ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

National Competence Center in Research
Mobile Information and Communication Systems
MICS

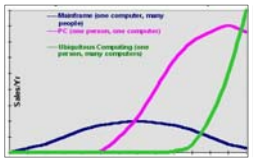
Deployment, Test and Validation of Sensor Networks

Jan Beutel
Computer Engineering and Networks Lab, ETH Zurich

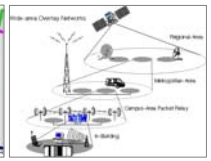
Wireless Sensor Networks

Visions 1991 1996 1999 2000 2001 2003 2004

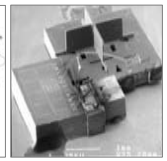
Ubiquitous Vision



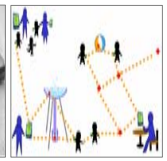
Wireless Overlay



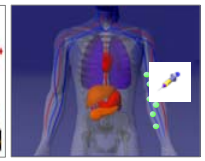
Smart Dust



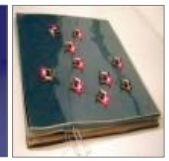
PicoRadio



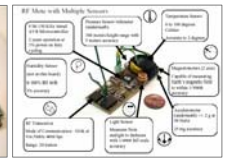
Directed Diffusion



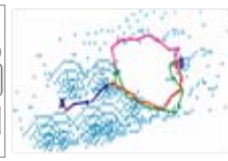
Paintable Computing



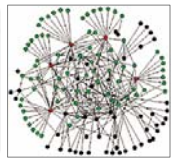
COTS Dust



Terminodes



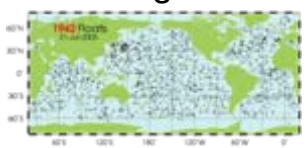
Scale Free Networks



Applications 2000 2001 2003 2004

.....

Argo



Sensor Webs

Military Surveillance

Duck Island

James Reserve

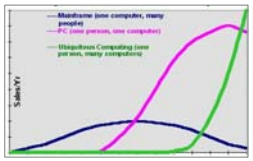
ZebraNet

Shooter Localization

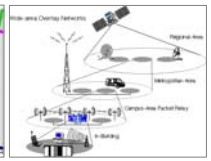
Wireless Sensor Networks

Visions 1991 1996 1999 2000 2001 2003 2004

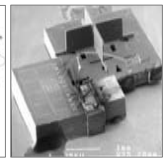
Ubiquitous Vision



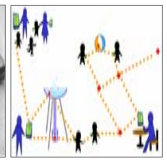
Wireless Overlay



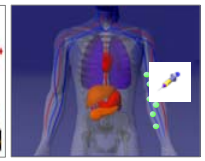
Smart Dust



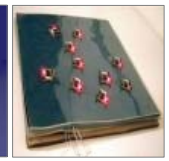
PicoRadio



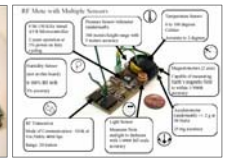
Directed Diffusion



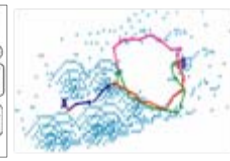
Paintable Computing



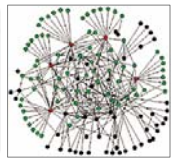
COTS Dust



Terminodes



Scale Free Networks

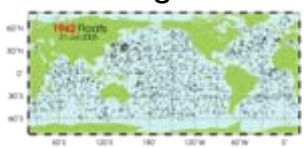


WSN Community

Applications 2000 2001 2003 2004

.....

