Content delivery techniques

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Public demonstration lecture@ University of Helsinki

Target audience: Master/PhD-students in networking
3 ECTS credits

Helsinki, Finland, Feb.1st , 2017

What will you get from this course?

- How content is delivered in the current Internet? *Part I*
- How can it be delivered in the Future Internet? *Part II*
- Wireless video delivery. *Part III*

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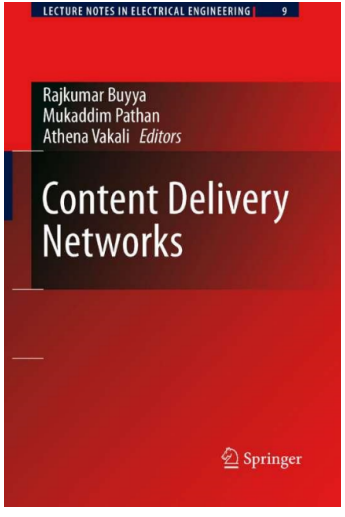
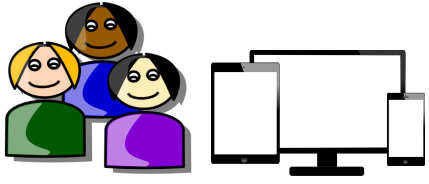


- Nygren, Erik, Ramesh K. Sitaraman, and Jennifer Sun. "The Akamai network: a platform for high-performance internet applications." ACM SIGOPS Operating Systems Review 44.3 (2010): 2-19.
- Maggs, Bruce M., and Ramesh K. Sitaraman. "Algorithmic nuggets in content delivery." ACM SIGCOMM Computer Communication Review 45.3 (2015): 52-66.

Content delivery components

Content provider
(Origin server)



Client/user

Content delivery components

Content provider
(Origin server)

- Static content
  - updated infrequently
- Dynamic content
  - generated on the fly

Client/user

Content delivery components

Content provider
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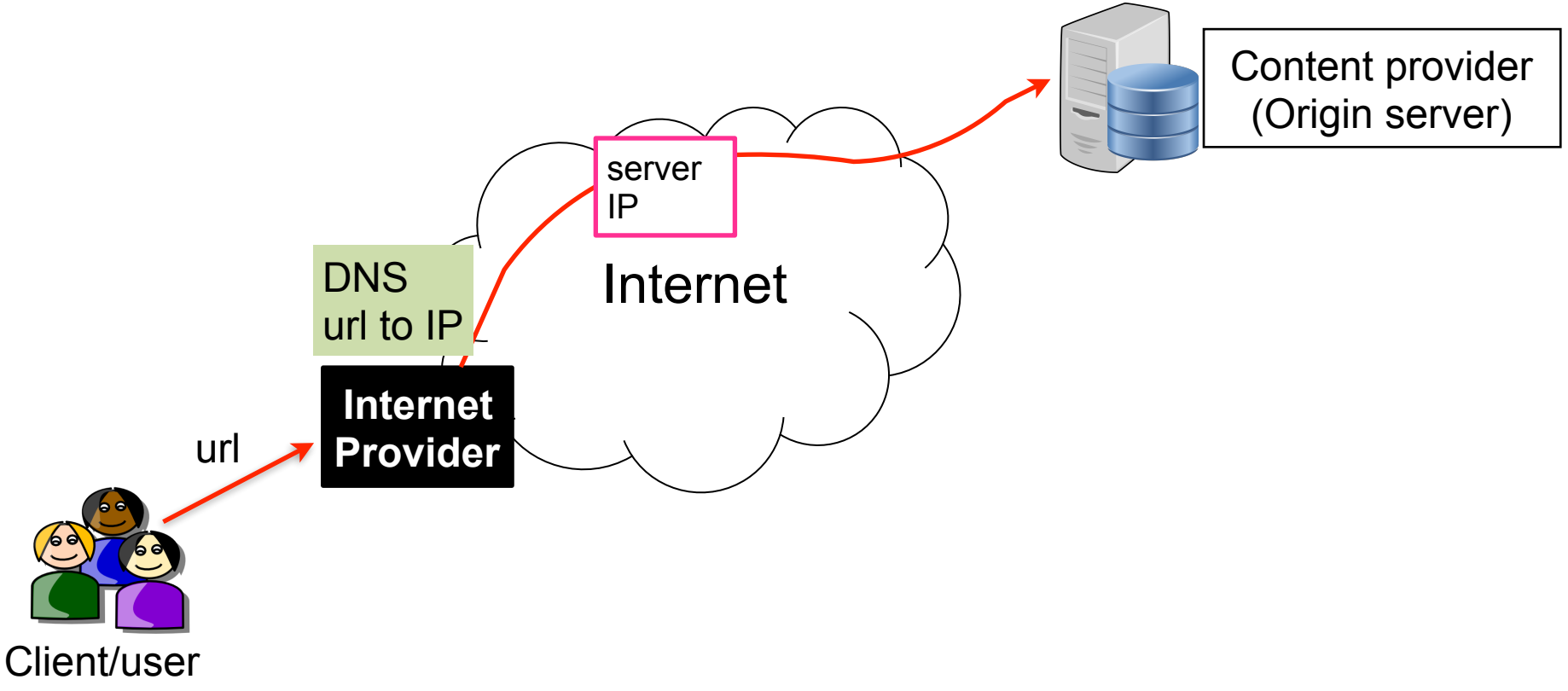
Internet

