Cloud Computing & Green IT?

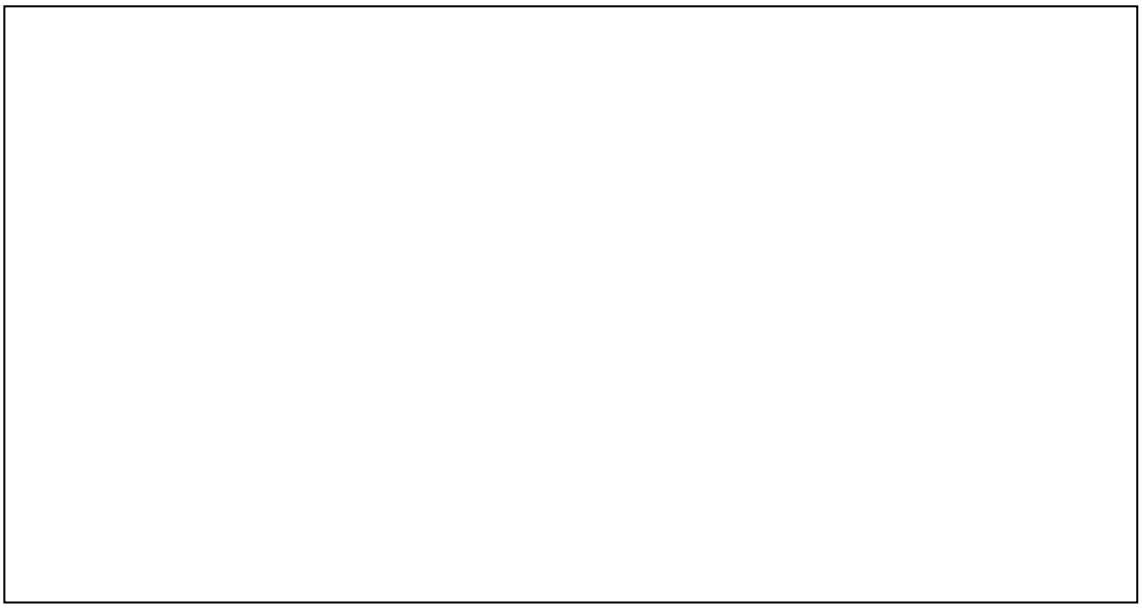
Towards Sustainable and Resilient IT Services

Alexander Schatten
www.schatten.info

Feb. 2010

Information and CommunicationTechnology:

Environmental Footprint?



1. Resources

2. Energy Consumption

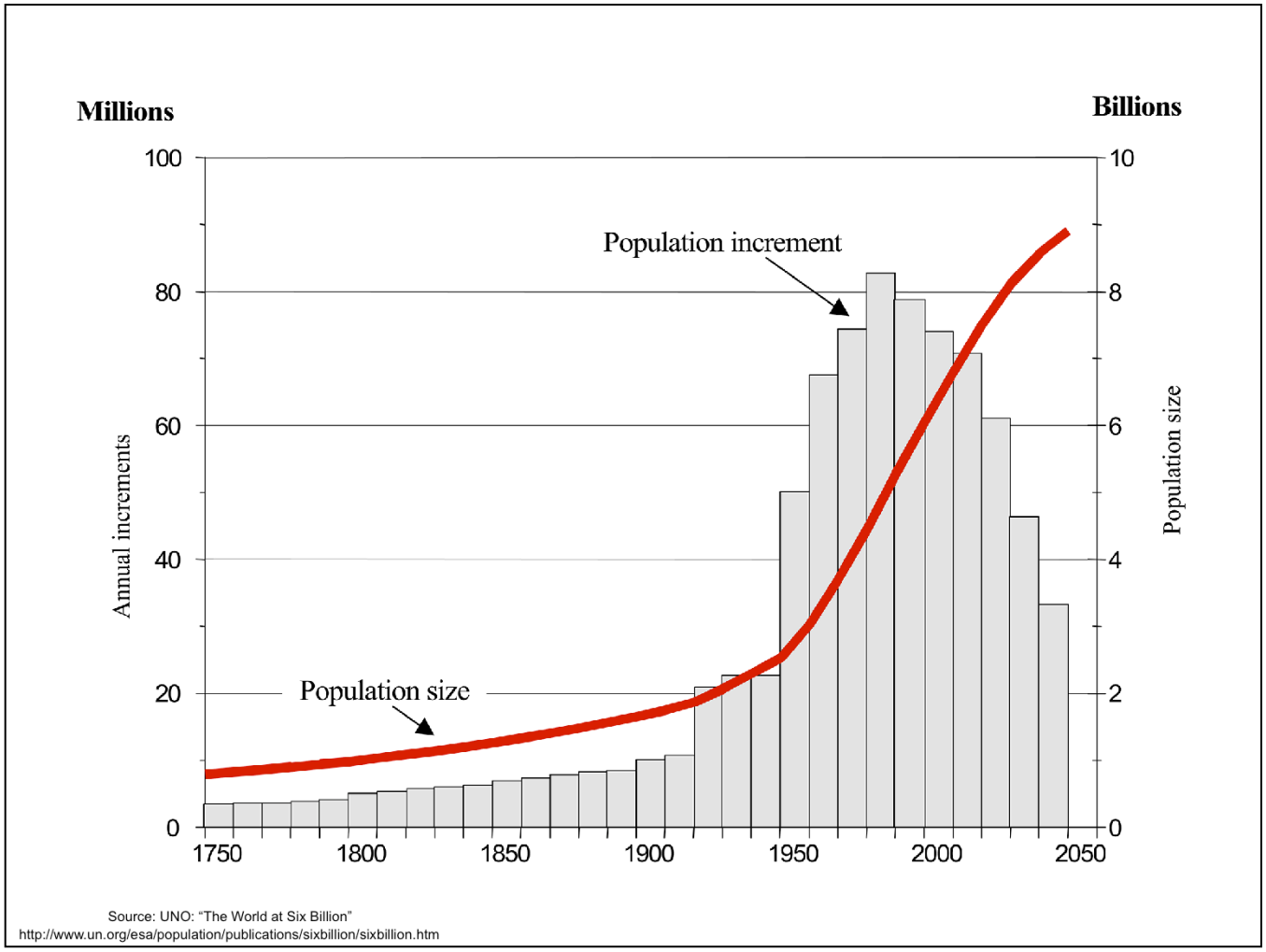
2. ICT as “Amplifier”

Photo from ezioman (flickr)

