A content delivery perspective on mobility in the Internet

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MPM 2012 workshop, 10.04.2012, Bern, Switzerland

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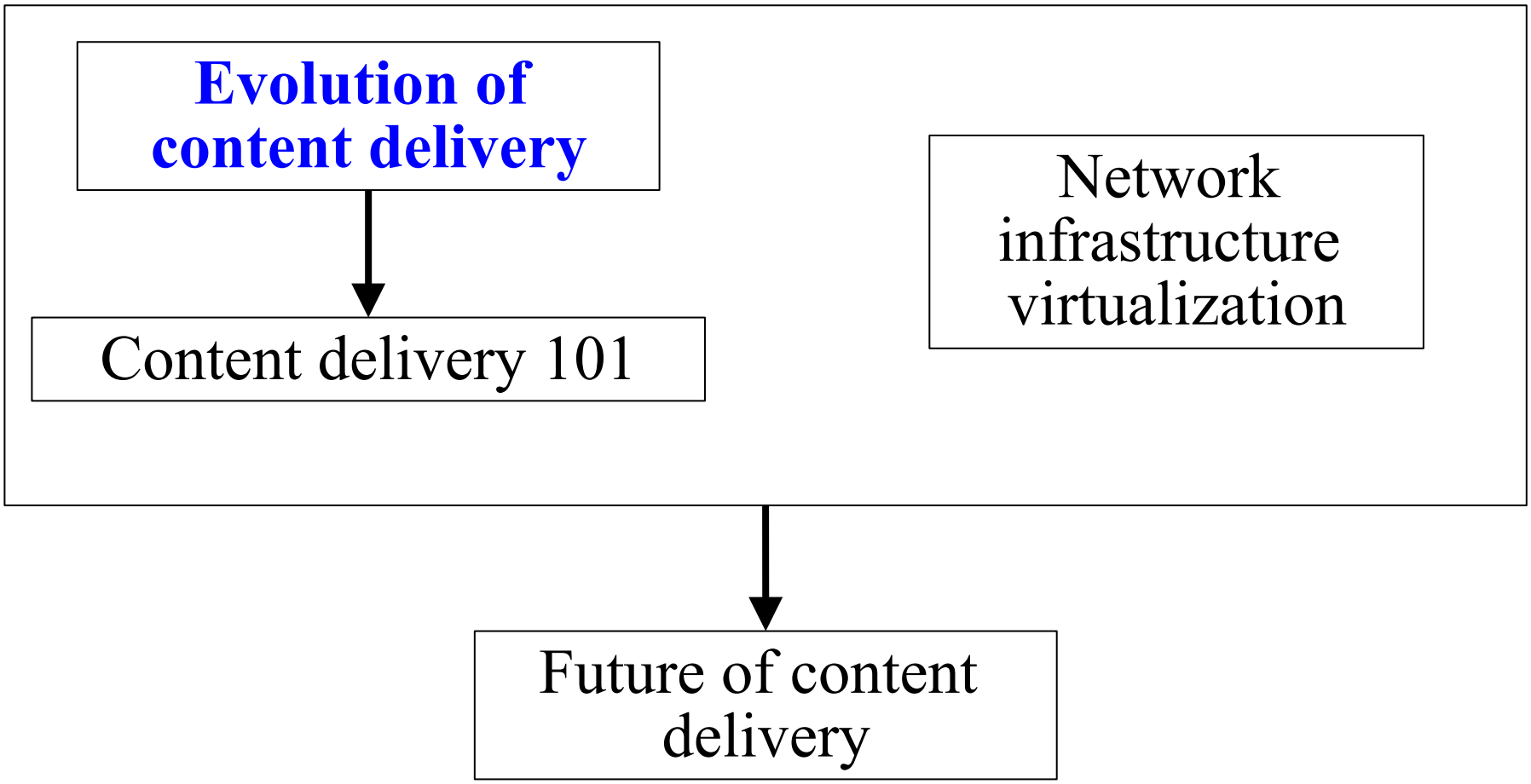
Mobility: end-user

Support for mobility:
network infrastructure

Roadmap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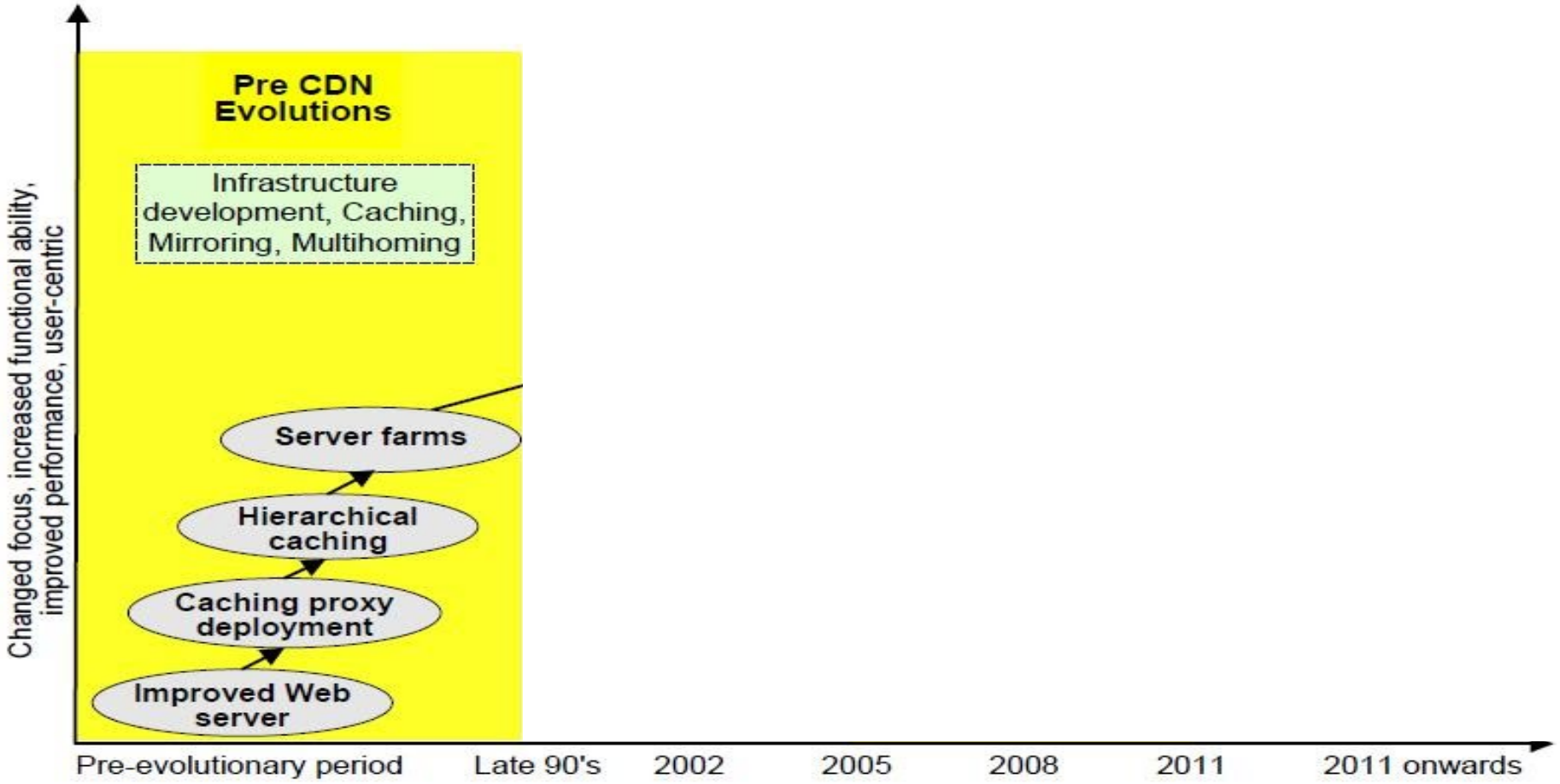
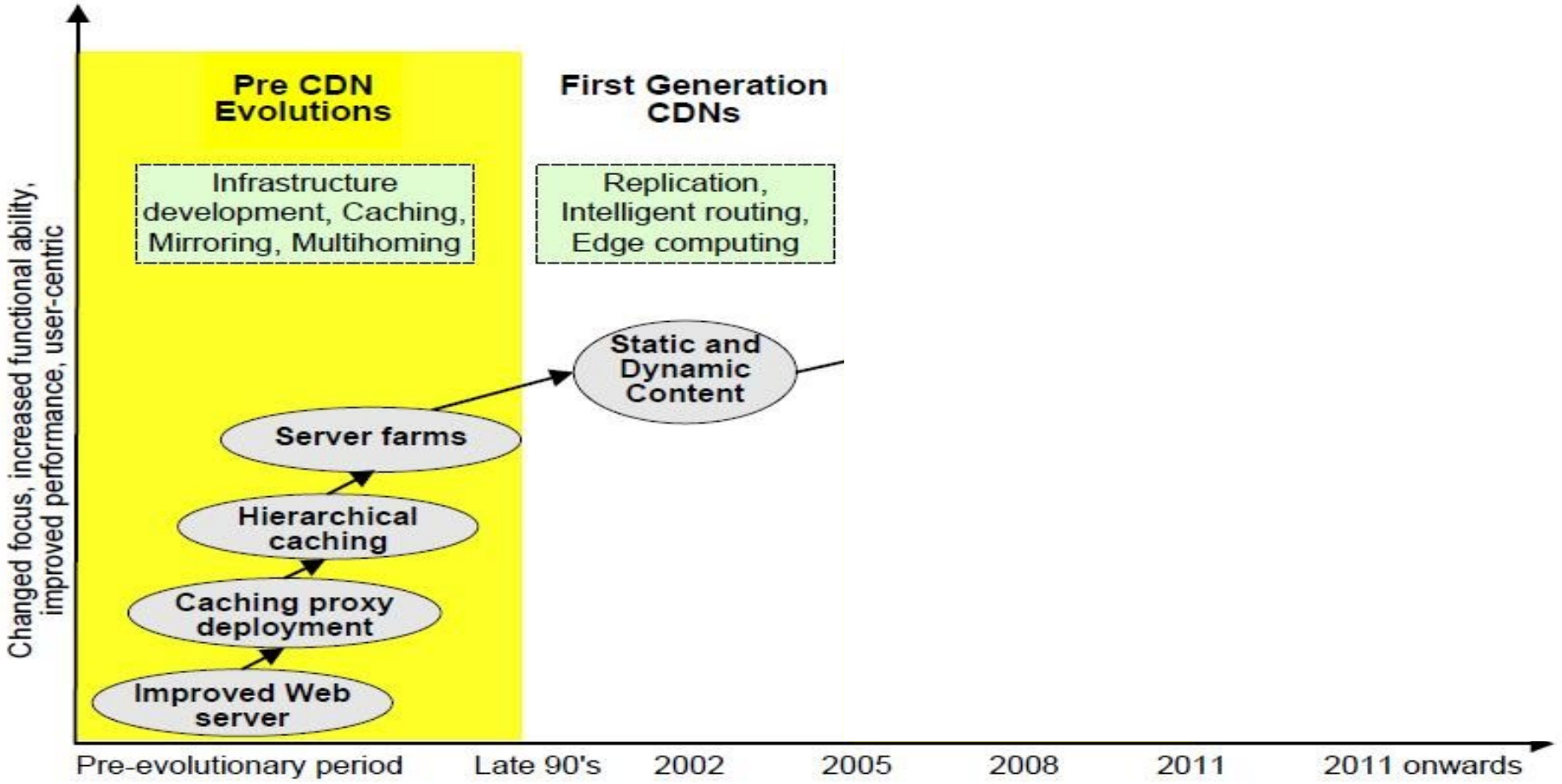
The Early Web



