

MICS Building Application Project

Kickoff Meeting WG2 – ETH Zurich



Participants

Ludger Hovestadt – Architecture – ETHZ

Thomas Gross – Computer Science – ETHZ

Manfred Morari – Automatic Control – ETHZ

Lothar Thiele – Computer Engineering – ETHZ

**Goal: Investigate Wireless Sensor and Actuator
Networks for Building Applications**

Scenario I

- **Simplicity**
 - Building Control
 - Light
 - Ventilation, Heat, Air Condition
 - Security
 - Challenges:
 - Simple to install, extent and to use; seamless operation
 - Localization, context dependency, personalization of services
 - Reliability
 - First Steps:
 - Simulation
 - Mock up
 - Involvement of users

Scenario II

- **Energy and Climate Management**
 - Wireless Sensor and Actuator Network
 - Distributed Control to Minimize Energy
 - Integrate Sensing and Actuation
 - First Steps:
 - Develop a sensor network for building diagnostics
 - Use this network to understand climate dynamics and propose solutions
 - Step 1; Use a simple network; concentrate on sensor issues
 - Step 2: Use a reliable ad-hoc network
 - Challenges:
 - Localization
 - Calibration
 - Deployment

Open Questions

- **Sensors**
 - CO₂, humidity, pressure
 - Calibration

- **Sensor Network Platform**
 - Hardware
 - Software
 - Deployment

- **Network Protocols**
 - Reliability

Starting Point - BTnode rev3

System core

- Atmel ATmega128
- 256 kB SRAM
- Generic IO/Peripherals
- Switchable power supplies

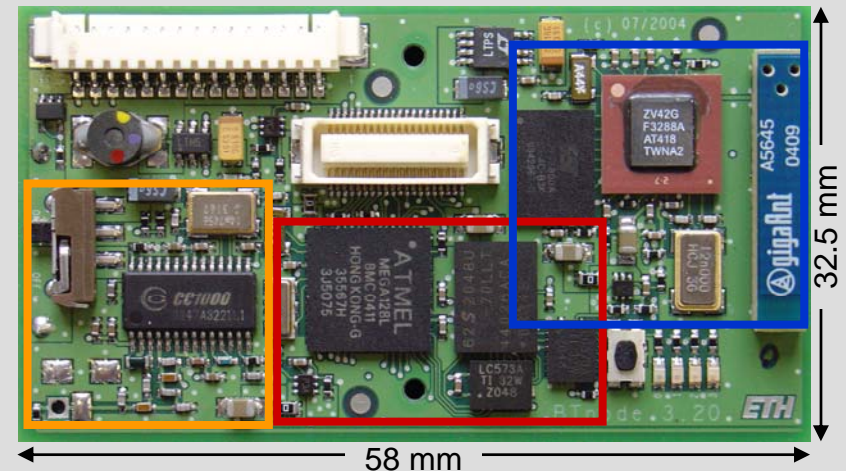
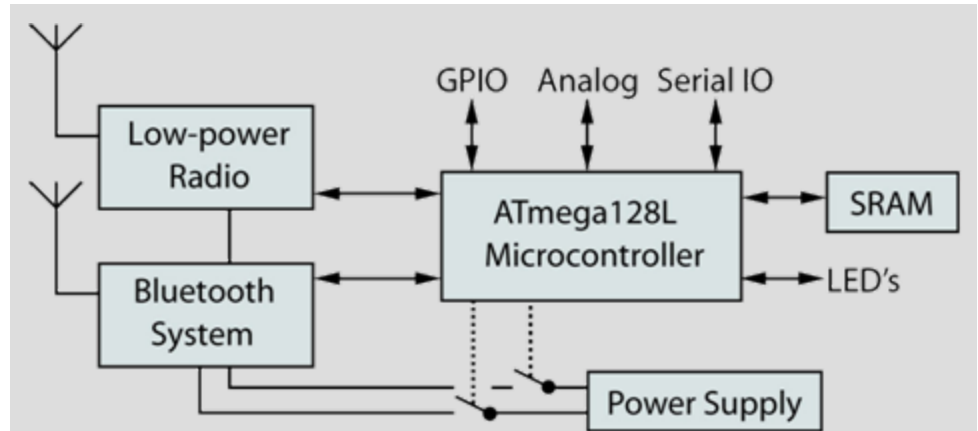
Dual radio system