Global Population Development

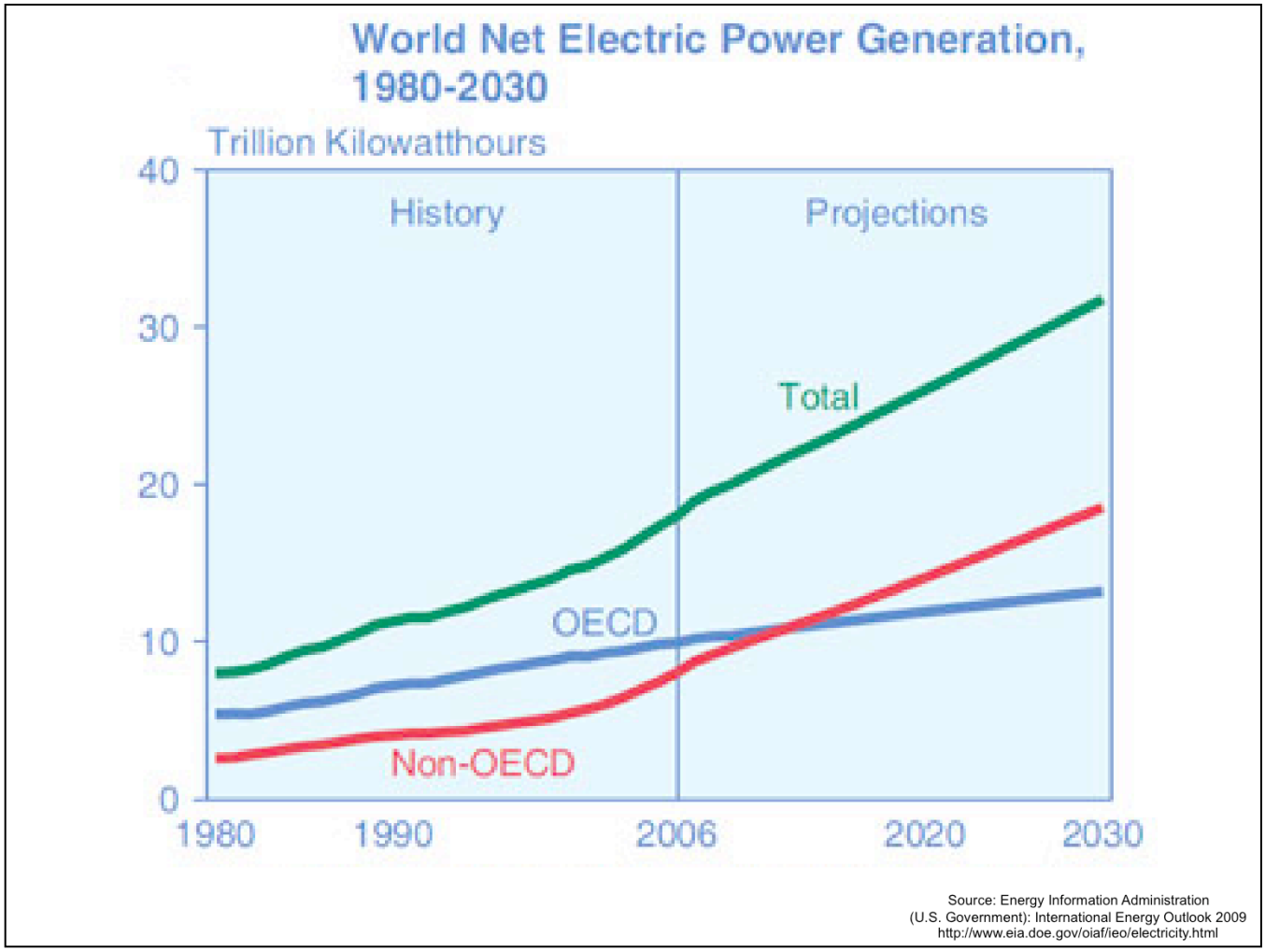
Energy Consumption

Year 0	300 Millionen	
1 billion in	1804	
2 billion in	1927	(123 years later)
3 billion in	1960	(33 years later)
4 billion in	1974	(14 years later)
5 billion in	1987	(13 years later)
6 billion in	1999	(12 years later)
7 billion in	2013	(14 years later)
8 billion in	2028	(15 years later)
9 billion in	2054	(26 years later)
10 billion in	2183	(129 years later)

