A Case for Peer-to-Peer Network Overlays in Sensor Networks[1]

Muneeb Ali[2] and Koen Langendoen

Delft University of Technology

The Netherlands

[1]WWSNA (IPSN'07), 24th April 2007, Cambridge, MA, USA

[2]Funded by Project "Relate" (European Commission)

Introduction

- P2P meets sensornets
- Sensornets say goodbye to proxies

- Sensornet nodes become “first class” citizens of the Internet

Internet vs. Sensor-Nets

The Internet

- Independent hosts
- End to end flows
- Two tier architecture
- Wired (generally)
- Latency
- Throughput
- Bandwidth is relatively cheap

v s.

Sensor-Nets

- Collaborative use
- Collect, disseminate, ...
- Ad-hoc (more homogeneous)
- Low power wireless
- Wake time / Energy
- Very low utilization
- Bandwidth is expensive

Reference: Philip Lewis, ICSI Talk, May 2004

Internet vs. Sensor-Nets

The Internet v s. Sensor-Nets

- Independent hosts
- End to end flows
- Two tier architecture
- Wired (generally)
- Latency
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We all know this!! (or so I believe …)

- Collaborative use
- Collect, disseminate, ...
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Reference: Philip Lewis, ICSI Talk, May 2004

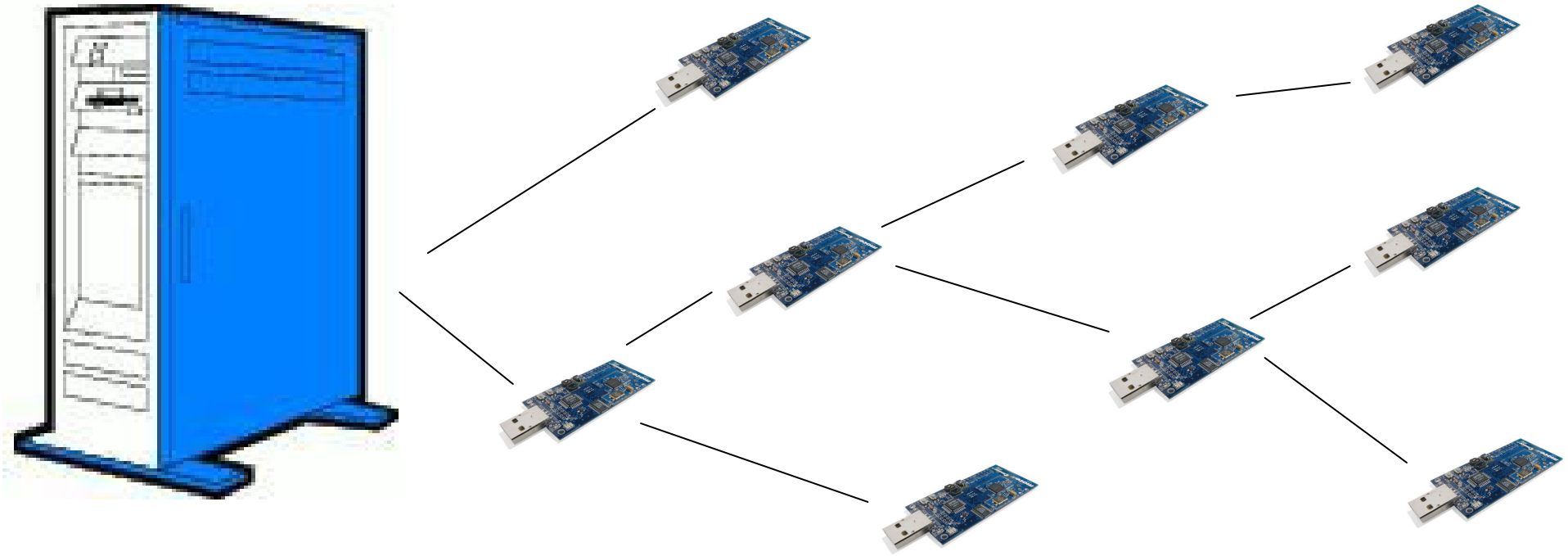
Internet vs. Sensor-Nets

The Internet v s. Sensor-Nets

- Internet solution generally do not apply to sensor networks
- Their underlying techniques do
- Apply, change, and adapt to the peculiarities of sensor networks

