Popularity-based Caching in Content Centric Networks

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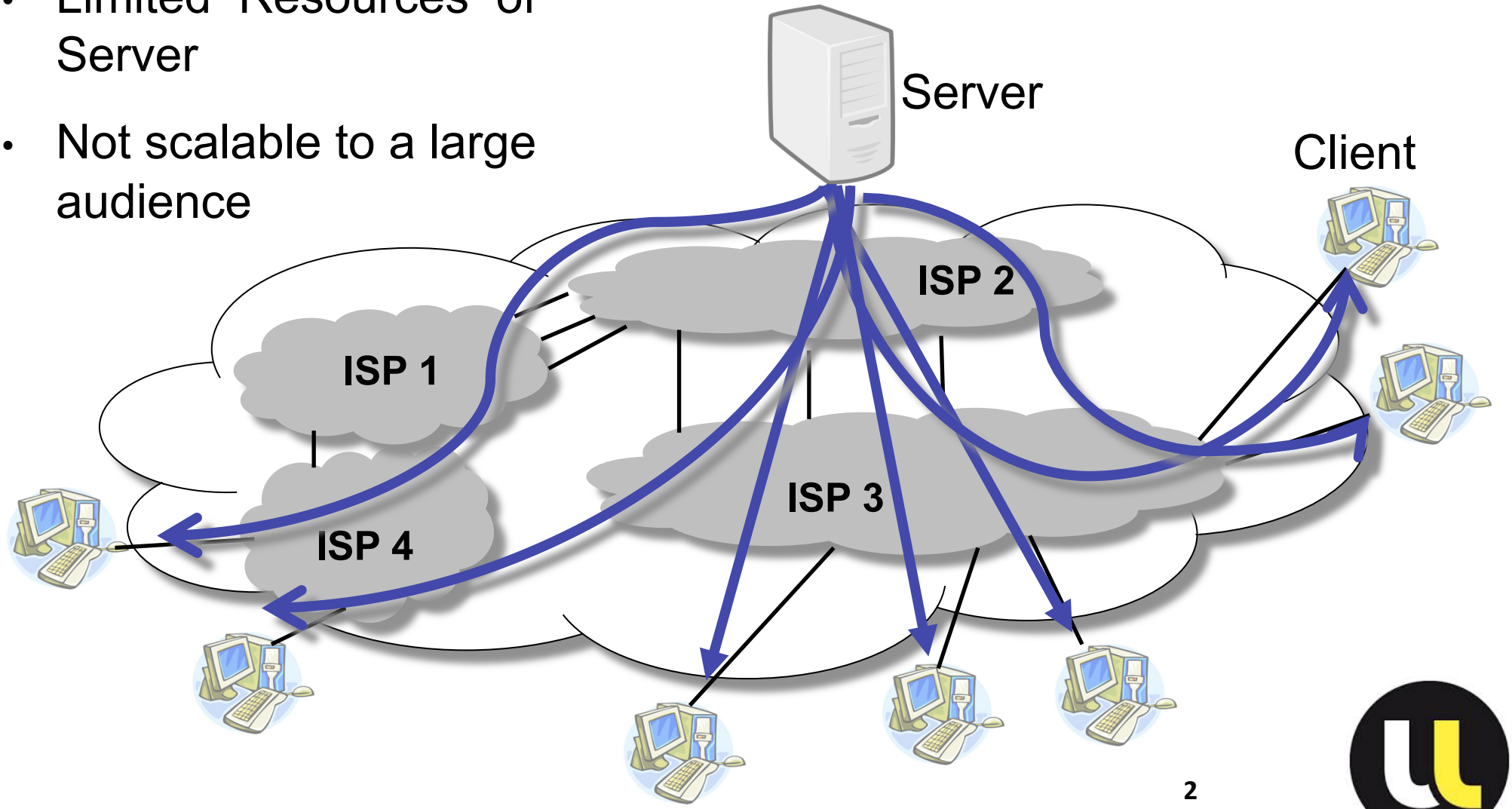
Motivation

- Internet is mostly used to access content
  - Video: 86% of global consumer traffic by 2016
    - Cisco VNI 2012
- Internet: host-to-host communication
  - Users are interested with content, not location
- Communication Models
  - Client/Server
  - Content Delivery Networks (CDN)
  - Peer-to-Peer (P2P)

