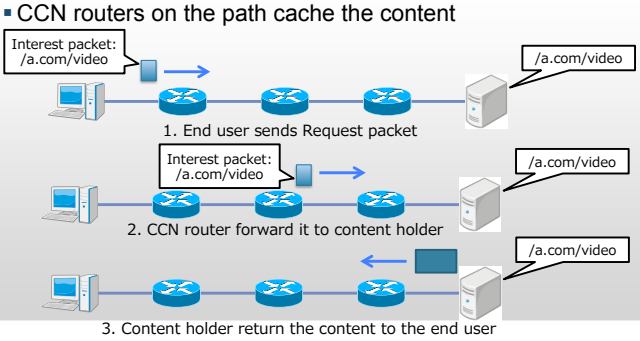
Cooperative cache sharing among ISPs for reducing inter-ISP transit cost in content-centric networking

Kazuhito Matsuda, **Go Hasegawa**, Masayuki Murata
Osaka University, Japan

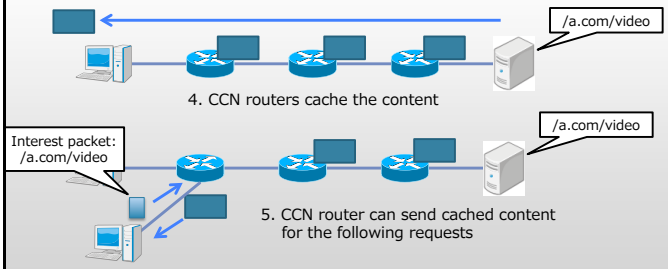
Content-Centric Networking (CCN) (1)

- End user request a content by its name, not by its location
- CCN routers on the path cache the content



Content-Centric Networking (CCN) (2)

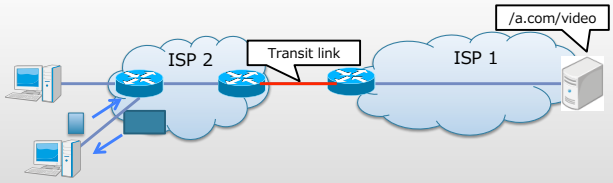
- End user request a content by its name, not by its location
- CCN routers on the path cache the content



Network traffic reduction, small response time for cache-hit contents, …

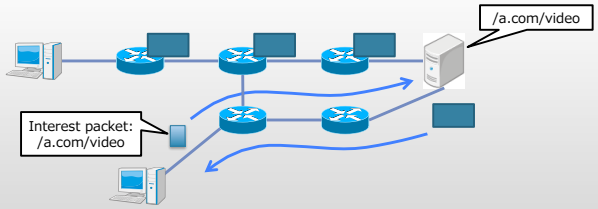
Reducing transit traffic

- For ISPs, CCN may decrease the network traffic on transit links to the upper-layer ISPs



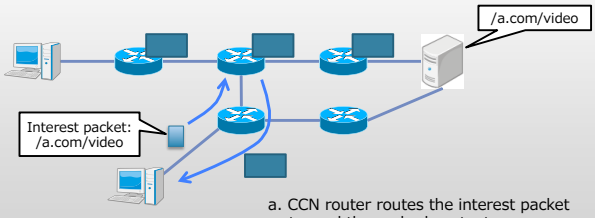
Cooperative caching in CCN (1)

- CCN can only utilize cached contents on the path to the original content holder



Cooperative caching in CCN (2)

- Cooperative caching in CCN can increase the utilization of cached contents and user response time would be further decreased
  - Two possible methods: **Interest packet routing** and cache duplication



Cooperative caching in CCN (3)

- Cooperative caching in CCN can increase the utilization of cached contents and user response time would be further decreased
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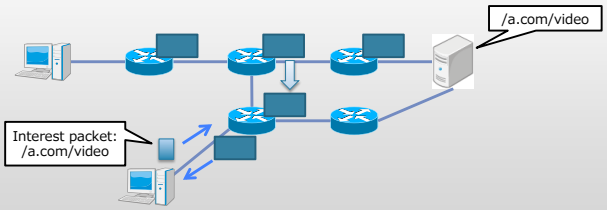
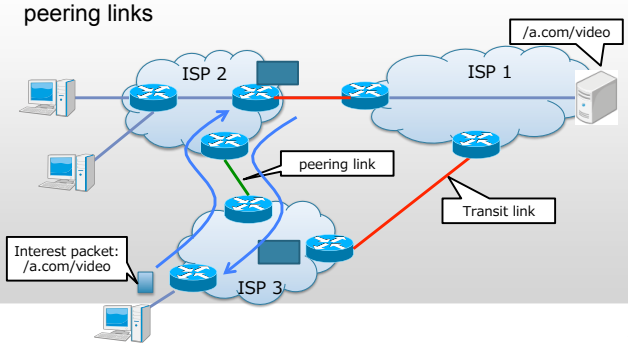


b. CCN router dupulicates the cached content to other router(s)

