Challenges in IP Traffic & Service Management Across Clouds, CDNs & ISP Networks

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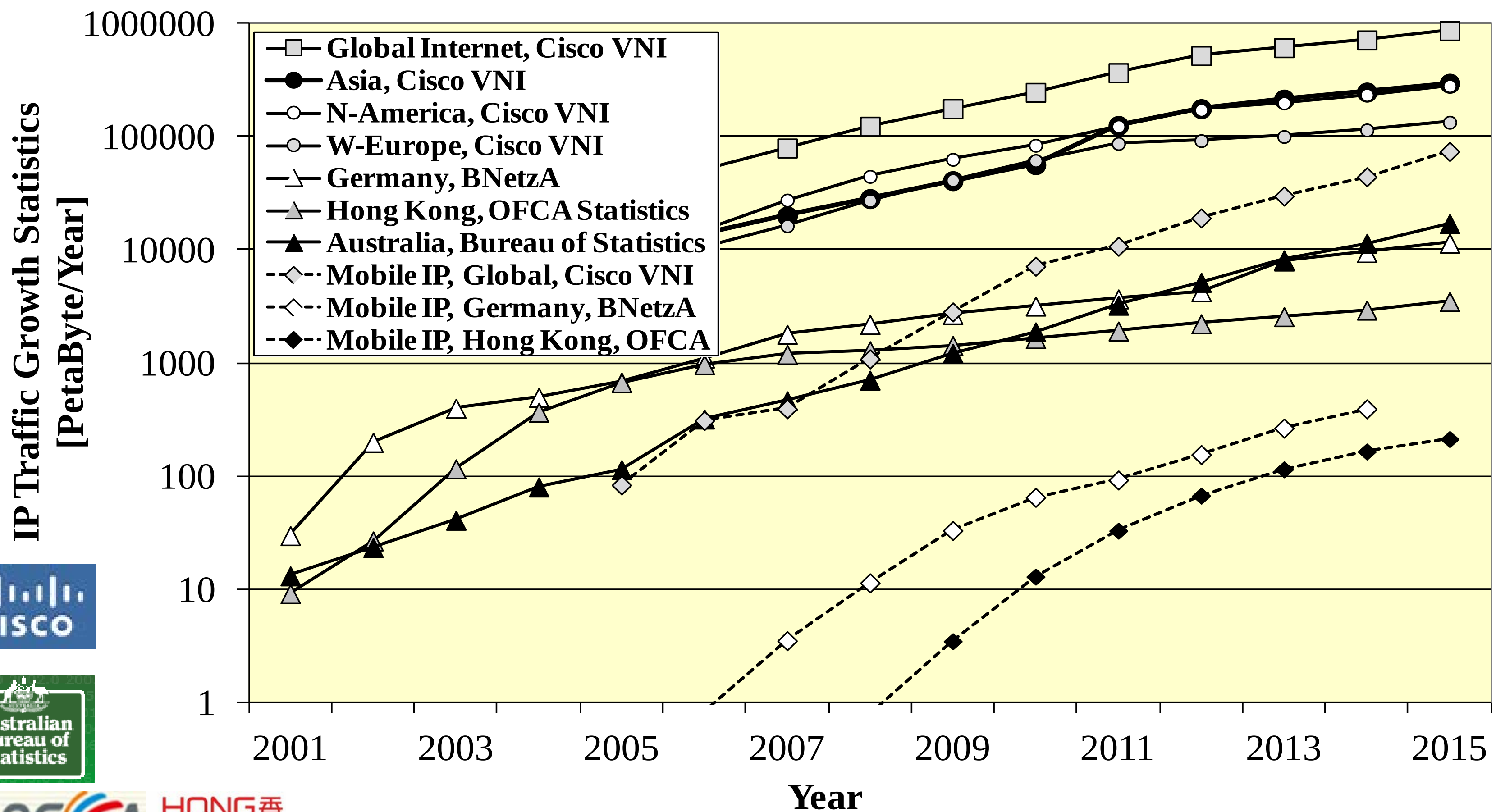
- User Demands and Main Traffic Sources in the Internet: Content Delivery via CDNs, Cloud Services
- Multiple Path TCP & Hybrid Access
- Energy and Resource Efficiency
- Conclusions

