

EN0556 Wireless Sensor Networks

Wireless Sensor Networks Image

Wireless sensor networks are emerging as an exciting, new application of low power, tiny computing devices, known popularly as 'Smart Dust'. This module aims to provide you with a solid grounding in both the theory and practice of wireless sensor networks so that you will be able both to develop reliable applications and to progress to research on open problems in the field.

There is an emphasis on practical work in the delivery of the module and you will have an opportunity to work directly with state-of-the-art wireless sensor network hardware and software, such as Crossbow motes, TinyOS and NesC.

The module is assessed by coursework assignment which includes a group programming project and a presentation or research report.

1. Module Team

Module Tutor

[David Kendall](mailto:david.kendall@northumbria.ac.uk) david.kendall@northumbria.ac.uk

Lecturer

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2. Teaching Arrangements

Lecture Ellison Building, A103

Lab/Seminar Pandon Building, Lab F2

Usually, the lecture session is on Tuesday at 15.00 in EB A103 and the lab/seminar session is on Monday at 16.00 in PB Lab F2.

In week 1 only, there is NO LAB SESSION. Instead there is a (additional) lecture at 10.00 on Tuesday in EB A103. All students should attend this session.

Weeks 6 and 10 are reading weeks. There are NO TAUGHT SESSIONS in those weeks. Weeks 11 and 12 are used for research presentations and software demonstrations. Details of attendance requirements in those weeks will be published later.

3. Synopsis

The aim of this module is to provide a grounding in the theoretical principles and

practical application of wireless sensor networks.

On completion of this module, students will be able to:

1. Explain in detail the principles of wireless communication as applied in sensor networks.
2. Discuss new applications and particular problems that distinguish wireless sensor networks from mainstream embedded or networked computers.
3. Apply appropriate theory, practices and tools to the development of wireless sensor network applications.
4. Discuss the design principles and implementation of a variety of key sensor networking protocols and algorithms and critically evaluate their effectiveness in a range of practical applications.

4. Teaching Plan

The following is a *provisional* guide to the organisation of the module for this year. These arrangements are subject to change during the course of the module.

Week	W/c	Lecture	Lab/Seminar	Independent Study
1	01-Feb	Lecture: Introduction to the Module and WSN (WDH) [Slides]	Lecture: Single-node Architecture (DK) [Slides]	[KW05 Chapters 1 and 2], TINYOS and nesC notes, [ASS02, CES04, PAP03]
2	08-Feb	Lecture: Network Architecture (DK) [Slides]	Practical: Intro to MOTE programming - Blinky (WDH) [Lab]	[KW05 Chapter 3], MOTE audio output exercise, Progress study on chosen research topic
3	15-Feb	Lecture: The Physical Layer (WDH) [Slides]	Practical: RF realities (WDH) [Lab]	[KW05 Chapter 4], Additional RF notes, [KNE03, VIT79], Progress study on chosen research topic
4	22-Feb	Lecture: Routing (DK) [Slides: Introduction] [Slides: Main]	Practical: MOTE wireless interface - PING (DK) [Lab] [Code]	[KW05 Chapters 11], MOTE exercise - extending PING, Progress study on chosen research topic
5	01-Mar	Lecture: The	Practical: Network	Assignment

		assignment <i>Minimum Cost Forwarding</i> (WDH) [Slides]	protocol implementation - e.g., MCF INIT (WDH) [Lab]	specification, UPPAAL models, [YCLZ01], Progress study on chosen research topic
6	08-Mar	Reading week (No session)	Reading week (No session)	Progress study on chosen research topic, Progress assignment on MCF
7	15-Mar	Lecture: WSN Routing (DK) [Slides]	Practical: The Tossim Simulator (DK) [Tutorial] [Code]	Tossim simulator literature, Progress study on chosen research topic, Progress assignment on MCF
8	22-Mar	Lecture: MAC layer (WDH) [Slides]	Surgery (WDH)	[KW05 Chapter 5], [YH04, YHE02], Progress study on chosen research topic, Progress assignment on MCF
9	29-Mar	Lecture: Transport Layer (DK) [Slides]	Surgery (DK)	[KW05 Chapter 13], Progress study on chosen research topic, Progress assignment on MCF
10	26-Apr	Reading week (No session)	Reading week (No session)	Progress assignment on MCF
11	03-May	Research Presentations (WDH, DK)	Research Presentations (WDH, DK)	Progress assignment on MCF
12	10-May	Software Demonstrations (WDH, DK)	Software Demonstrations (WDH, DK)	

Note:

In addition to the taught sessions, you are expected to undertake independent and directed learning. On average, you should be spending about 8 hours per week on this module.