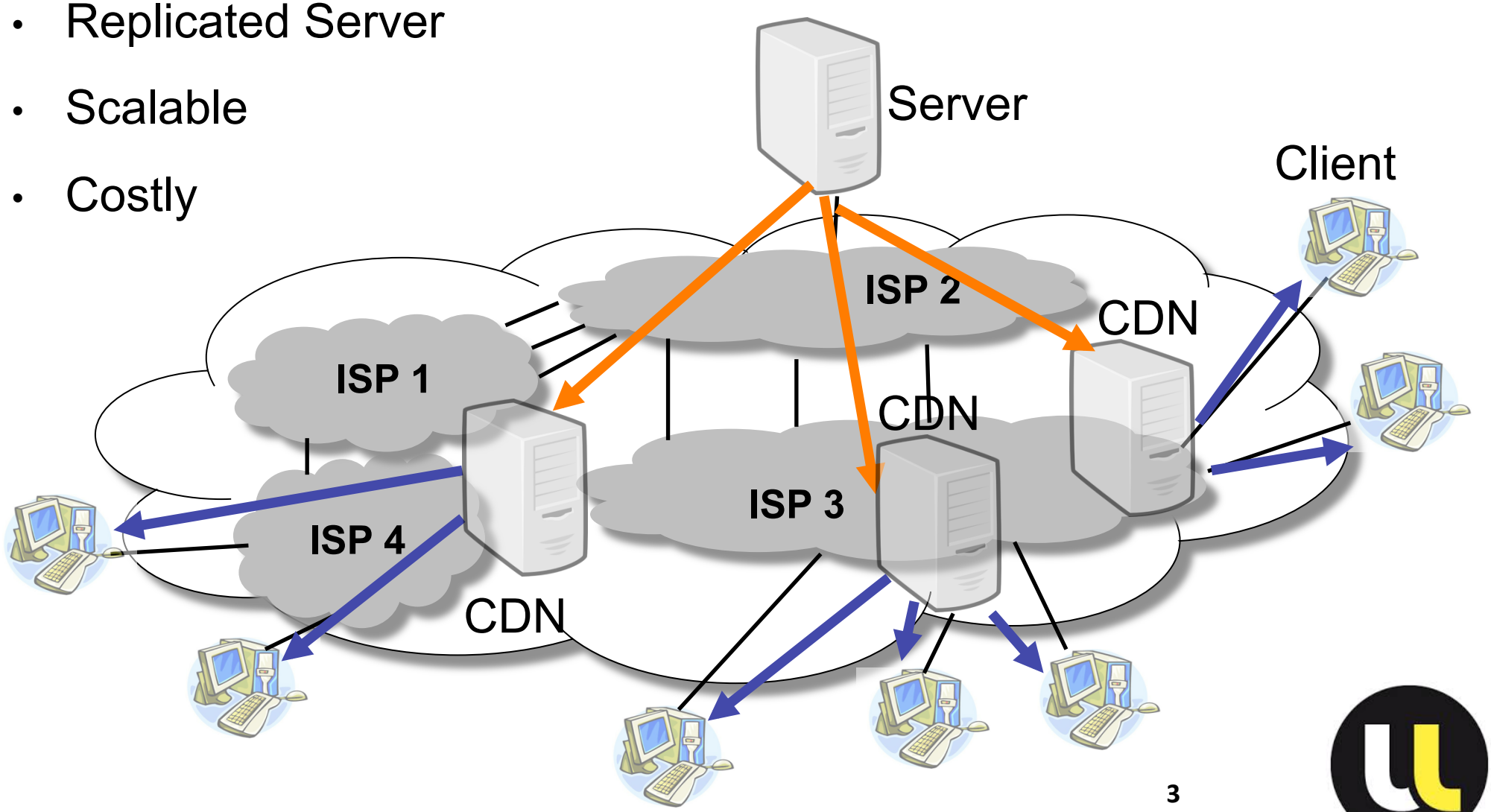
Communication Models: Client/Server

- Limited Resources of Server
- Not scalable to a large audience



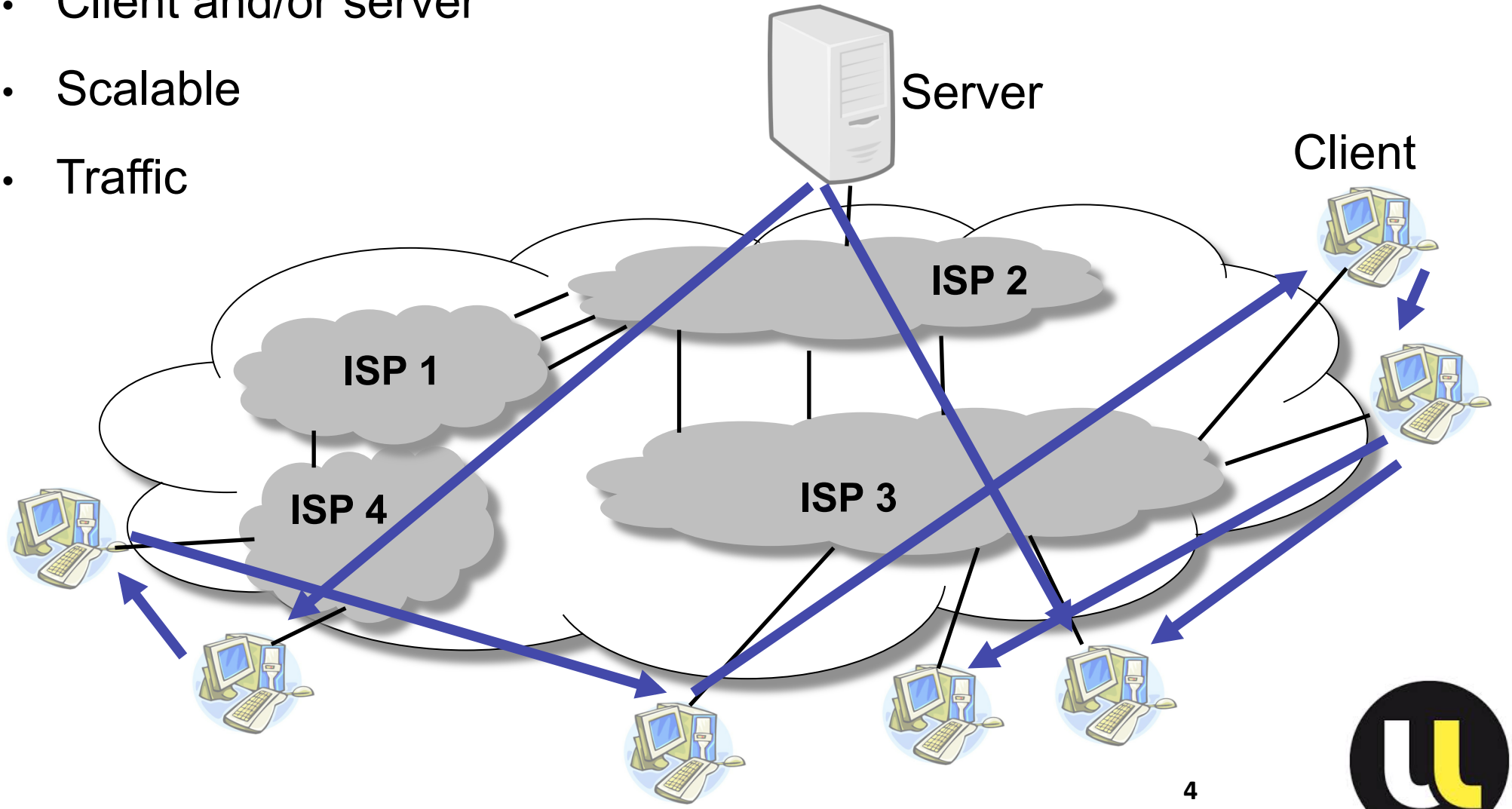
Communication Models: Content Distribution Networks

- Replicated Server
- Scalable
- Costly



Communication Models: P2P

- Client and/or server
- Scalable
- Traffic



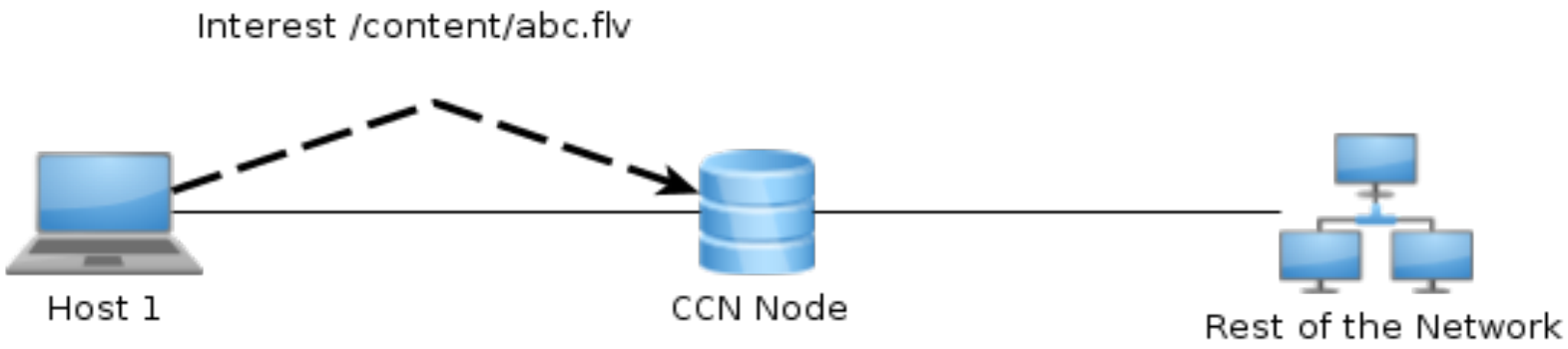
Motivation

- Internet is mostly used to access content
  - Video: 86% of global consumer traffic by 2016
    - Cisco VNI 2012
- Internet: host-to-host communication
- Users are interested with content, not location
- Future Internet: Information Centric Networks
  - Content Centric Networks (CCN)
    - Van Jacobson [ACM CoNext 2009]

CCN Overview

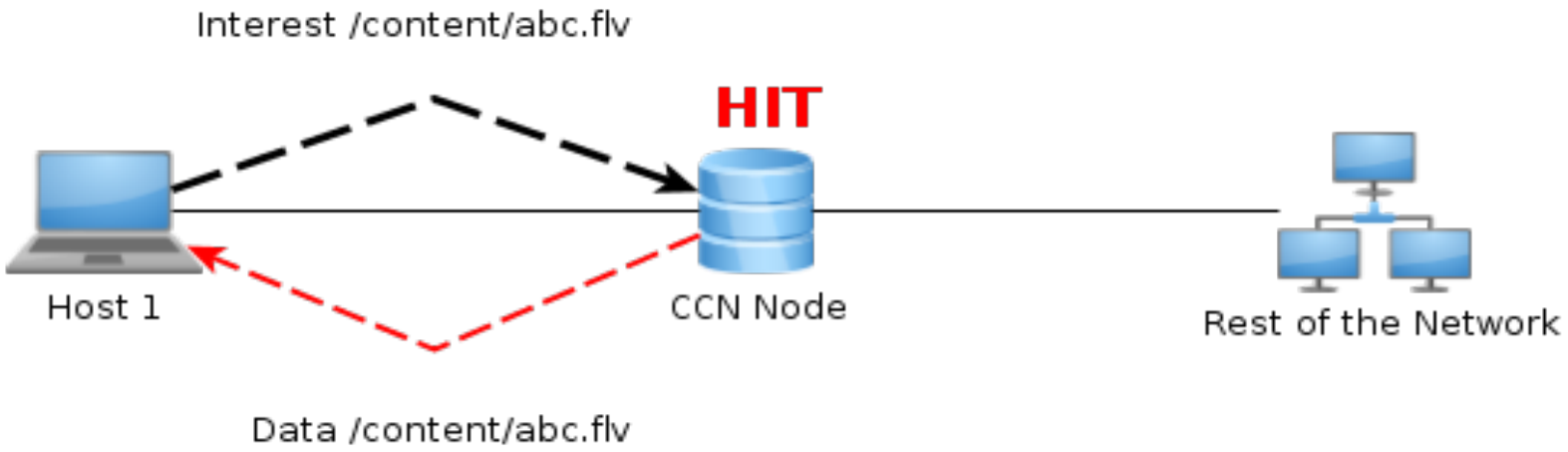
- In-Network Caching
- Packet address refers to content and not location
- Two primitives
  - *Interest*, user requests content by issuing an Interest message
  - *Data*, a node having the content answer with a Data message
- Data at the core of the communication
- *'Network Layer'* for Content Delivery

CCN Overview



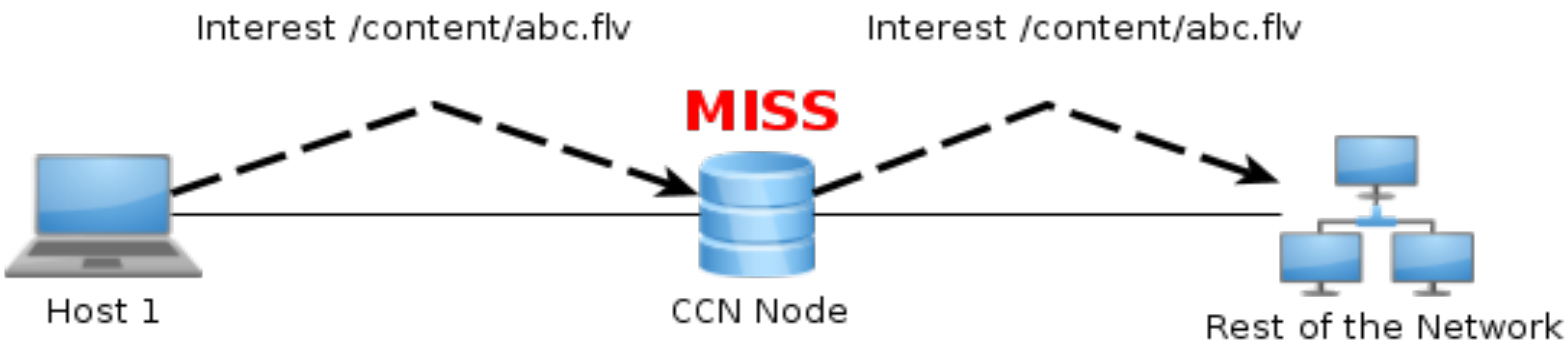
- Host 1 wants content /content/abc.flv
- Host 1 issues an *Interest* message

