The Need for a Name to MAC Address Mapping in NDN: Towards Quantifying the Resource Gain

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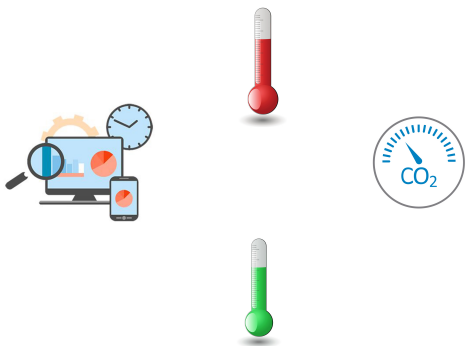
4th ACM Conference on Information-Centric Networking (ICN 2017)

September 27, 2017

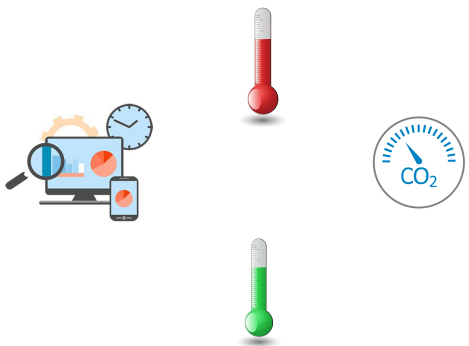
A Common IoT Scenario



A Common IoT Scenario

Why ICN in the IoT?

- NDN improves constrained networks (IoT)
  - \+ Hop-wise caching increases reliability
  - \+ Request-response pattern protects constrained nodes



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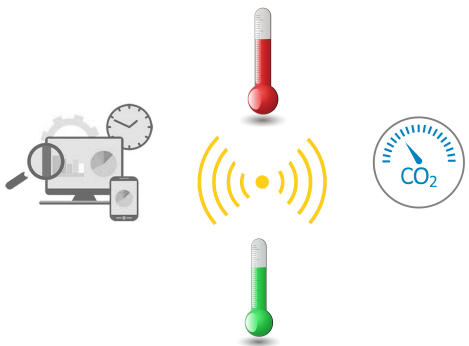
BUT: What happens on the data link layer with Interest and Data packets?

→ IoT runs on lossy wireless networks



Without Name to MAC Address Mapping

Broadcast forwarding on L2 ...

+ Simplifies content distribution
+ Adds redundancy

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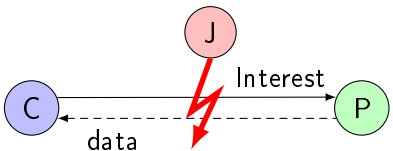
... includes also drawbacks

– Increases processing overhead
– Lacks error handling on data link layer

Why should we care about about L2 error handling?

A noisy network



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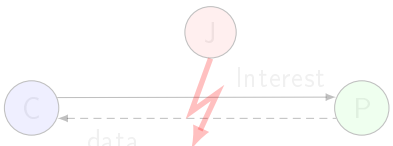


Unsatisfied Interest rates

Interest \ Data	Broadcast	Unicast
Broadcast	12.1 %	10.6 %
Unicast	3.3 %	1.9 %

Current Solution Space

		Energy	Reliability
[NDN'12]	**NDN-specific link layer functions** implemented between L2 and L3	✘	✓
[ICN'16]	**Name-based filtering on NIC** still sends all packets via broadcast challenges multiple ICN flavors	✓	✘
[EUNICE'13, ICN'14]	**Adaptive unicast faces** sends only data packets via unicast	✓	✓

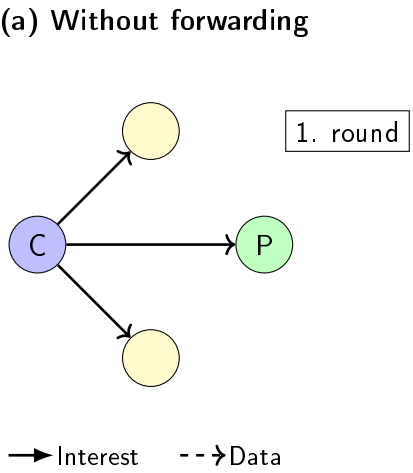
What is this talk about?

1. Motivation why we need a name to link layer mapping in the IoT
2. A systematic understanding of effects of unicast and broadcast on Interest and Data
3. Experimental evaluation of different mapping configurations

MAC Layer Mapping

Interest Broadcast, Data Unicast

- All nodes receive Interest
- Receivers create PIT entries
- Faces map to source MAC



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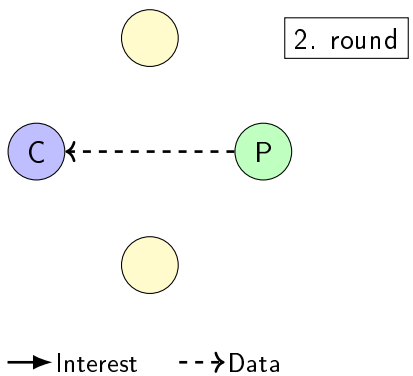
(a) Without forwarding Interests