Internet Provider

Client/user

Content delivery components



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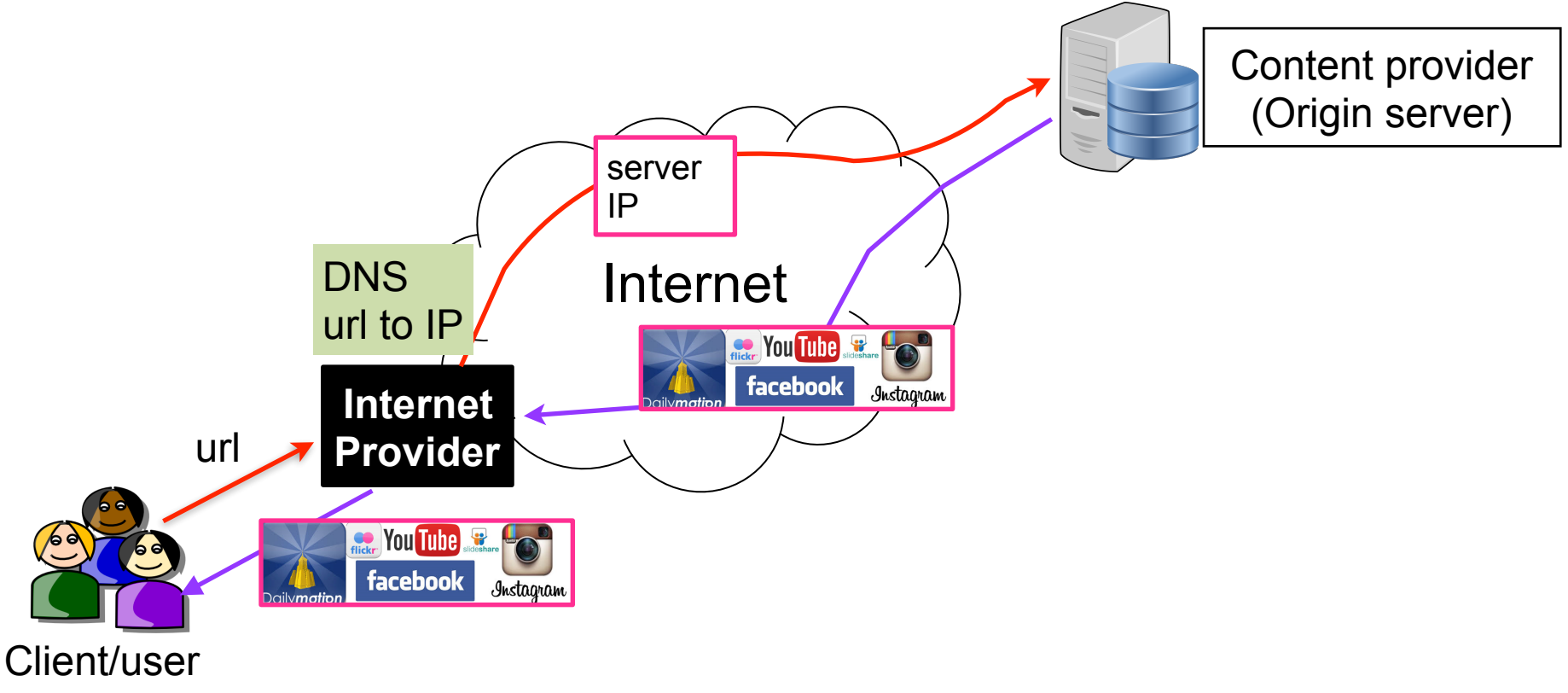
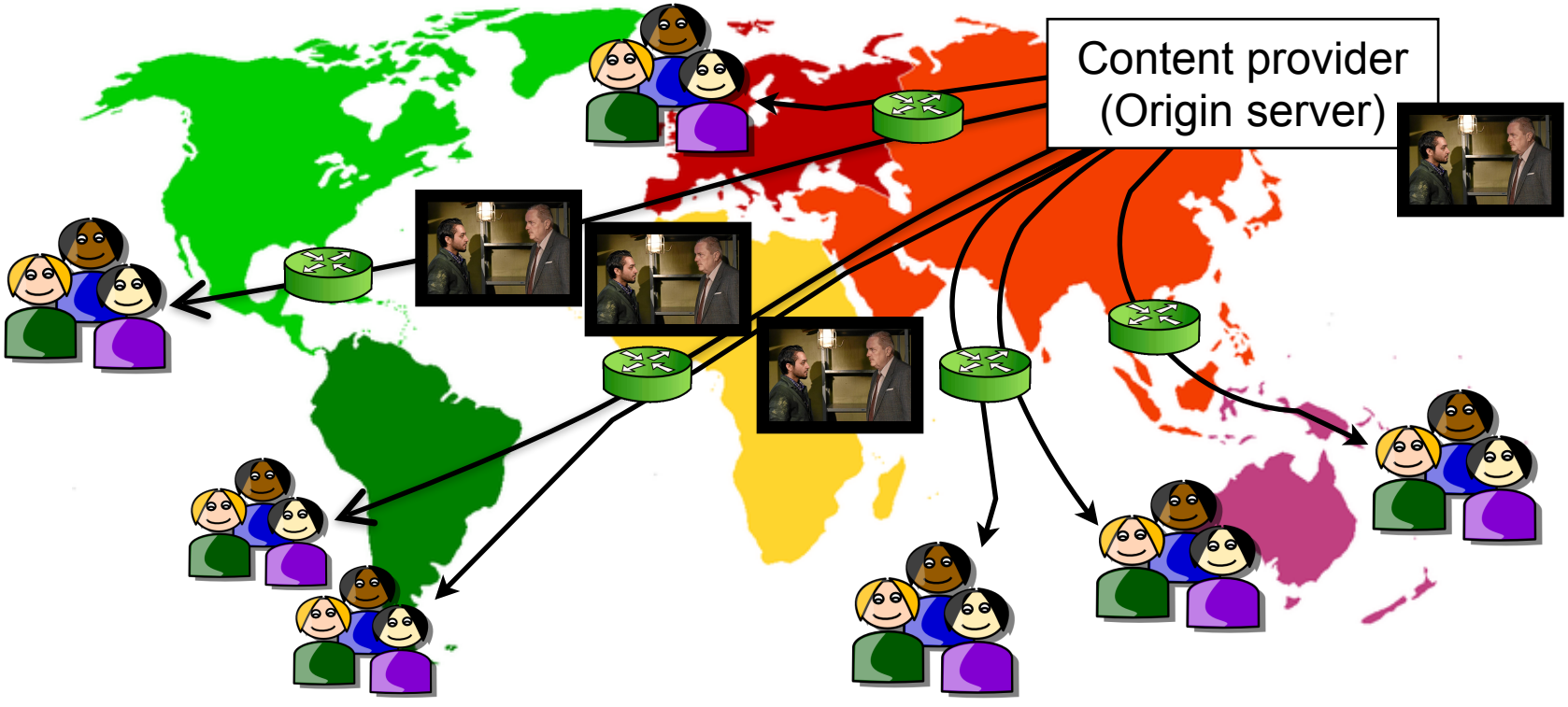


Unicast delivery not efficient large-scale delivery



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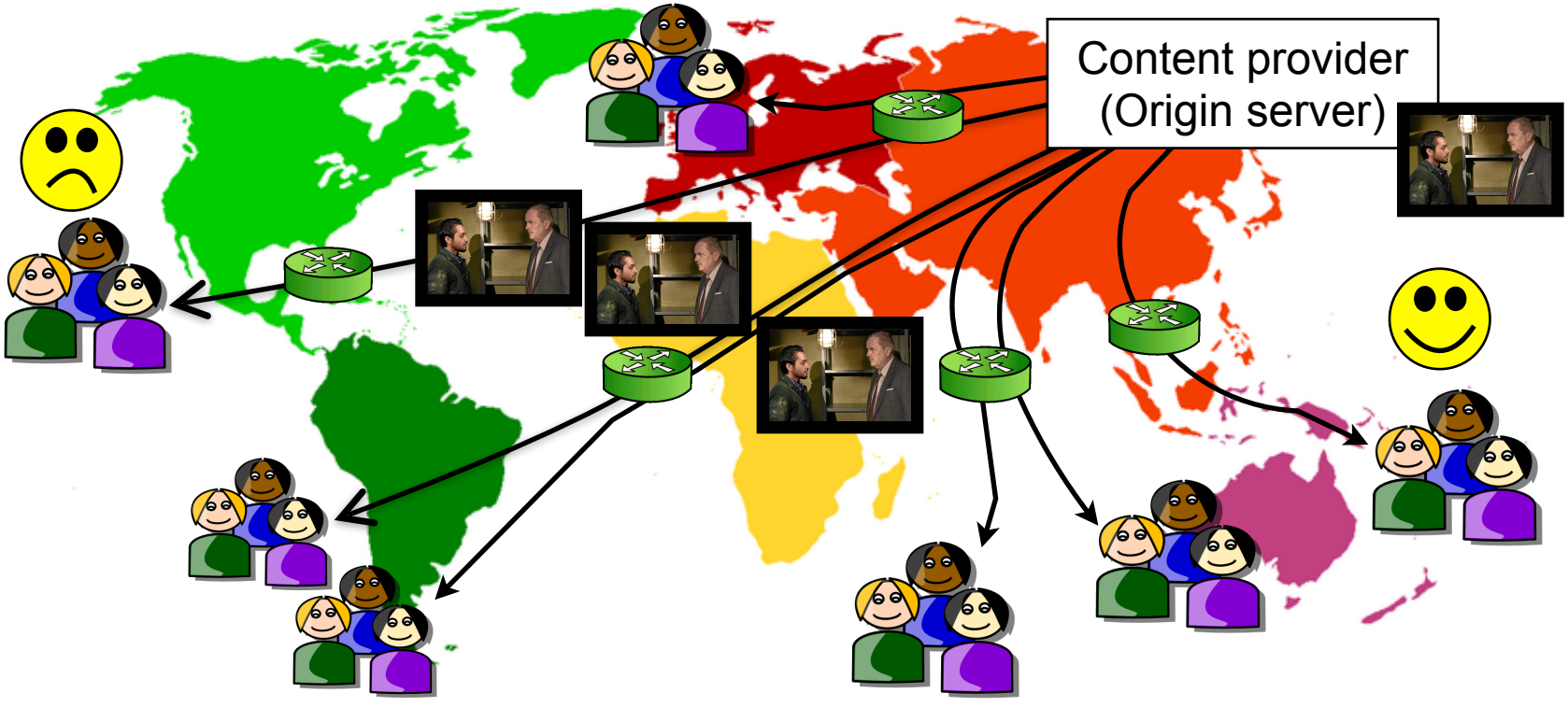
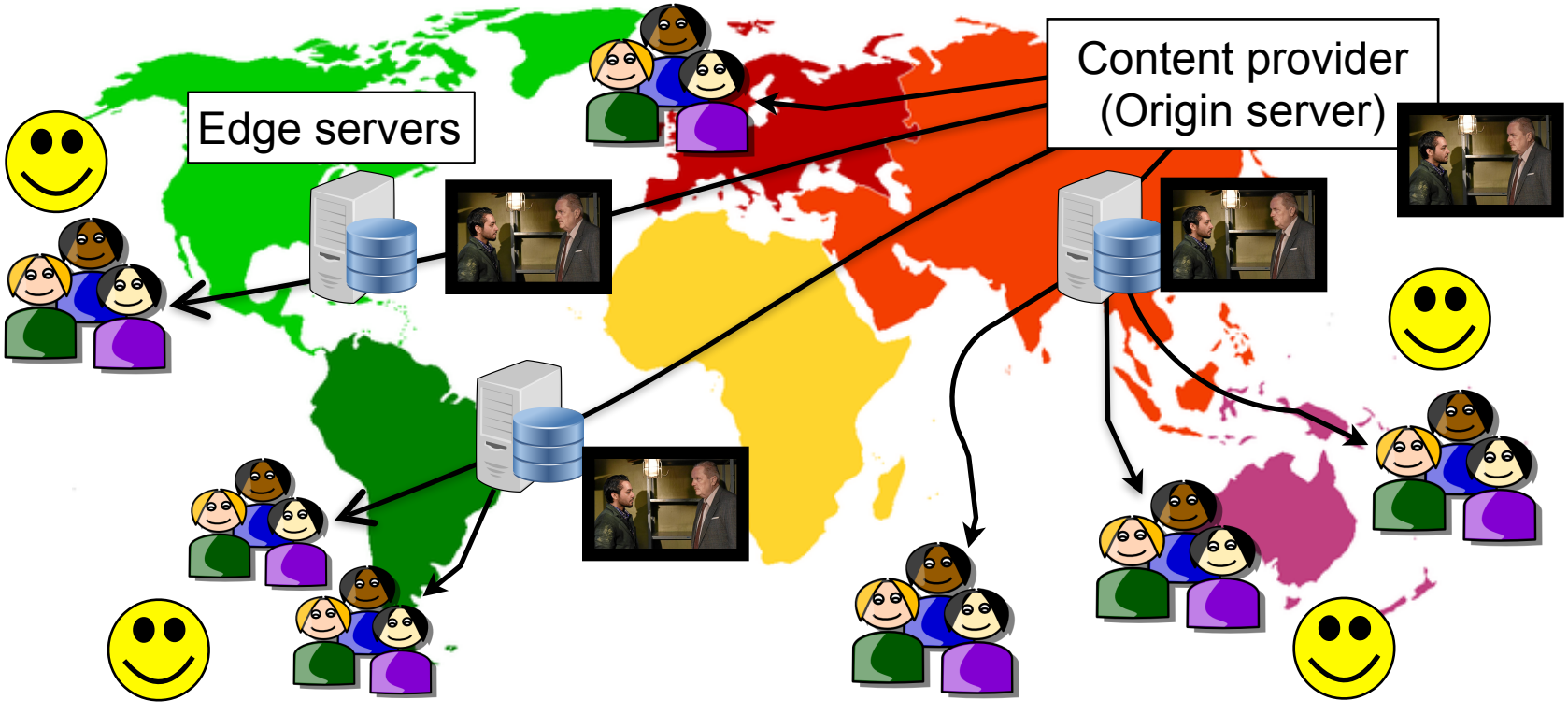


