Title: Secure Radio Identification Tag with Wakeup Receiver

Responsible person: Andreas Burg

General description

In this project, you will construct a secure identification and authorization tag that is worn on the body, for example as part/component of a wrist-watch. The tag communicates with the outside world either through a low-power wireless link or through the body, using capacitive coupling. The identification process is partitioned into two steps: in the first step, the tag waits for a predefined wakeup sequence on the communication link. Once this sequence is received, the secure phase starts, in which the tag communicates actively with the host and performs complex computations to carry out the authentication process. Sufficient energy to complete this phase must be collected over time through harvesting.

This project involves:

- General system architecture
- Selection of system components and communication/authentication algorithms/standards
- Initial power budget
- Technology selection
- High-level circuit design of the wakeup receiver and the systems low-power mechanisms
- Evaluation of trade-offs between false-alarm and miss probability in the wakeup mechanism

Specifications

Sensing

A capacitive sensor to detect and sample a wakeup signal from the host

Communication

A capacitive on-body communication link with 10 kbit/s
Alternatively: a short range wireless link OOK (10 kbit/s)

Electronics and power management

A digital ULP wakeup receiver to discriminate a wakeup signal from noise
A data processor to perform the secure authentication step in 100ms
Basic Tx and Rx for capacitive coupled communication
Circuit for charging temporary storage
Power gating of the authentication processor
Voltage regulators for ULP wakeup detector

Power supply

Based on energy harvesting from motion
Voltage regulators to provide appropriate voltage levels for the wakeup circuit and for the authentication circuit
A mechanisms to store energy for powering the circuit in its authentication phase

Title: Solar powered environmental sensor for recording illumination levels

Responsible person: Andreas Burg

General description

We are interested in records of the amount of light present in an outdoor location over a long duration. Since the sensor is placed in the environment, the information can be read out only in irregular intervals that may be months or even years apart. If the sensor dies, the information should not be lost. Hence, it should be recorded on a non-volatile memory and the sensor should be powered from a harvesting source (solar cell). Sampling rates do not need to be constant, but can vary according to energy available. Also, ideally, when the storage medium runs full, old data can be compressed (subsampled) to make room for new data.

This project involves:

- Definition of the functional modes of the system and detailed specification
- Selection of an appropriate solar cell based power source with short-term backup
- Planning of the power management strategy using low-power modes of the EMF32LG microcontroller and including information from the light sensor
- Implementation of the on the EMF32LG-DK3600 evaluation board
- Power analysis using the on-board power monitoring tools of the MF32LG-DK3600
- Demonstration of the system

Specifications

Specifications

Target lifetime of the system: unlimited
Sampling rate of the illumination sensor: variable

Storage

Non-volatile memory

Scavenger and power supply

Based on solar cells of your choice and potentially a basic backup capacitor

Electronics and power management

EMF32LG-DK3600 evaluation kit with peripherals, including light sensor and Flash memory

The power management strategy should include the availability of information on the amount of light (and hence energy from the solar cells) available from the light sensor on the board. With this, the system can set for example sleep mode durations, clock sources and sampling rates.

Title: Door Open/Close Counter

Responsible person: Andreas Burg

General description

In an office/lab environment, one would like to know how often a day people enter a room with a locked door. To this end, you are asked to implement a device that counts how often on average a door is opened and closed per day. This device can not be powered from the mains, but should operate for as long as possible (ideally for years) on a single battery charge. It uses a metal sensor (present on the EMF32LG-DK3600 evaluation board) to detect if a door is closed. Whenever it open it registers the change. On the push of a button, it shows the current count on the LCD display present on the board for the duration of 1 second. When the battery becomes empty, the status of the device is still kept in non-volatile memory, to be still available after the battery has changed.

This project involves:

- System design and detailed specification
- Planning of the power management
- Software implementation
- Implementation and optimization of the power management
- Detailed power analysis with the EMF32LG-DK3600 built-in power management tool
- Prediction of the battery lifetime
- Demonstration of the system

Specifications

Sensing

Based on the metal sensor present on the EMF32LG-DK3600 evaluation board

Power supply

Battery

Electronics and power management

ARM M3 Low-Power Microcontroller and EMF32LG-DK3600 evaluation board

Power management strategy that combines low-power modes and features of the EMF32LG microcontroller with the specifics of the application (properly setting sleep mode durations, clock sources and sampling rates)