Pathan Mukaddim. Ongoing Trends and Future Directions in Content Delivery Networks (CDNs). Available online from: http://amkpathan.wordpress.com/article/ongoing-trends-and-future-directions-in-3uxfz2buz8z1w-2/

CDNs 1.0



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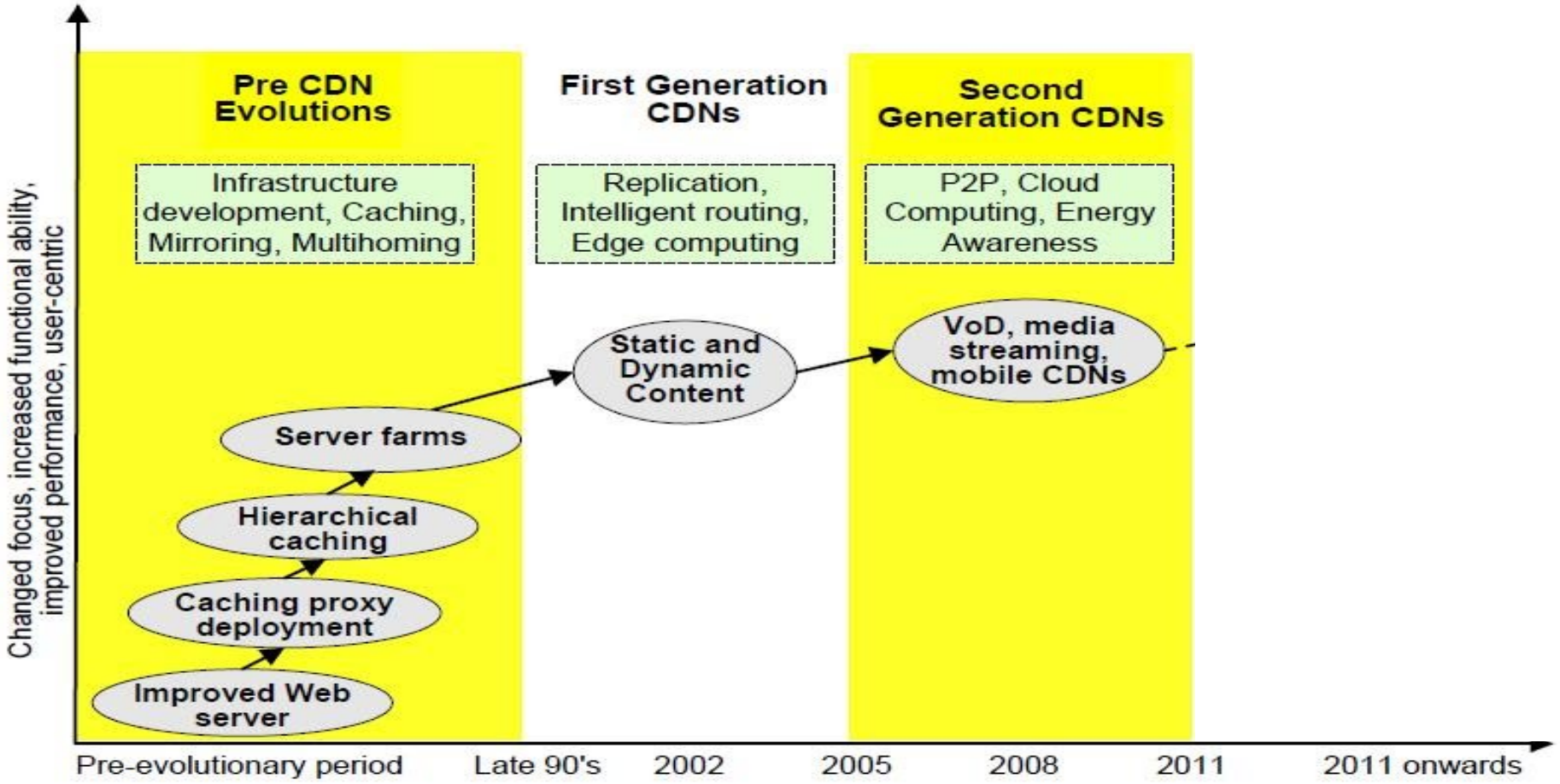
CDNs 2.0



