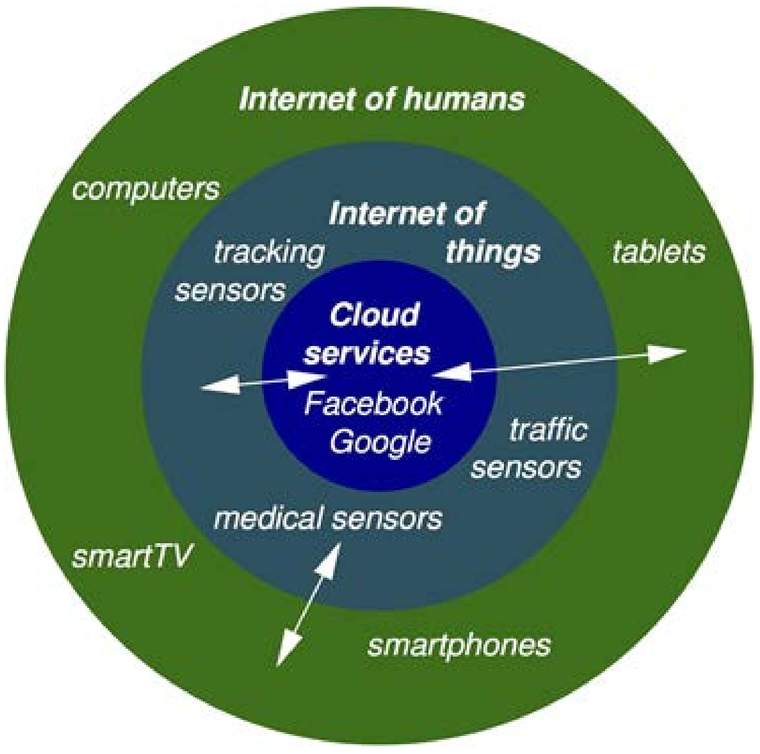
# Electronics for Internet of Things

**A Research Theme within Research for Innovation**
–the overarching strategic research programme at Halmstad University, with support from The Knowledge Foundation




## Background and Motivation

Internet of Things (IoT) is one of the most important and groundbreaking technological trends we see today, and it has already started to affect our society. Internet follow something similar to Moore's Law (Metcalfe's law) and doubles its size every five years. According to Cisco, in 2009 there were more devices connected to the Internet than there were people on earth. The development of IoT is described to be of paramount importance for the development of future business and society. In order to fully exploit the possibilities that IoT bring we need to develop new design and building practice for integrated electronics.

## Purpose and Long-term Goals

The purpose of this research theme is to provide new methods and processes for the design, development and integration of electronics. An important long-term goal is to increase the technology knowledge and point out the business opportunities that pervasive computing and Internet of Things provides industry and society.This, together with an increased knowledge about the possibilities and limitations with the new 3D printing production methods, nano-electronics, and computational methods will lead to the emergence of new and earlier unthinkable devices with highly competitive integration of embedded electronics.
The specific outcomes in terms of research are: a better understanding of physical properties of new printable materials as well as new innovative design and production methods to realize embedded systems suitable for fulfilling the vision of the pervasive computing revolution. The merging of mechanical and electromagnetic modelling is a very important part of future building practice of highly integrated electronic systems.

## Research Areas and Methods

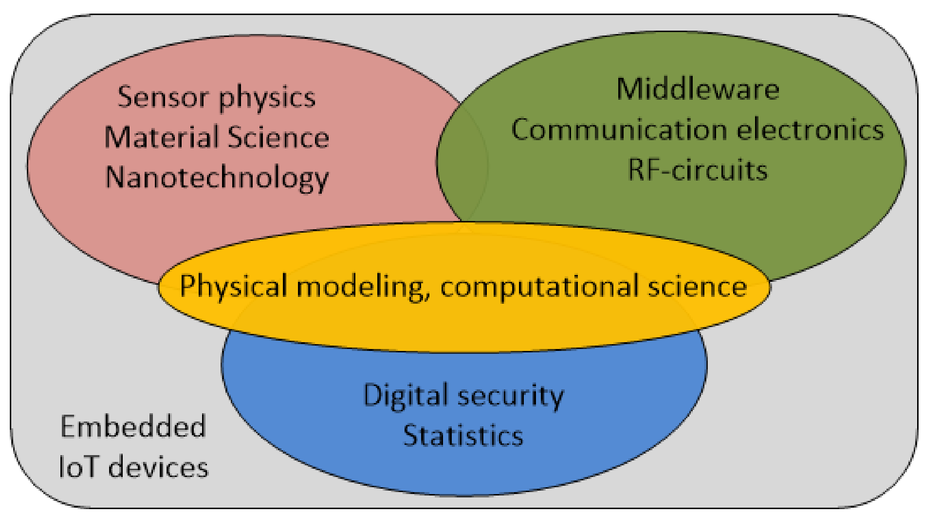
Nano-electronics is an area of research that has great potential for IoT in terms of the production of e.g. new types of sensors and for the realization of efficient receivers. A very important condition for the realization of IoT is the seamless integration of radio and digital functionality at a very low cost. The research in the RF electronics is conducted together with nano-electronics group on the development of nano-sensors and high-frequency ultra-low-power receiver. The research activities include device fabrication, measurements,  and studies of system properties such as e.g. power consumption.
An area under extreme development is additive manufacturing, in this research initiative we aim at blending this technology with electronic design in order to propose new building practices for electronic design of IoT devices

## Status and Development Plans

The research areas described above is the hardware basis for the IoT. The high level of competence in physics, material science and design of nano-electronics enable new types of sophisticated sensors. A deep understanding of advanced RF components, circuits and methods of construction ensures the development of middleware and communication electronics. For characterization of RF receivers we use the test center ECH, which today is realized with the support of the KK-Foundation (project: EMC_NG) and local businesses. Production of nanostructures occurs at nmC @ LU, while the characterization is done in Rydberg Laboratory.
Further we plan to include expertise in mathematics and computing technologies in this theme. This will enable the development of modeling tools for component production using multiphysics modeling which significantly shortens lead times and thus prototyping costs. For this purpose we seek funds from the Knowledge Foundation (new project: EMC Hammer).
Another important aspect of mathematics research in the context of IoT is mathematical statistics, affecting digital security about privacy issues in network communications, detection of encrypted code, development of ciphers, encryption key generation procedures, cryptography and related statistical methods.

## Important Results so Far

We have created an arena for closer regional cooperation in the field of electronics, where regional small and medium enterprises with common technology challenges transforms a regional knowledge/resource cluster in collaboration with the university/college and authorities in the region.
We have conducted a comprehensive systematic study of the power consumption of RF systems aimed at providing an overview and understanding of the relationships between the receiver sensitivity, bandwidth, carrier frequency and power consumption.
Antennas has been manufactured in metal and in plated polymers. The antenna are now undergoing tests and evaluation.




## Strategic Partners

The network for future electronics in Halmstad, HälsoteknikCentrum Halland (HCH), Svensk Elektronik

## Key Funding Sources

KK-foundation and Halmstad University

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