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Energy-related Aspects in Backbone Networks.

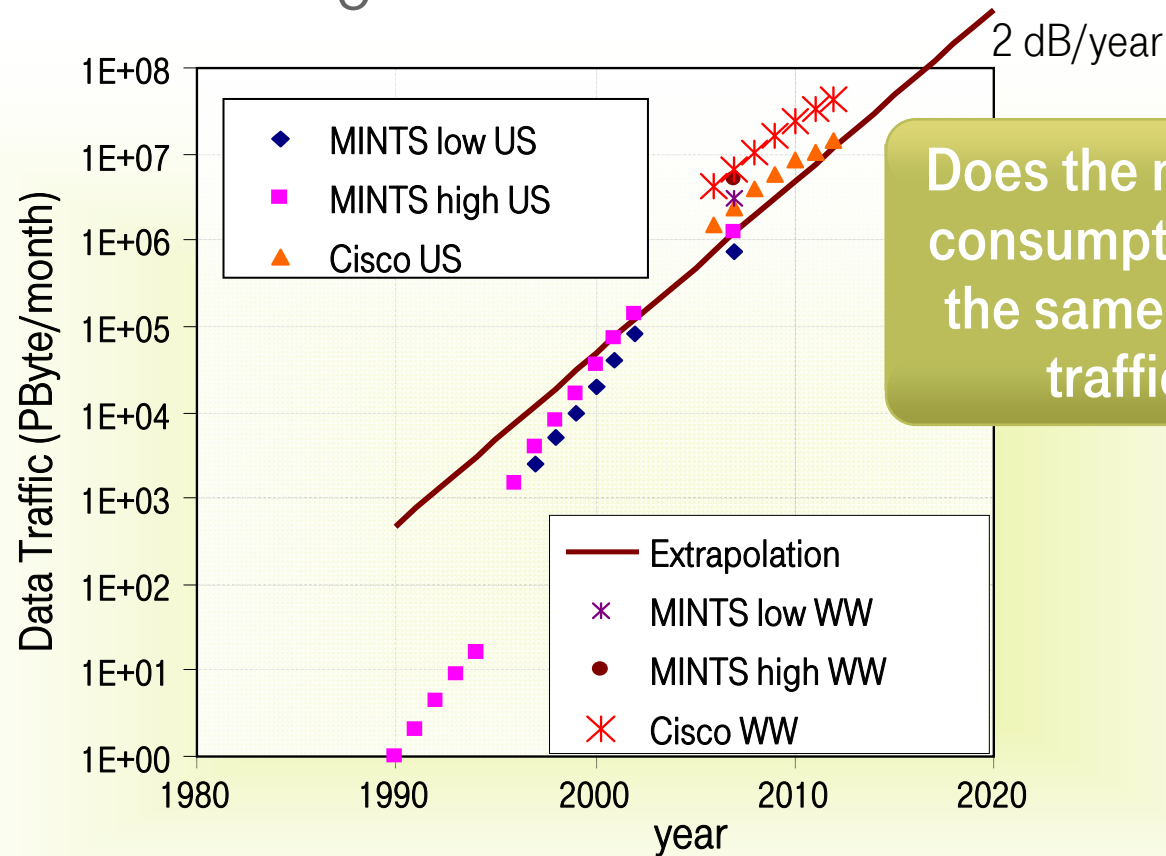
Christoph Lange

Deutsche Telekom AG, Laboratories



Introduction and motivation.

The Internet traffic growth.



