BIDCACHE
AUCTION BASED IN-NETWORK CACHING IN ICN

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OUTLINE

› Introduction

› “Global” vs “Local” caching methods

› BidCache: The algorithm

› Caching flow with BidCache

› Performance assessment results

› Conclusions and future work
INTRODUCTION

- In-Network caching is one of the most powerful features of ICN
- Proper caching strategy may lead to:
  - Enhanced user experience
  - Minimization of traffic over busy links
  - Decreased content delivery latency
  - Increased network robustness (e.g. upon content sources going offline)
- Caching strategies main trade-off
  - High traffic overhead → Optimal caching decisions ("Global decisions")
  - Low traffic overhead → Sub-optimal caching decisions ("Local decisions")
- Significant volume of work on the two variants
  - Each with its Pros & Cons
GLOBAL INFORMATION CACHING STRATEGIES

Distributed approach

Centralized approach

Requester

Cache

Producer

Cache Manager
GLOBAL INFORMATION CACHING STRATEGIES

Pros (+)

- Optimum utilization of caching resources
- Optimum content distribution

Cons (-)

- Significant traffic overhead
- Computationally expensive (CPU, Tx / Rx)
- Bad scalability for large networks
- Usually requires definition of new structures (tables) and / or fields in the messages
Local information, e.g.:
- Least Recently Used (LRU) item
- Own cache size

Request context, e.g.:
- Estimated popularity of content (frequency of requests)
- Desired latency of content
LOCAL INFORMATION + CONTEXT

Pros (+)

- Minimal to none traffic overhead
- Highly scalable for larger networks
- Easy to implement

Cons (-)

- Nodes still make individual caching decisions
- Sub-optimal use of caching resources
- Sub-optimal distribution of content
BIDCACHE = BEST OF BOTH APPROACHES

Local approach

Global approach

BidCache
Auction to win the “right to cache”

“context information” and bid values are piggy-backed in the Interest message

An indication for the winning node is piggy-backed in the Data message
Bid value calculation per node:

\[ BID = w_1 \cdot f_1 (LRU) + w_2 \cdot f_2 (LFU) + w_3 \cdot f_3 (BW) + w_4 \cdot f_4 (CS) + w_5 \cdot f_5 (HOP) + w_6 \cdot f_6 (LD) \]

Auction flow:

- **Node 1**
  - bid = 5
  - bid_issued = T
  - bid_win = 5
  - Interest

- **Node 2**
  - bid = 4
  - bid_issued = F
  - bid_win = 5
  - Interest

- **Node 3**
  - bid = 7
  - bid_issued = T
  - bid_win = 7
  - Interest

- **Node 4**
  - bid = 6
  - bid_issued = F
  - bid_win = 7
  - Interest

**Auction Winner**
Bid value calculation per node:

\[ \text{BID} = w_1 \cdot f_1(\text{LRU}) + w_2 \cdot f_2(\text{LFU}) + w_3 \cdot f_3(\text{BW}) 
+ w_4 \cdot f_4(\text{CS}) + w_5 \cdot f_5(\text{HOP}) + w_6 \cdot f_6(\text{LD}) \]

Auction flow:

- Bid issued: T  F  T  F
- Can cache: F  F  T  T

Auction Winner

Cached
BIDCACHE – PERFORMANCE ASSESSMENT

- Icarus simulator: Discrete-event, highly scalable simulator
  - Large realistic network deployments
  - Network layouts: Tree (511 nodes) / Barabasi-Albert (551 nodes)
  - Variable caching capacity of the nodes
  - Zipf content popularity

- BidCache Variants
  - LRU + HOP
  - LRU + LD

- Benchmark caching strategies
  - LCE, LCD, Probcache
Bidcache performs better for more realistic content popularities i.e. $\alpha = [0.6,0.8]$

BidCache offers significantly better CHR than LCE and ProbCache

Also outperforms LCD in most cases for this topology (smaller gains)
Both versions of BidCache outperform the benchmarked strategies. The version based on LRU and Link Delay is the best.

The more restricted the caching capacity of the network (larger RCC) the greater the gains of BidCache (optimum caching necessary when capacity is scarce).
Both versions of BidCache offer slightly reduced End-to-End latency

- Content closer to where it is requested
- No extra computational delays
- Latency increases for all caching strategies as the caching capacity decreases
CONCLUSIONS & FUTURE WORK

Main conclusions

- BidCache offers significant CHR gains under realistic network topologies, while at the same time reducing the E2E latency
- Optimal cache resource utilization and content distribution with minimal overhead
- Collaborative decision regarding the caching of an item
- BidCache has the potential for even greater gains when temporal and spatial characteristics of traffic are taken into account

Future work

- Enhanced version of BiCache (comprehensive implementation with increased number of decision parameters)
- Evaluation in scenarios with temporal and spatial traffic variations
THANK YOU FOR YOUR ATTENTION