

# Congestion control and in-network caching

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  - most popular contents tend to be cached close to the consumers
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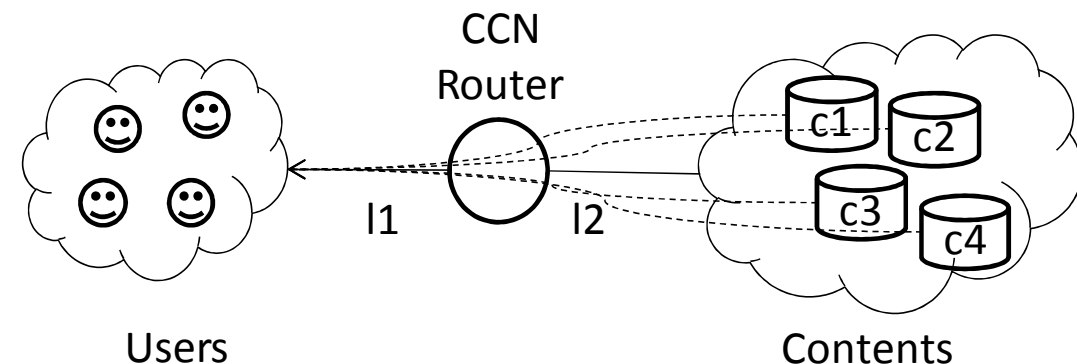
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- **How does it influence the fairness?**
- **How does in-network on-path caching impact server load?**

# 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)
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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

$$RTT(c) = d \sum_{i=1}^H i \omega_i(c) \prod_{j < i} [1 - \omega_j(c)]$$

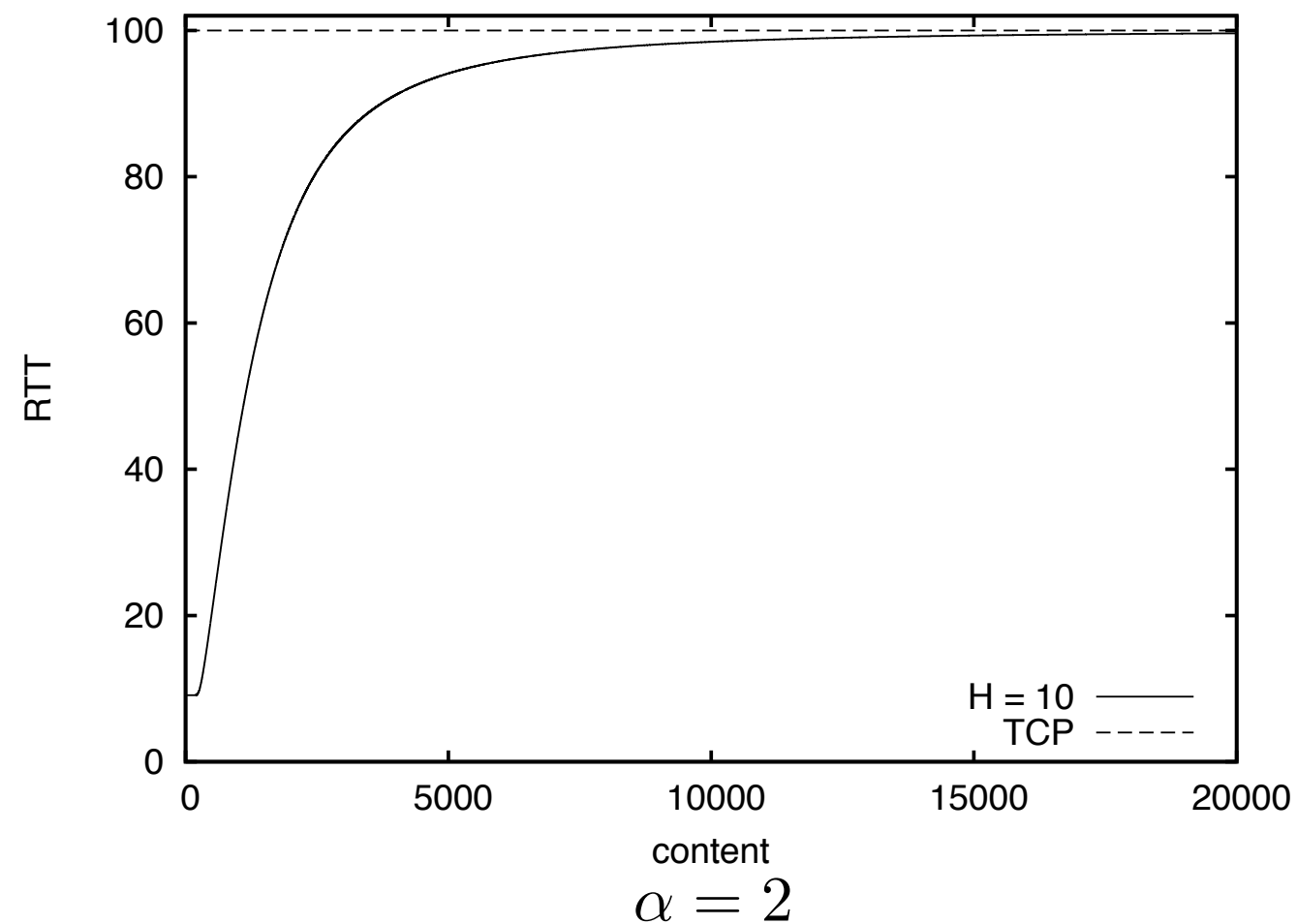
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# Short RTT for popular contents