Internet Traffic Growth



Sources: Cisco Systems, Visual Networking Index <www.cisco.com>
Australian Bureau of Statistics <http://abs.gov.au/ausstats/abs@.nsf/mf/8153.0>
Hong Kong OFCA <www.ofca.gov.hk>
Germany, Bundesnetzagentur <www.bundesnetzagentur.de>

Main Traffic Categories in ISP Networks

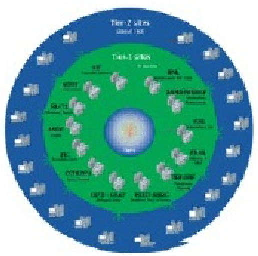
- CDN-to-User Traffic (OTTs, Google, Akamai etc.) (>40%*)
- Cloud/Server-to-User Traffic (without global CDN) (>20%*)
- User-to-User Traffic (Voice, Video Conferencing Interactive Gaming, P2P) (>10%*)

* of traffic to end users

- Traffic between Data Centers incl. Grid/Cloud Computation (>30% of and additional to traffic to end users)

(→ Cisco cloud networking index)

Distributed Cloud with High Cross Traffic @ CERN



Run 1/LS 1

~1 PB/sec

25-30 PB/year

0.5 M cores

0.5 EB storage

2 M jobs/day

24/7 operations

CERN has extreme gird computation demands
in parallel tasks

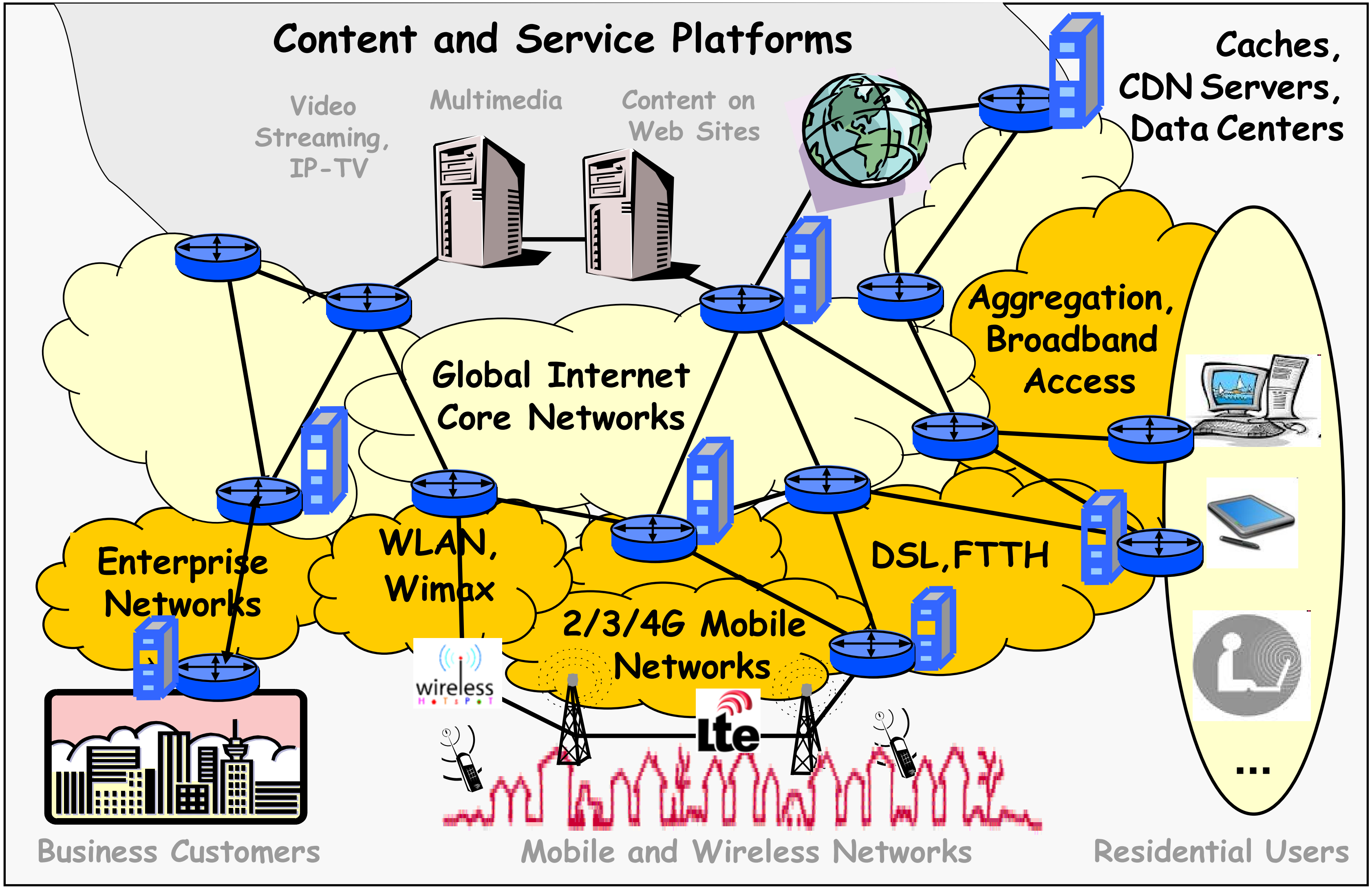
combined with huge data vol-umes per task