Argo



Sensor Webs

Duck Island

ZebraNet

Military Surveillance

James Reserve

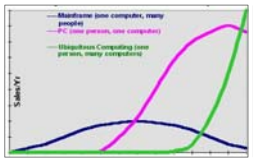
Shooter Localization

Prototypes, Experiments and Research Demos

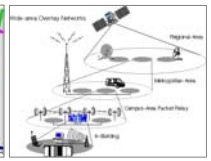
Wireless Sensor Networks

Visions 1991 1996 1999 2000 2001 2003 2004

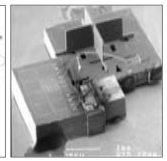
Ubiquitous Vision



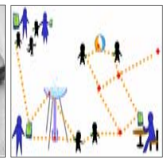
Wireless Overlay



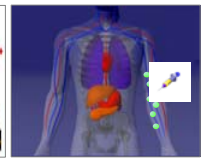
Smart Dust



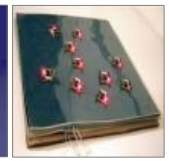
PicoRadio



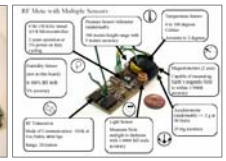
Directed Diffusion



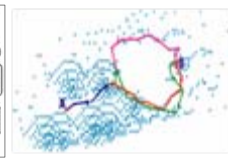
Paintable Computing



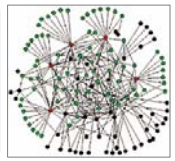
COTS Dust



Terminodes



Scale Free Networks



Other People Applications

WSN Community

2000 2001 2003 2004

Production Applications

Argo

Prototypes, Experiments and Research Demos

Military Surveillance

James Reserve

Shooter Localization

Sensor Webs

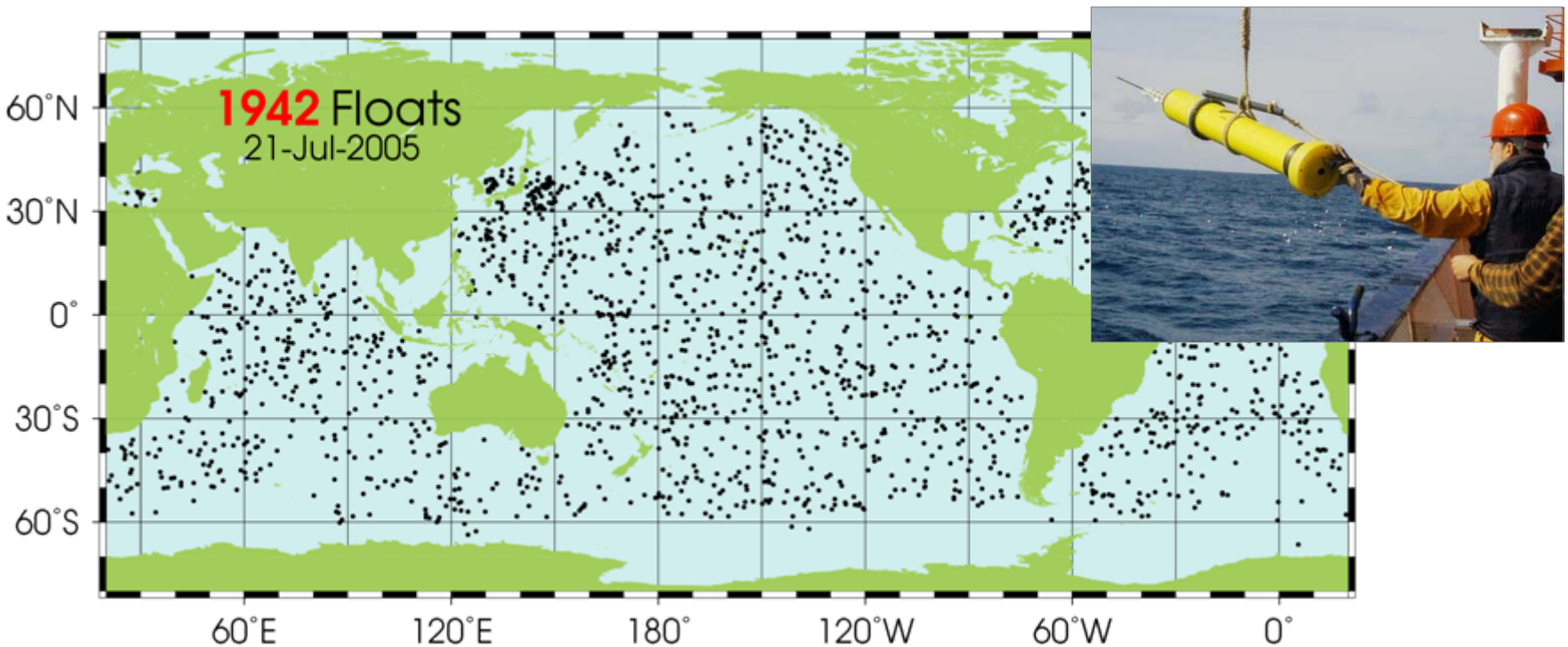
Duck Island

ZebraNet

Argo – Global Ocean Observation Strategy

Global array of temperature/salinity profiling floats

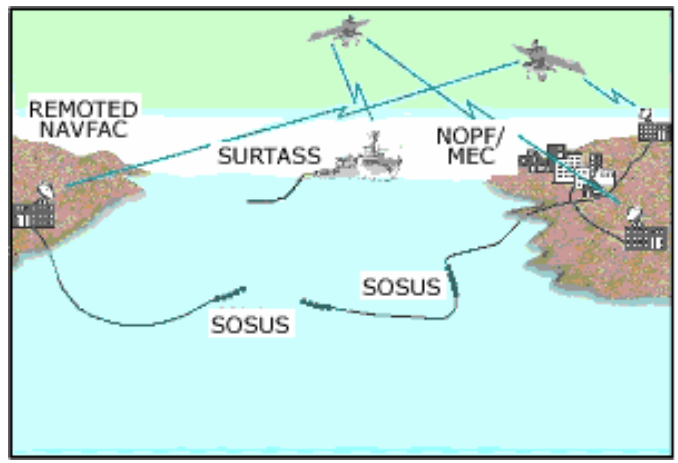
- Satellite data relay to data centers on shore
- Operational since 2000
- Developed and maintained mainly by oceanographers

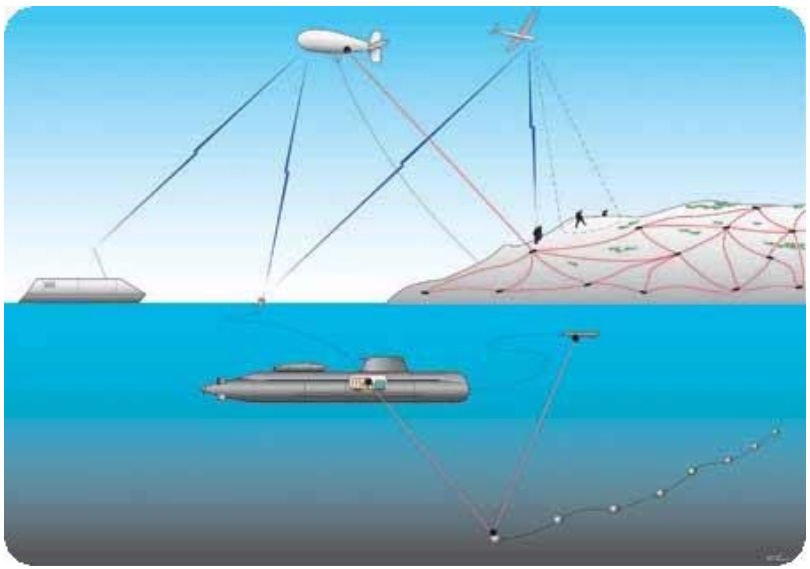


Anti-Submarine Surveillance

Distributed acoustic monitoring and surveillance

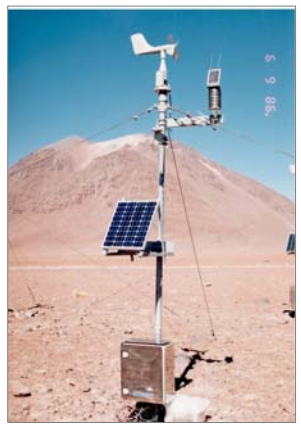
- Advanced signal processing
- Mostly wireline and analog
- Fixed installations and mobile units
- Military development since the cold war