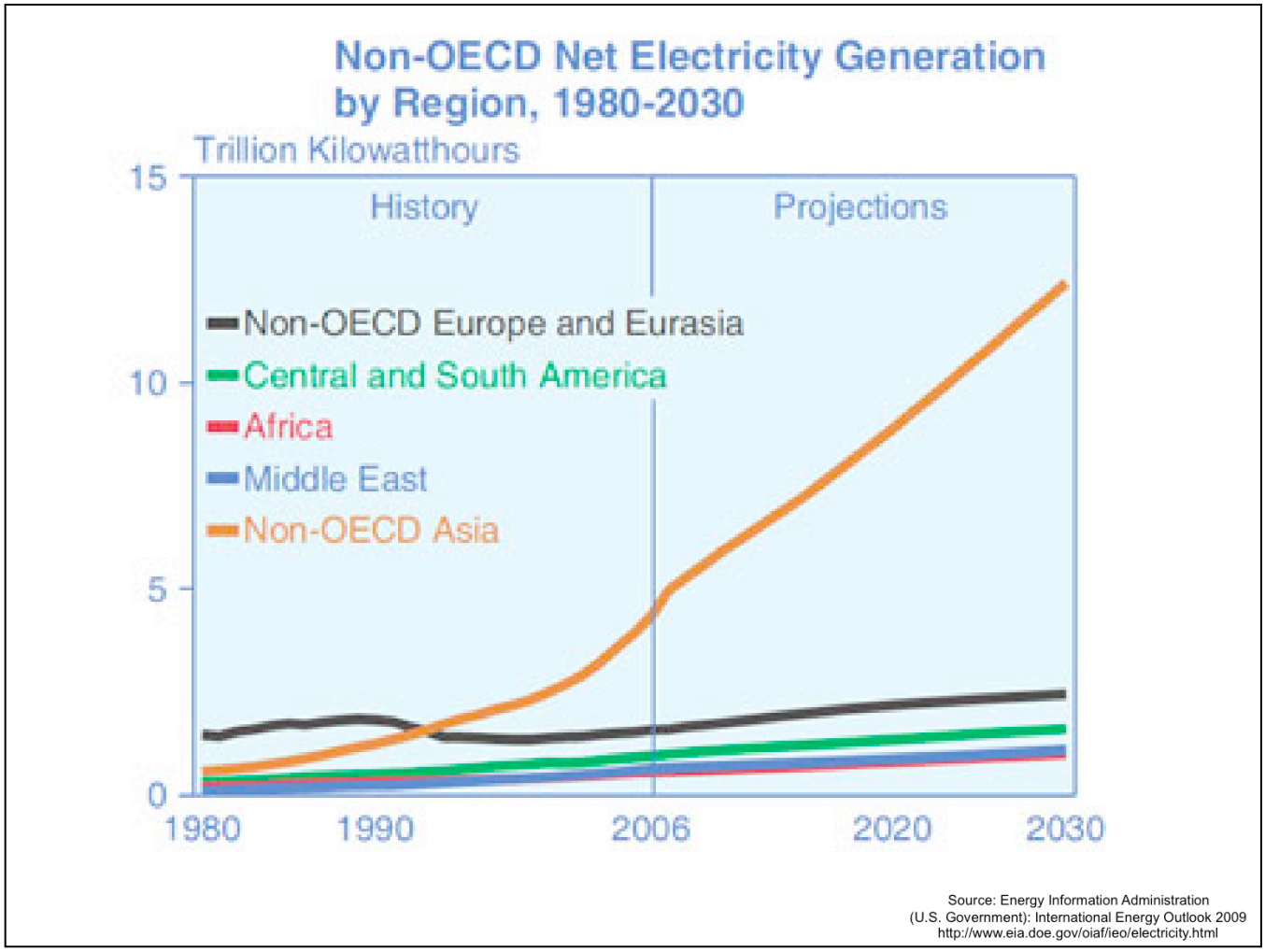


Source: UNO: "The World at Six Billion"
http://www.un.org/esa/population/publications/sixbillion/sixbillion.htm

Year 0	300 Millionen	
1 billion in	1804	
2 billion in	1927	(123 years later)
3 billion in	1960	(33 years later)
4 billion in	1974	(14 years later)
5 billion in	1987	(13 years later)
6 billion in	1999	(12 years later)
7 billion in	2013	(14 years later)
8 billion in	2028	(15 years later)
9 billion in	2054	(26 years later)
10 billion in	2183	(129 years later)



Year 0	300 Millionen	
1 billion in	1804	
2 billion in	1927	(123 years later)
3 billion in	1960	(33 years later)
4 billion in	1974	(14 years later)
5 billion in	1987	(13 years later)
6 billion in	1999	(12 years later)
7 billion in	2013	(14 years later)
8 billion in	2028	(15 years later)
9 billion in	2054	(26 years later)
10 billion in	2183	(129 years later)

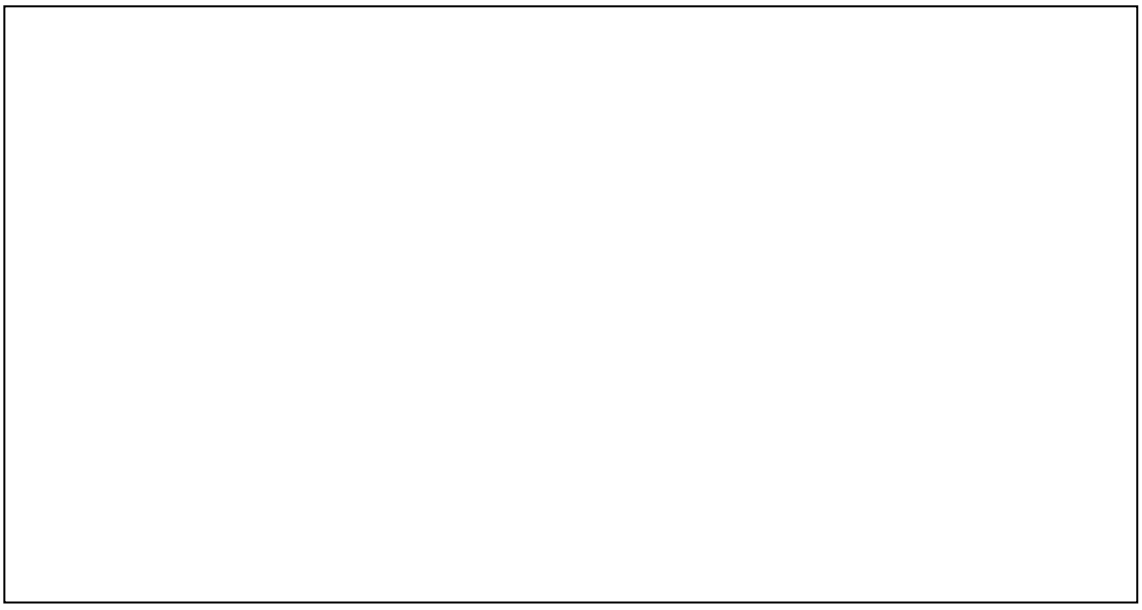


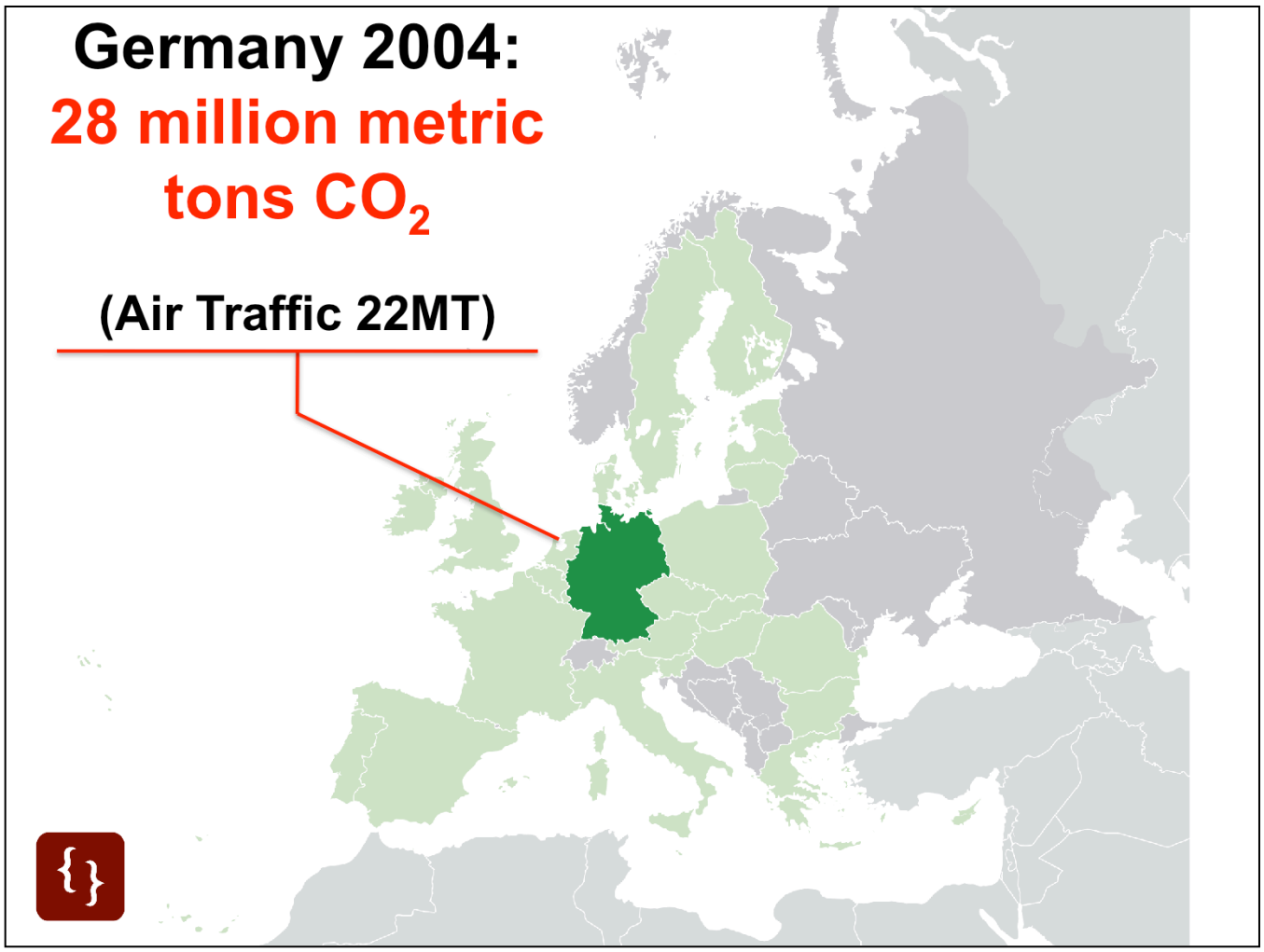
Year 0	300 Millionen	
1 billion in	1804	
2 billion in	1927	(123 years later)
3 billion in	1960	(33 years later)
4 billion in	1974	(14 years later)
5 billion in	1987	(13 years later)
6 billion in	1999	(12 years later)
7 billion in	2013	(14 years later)
8 billion in	2028	(15 years later)
9 billion in	2054	(26 years later)
10 billion in	2183	(129 years later)