- Producer unicasts data
- Multiple stale PIT entries
- Single-path content caching

(a) Without forwarding



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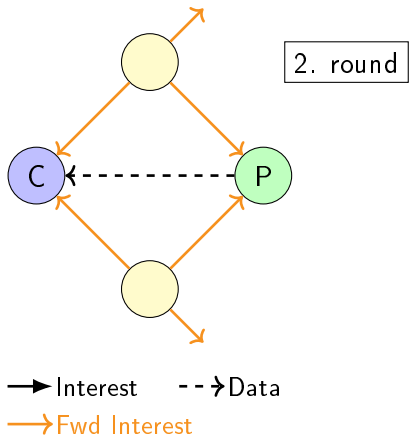
(b) With forwarding Interests

- Intermediate nodes forward Interest

(b) With forwarding



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(a) Without forwarding Interests

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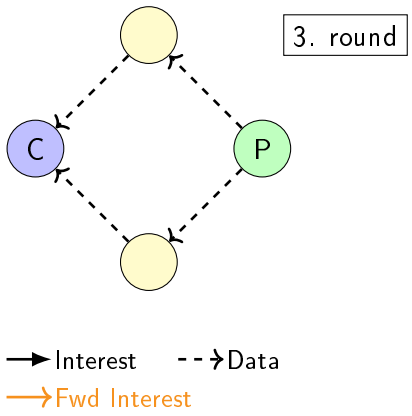
(b) With forwarding Interests

- Intermediate nodes forward Interest
- Multiple data unicasts in return
- High redundancy and network load

(b) With forwarding



Broadcast vs. Unicast

Wireless Link Layer

	Unicast	Broadcast
General	• Enables MAC intelligence • Reduces system load • Isolates communication channels	• High interference, no ACK REQ • Increases system load • Increases redundancy
Interest	• Requires route to MAC mapping maintenance	• Simplifies forwarding
Data	• Requires simple mapping	• Facilitates caching

Broadcast versus unicast - how large is the difference in wireless networks?

Measurement Setup

Scenario

- Single consumer, multiple producers
- Varying MAC to face mappings
- Single- and multi-hop

Metrics

- Wakeups, Energy
- CPU time, Unsatisfied Interest Rates

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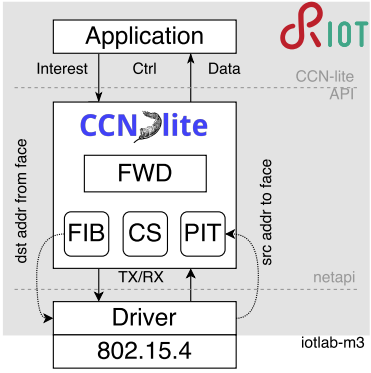
Software

- RIOT with CCN-lite as network stack
- Assigns MAC addresses to faces

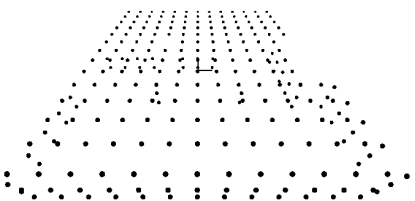


Testbed Deployment

- FIT IoT-LAB testbed
- 6 sites, $\sim$ 2800 constrained nodes of 4 architectures
- M3 nodes: *class 2* device with 802.15.4 radio

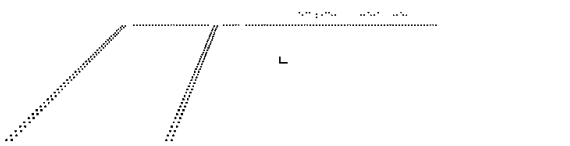
Lille

- 256 M3 nodes in one broadcast domain

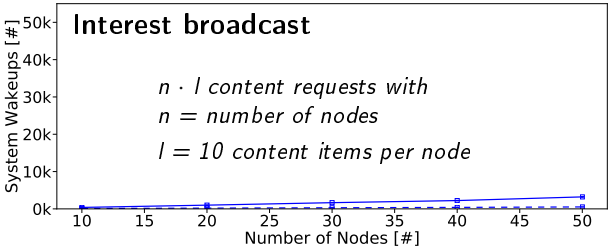


Grenoble

- 384 M3 nodes in an extended ring topology
- Mesh networks up to 9 hops



Single-hop System Wakeup



Data

broadcast w/o fwd
unicast w/o fwd

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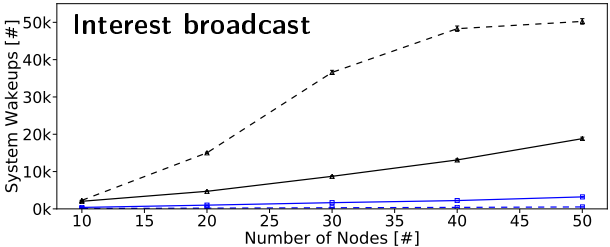

