

Space Internetworking Center 2014

Content-Centric Networking in Opportunistic and Delay-Tolerant Networks

Torsten Braun, Universität Bern, Switzerland

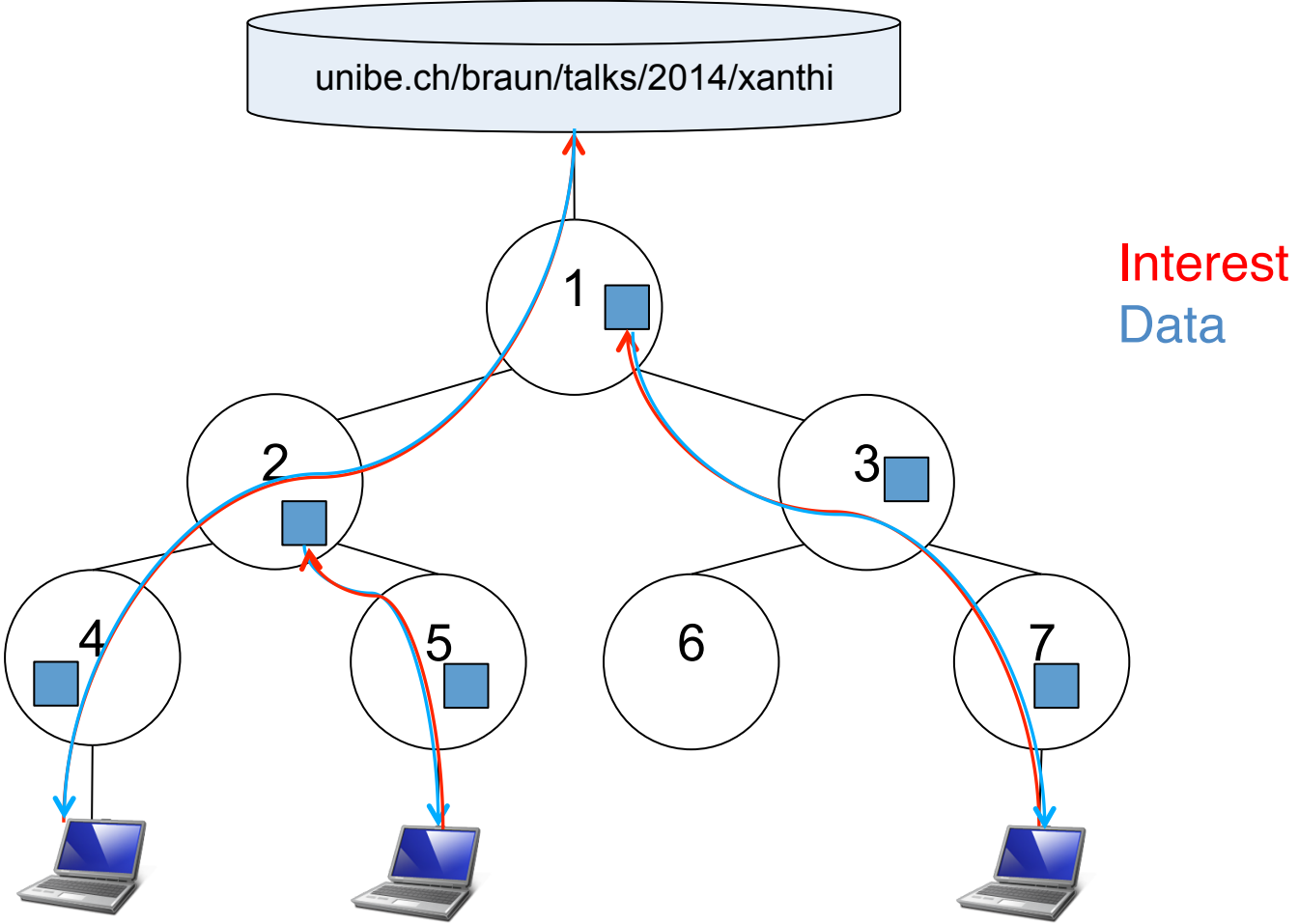
braun@iam.unibe.ch, cds.unibe.ch

Joint work with Wafaa El Maudni El Alami,
Carlos Anastasiades, Jürg Schmid, Tobias Weber

Content-Centric Networking (CCN)

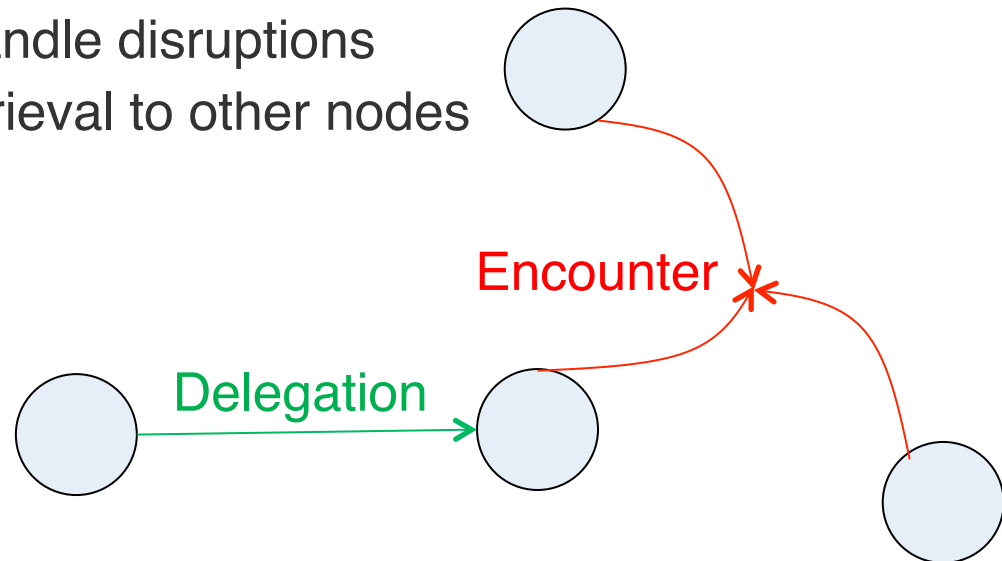
- > Messages
 - **Interest**: content name, selector
 - **Data**: content name, signature (info), data
- > Hierarchical content names
 - Example: /unibe.ch/braun/talks/2014/xanthi

