Congestion control and in-network caching

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Motivation

- Information-Centric Networking can massively rely on in-network on-path caching
  - most popular contents tend to be cached close to the consumers
  - least popular contents tend to be cached farther
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• **How does it influence the fairness?**
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• How does it influence the fairness?

• How does in-network on-path caching impact server load?
Hypotheses 1/2

• One consumer site initiates ALL the Interests

• One (other) site initiates ALL the Data packets (content producer)

• Consumer and producer sites connected by a chain of LRU caches of length $H$

• Every link with delay $d$, total delay $H*d$

Example for $H=1$
Hypothesis 2/2

- Congestion is controlled by and only by the requester with “Additive Increase Multiplicative Decrease” (AIMD)

- Throughput for content $c$ in AIMD given by

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How does in-network on-path caching impact the retrieval time?

- RTT for a content is the RTT to the first node that caches the content.
- The average position is given by the hit rate $\omega_j(c)$ of nodes in the chain.
- The average delay for $c$ is then

$$RTT(c) = d \sum_{i=1}^{H} i\omega_i(c) \prod_{j<i} [1 - \omega_j(c)]$$
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Probability of reaching node $i$
Short RTT for popular contents

- 1,000,000 contents
- 10,000 caching entries total

\[ \alpha = 2 \]
How does it influence the fairness?

• Baseline: TCP (i.e., no cache) throughput
• Is the throughput gain identical for every of the $N$ downloads?
• Metric: ratio of throughput with and without cache, for any download $i$

$$\eta(c_i) = \frac{T(c_i)}{\hat{T}(c_i)} \approx \frac{1/RTT(c_i)}{\sum_{j=1}^{N} 1/RTT(c_j) / N}$$
Negative impact for least popular contents

- Individually, very popular contents might not gain that much...
- ... but least popular lose a lot (up to $\frac{1}{H+1}$)
How does in-network on-path caching impact server load?

• Hypothesis: processing cost and data size is the same for every content

• Metric: ratio of server link usage with and without cache, for any content $c$

$$\gamma = 1 - \frac{\Lambda(l_{H+1})}{\Lambda(l_{H+1})} = 1 - \frac{\sum_{i=1}^{N} \prod_{j=1}^{H} [1 - \omega_j(c_i)]}{\sum_{j=1}^{N} \frac{1}{RTT(c_j)}}$$
Server load is reduced

- Limited impact of the chain length on server load
Conclusion

• What’s happening if AIMD is used by ICN clients?
  • RTT is a function of the popularity when caches are used
  • Throughput is a function of the invert of RTT
  • Popular contents obtain more resources than the others
• We MUST think about this problem when we will design a congestion control
Question to the RG

• Is the RG ready to work on this?
• Who?
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more details: http://hal.inria.fr/hal-00719793/