ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

NCCR-MICS Working Group 2
Sensor and Actuator Platforms

Sensor Network Platform Kit – Proposal

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Results of the WG2 Kickoff Meeting

Many applications have similar requirements.

- Periodic, duty-cycled, low-power SNs

Establish a “known-to-work” platform for MICS members

- For “standard” data collection and analysis
- Hardware (+embedded software)
- Software systems (access, infrastructure)
- Support through staffed “product group”

~6 groups interested

- Murphy, Decotignie, Baumgartner, Tschudin, Thiele, Grossglauser

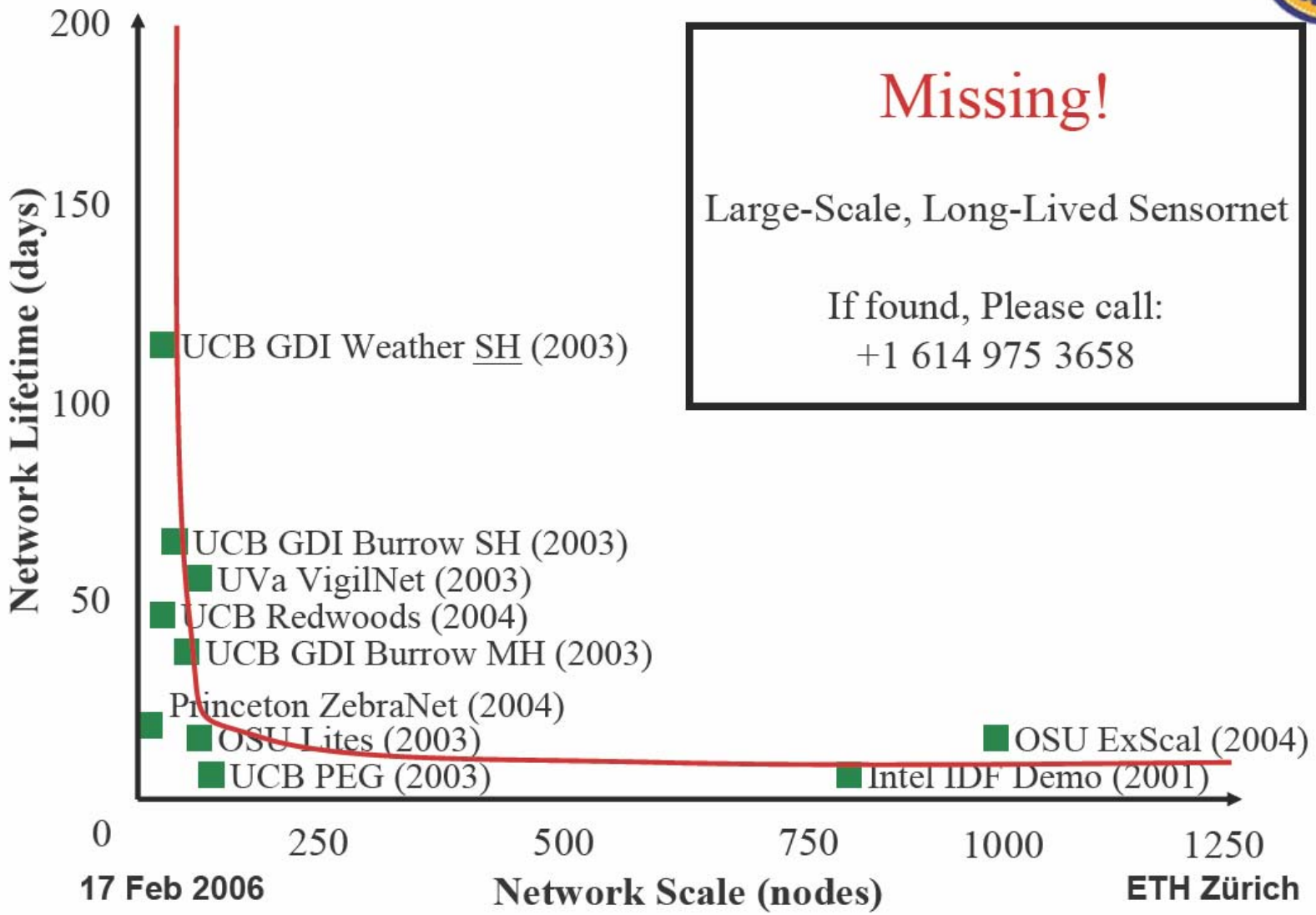
MICS Application Requirements

	Pollution	UWB	Wise Net	Deploy ment	Sensor Scope	Odor Source	Perma-forst	Event Detect	Avalan ches	Mobility	Global	Building
# Devices	+++++	no	yes	+++++	+++++	+/-	+/-	+/-	+/-	yes	+/-	yes
Miniaturization	+/-	no	yes	+/-	no	+/-	yes	no	yes	+/-	no	+/-
Autonomy	yes	no	yes	yes	yes	yes	+++++	no	yes	yes	?	yes
Battery power Lifetime	yes	no	+++++	yes	yes	+/-	yes	?	yes	yes	+/-	+++++
Environmental hazards	yes	no	?	no	+++++	yes	+++++	no	+++++	yes	no	yes
Infrastructure access	yes	no	yes	yes	yes	no	yes	?	yes	no	+++++	yes
Performance computation	no	+++++	no	no	no	yes	no	+++++	yes	yes	yes	no
Performance networking	no	yes	no	yes	no	no	no	no	yes	no	yes	no