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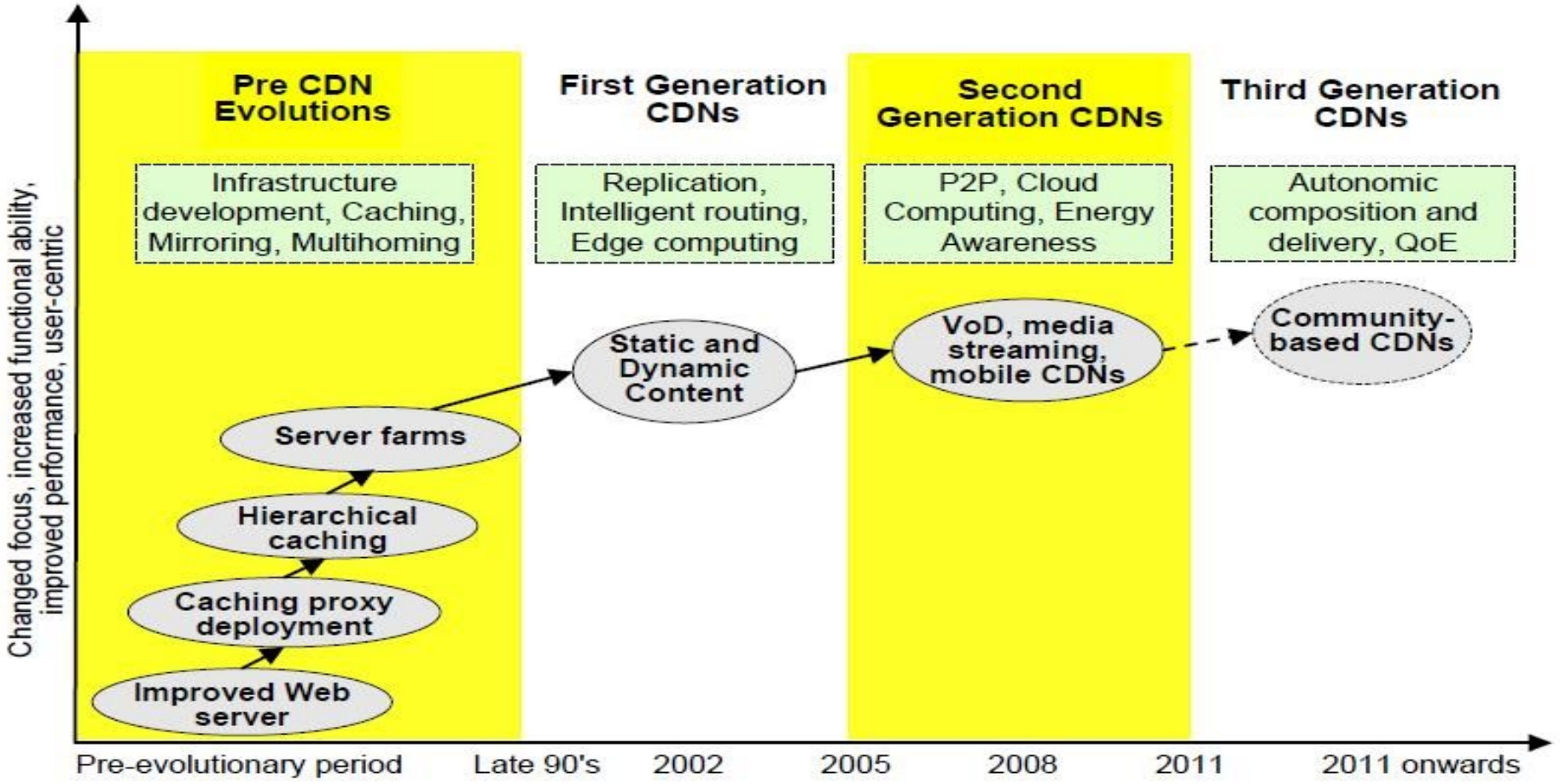
Autonomic CDNs



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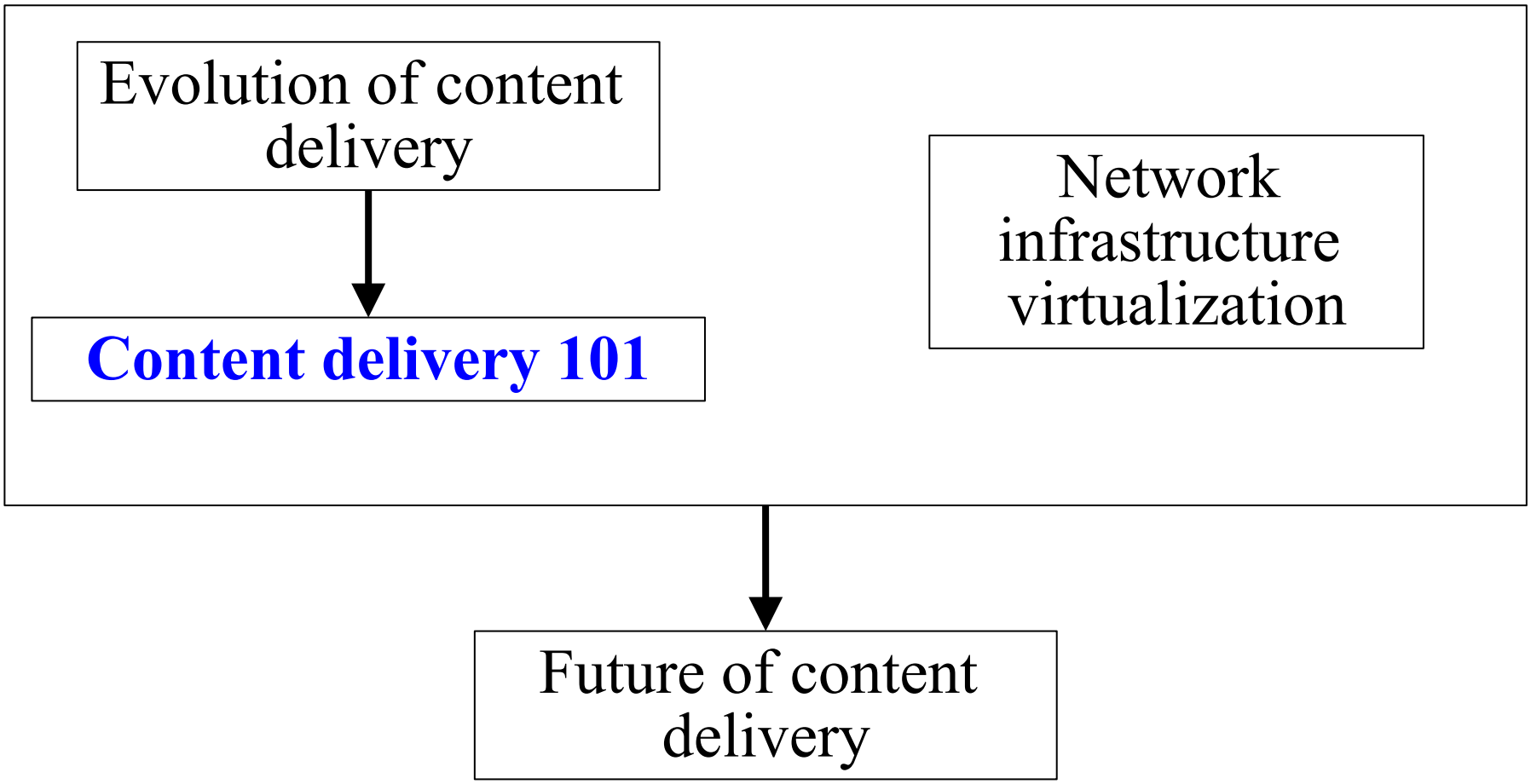
Roadmap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Foundations

- Deployment
  - HTTP: data centers and CDNs
  - P2P: swarms
- Server selection
  - DNS
  - P2P
- Exposed network location diversity

Today's popular CDNs

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Rank	# hostnames	# ASes	# prefixes	owner	content mix
1	476	79	294	Akamai	
2	161	70	216	Akamai	
3	108	1	45	Google	
4	70	35	137	Akamai	
5	70	1	45	Google	
6	57	6	15	Limelight	
7	57	1	1	ThePlanet	
8	53	1	1	ThePlanet	
9	49	34	123	Akamai	
10	34	1	2	Skyrock	
11	29	6	17	Cotendo	
12	28	4	5	Wordpress	
13	27	6	21	Footprint	
14	26	1	1	Ravand	
15	23	1	1	Xanga	
16	22	1	4	Edgecast	
17	22	1	1	ThePlanet	
18	21	1	1	ivwbox.de	
19	21	1	5	AOL	
20	20	1	1	Leaseweb	

only on TOP, both on TOP and EMBEDDED, only on EMBEDDED, TAIL.