Content-Centric Networking (CCN)



CCN and Opportunistic Networks

- > CCN and Opportunistic Networks seem to be a good match.
 - No beaconing required to learn about neighbor nodes
 - No need for neighbour lists
 - Exploitation of broadcast property of wireless media:
 - single Interest to many neighbor nodes
- > Short node encounters require
 - Resume operations to handle disruptions
 - Delegation of content retrieval to other nodes



File Exchange in Opportunistic Networks

> Problems

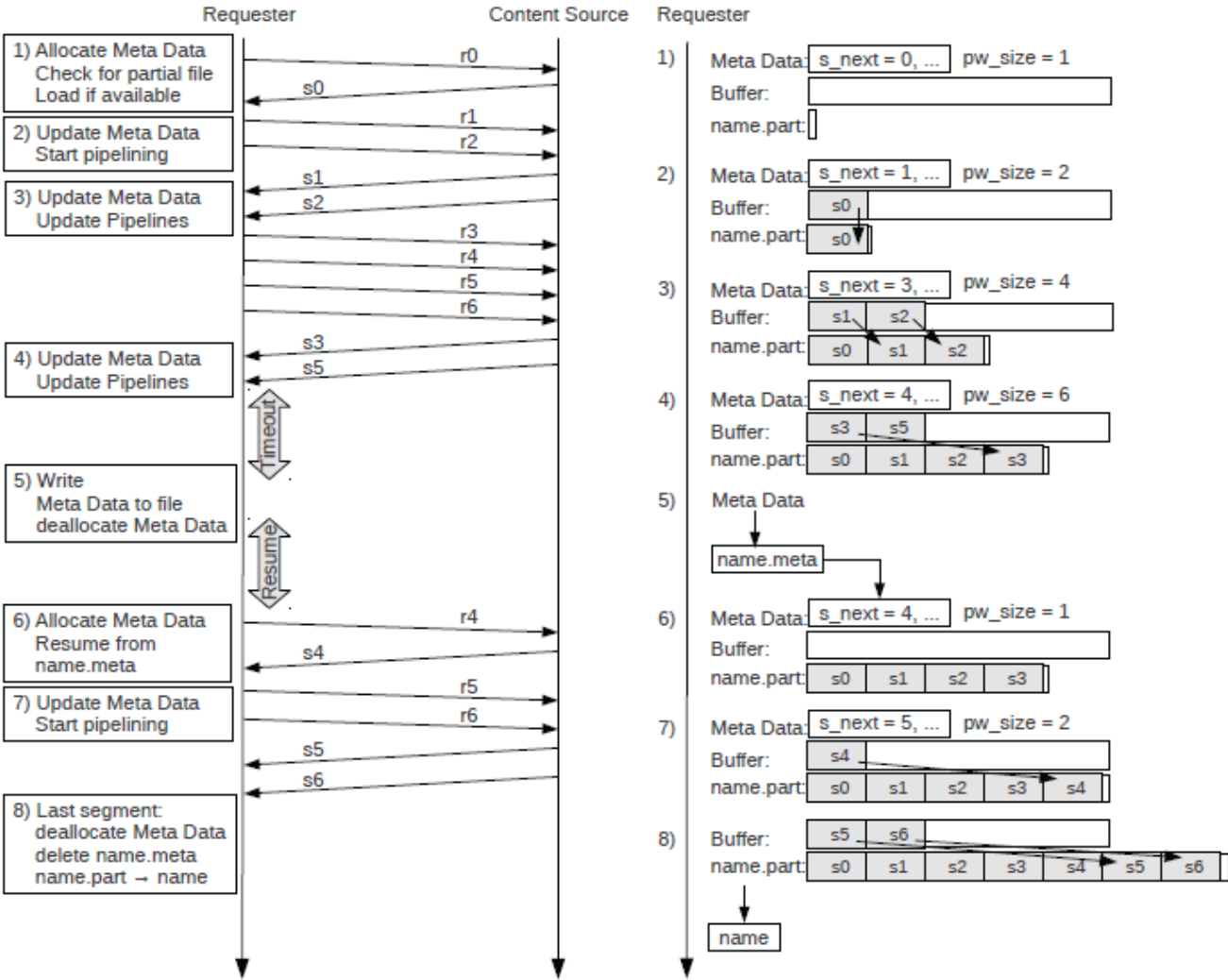
- File exchange might not be completed during short encounter.
- Caches do not store data persistently

