TOWARDS GREEN CLOUD COMPUTING IN HETEROGENEOUS NETWORK INFRASTRUCTURES

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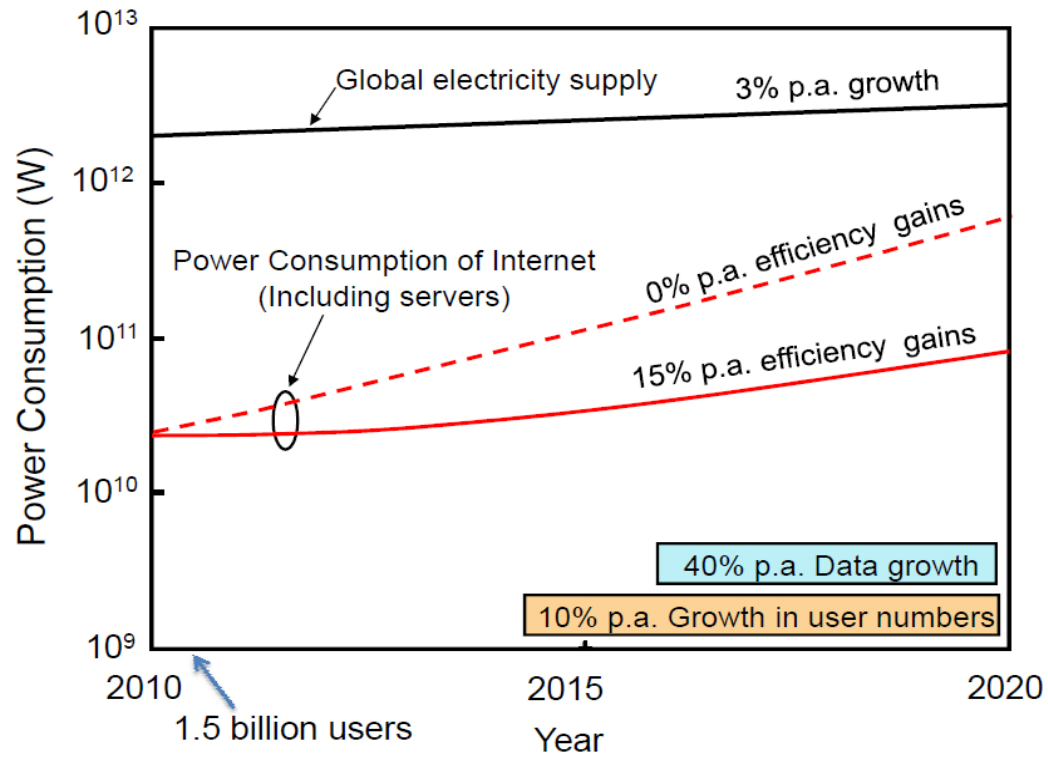
Today's Network Status and Trend (1/4)

- 40% per annum growth in network traffic
- 10% per annum growth in number of users
- Data center traffic increases quickly
  - ☐ Distributed data center is becoming more common
- New applications lead to increased traffic volume in the core of the network
  - ☐ Cloud applications and services:
    - ◇ Software as a Service: Search, email, social networking, data mining, utility computing
      - – Google Docs etc.
      - – Social networking: Facebook, Twitter etc.
      - – Flickr, YouTube
    - ◇ Storage as a Service:
      - – Dropbox, Sky Drive
    - ◇ Processing as a Service
  - ☐ P2P applications: Bittorrent