CCN Overview



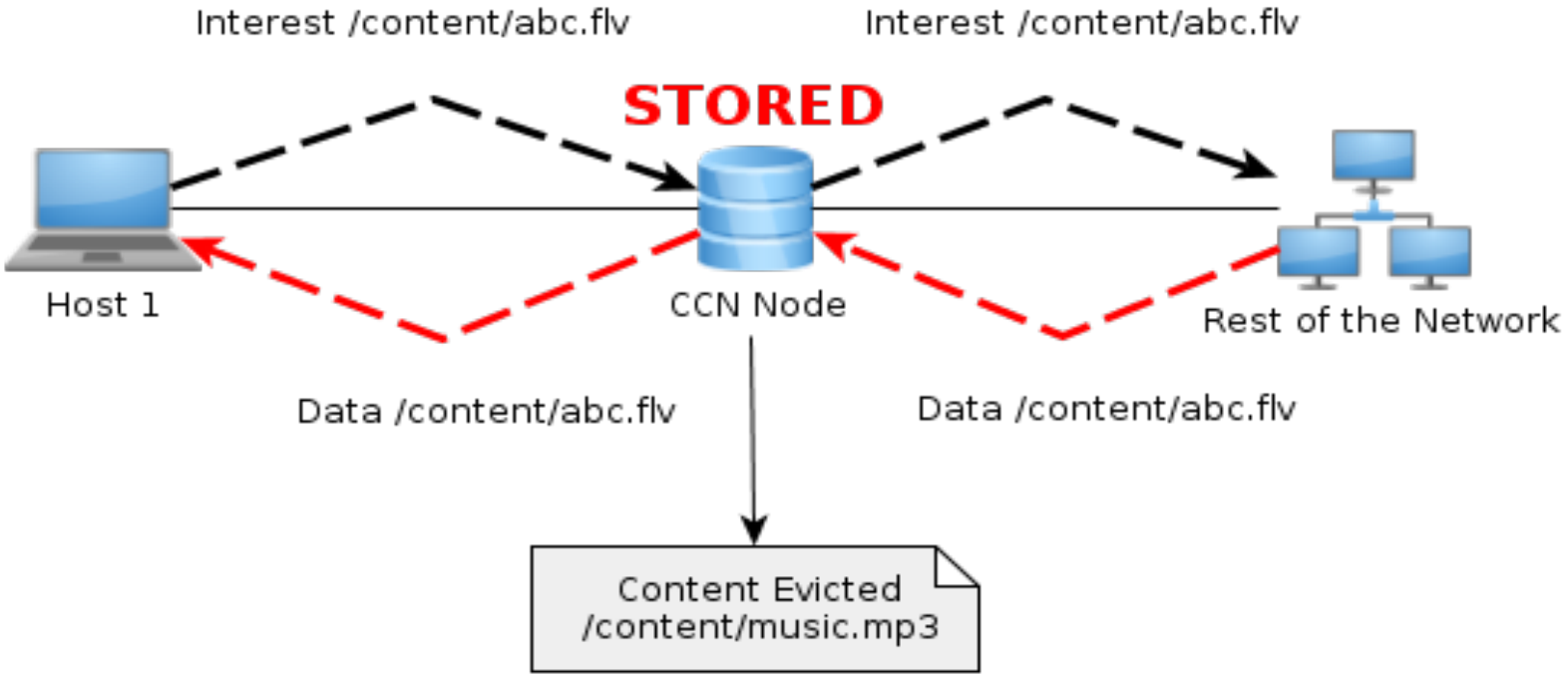
- CCN Node has /content/abc.flv in its Cache
- CCN Node issues a Data message

CCN Overview



- CCN Node has NOT /content/abc.flv in its cache
- CCN Node transfers the *Interest* to the rest of the Network

CCN Overview



- /content/abc.flv is found
- A Data message is transmitted along the delivery Path
- CCN makes room by evicting some content
- CCN Node stores /content/abc.flv and forward it to Host 1

CCN Cache Management

- Caching along the delivery Path
  - In-Network caching
- Replacement Policies
  - Decide the element to be replaced
    - LRU, FIFO, MRU MFU etc.
    - Well-studied for systems, memory etc.
- Caching Strategy
  - Decide whether to cache content
    - Huge cache, Fricker et. al [IEEE NOMEN 2012]
    - Cache less, Chai et. al, [IFIP Networking 2012]

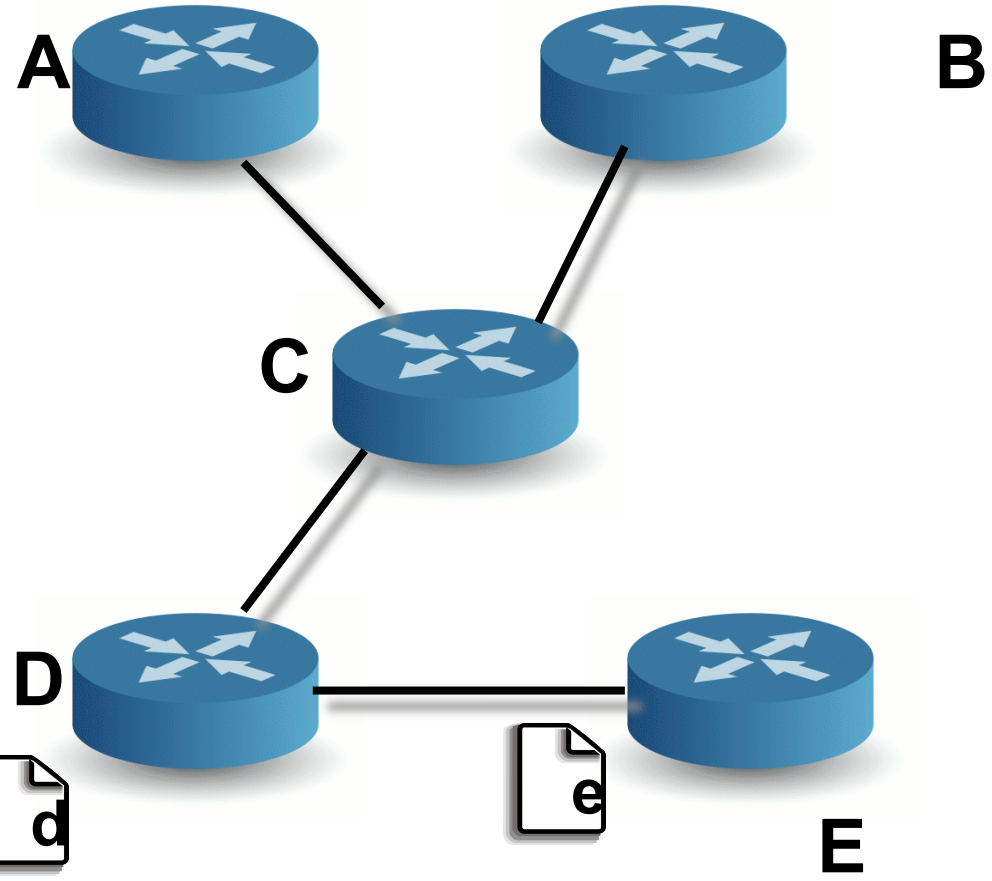
Essential to design caching management for CCN

Popularity-based Caching Strategy

- CCN in-network caching
  - Storing content at every nodes on the path
  - Overloading nodes and network Resources

- MPC Caching Strategy [IEEE ICC 2013]
  - Decide to cache the content only if the content is *popular*
    - *Counts* locally *#Interests* (Requests) for a *Content*
    - *#Interests > Popularity Threshold* ➡ *Popular*