Not scalable for large scale content delivery!

Content delivery networks (CDN)



CDN: geographically and *strategically* distributed web servers, replicate the contents and store at the **edge servers** in multiple locations

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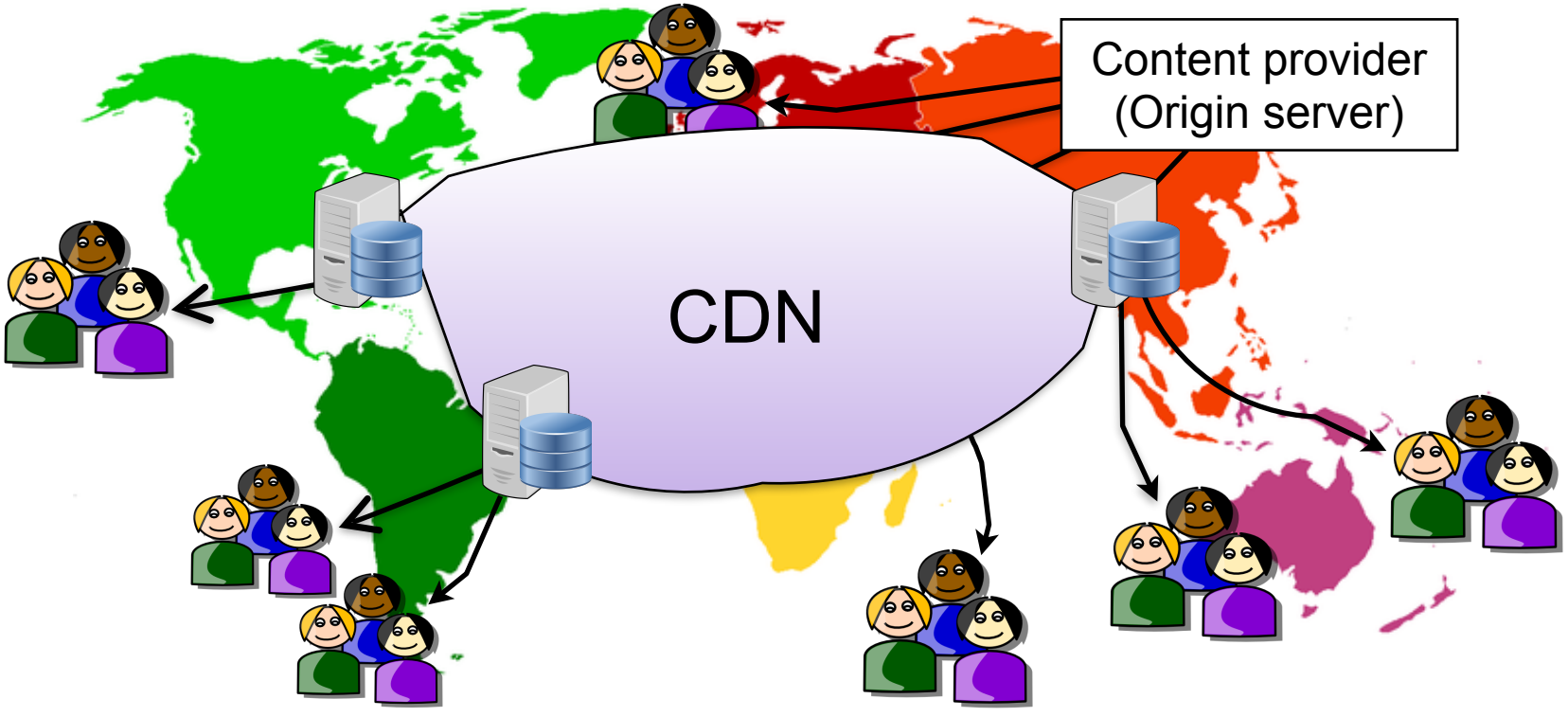

CDN: geographically distributed web servers, replicate the contents and store at the **edge(replica) servers** in multiple locations

CDN providers

- Emerged late 90s
- Akamai, Limelight, Level 3, MaxCDN, Incapsula, Amazon, etc.
- Akamai (1999)
  - Carrying 15-30% of web traffic
  - 216000 edge servers, 120 countries, 1500 ISPs*

*https://www.akamai.com/us/en/about/facts-figures.jsp

CDN benefits

- **Content providers (CP):** delegate namespace via CNAME field in DNS or url of cdn, e.g., cdn.x.com
  - Reduced latency in distributing content
  - Lower load on CP infrastructure
  - Higher service/content availability due to multiple servers
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  - Transparent

