Design of an RFID / Zigbee Network for Blind Navigation

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Abstract:

The project aims to provide a robust hardware solution towards blind navigation in mass-transit, crowded public transportation systems (airports, bus stations, railways, etc.). The IEEE 802.15.4/Zigbee based transceiver and RFID tags would be used to incorporate this wireless network solution. The three distinct phases of the project are – Design of a passive RFID tag; Design of a Zigbee transceiver and Design of the dual-standard RFID/Zigbee based transceiver.

Responsibilities:

- Power Generation Block in the Passive 13.56 MHz RFID tag; Summer 2004/Fall 2005
- Frequency Synthesizer (with Didem Turker); Fall 2004-Fall 2005

Description:

1. The Navigation and Communications Network for Blind

Technology is an avenue towards providing reliable and effective solutions provided they are viable. Visually impaired/Blind persons have shown amazing alacrity and determination in their struggle towards "Complete Independence". They are able to walk their way through most places courtesy their strong intuitions and brilliant mental picture of the roadmaps. However, places that are very crowded and which they happen to visit infrequently, like an airport, continue to be a nightmare. The project incorporates a RFID/Zigbee based navigation system for such applications.

The desired network would consist of reduced function nodes (RFID tags), active nodes (Zigbee transceivers) and an user-friendly device (RFID/Zigbee compatible dual-mode transceiver). Passive RFID tags would be used for providing information on locations and Active Zigbee transceivers would provide real-time information (emergencies, changes in schedule, temporary construction activities, etc.)

2. Design of a 13.56 MHz RFID Tag

Radio Frequency Identification Systems have proved to be popular due to their ubiquitous presence in a variety of information based application systems ranging from stock and inventory management to biomedical applications to tagging of livestock to civil and petroleum engineering applications and more.

A typical RFID system consists of a tag and a reader interfaced to a host computer. Different classifications and standards exist for an RFID tag. Passive tags make use of the RF energy from the readers to power themselves up. Power Consumption and Silicon area are the two most important constraints in their designs.

A 13.56MHz passive RFID tag was designed during Spring/Summer 2004 and was fabricated in 0.35µm CMOS technology. The tag and the chip micrograph are shown in Fig. 1(a) and (b), respectively. Was responsible for the Power Generation block of the 13.56 MHz passive RFID tag.

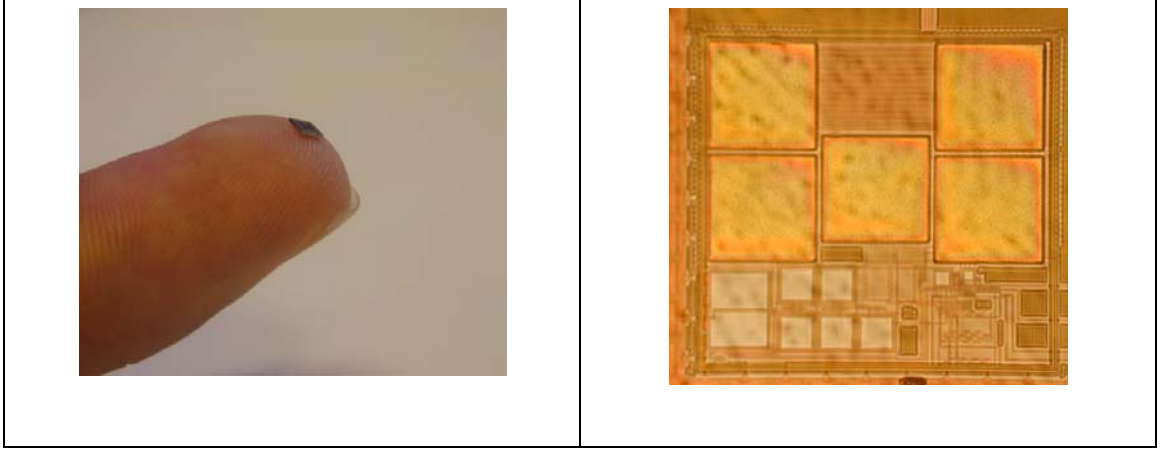

FIG. 1(A) A 13.56MHZ PASSIVE RFID TAG ; 1(B) CHIP MICROGRAPH

3. Design of a Zigbee Transceiver

IEEE 802.15.4/Zigbee is a relatively new standard developed to meet the needs of low data rate, low power consumption based wireless network systems. Machine to machine systems eliminate the user effort and try to form a network for automation, environmental control, health monitoring or security purposes. For these M2M applications there is no need for the high-speed capabilities like video /audio transmission or for very high communication ranges. They would offer the best solution in sensor based M2M systems when compared to its counterparts – the IEEE 802.11 series and Bluetooth.

The IEEE 802.15.4 is a WPAN standard optimized for a relatively low data rate and low power applications, where the battery life should last as long as the shelf life of battery. It defines the PHY and MAC layers while the upper layers are defined by Zigbee, the routing protocol designed to run over 802.15.4 and supported by the Zigbee Alliance. The protocol has 16 channels in 2.4 GHz ISM band with a data rate of 250 kbps. Modulation scheme is O-QPSK with a chip rate of 2Mchips/sec and the channel access is through CSMA-CA.

A Zigbee transceiver is currently being designed with all the analog solution circuitry (i.e. LNA, PLL, Mixer, Filter, PA, VGA and Antenna design is taken over by this research team). The responsibility taken in this project is the design of an integer-N based PLL with colleague Didem Turker. Minimizing the power consumption would be the main challenge. The technology used in this project is 0.18μm CMOS.

4. Design of a Zigbee/RFID Dual Transceiver

This is the last step of this project. The specifications of the architecture are currently being developed and the design will be performed starting by fall 2005.

Status:

- The 13.56MHz RFID tag is currently under characterization in our lab.
- RF front-end blocks of Zigbee Transceiver will be submitted for fabrication in May 2005 and the whole transceiver will be fabricated in August 2005. Testing and measurements will be performed in fall 2005.
- The dual standard transceiver (RFID/Zigbee) will be designed in fall 2005 and fabricated in the beginning of spring 2006. By summer 2006 the characterization of this final design will be completed.