5. Assessment

Summative assessment is undertaken via:

1. a [research investigation and presentation](#) assessing learning outcomes 1 and 2 (30%)
2. a group programming project + individual report, assessing aspects of all learning outcomes, but primarily learning outcomes 3 and 4 (70%)
 - [\[Project Requirements Specification\]](#), [\[Groups 2009-10\]](#).

Formative assessment is provided in the form of a variety of small development or analytical exercises with opportunities for discussion and review.

6. Recommended Reading

You are strongly advised to obtain a copy of the first text below for your personal use. Try the [Northumbria University campus bookshop](#).

- **[KW05]** Karl, H. and Willig, A. *Protocols and Architectures for Wireless Sensor Networks*, John Wiley and Sons, 2005 [[Amazon](#)]
- **[ZG04]** Zhao, F., Guibas, L., *Wireless Sensor Networks: An Information Processing Approach*, Morgan Kaufmann, 2004
- **[CAL03]** Callaway, E., *Wireless Sensor Networks: Architectures and Protocols*, CRC Press, 2003
- **[ASS02]** Akyildiz, I. Su, W., Sankarasubramanian, Y. and Cayirci, E., *Wireless Sensor Networks: A survey*, Computer Networks 38, 2002 [[PDF](#)]
- **[CES04]** Culler, D., Estrin, D., Srivastava, M., *Overview of Sensor Networks*, IEEE Computer, August 2004 [[PDF](#)]
- **[CRO07]** *Avoiding RF interference between WiFi and Zigbee*, Crossbow, 2007 [[PDF](#)]
- **[HT06]** Henderson, W., Tron, S., *Verification of the Minimum Cost Forwarding Protocol for Wireless Sensor Networks*, 11th IEEE Int. Conf. Emerging Technologies and Factory Automation, Prague, September 2006 [[PDF](#)]
- **[KNE03]** Kotz, D., Newport, C., Elliott, C., *The mistaken axioms of wireless-network research*, Technical Report TR2003-467, Dartmouth College, July 2003 [[PDF](#)]
- **[KNG04]** Kotz, D., Newport, C., Gray, R., Liu, J., Yuan, Y., Elliott, C. *Experimental evaluation of wireless simulation assumptions*, International Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 04), ACM Press, 2004 [[PDF](#)]
- **[LEV06]** Levis, P., *TinyOS Programming*, 2006 [[PDF](#)]
- **[MC03]** Min, R., Chandrakasan, A., *Top Five Myths about the Energy Consumption of Wireless Communication*, ACM Sigmobile Mobile Computing and Communications Review (MC2R), volume 7, Issue 1, January 2003 [[PDF](#)]
- **[PAP03]** Papageorgiou, P., *Literature Survey on Wireless Sensor Networks*, Unpublished note, 2003 [[PDF](#)]

- [VIT79] Viterbi,A., *Spread Spectrum Communications -- Myths and Realities*, IEEE Communications Magazine, pages 11-18, May 1979 [PDF]
- [YH04] Ye,W., Heidemann,J., *Medium access control in wireless sensor networks*,in Wireless sensor networks, Kluwer Academic Publishers, 2004 [PDF]
- [YHE02] Ye,W., Heidemann,J., Estrin,D., *An Energy-Efficient MAC protocol for Wireless Sensor Networks*, Proceedings of IEEE Infocom, pages 1567-1576, IEEE, 2002 [PDF]
- [YCLZ01] Ye,F., Chen,A., Liu,S., Zhang,L., *A scalable solution to minimum cost forwarding in large sensor networks*, Proceedings of Tenth International Conference on Computer Communications and Networks, pages 304 -309, 2001 [PDF]

Selected articles from the technical literature, as directed, e.g.

- ACM Transactions on Sensor Networks
- ACM International Workshop on Wireless Sensor Networks and Applications (WSNA)
- ACM Conference on Embedded Network Sensor Systems (SENSYS)
- International Conference on Mobile Systems, Applications and Services (MobiSYS)
- International Symposium on Mobile Ad Hoc Networking and Computing (MobiHOC)
- International Conference on Information Processing in Sensor Networks (IPSN)

7. Other resources

- [Atmega 128 documentation](#)
- [Chipcon 2420 documentation](#)
- [Contiki](#)
- [Sensor Networks Bibliography \(USC\)](#)
- [Binghamton University -- Sensor Networks Reading List](#)
- [Crossbow Wireless Sensor Networks](#)
- [Crossbow Solutions Blog](#)
- [Manuals for Motes, Sensorboards etc.](#)
- [Nano-RK](#)
- [The TinyOS website](#)
- [TinyOS 2.0 documentation](#)
- [Python](#)
- [Sensor Network Museum](#)
- [Wireless Sensor Networks Blog](#)
- [Zigbee Standard](#)