Wireless Sensor Networks for Smart Metering

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EnergyCon 2014 - IEEE International Energy Conference
Dubrovnik, Crotia, 13-16 May, 2014
May 14th, 2014

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- What? Smart Metering / Advanced Metering Infrastructure.
- How? Wireless sensor network.

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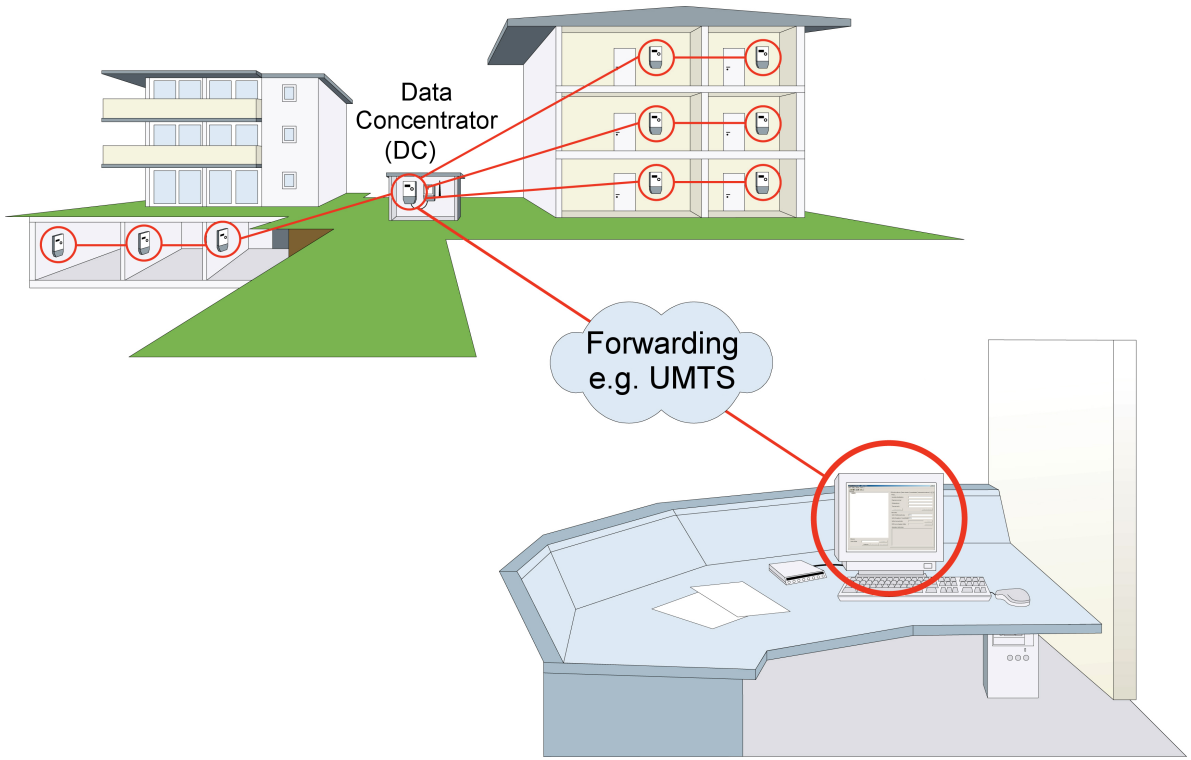

Alternatives

- PLC: straightforward, viable option around electricity meters
  - ⇒ not feasible in some regions
- Customer DSL/Broadband: fast, reliable, high bandwidth
  - ⇒ legal implications; may necesssitate additional WiFi
- Cellular: Simple deployment, no additional infrastructure
  - ⇒ additional communication cost, communication problems in cellars
- Wireless sensor networks
  - ⇒ license free bands, no communication cost
  - ⇒ low cost, low power consumption; but also: lossy environment, low bandwidth

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  - ⇒ license free bands, no communication cost
  - ⇒ low cost, low power consumption; but also: lossy environment, low bandwidth
  - ⇒ **attractive alternative**