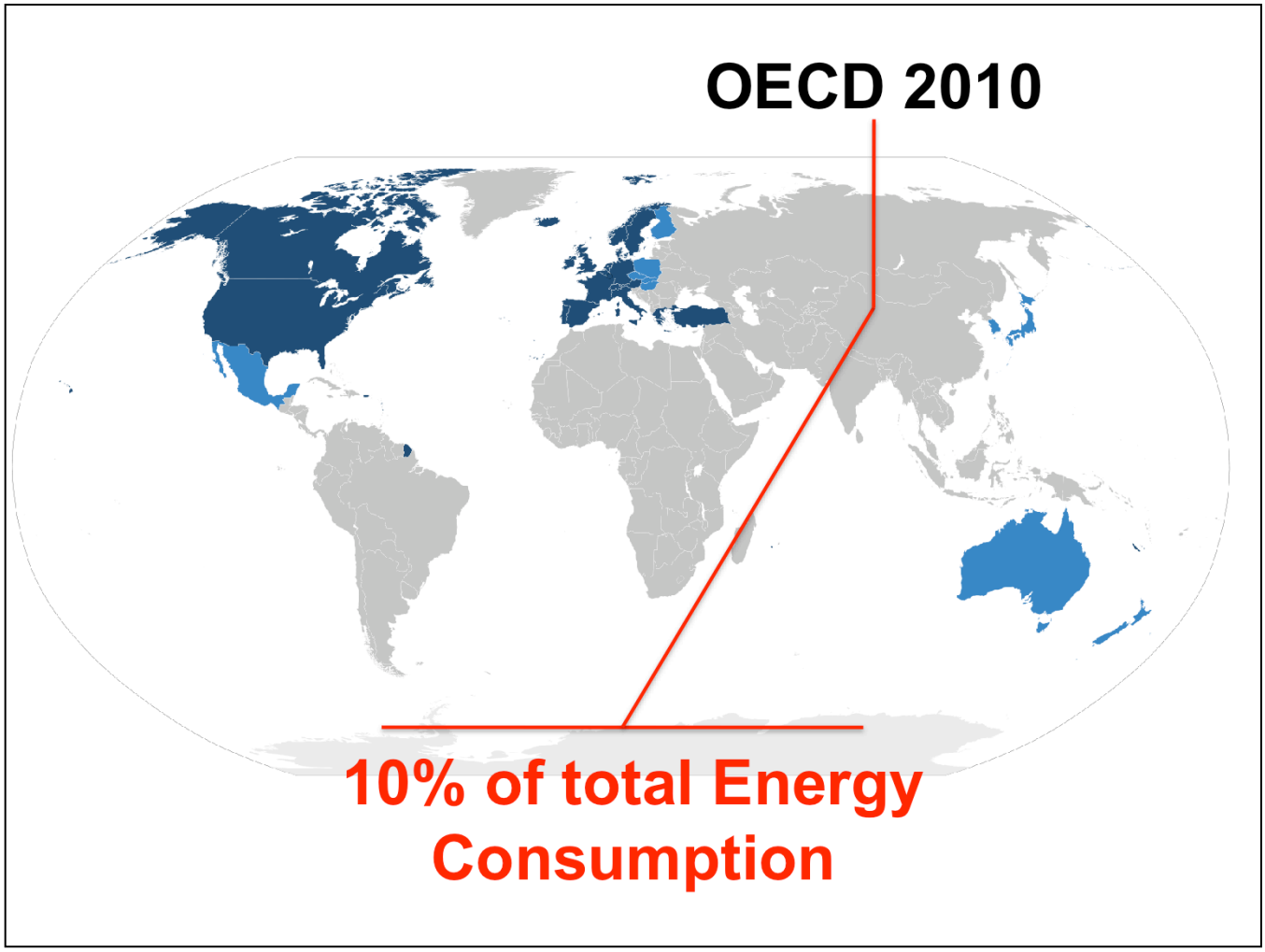
Energy Consumption and ICT Carbon Footprint