running in a European cloud

<home.cern>
<opennebula.org>

Data throughput between comp. clusters is delay sensitive from >~30ms

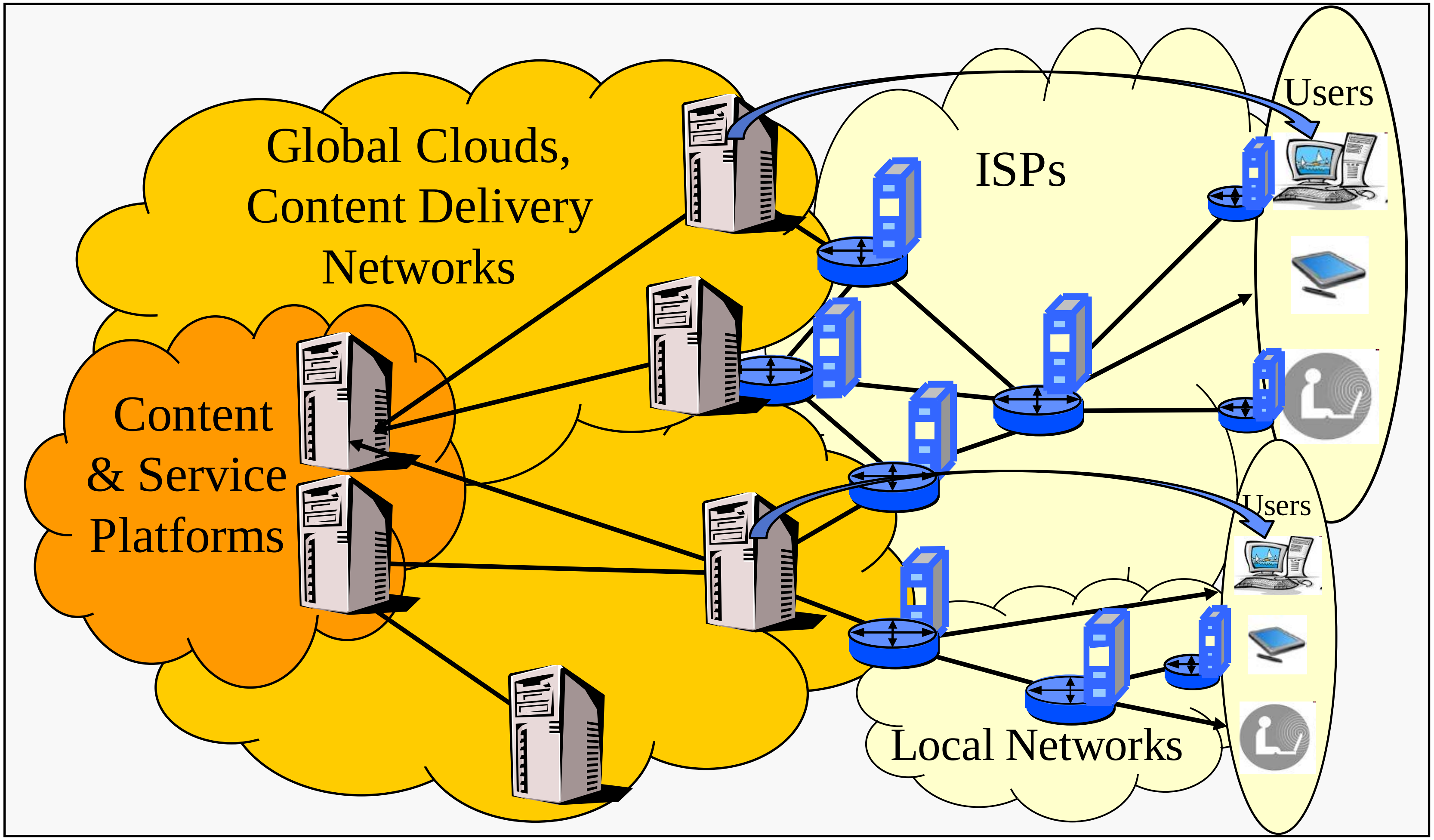
Content Distribution Across Clouds, CDNs, ISP Networks