Geographic coverage of less popular CDNs

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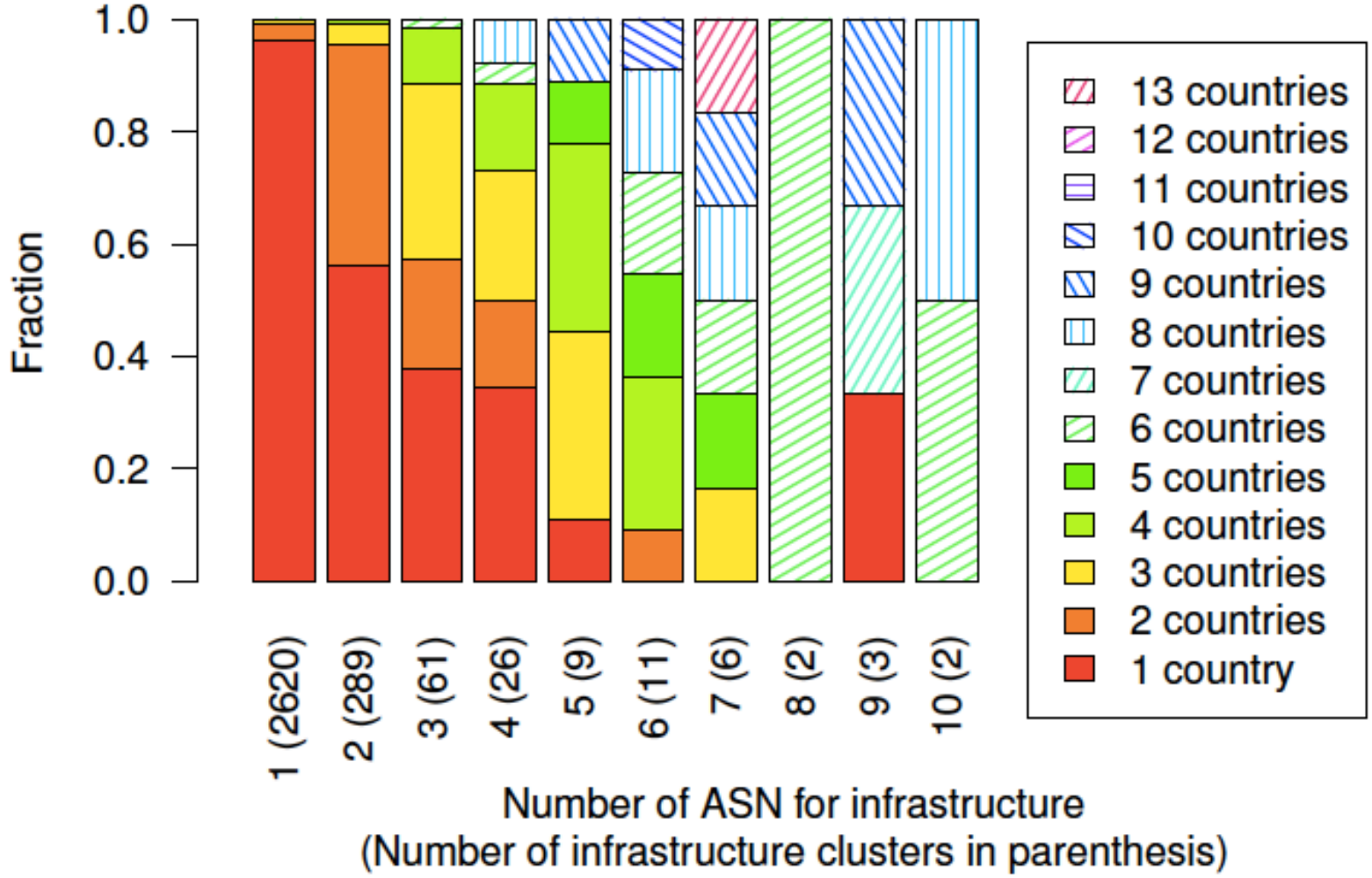

Deployment of popular P2P swarms

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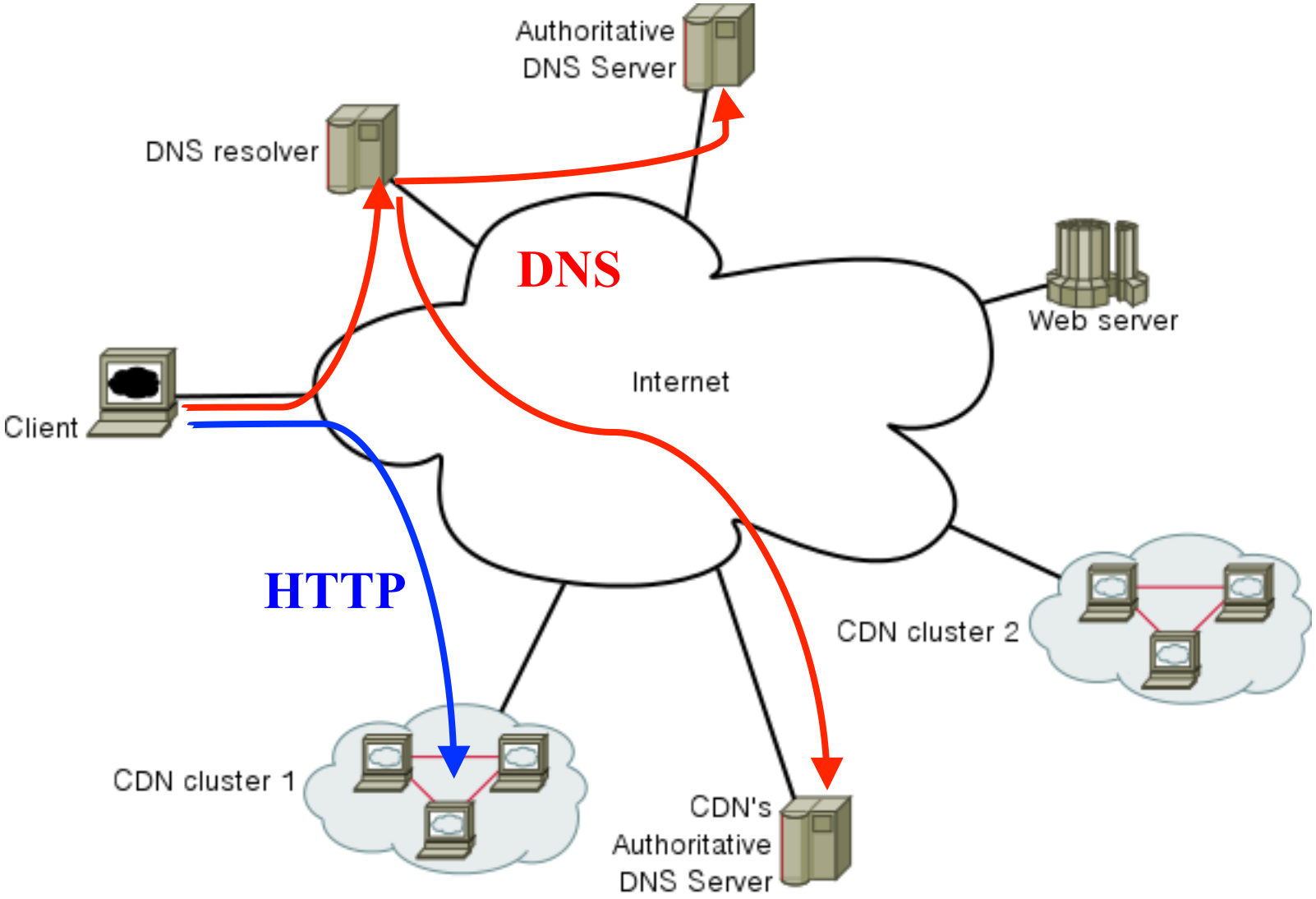
#	Country	U. Peers
1	US	1379462
2	ES	887480
3	GB	800308
4	CA	551820
5	IN	514246
6	AU	322009
7	BR	318294
8	IT	295339
9	PL	288780
10	PT	220124