> Solution

- Partial file download and resume operation (supported by **meta data** per file)

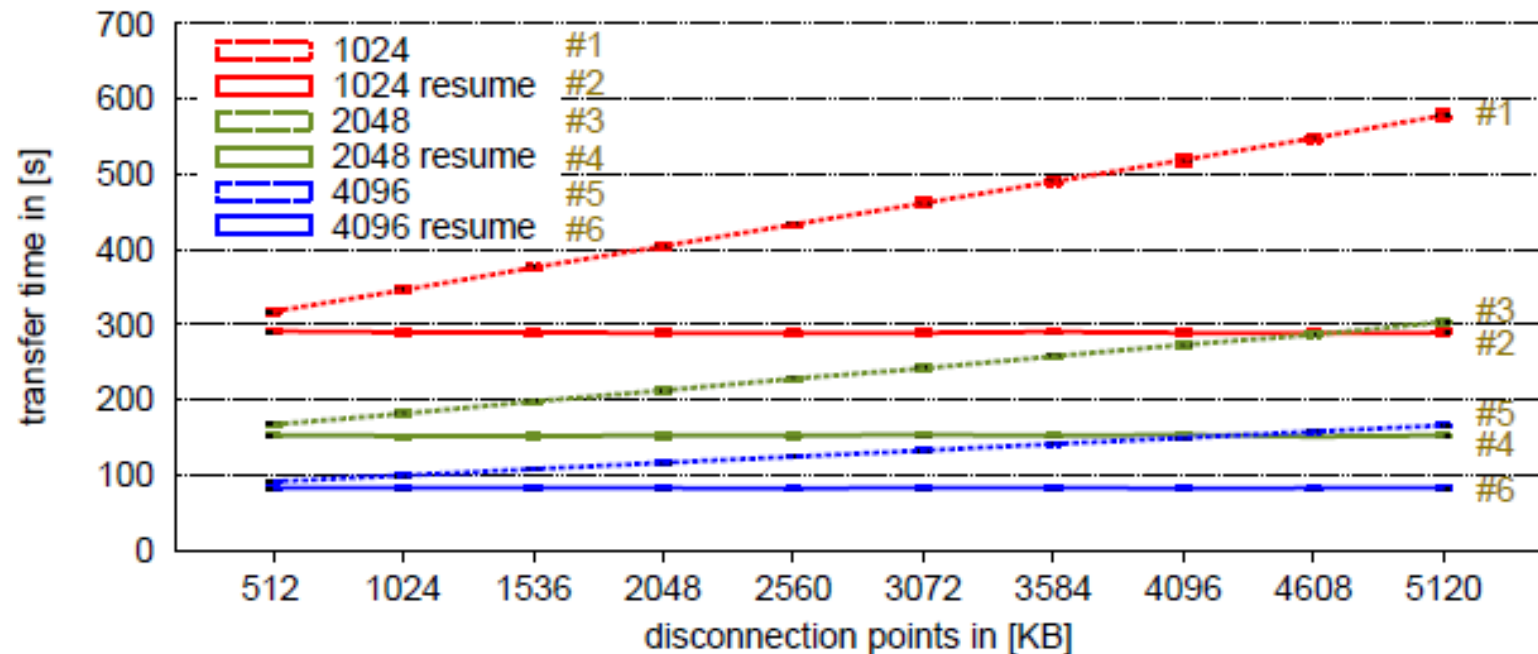
Name of Content Object
Version of Content Object
Next Segment
File Position
Publisher's public key digest
Expiration time