Data Center

CDNs

Users

Data Centers
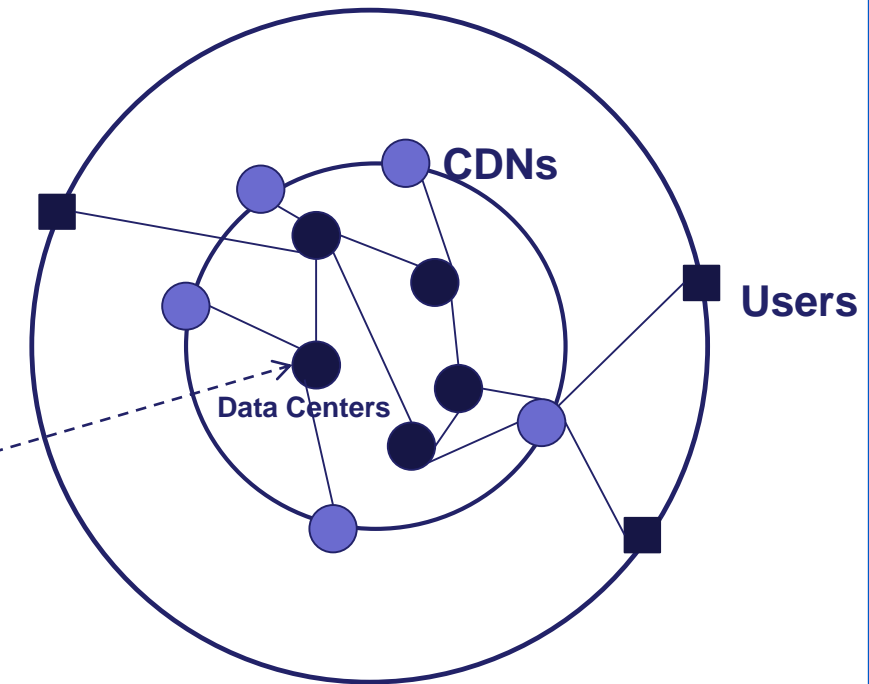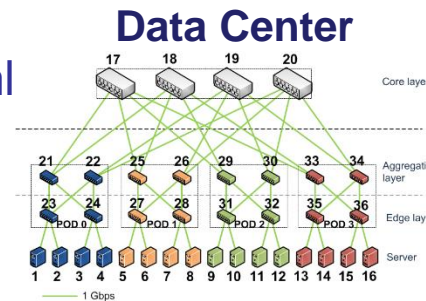
Today's Network Status and Trend (2/4)

■Challenges in providing cloud services:

  ❑High scale DCs: 10's to 100's thousand of servers

  ❑Geographically distributed

  ❑Stringent requirements on reliability: 99,9th percentile SLAs

  ❑Complexity: plethora of components (OS, servers, switches, load balancers, DNS etc.) and hard-/software
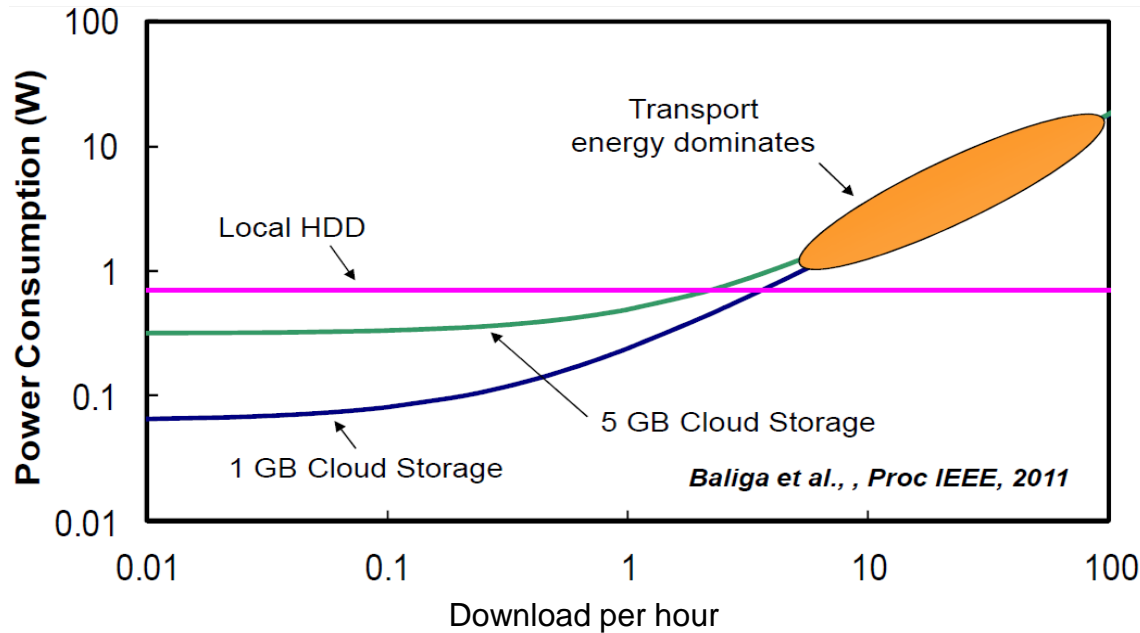
Today's Network Status and Trend (3/4)
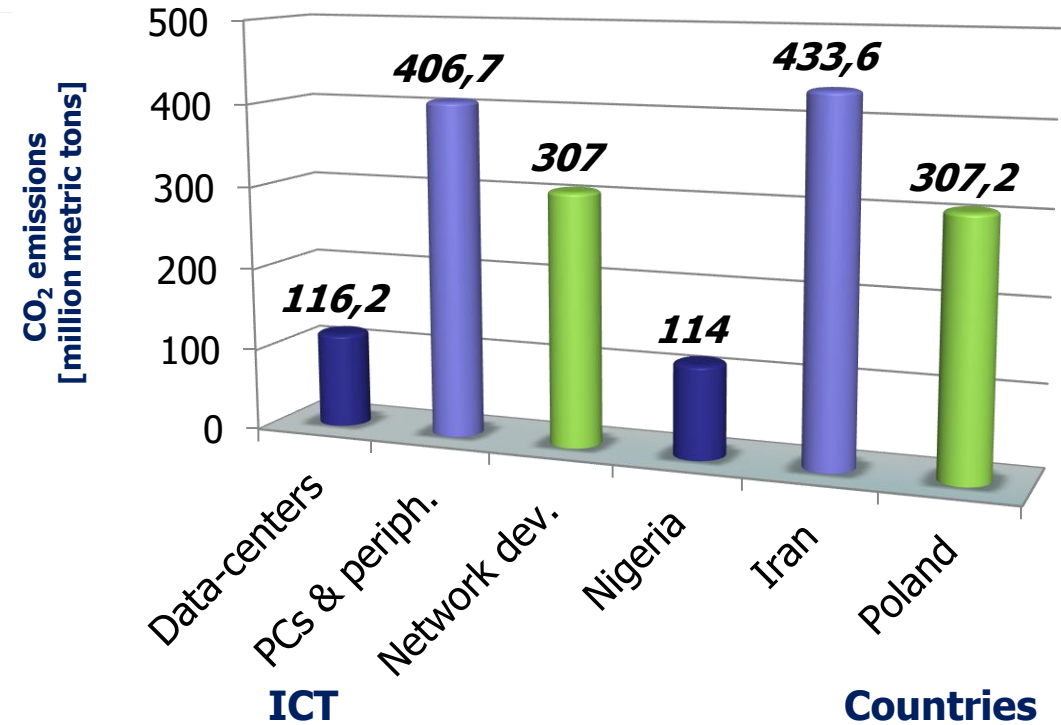