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



# 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  $i$

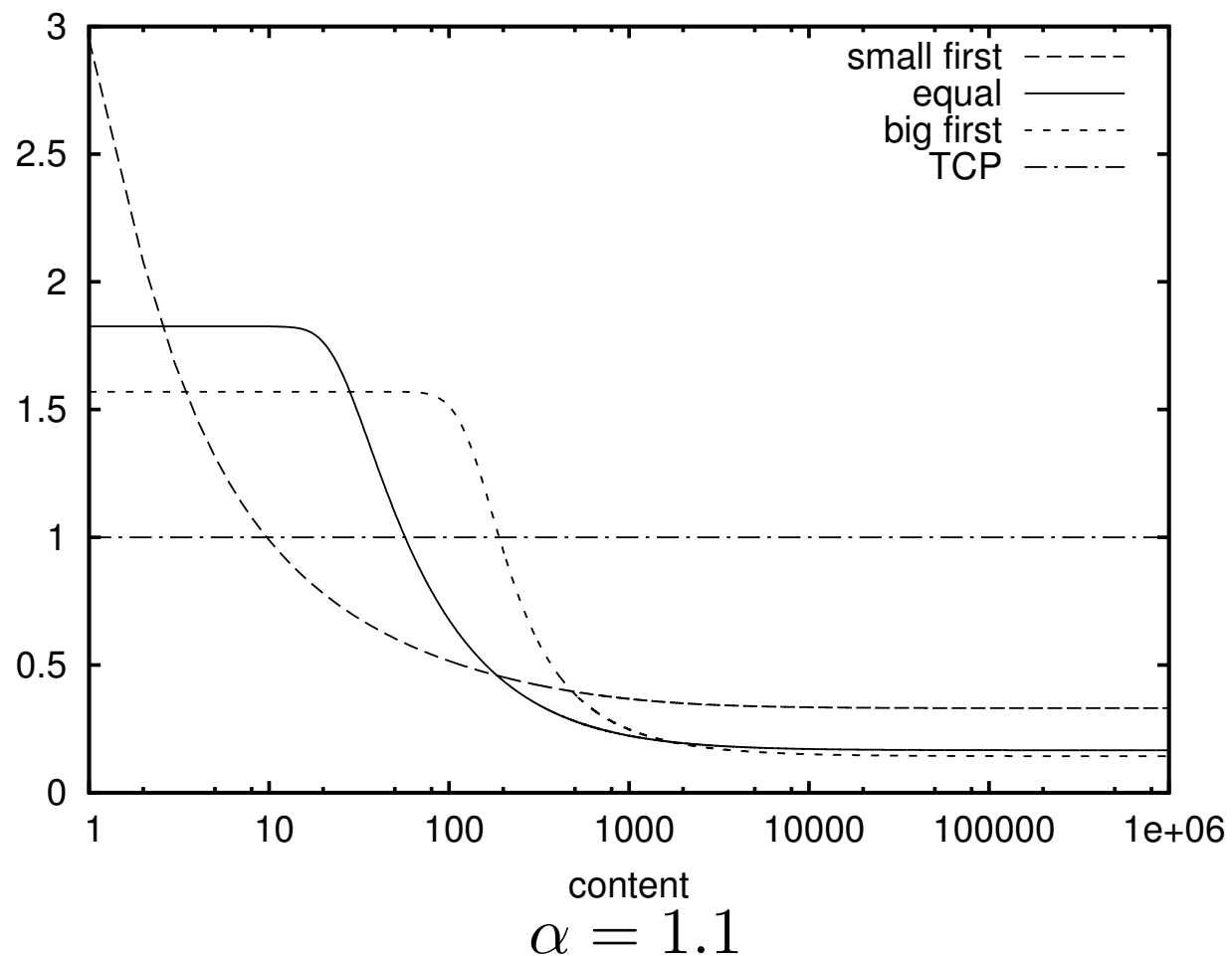
$$\eta(c_i) = \frac{T(c_i)}{\hat{T}(c_i)} \approx \frac{1/RTT(c_i)}{\frac{\sum_{j=1}^N 1/RTT(c_j)}{N}}$$