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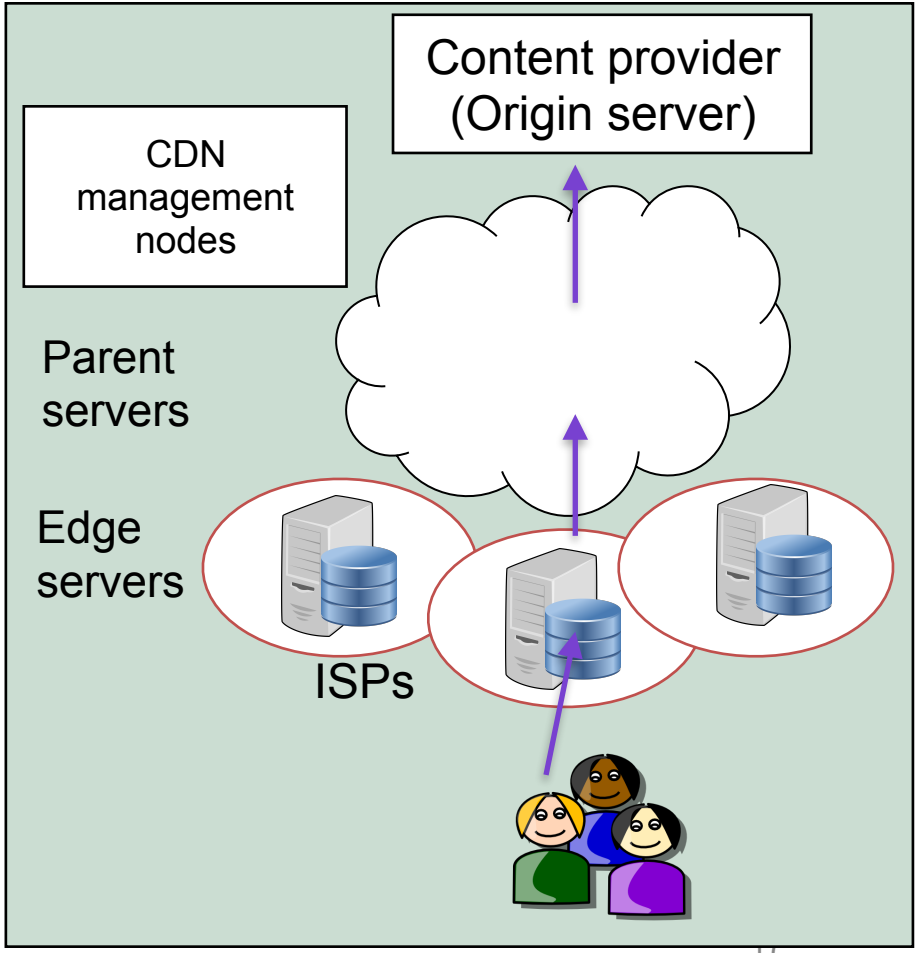
CDN: overlay solution on public Internet



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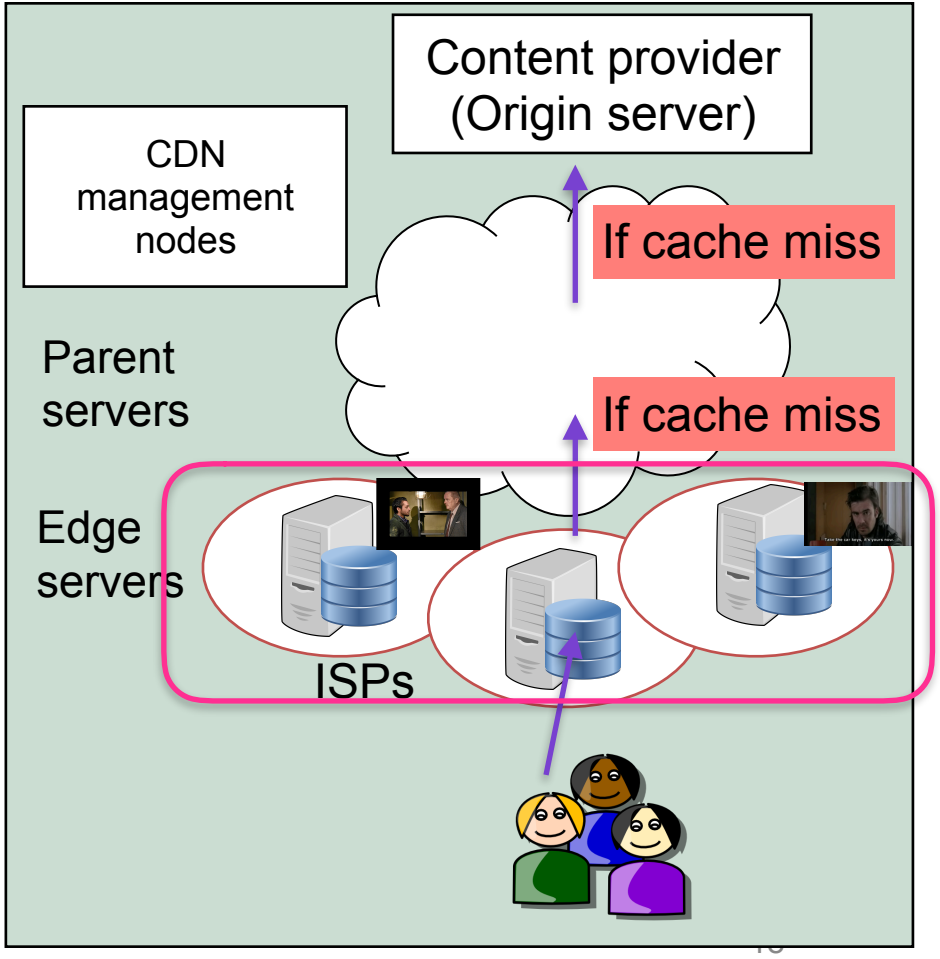
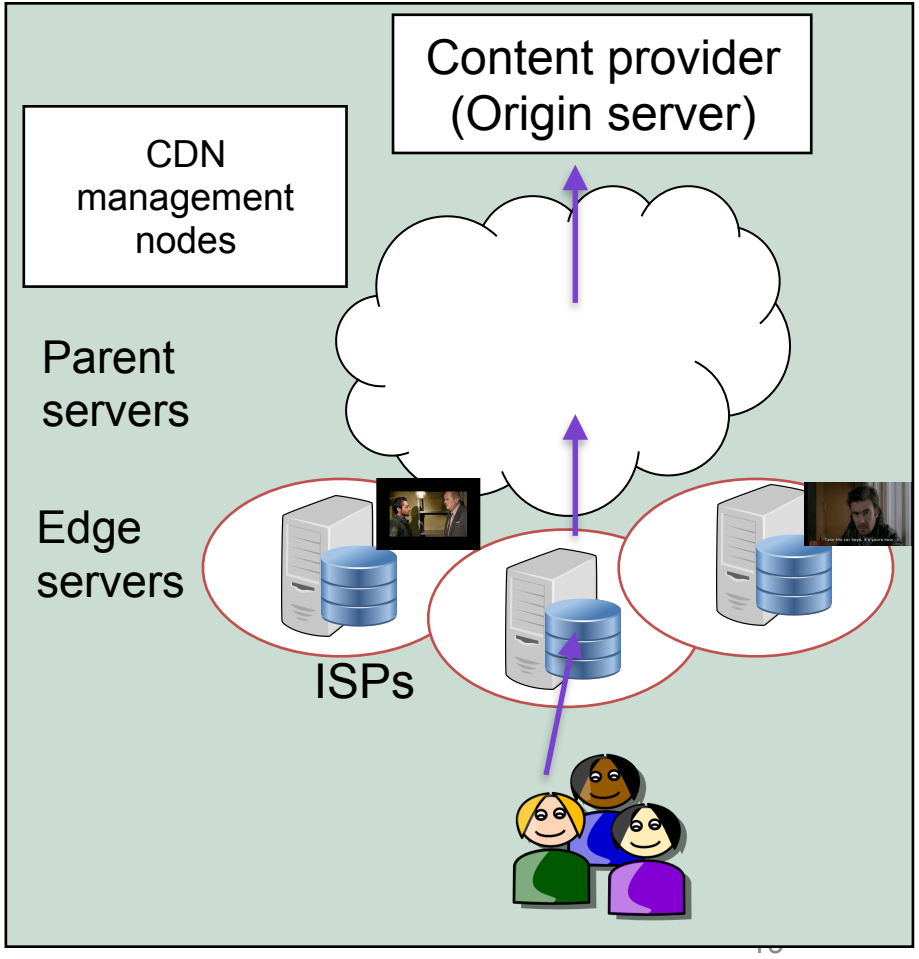


- Caching (of popular content)