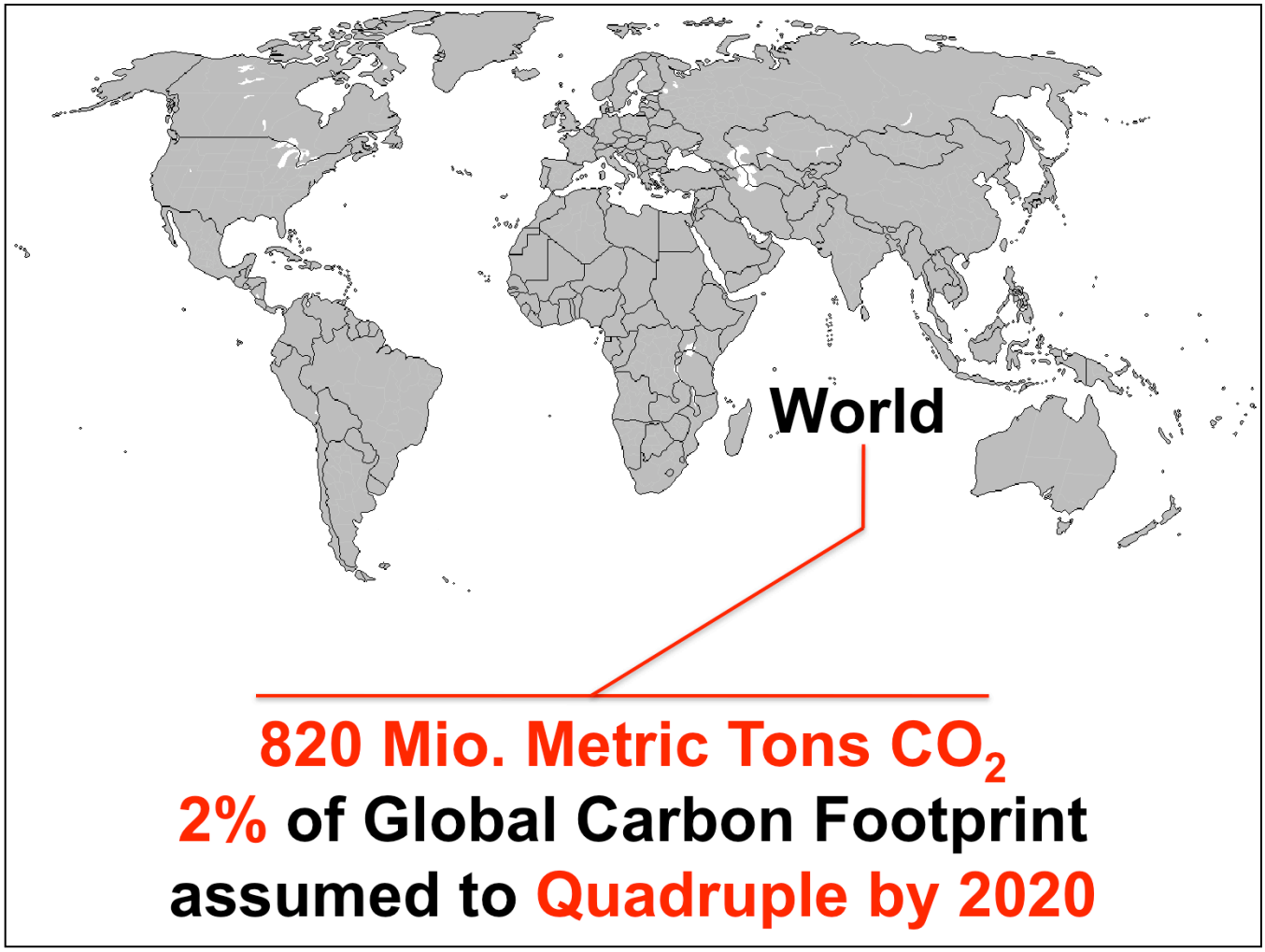
incl. power consumption & embodied energy,
data centers, PCs, network devices

"Some Computer Science Issues in Creating a Sustainable World",
Jennifer Mankoff, Robin Kravets and Eli Blevis, IEEE Computer Magazine (2008)
Data from "The Climate Group", OECD, Presentation 2009 from Klaus Fichter




Germany 2004:
28 million metric tons CO_2
(Air Traffic 22MT)


