



DTU ELECTRO

Department of Electrical and Photonics Engineering



Library of Congress Designing
Storage Architectures meeting 2023

Leif Katsuo Oxenløwe, professor, DTU, centre leader, SPOC

Optical Data Transfer

Large potential of the internet

Internet: The key for climate improvements

- **Internet compensates own weight in CO2 1.5x (~10x in 2030)**
- **Autonomous cars and digitalisation can cut 50% of energy consumption and 75% CO2 in transport sector**
- **Buildings: 10% energy saved by better temperature control**
- **Lighting: 20% electricity with smart-light**
- **Digital technologies can cut global emissions by 15%**



GeSI GLOBAL ENABLING
SUSTAINABILITY
INITIATIVE

iea International
Energy Agency
Secure
Sustainable
Together

Digitalization
& Energy

WORLD
ECONOMIC
FORUM

Only possible if internet doesn't use more energy than it saves



How to stop data centres from gobbling up the world's electricity

ENERGY SCALE

Global electricity demand

20,000 TWh

Electricity use by ICT

2,000 TWh

Data-centre electricity demand

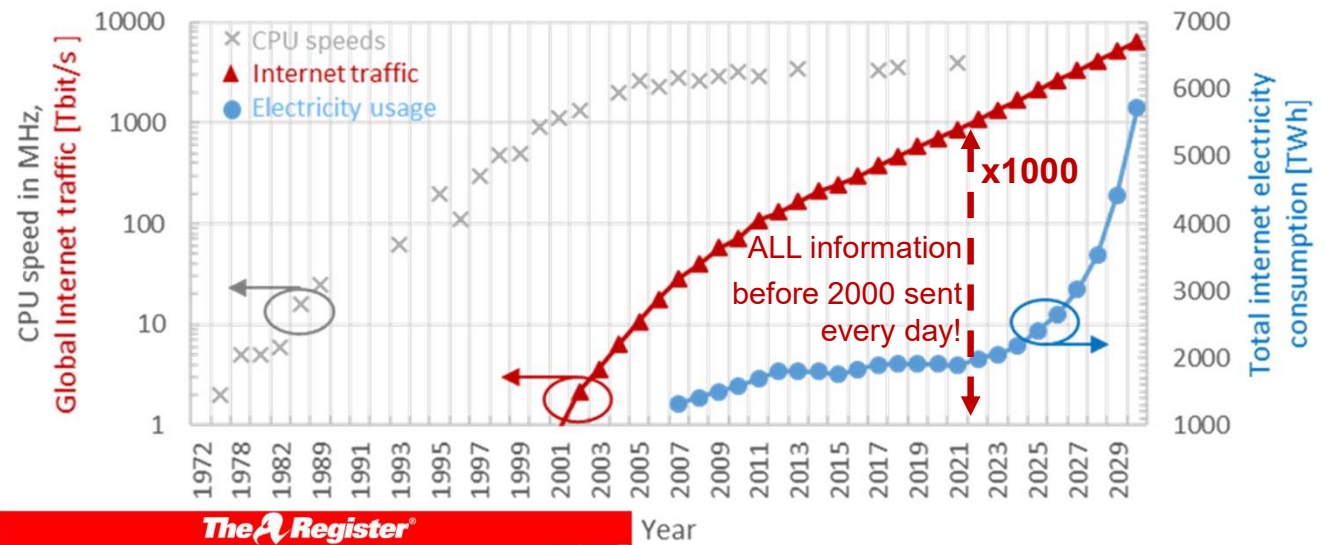
200 TWh

Bitcoin use by mid-2018

20 TWh

Figures are approximate.

Internet traffic and electricity consumption



< Death notice: Moore's Law. 19 April 1965 – 2 January 2018

ICT: 5-10% global electricity
ICT: 2-3% global CO2



"We will need new more energy-efficient technologies in 3-4 years from now!"

Masnet, Koomey et al, Science 2020

Derfor sluger dit videoplag på Facebook og din yndlingsserie på Netflix meget strøm

Det er ikke kun din mobiltelefon, din tablet eller dit fjernsyn, der bruger strøm, når du deler en video på Facebook eller streamer en time af din yndlingsserie på Netflix. Den tunge datastrøm mellem dit hjem og det datacenter, du bruger ude i verden, bruger endnu mere strøm.

Hvis datacenteret kører på sort strøm, som stammer fra et **kuldrivet** kraftværk, vil din handling føre til et udslip af drivhusgassen CO₂.

Hvis datacenteret derimod kører på **grøn strøm**, vil CO₂-udslippet være nul.



2x Washington DC reservoirs:
 Rocky Gorge Res. + Lake Mooney + Little Seneca Lake + Nedwood Dam + Breckenridge Res. + Georgetown Res.