Resume Operation



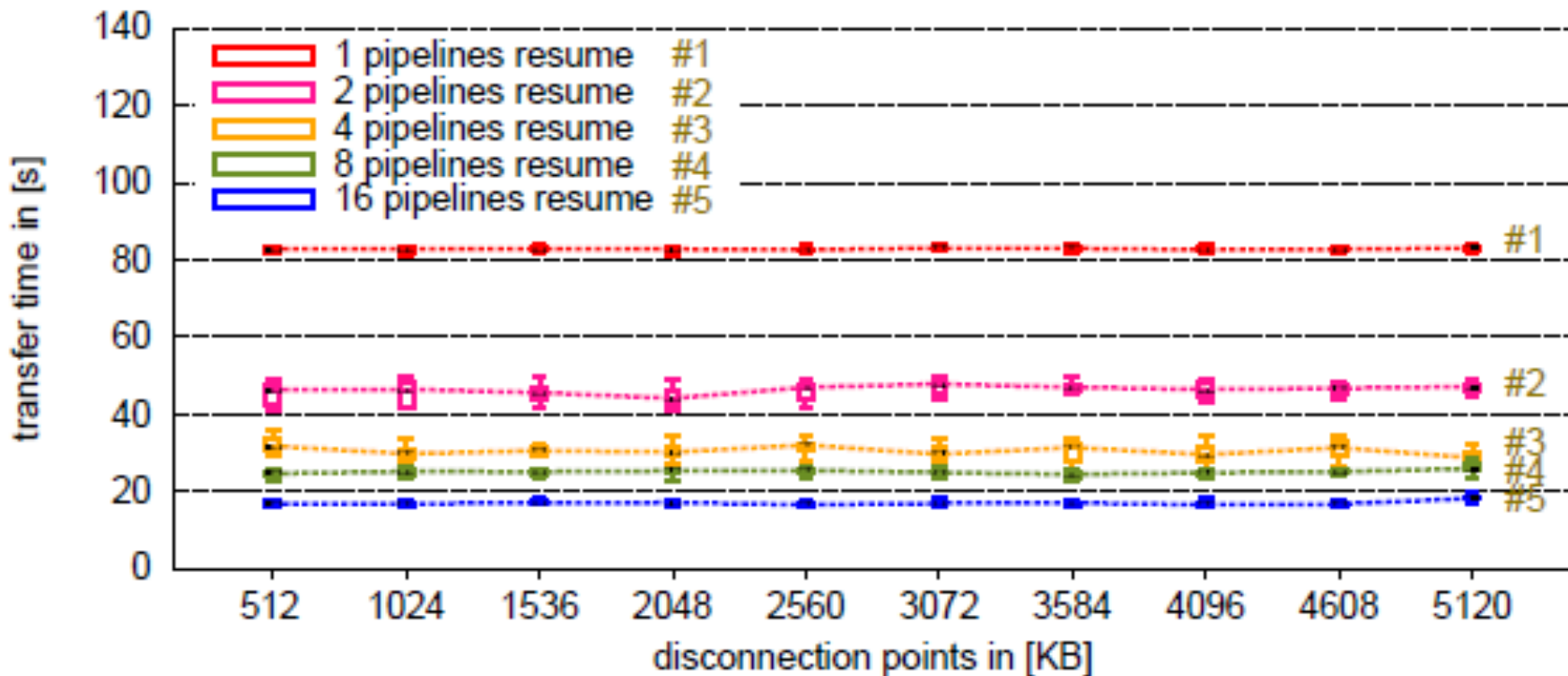
Evaluation of Resume Operation

- > Scenario: 1 source and 1 consumer with 1 disruption after a certain amount of exchanged data
- > Evaluation of transfer time for a 5 MB file with PCEngines ALIX wireless mesh nodes and different data message sizes



Pipelining

- > Pipelining to support fast file exchange: TCP-like control of pipeline sizes: slow start and additive increase of concurrent Interest messages
- > MAC layer multicast: no MAC layer acknowledgments/retransmissions
→ Interest retransmissions, 56-97 % throughput increase by unicast