OECD 2010
10% of total Energy Consumption



820 Mio. Metric Tons CO_2

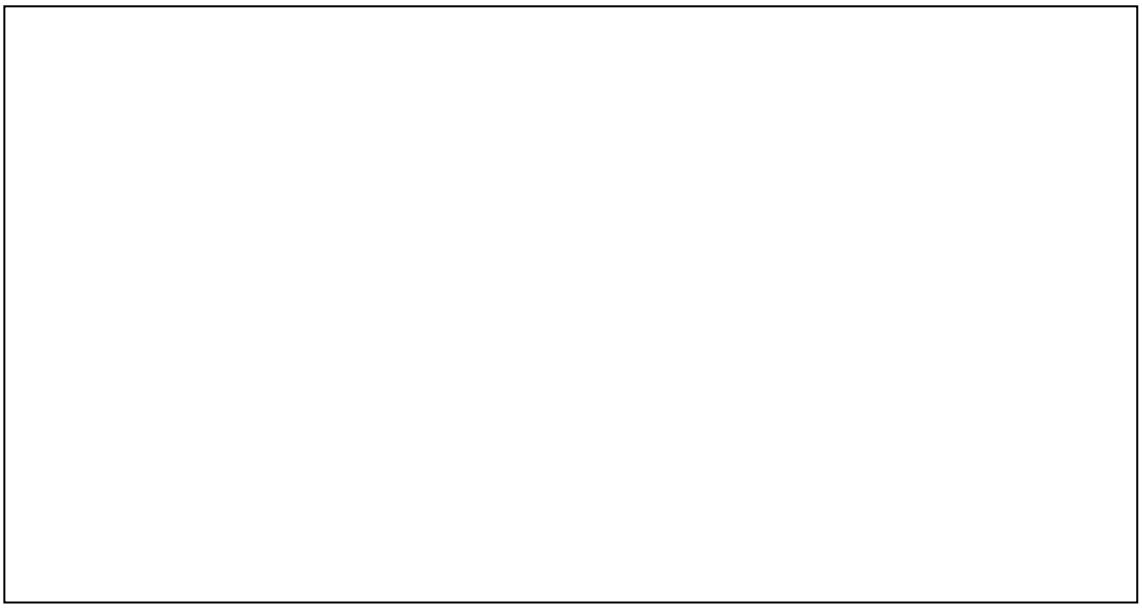
2% of Global Carbon Footprint

assumed to Quadruple by 2020

ICT Efficiency

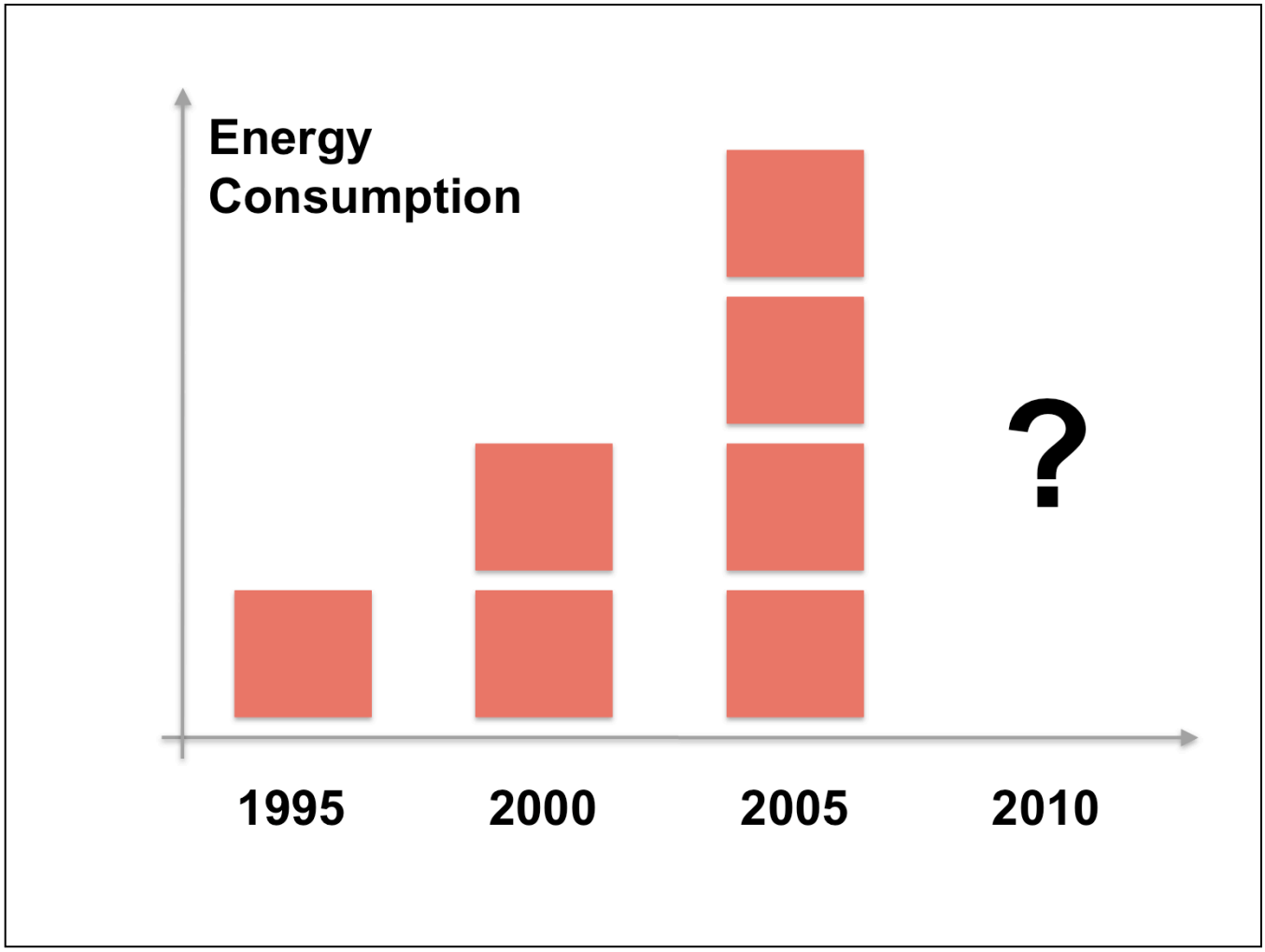
… some Numbers

Source: McKinsey and Company, part of a report titled "Revolutionizing Data Center Efficiency",
Malone, C. and Belady, C. (2006) Metrics to Characterise Data Centre & IT Equipment Energy Use. Proc. Digital Power Forum, Richardson, TX, USA, September.
InfoWorld, Ted Samson (2008)
Smart2020 Report
Borderstep Institute

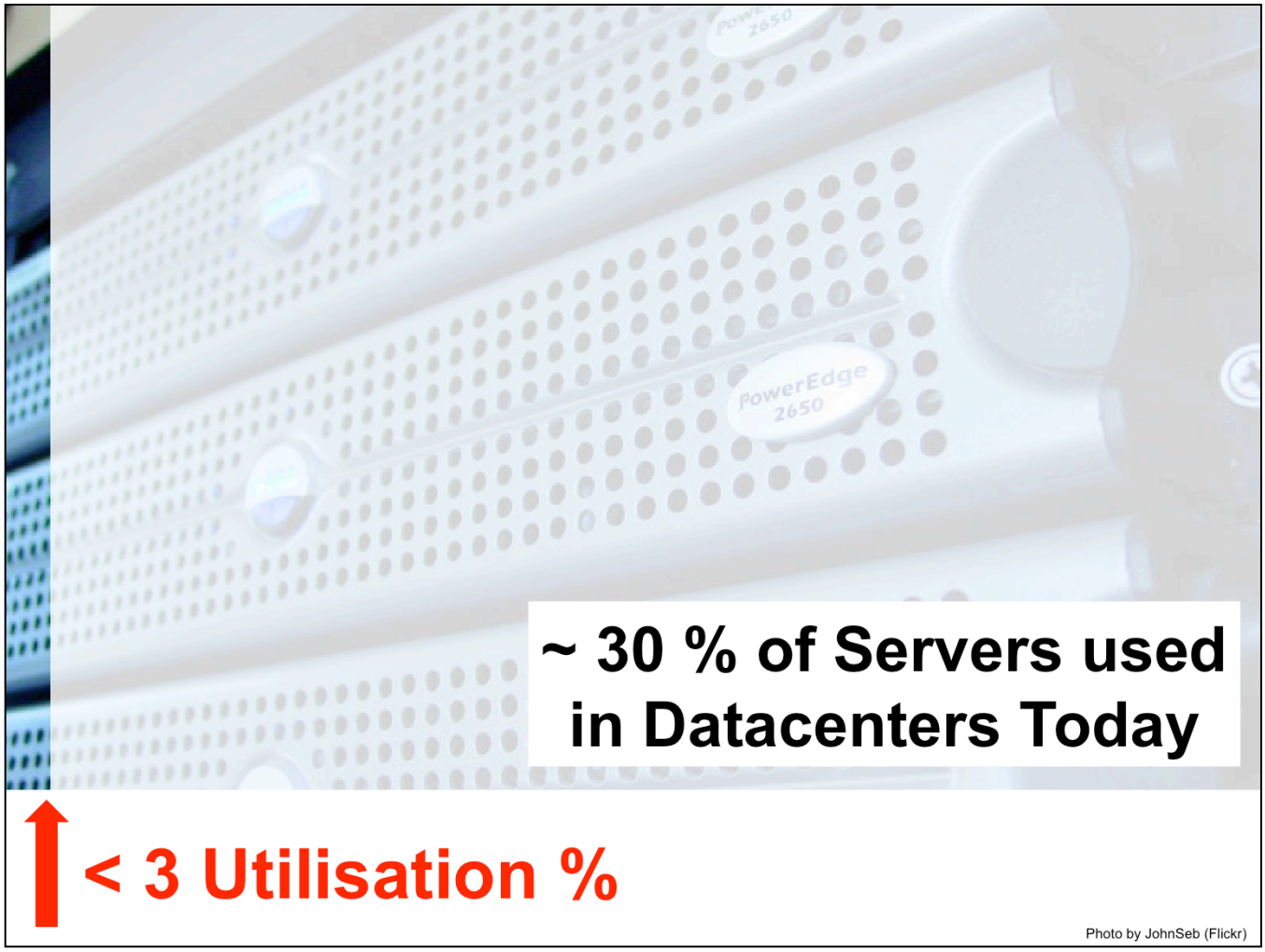


8-9 Billion $ Energy Bills
Datacenters Worldwide

~ 1900 $ Annual Expenses for **Powering** and **Cooling** a Single 2500 $ Server


Energy
Consumption
?
1995
2000
2005
2010

Mainframe Utilisation
(1970/1980s)
70 – 80 %
Photo by Marcin Wichary (Flickr)



Großer Unterschied zwischen spezialisierten und großen Datacenter z.B.