Reference: Philip Lewis, ICSI Talk, May 2004

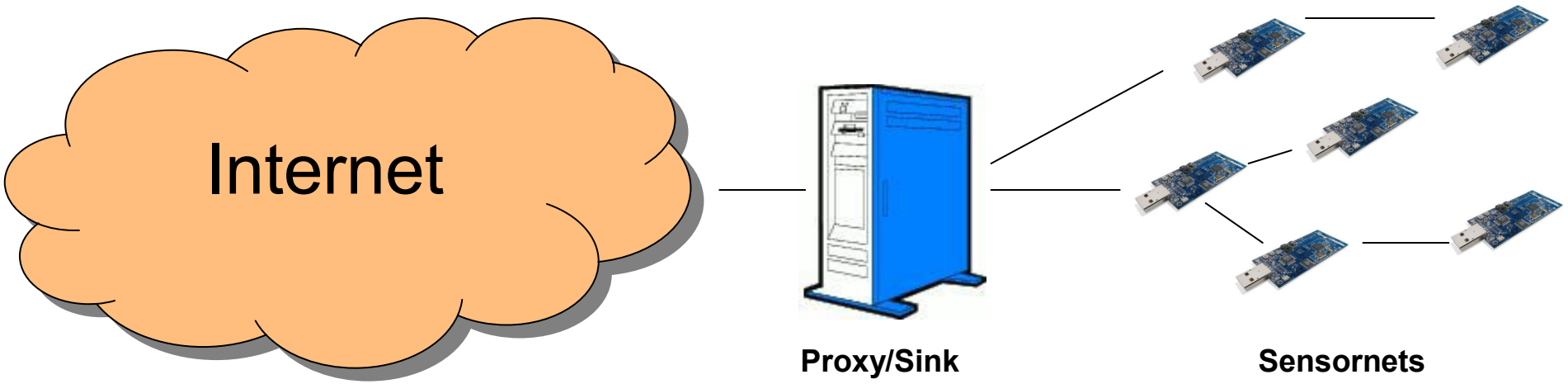
Sensor Networks



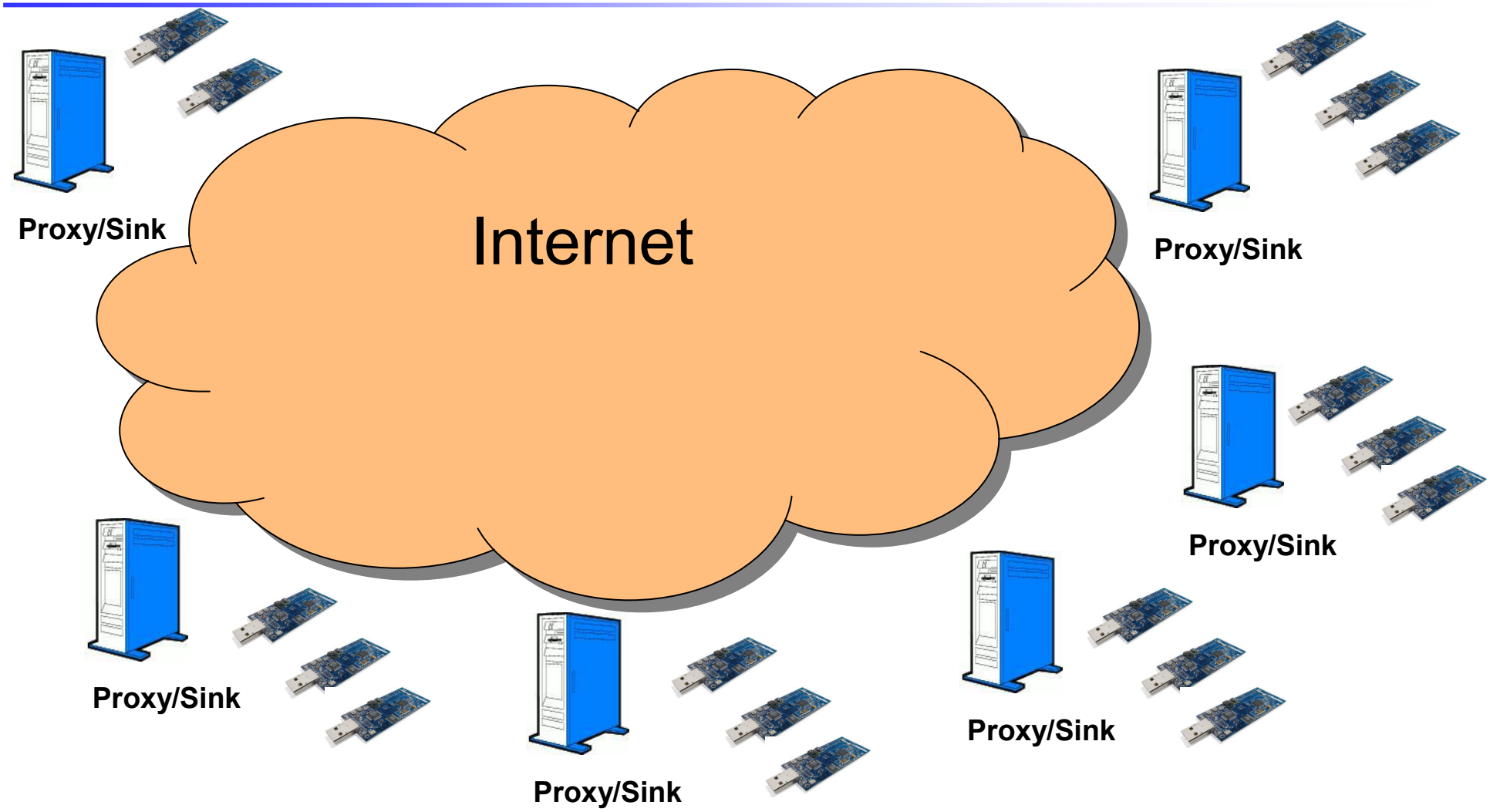
Sink

Sensornet Nodes

