Agenda

• Shockfish SA and Spotme™

• Wireless Sensor Networks Today and Tomorrow

• TinyNode Hardware
Shockfish SA

- Founded in 1998 by Rémy Blank, Roger Meier and Bänz Ledin
- 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 Overview

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

Ethernet
Over 100 Satisfied Customers
Next Generation - Spotme II

- State-of-the-Art hardware
- Multiple Radios
  - Proprietary radio with 2MBit/s and ranging
  - WLAN with VoIP support
  - NFC for logistics and access control
  - GSM/GPRS module
- Color screen and keyboard
- CPU for video and audio applications
Wireless Sensor Networks
Wireless Sensor Networks Today

... today, WSN deployment is limited to only extremely experienced integrators and developers. Ninety percent of the adopting WSN market place cannot afford to spend the time and expense necessary to create a working WSN system. There has to be a simpler, cheaper way to go about deploying these networks,"

Chris Onan, Appian Venture Partners

Today, we have...

- ...custom made systems
- ...manual insertion of nodes in the Network
- ...6 month pilot projects
Wireless Sensor Networks in 2010

- Customizable systems
- Automated, location aware insertion
- 3 week pilot projects
Proprietary will grow together with ZigBee

Figure 13: Global RF Modules, ZigBee vs Proprietary 2004-2010

Table 6: Global RF Modules, ZigBee vs Proprietary 2004-2010

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZigBee</td>
<td>0.30</td>
<td>7.16</td>
<td>13.12</td>
<td>27.30</td>
<td>62.76</td>
<td>157.00</td>
<td>362.08</td>
</tr>
<tr>
<td>Proprietary</td>
<td>5.89</td>
<td>10.07</td>
<td>15.74</td>
<td>25.30</td>
<td>40.79</td>
<td>67.00</td>
<td>103.50</td>
</tr>
<tr>
<td>Total</td>
<td>6.19</td>
<td>17.23</td>
<td>28.86</td>
<td>52.60</td>
<td>103.55</td>
<td>224.00</td>
<td>465.58</td>
</tr>
</tbody>
</table>

Source: OnWorld 2004
Strategy: Interfacing Academia and Industry

Academia

Hardware Modules
Access to Test Beds
Hardware for Research Deployments
Innovation
Visibility in Research Community

Shockfish SA

Growth Spiral

Application Specific Technology
New markets
Volume

Industry

Leading Edge Technology
Short Time-to-Market

Shockfish SA

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07/02/2006
TinyNode Design Criteria

- Modular and flexible design to allow multiple applications
  - Group components used in all applications
  - Separate application specific board (sensors, actuators)
  - 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
TinyNode Hardware Modules

**Extension Board**
- RS-232
- JTAG
- Some Basic Sensors
- Can be AC powered

**TinyNode 584**
- MSP430 µC
- XE1205 Transceiver
- 4Mbit Extra Flash
- Power Management
- 40 x 30 mm

**Mama Board**
- Extension Board + ..
- ..Ethernet module
- ..GPRS module
- ..SD memory card
# Range vs. Data Rate

<table>
<thead>
<tr>
<th>Data Rate (kbit/s)</th>
<th>152,3</th>
<th><strong>76,2</strong></th>
<th>9,6</th>
<th>1,2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver Sensitivity (dBm)</td>
<td>-101</td>
<td><strong>-104</strong></td>
<td>-110</td>
<td>-122</td>
</tr>
<tr>
<td>Line of Sight *) (m)</td>
<td>150</td>
<td><strong>200</strong></td>
<td>400</td>
<td>1600</td>
</tr>
<tr>
<td>Indoor *) (m)</td>
<td>30</td>
<td><strong>40</strong></td>
<td>60</td>
<td>150</td>
</tr>
</tbody>
</table>

*) Typical Range with ¼ Wave Antenna, Transmission Power = +10 dBm,
## Power Consumption

<table>
<thead>
<tr>
<th>State</th>
<th>mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep, Timer off</td>
<td>0.004</td>
</tr>
<tr>
<td>Sleep, Timer on</td>
<td><strong>0.007</strong></td>
</tr>
<tr>
<td>µC only</td>
<td>2</td>
</tr>
<tr>
<td>Receive (inc. µC)</td>
<td><strong>16</strong></td>
</tr>
<tr>
<td>Transmit 0dBm/1mW</td>
<td>25</td>
</tr>
<tr>
<td>Transmit 10dBm/10mW</td>
<td>45</td>
</tr>
<tr>
<td>Transmit 12dBm/16mW</td>
<td>62</td>
</tr>
</tbody>
</table>
Different Applications in a Quasi-Static Ad-hoc Mesh Network

- **Throughput**
  - High
  - Mid
  - Low

- **Latency**
  - High
  - Low

- **Infrastructure Mesh**
  - Ad-hoc Mesh

Applications:
- **Very Low Power**
  - Environmental Monitoring
  - Meter Reading (AMR)
- **Low Power**
  - Home Automation
  - Alarm Systems
- **Mid Power**
  - Industrial Control
  - Building Automation
- **High Power**
  - Firmware Updates
  - Data Aggregation
Proposition: Separate Mesh Control from Data

• Mesh Control is needed in all WSN applications and manages:
  › Installation behavior (bootstrapping)
  › Insertion and removal of nodes (discovery, self-healing)
  › Overlapping networks (multiple sink problem)
  › Firmware updates
  › Health and Traffic Monitoring
  › Parameters for underlying MAC layer
  › Routing table and bandwidth allocations for data packets

• It should run on a separate (synchronized) low bandwidth channel with a reasonable latency

• MAC parameters and bandwidth allocations for data are adaptive and application specific