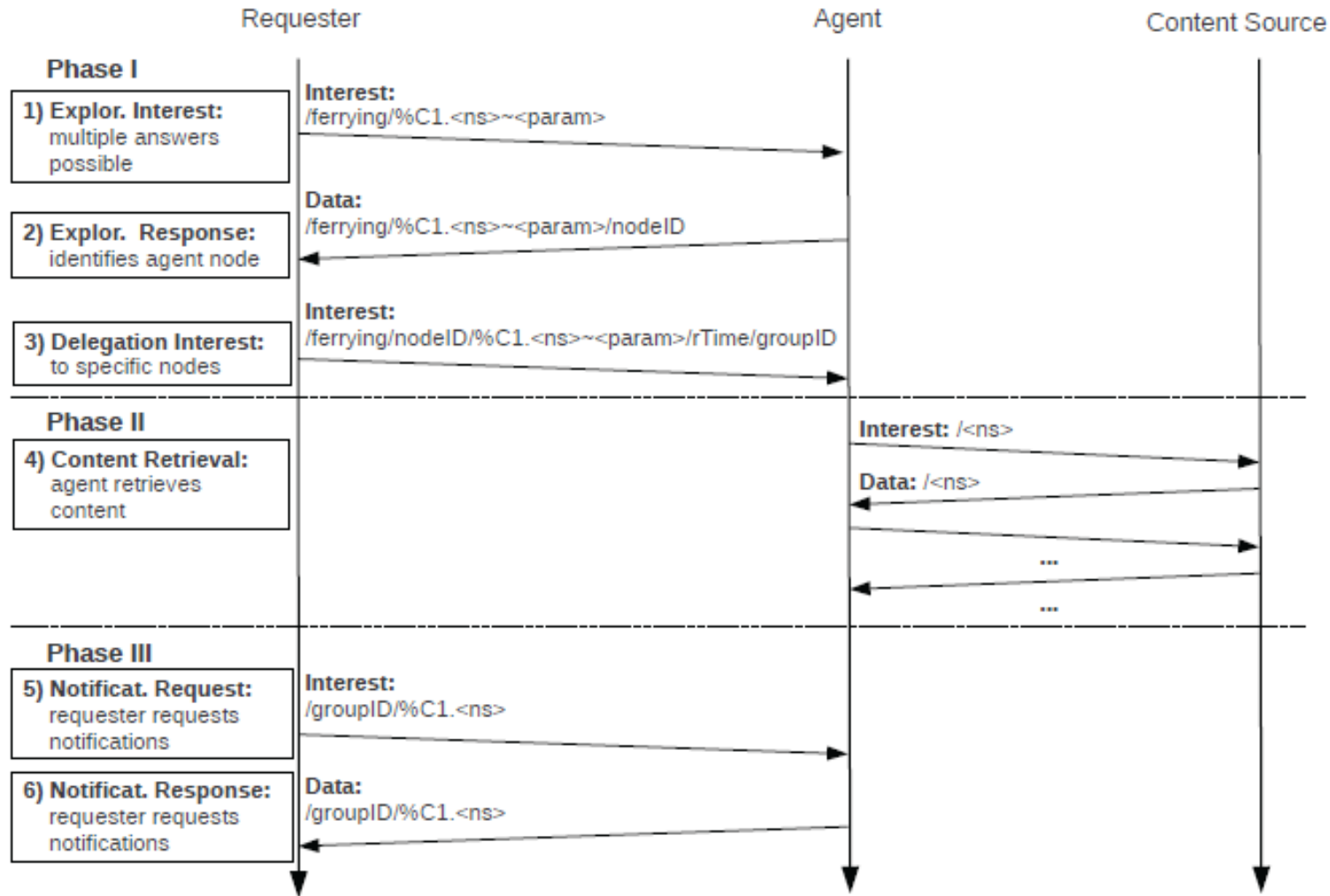


Agent-Based Content Retrieval

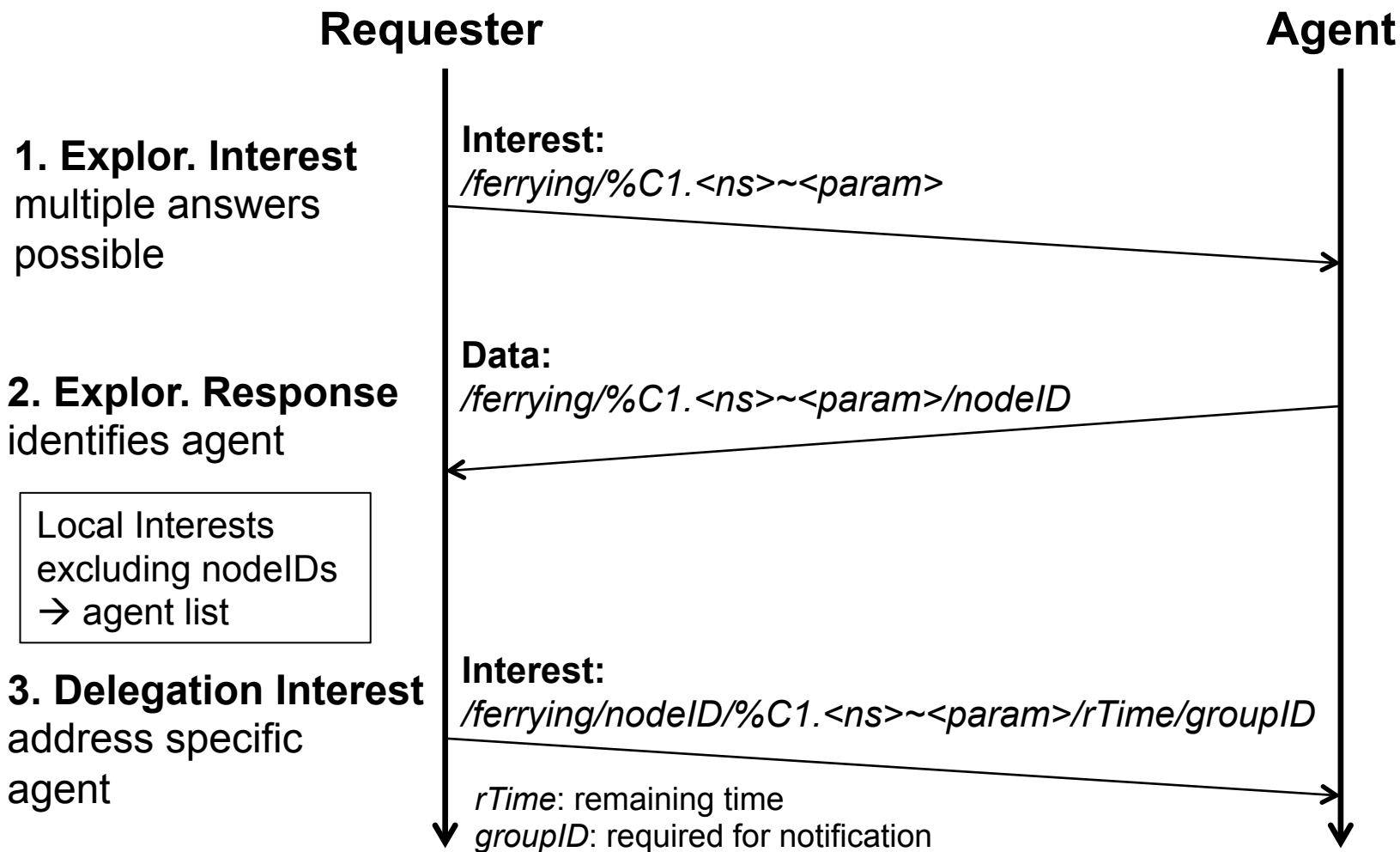
Agent delegation:
requester finds agent and delegates content retrieval

Content retrieval
performed by agent

Notification:
Agent notifies requester that content has been found and delivers data