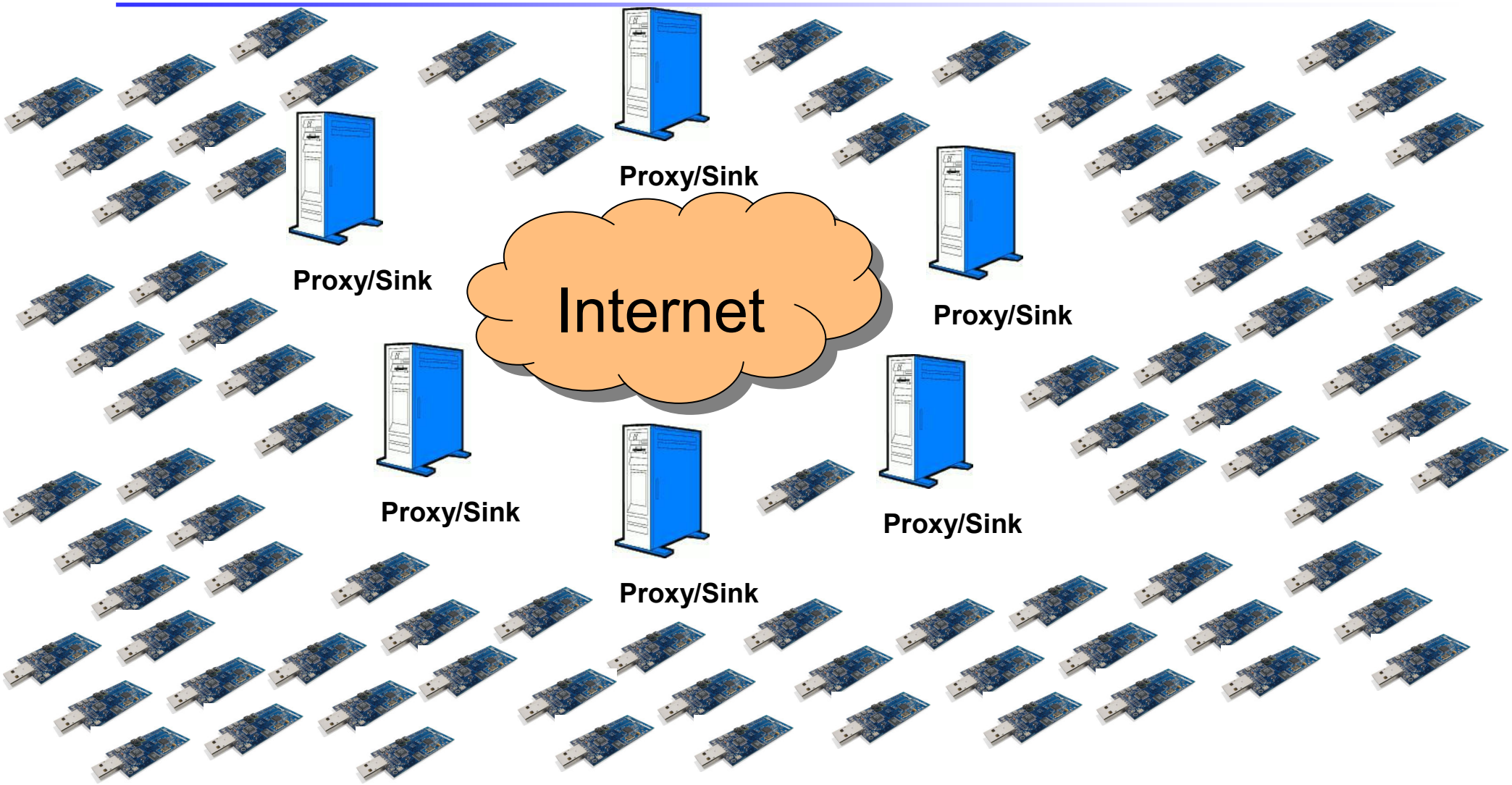
Sensornets Go Online



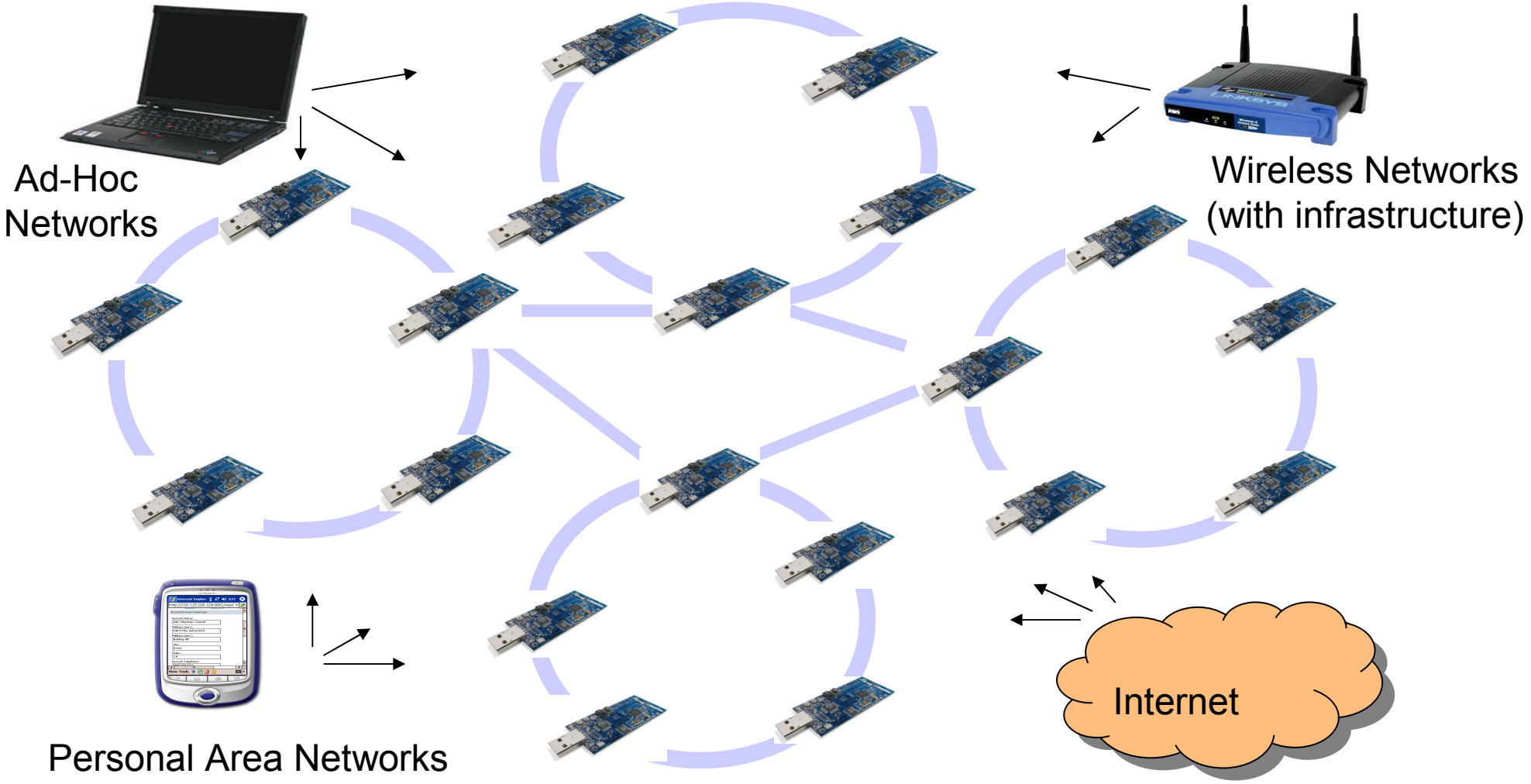
Sensornets Go Online



Proxies Considered Harmful!