Case Study: CCN



Scenario

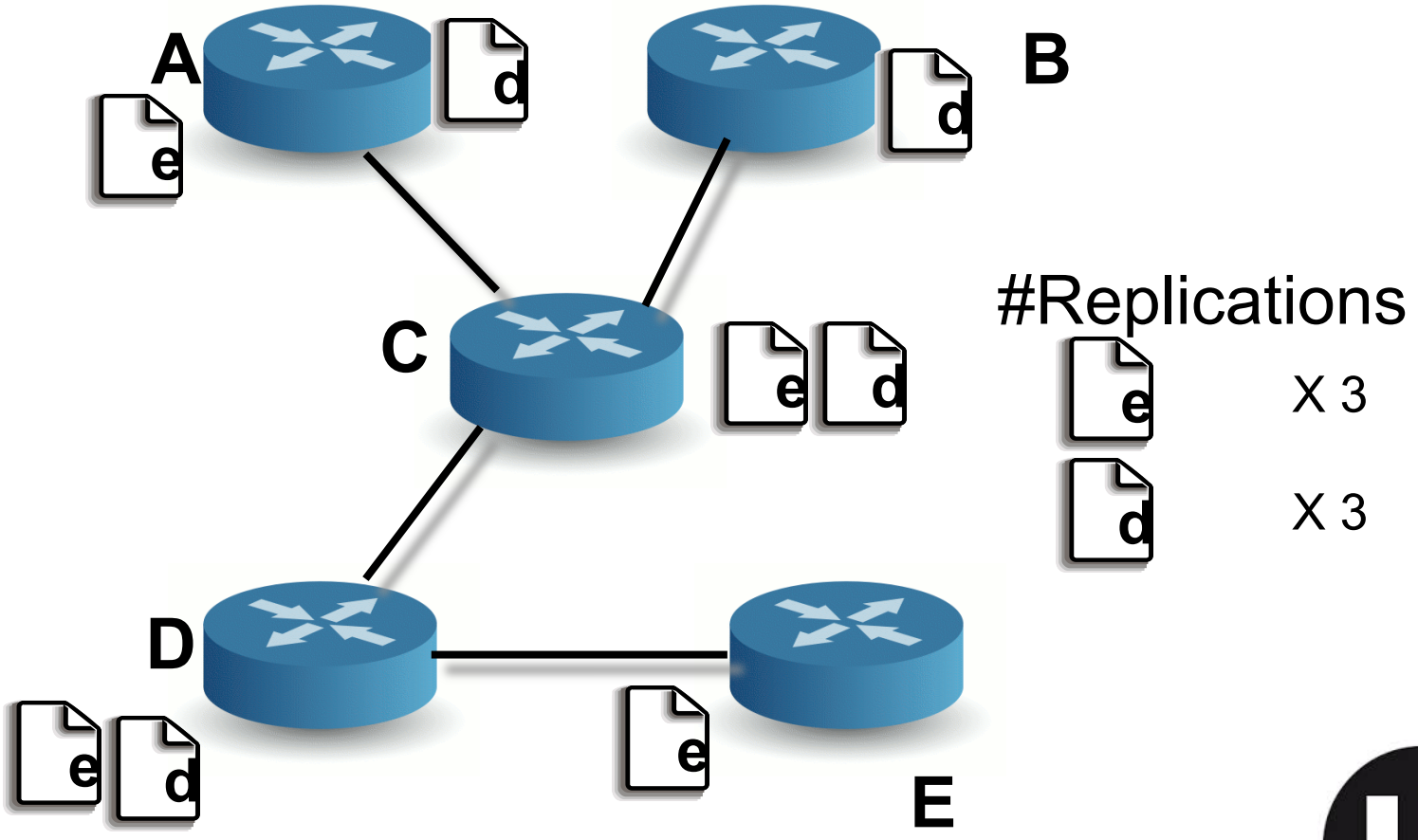
A requests e

B requests d

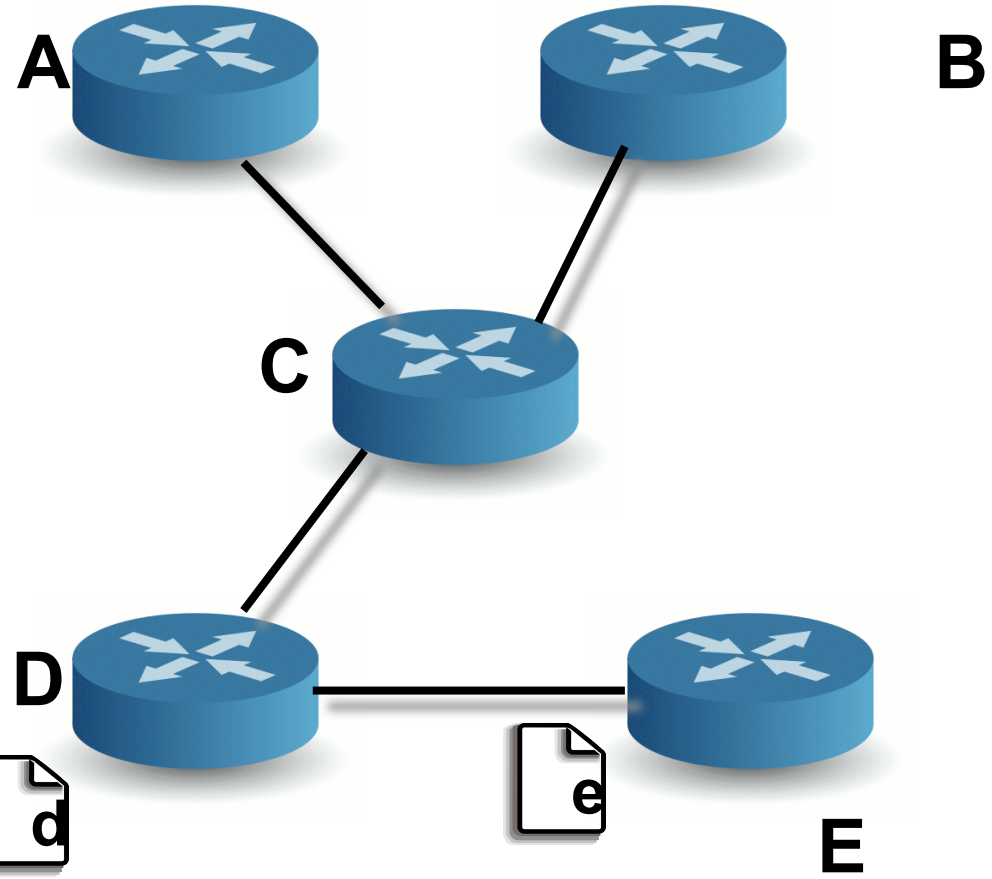
A requests d

C requests d

Case Study: CCN



Case Study: MPC



Scenario

A requests e

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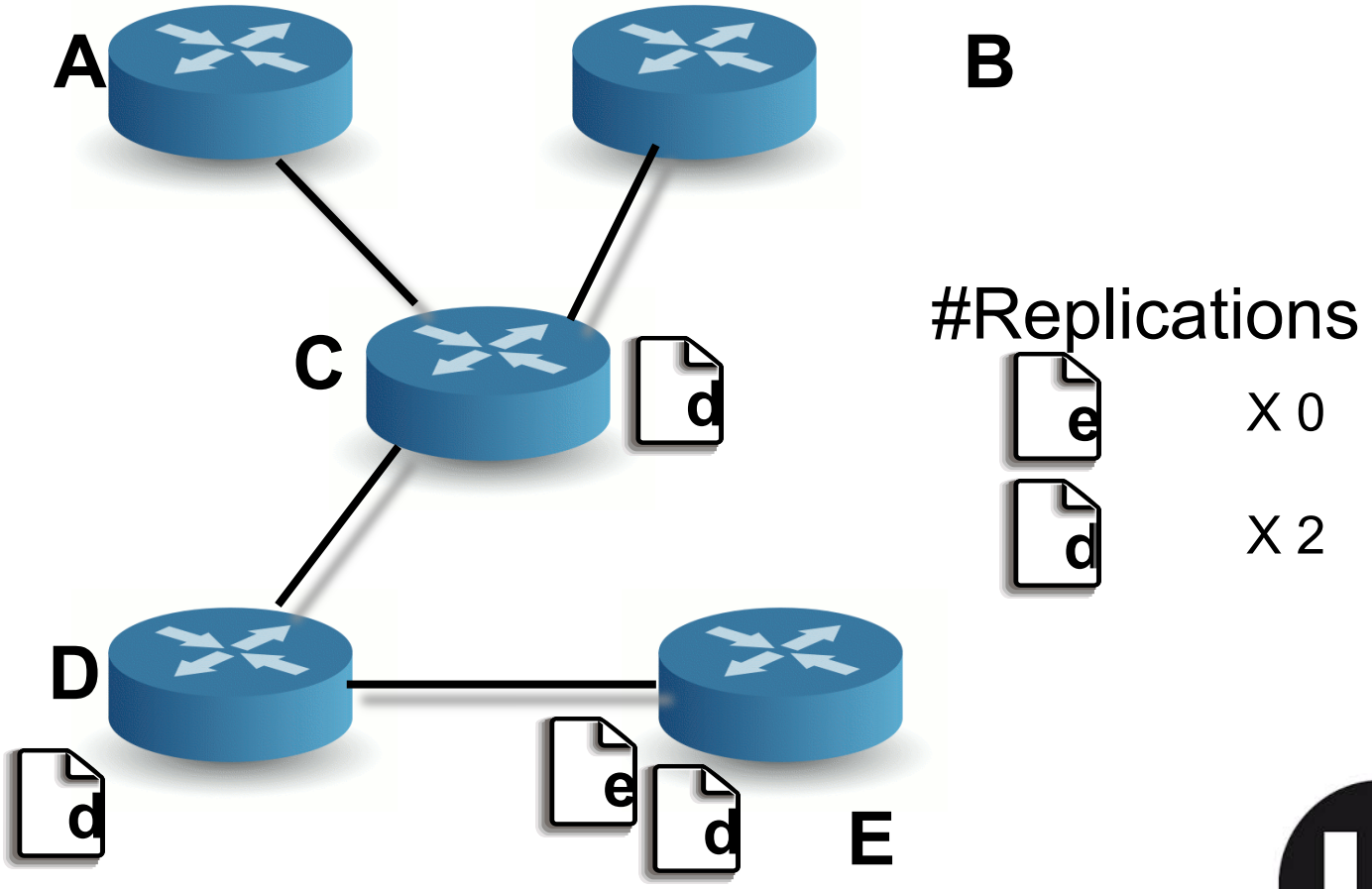
Case Study: MPC