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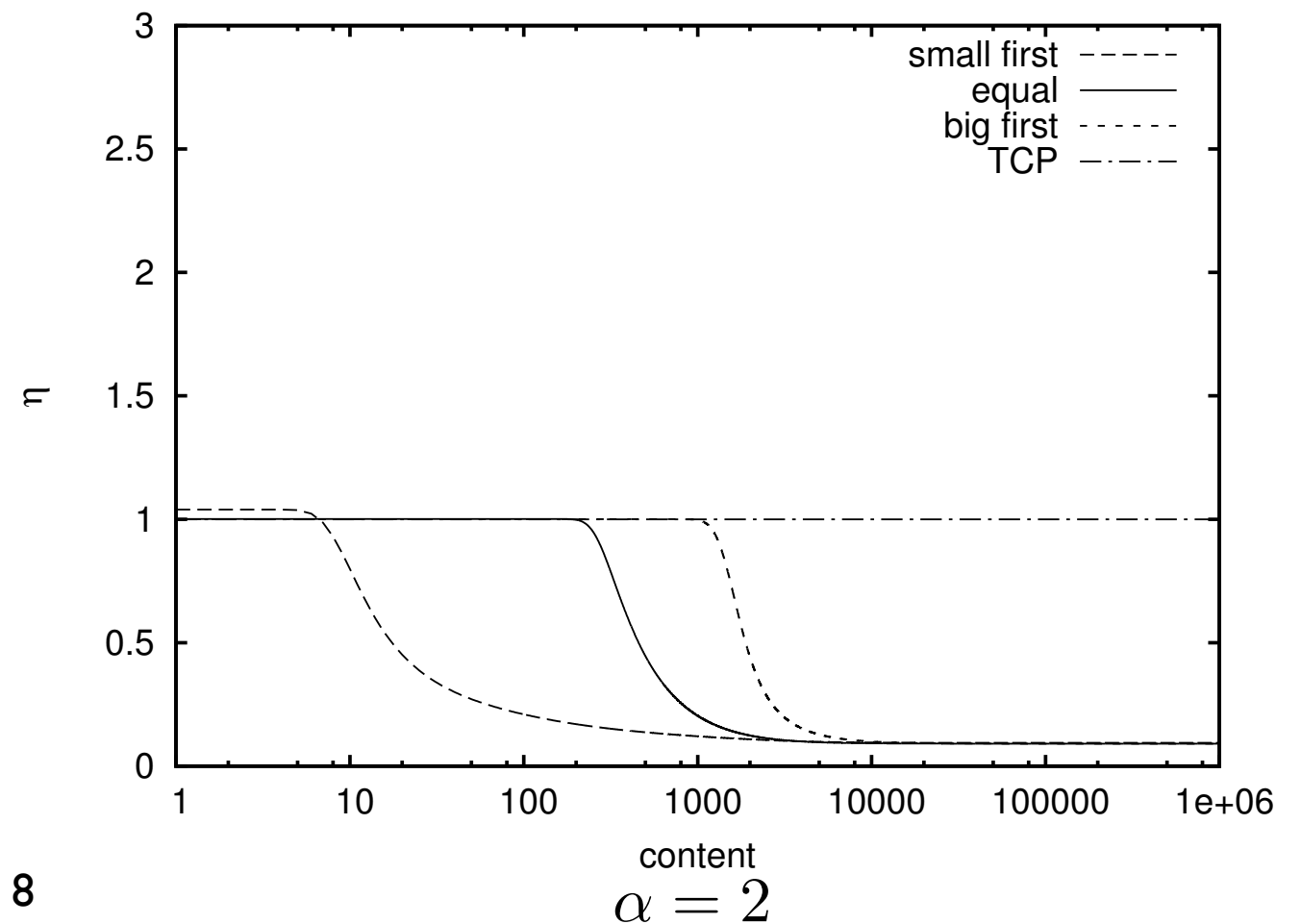
# Negative impact for least popular contents

- Individually, very popular contents might not gain that much...