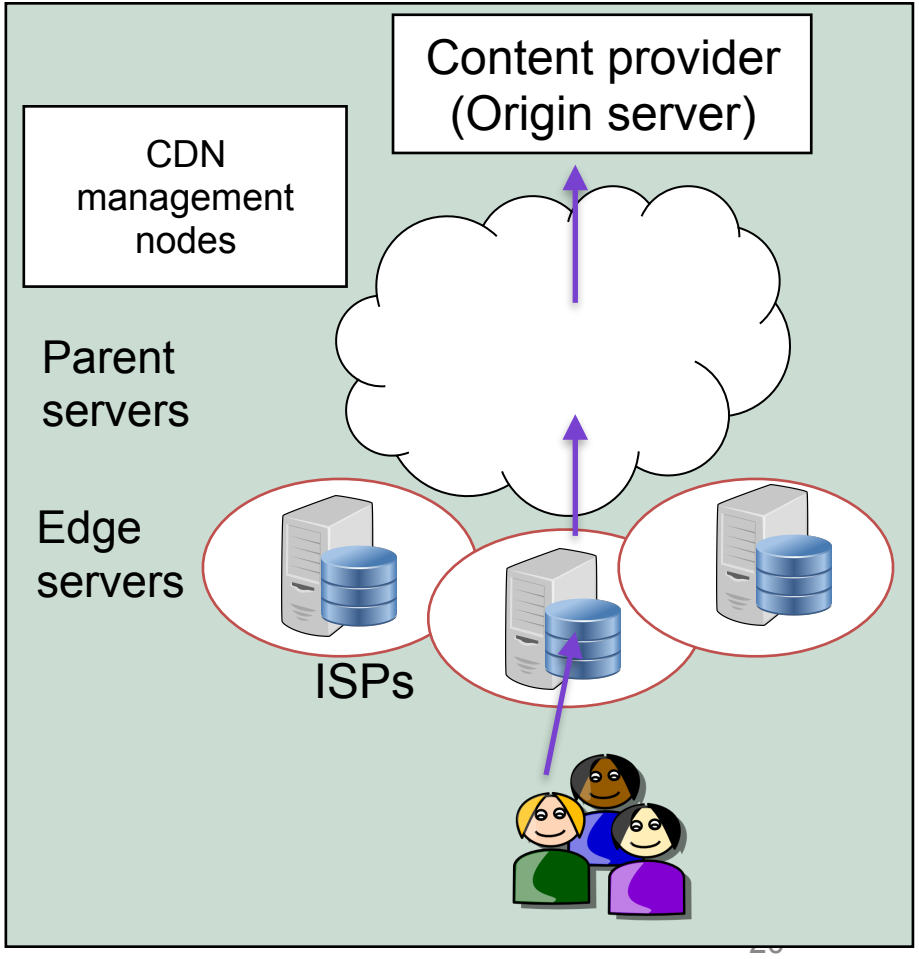
Popular content

CDN: overlay solution on public Internet



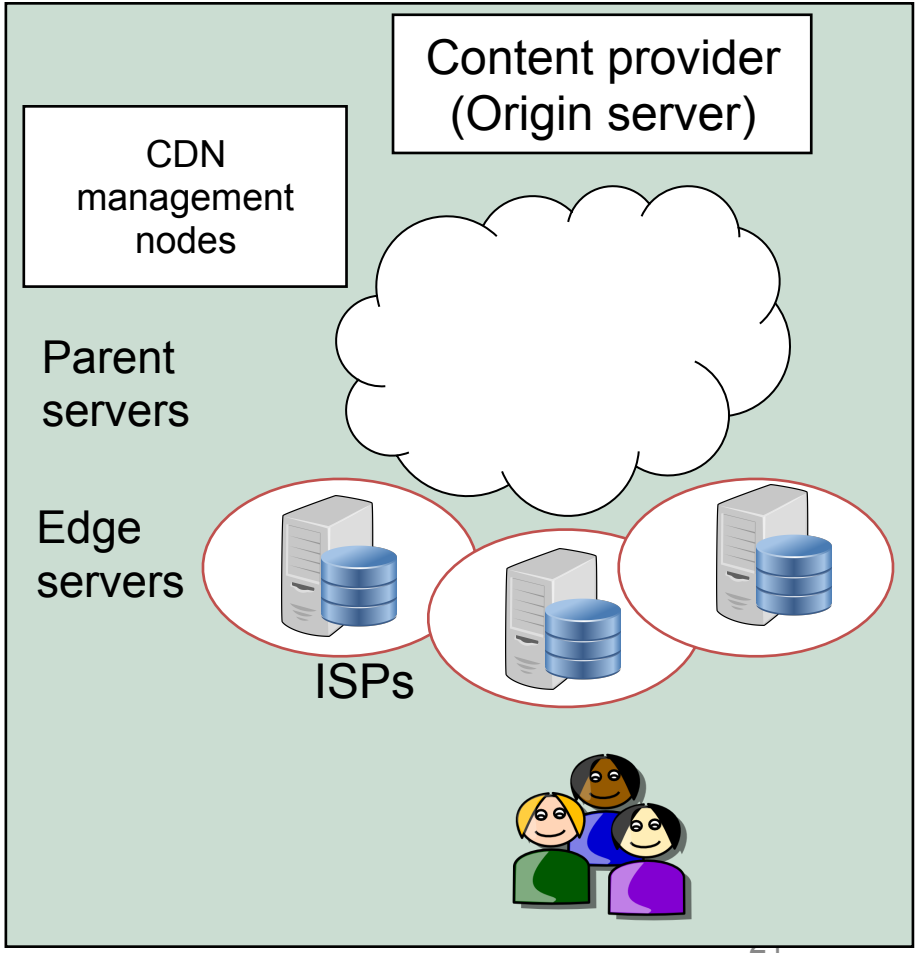
- Caching
  - cache capacity is limited!
  - some content is not cacheable!

CDN: overlay solution on public Internet



- Caching
  - cache capacity is limited!
  - some content is not cacheable!
- Routing
  - Shorter paths
  - More reliable paths

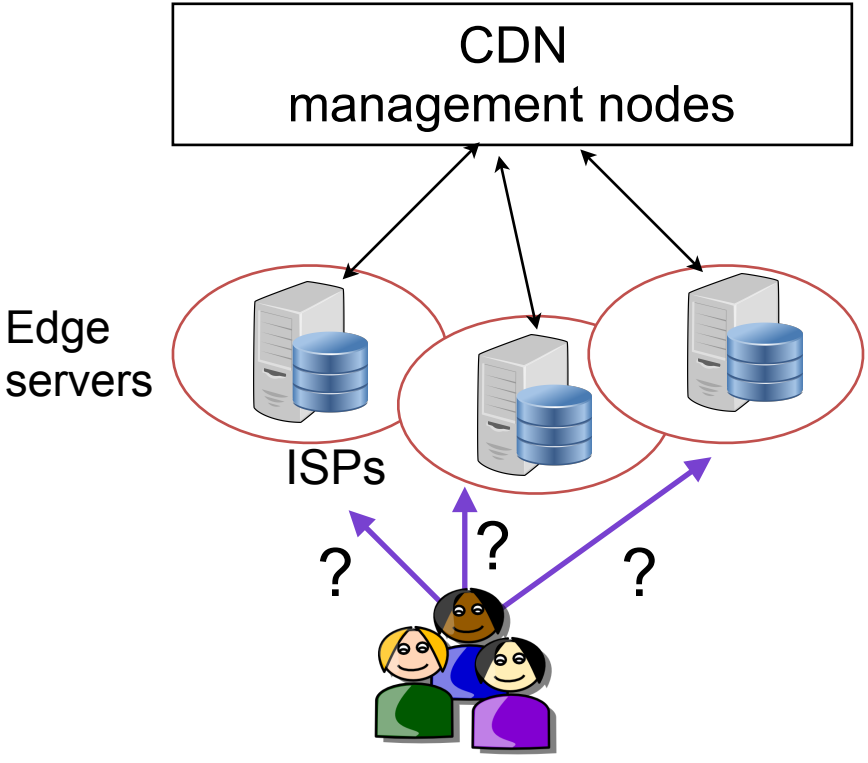
CDN provider needs to optimize:



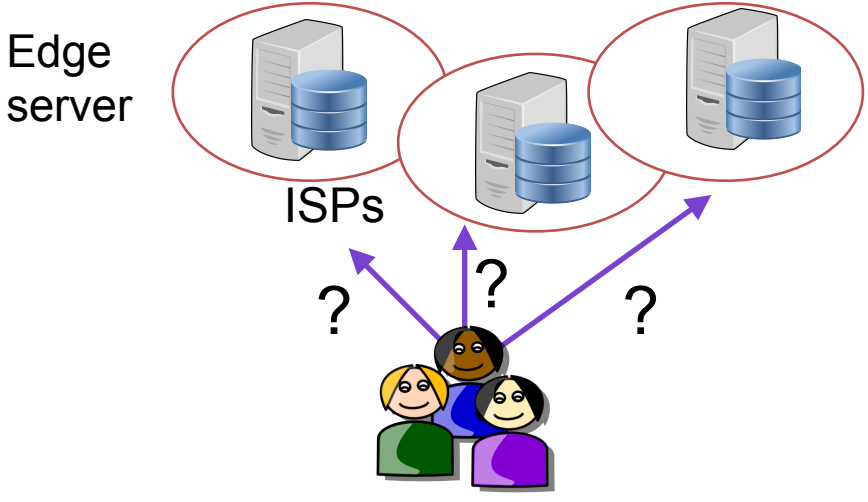
- Where to deploy edge servers?
  - ISP business strategies
  - Understanding of traffic demand
- Which content to replicate?
  - CP preferences
  - User preferences
- How to manage cache space?

