Chipcon

- Connecting Smarter

RF-IC Trends for Wireless Embedded Sensor Networks

Svein Anders Tunheim

CTO, Chipcon

s.a.tunheim@chipcon.com

www.chipcon.com

Network Embedded Systems Technology (NEST) Retreat

Santa Cruz (CA), June 3-4, 2004

Future Perspective

Low power wireless embedded networks is a fast growing field with high volume potential.

Chipcon's goal is to deliver chip no. 1 billion in 2011 !

Applications for Wireless Networks

- Industrial control applications
- Home and building automation
  - Heating, ventilation, air-conditioning (HVAC)
  - Lighting control
  - Alarm/security
- Remote metering (water, gas, electricity)
- Agricultural
- Environmental

Characteristics

- Large number of nodes → wireless solutions are required
- Battery operated systems requires low power consumption of RF-ICs and communication protocols
- Low system cost is critical in order to enable a high volume market.

Characteristics (cont.)

- **Low data rate**
  - **A few tens of kbps is sufficient in most cases.**
- **Low-complexity protocol**
  - **Must be able to run on an 8 bit microcontroller**
- **Communication distance from 0.1 – 50 m**

Enablers

- Standards and open source initiatives are enablers of wireless embedded sensor networks.
  - IEEE 802.15.4
  - ZigBee
  - TinyOS

- Standard-based and open source solutions gives an additional market push due to:
  - Interoperability
  - Radios providing the same physical layer (PHY) are available from several RF-IC vendors
  - Proven robust network protocols available makes it easy to build applications

Chipcon

Development Trends

Trends for Stand-Alone RF-transceivers

- Use of higher integration levels to reduce cost
  - Low/zero-IF receivers
  - Direct upconversion transmitters
- Extensive use of digital signal signal processing in the receiver and transmitter chains
- Compensation of production tolerances of analog/RF modules by using automatic self-calibration.

Trends for Stand-Alone RF-transceivers (cont.)

- More digital hardware support included, e.g.:
  - CSMA functionality
  - Automatic polling modes
  - Packet handling
  - CRC
  - Data coding/whitening/FEC
  - Encryption
  - Address recognition

⇓

- Significantly offloads the burden of the host microcontroller

⇓

- Lowers the total system cost because lower-cost microcontrollers can be used

Submicron CMOS advantages

- Reduced chip area
- Reduced power consumption of the digital part

⇓

- Strong incentives for implementing more functionality in the digital domain :
  - More flexibility related to system design and which functions to implement in the RF/analog/digital domains.
  - It is possible to move the analog/RF interface closer to the antenna (i.e. towards the up/down-conversion mixers)
  - Enables system-on-chip solutions

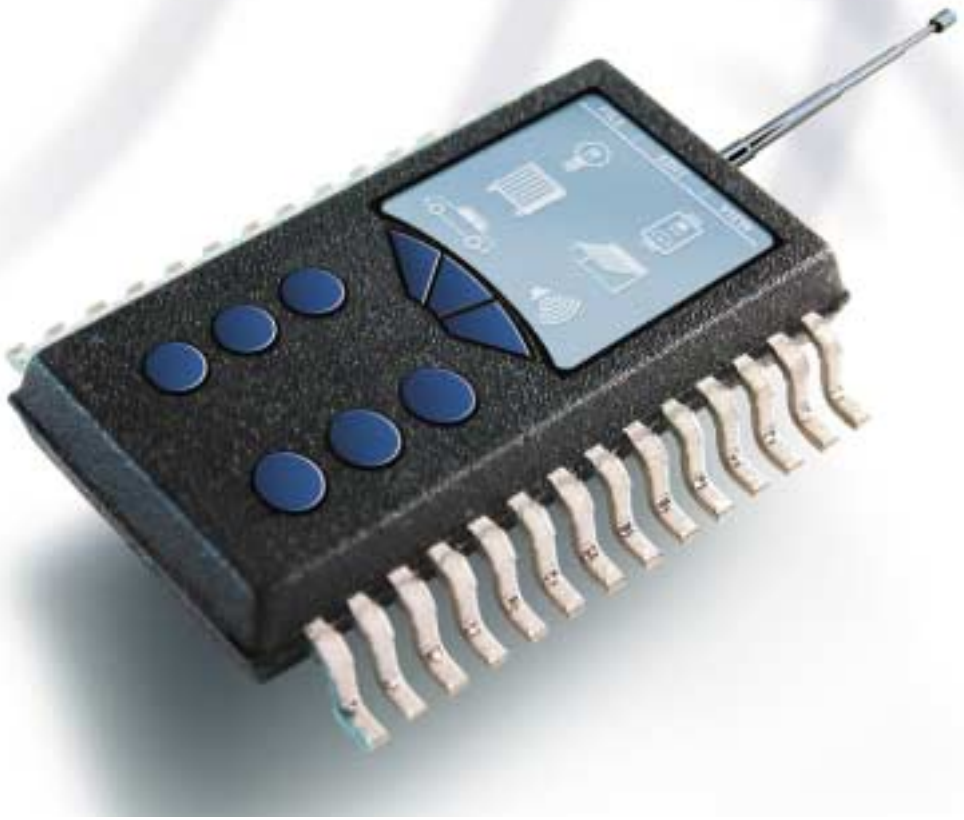
Submicron CMOS disadvantages

- Reduced supply voltage
  - More difficult to design RF/analog modules ; noise level vs. dynamic range
- Leakage current increases
- Expensive mask sets

System-On-Chip (SoC)

- Using CMOS enables implementation of true single chip solutions, i.e. :

- Radio transceiver
  + Microcontroller
  + Flash memory
  + Peripheral modules



SoC Advantages

- Lower system cost
- Simpler assembly
- Simpler testing
- Increased reliability
- Less susceptibility to external stray noise pickup
- Smaller footprint
- Integrated Development Environment ; the RF-transceiver becomes a peripheral unit of the microcontroller

Some Future Opportunities/Challenges

- Miniaturisation
  - MEMS:
    - Rx/Tx switches
    - Resonator to replace the crystal
  - Advanced pakaging techniques
    - E.g. chip scale packaging
- Positioning/ranging
- Increased focus on secure communication
  - ZigBee/IEEE 802.15.4's AES-128 encryption scheme is expected to become important

Conclusions

- Highly integrated radios implemented in submicron CMOS is the key for achieving low cost and low power RF-ICs
- System-on-Chip solutions will become increasingly important
- Important enablers for the wireless embedded sensor networks:
  - IEEE 802.15.4 / ZigBee
  - TinyOS
- Chipcon is interested in hearing from the TinyOS community which features/performance you would like to see in future RF-ICs / SoCs.

Contact Information

General	wireless@chipcon.com
Address	Chipcon AS Gaustadalléen 21 NO-0349 OSLO NORWAY
Phone	+47 22 95 85 44
Support	+47 22 95 85 45
Fax	+47 22 95 85 46
Web	www.chipcon.com