A**ni**M**ator
NP	**N**eighbor **P**rotocol
NS	**N**etwork **S**imulator
OTcl	**O**bject-oriented **T**ool **C**ommand **L**anguage
PAMAS	**P**ower **A**ware **M**ulti-**A**ccess with **S**ignaling
RAND	**RAND**om
RICER	**R**eceiver **I**nitiated **C**ycl**E**d **R**eceiver
RTS	**R**equest **T**o **S**end
SEP	**S**chedule **E**xchange **P**rotocol
S-MAC	**S**ensor **MAC**
SP	**S**hort **P**eriod

STEM	**S**parse **T**opology and **E**nergy **M**anagement
SYNC	**SYNC**ronization
.....	
TC	**T**raffic **C**ontrol
TCP	**T**ransmission **C**ontrol **P**rotocol
TDMA	**T**ime **D**ivision **M**ultiple **A**ccess
TF	**T**ime **F**rame
TICER	**T**ransmitter **I**nitiated **C**ycl**E**d **R**eceiver
T-MAC	**T**imeout-**MAC**
TORA	**T**emporally **O**rdered **R**outing **A**lgorithm
TRAMA	**TR**affic-**A**daptive **M**edium **A**ccess
.....	
UDP	**U**ser **D**atagram **P**rotocol
.....	
VINT	**V**irtual **I**nter**N**etwork **T**estbed
.....	
WiseMAC	**Wi**reless **Se**nsor **MAC**
WLAN	**W**ireless **L**ocal **A**rea **N**etwork
WPAN	**W**ireless **P**ersonal **A**rea **N**etwork
WSN	**W**ireless **S**ensor **N**etwork
.....	
Z-MAC	**Z**ebra-**MAC**

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