- ... but least popular lose a lot ( up to  $\frac{1}{H+1}$  )



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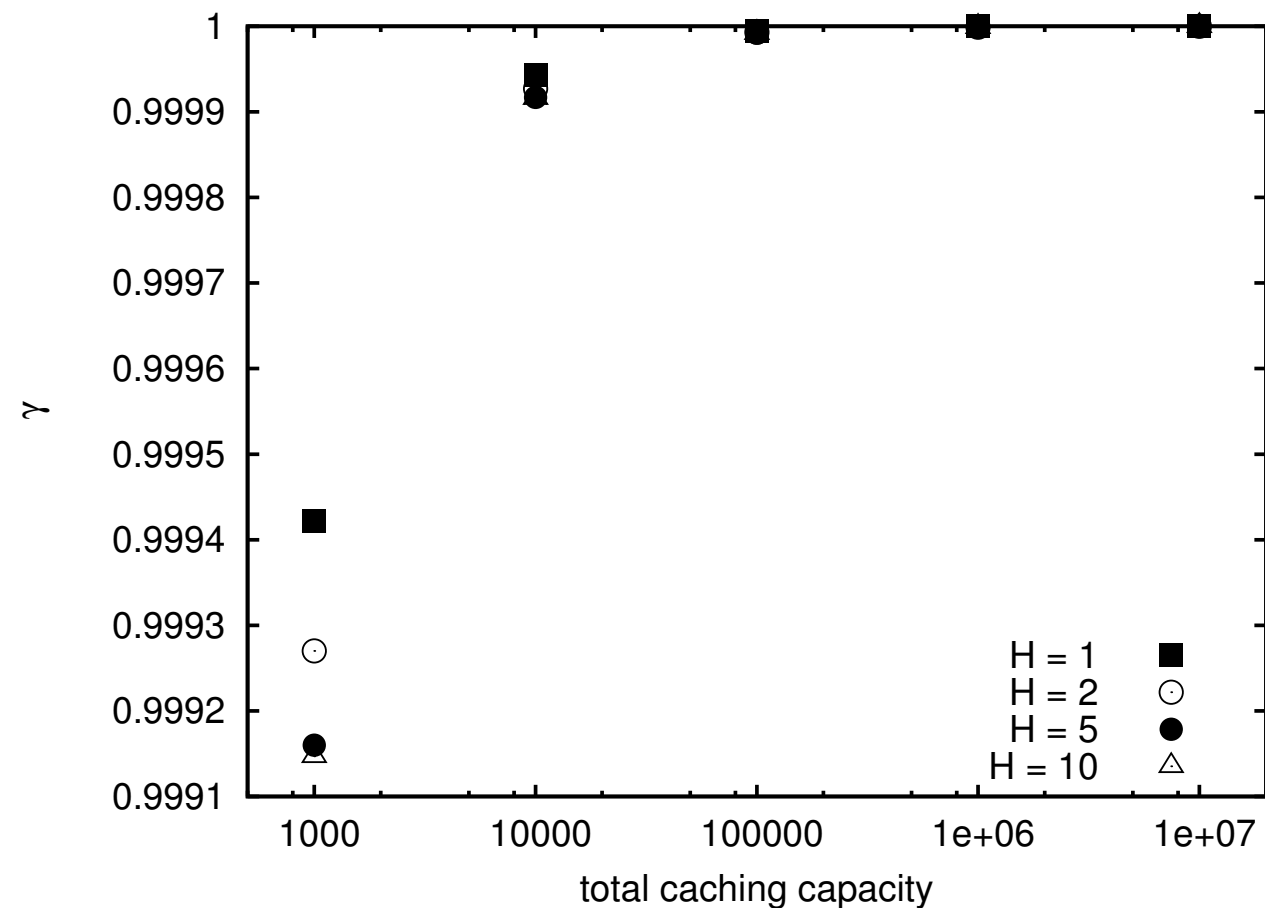
# How does in-network on-path caching impact server load?

- 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  $c$

$$\gamma = 1 - \frac{\Lambda(l_{H+1})}{\Lambda(\hat{l}_{H+1})} = 1 - \frac{\sum_{i=1}^N \frac{\prod_{j=1}^H [1 - \omega_j(c_i)]}{RTT(c_i)}}{\sum_{j=1}^N \frac{1}{RTT(c_j)}}$$

# Server load is reduced

- Limited impact of the chain length on server load



$$\alpha = 2$$

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# 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/>