Use Cases / Latency Requirements

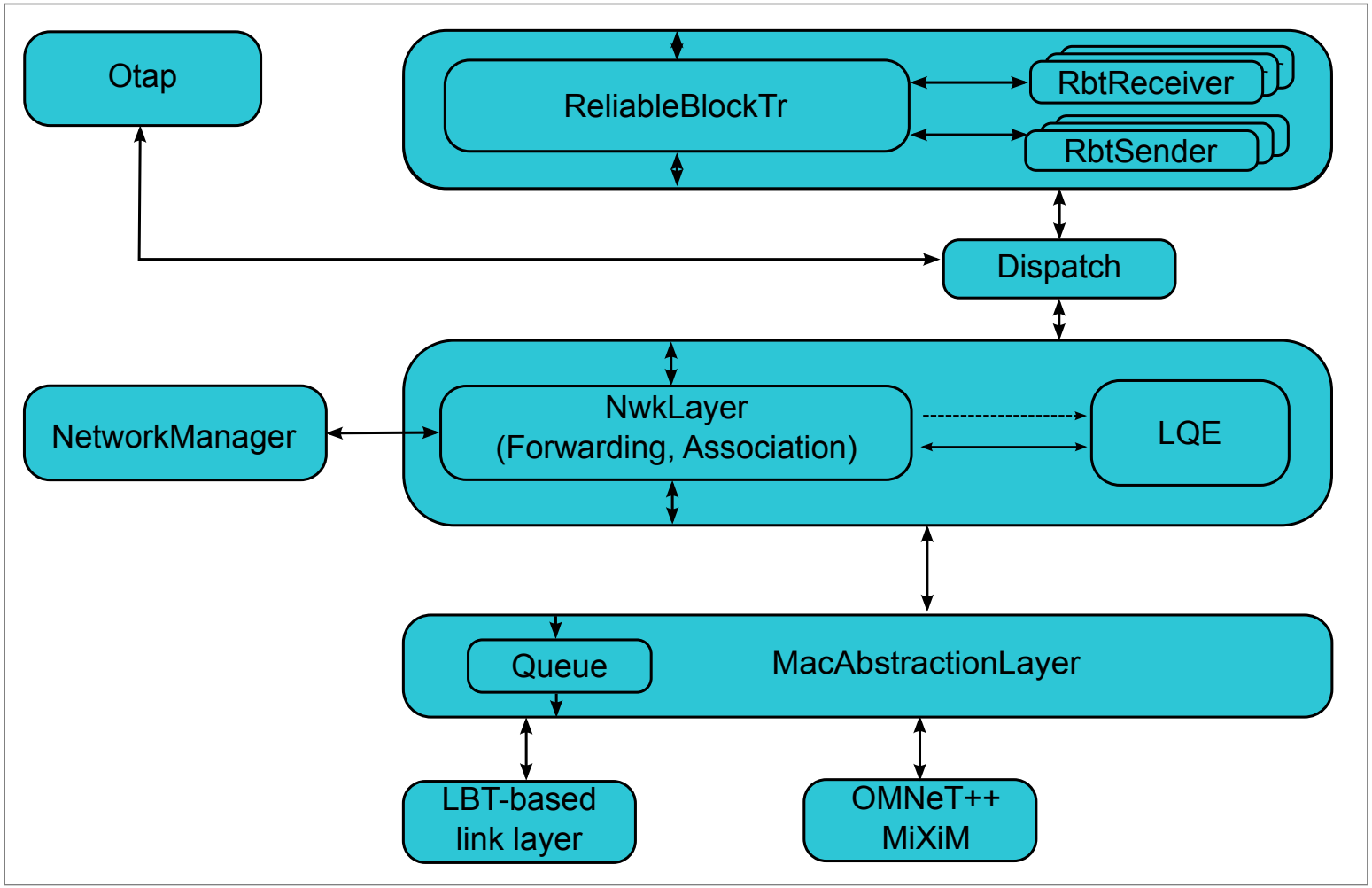
Meter → DC

- Collect energy consumption, load profiles: 1 h to 1 day

DC → Meter

- Regular distribution of price tables: 1 h (individual) 24 h (whole network)
- Ad-hoc commands (e.g., (dis)connection): 10 min to 1 h

Software Architecture



Network Layer

Different routing for different directions of communication:

Meters $\rightarrow$ DC (many-to-one)

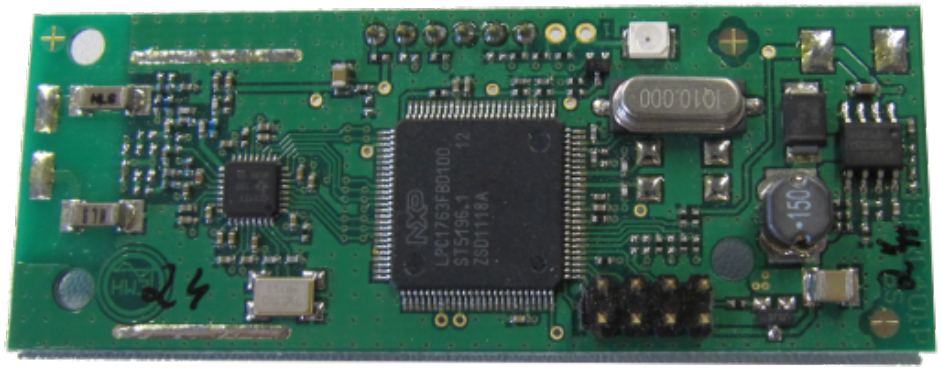
- Tree constructed from periodic beacons
- Expected number of transmissions metric to determine next hop

