ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Using TinyOS on BTnodes

A little more than porting to another platform...

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Outline

Devices

- BTnode rev3 architecture details

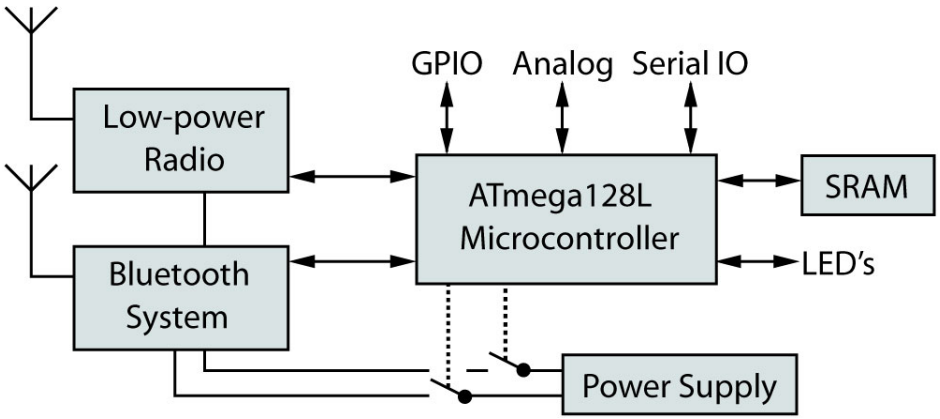
Software

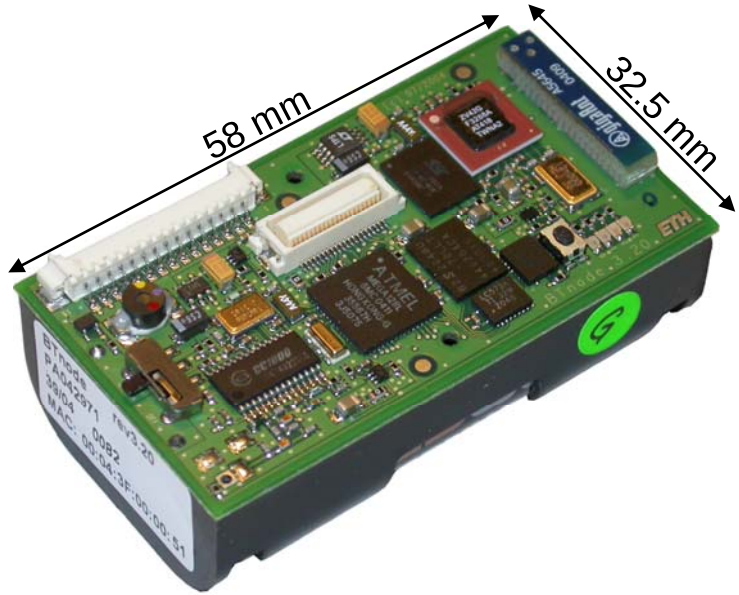
- Current state of TinyOS 1.x
- Porting TinyOS 1.x onto the BTnode rev3

Cross platform applications

- Interfacing Motes and BTnodes using Surge
- Experiences with TinyOS – Outlook to TinyOS 2.x

New BTnode rev3: a lightweight dual radio platform





BTnode success story

- Running both, TinyOS and the BTnut system software
- Prototyping Wireless Sensor Networks with BTnodes [EWSN2004]
- 3rd generation node commercialized with industrial partners AoT and Iftest
- Open-source policy has led to commercial replicas (Cobalt Blue by Vitronics)

BTnode rev3 architecture details

System core

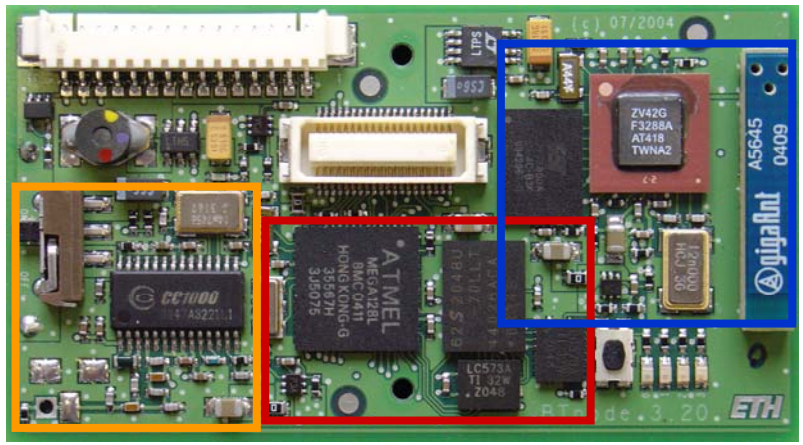
- Atmel ATmega128, AVR RISC, 8 MIPS @ 8 MHz,
  128 kB Flash, 64 kB SRAM, 180 kB data cache, 4 kB EEPROM
- 4 LEDs, reset button
- External DC supply or 2 AA cells with on/off switch
- Generic sensor interfaces