Relevance of caching in the IP infrastructure

- Caching is crucial to reduce load on
  expensive inter-domain & inter-continental links
  efficiently optimized by global CDNs
- Caching can also reduce load in the core and aggregation
  - although core network capacity are less expensive
  - many small caches are required in the aggregation
- Transparent caching requires coop. with global CDNs
  is most helpful for popular services without CDN support
- Caching in home gateways is an option (user or ISP control)
- Caching on user end systems e.g. in browsers still can save
  >20% of traffic load (most important in mobile networks)

Global CDNs, Clouds: Efficient WAN Content Distribution, but Bypass Local Data Centers, Caches

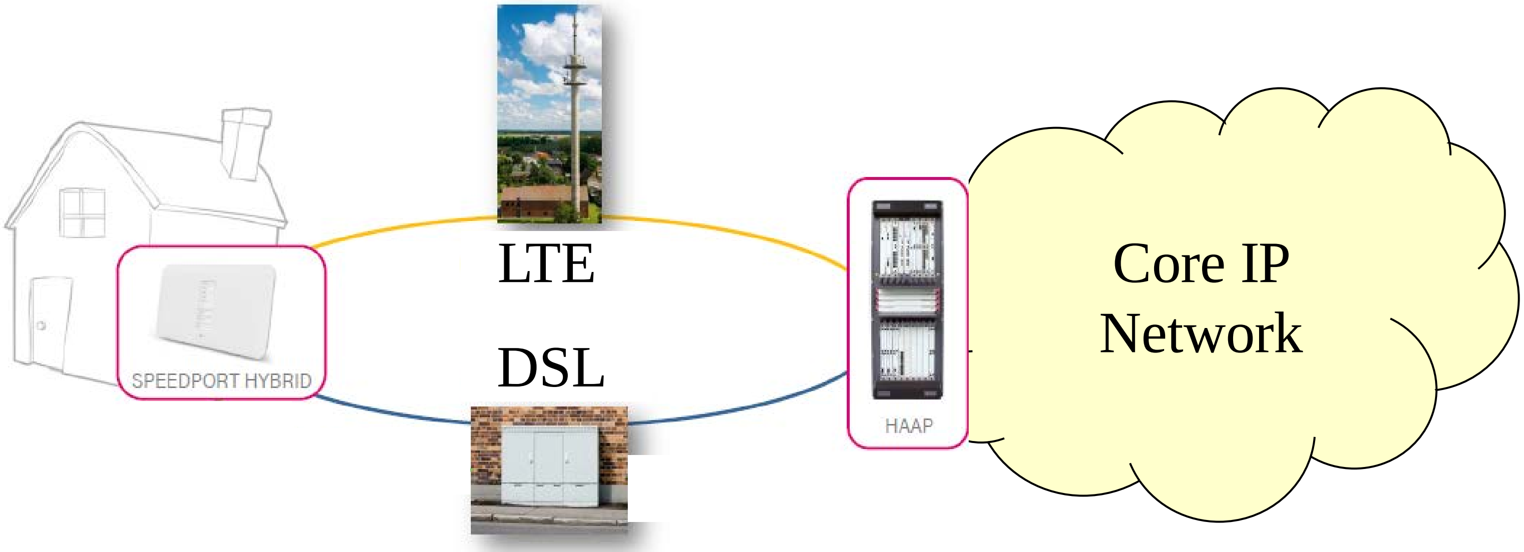


Interoperability between CDNs/clouds and ISPs

- Large CDNs offer cache servers in ISP networks
  but then large ISPs would have to manage
  Google/Akamai/Netflix caches in their core/aggregation
- ISPs are extending data centers in the core as IaaS
- Clouds / CDNs control the application layer
  ISPs control network layer and traffic engineering
  Cooperation is possible between layers / admin. domains
  but business incentives and partly standardization is open
- Standardization at IETF and other bodies on
  CDN Interconnection & Cloud Federation
  ALTO, HTTP1.0 Caching, ICN

Multipath & Hybrid Access as Traffic Engineering Challenges