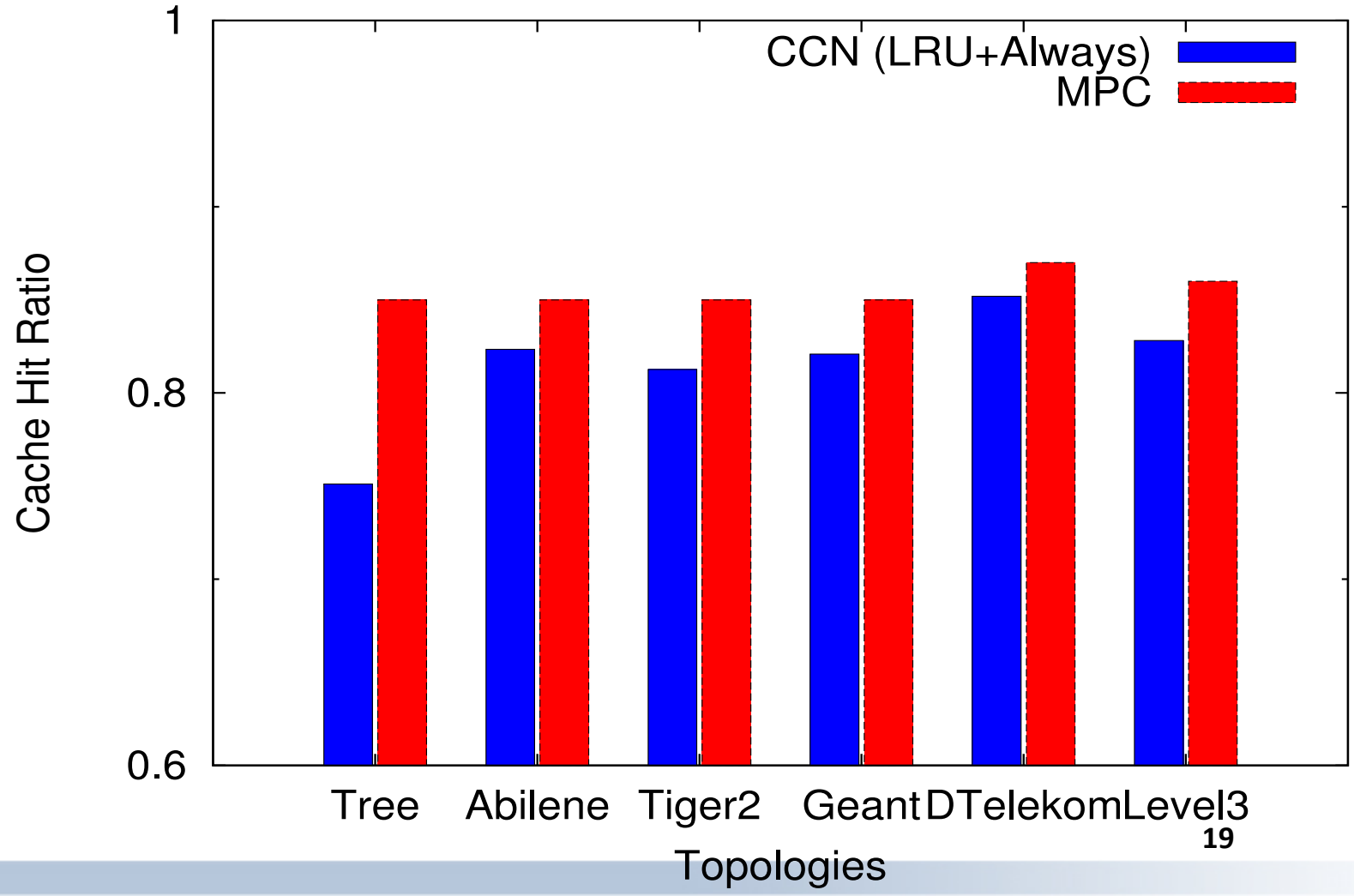
Content Popularity-based Caching

- CCN in path caching
  - **3 replicas of each content d and e**
- MPC caches only popular content
  - **2 replicas of content d (popular)**
  - **No replica of content e**
  - Pro-active caching of popular content

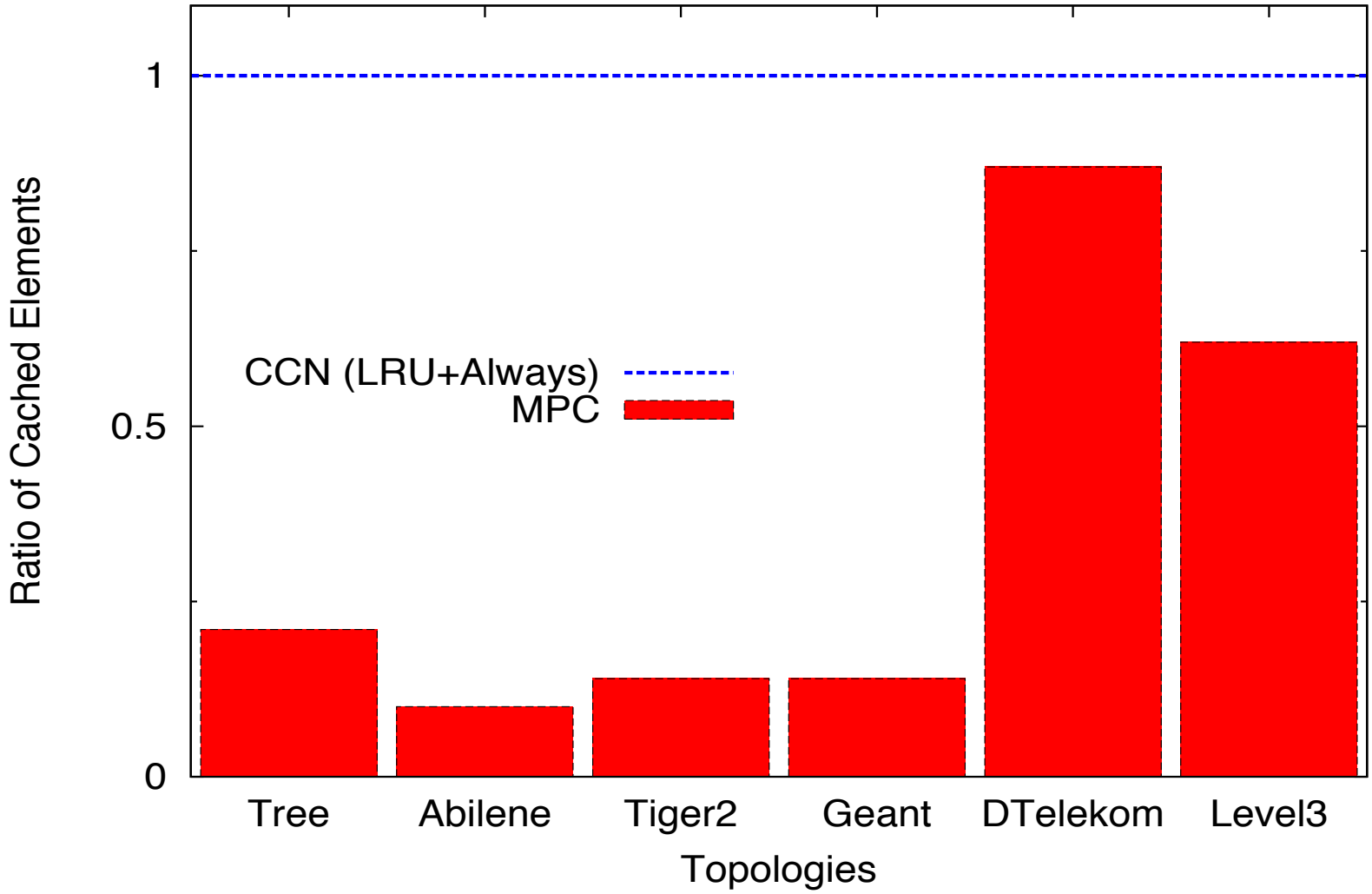
Evaluation

- Does Caching only popular content improve CCN performances?
- ccnSim simulator
  - Standard parameters
- Comparison
  - MPC vs. CCN

MPC Evaluation



MPC Evaluation



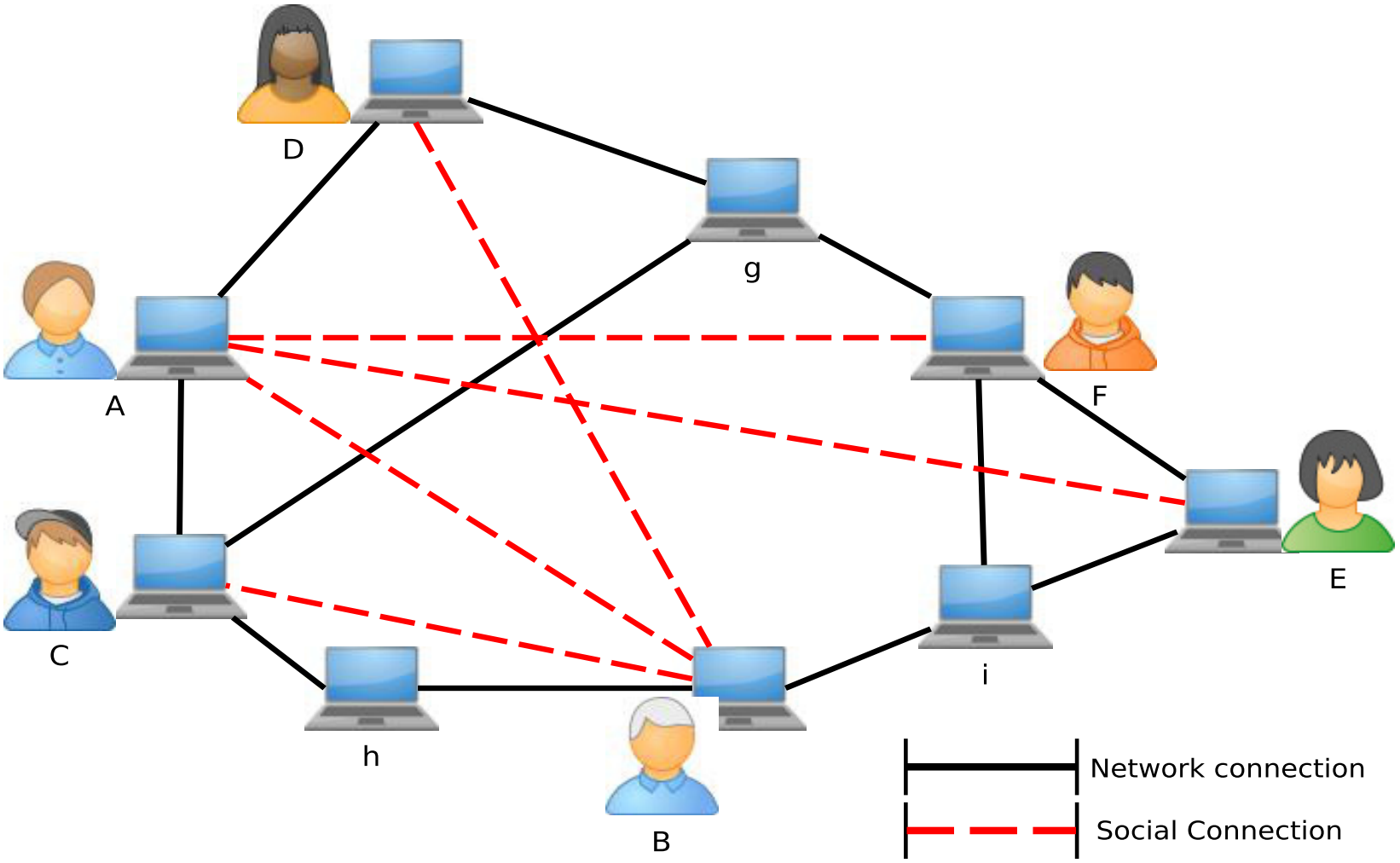
Popularity

1. Content
2. Users

Future Internet

- Internet has become a « content network »
  - Video counts for 86% of traffic up to 2016
- Users 'activity: Online Social Network
  - Internet has become a « social network »
- Future Internet
  - OSN over CCN