DC $\rightarrow$ Meters (one-to-many)

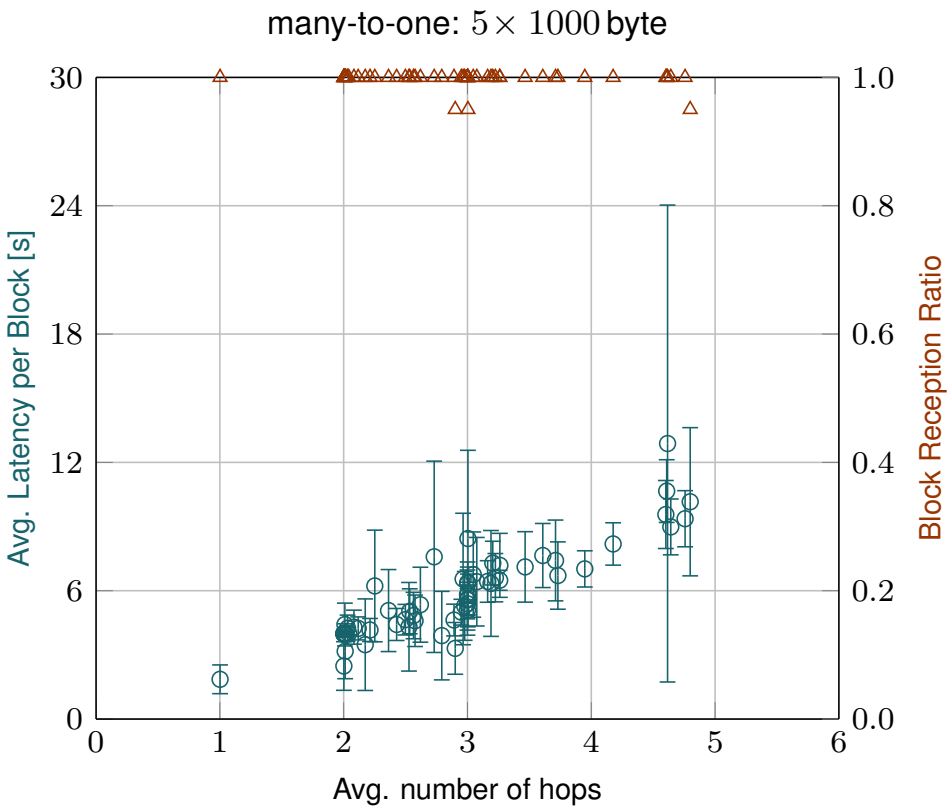
- Restricted re-broadcasting based on subtree tables