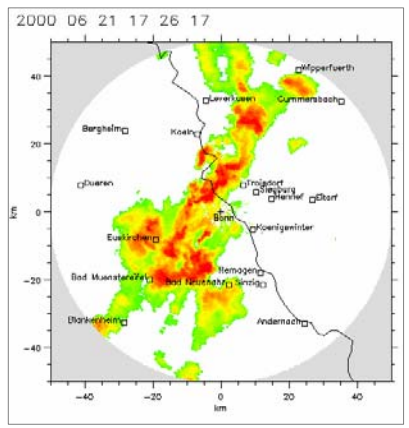


Globally Networked Weather Stations

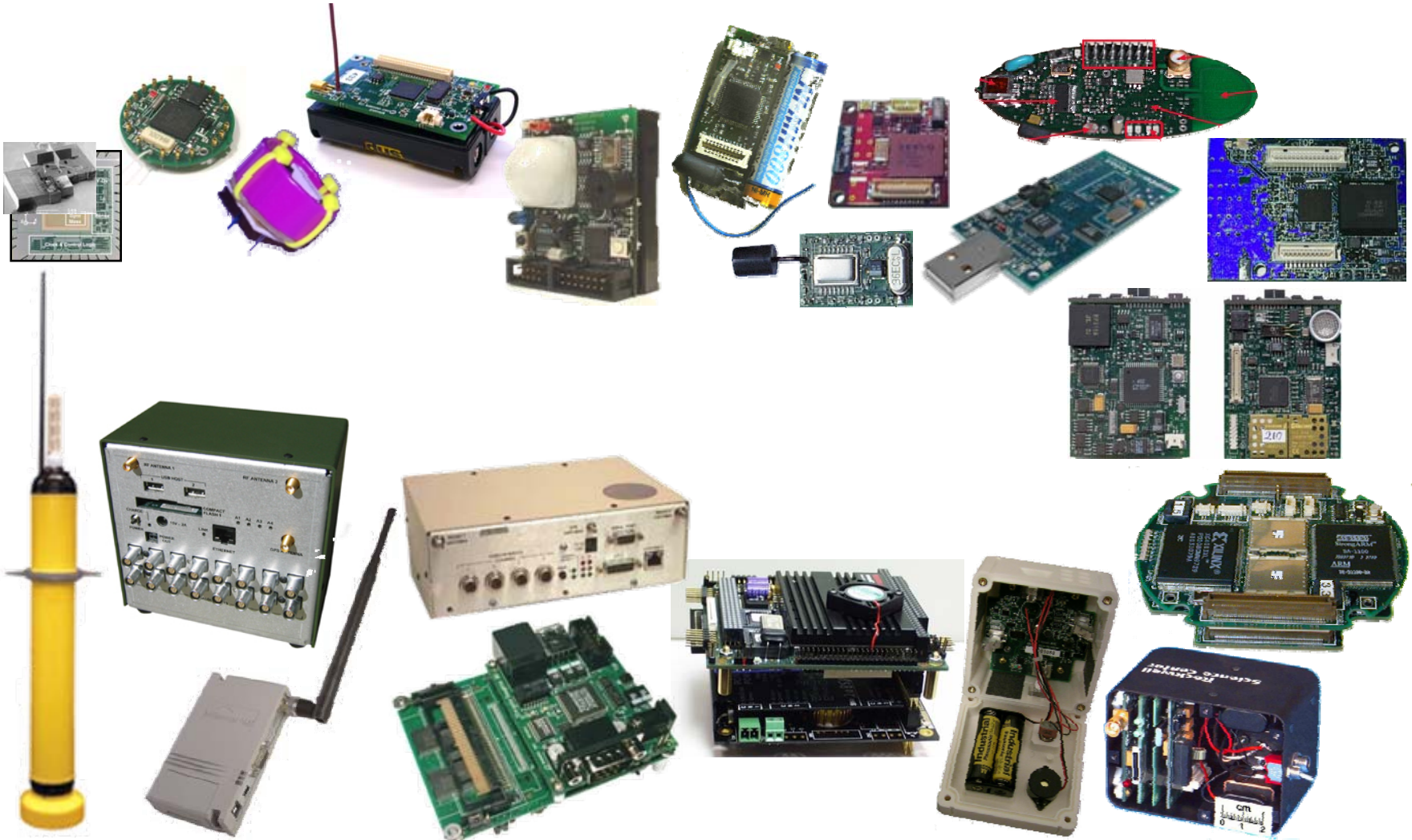


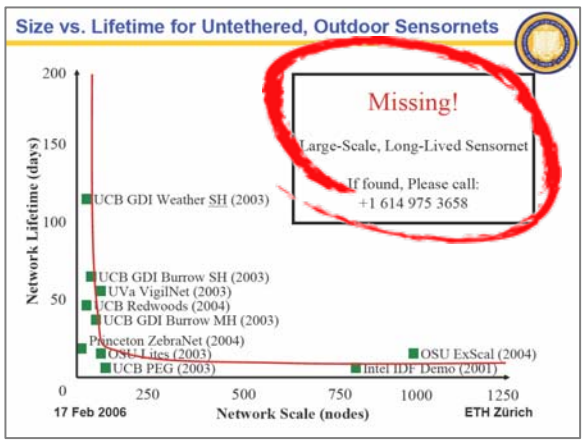




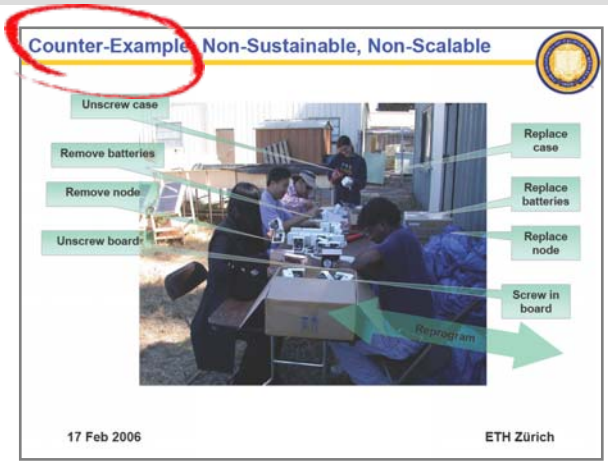
Wireless Sensor Network Systems Today



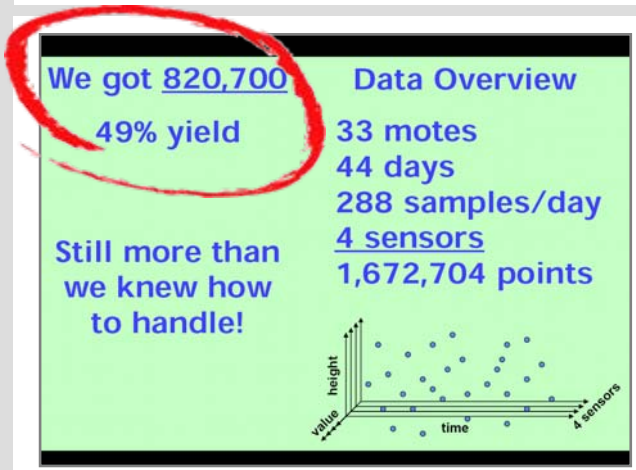
"Proof-of-Concept" Deployment Experience



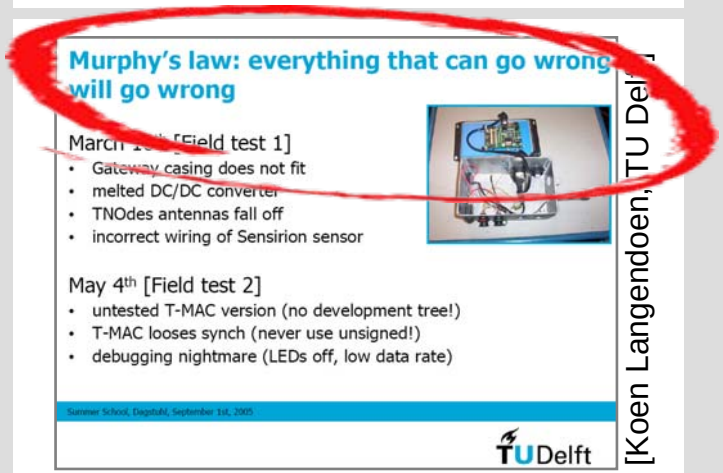
[Prabal Dutta, UC Berkeley]



[Prabal Dutta, UC Berkeley]