Future Internet



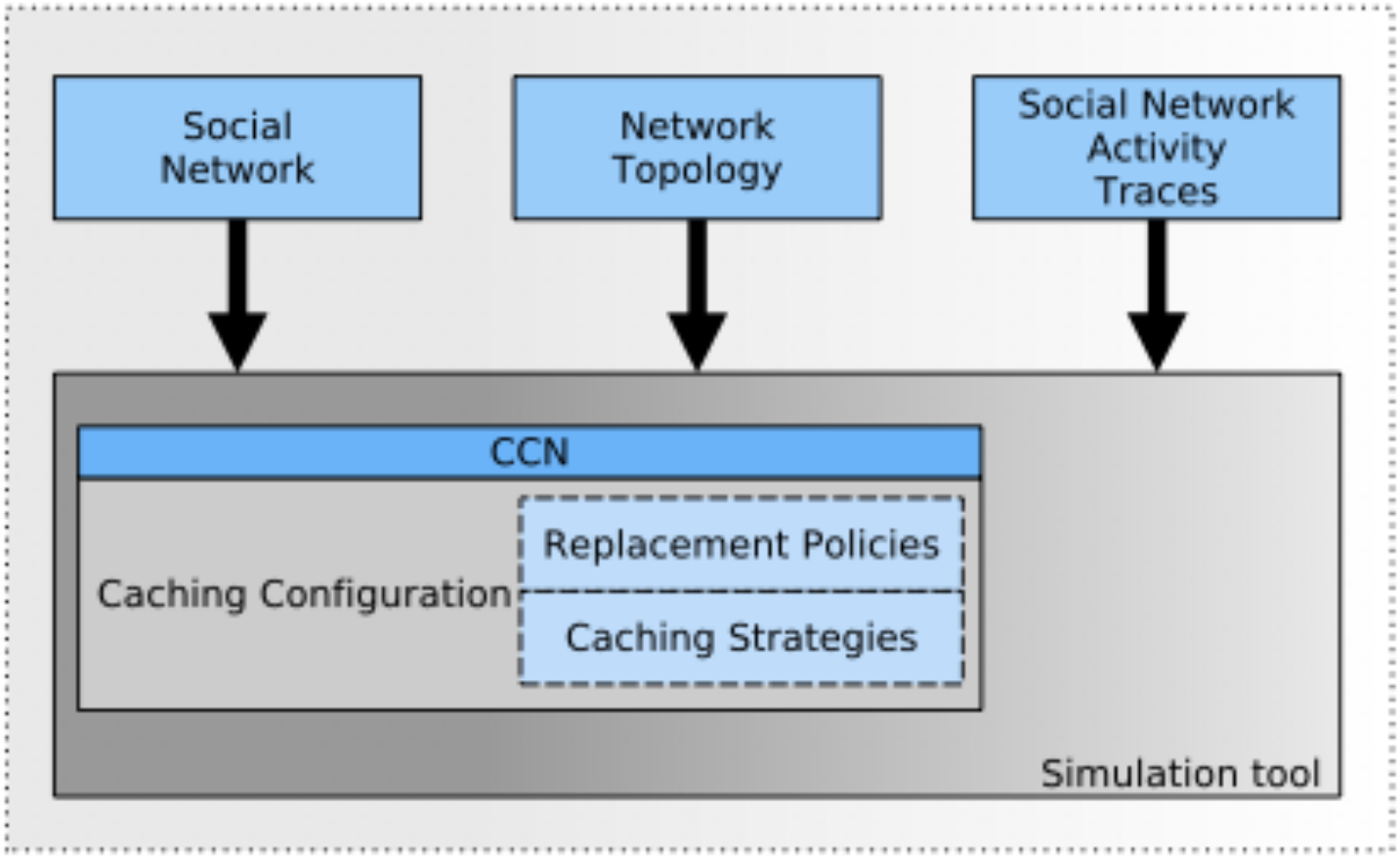
Future Internet

- Internet has become a « content network »
- Users 'activity: Online Social Network
  - Internet has become a « social network »
- Future Internet
  - OSN over CCN
- Does OSN may improve CCN ?
  - Privilege content published by popular users
- Does popularity of users help In CCN?

Popularity of Users

- Score for users regarding their *importance*
- Eigenvector centrality measures
- PageRank centrality measures
  - Google
- If score(user) > Avg_score
  - Influentials <- user