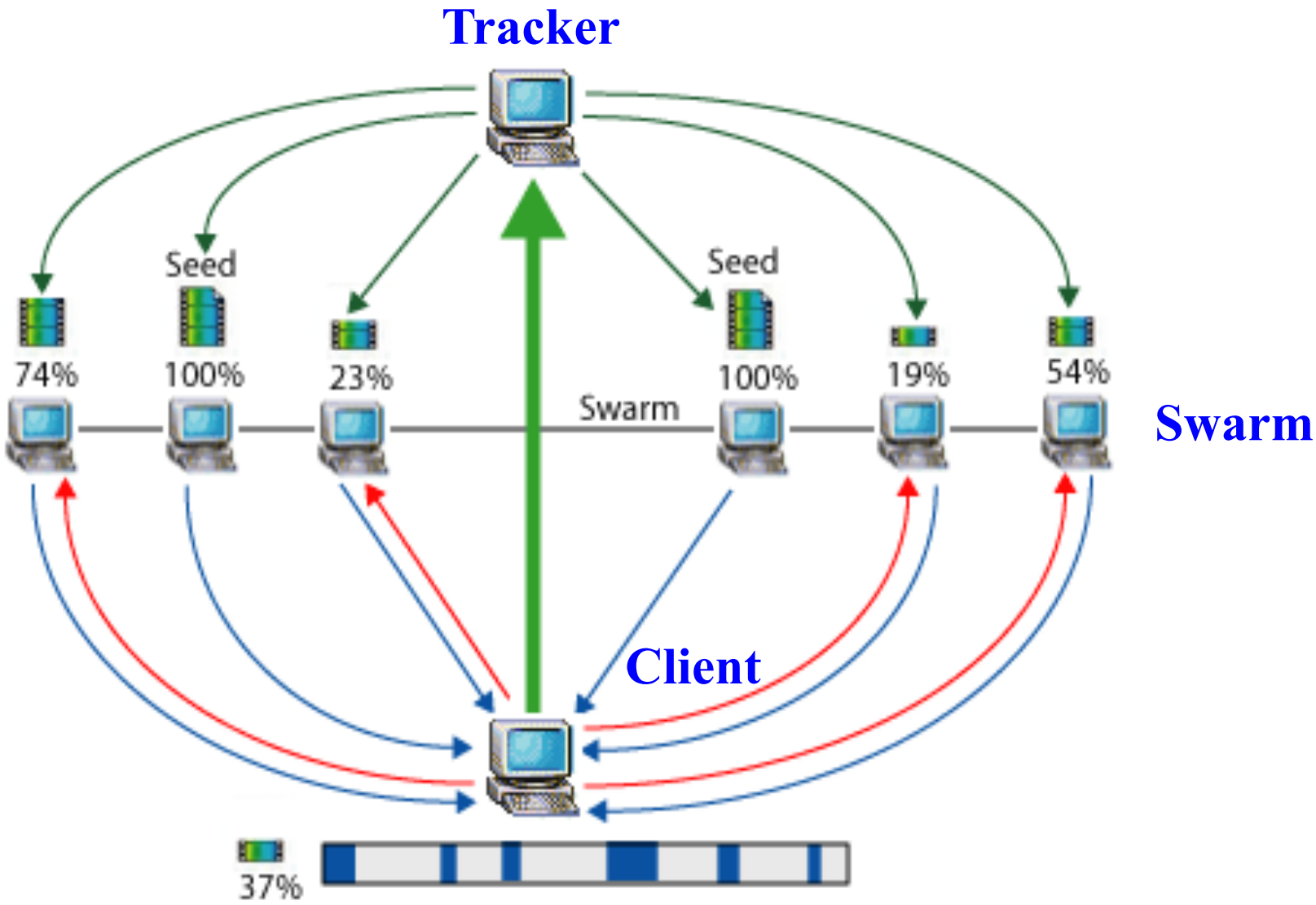
TOP 10 ISPS (BT VIDEO USER)

	AS#	Peers	AS Name-Internet Service Provider
1	3352	165469	TELEFONICA-DATA-ESPANA(TDE)
2	3662	129047	DNEO-OSP7-COMCAST CABLE
3	6461	127297	MFNX MFN-METROMEIDA FIBER
4	2119	113597	TELENOR-NEXTEL T.NET
5	19262	101390	VZGNI-TRANSIT-Verizon ISP
6	3301	97658	TELIANET-SWEDEN TELIANET
7	3462	96564	HINET-DATA CBG
8	4134	87392	CHINANET-BACKBONE
9	6327	86964	SHAW-SHAW COMMUNICATION
10	174	74453	COGENT COGENT/PSI