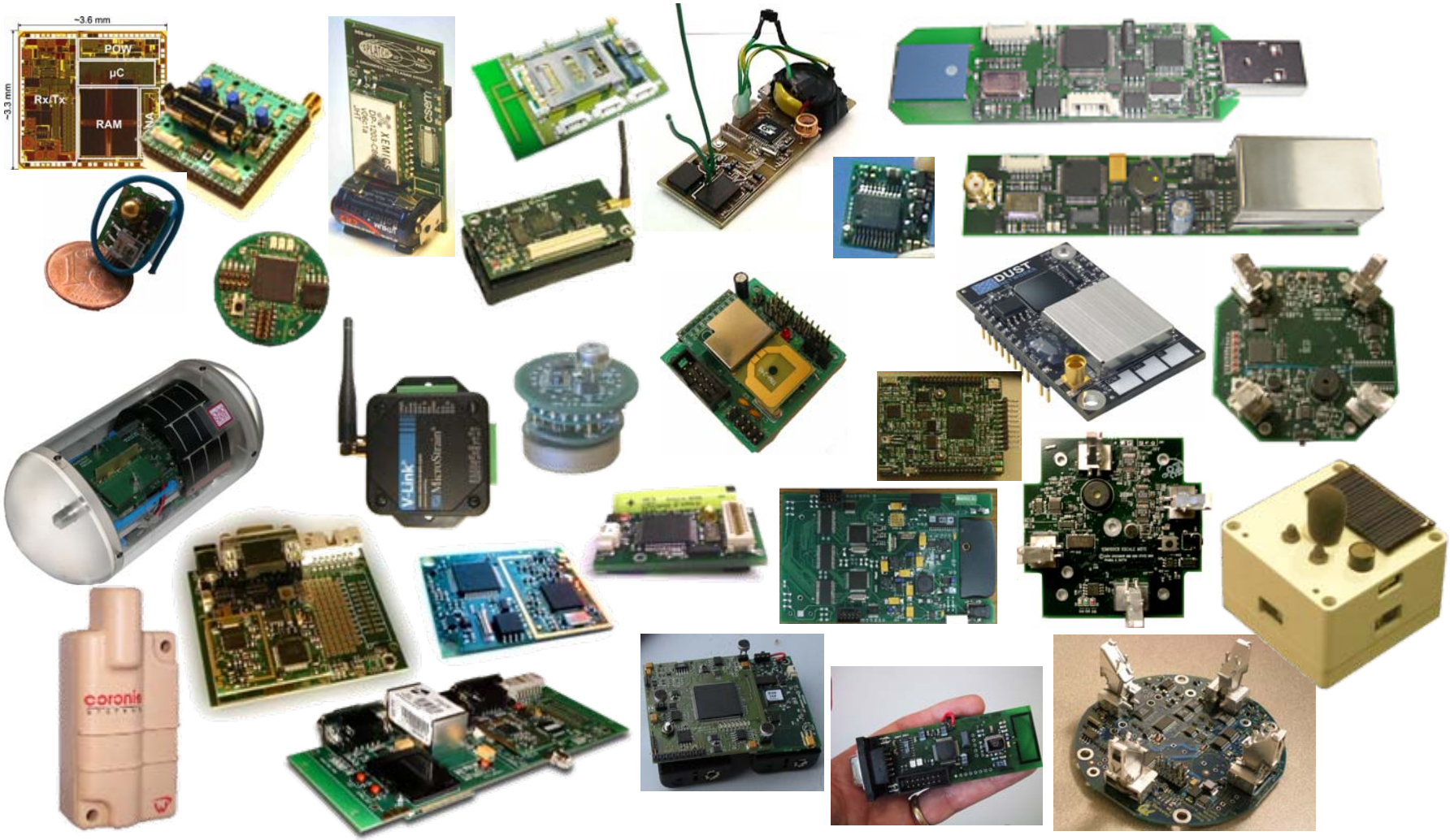


[Gilmann Tolle, UC Berkeley]



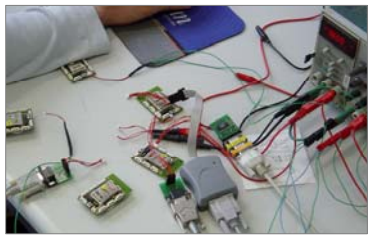
[Koen Langendoen, TU Delft]

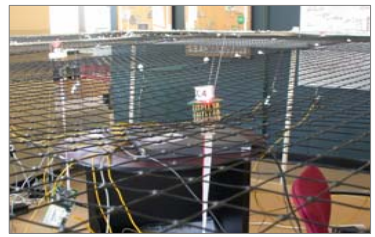
More Wireless Sensor Network Systems…

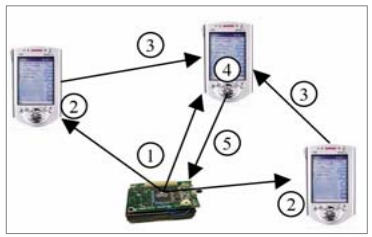


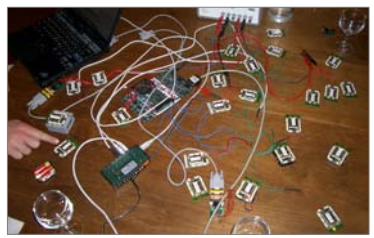
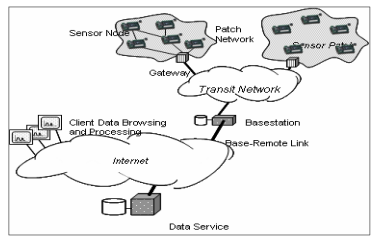
WSN Development Reality

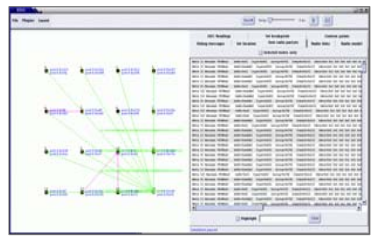
It is hard to deploy anywhere beyond 10-20 nodes today.