Proxy-less Architecture



P2P for Sensor-net

Why (BIG)

- Proxies considered harmful!
- Storage-based sensornets
- Efficient data lookup
- Location independence
- Overlay applications & services

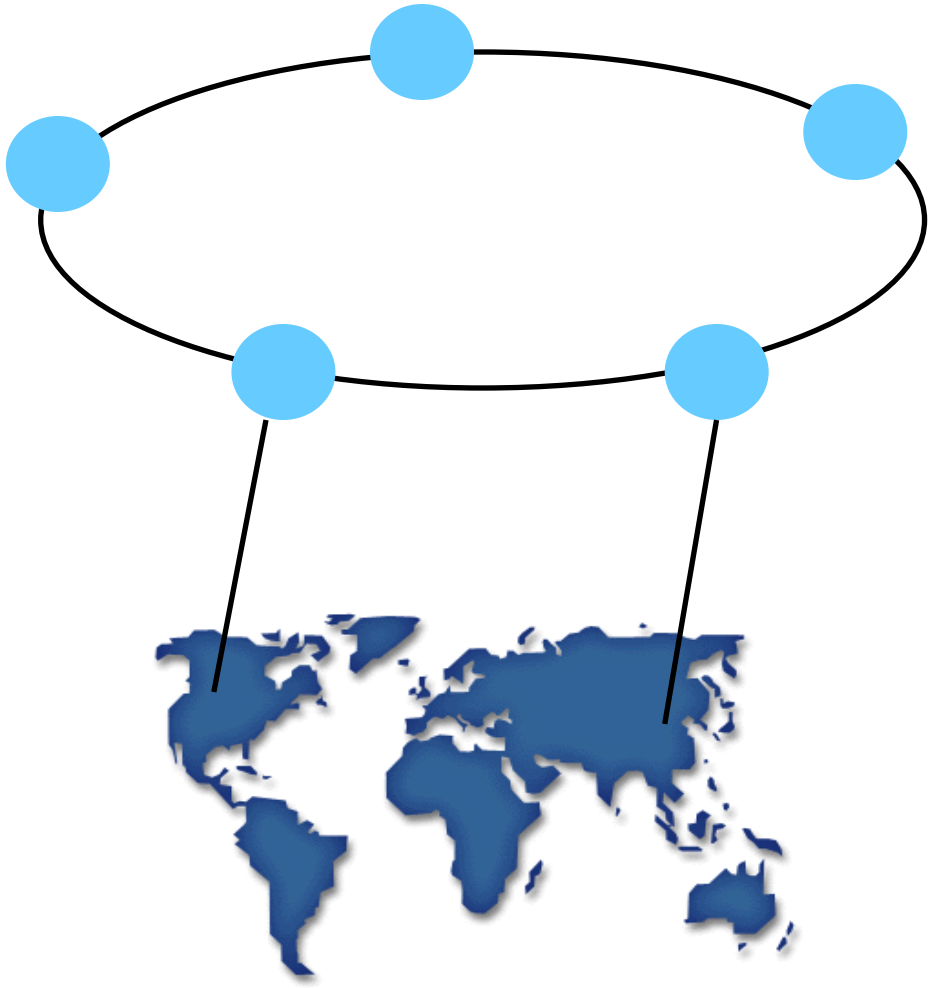
v s.

Why Not (small)

- Routing maintenance overhead
- Sensor nodes are not named
- Logical topology is not equal to physical topology
- DHTs are computationally intensive

Logical Topology vs Physical Topology

A Virtual P2P Ring



Physical Location of
Virtual Neighbors

Ref: I. Stoica et al., Chord: A Scalable Peer-to-peer Lookup Protocol for Internet Applications, Tran. on Networking, Feb 2003

DHTs are Computationally Intensive

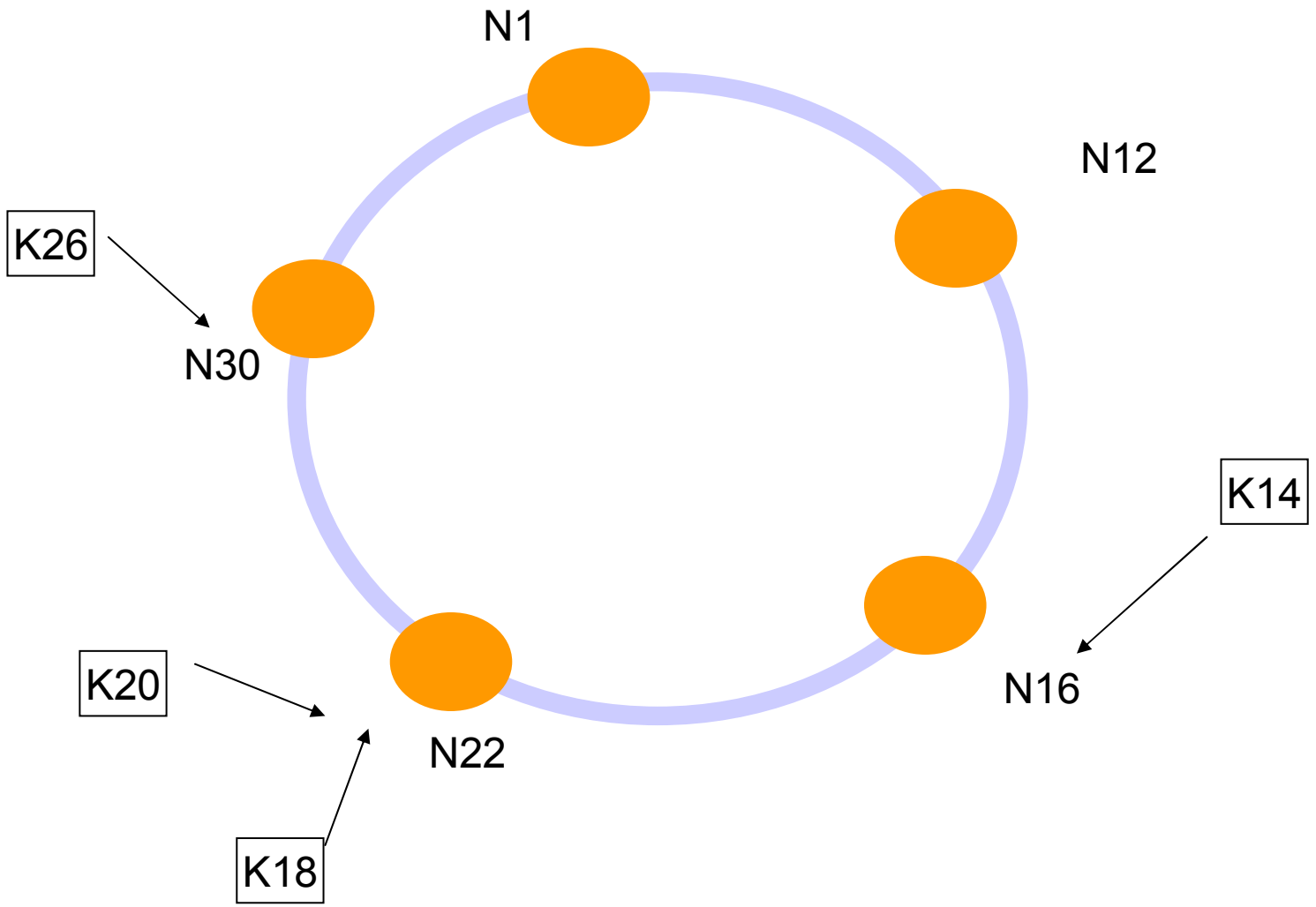
- DHT implementation even on Mica2
- Hardware trend in sensornets
  - 32-bit processing
  - more program memory
  - more storage memory