Request routing

- Take Akamai as an example
- Which of **216000** servers in 1500 ISPs should a user get service from?

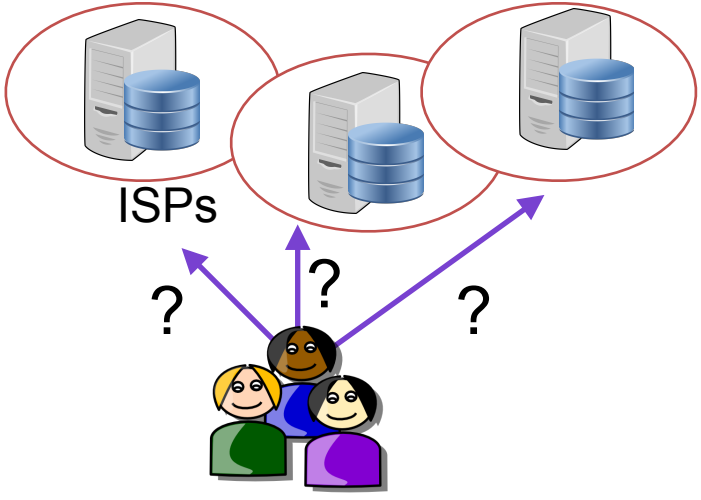


Which server is the best server for a user?



Which server is the best server for a user?

- network proximity,
- client perceived latency,
- server load
- server capacity
- content should be highly likely in the cache



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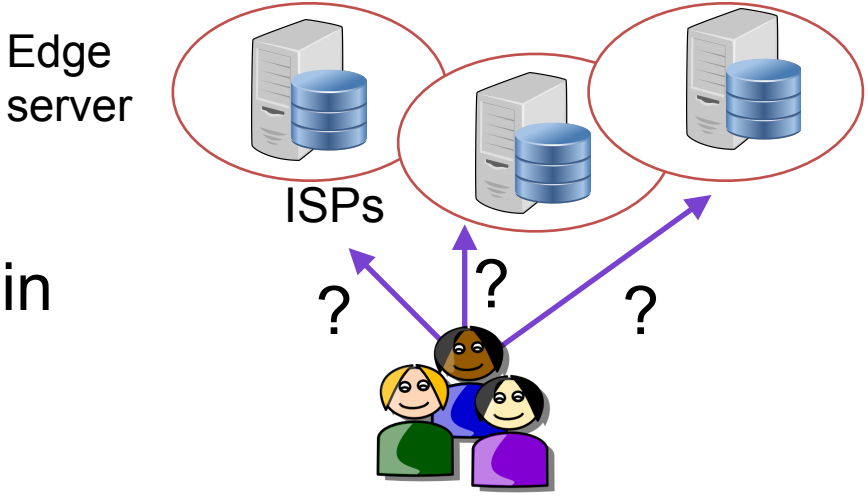
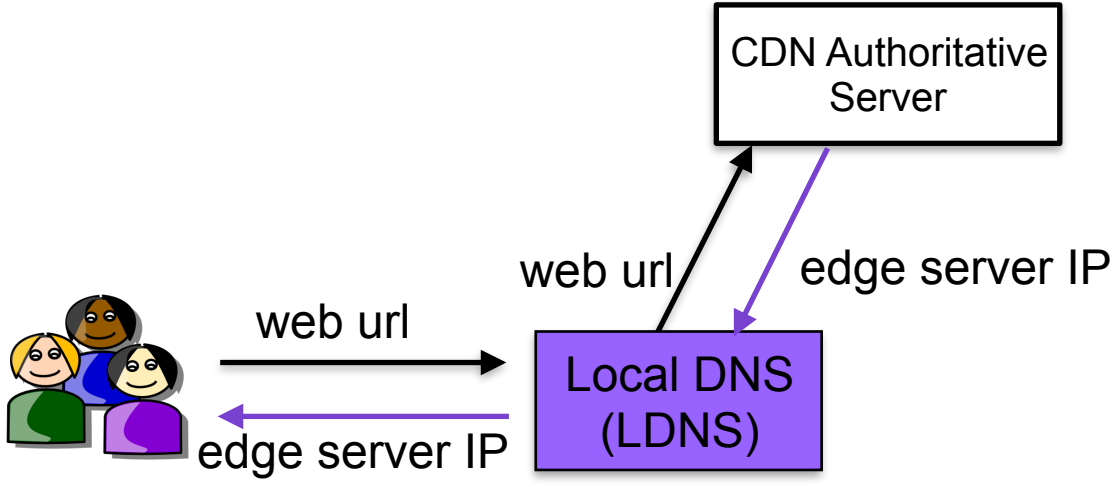
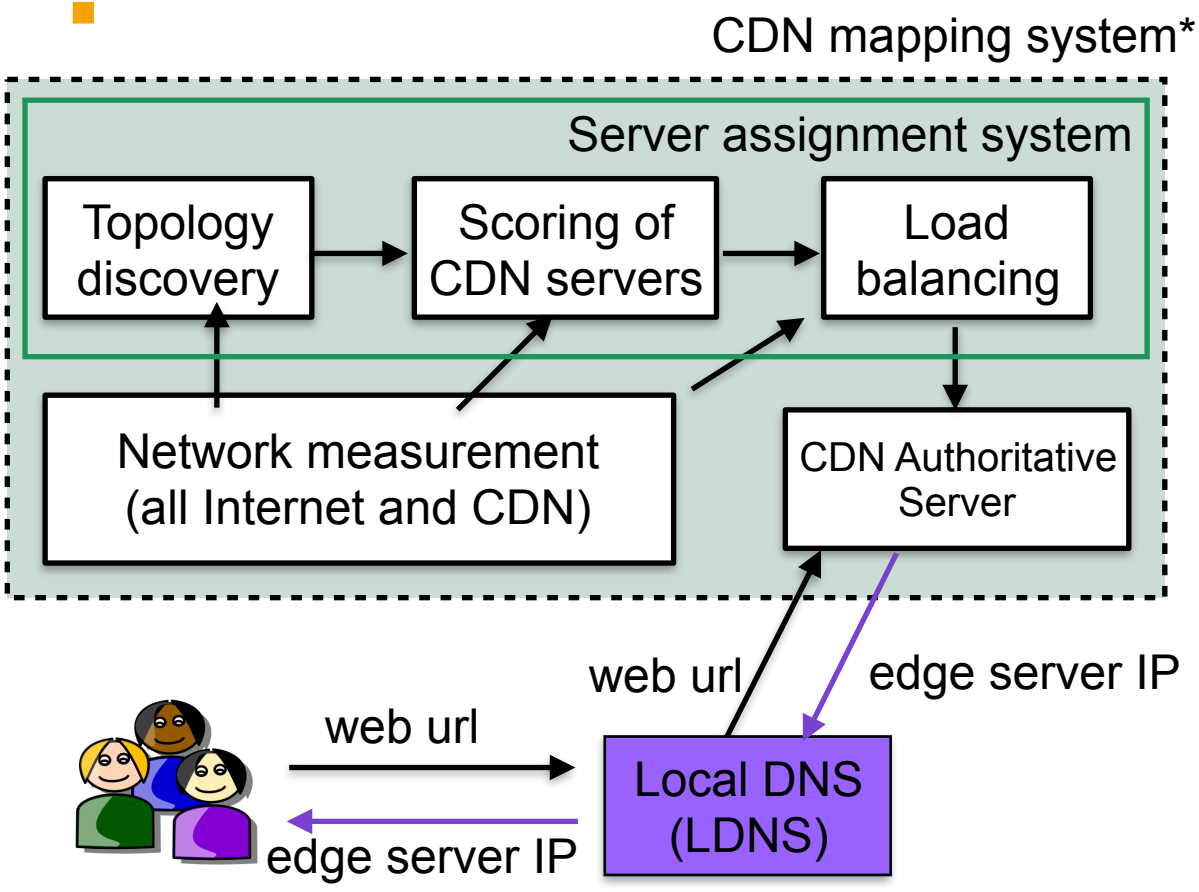


Akamai: User group to server cluster assignment using the stable marriage problem [Gale and Shapley, 1962]

Request routing steps



CDN mapping system



* adapted from Chen et.al, End-User Mapping: Next Generation Request Routing for Content Delivery, ACM SIGCOMM 2015.