QoS	no	?	no	yes	no	no	no	no	yes	no	no	+++++
Location	yes	yes	no	+/-	yes	yes	+/-	yes	+++++	+++++	+/-	yes
Sensors	yes	no	no	no	yes	+++++	yes	+++++	yes	yes	?	yes
Testing Deployment	+++++	yes	yes	+++++	yes	yes	yes	yes	yes	yes	+++++	yes

MICS Application Types

- **Periodic, duty-cycled, low-power SNs**
  - Pollution, WiseNet, SensorScope, Odor Sources, WaterSense, PermaSense, Smart Buildings, Mobility
- **Specialized test systems**
  - UWB platform, Event detection, Avalanches
- **Tools, testbed infrastructure**
  - Deployment

Size vs. Lifetime for Untethered, Outdoor Sensornets



Counter-Example: Non-Sustainable, Non-Scalable

Keep detailed records

	A	B	C	D	E	F
1	INTERIOR TREE					
2						
3	Wireless Mote Deployment - Sonoma Study Site (Grove of the Old Trees) - 4/27/04					
4						
5	Mote #	Crown height (m)	General orientation (in relation to main trunk)	Distance from main trunk (m)	Chamber	
6	78	66.5	SW	0.1	28	
7	113	65.5	SW	0.1	28	
8	109	64.5	SW	0.1		
9	118	63.5	SW	0.1	28	
10	106	62.9	SW	0.1	28	
11	129	62	SW	0.1	28	
12	122	61.1	SW	0.1		
13	127	60.1	SW	0.1	28	
14	42	59.1	SW	0.1	28	
15	138	57.8	WSW	0.1	28	
16	134	56.1	WSW	0.1	28	
17	119	55.2	WSW	3	28	
18	59	54.5	NW	4	27	

Deploy Quickly

Test the network before you go home

Gilmann Tolle, UC Berkeley [Sensys2005]

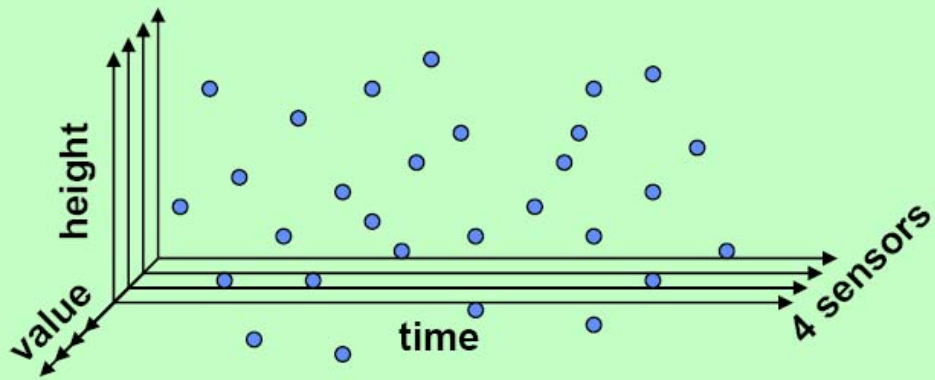
We got 820,700

49% yield

Still more than we knew how to handle!