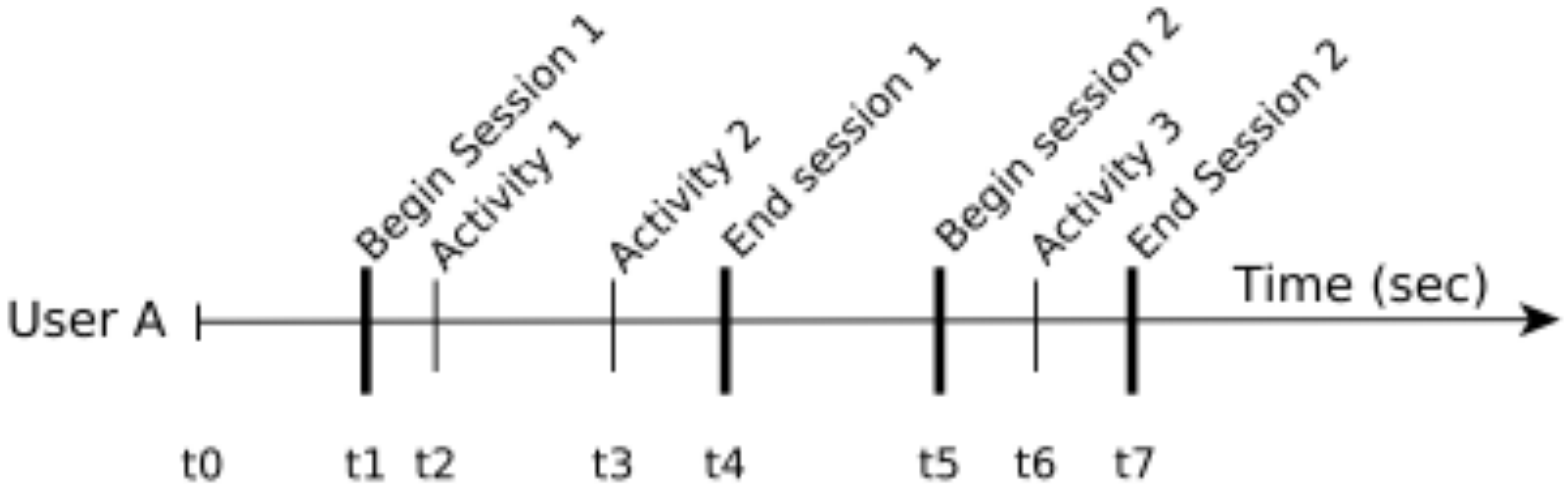
Simulation Environment

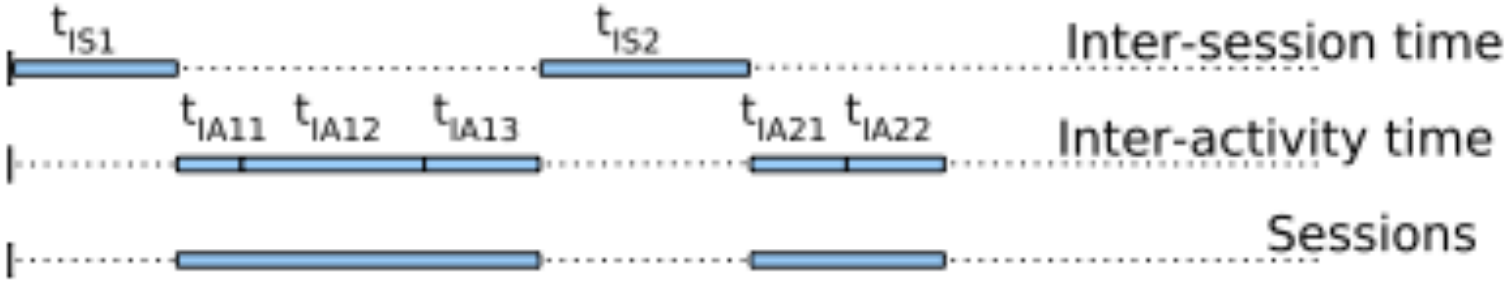


Simulation Environment

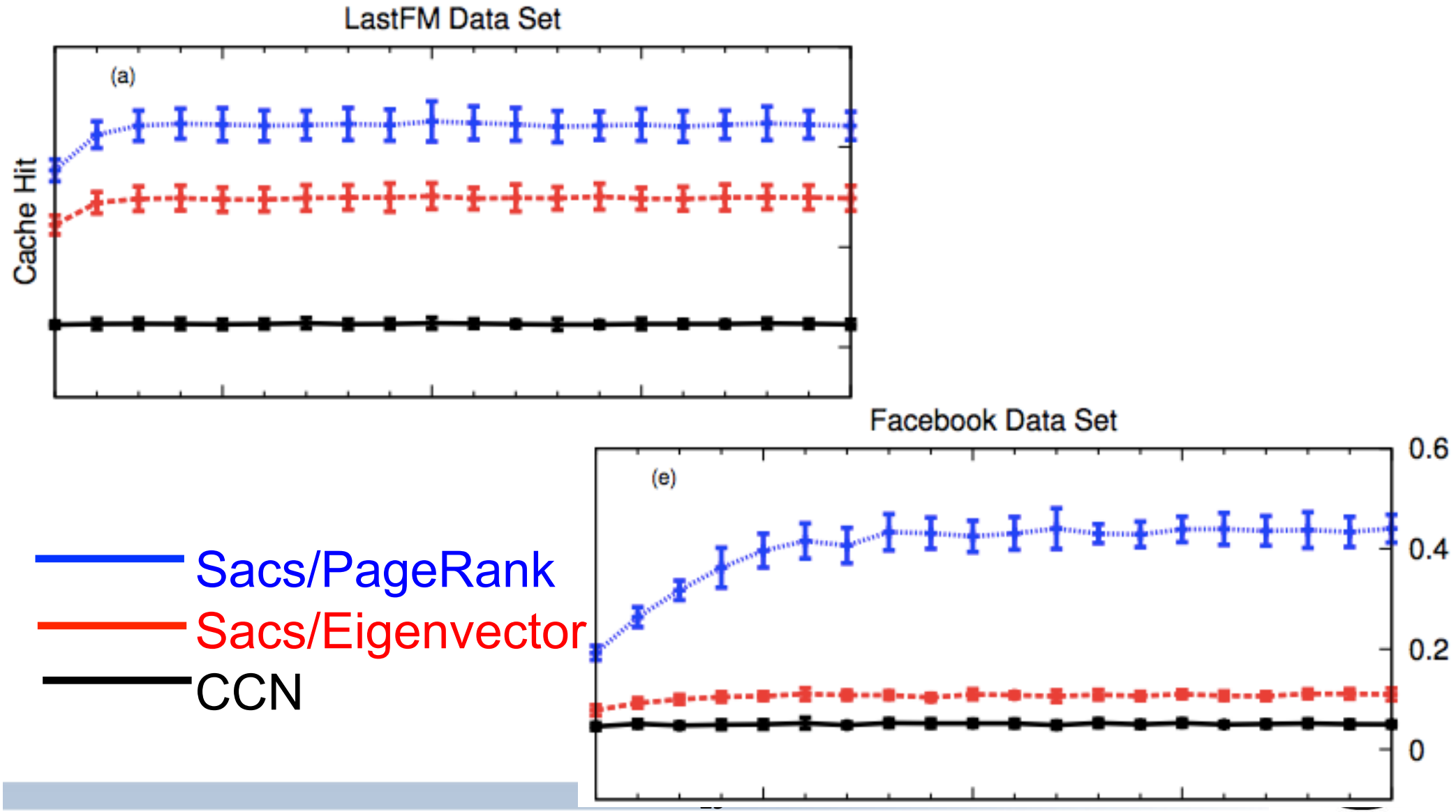
- Social Networks
  - LastFM and Facebook data set
- Network Topology
  - iNet (default parameters) : 3,037 CCN nodes
- Activity Traces
  - Sonetor: SOcial NEtwork Traffic generatOR
  - ~50,000 activities by synthetic traces [IEEE ICC 2014]

Users' Interaction Model





Users Popularity-based Caching



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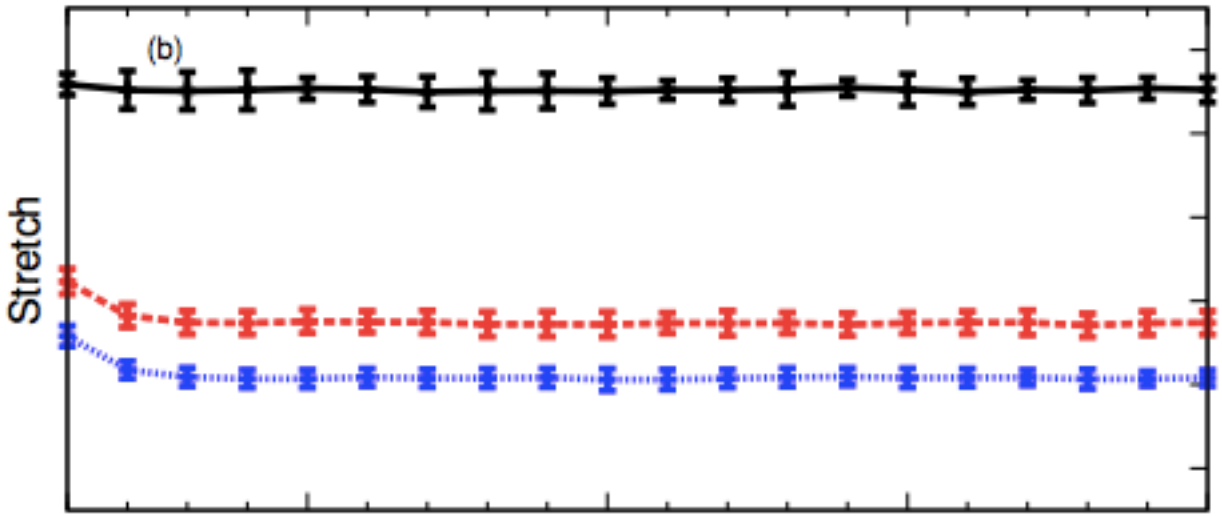
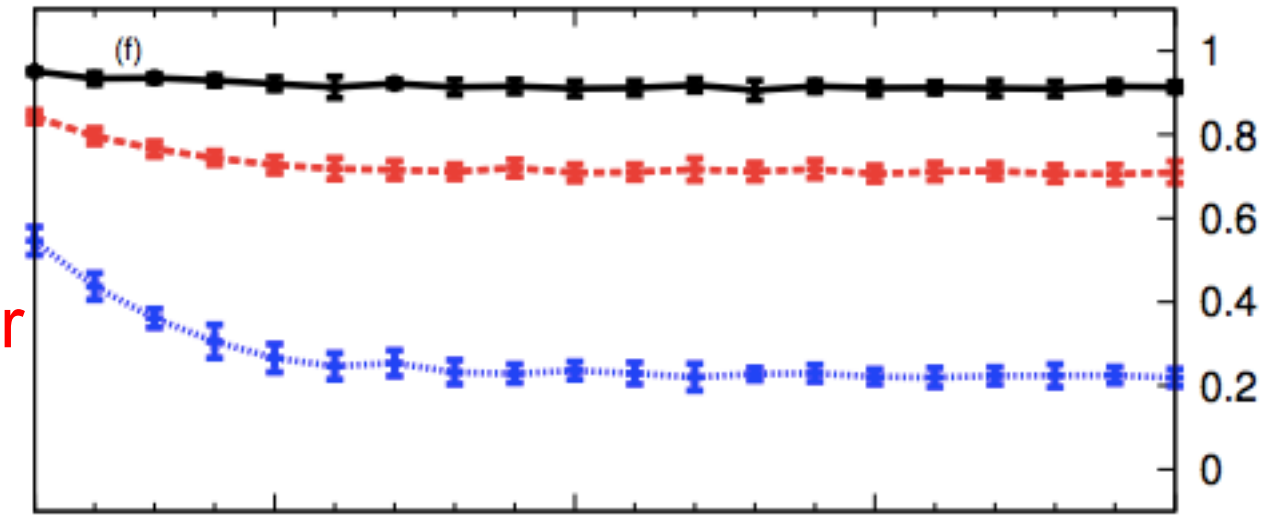