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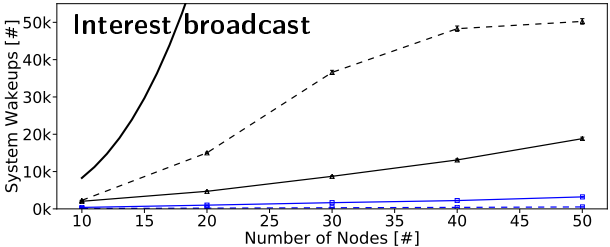

Data

- Theory
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- unicast w/ fwd
- broadcast w/o fwd
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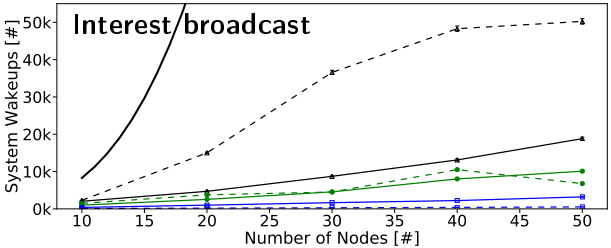

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- unicast w/ fwd w/ DUP
- broadcast w/o fwd
- unicast w/o fwd

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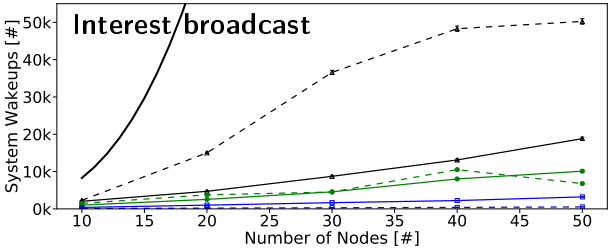

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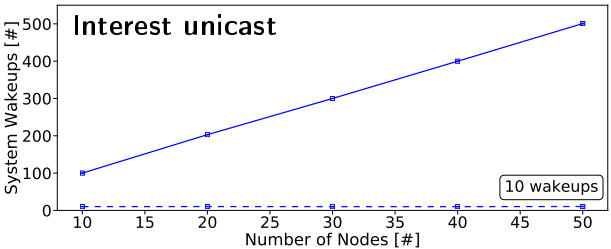

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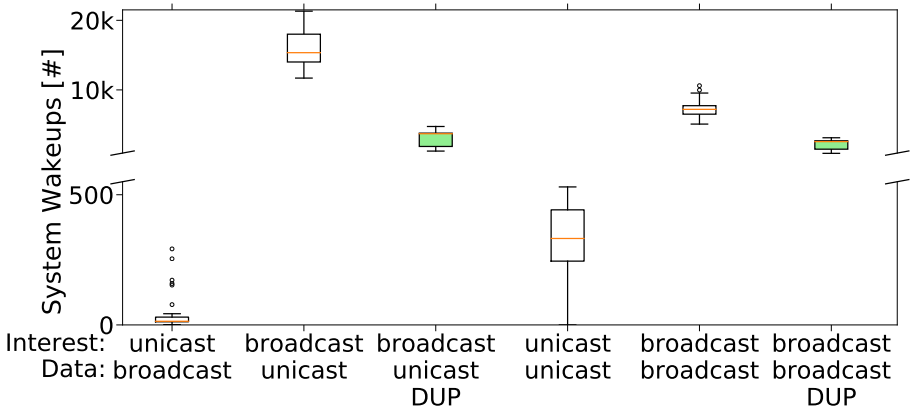
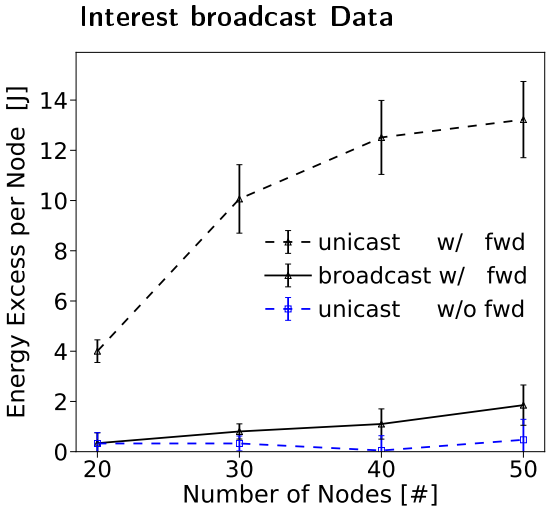


Single-hop Energy

Energy excess in comparison to the leanest mapping: Interest unicast, data unicast

We can benefit from proper mappings to save battery resources and increase node lifetimes



Conclusion: What was this talk about?

Motivation why we need a name to link layer mapping in the IoT
ICN without MAC layer mapping harms the IoT

A systematic understanding of effects of unicast and broadcast on Interest and Data
Link layer mapping does not sacrifice the concepts of NDN

Experimental evaluation of different mapping configurations
Without unicast for Interest and data, broadcast storms kill communication

Agree on a common *adaptive* mapping scheme in the community!