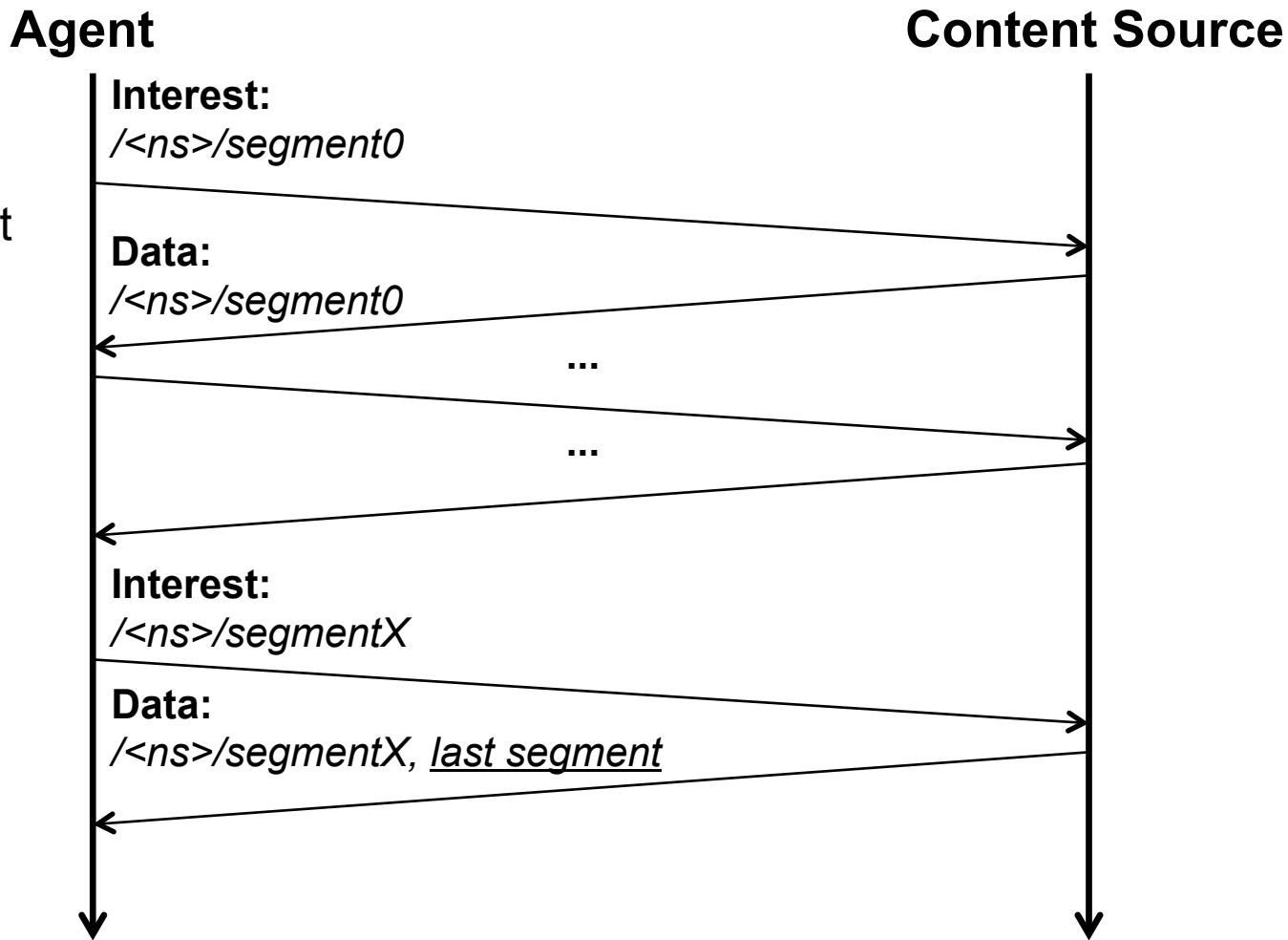
Agent Delegation



Content Retrieval

4. Content Retrieval

Agent retrieves content



Content complete!
 FIB:
 → register /groupID

Notification

Requester

Agent

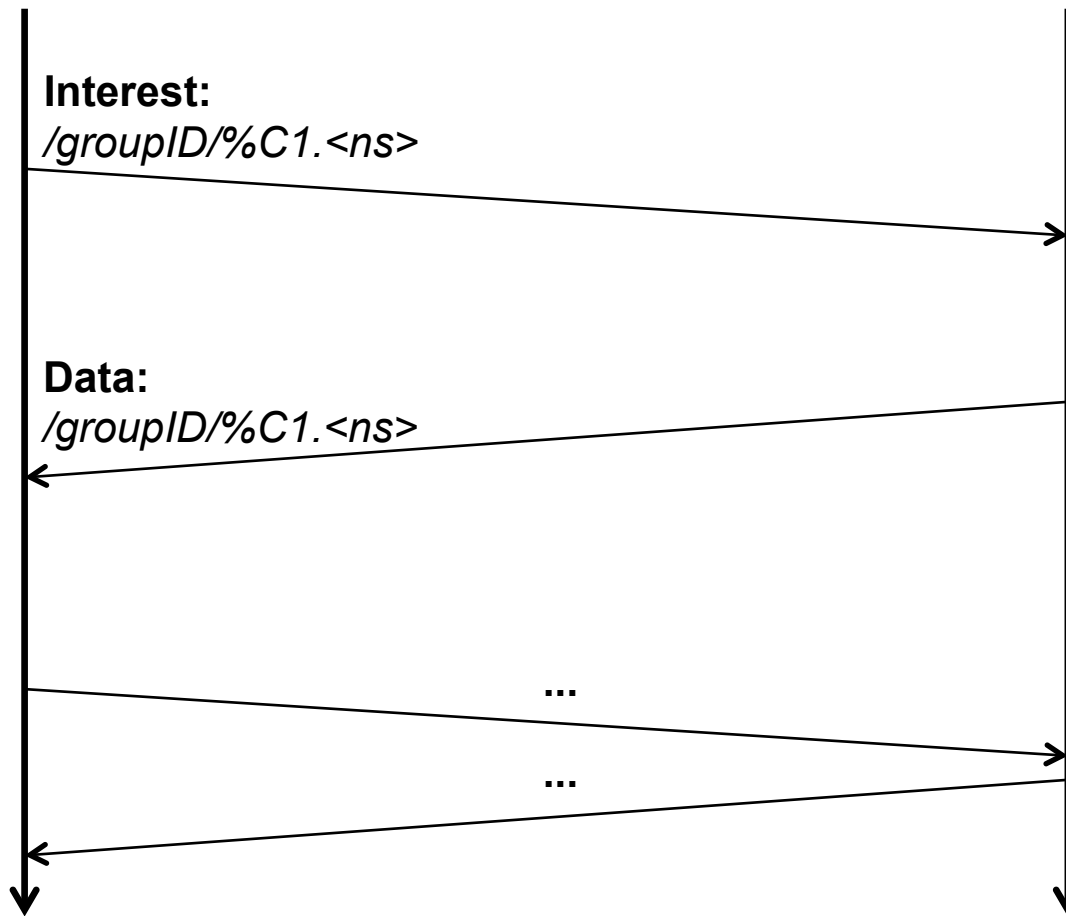
5. Notification Request
periodically asking
agents for notifications