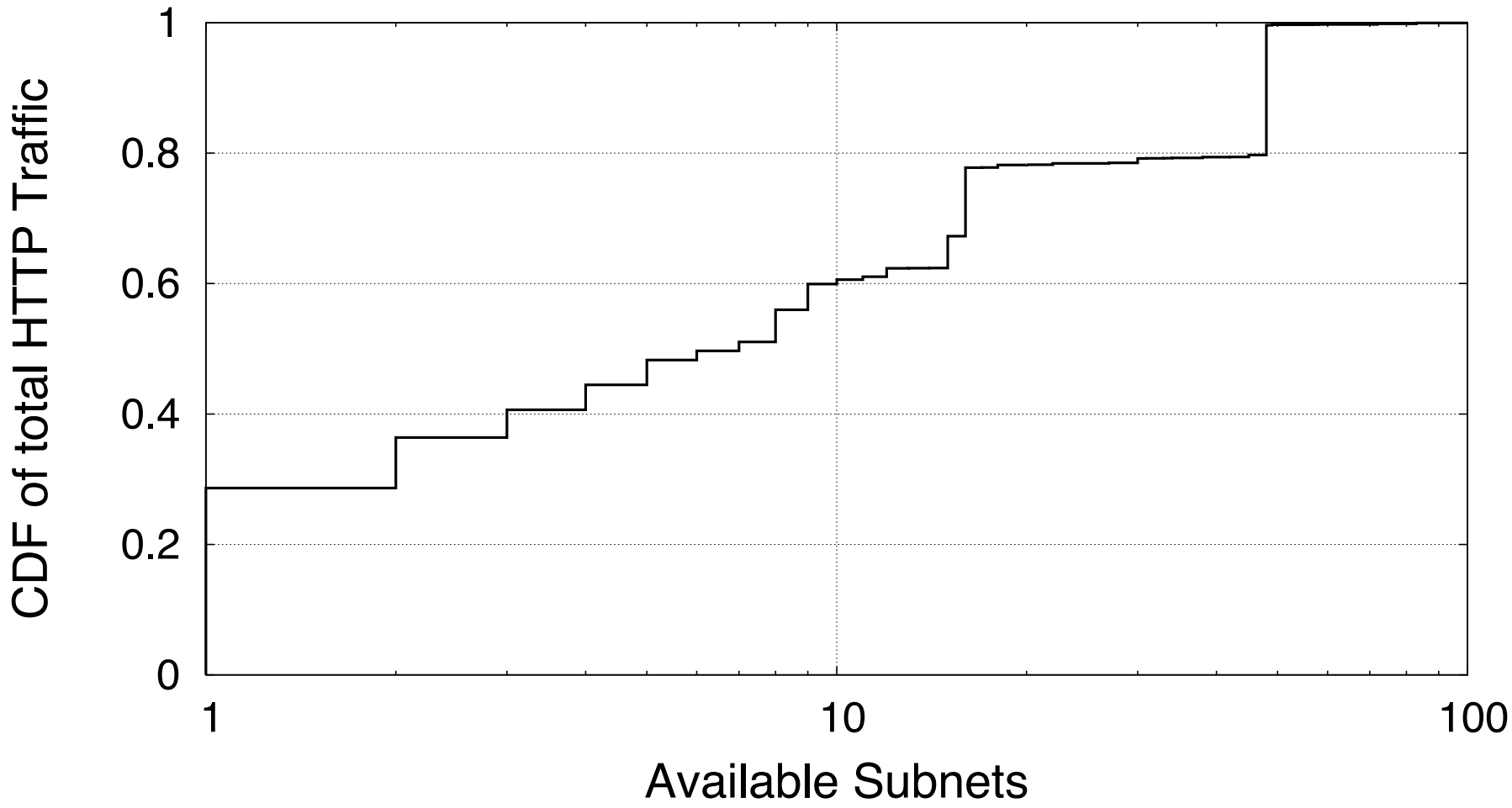
Server selection: HTTP



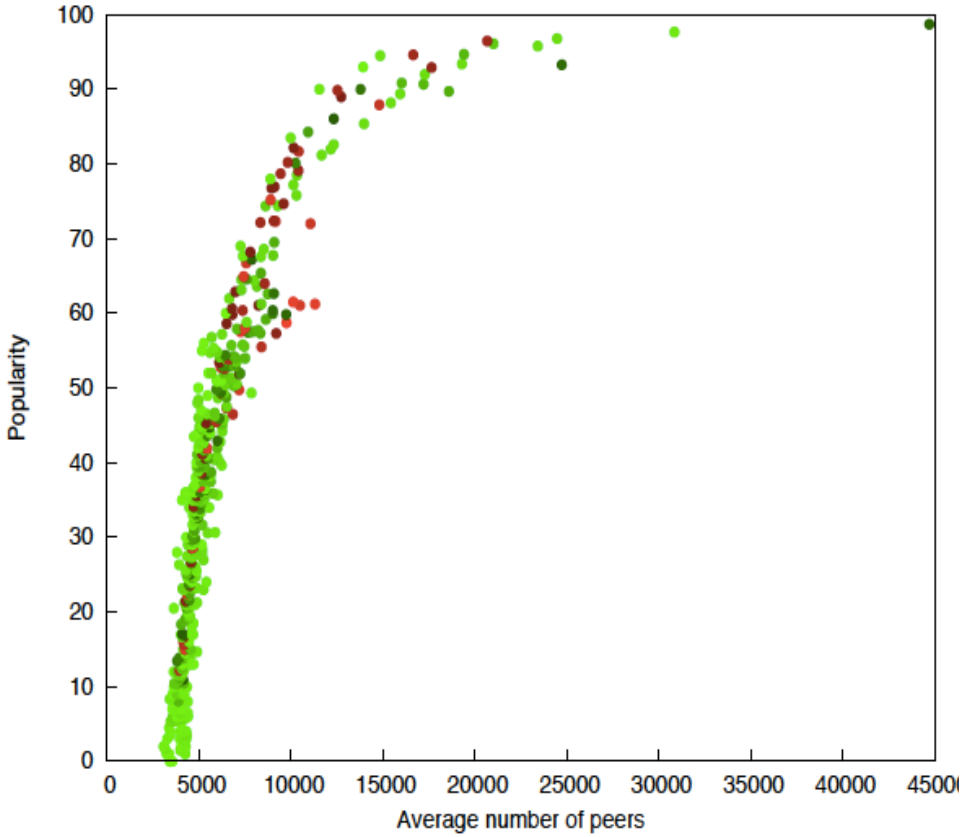
Server selection: P2P

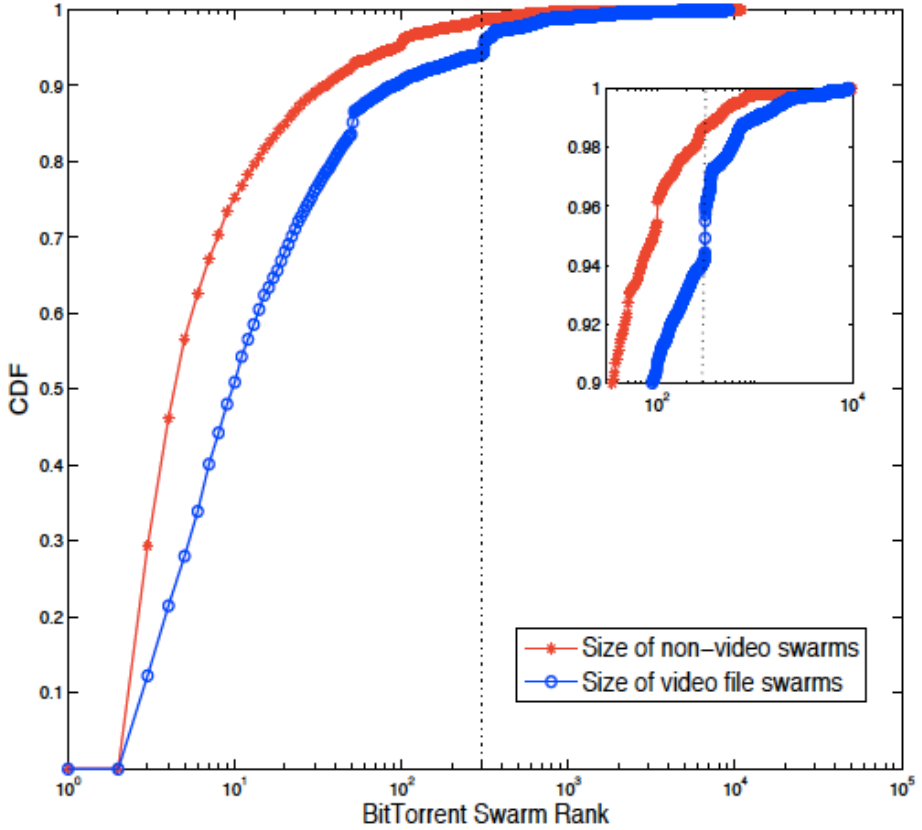


CDN diversity

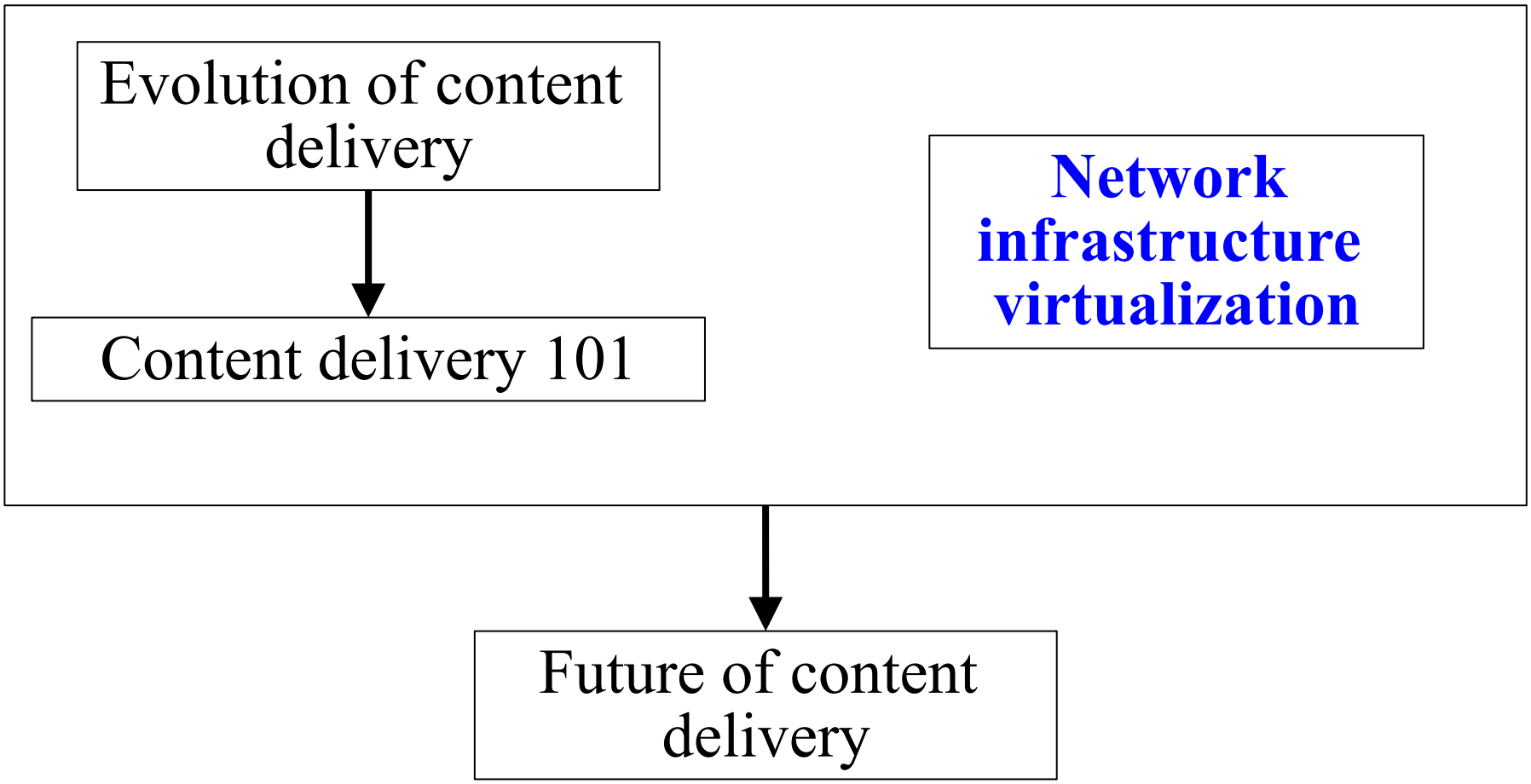


P2P diversity





Roadmap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Why virtualization?