Power consumption
of the global Internet [22]
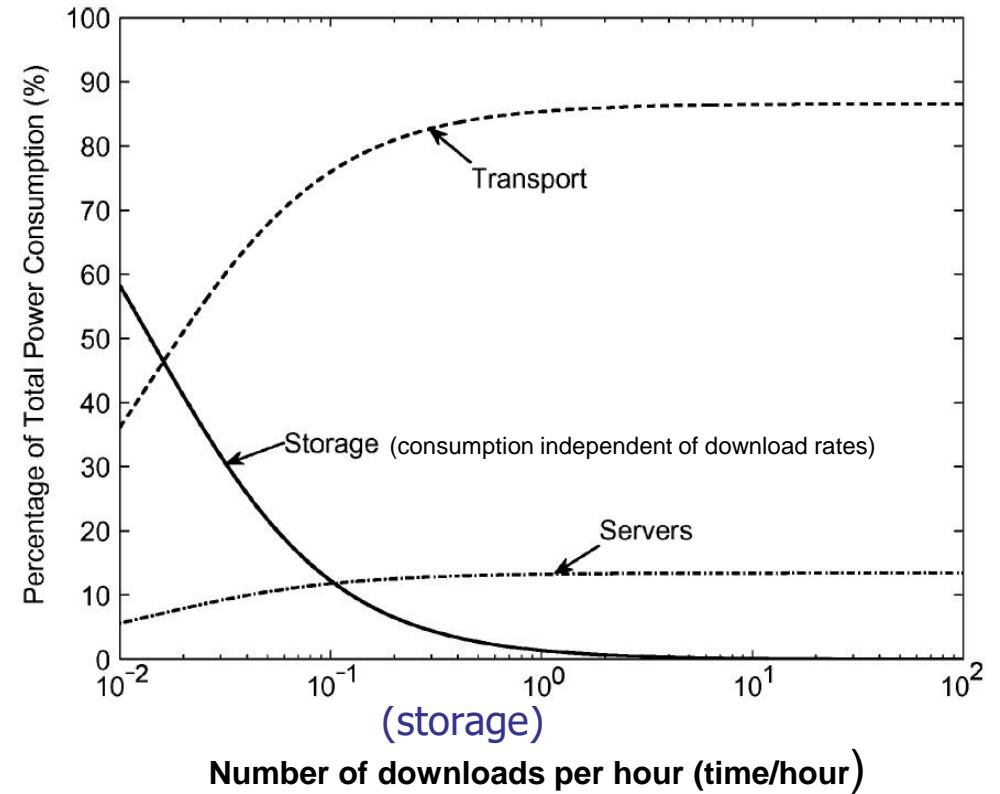
Source: J. Baliga et al., "*Green Cloud Computing: Balancing Energy in Processing, Storage, and Transport,*" Proc. IEEE, vol. 99, no. 1, pp. 149-167, Jan. 2011

Today's Network Status and Trend (4/4)

Energy-consumption of cloud services (Storage as a Service)
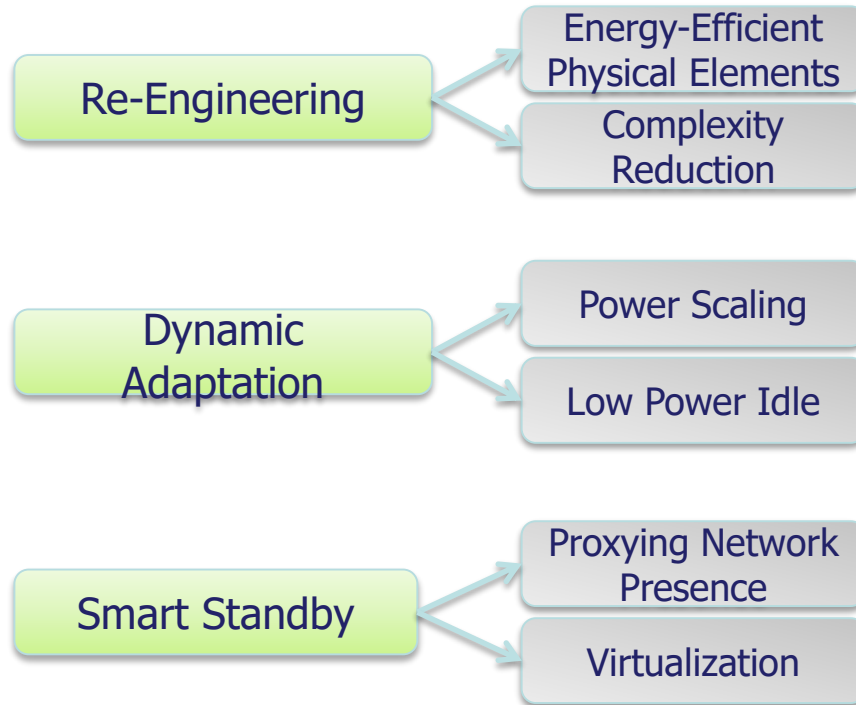