Interest:
/groupID/%C1.<ns>

6. Notification Response
agent responds to
notification requests

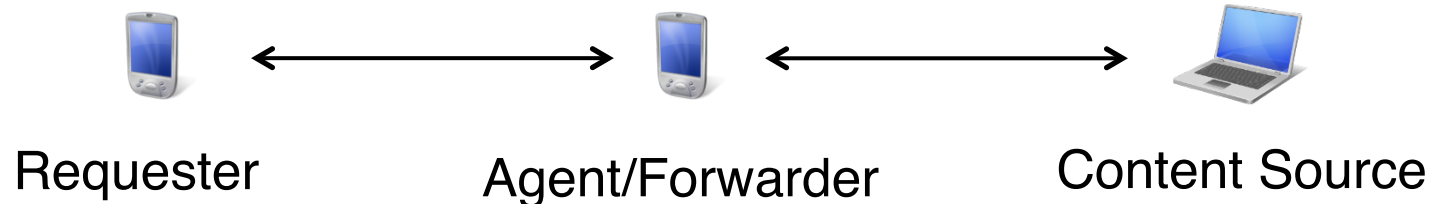
Data:
/groupID/%C1.<ns>

Content Retrieval
directly from agent

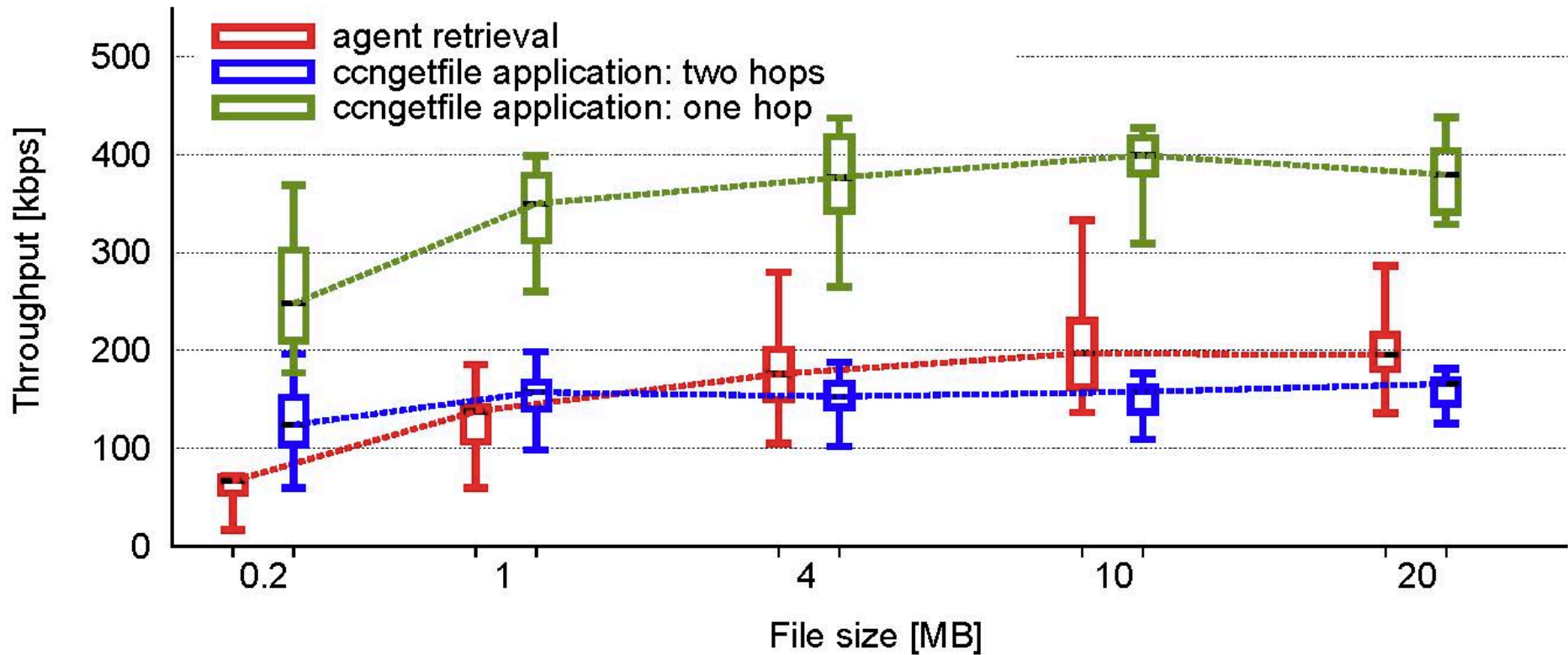


Evaluation

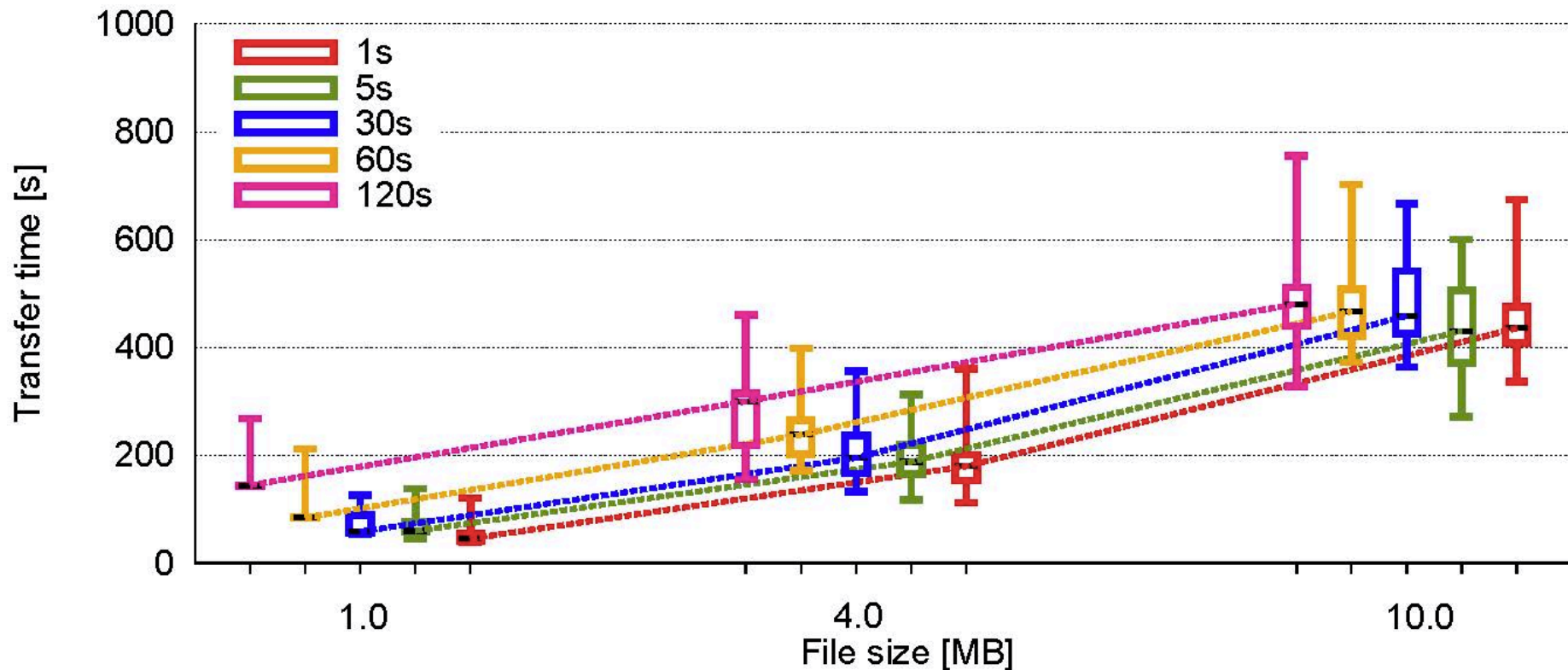
- > Implementation on Android smart phones
- > Communication via IEEE 802.11n
- > Agent-based content retrieval vs. multi-hop forwarding
- > Data transmission: first hop unicast, second hop multicast



Throughput of Agent-based Content Retrieval vs. Multi-Hop Forwarding



Transfer Time for Different Probing Intervals



Conclusions and Outlook

- > CCN has benefits in opportunistic / delay-tolerant networks
- > Recommended optimizations and adaptations of CCN
 - Resume operations
 - Delegation of content retrieval to agents
- > Outlook
 - Mobility
 - Larger network scenarios
 - Evaluation using ns-3 network emulation

Further Information

- > Carlos Anastasiades, Wafaa El Maudni El Alami, Torsten Braun: Agent-based Content Retrieval for Opportunistic Content-Centric Networks, 12th International Conference on Wired & Wlred Internet Communications (WWIC), May 2014
- > Carlos Anastasiades, Tobias Schmid, Jürg Weber, Torsten Braun: Opportunistic Content-Centric Data Transmission During Short Network Contacts, IEEE Wireless Communications and Networking Conference (WCNC 2014), April 2014

Thank You for Your Attention !

- > braun@iam.unibe.ch
- > <http://cde.unibe.ch>