Module Title	Enabling Technologies for Internet of Things

Module Code	TGI_S03 *(University of Ulster code to be confirmed)*

Module Level	7 (Masters)	**Credit Points**	10 (5 ECTS)

Module Coordinator	Dr. PJ Morrow, School of Computing and Information Engineering, University of Ulster, Coleraine Campus (pj.morrow@ulster.ac.uk)

Guest Lecturer	Prof. Y. Koucheryavy, Department of Communications Engineering, Tampere University of Technology, Finland

Location	University of Ulster, Coleraine Campus, Northern Ireland

Mode of Delivery	1 week intensive for presentation of lectures / laboratory material; subsequent independent study and assessment.

Hours *(notional student effort hours: 1 credit point = 10 hours)*			
Lectures	20 hours	**Independent study**	70 hours
Practicals	10 hours	**Total Effort**	100 hours

Rationale

The 'Internet of Things' is concerned with the integration of physical and virtual objects in an information framework where the objects or 'things' become actively involved in business or information processes. IoT is based on Machine-to-Machine (M2M) communications between 'things' and the Internet, transforming them into intelligent devices that exchange real time information. IoT is a significant strategic technology trend and will enable a wide range of new applications and services to be developed. This module will introduce students to the underlying technologies which support IoT; describe key service scenarios; and provide an outlook on IoT business models. In particular the current and future (2-5 years) trends will be discussed in terms of 3GPP, IEEE and IETF technologies and applications, services and frameworks. Network layer specifics such as IPv6 addressing applicability and operation will be considered. Standardization efforts will be outlined and summarized.

Aims

The primary aims of the module are:

1. To provide a foundation in the underlying technologies which support IoT and M2M, such as 3GPP, IEEE and IETF.
2. To equip students with the necessary skills to allow them to design and implement solutions to IoT problems.
3. To outline the roadmap for prospective IoT services development and deployment.
4. To provide valid use-cases, review stakeholders' interests and correspondent business models.

Content

The module is targeted at understanding the big picture of Internet of Things and M2M communications and the corresponding existing and future (2–5 years) applications, services, frameworks and technologies. It will reveal existing and upcoming algorithms and protocols as well as corresponding challenges for different wireless technologies standardized by IEEE 802.11 and IEEE 802.15 committees; by 3GPP, e.g. UMTS, HSPA, HSPA+, LTE, LTE-A; ZigBee; and IETF 6LoWPAN. The module also introduces up-to-date developments within RFID, such as printed electronics, and defines a roadmap towards IoT through a wireless sensing paradigm. Special attention will be given to emerging areas of micro and nano scale communications where communicating microscopic and nanoscale devices form a network which will enable even more advanced applications of IoT in the biomedical, environmental and defence fields as well as in industrial and consumer goods. Energy efficiency issues will also be addressed and investigated throughout the module agenda.

Introduction

IoT challenges and opportunities; demand and trends in new services; wireless sensing paradigm; operator's revenue structure; governmental, academic and standardization vision of IoT.

IoT principles and fundamentals

IoT architectures; networking and communications; management infrastructure; services and applications development; human technology interaction; ecosystem; IPv6.

Topic 3M2M and reference scenarios

M2M market and its analysis; emerging M2M opportunities for telematics; integrated and PaaS M2M solutions; relevant usage models and potential customers; examples of deployed services; changes in conventional mobile operator role; case studies on mHealth; examples of relevant business models.

Wireless Technologies as enablers for IoT (I)

General challenges for IoT wireless technologies; energy efficiency; IoT standardization activities; M2M in 3G, LTE, LTE-A; research challenges for efficient support of M2M traffic.

Wireless Technologies as enablers for IoT (II)

IEEE 802.11 and 802.15; IETF 6LoWPAN and others.

Next steps in IoT – Internet of Nano Things

Cyber-physical systems; miniaturization of devices; printed electronics and RFID; nanomaterials; nanodevices; nanocommunications; Teraherz wireless channel and its challenges; advanced applications and services.

Assessment

This module is assessed through coursework only. There will be one piece of coursework which will be assessed subsequent to the delivery of the module.

The assessment typically will consist of:

- the design and implementation of simulation experiments using an appropriate network simulation package together with a detailed report describing results;
- writing a technical report / essay on a selected topic.
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Feedback will be through individualised and general (class) comments on the submissions.