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Virtual network = resource isolation/sharing

- Different architecture/protocol per virtual network
  - Does not have to be IP protocol, e.g., CCN
  - For QoS, security, different types of content/ applications
- Expose network components to applications and services
- Dynamic: migration/expansion/contraction

Benefits

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- Isolation as enabler for new technologies
  - Away from traditional native services, e.g. IPv6, multicast
  - Deployment of innovative services
- Agile network management
  - Migration of devices (such as routers)
  - Managing a network “as a cloud”

The Virtualized Network

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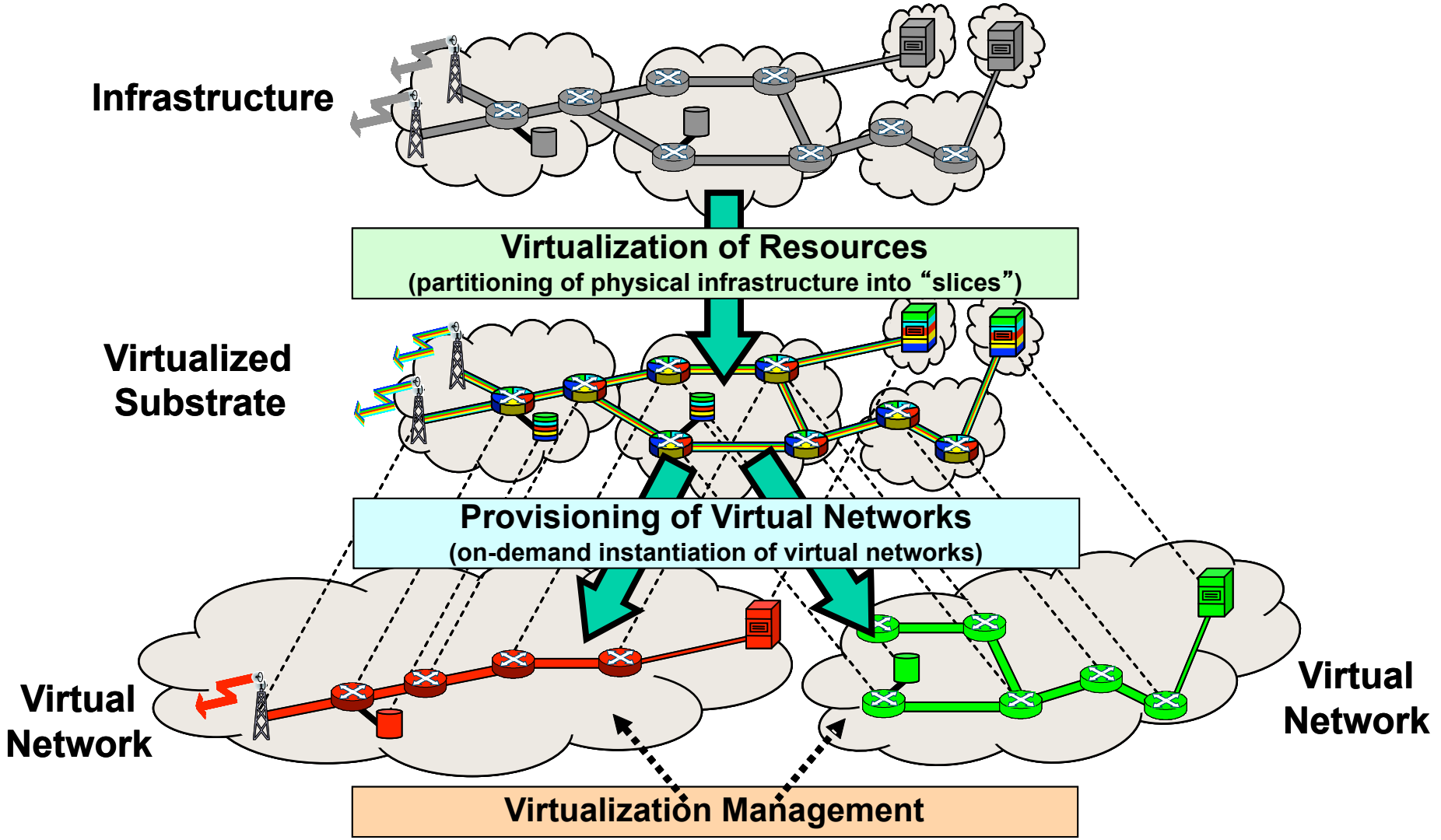
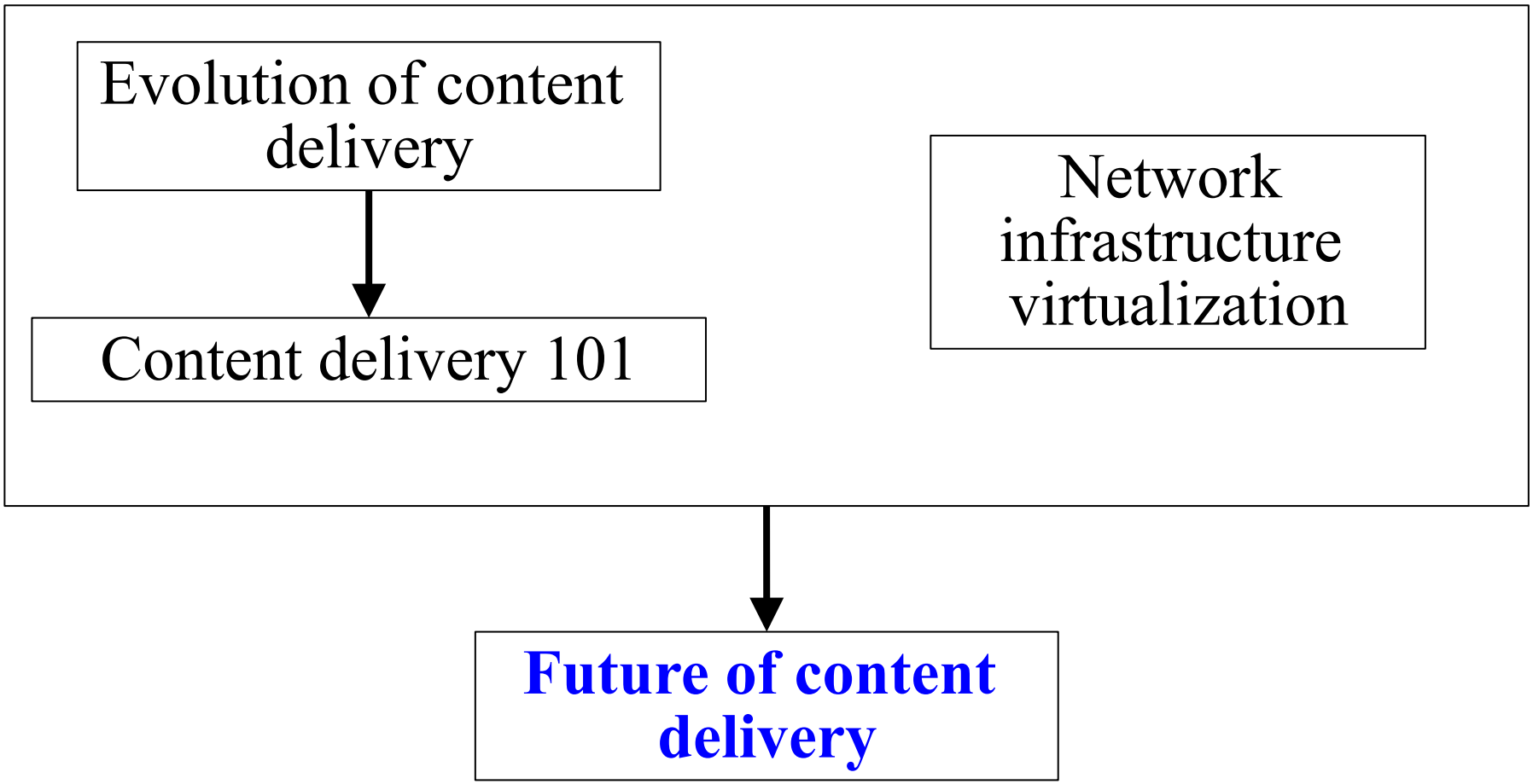