Bluetooth radio

- Zeevo ZV4002, supporting
  AFH/SFH Scatternets with
  max. 4 Piconets/7 Slaves,
  BT v1.2 compatible

Low-power radio

- Chipcon CC1000 operating
  in ISM Band 433-915 MHz



Related development on TinyOS 1.x

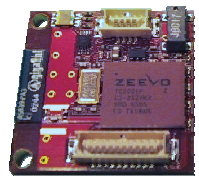
TOS 1.x radio interfaces are bit-stream oriented

Tinybt – TinyOS on BTnodes rev2

- Proof of concept and benchmarks

Imotes – TinyOS with Bluetooth and 802.15 radios

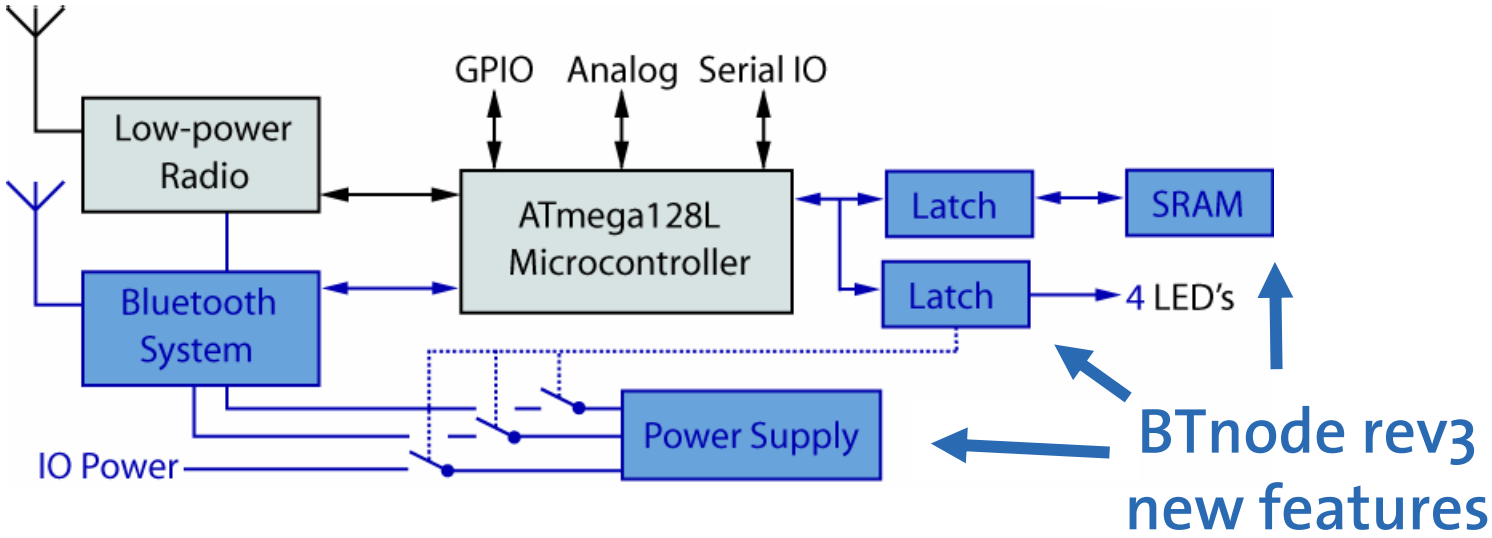
- Using ARM7 and PXA273 processors



Telos – 802.15 radio

- Link oriented stack

TinyOS Integration: BTnode rev3 platform definition



TinyOS 1.x prerequisites

- Platform definitions, radio stacks and applications separated
- New platform definition and drivers integrated into build system
- Driver functions often application dependant

Interfacing Motes and BTnodes

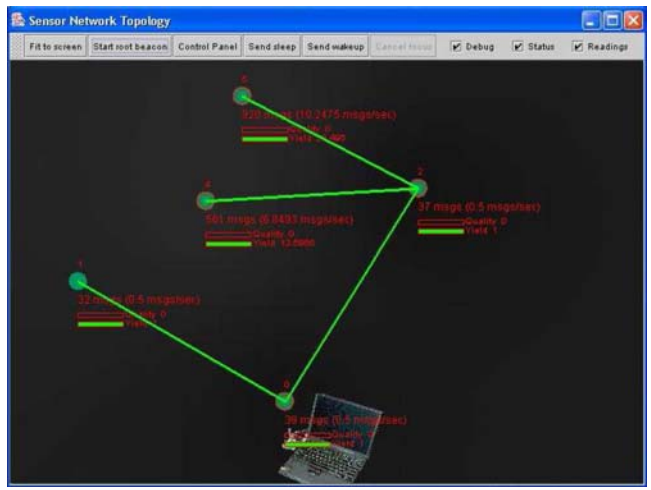
Seamless interoperation using TinyOS standard applications