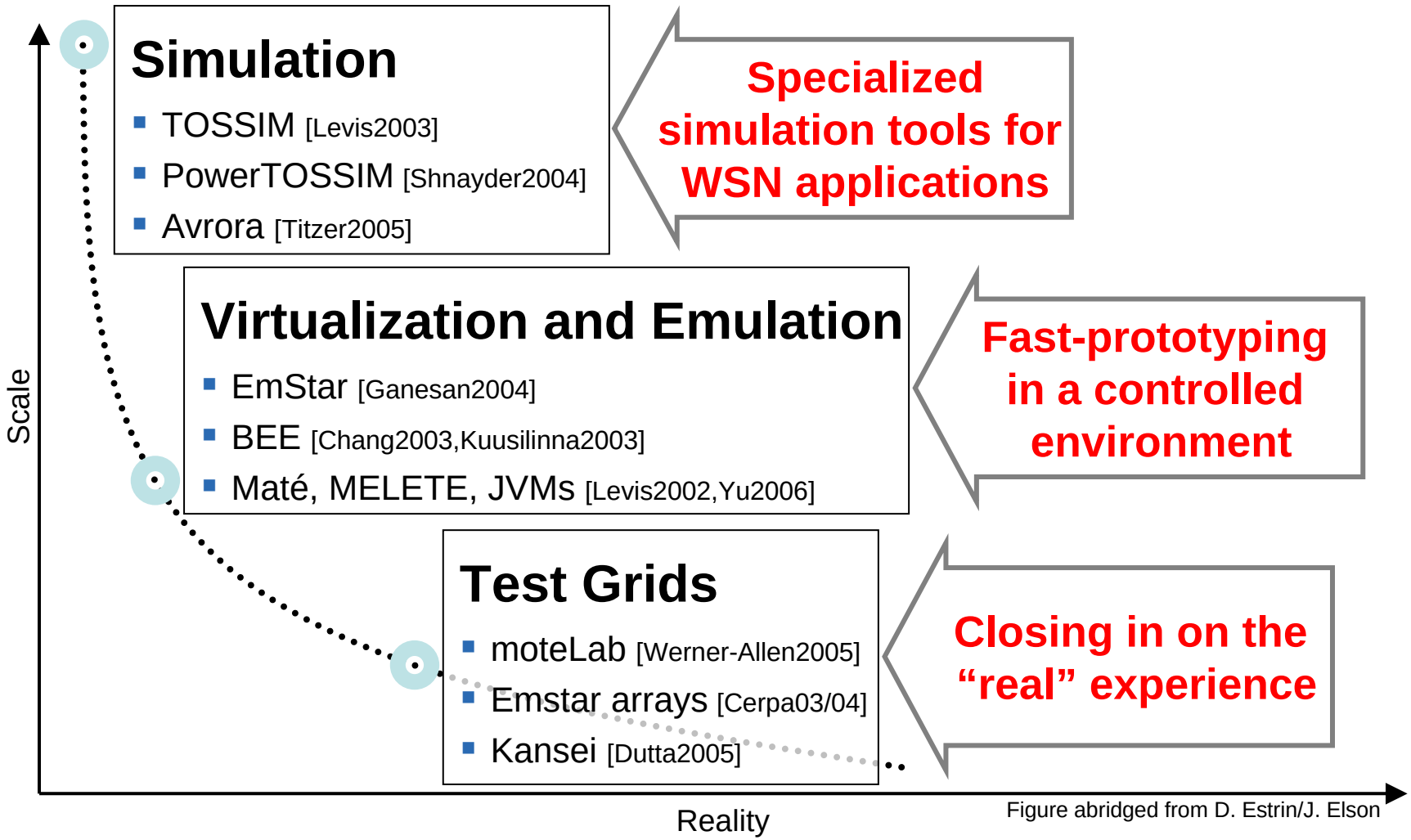



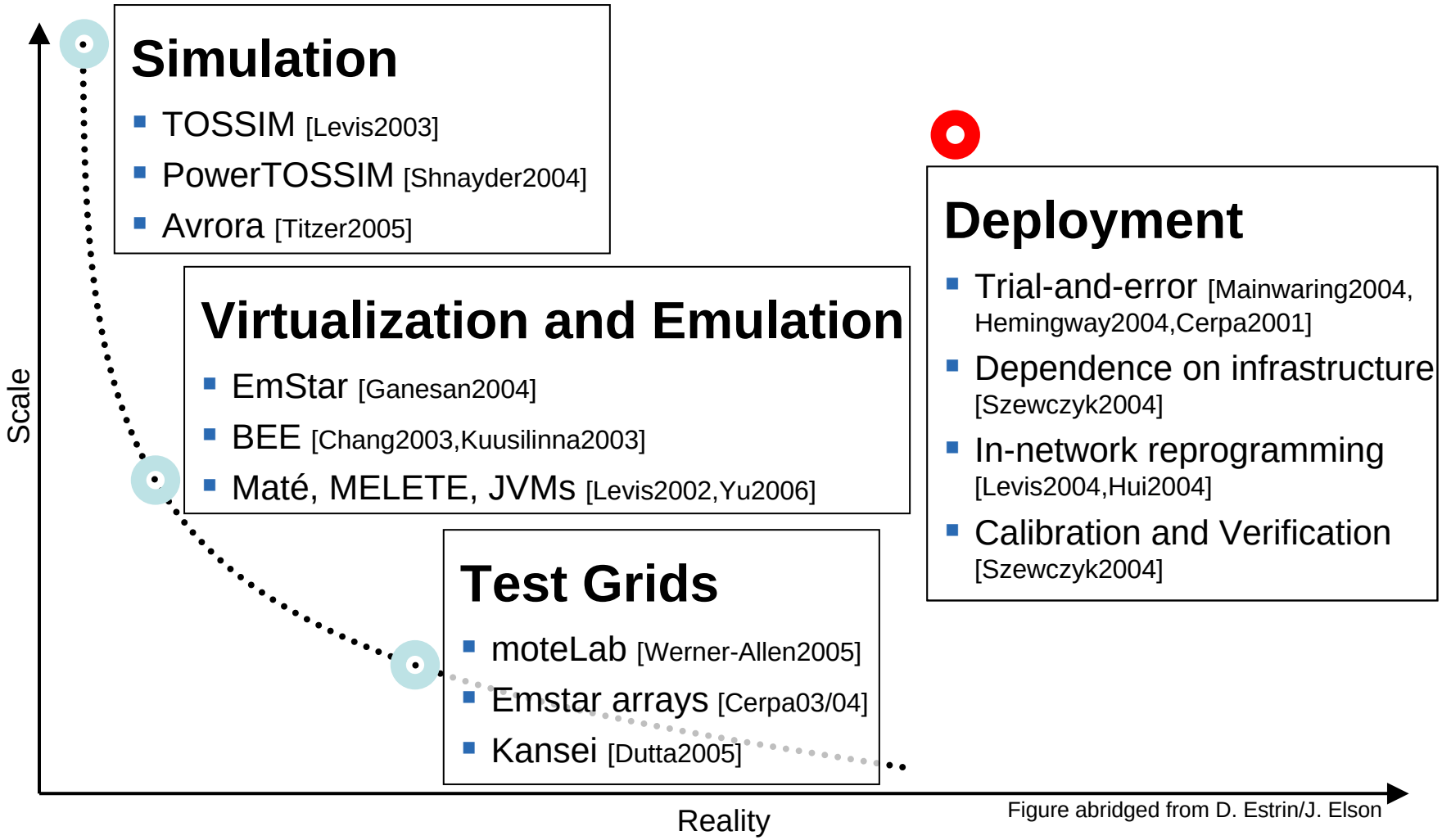


Coordinated methods and tools are missing today.

Today's WSN Design and Development



Today's WSN Design and Development



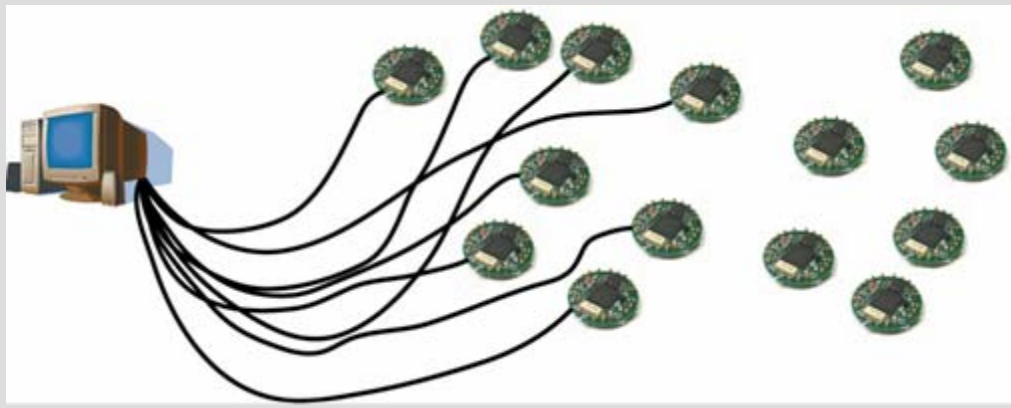
From Proof-of-concept to Real-world WSNs