Sun Spot

- 32 bit ARM7 core
  - 256K RAM
  - 2M Flash
- [802.15.4] Radio (ChipCon CC2420)

Image courtesy Sun microsystems

Chord Protocol



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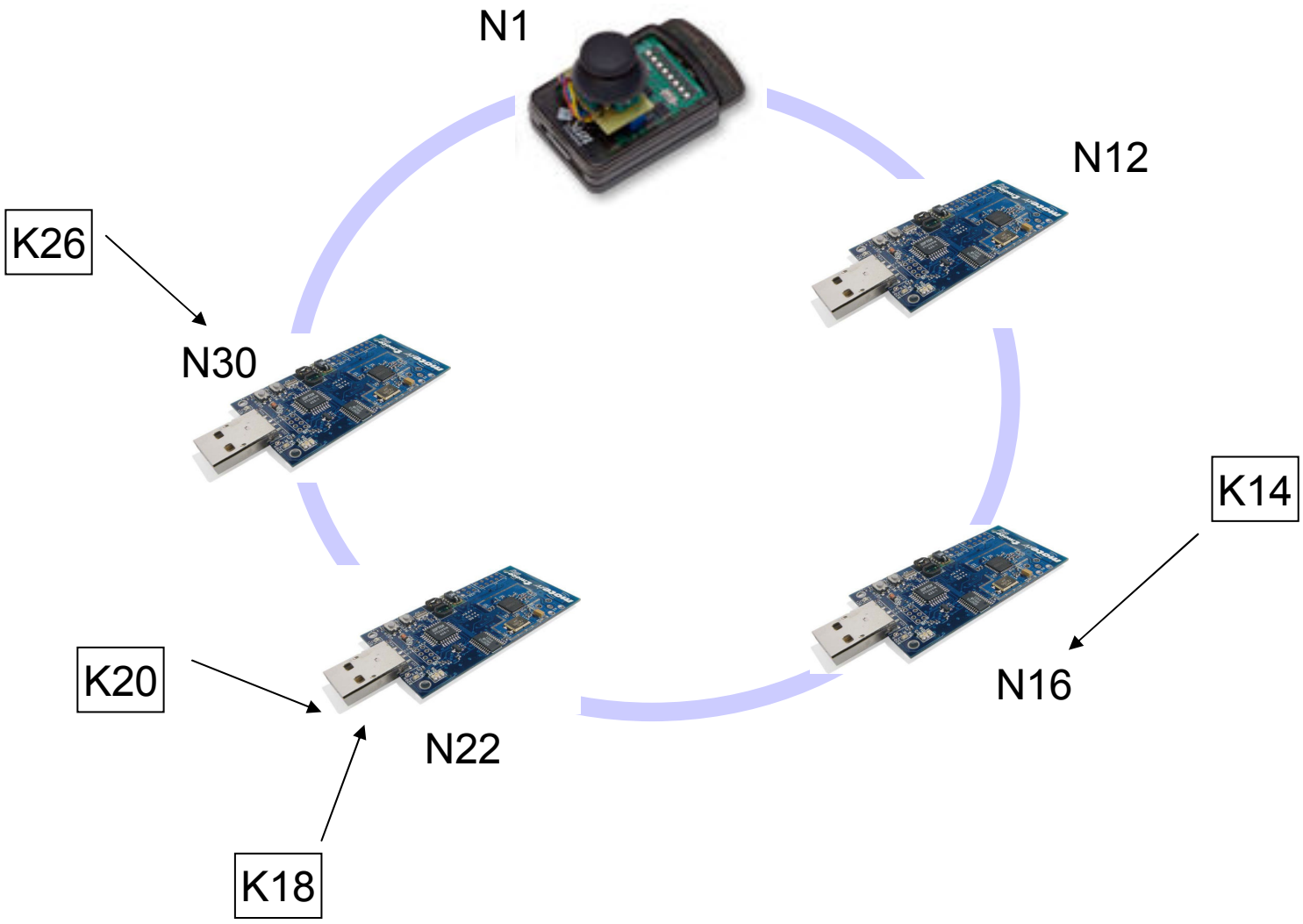
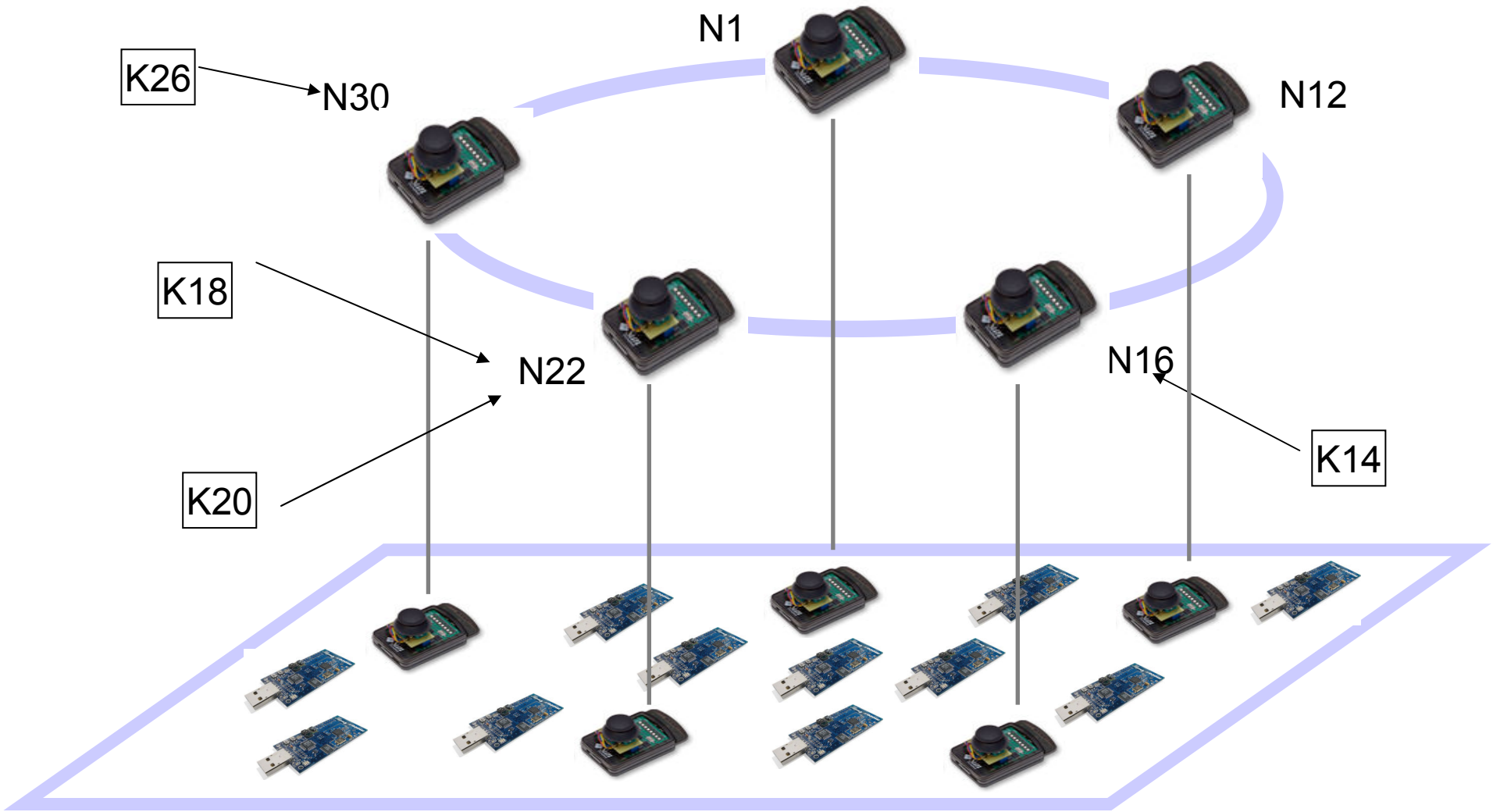
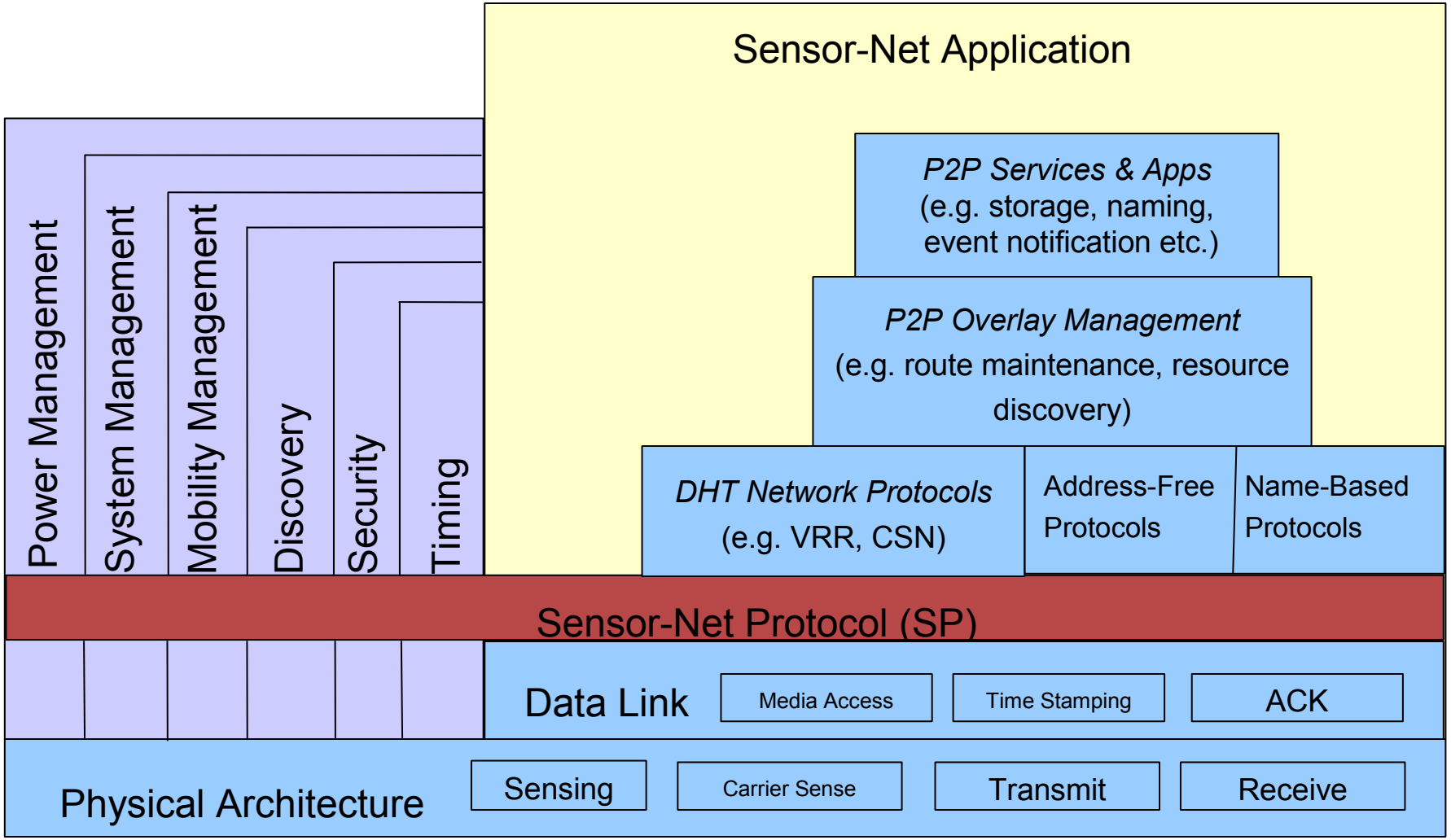
TChord Protocol