- Multipath TCP for using available access technologies in parallel
  WiFi & Cellular & Fixed Access ... ⇔ Distributed Content Servers
- Deutsche Telekom is offering hybrid access combining LTE / DSL
  - mainly to improve rural access speeds
  - LTE as additional best effort option
  - Experience since 2015: Users exploit available LTE resources



Energy Efficiency

If bandwidth is growing proportional to energy consumption

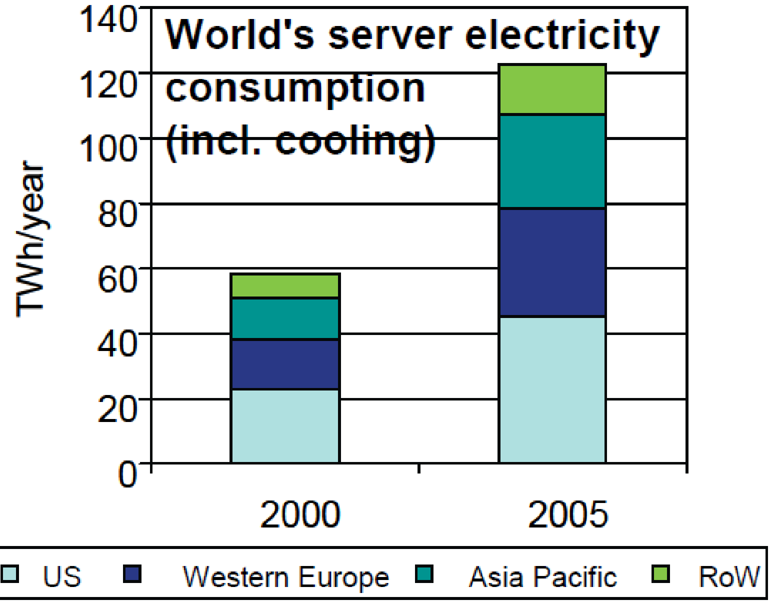
⇒ Energy will limit future bandwidth growth

Energy costs contribute ~30% of OPEX in mobile networks

ICT comsumes ~2-4% of energy; trend to double in 5 years

- Energy efficient technologies
- Elastic, optimized resource usage adapted to demands
- Reduction of cross traffic

are crucial goals



G. Fettweis, E. Zimmermann, ICT Energy Consumption, Trends and Challenges, WPMC 2008

Conclusions

- Content distribution on the Internet depends on CDN & caching for improved delay, throughput, avilability & traffic reduction
- Dominant HTTP traffic for video streaming & IP-TV is cacheable Zipf distributed request pattern, prefetching and appropriate caching strategies make caching efficient
- Lack of cooperation between global content / CDN providers and network providers / users reduces caching options in core & access
- More challenges for traffic engineering arise from multipath / hybrid access options
- Energy efficiency is crucial for future IP bandwidth growth