Traditional test grid

- Wired
- Immobile
- Not scalable

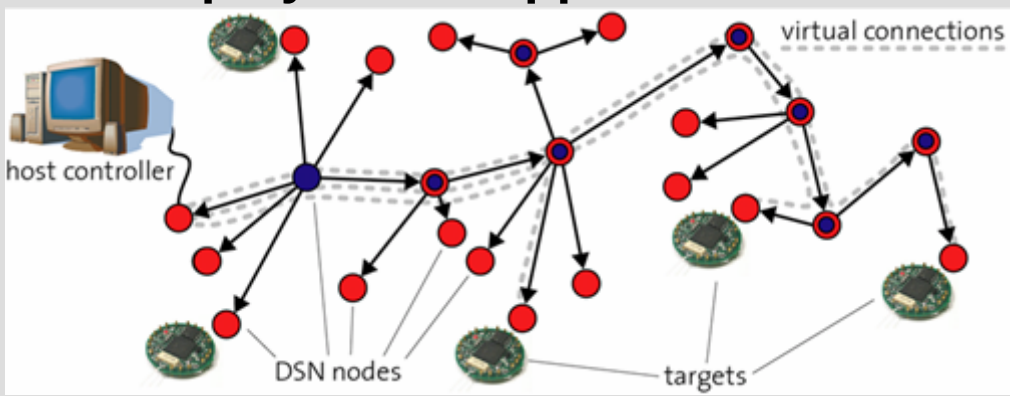
In-network tools

- Limiting, unreliable

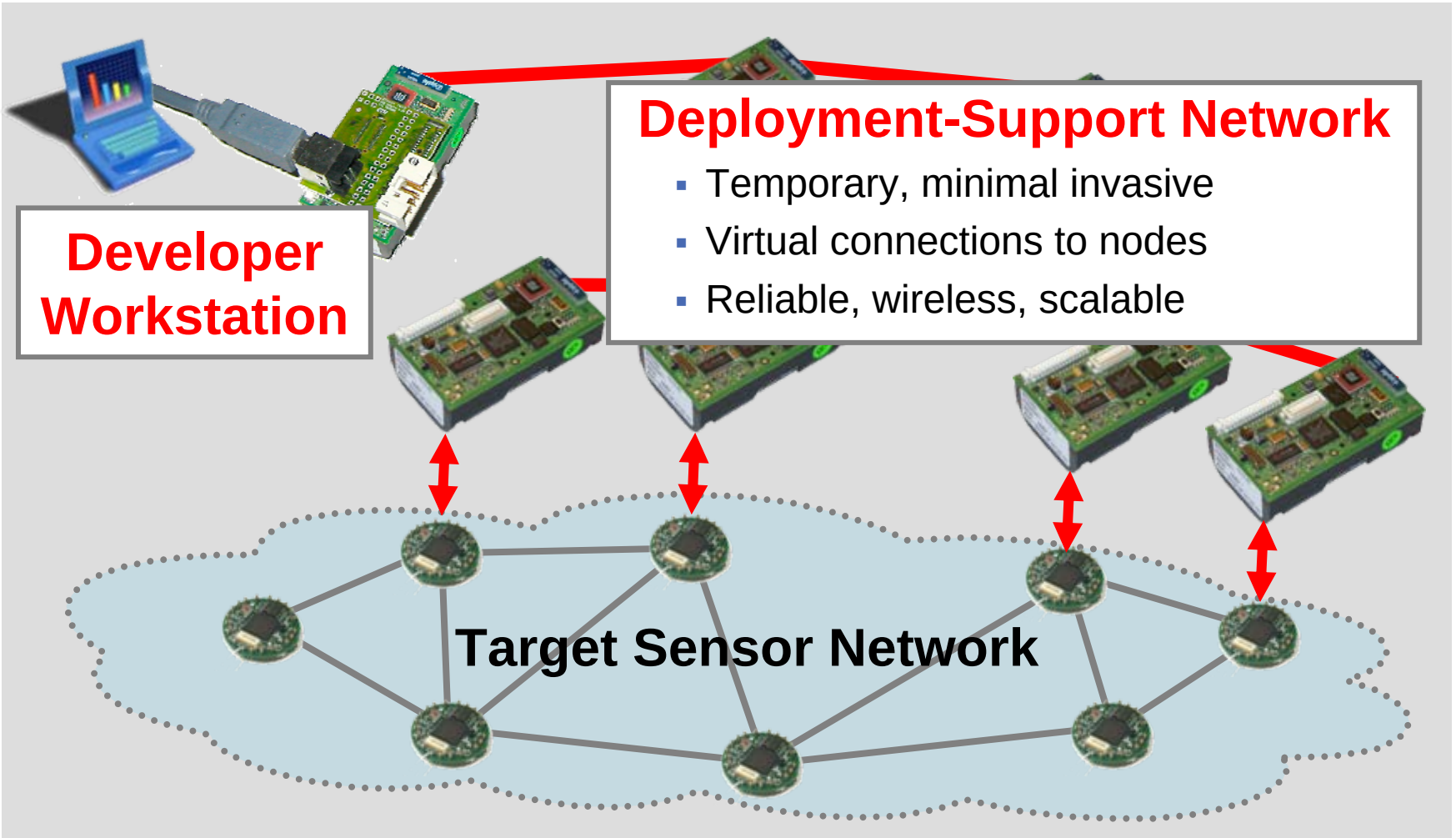


Self-organizing backbone network with deployment-support services

Deployment-Support Network



Next-Generation Deployment-Support

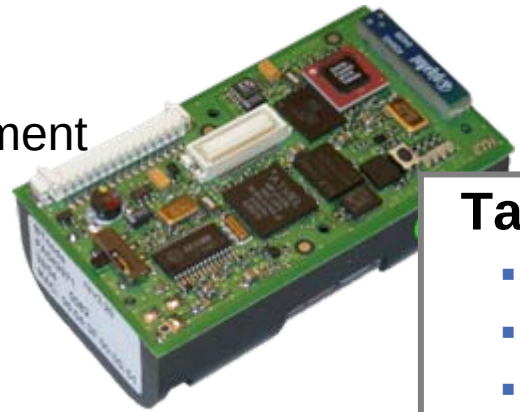


JAWS – Application Partitioning

JAWS Application

Codesize 100 kB

- Topology Control
- Connection Management
- Data Transport
- Caching
- Node Management



