Economic Incentives for Deploying Local-Aware ICN-Based Content Delivery

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Timeline

- Evolution of business models and actors relationship with ICN deployment

- Local-aware NDN routing architecture
  - use-case: Online Social Network (OSN) applications

- Economic Incentives for the local-aware ICN-based content delivery

- Conclusion
Evolution of business models and actors relationship with ICN deployment (1/)

- **Current ecosystem**: well installed & identified players

- **End-users** (Eyeballs)
  - consume contents provided by CP

- **Content Publisher**:
  - Provides content (UGC or premium) on Internet over a given geographical area (possibly defined according to distribution rights)

- **CDN providers** (can be CP: e.g.; GC)
  - Manages optimized content storage and delivery resources to sell scalable and quality content storage and delivery services

- **Transit ISP**
  - Provides transport services to CPs and access ISPs to reach Internet

- **Access ISP**
  - Provides Internet Access service to end-users (eyeballs)
ICN Main features

- user mobility
- multipath
- multicasting
- caching
- content protection and authentication

=> Can change the delivery chain and business models ("transparent" caching, "transparent" multicasting)
Evolution of business models and actors relationship with ICN deployment (1/)

- Main consideration: Keep Actors and values for them, from a smooth integration and deployment of ICN, valuable for each of them
  - => no strong opposition

- ICN-based content delivery, provided by CDN providers or ISP providers or both

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**Level of contractualisation between ISP and 3rd parties**

- **Contracted CPs services**
- **Non-Contracted CPs services**
- **ISP own services**
Local-aware NDN routing architecture (1/)

- We consider Twitter for the sake of clarity

- The networking behaviour is not in line with the end-users’ behaviour
  - Users are very frequently connected to other users in the same town or region, in short in the immediate vicinity. A majority of tweets are destined to local or close users, except for very popular accounts.
  - But almost all the network traffic is send to the remote servers (US Twitter servers or US/Ireland Facebook server) and all consumed tweets are retrieved from the remote servers

- What can we do to optimize the delivery of contents, more in line with local users relationships?
  - NDN (Named Data Networking): a candidate for improvement
NDN-based Routing for Local-Awareness in Twitter-like Social Networks

- We use the NDN architecture to optimize the networking behaviour while better reflecting the local end-users behaviour.

- Popular end-users, whose content is consumed worldwide, should have a different way of working than non-popular local end-users, whose content will be locally consumed.

- We perform local routing between the end-users who are in the immediate vicinity.

- Locality is defined by network routing hop:
  - Two users are local if there are separated by 2 routing hops (or any other value depending on the design configuration).

- A centralized (SDN-based) controller allows to dynamically configure the NDN forwarding tables, based on the social interactions in the OSN:
  - e.g. add route in the local NDN routers if close friends/followers are on-line, remove it if not.
Publication of a Content

- For naming end-users and their contents (text messages, videos, photos, etc), we suggest the following hierarchical naming:
  - /Twitter/UserXXX/TweetAAA, /Twitter/UserXXX/VideoBBB

- We consider local network regions of 2 routing hops.
Local Routing for Retrieving Content from Local Users

- Local users (2 routing hops far away from Joe) will get content directly from Joe, instead from the Twitter server.
Using Twitter Server for Retrieving Content from Non-Local Users

- Non-local users will be served by the Twitter server.

Use prefix /Twitter to route the Interest to the server.

Interest (/Twitter/Joe/Video10)

Non-local user Bob requests Joe’s content

User Joe is online and can serve his contents

User Alice

User Walter

NDN controller (SDN-like architecture)

NDN forwarding table (NDN FIB)
Economic Incentives for the local-aware ICN-based content delivery

- Estimate the economic viability for each involved stakeholder when adopting our locality-aware and NDN-based routing scheme for delivering content

- Compare current delivery chain vs local-aware ICN-based delivery
  - with involved actors:
    - Service Providers
    - Delivery Service Provider provider
    - Access ISP

- Variables:
  - the ratio of users (ε) which can retrieve content from local users
  - the probability of cache hit (p)
Economic Incentives for the local-aware ICN-based content delivery

- Exemple : Cost for Service Provider :

  - With local-aware ICN-based delivery

  \[
  \text{COSN} = [(1-p).D.(1-\varepsilon).F.W.T] \\
  + [\gamma p].D.F.T] \\
  + [\tau f.T] \\
  + [p.D.\tau v.T]
  \]

  - network cost to serve cache miss
  - processing cost for handling cache miss
  - cost for delivering content from caches
  - transaction costs for outsourcing delivery
Economic Incentives for the local-aware ICN-based content delivery

- Exemple: Cost for Access ISP
  
  - With local-aware ICN-based delivery

  \[
  \text{COSN} = [(1-p).D.(1-\varepsilon).F.B.T] \\
  + [S_{E}.F.T] \\
  + [P_{E}.D.T] \\
  + [p.D.K_{E}.T] \\
  + \delta
  \]

  - transport cost for cache misses
  - transit cost for cache misses
  - storage cost
  - processing cost
  - Accounting and billing cost
  - additional cost

  the ratio of users ($\varepsilon$)
  the probability of cache hit ($p$)
Conclusion

- ICN can be deployed if actors can keep some of their business

- We envision a progressive deployment of ICN, with relationships between actors to set up

- For a network point of view (network traffic), a local-aware delivery is interesting

- The economic evaluation we performed proved the interest of a local-aware NDN-based delivery architecture for most of the involved actors.
Thanks.

Q&A