Roadmap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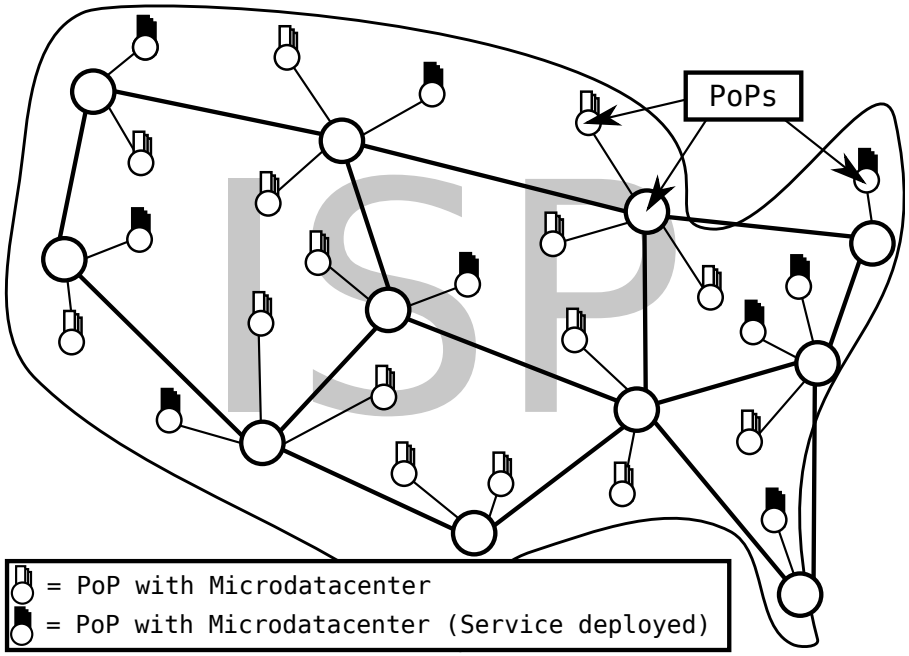
CDN 3.0

- Hybrid infrastructures, e.g., Xunlei
- Meta-CDNs
- Agile CDNs through virtualization:



Content-Processing-Network

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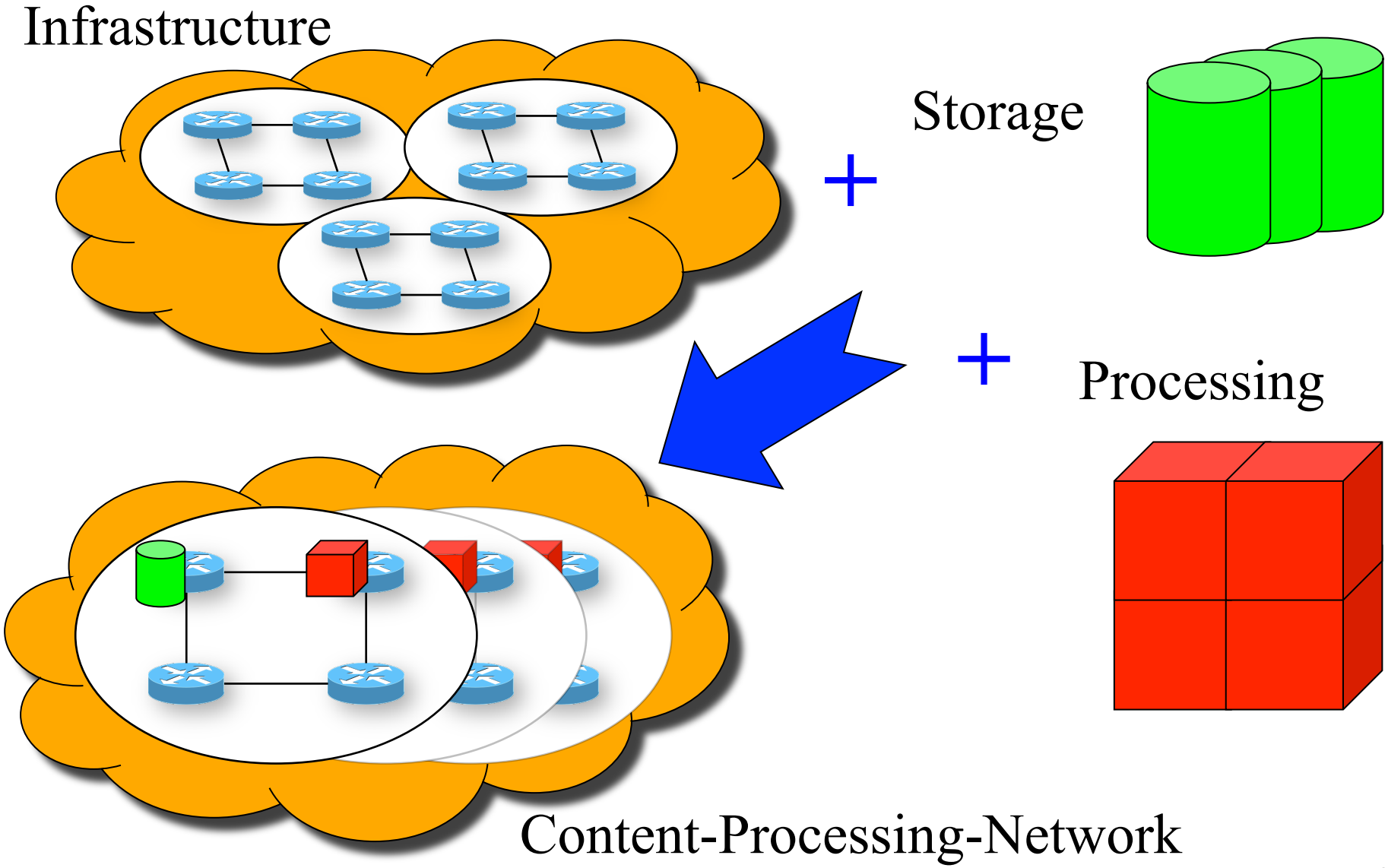

Summary

- Massive content infrastructure deployment
- Significant location diversity
- Increased diversity and agility through virtualization
- Network infrastructure supports end-user mobility

References

- R. Buyya, M. Pathan, A. Vakali (Eds.). ***Content Delivery Networks.*** Springer-Verlag Lecture Notes in Electrical Engineering, 2008.
- H. Wang, J. Liu, and K. Xu. ***On the locality of BitTorrent-based video file swarming.*** IPTPS 2009.
- I. Poese, B. Frank, B. Ager, G. Smaragdakis, and A. Feldmann. ***Improving content delivery using provider-aided distance information.*** IMC 2010.
- B. Ager, W. Mühlbauer, G. Smaragdakis, and S. Uhlig***. Comparing DNS resolvers in the wild.*** IMC 2010.
- B. Ager, W. Mühlbauer, G. Smaragdakis, and S. Uhlig. ***Web content cartography.*** IMC 2011.
- P. Dhungel, K. Ross, M. Steiner, Y. Tian, X. Hei. ***Xunlei: Peer-Assisted Download Acceleration on a Massive Scale.*** PAM 2012.
- B. Frank, I. Poese, G. Smaragdakis, S. Uhlig and A. Feldmann. ***Content-aware traffic engineering***. Proc. of SIGMETRICS 2012.