Target Adapter 4 kB

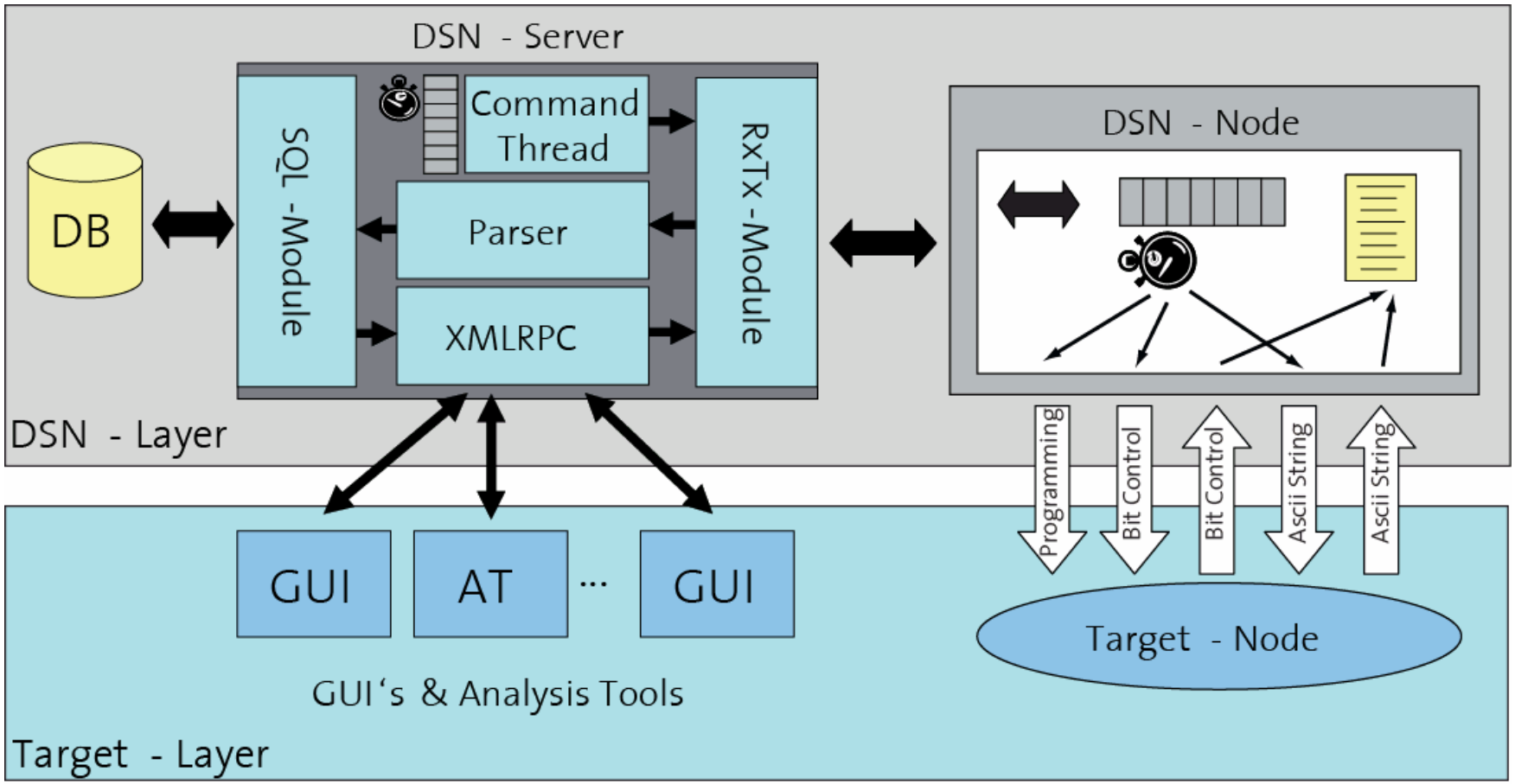
- Target Control
- Programming
- Logging