Bluetooth radio

- 2.4 GHz Zeevo ZV4002

Low-power radio

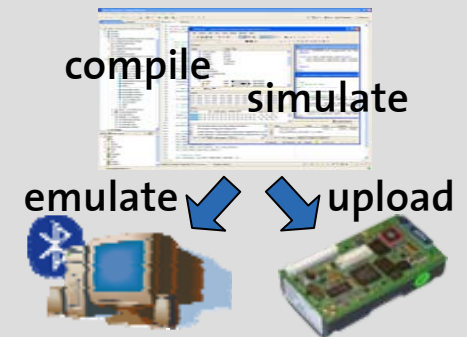
- 433-915 MHz ISM
Chipcon CC1000



BTnut System Software

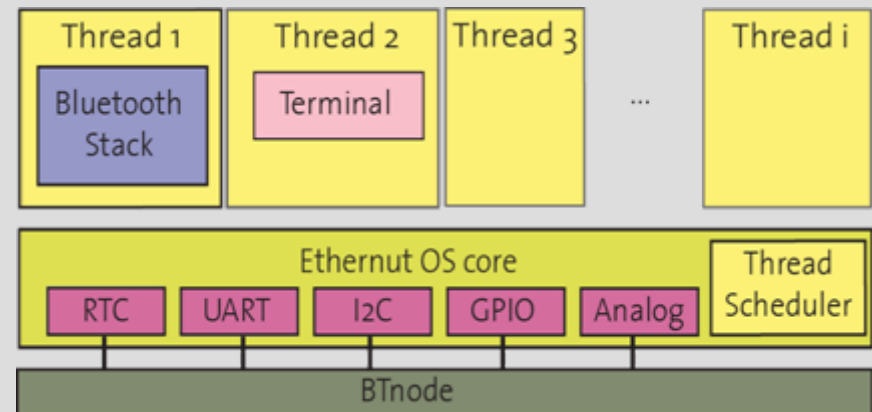
Versatile and flexible fast-prototyping

- Lightweight operating system support in plain C
- Linux-to-AVR embedded emulation
- Demo applications and tutorial



Built on top of multi-threaded Nut/OS framework

- Non-preemptive, cooperative multi-threading
- Events, timers
- Priorities for threads
- Dynamic heap allocation
- Interrupt driven streaming I/O



[Open Source Collaboration – IP9 Mattern/Thiele]

Industrial technology transfer

- Commercialization with ETH spin-off “Art of Technology”
- Commercial replicas resulting from open source policy



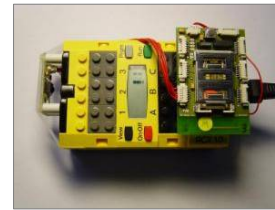
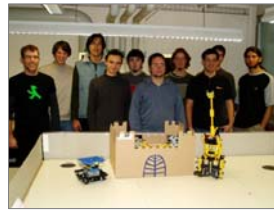
BTnode dev kit €500

*Vitronics Cobalt Blue™
Bluetooth Board*



BTnodes in Education

- Different labs and demos
- Biannual undergraduate robotics lab using Lego Mindstorms
- Graduate lab in embedded systems (120 participants @ETHZ)
- 30-40 successfully completed student projects



25+ wearable and ubiquitous computing applications and demos

- Cooperating smart objects [PhD Siegemund2005]
- Physical activity detection network [PhD Junker2005]
- Context-aware interaction and applications [PhD Michahelles2004, Antifakos2005]

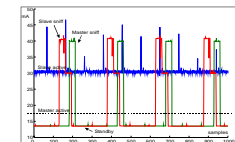
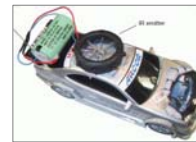
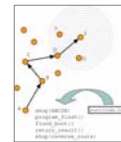
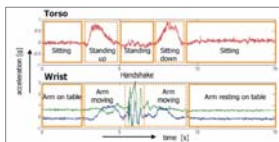
Wireless (sensor) network research

- Time synchronization and localization in sensor networks [PhD Römer2005]
- Design and Deployment of Wireless Networked ES [PhD Beutel2005]

