Transport issues in ICN

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Transport issues in ICN

RTT unpredictability

Since contents are cached with a packet-level granularity and content chunks are requested by name, chunks may be delivered from different network nodes when retrieving an entire content object.
This makes TCP-based congestion control mechanisms unusable:

- Out-of-order delivery or variations in inter-arrival intervals may be caused by adjacent chunks being served by different caches rather than congestion.
- RTO estimation is unreliable because of great RTT variability caused by frequently changing chunk sources

Transport issues in ICN

PIT vulnerability

The expiration timer of the Pending Interest Table (PIT) entries is crucial not only for performance but also for security reasons:

- Short timers leads to an increased number of spurious timeouts.
- Long timers make caches vulnerable to DoS attacks aimed to triggering PIT expirations and therefore Interest retransmits with subsequent performance degradation. [1]

There is a need for adaptive algorithms for PIT timer estimation, but RTT is difficult to estimate

[1] M. Wahlisch, T. Schmidt, M. Vahlenkamp. Backscatter from the Data Plane - Threats to Stability and Security in Information-Centric Networking. Available: http://arxiv.org/abs/1205.4778

Proposed transport protocols for CCN

Currently proposed transport protocols can be categorized in:

- Receiver-driven
  - Control loop in the receiver, stateless routers
  - Proposals: ICTP [2], ICP [3], ConTug [4]
- Hop-by-hop
  - Control loop in the routers which need to keep per-flow state
  - Possibility to control misbehaving receivers
  - Proposals: HoBHIS [5] HR-ICP [6]

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[2] S. Salsano, A. Detti, M. Cancellieri, M. Pomposini, and N. Blefari- Melazzi, "Transport-layer issues in information centric networks, ICN workshop", ACM SIGCOMM 2012

[3] G. Carofiglio, M. Gallo, and L. Muscariello, "ICP: Design and evaluation of an interest control protocol for content-centric networking, NOMEN workshop, IEEE INFOCOM 2012

[4] S. Arianfar, P. Nikander, L. Eggert, and J. Ott, Contug: A receiver-driven transport protocol for content-centric networks, in IEEE ICNP 2010 (Poster session)

[5] N. Rozhnova and S. Fdida, "An effective hop-by-hop interest shaping mechanism for CCN communications, NOMEN workshop, IEEE INFOCOM 2012

[6] G. Carofiglio and L. Muscariello, Joint hop-by-hop and receiver-driven interest control protocol for content-centric networks, ICN workshop, ACM SIGCOMM 2012

Proposed transport protocols for CCN

Receiver-driven

ICTP

- Is exactly like a receiver-driven TCP with minimal adaptation to operate in a CCN environment
- One single retransmission timeout regardless of the actual content source
- Out-of-order and timeout expiration to infer congestion

ICP

- AIMD window-based transport protocol
- No out-of-order packets, congestion inferred only by timeout expiration
- One single timeout regardless of the source, calculated as in TCP-LP

ConTug

- Keeps multiple timeouts and windows per flow (one per each *forwarding channel*) but still one timeout for all sources/caches belonging to the same channel
- Can use ECN information from routers to detect congestion

Proposed transport protocols for CCN

Hop-by-hop

HoBHIS

- Rate control performed at each router
- *Interest* packets forwarding is paced according to the current queue occupancy on the *Data* path
- Requires a dedicated queue for each flow

HR-ICP

- Essentially an integration of ICP and HoBHIS
- AIMD control at the receiver and *Interest* pacing at routers

Summary and Conclusions

- Transport protocols need to address RTT unpredictability in a scalable way
- Where to place transport layer functionalities? Endpoints? Forwarding entities?
- Need to architect transport protocols to limit the amount of forwarding states required