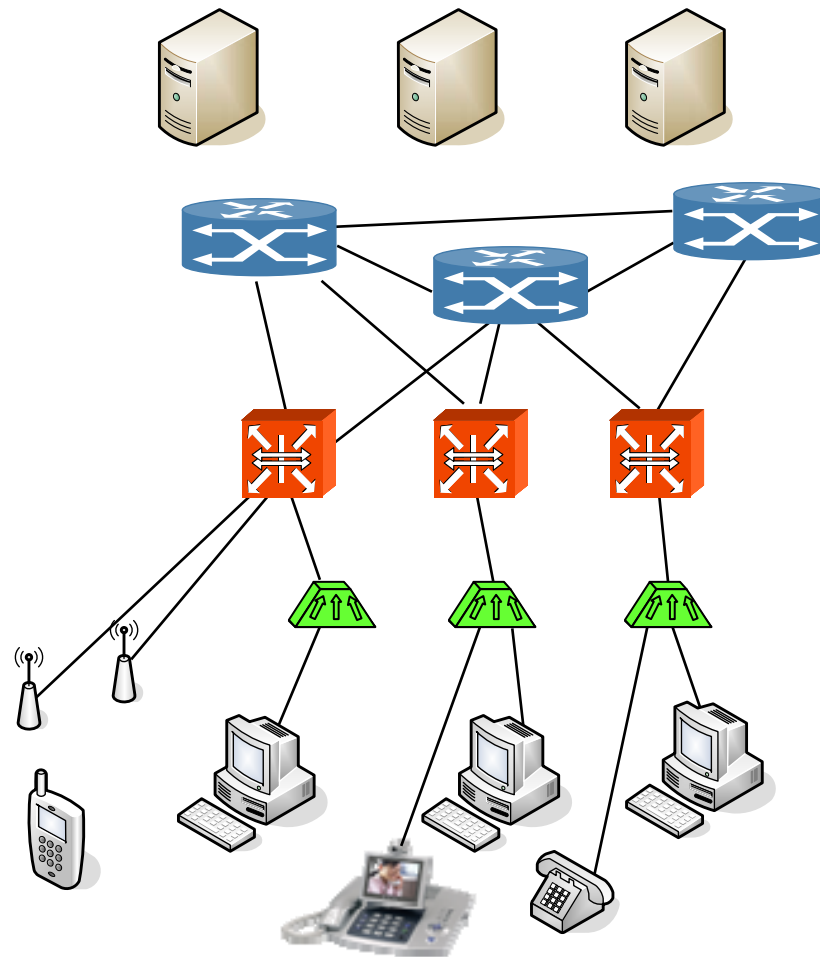
Average annual Internet traffic growth rate: 50-60%

Source: Odlyzko et al: <http://www.dtc.umn.edu/mints/2002-2008/analysis-2002-2008.html>

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Energy consumption of broadband networks.

Telecommunication networks: Layers and functions.



Service delivery platforms
Network control

Backbone network

Aggregation network

Access network

Home networks
Customer equipment

Operational support systems (OSS)
Business support systems (BSS)



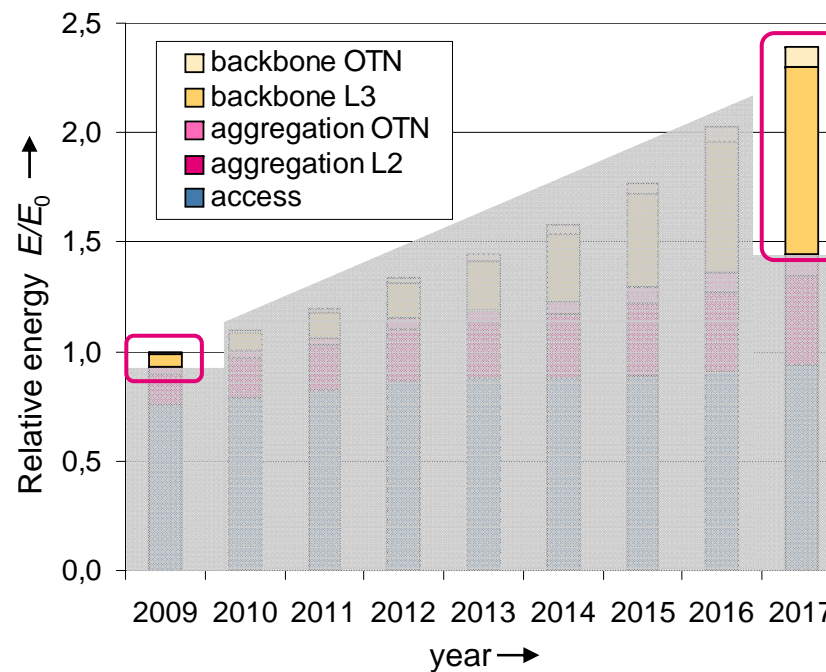
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Energy consumption of broadband networks.

Energy consumption of a telecommunication network.