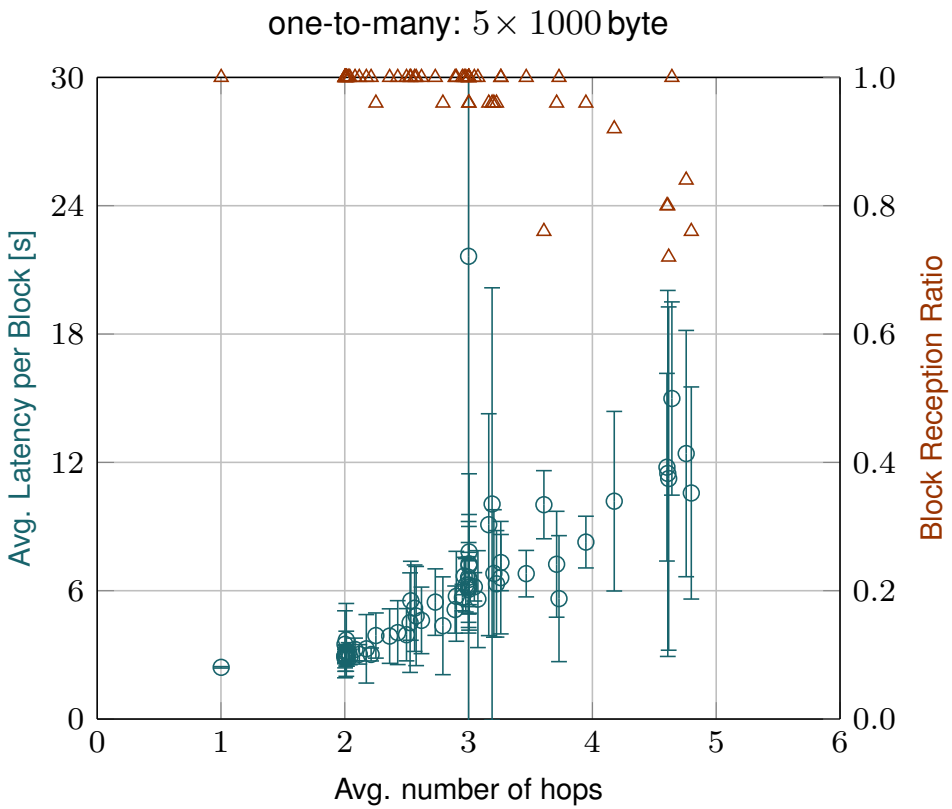
Experiment Setup

- Hardware: LPC1763 (CortexM3) + CC1120 transceiver
- Experiment:
  - 1 DC, 63 meters, 3 floors of large office building
  - 5 blocks of 1 kB, 50 blocks of 75 B, both directions
  - 5 runs per setup



Evaluation - Collection and Distribution





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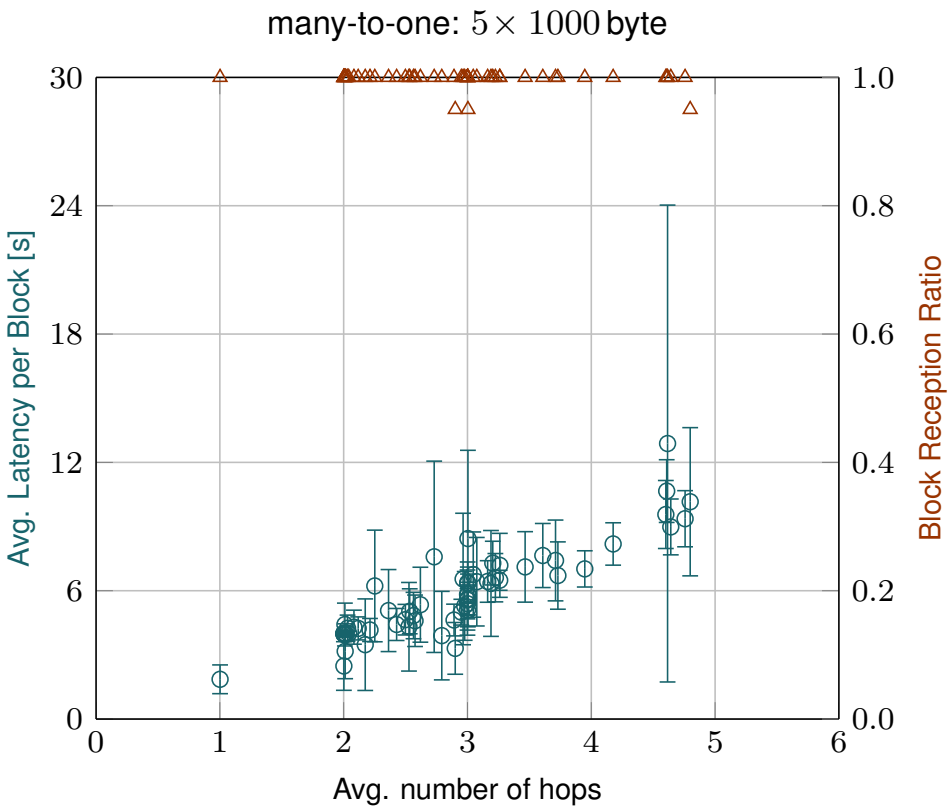