ICT   **Countries**

Source: J. Mankoff, R. Kravets, and E. Blevis, "Some Computer Science Issues in Creating a Sustainable World,", IEEE Computer, pp. 102-105, Aug. 2008.

Why Going Green?

- ICT has been considered as a key objective to reduce energy wastes and achieve higher levels of efficiency

- Until recently, ICT has not applied the efficiency concepts, not even in fast growing sectors like telecommunications, datacenters and the Internet

- Two main motivations for "green" ICT:
  - **Environmentally**, it is related to the reduction of wastes, in order to impact on CO_2 emission;
  - **Economically**, it stems from the reduction of operating costs (OPEX) of ICT services.

Taxonomy in Green Networking

Re-Engineering
→ Energy-Efficient Physical Elements
→ Complexity Reduction

Dynamic Adaptation
→ Power Scaling
→ Low Power Idle

Smart Standby
→ Proxying Network Presence
→ Virtualization

Source: Raffaele Bolla et al., "Energy Efficiency in the Future Internet: A Survey of Existing Approaches and Trends in Energy-Aware Fixed Network Infrastructures", IEEE Communications Survey and Tutorials, 2011

- Gaps Between Theory and Practice
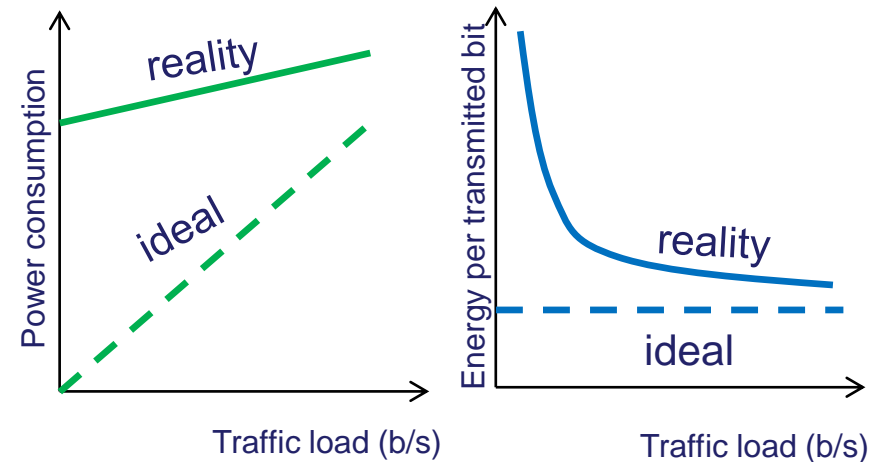
→ How to make energy consumption proportionally to network load?
→ How to reduce energy consumption per transmitted bit?

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Main Research Focuses

- Study energy consumption in common data centers
- Defining suited network architecture and network management
- Study realistic traffic patterns in data centers
- Defining energy-aware methods and algorithms
- Deployment of energy-aware algorithms in hardware
- Building testbed and evaluation methods

- Past activities

  - ECODANE - *Reducing Energy COnsumption in DAta Center NEtworks based on Traffic Engineering*
  - HUST (VN) – Univ. of Wuerzburg (DE)
  - Vietnamese members
    - Dr. Truong Thu Huong
    - Assoc. Prof. Nguyen Huu Thanh
    - Assoc. Prof. Pham Ngoc Nam

Conclusions

- Our contributions in ASEAN IVO
  - SDN-based testbeds and tools for experimenting and research on green cloud networking
  - In-depth analysis, algorithms and mechanisms in support of energy-efficient green technologies in cloud networking

THINK GREEN

Thank you!