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# Minimum Energy Wireless Sensor Networks

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**Key skills:** *computer systems engineering; electronics; physics; telecommunications*

## Background

The internet is integral to many of our lives and connects people across the globe enabling social and business networking. More recently there has been much attention on the 'internet of things' that enables the connection between physical entities without human intervention. Examples include: environmental control of a building; mechanical monitoring of civil engineering structures [1]; production line command and control; and monitoring of mine complexes [2]. This is achieved by embedding wireless sensors within the entities that relay data to a central control point. Many of these networks may be connected to a single remote point which may also be required to interact with each other. The sensors are often self-powered by a battery or perhaps through harvesting power from the environment. Thus they are power constrained and the design must enable prolonged operation without human intervention since the sensors may be inaccessible.

Energy consumption in wireless networks, especially in wireless sensor networks, has always been a very hot research topic and has gained a lot of interest. It is important to enable wireless sensor networks to perform their duties efficiently even in the presence of improved energy saving techniques, e.g. long battery life. Energy consumption stems from both communicational and computational losses, where the transceiver is a major contributor of the former type of energy consumption and latter is due to computations performed in the hardware [3]. Accordingly, research has been performed which strives to provide both communicational and computational energy saving. Although energy saving approaches could target either a single or multiple layers of the OSI protocol stack, most research has so far focused on layer 3 and layer 2, such as novel energy efficient routing algorithms [4] and energy efficient medium access control scheme [5]. Energy saving could also be achieved at the physical layer by improved energy efficient modulation schemes, for example. Alternatively, research could be focused on energy saving techniques aimed for both the data link (MAC) and physical layers together. Much less work has considered reducing energy requirements through novel modulation and coding techniques so far, however one promising example is given in reference [6]. Here, on-off keying modulation is used as a means of reducing the transmit energy requirements whilst exploiting inherent channel coding, which sets the scene of this PhD study.

## Programme

The aim of this PhD is to build on research reported in [6] as follows.

i. Determine the practical implications of minimum energy coding
ii. Devise sub-optimal modulation & coding techniques that reduce the energy requirement whilst providing an implementable solution
iii. Devising a medium access control scheme to enable support of many devices whilst retaining the energy efficient power properties of the modulation and coding scheme
iv. Devise a concept demonstrator and conduct experiments so show the reduced energy requirements from using the novel schemes obtained through the research programme

The programme is a blend of communications theory, computer simulation and experimentation and has the following milestones:

i. report of prior art (6 months)
ii. analysis of candidate solutions and transfer report (12 months)
iii. results from performance modeling and 2nd year report (24 months)
iv. experimentation using a suitable wireless development platform (30 months)
v. thesis submission (36 months)

**Impact potential**

The researcher is encouraged to publish in leading academic journals. Examples relevant to this programme of study are: IET Wireless Sensor Systems; IEEE transactions on Wireless Communications; IEEE Journal on Selected Areas of Communications.

The researcher is encouraged to develop exploitable outputs. Examples pertinent to this programme of study are: concept demonstrator for use in attracting further investment and patenting of novel techniques.

**References**

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