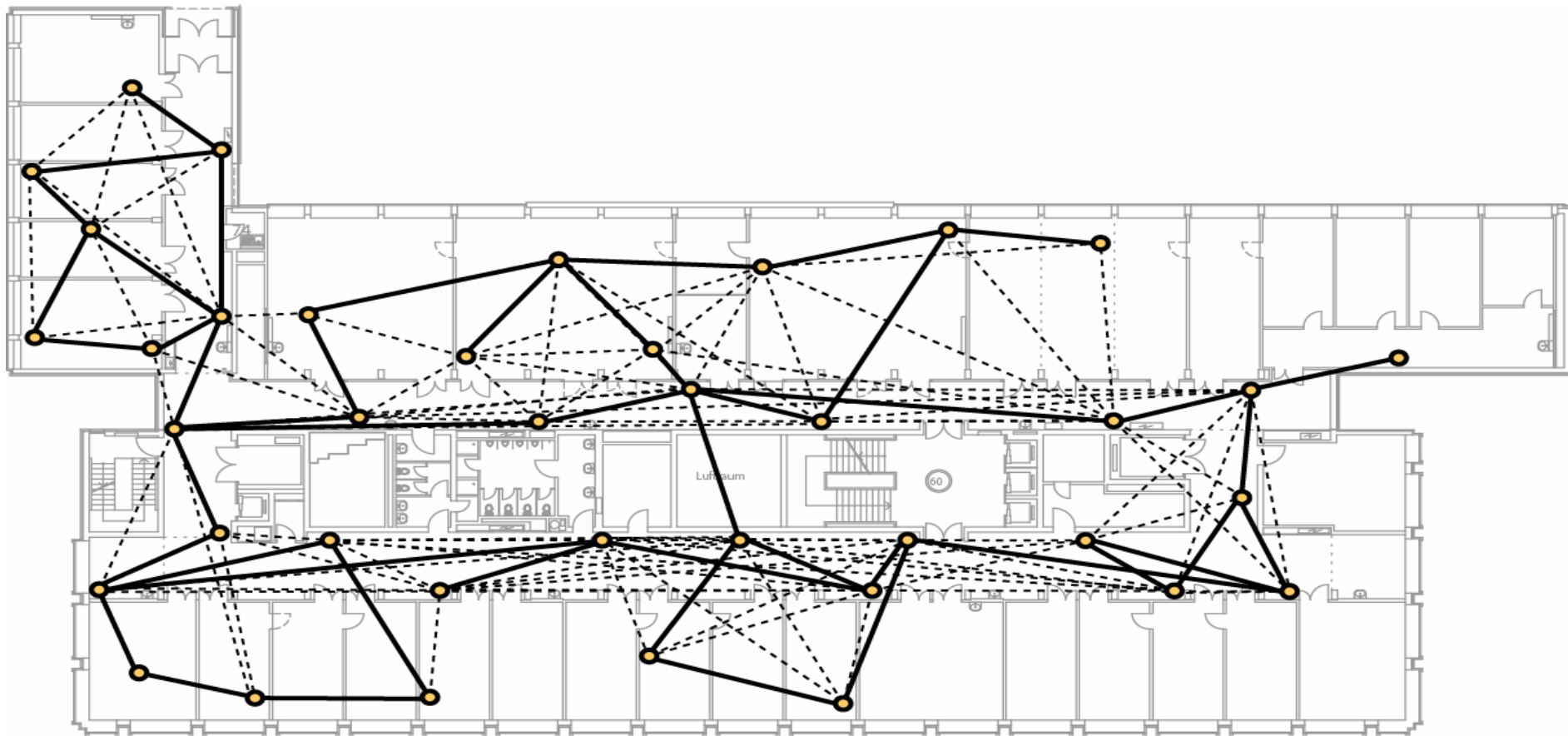
Academic outreach beyond NCCR-MICS

- Collaboration with TinyOS Group, UC Berkeley
- U Kopenhagen [MA Leopold2004, PhD Dydensborg2004], Politecnico di Milano [Negri2005]

40+ scientific publications based on or related to BTnodes



XTC Topology Control and Routing



Next-Generation Deployment-Support