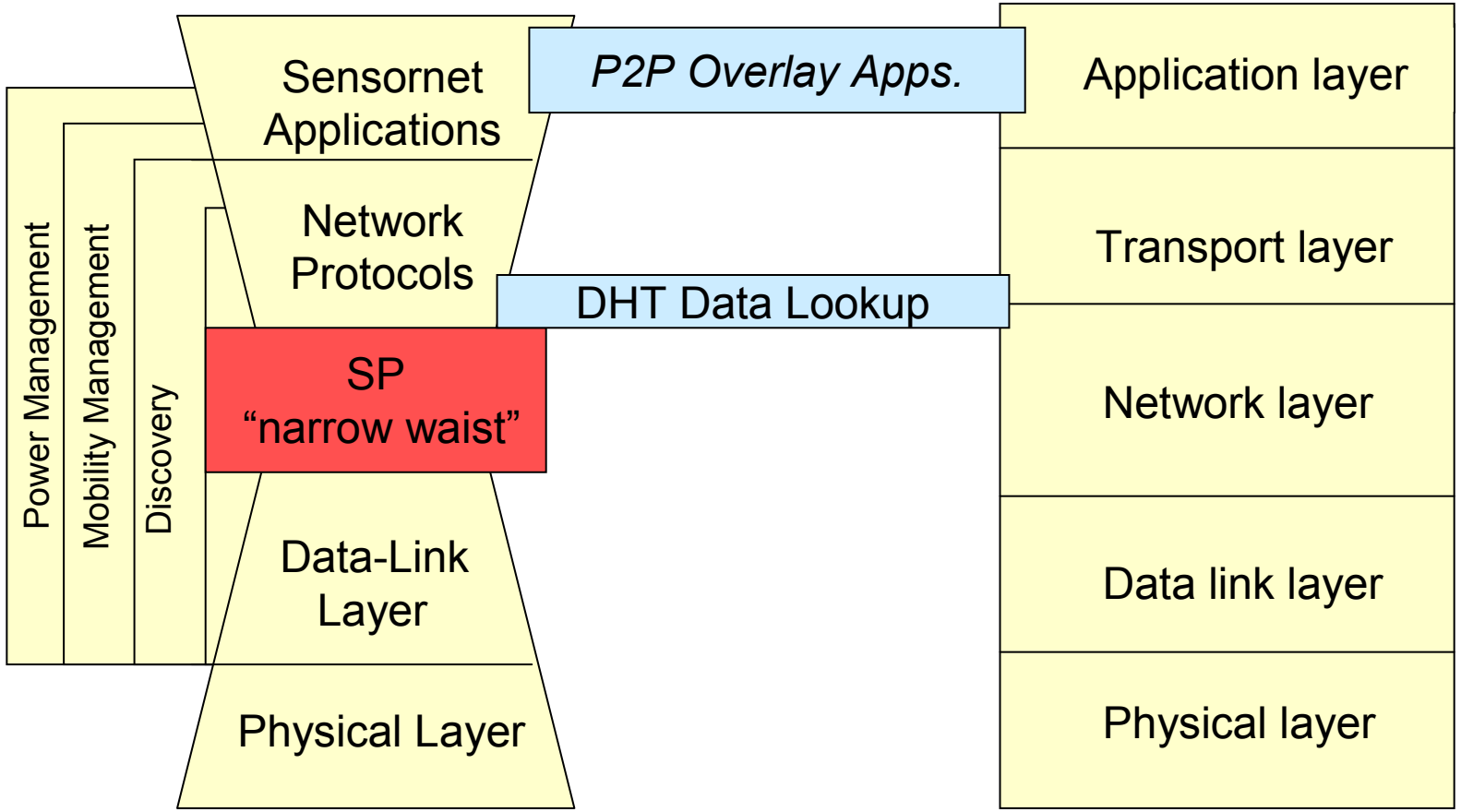
TChord Master Ring



P2P Overlay in SP Architecture



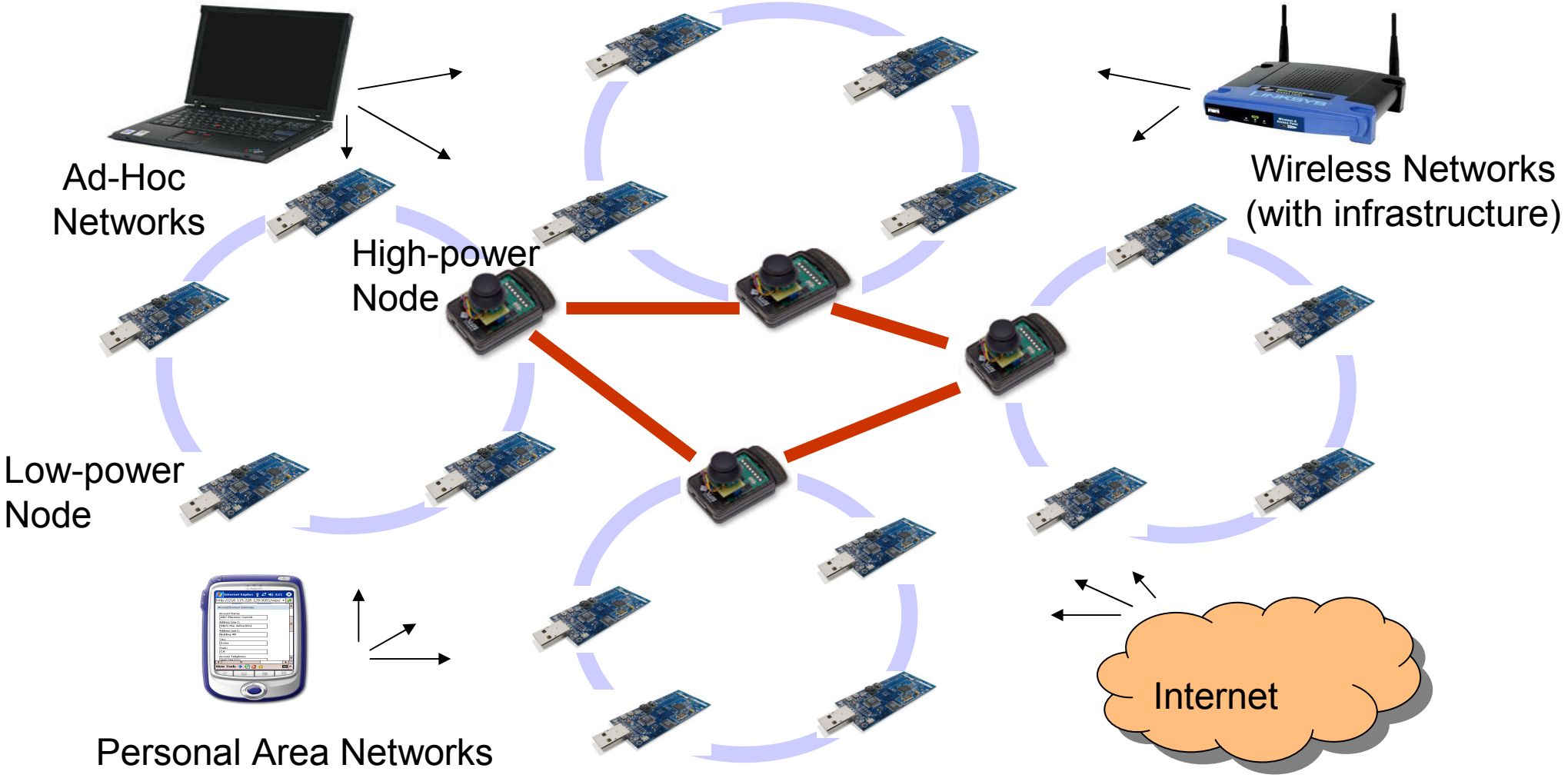
Integration of Sensornets with IP Networks



Sensornet Protocol Stack
(SP Architecture)

Generic Network Stack
(Ad-Hoc Networks or Internet)

Putting the Pieces Together



Open Questions

- Overhead of P2P overlays

- Changing environmental parameters (e.g., query rate, replication rate, and QoS requirements)

- Changing network parameters (e.g., mobility, number of nodes, and network dynamics)

- Is structure required in sensornets? If yes, how much of it?

- Right abstraction for a large class of sensornet applications?