Data Overview

33 motes
44 days
288 samples/day
4 sensors
1,672,704 points



Gilmann Tolle, UC Berkeley [Sensys2005]

Murphy's law: everything that can go wrong will go wrong

March 16th [Field test 1]

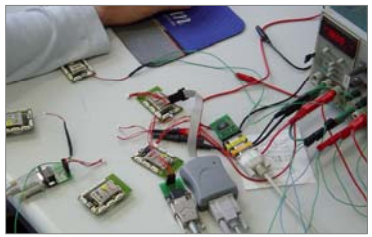
- Gateway casing does not fit
- melted DC/DC converter
- TNOdes antennas fall off
- incorrect wiring of Sensirion sensor

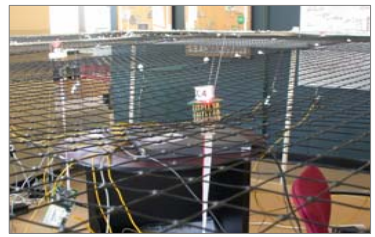
May 4th [Field test 2]

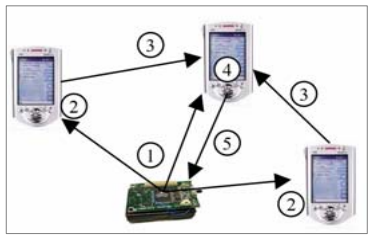
- untested T-MAC version (no development tree!)
- T-MAC looses synch (never use unsigned!)
- debugging nightmare (LEDs off, low data rate)

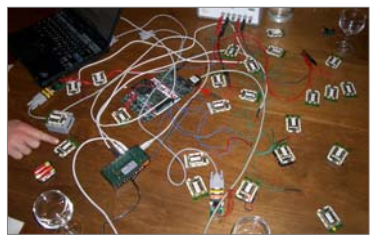
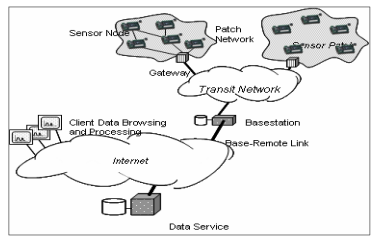
WSN Development Reality

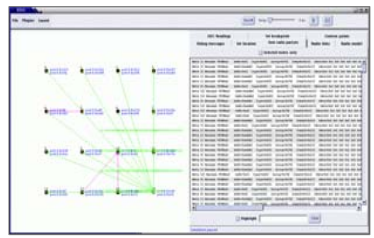
It is hard to deploy anywhere beyond 10-20 nodes today.



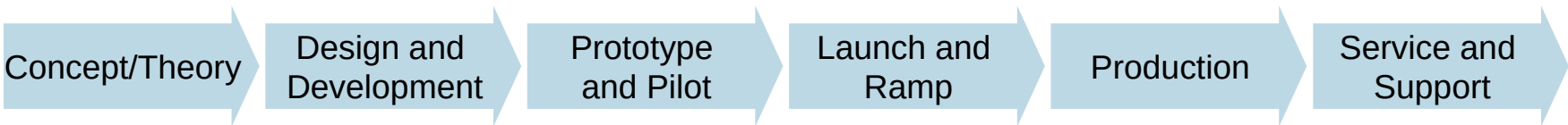






Coordinated methods and tools are missing today.

Tools for Life-cycle Support

- **What are the Hard Parts in Applications?**
  - It's NOT in the network/link protocol details!
  - It's in the unexpected.
  - Moving from lab to testbed. Scaling issues
  - Sensors
  - Enclosures
  - Testing, calibration, validation, maintenance, sustainability, etc.
  - I have the data. What's next?
  - Publications, visibility and collaboration



- **What can be done about it?**

Towards a Sensor Network Platform Kit

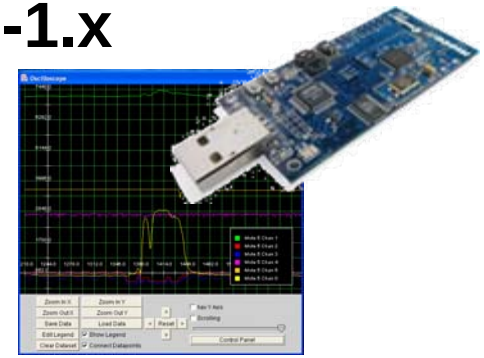
- **Lego Mindstorms for WSN Research**
  - Want a “production ready” not an “experimental” kit
  - Fast learning curve
  - Standard, known-to-work demo app from sensor to web interface
- **Technical Requirements**
  - Lot’s of memory for flexible development
  - ~1 year lifetime at industrial temperature ratings
  - Fast radio (system) wakeup time