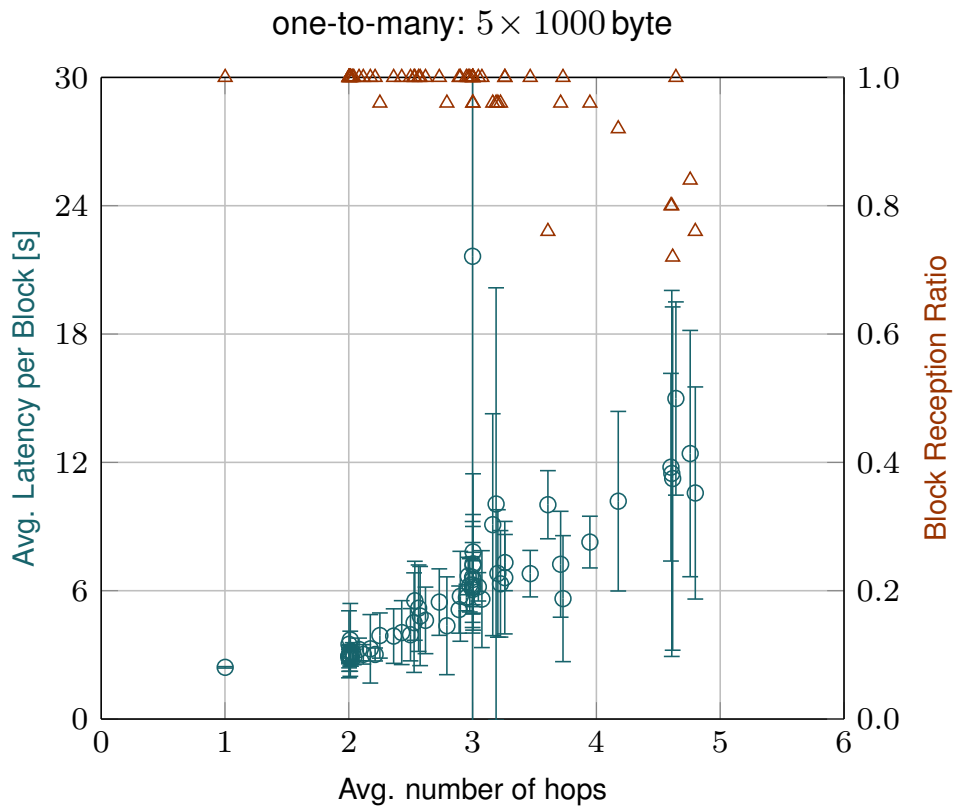

$\Rightarrow$ Latency Requirements fulfilled

Conclusion

- Latency requirements could be fulfilled
- Wireless sensor networks: possible solution for AMI
- Unacknowledged broadcasts cause performance problems

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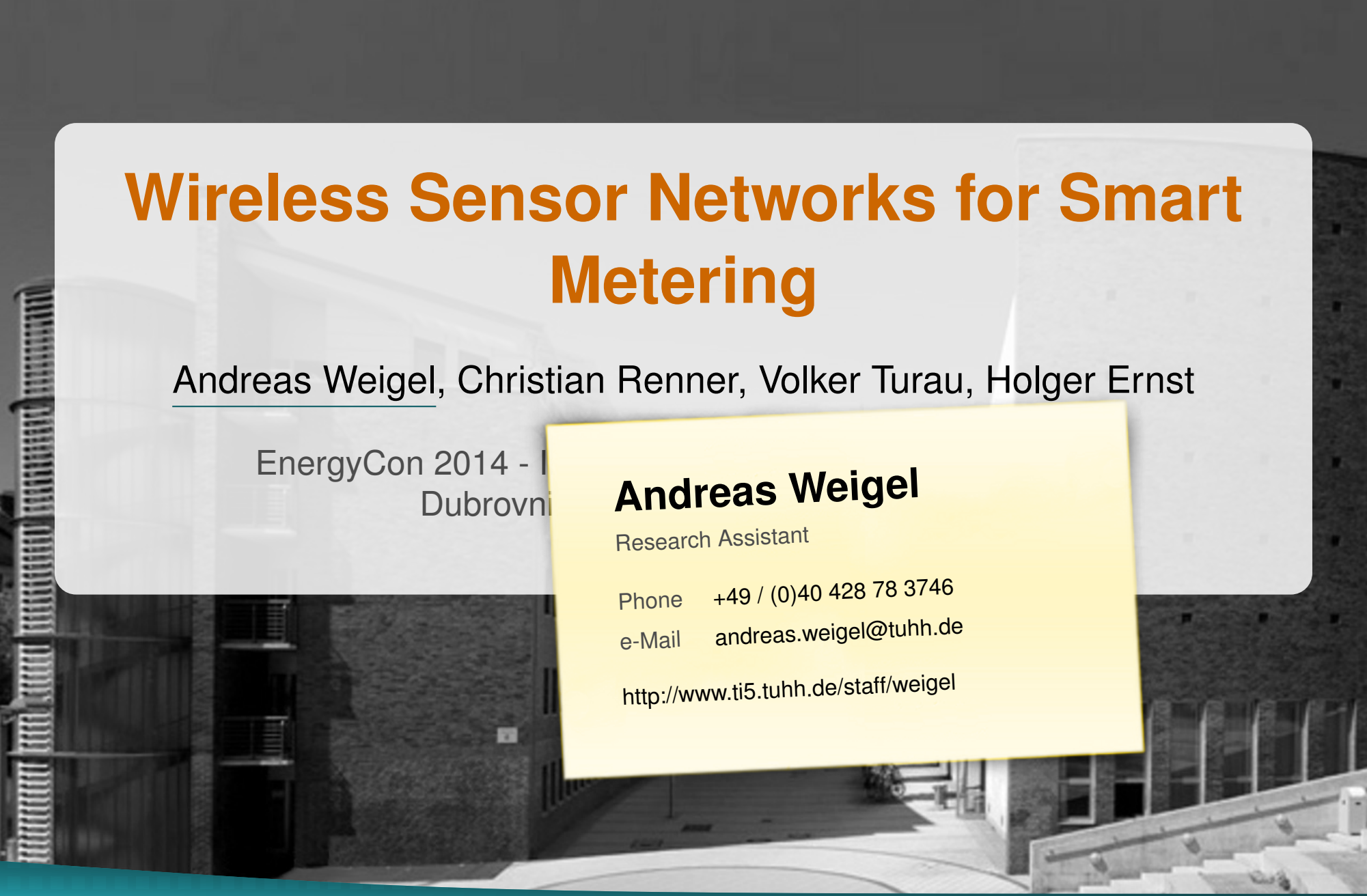