- Applications, methods, and tools directly used/mapped?

- What new methods and tools are needed?

- Scale under Churn?

- Evaluation / simulation

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Conclusions

- P2P meets sensornets
  - both communities working in isolation
  - cross-community problems

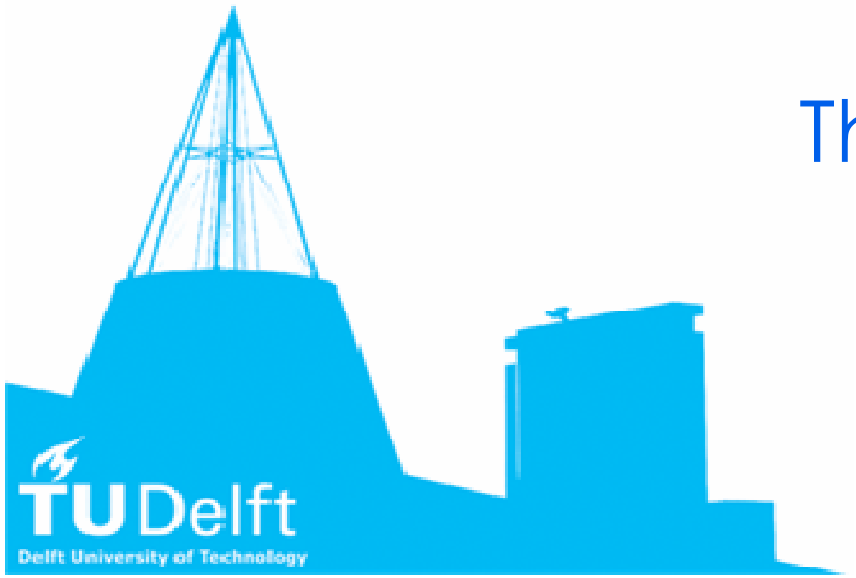
- Sensornets say goodbye to proxies
  - direct IP access
  - “first class” citizens

Further Information

Muneeb Ali

http://ali.dritte.org

Thank You !



Further Information

Shameless Advertisement

ACM MobiShare

Muneeb Ali

http://ali.dritte.org

Thank You !