- **Google**
- **Strato**
- **Host Europe…**

Und dem “durchschnitts” Datacentre kleiner und mittlerer Betriebe und Behörden

18 Million Server 2002

122 Million Server 2020 (estimation)

The Power of “10”: PCs

~ 150-250 W

~ 100-200 W

~ 50 W

~ 10-45 W

~ 2 W

PC with CRT

PC with LCD

Thin Client with LCD

Notebook

OLPC / XO

Photos from Flickr: Gene, Plutor, John Pastor, One Laptop per Child

This example outlines the potentials at the client side. Similar effects are still available at Server-Side; e.g.

- efficiency of power supply
- mainboards
- storage units…

Concrete Saving Potential in CO_2eq

From	To	Savings (CO_2 eq. Emissions)
PC + CRT	PC + LCD	**> 15%**
PC + LCD (CRT)	Thinclient + Terminal Server	**44% (54%)**
PC	Notebook (stationary)	**79%**
Thinclient	Notebook (stationary)	**55%**

Source: "Ökologischer Vergleich der Klimarelevanz von PC und Thinclient Arbeitsplatzgeräten 2008", Studie des Fraunhofer Institut Umwelt-, Sicherheits-, Energietechnik UMSICHT

Target/Demand-oriented Performance!

After pouring millions of dollars into in-house data centers, companies may soon find that it's time to start shutting them down. IT is shifting from an asset companies own to a service they purchase.

Nicolas G. Carr
"The End of Corporate Computing"
MIT Sloan Business Review (2005)

Question is: will this issue be understood early enough or will companies waste a lot of money in the next years?

Data-Centers and Services

“Hummer Strategy”

Photo from Paul Keleher, Flickr

… or Virtualisation, Cloud Computing and Software as a Service?

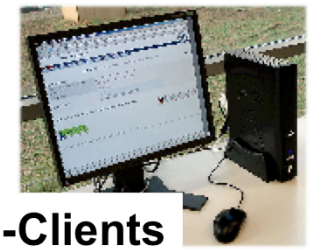
In US this is a typical question asked startups by investors

“Green IT”

Virtualisation & Software as a Service

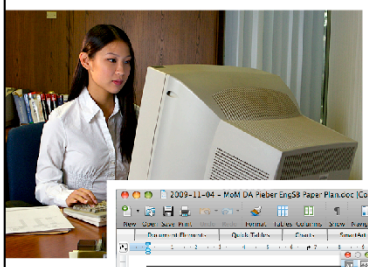
Virtualisierung & Cloud Computing als ein Baustein für eine resiliente nachhaltigere IT Landschaft

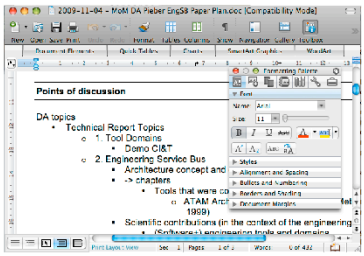
Desktop / Client



Thin-Clients

Tele-Working





Cloud Computing

Fat-Clients

Software as a Service

Remove Fat-Clients where not absolutely necessary and replace them with thin-clients and web-applications or

Thin-clients using remote desktops

Provide support for **tele-working** (virtual private networks…)

Software as a Service: z.B. der schweizer Ringier Verlag (8.000+ Mitarbeiter) verwenden seit kurzem Google Docs.

Cloud Computing

Datacenter

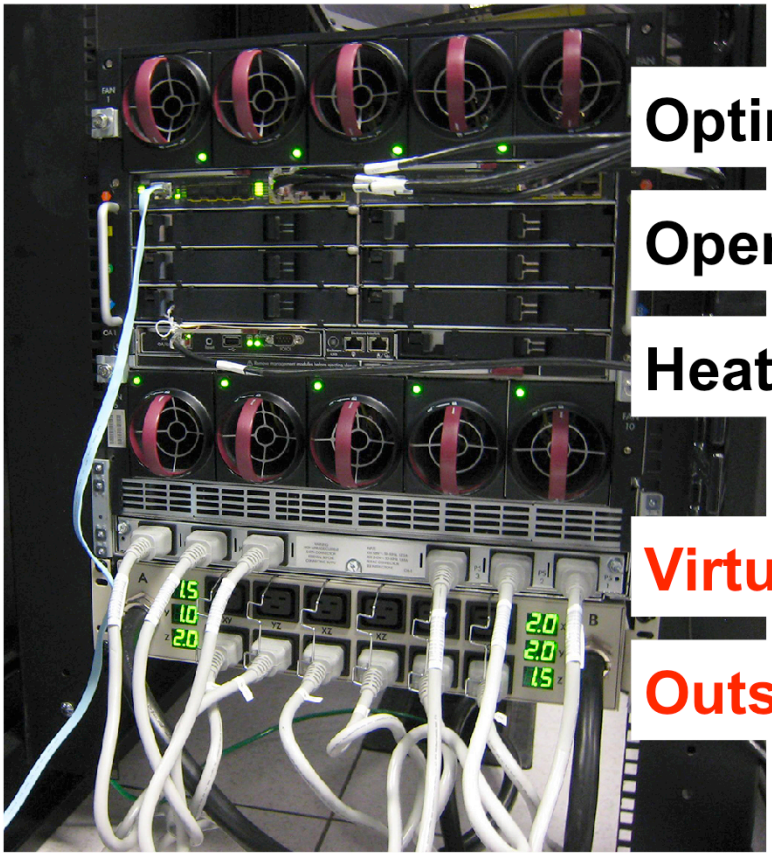


Photo by bugeaters (flickr)

Optimise Facilities

Operation Temperature

Heat Reuse

Virtualisation

Outsourcing – Cloud !

Why is Cloud Computing better?

Pay Usage…

…not Build for Peak Load

Get Rid of Complex IT

Efficiency of Large-Scale

Load can be balanced over many customers, hence servers in large data-centers can work at higher average utilisation

Data-centers can be build in regions where less cooling is needed and more renewable energy sources are available

But ?