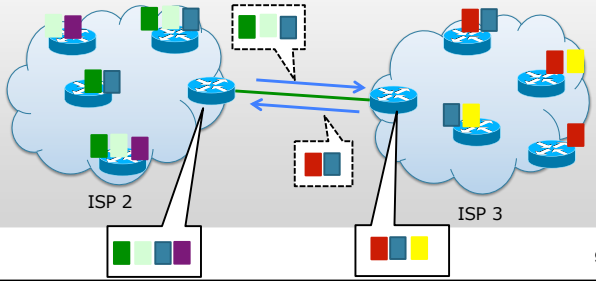
Combining two: cooperative cache among peered ISPs

- ISPs under peering relationships share the cached contents and route interest packets and cached contents on the peering links



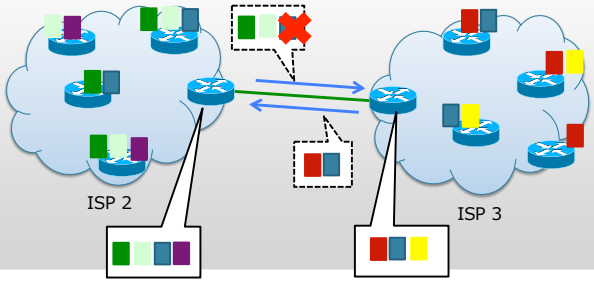
How? (1)

- Edge routers gather the information of cached contents at each ISP
- Advertise selected contents to peered ISPs
- Problem: imbalanced traffic on peering link

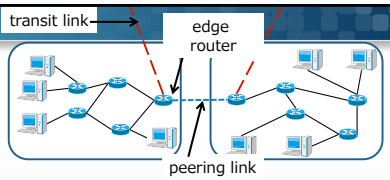


How? (2)

- Balance the network traffic on both directions by controlling advertised contents



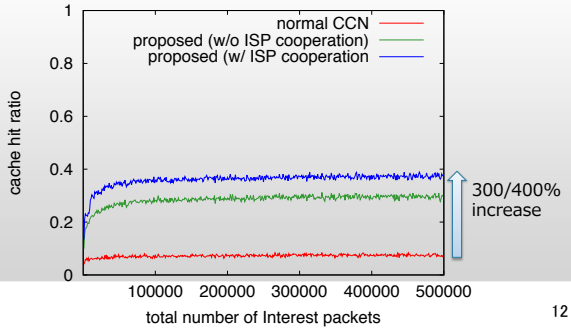
Evaluation



- Two peered ISPs with identical network topology of 82 CCN routers
- CCN router cache: 500MB, LFU replacement policy
- 10,000 unique contents with uniform size distribution from 1 to 150 MB, Zipf distribution of popularity
- 500,000 interest packets are generated
- Performance metric: cache hit ratio, traffic amount on transit and peering links
- Normal CCN, Proposed method with and without ISP cooperation

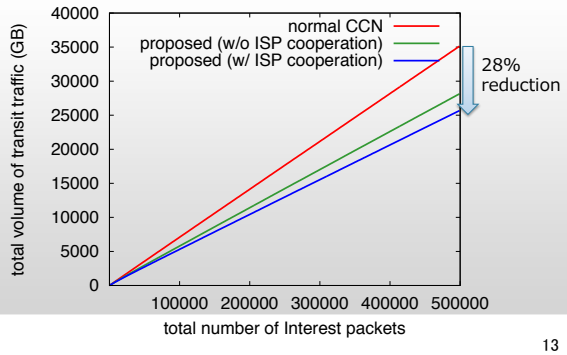
Cache hit ratio

- 300% improvement in cache hit ratio even without ISP cooperation, and additional 100% increase with ISP cooperation



Network traffic on transit link

- 28% reduction by proposed method with ISP cooperation



Other results

- User response time: average hop count to requested contents is reduced by up to 25%, depending on the ISPs' network size
- When the skew parameter of Zipf is small, the effectiveness of the proposed method increases, up to 80% reduction of transit link traffic
  - Smaller Zipf parameter means less bias in content popularity distribution
- While the transit link traffic is reduced with the proposed method, the peering link traffic increases due to ISP cooperation
  - Duplication of cached contents to other ISPs may be effective

Conclusions and future works

- Conclusions
  - Cooperative caching in CCN among peered ISPs can increase the cache hit ratio by up to 400%
  - The amount of transit link traffic can be reduced by up to 80% and smaller user response time can be achieved
  - The proposed method shift the transit link traffic to peering link, resulting in the reduced operation cost for ISPs
- Future works
  - Performance evaluation in larger scale networks with more ISPs
  - Reduction of control traffic for advertisement of cached contents
  - Duplication strategies of cached contents for reducing peering link traffic
  - Protocol implementation