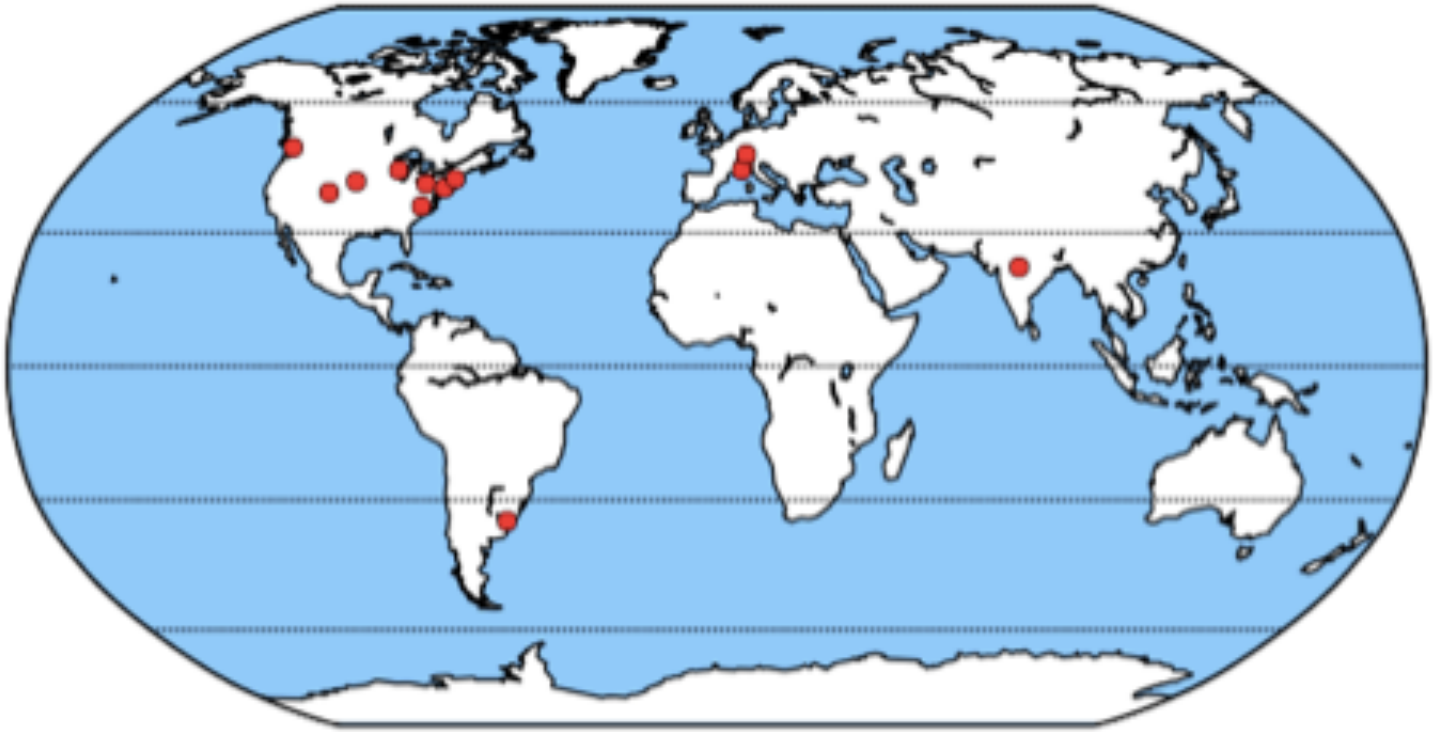


Sacs/PageRank

Sacs/Eigenvector

CCN

PlanetLab Experiments



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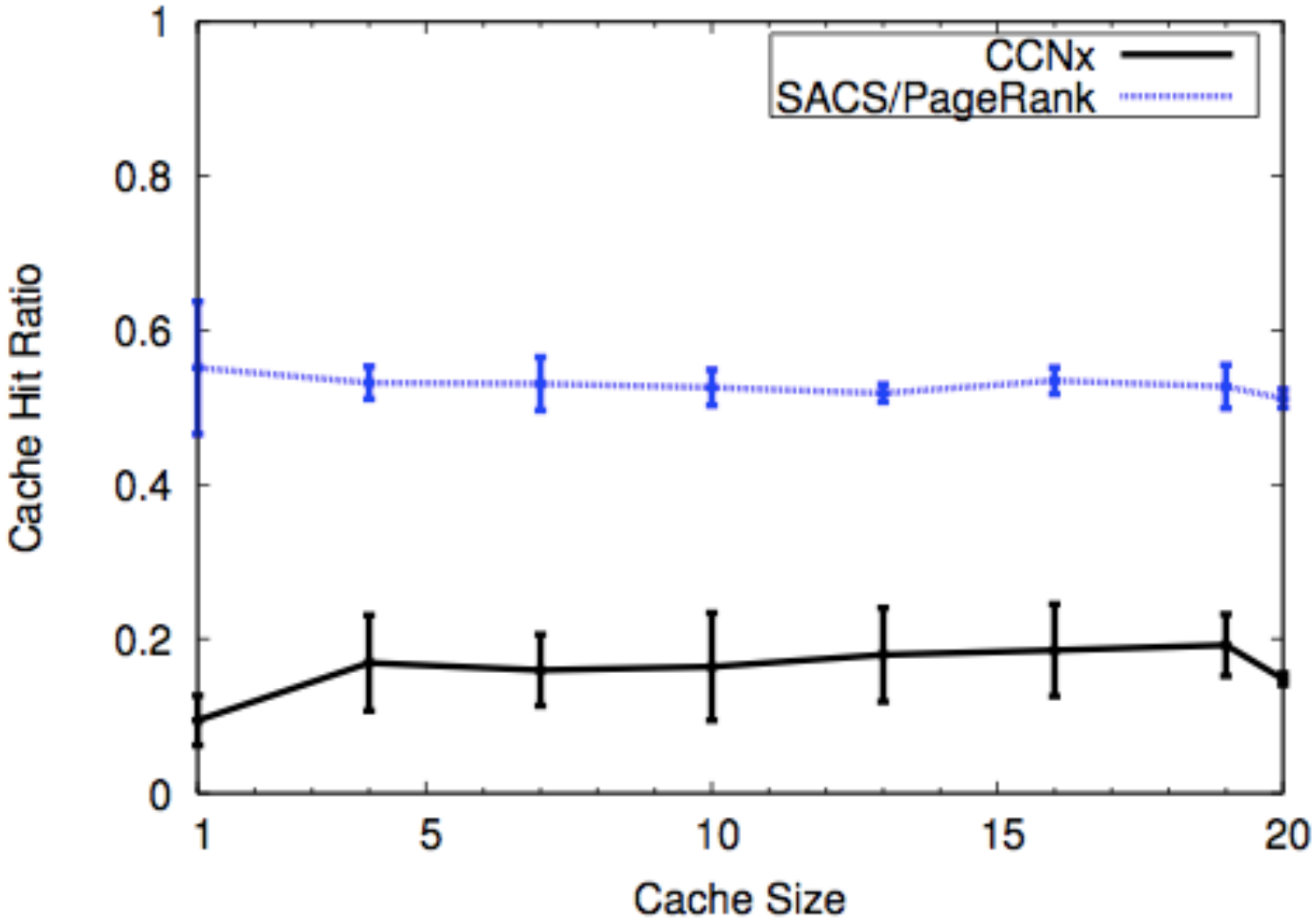


Summary

- Internet: a “Content” and a “Social” network
- CCN as a novel “Network Layer” for Content Delivery in the Future Internet
  - In-network Caching
- Popularity-based Caching Strategies for CCN
  - Content Popularity
  - Users Popularity [IFIP Networking 2014]
- Improve Cache Performances
- Experiments on CCNx and PlanetLab

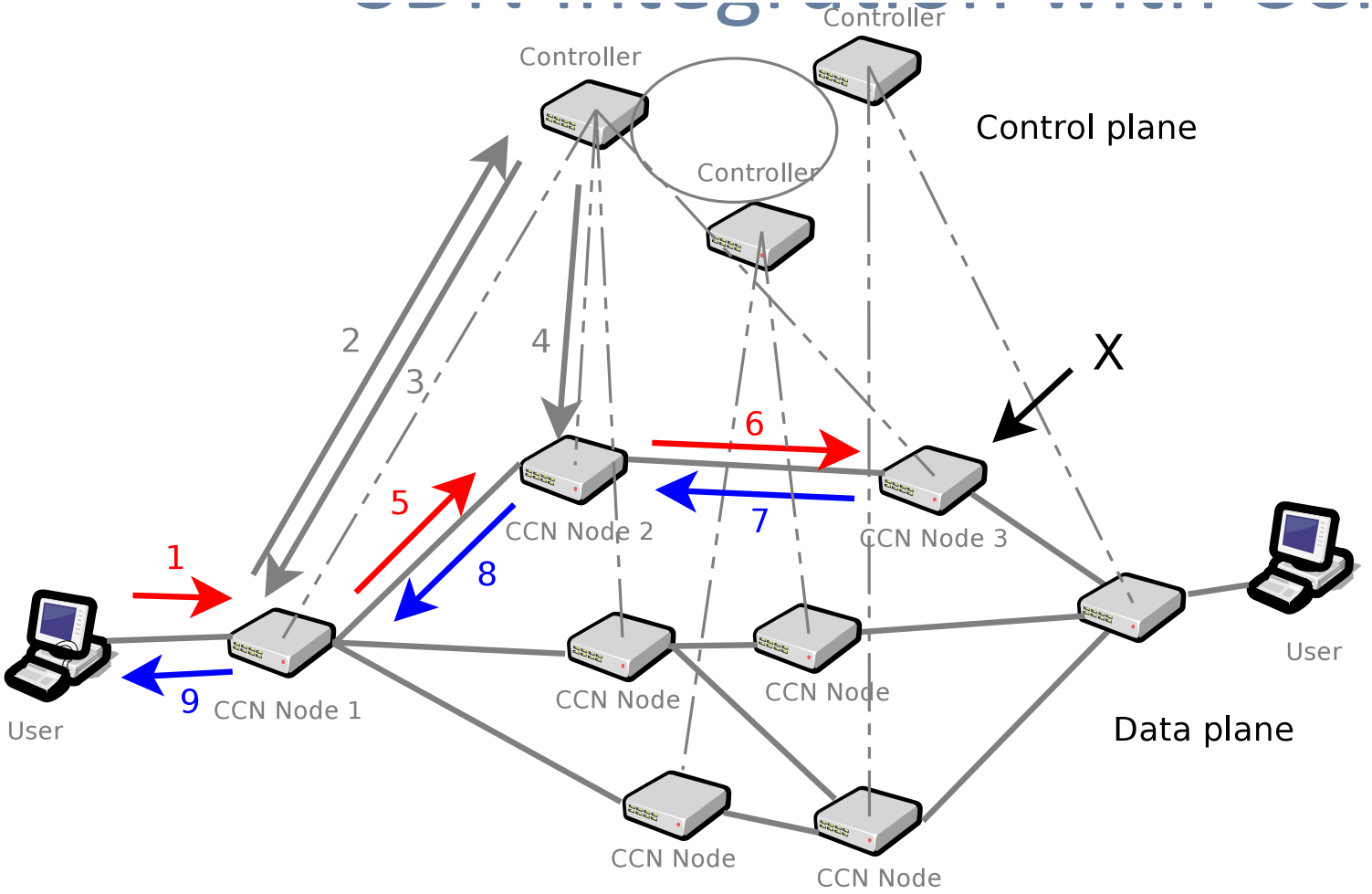
Software-Defined Networking

- Decoupling
  - Data Plane (traffic forwarding) from
  - Control Plane (Routing decision)
- Controller
  - Openflow
- ICN/CCN: alternatives to TCP/IP architecture
  - Focus on content and not hosts
  - Lack of deployments

SDN integration with ICN

- Openflow-compliant ICN
  - CONET architecture
  - IP-compatible layer to enable ICN nodes
- Abstraction layer between CCN nodes and Controllers based on IP
  - Not full ICN
- Goal: SDN with ICN without IP

SDN integration with CCN



Interest(X) messages sended to find content X

Data(X) messages which contains the content X sended to user

Interest/Data messages exchange to communicate between switches and controller

Ongoing Work

- Model this SDN/CCN architecture
- Simulations with NS-3
- Also with Controllers (SDN):
  - Network security (Firewall, Access Control), etc.

Thank You!

Questions?