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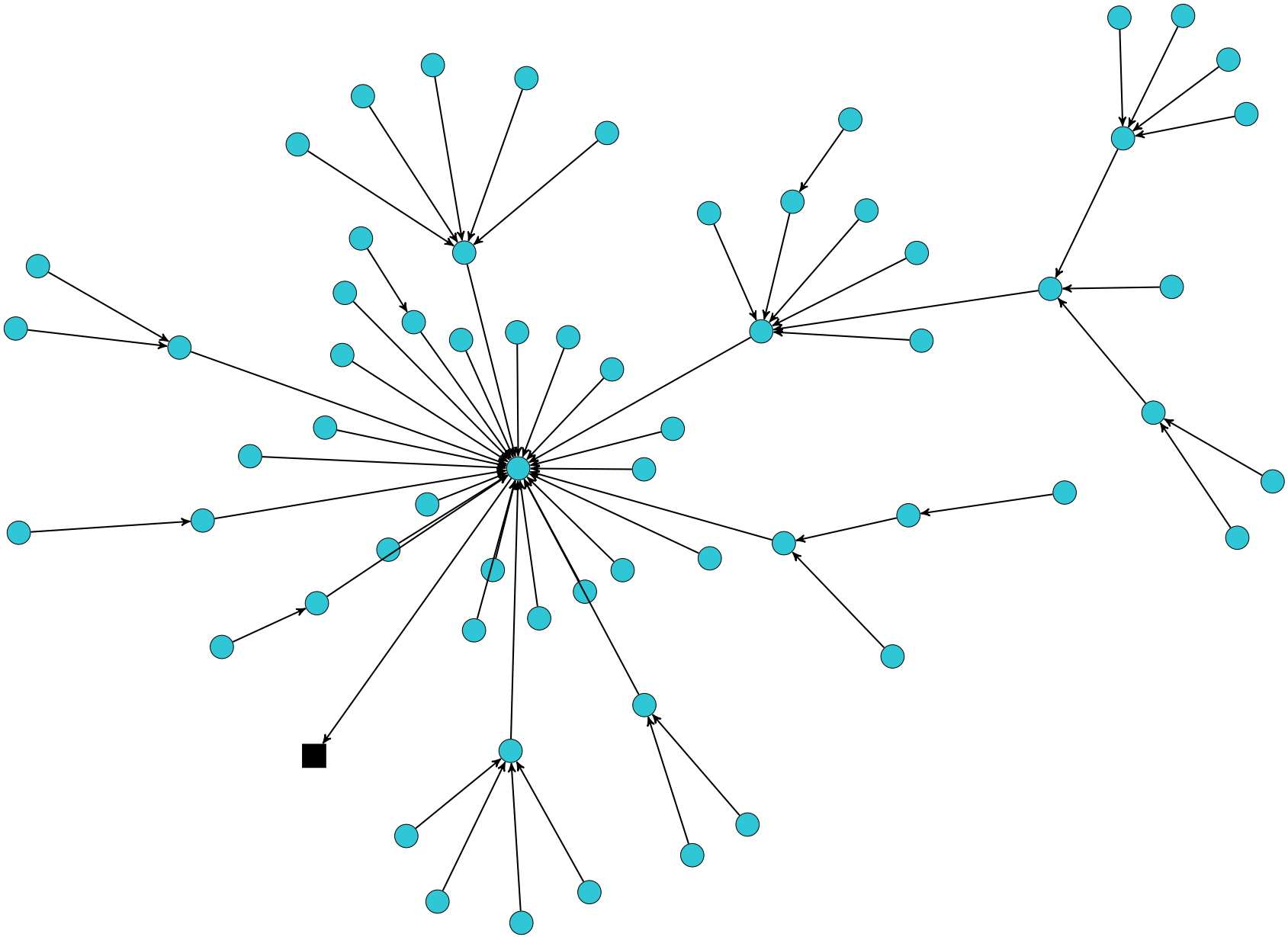