- Blink, RfmToLeds, CntToRfm, CntToLedsAndRfm
- 3 BTnodes and 2 Mica2 Motes interoperate on Surge (no sensors)
- 1-click build from same application code

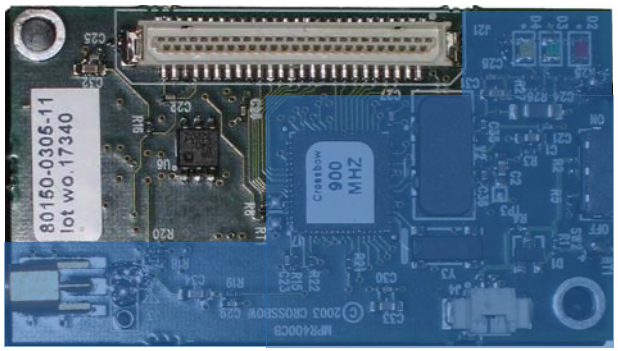
```
module BlinkM {
  provides {
    interface StdControl;
  }
  uses {
    interface Timer;
    interface Leds;
  }
}
  command result_t StdControl.init() {
    call Leds.init();
    return SUCCESS;
  }
  command result_t StdControl.start() {
    // Start a repeating timer that fires every 1000ms
    return call Timer.start(TIMER_REPEAT, 1000);
  }
  command result_t StdControl.stop() {
    return call Timer.stop();
  }
  event result_t Timer.fired()
  {
    call Leds.redToggle();
    return SUCCESS;
  }
}
```

make btnode3

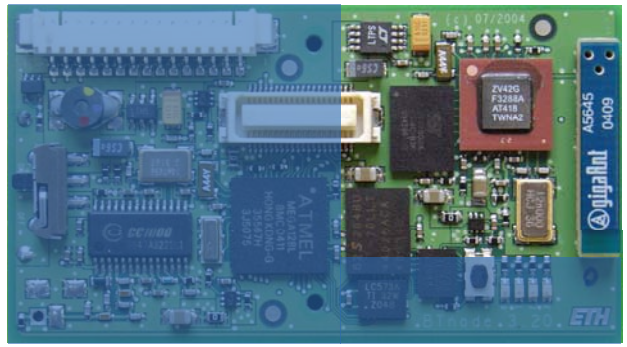
make mica2



Experiences – TinyOS on the BTnode rev3



Twin architecture of Mica2 and BTnode 3



Basics are working: BTnode rev3 is a Mica2 replacement

- Cooperation with Uni Copenhagen/ P. Bonnet
- BTnode3 platform definition available in **`contrib/tinybt`**
- Hard to "just port" without an application requirement because of hardware dependencies in the software
- **`tinyos-1.x`** – 162 MB CVS nightmare
- nesC makes debugging harder, complexity is hidden within

Experiences 2 – beyond the proof-of-concept

Emerging (open) standards?

- Monthly TinyOS 1.1.x developer releases
- Stable "even" deployment release: TinyOS 1.2
- nesC 1.1 -> 1.2 major revision with new features is breaking compatibility

A clean break for a new architecture: TinyOS 2.x

- Recently a lot of "back to the roots" discussion in the 2.0 WG – component based – platform design – hardware independence – compatibility – robustness – reuse – many new platforms
- Fixing many well known problems (multiple threads/tasks, RT issues, abstractions, modularity)
- TinyOS Enhancement Proposals: Open discussion
- Beta is available – looks very promising