Sensor Network Platform Kit – Proposal

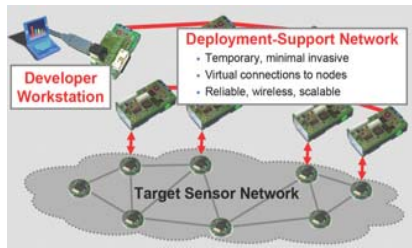
- **Hardware/Software**
  - Hardware platform (nodes)
  - System software support with demo applications
  - Debugging/deployment support
  - Central DB repository for collecting and analyzing data
- **Support**
  - Standard app for environmental sensing (duty-cycled multihop network)
  - Tutorial/Documentation
  - Installer CDROM
  - Staffed support for MICS members
- **Target Audience**
  - MICS partners that need platform know-how to jumpstart their research
  - Projects that want to share/integrate their work with others
  - Projects that target a basic environmental sensing application

Sensor Network Platform Kit – Details

- **Platform kit based on Tmote Sky and TOS-1.x**
  - Lowest deep-sleep power consumption
  - Fastest wakeup from sleep
  - Pretty high data rate
  - Possible migration path to TOS-2.x
  - **Reference SW apps available**



- **Deployment-Support**
  - Based on USB backbone and BTnode DSN



- **Backend Infrastructure Access**
  - Based on generic DB, maybe SensorScope or GSN?

SNPK – HW candidates – Tmote Sky

Overview:

- Low power platform based on MSP430 and CC2420 radio
- Variant with housing exists (Tmote Invent)
- Memory somewhat limited (10K SRAM, 48K Flash)

Power:

- Lowest deep sleep power (**0.0153mW**)
- Good power figures on other modes
- Fastest wakeup time on the market (**580usec** radio startup)
- Active/idle-listening/deep-sleep ratio: 58.5/65.4/0.0153

Sensors:

- On-board temperature, humid and light

Political:

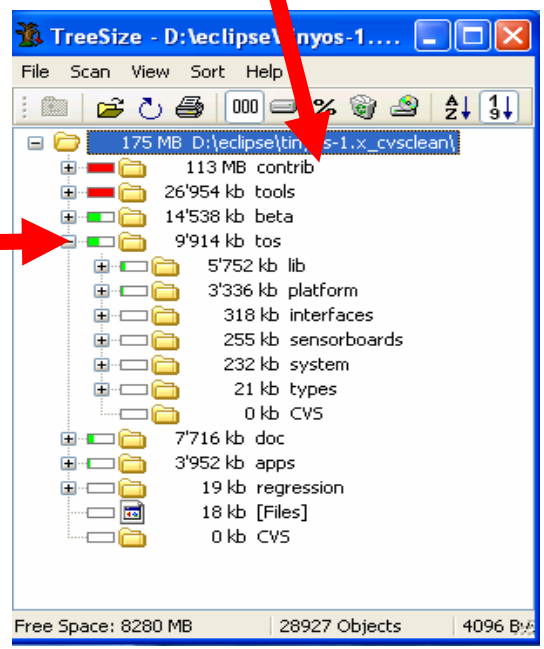
- US based research by-product, now commercialized
- Long-term availability/compatibility

Technical:

- Best package, power-performance, large and active community base

SNPK – TinyOS-1.x Revisited

- **Some really bright ideas (people) at the start, not that revolutionary any more…**
- **Has been very successful in the community**
- **Some abstractions are very unfamiliar**
- **Complicated to use**
  - Chaotic build system
  - Many replications
  - Structure often unclear
  - New/working versions not marked
- **Core TOS functionality is not that big at all**
- **TinyOS-2.x**
  - VERY PROMISING
  - Beta available
  - Reference apps are still missing



SNPK – Goals/Benefits

Goals – Mid-Term

- Fast jump-start for inexperienced MICS partners
- Outsourcing of engineering workload (MICS Staff, Moteiv, AoT, Shockfish)

Goals – Long-Term

- Re-use in parallel projects (PermaSense, WaterSense, Pollution, SensorScope, SBT-Fire, Smart Buildings)