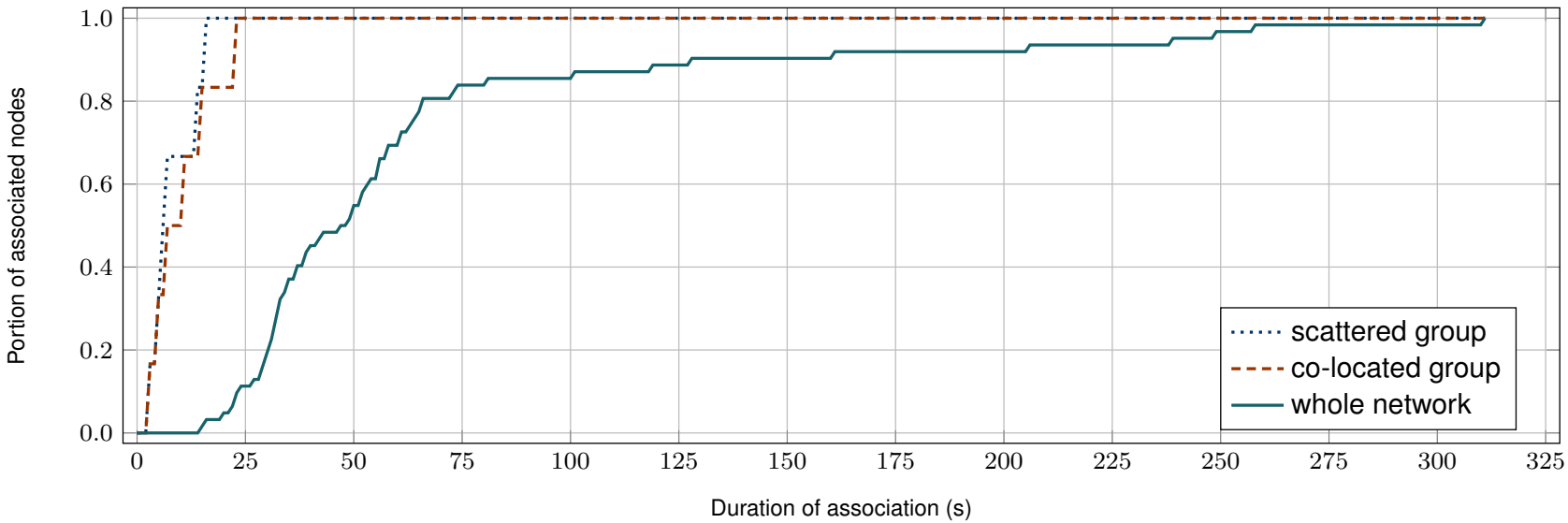
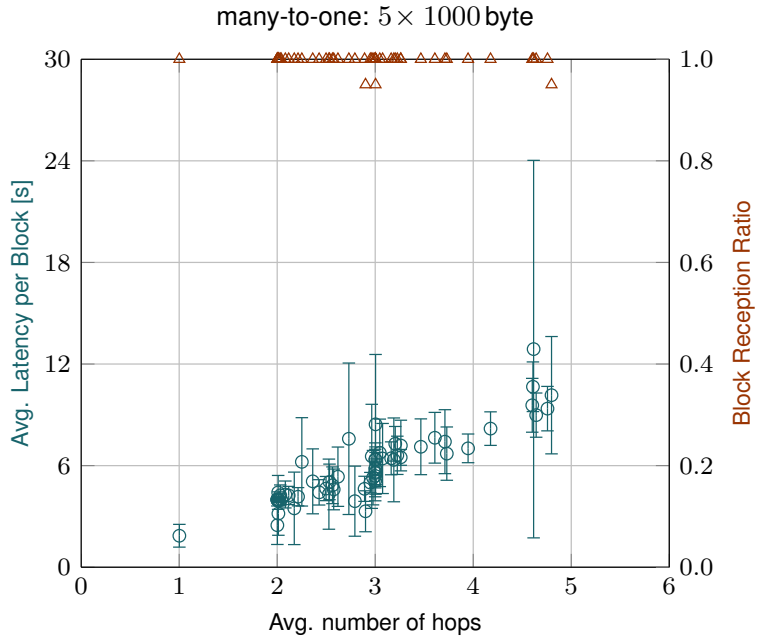