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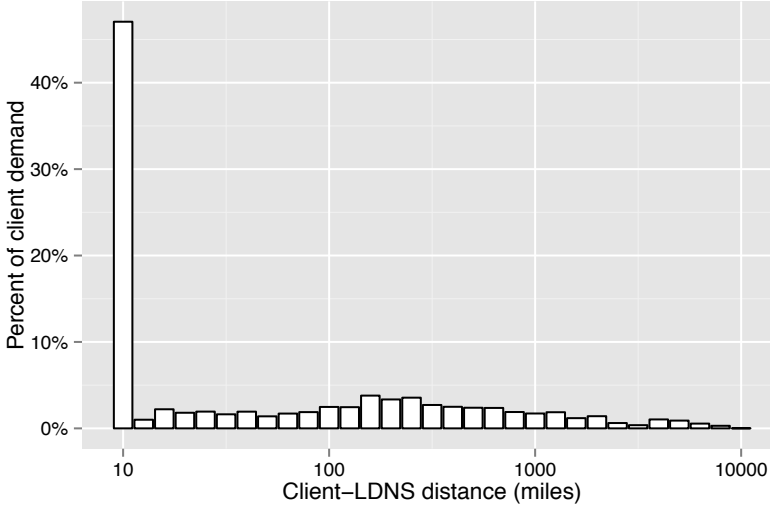

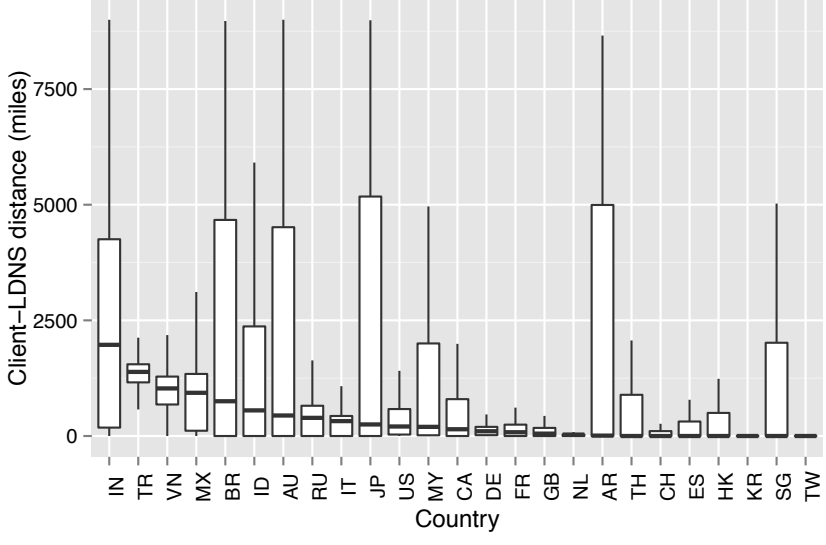

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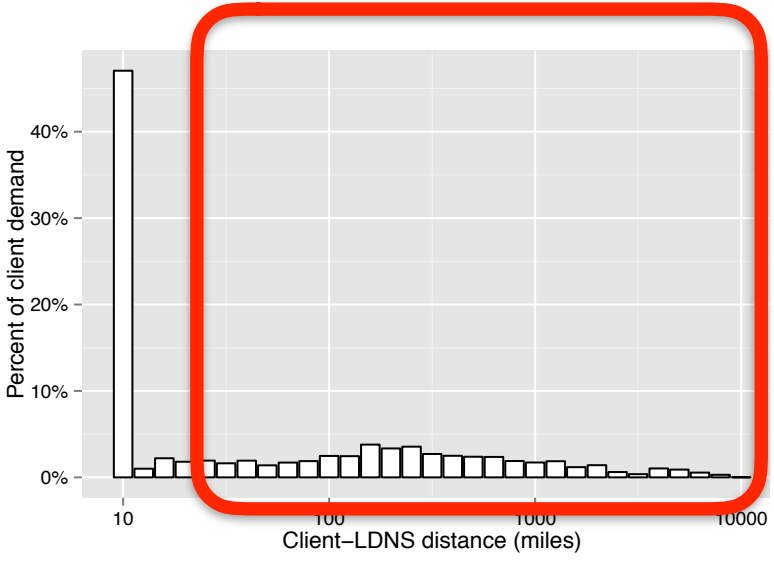

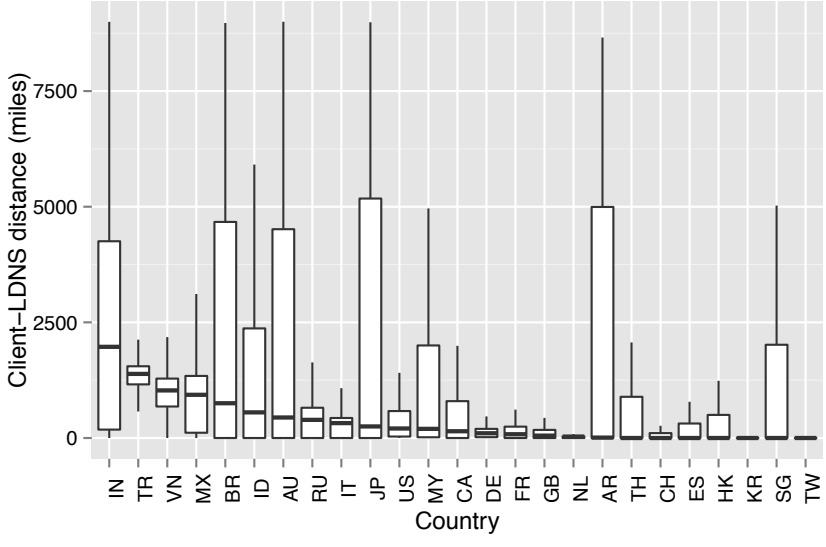

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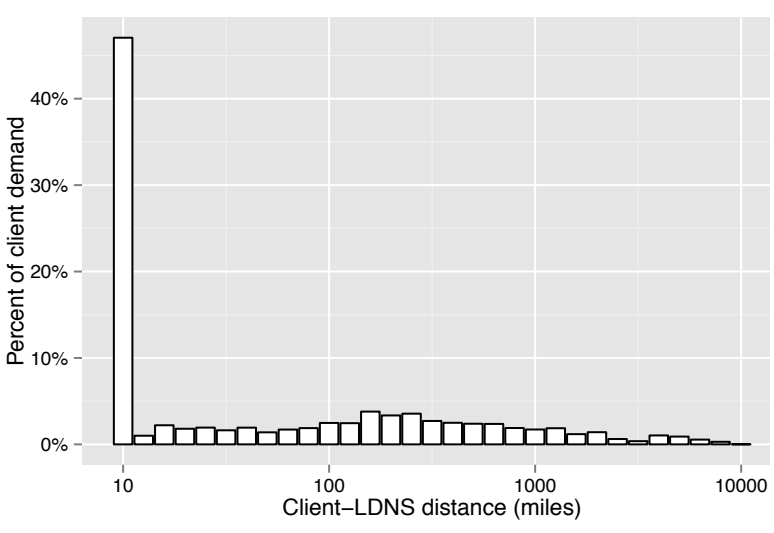