Benefits – Mid-Term

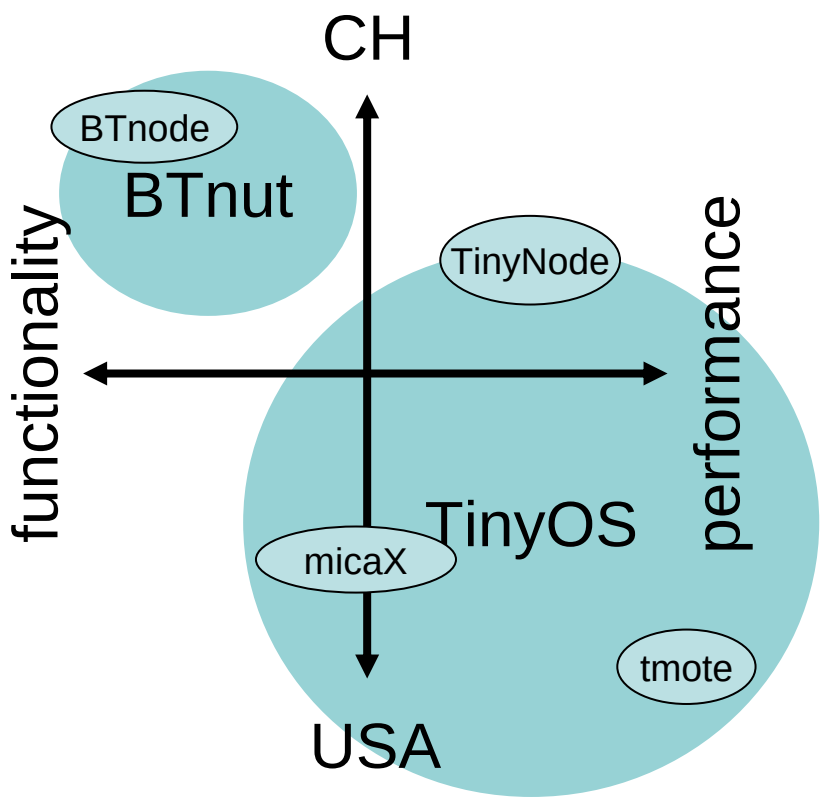
- Short-term availability
- Co-existence with Shockfish/TinyNodes

Benefits – Long-Term

- No reliance on a single platform
- Large community base
- State-of-the-art outsourcing partners enable us to focus on the important tasks
- Possibility to interact in TOS-2.0-WGs
- Make SNPK and our expertise available to public

SNPK – A Bit of Politics

- **We cannot run though phase 2 with 5+ groups just copying US research results**
- **A certain amount of Swiss-Made, Swiss-Ness is required by our sponsor (SNF)**
- **A "competing" platform lacks in term of community support and collaboration possibilities**
- **Where is our position?**



MICS has to generate "value" in research.

SNPK – Are We Reinventing the Wheel?

TASK – Tiny Application Sensor Toolkit

- Research project
- No ongoing support
- Not for generic applications

TinyOS/BTnut Tutorials

- Require mentoring, instruction
- Important parts (backend, deployment support) are missing

Industry: Developer Kits

- Are an important piece in the puzzle
- Mostly focus on different needs

There seems to be a void for a one-stop-shop SNPK!

SNPK – Incentive for MICS Researchers

- **Faster Jumpstart**
- **Faster Design Cycle**
- **Less Bugs**
- **Pooling of Know-how and Experience**
- **Less Parallelism in Development Projects**

- **Increased Visibility**
- **Educational Support**
- **Collaborative Research**
- **Support/$$ by Additional Central MICS Funding**

SNPK – Discussion

- **Questions for Discussion**
  - Who would be interested to use a SNPK? long-term? short-term?
    - Mobility (Grossglauser)
    - Smart Buildings (Hovestadt, Thiele, Morari)
    - Deployment (Mattern, Thiele)
  - Who can contribute?
    - Deployment-Support Network (Thiele, Mattern)
    - Global Sensor Network (Aberer)
    - WASL Testbed Backend (Grossglauser)
    - TinyNodes, Support (Shockfish)
  - Who can staff Support/knows people we can hire?

- **Discussion now, decision via mailing list in 2 weeks**

MICS WG2 Future Planning

- **Future Meeting Topics**
  - Programming Workshop – NO
  - MICS WG2 Demo Session – MAYBE
  - Sensors – YES
  - Enclosures – YES
  - Data Analysis – FUTURE
- **Next Meeting Date**
  - Combination with industry forum and research review @ EPFL in May
- **Joint meeting with WG1 regarding backend infrstructure (sensor internet)**