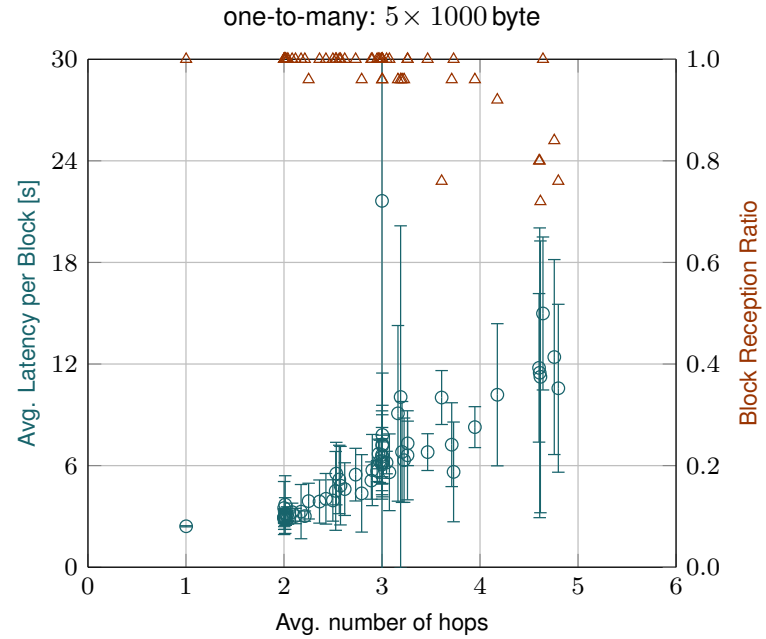
Association Results

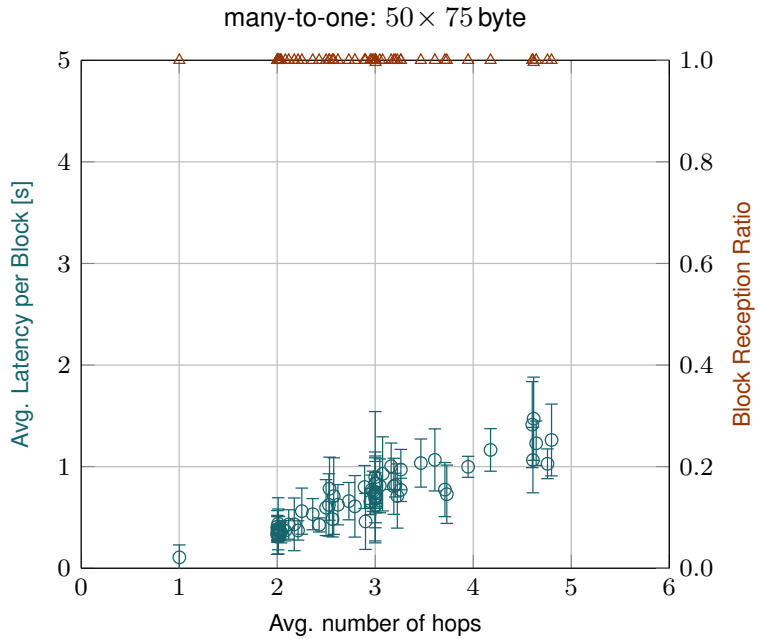
- Duration of association for different groups of nodes:
  - All 64 nodes
  - 7 co-located nodes
  - 6 spatially scattered nodes

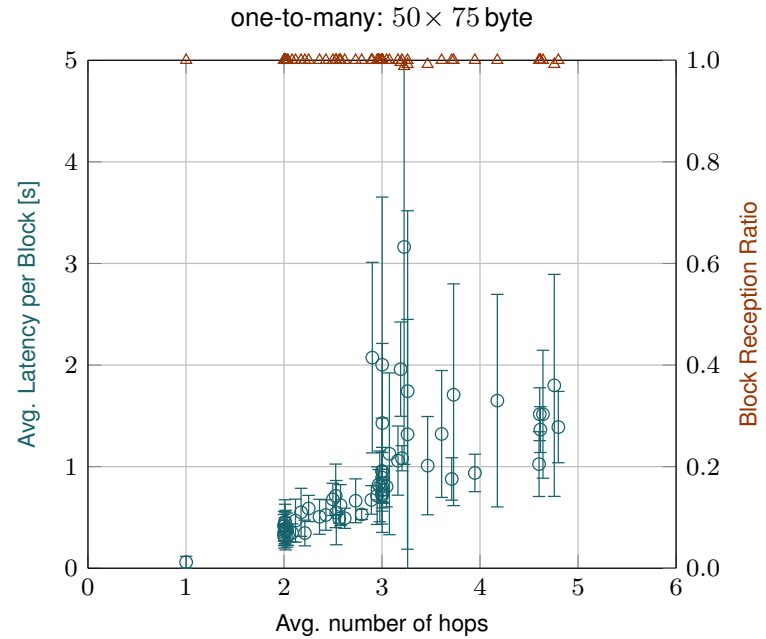


Evaluation - Collection and Distribution (1)









Evaluation - Collection and Distribution (2)