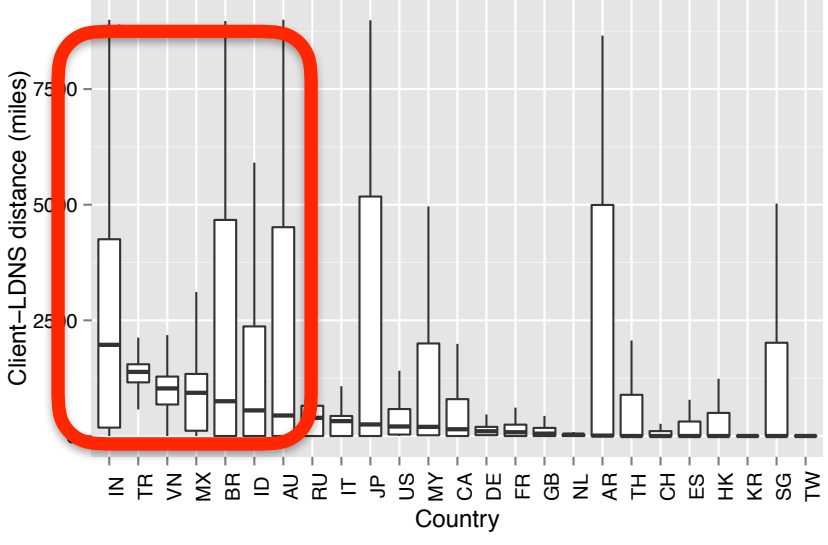

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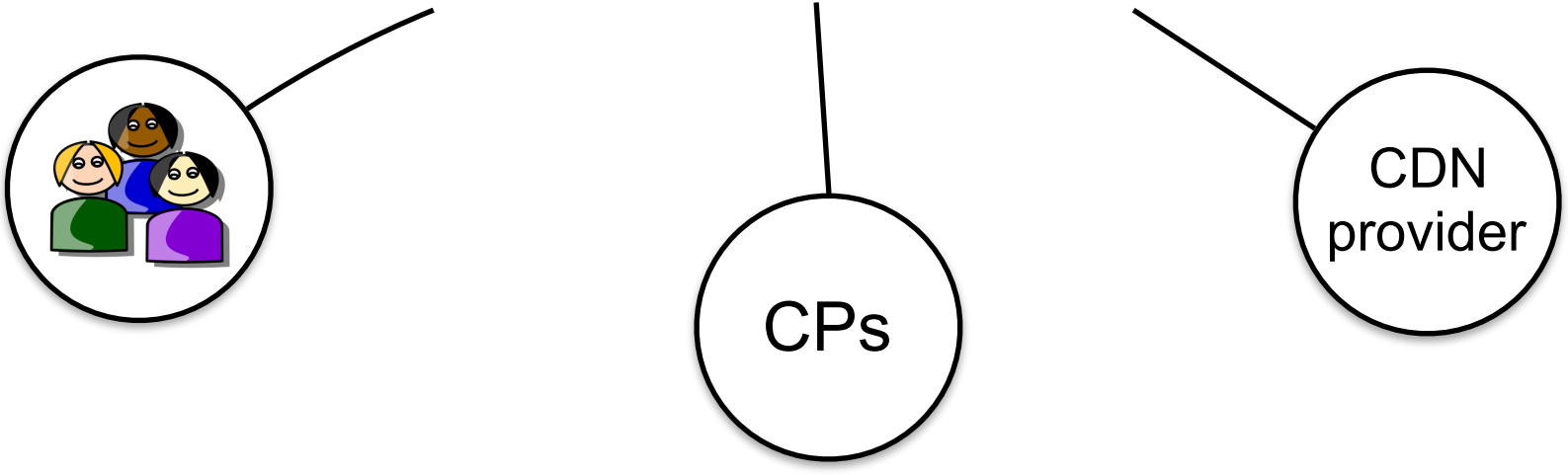
- Proposed solutions in the literature: extended DNS, etc.

CDN performance metrics

- How to assess the CDN performance?



CDN performance metrics

- How to assess the CDN performance?

- Response time
- Delivery quality (for video)

CPs

CDN provider

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- User engagement
- Origin server load
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- Cache hit ratio
- Edge server utilization

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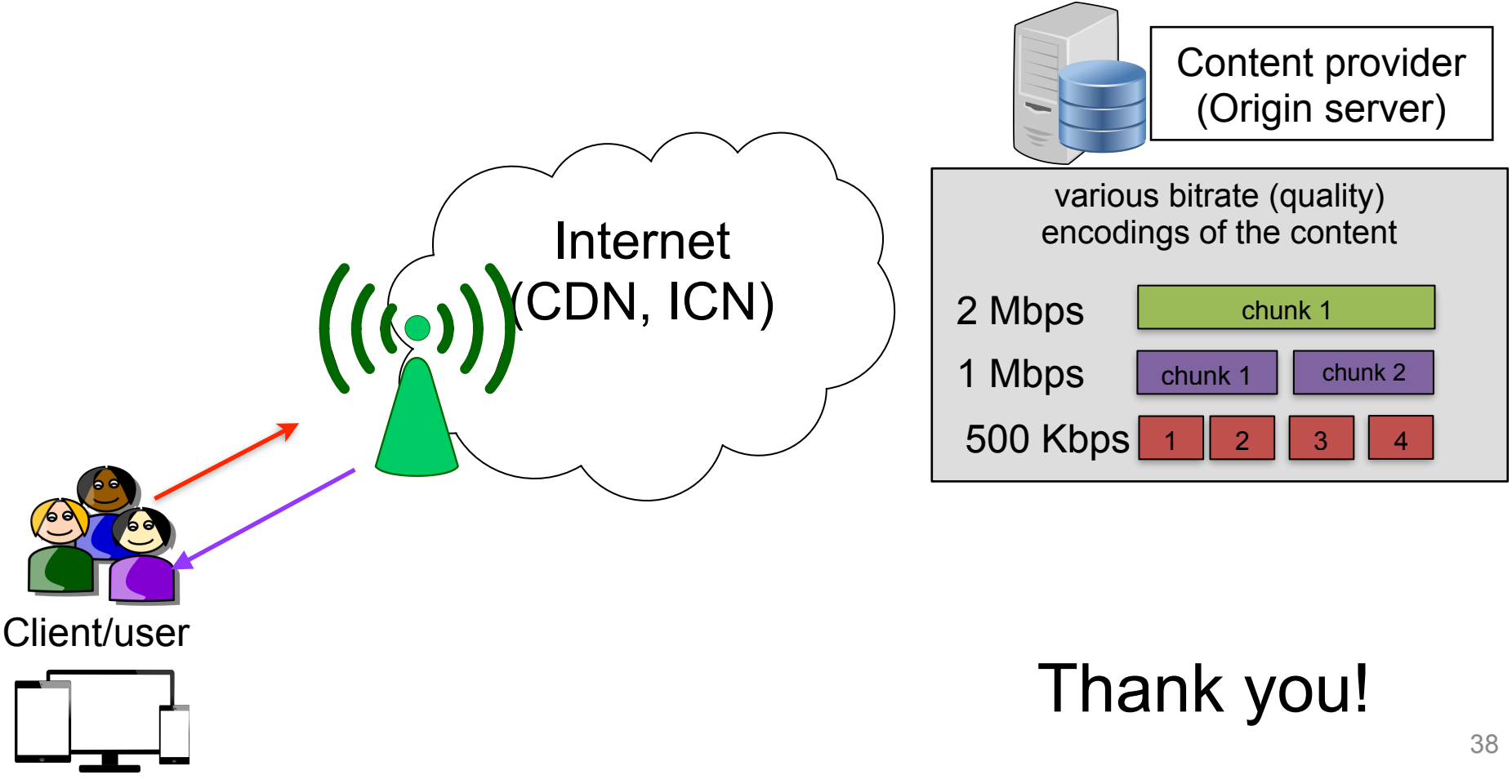
Net profit

Content delivery techniques



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References

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  - Online book: http://www.e-reading.club/bookreader.php/142069/Buyya_-_Content_Delivery_Networks.pdf
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  - Ahlgren, Bengt, et al. "A survey of information-centric networking." IEEE Communications Magazine 50.7 (2012).
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  - Thomas Stockhammer. 2011. Dynamic adaptive streaming over HTTP: standards and design principles. ACM MMSys.
  - Begen et al. “Watching video over the Web, part 2: applications, standardization, and open issues,” IEEE Internet Computing, May/June 2011
  - Begen et al. , “Watching video over the Web, part 1: streaming protocols,” IEEE Internet Computing, Mar./Apr. 2011