Issues
Standardisation
Young Technology
Legal & Privacy Issues
“Resilience”

Thomas Friedman, **"The world is flat".** We move(d) from

Command and Control to

Collaborate and Connect Economy/Society

3 Billion people reach for the western lifestyle

It is impossible to fulfil this demand with the current approach

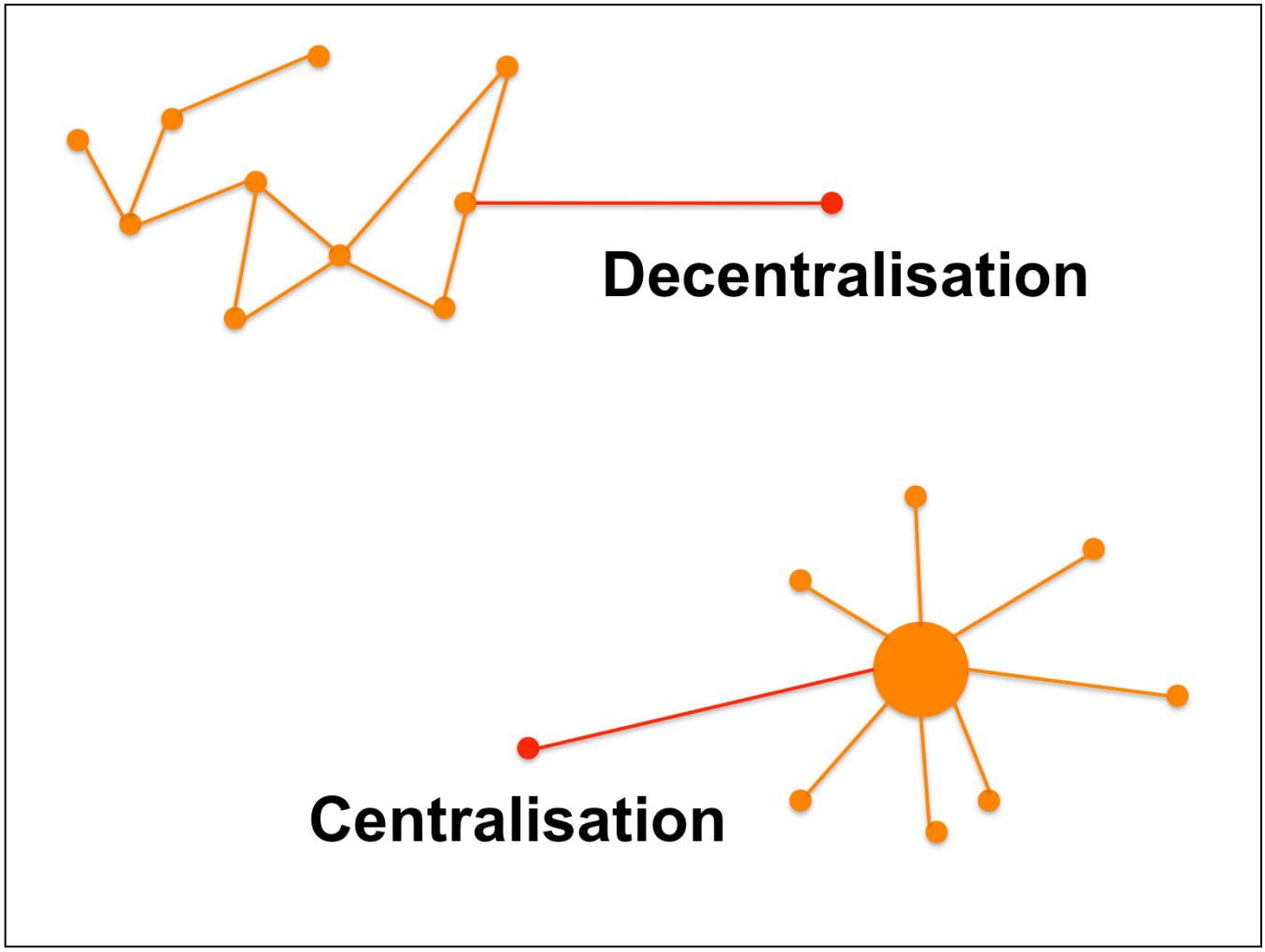
Economy, knowledge, work-force, natural-resources are global issues

"Economic Crisis" showed global-dependencies leading to "Domino-Effect", foretaste of what we might expect the next decades.

Our **global ICT infrastructure** has to be given more consideration

Allenby, B., Fink, F. 2005.
Toward Inherently Secure and Resilient Societies,
Science 309: 1034-1036

Resilience



Centralisation vs. **De-Centralisation vs. "Local-Pooling"**

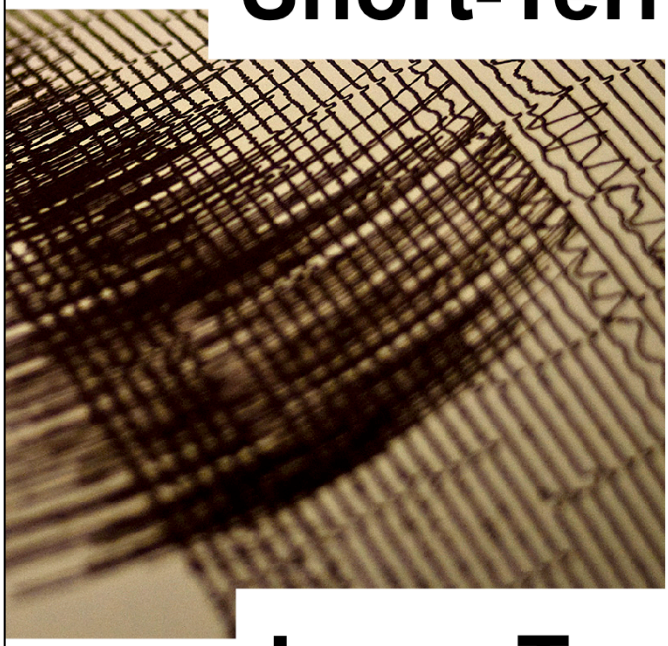
Communication in case of unreliable parts of the infrastructure or attacks

Economic, political shockwaves?

Dependency Analysis & Management

Open Systems vs. Closed Systems

Short-Term Benefits



Resilience against Disruption?

Long-Term Effects

Photo by mactent (flickr)

Currently Focus on short-term benefits; particularly ICT is very focused on near-term planning

Potential negative influence on resilience and long-term health of the system

Domino-Effect when long-term effects are not taken into consideration

Consideration of Resilience (of infrastructure) will be **dominating theme** due to major disruptions (economic, environmental, resources) in the next decades

Conclusion

- Upcoming **Resource** and Energy Crisis
- Massive **Inefficiencies** in Current ICT Services
- Expected Growth & **Environmental Impact**
- Potential of **Virtualisation** and Cloud Computing
- System **Resilience** against Disruption?

Dr. Alexander Schatten

Senior Researcher: Vienna University of Technology
IT Consulting

www.schatten.info | alexander@schatten.info | alex_buzz (Twitter)
best-practice-software-engineering.blogspot.com
sichten.blogspot.com

INDOQA

Competence Center

maßgeschneiderte Weiterbildung
für Software-Entwickler
und Entscheider