WSN Target Application

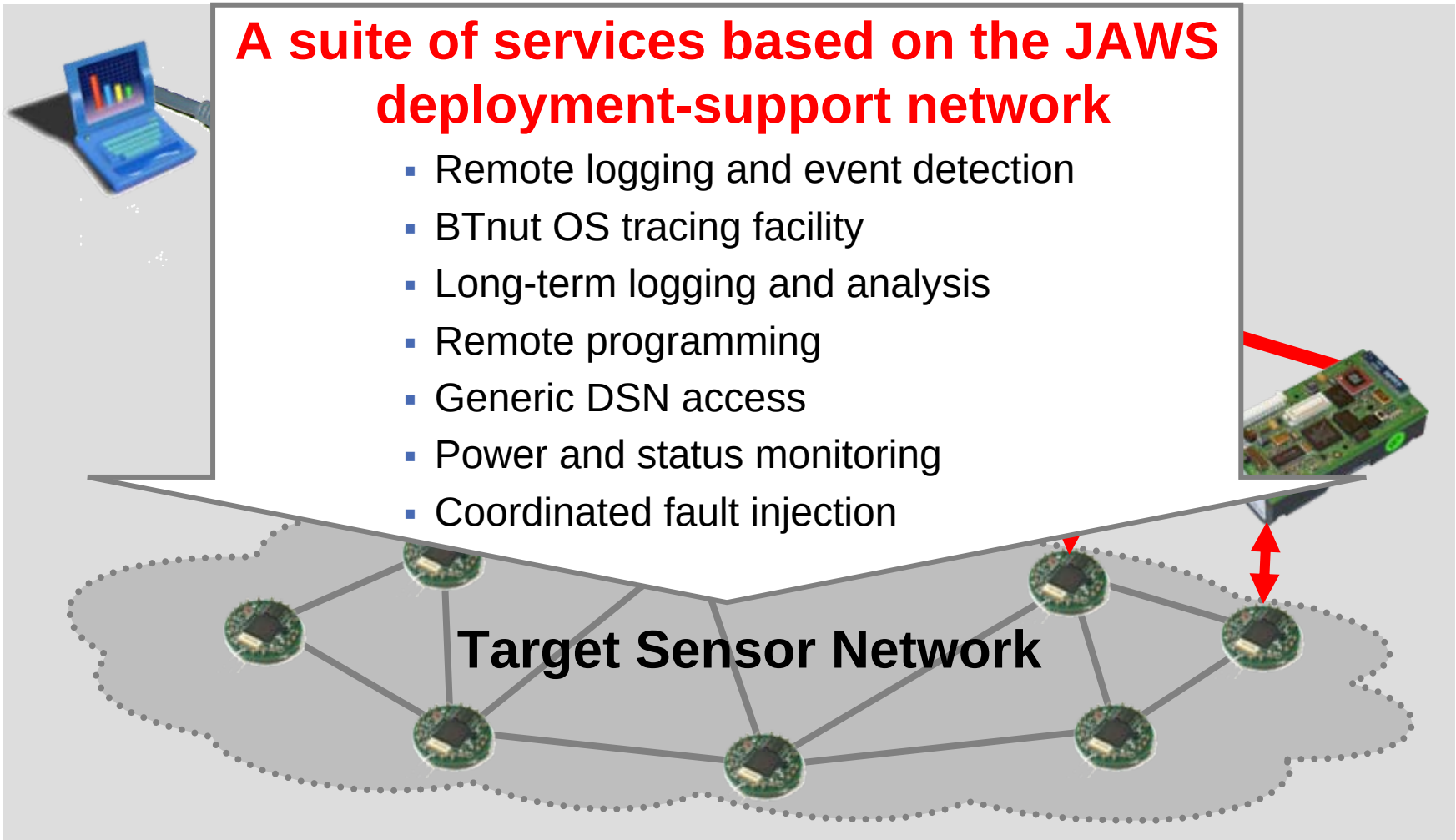
Monitor 2 kB

- Threads/IRQs
- High level context

JAWS – DSN Architecture Details



JAWS – Sensor Network Monitoring Toolkit

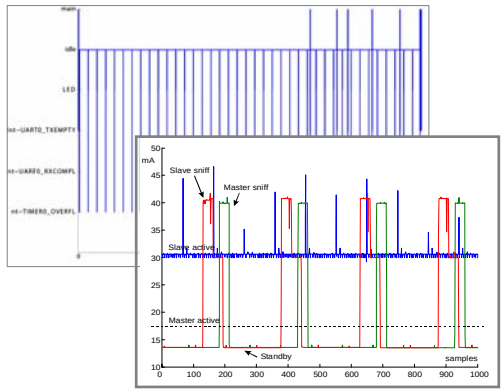


JAWS Application – Fire Sensor Networks

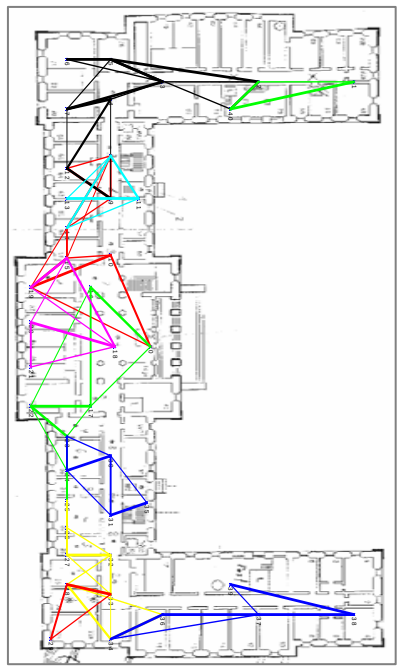
KTI Cooperation: CSEM – Siemens – TIK

Test Setup

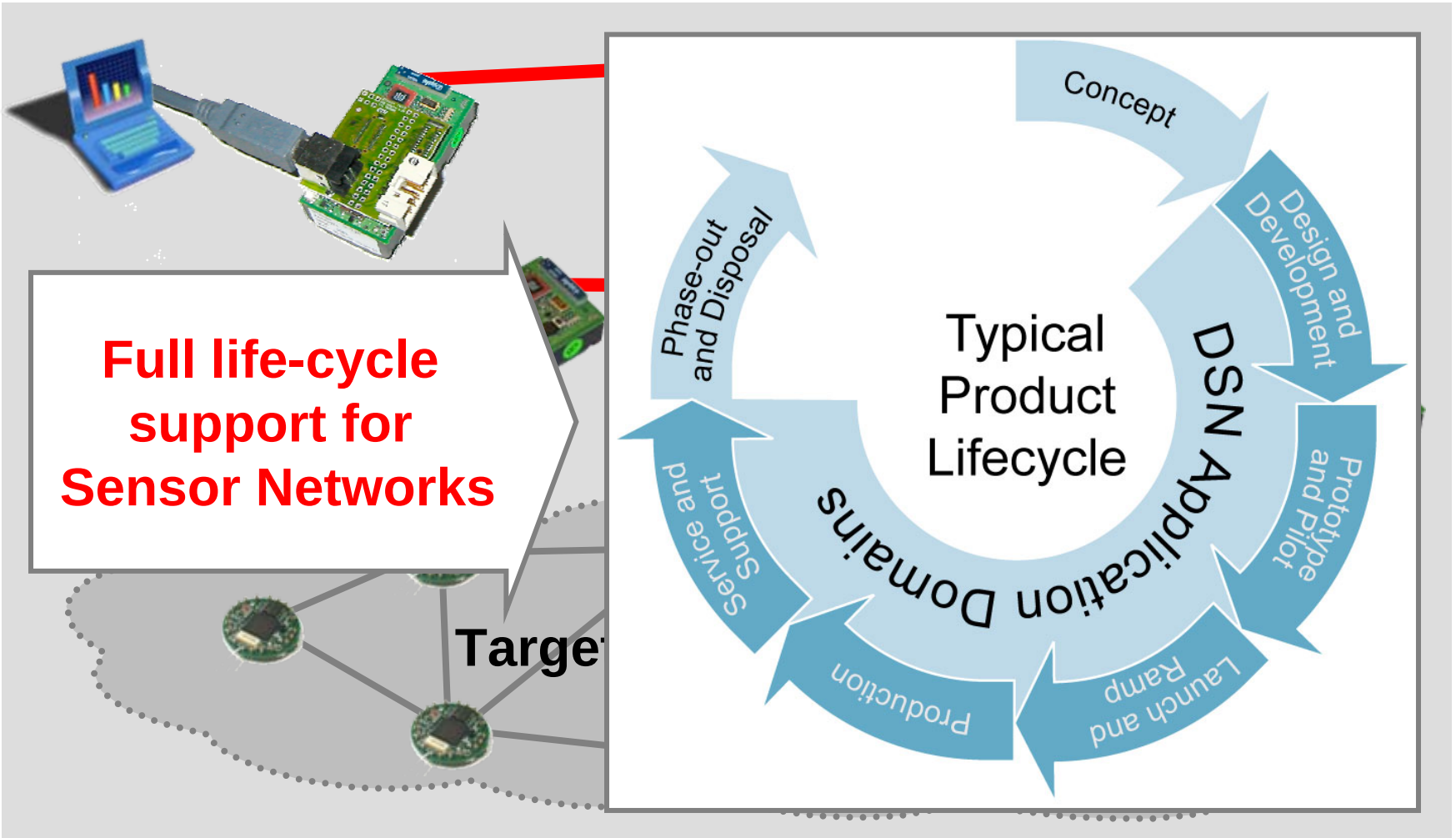
Development & Analysis



Field Testing



Deployment-Support – Closing the Loop…



Acknowledgements

BTnode Core Team

National Competence Center in Research
Mobile Information and Communication Systems
MICS

- Oliver Kasten, Marc Langheinrich, Matthias Ringwald, Kay Römer, Friedemann Mattern
- Philipp Blum, Matthias Dyer, Martin Hinz, Kevin Martin, Lennart Meier, Luca Negri, Mustafa Yuecel, Lothar Thiele

Material used on this presentation is courtesy of

- Koen Langendoen (TU Delft), Prabal Dutta (UC Berkeley), Gilmann Tolle (UC Berkeley)

Related publications

- M. Dyer, J. Beutel, L. Thiele: *S-XTC: A Signal-Strength Based Topology Control Algorithm for Sensor Networks*. AHSP 2007.
- M. Dyer, J. Beutel, L. Thiele, T. Kalt, P. Oehen, K. Martin, P. Blum: *Deployment Support Network - A Toolkit for the Development of WSNs*. EWSN 2007
- J. Beutel: *Fast-prototyping Using the BTnode Platform*. DATE 2006
- J. Beutel, M. Dyer and K. Martin: *Sensor Network Maintenance Toolkit*. EWSN 2006.
- J. Beutel, M. Dyer, L. Meier, and L. Thiele. *Scalable topology control for deployment-sensor networks*. IPSN 2005.
- J. Beutel. *Robust Topology Formation using BTnodes*. Computer Communications 2005.
- J. Beutel, M. Dyer, M. Hinz, L. Meier, M. Ringwald. *Next-Generation Prototyping of Sensor Networks*. SenSys 2004.
- J. Beutel, O. Kasten, F. Mattern, K. Römer, F. Siegemund, and L. Thiele. *Prototyping wireless sensor network applications with BTnodes*. EWSN 2004.

To probe further…

http://www.btnode.ethz.ch