Backbone energy
consumption

2009:
< 10%



Backbone energy
consumption

2017:
≈ 40%

[C. Lange et al.: Energy Consumption of Telecommunication Networks. ECOC 2009]



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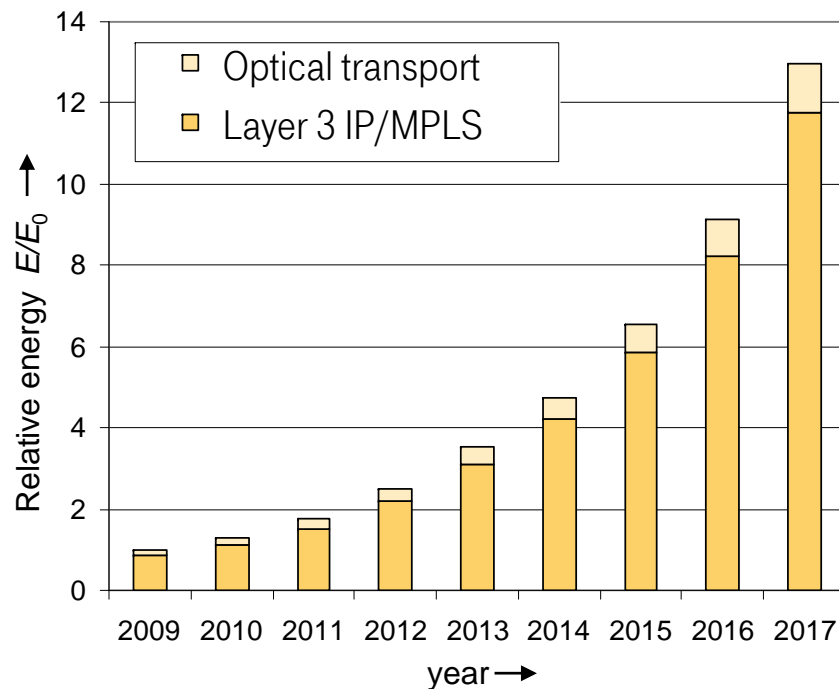
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Energy consumption of broadband networks.

Energy consumption of backbone networks.

Energy consumption growth of backbone networks



Observations

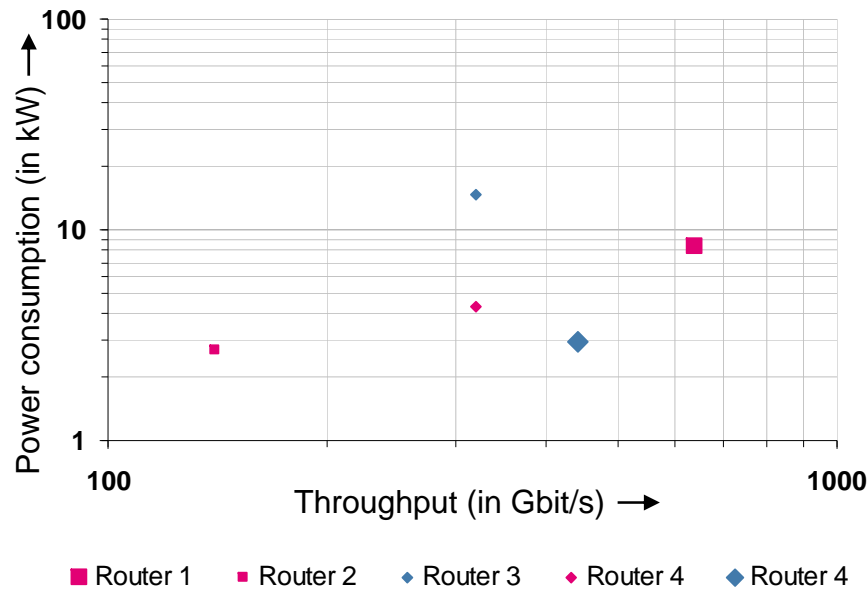
- Backbone energy consumption scales with traffic volume
- Layer 3 IP/MPLS backbone: Major energy consumer compared to OTN
- Optical transport network (OTN): Small energy consumption share



Energy consumption of broadband networks.

Backbone router measurements.

Router measurement results



Observations

- Broad spreading of the results.
- Increased energy efficiency in recent equipment.



Conclusion.

Observations

- Backbone router's energy consumption scales with traffic volume.
- Backbone energy consumption share in operator networks increases and becomes more important.

Challenges

- Improving the energy efficiency of backbone routers facing increasing traffic volume.
- Establishing energy efficient router and network architectures.



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Thank you for your attention!

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