The TinyNode Platform for Wireless Sensor Networks

February 2006 - Roger Meier
Agenda

• Shockfish SA

• Spotme™

• TinyNode Hardware and TinyOS Support

• TinyNode Kits, Products and Projects
Shockfish SA

• Founded in **1998**
  by Bänz Ledin, Rémy Blank and Roger Meier

• Spin-off of the Swiss Federal Institute of Technology

• **10 Employees**

• Products & Services:
  › **Spotme (since 2001)**
  › **Wireless Sensor Networks (since 2004)**
Instant Knowledge in Your Hand

Messaging, News

Up-to-the-minute Delegate Photos & Data

Event Schedule, Personal Agenda

Personal Contacts, Business Card Exchange

People Spotting, Radar

Interactive Voting On-line Surveys
Spotme System - Wireless Communication amongst 1500 devices

- Handhelds
- Photo-stations
- Server
- Basestations
- Message Kiosk
- Charge and Transport Case

Ethernet
Over 100 Satisfied Customers
TinyNode Platform
TinyNode Design Criteria

- Modular and flexible design for doing industrial pilots efficiently
  - Group components used in all applications (μC, Radio)
  - Compact module that can easily be inserted
  - State-of-the-Art Radio with configurable data rates and bandwidth
  - Full access to MAC layer for innovative protocols

- Highest autonomy for battery operation
  - Low sleep current and fast wake-up cycles
  - Very low duty cycle operation

- Highest possible range in license free frequency bands

- TinyOS compatible

- Tools for development
## TinyNode Hardware Components

<table>
<thead>
<tr>
<th>TinyNode 584</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSP430 μC</td>
</tr>
<tr>
<td>XE1205 Transceiver</td>
</tr>
<tr>
<td>4Mbit Extra Flash</td>
</tr>
<tr>
<td>Power Management</td>
</tr>
<tr>
<td>$V_{bat}$ and T Sensor</td>
</tr>
<tr>
<td>40 x 30 mm</td>
</tr>
</tbody>
</table>

### Extension Board
- RS-232
- JTAG
- Light and Humidity Sensor
- Breadboard for interface electronics
- AC or Battery powered

### Mama Board
- Extension Board + ..
- ..Ethernet module
- ..GPRS module
- ..SD memory card up to 4GB data
Range vs Datarate Comparision

<table>
<thead>
<tr>
<th>Platform</th>
<th>Mica2</th>
<th>Telos Sky</th>
<th>Eyes</th>
<th>TinyNode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transceiver</td>
<td>CC1000</td>
<td>CC2420</td>
<td>TDA5250</td>
<td>XE1205</td>
</tr>
<tr>
<td>Frequency</td>
<td>869 Mhz</td>
<td>869 Mhz</td>
<td>869 Mhz</td>
<td>869 Mhz</td>
</tr>
<tr>
<td>Max. Tx Power</td>
<td>5dBm</td>
<td>0 dBm</td>
<td>9dBm</td>
<td>15dBm</td>
</tr>
<tr>
<td>Data Rate</td>
<td>76.8 kbps</td>
<td>250 kbps</td>
<td>64 kbps</td>
<td>76.8 kbps</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>-98 dBm</td>
<td>-94 dBm</td>
<td>-96 dBm</td>
<td>-106 dBm</td>
</tr>
<tr>
<td>Link Budget</td>
<td>103 dB</td>
<td>94 dB</td>
<td>105 dB</td>
<td>119 dB</td>
</tr>
<tr>
<td>Range Outdoor¹</td>
<td>160m</td>
<td>80m</td>
<td>200m</td>
<td>600m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>300m</td>
<td></td>
<td></td>
<td>600m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1800m</td>
</tr>
</tbody>
</table>

**TABLE I**

Comparison of Radio Transceiver Characteristics.

- LOS Range, Outdoor with ¼ wave monopole antennas
- Measured with TinyOS
# Power Consumption Comparison

<table>
<thead>
<tr>
<th></th>
<th>Mica2</th>
<th>Telos Sky</th>
<th>Eyes</th>
<th>TinyNode</th>
</tr>
</thead>
</table>
| Min Voltage                    | 2.7   | 1.8       | 2.1  | 2.4      | V  
| Max Voltage                    | 3.3   | 3.6       | 3.6  | 3.6      | V  
| MCU sleep with RTC on (LPM3)   | 19    | 5.1       | 5.1  | 5.1      | μA 
| MCU active                     | 8     | 1.8       | 1.8  | 1.8      | mA 
| MCU active, Radio RX           | 15.1  | 21.8      | 10.8 | 15.8     | mA 
| MCU active, Radio TX at +0dBm (1mW) | 25.4 | 19.5      | 13.7 | 25       | mA 
| MCU active, Flash Read         | 9.4   | 4.1       | 5    | 5        | mA 
| MCU active, Flash Write        | 21.6  | 15.1      | 16   | 16       | mA  
| MCU wake-up latency            | 180   | 6         | 6    | 6        | μs  
| Radio wake-up latency          | 1800  | 580       | 2200 | 1500     | μs  

**TABLE II**

**Current Consumption and Wake-up Times.**

![Image](image-url)
# Average LPL Current Consumption

<table>
<thead>
<tr>
<th></th>
<th>Mica2 at 1%</th>
<th>TinyNode at 1%</th>
<th>TinyNode at 0.2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Rate</td>
<td>19.2 kbps</td>
<td>152 kbps</td>
<td>152kbps</td>
</tr>
<tr>
<td>Listen Time</td>
<td>8 ms</td>
<td>1.9 ms</td>
<td>1.9</td>
</tr>
<tr>
<td>Listen Period (Max. Latency)</td>
<td>1085 ms</td>
<td>190 ms</td>
<td>950 ms</td>
</tr>
<tr>
<td>Max throughput</td>
<td>0.89 pkts/sec</td>
<td>5.5 pkts/sec</td>
<td>1.05 pkts/sec</td>
</tr>
<tr>
<td>Average Power Consumption</td>
<td>509μW</td>
<td>489μW</td>
<td>104 μW</td>
</tr>
<tr>
<td>Lifetime² for 2 x AA alkaline cells, 2000mAh</td>
<td>1.3 years</td>
<td>1.4 years</td>
<td>6.6 years</td>
</tr>
</tbody>
</table>

**TABLE III**

CURRENT CONSUMPTION AND WAKE-UP TIMES.
TinyOS Support for TinyNode

- TinyOS-1.x ported by Henri Dubois-Ferrière, LCAV EPFL
- Hardware files under tinyos-1.x\contrib\shockfish
- Radio stack under tinyos-1.x\contrib\epfl\lcav
- TinyOS on-line tutorials (Blink, Scope, TOSBase, ScopeRF)
- Berkley (mesh-) protocols
- Deluge 2.0 with up to 8 images
- TinyOS-2.0 port in progress by Henri Dubois-Ferrière
TinyNode Development Kit

- Install CD for Windows
- 3 TinyNodes
- 3 Extension Boards
- 3 Power Supplies
- Battery Case, RS-232 and USB
- 2h of Shockfish Support
- Price: 950 CHF, excl. VAT