Acknowledgements

Attila Dogan – term thesis @ ETHZ

Manatee Project – University of Copenhagen

- Philippe Bonnet, Mads Dydensborg, Martin Leopold, Klaus Madsen

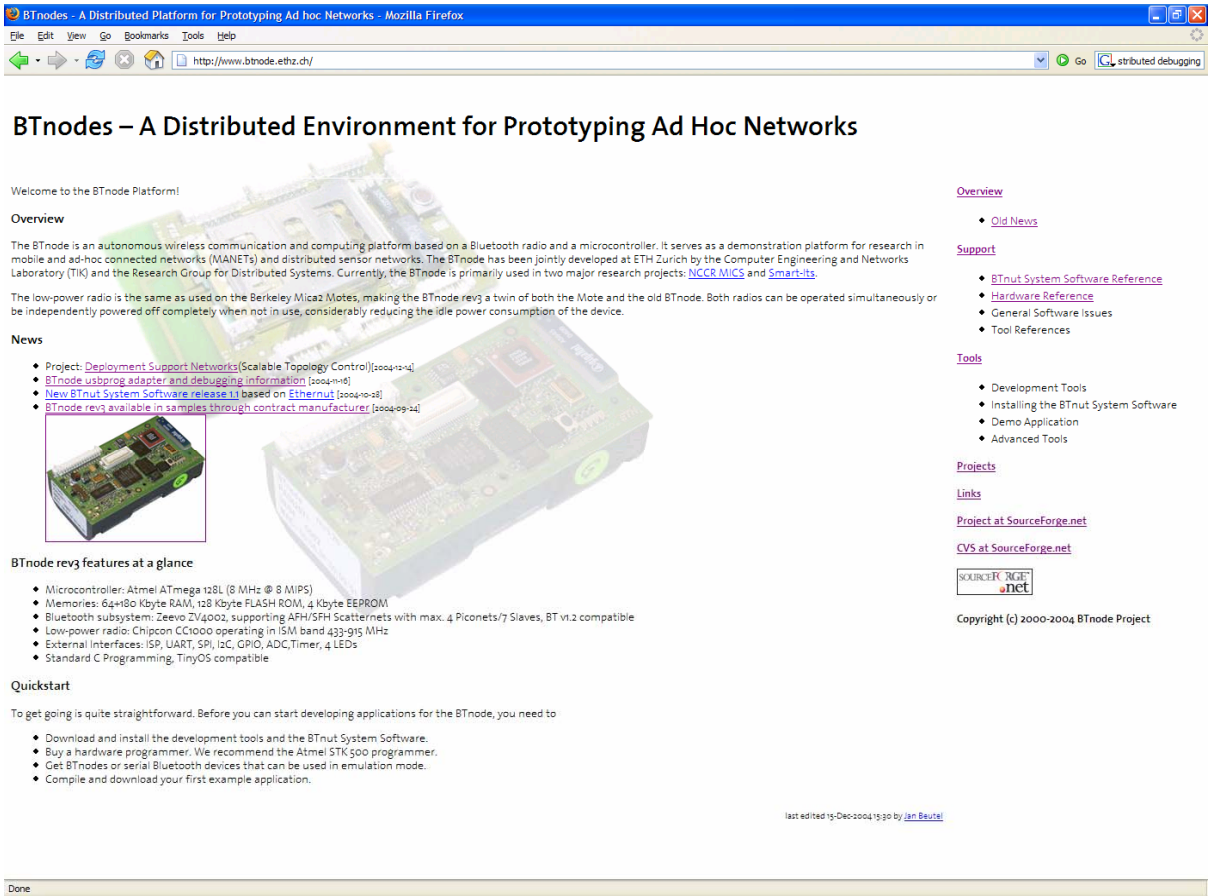
Imote Project – Intel Research

- Ralph Kling

TinyOS 2.x Working Group – UC Berkeley…

BTnode Team @ ETHZ

To probe further…



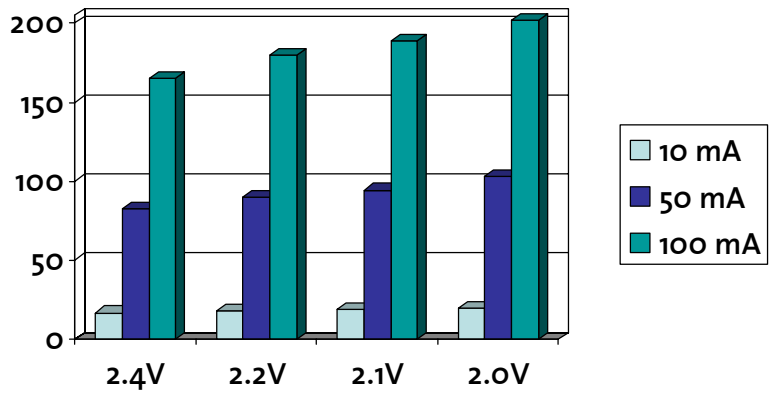
http://www.btnode.ethz.ch

Backup: BTnode rev3 additional information

Power Budget on typical AA cells (2x1.2V, 2500mAh)

- 0.5 – 150 mA current consumption
- ~80% efficiency in up-conversion to 3.3V
- Non power-aware apps can last a few days on batteries
- Power optimized apps can last many weeks depending on duty cycle

Input Current at selected voltages



Commercialization

- **Availability** samples now, volume Q1/2005
- **Pricing** USD 215/EUR165/CHF255 for samples, larger quantities upon request
- **Contract Manufacturer** Art of Technology, Zurich, Switzerland