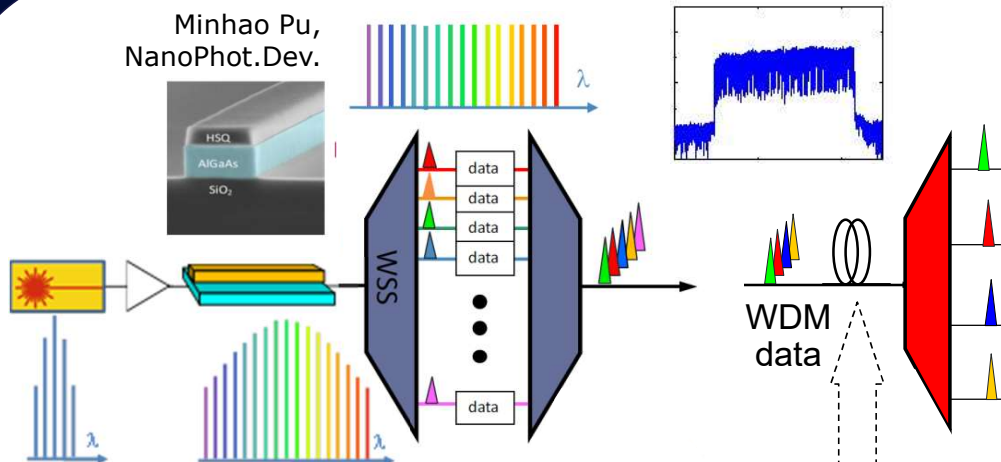
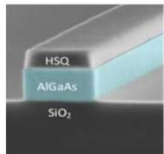
4 friends for 2 hours:
 140 Wh, 24 g CO₂ ~ boil 1.2 litres water.

125 million gamers worldwide 1 year:
 14 TWh, ~ boil 125 billion litres water:
 ~ 2x W-DC res

A single chip capable of feeding the whole internet



Minhao Pu,
NanoPhot.Dev.



CLEO - postdeadline CLEO 2016

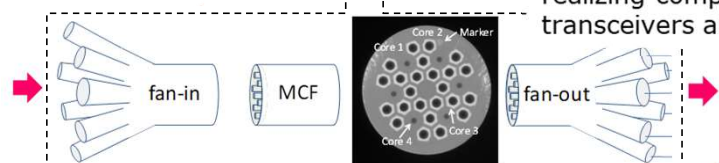
nature photonics Vol. 12, No. 8, 2018
Hao Hu et al,

nature.com > nature photonics > news & views > article

nature photonics news & views VOL 12 | AUGUST 2018

Integrated combs drive extreme data rates
Daniel J. Blumenthal

"This work is an important step towards realizing compact, energy- and cost efficient... transceivers and fibre optic links that scale..."



Horizon Prize
BREAKING THE OPTICAL TRANSMISSION BARRIERS

PHOTONMAP
cracked the optical transmission challenge and won the prize
Team led by Technical University of Denmark

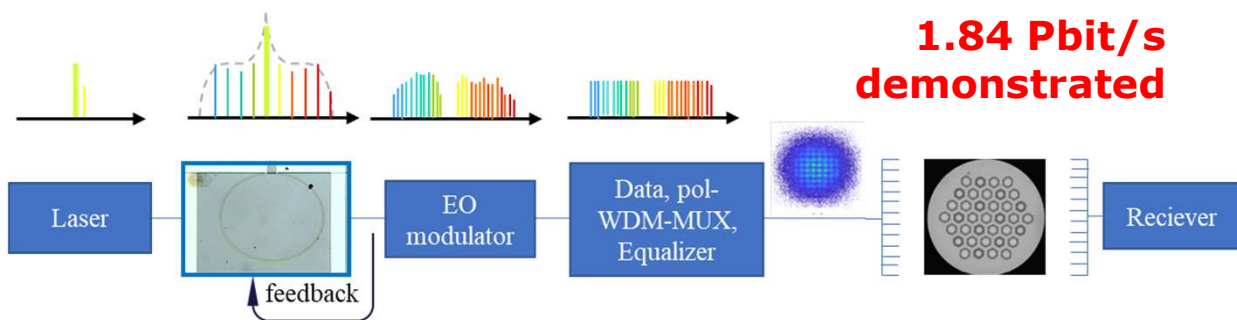
661 Tbit/s: more than 2x global internet traffic!
All on the light from a single optical chip
Won EU prize competition

Into the Pbit/s regime using a single comb source



nature
photonics

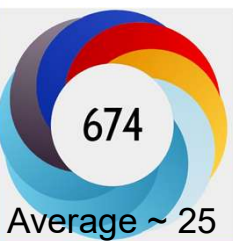
A.A. Jørgensen et al, 20/10-2022
Petabit-per-second data transmission using a chip-scale microcomb ring resonator source



1.84 Pbit/s demonstrated

One source for >2x world internet traffic (~932 Tbit/s)
 ~save >1.000 lasers ~ **LoC 40 Pbyte in 3 minutes**
 Potential for 100 Pbit/s ~save 100.000 lasers ~**LoC 3 sec**

Online attention



- 93 tweeters
- 66 news outlets
- 12 blogs
- 2 Redditors
- 4 Facebook pages
- 3 Wikipedia page

The Washington Post

BBC WORLD SERVICE newshour

Berlingske

28. March 2023

DTU Electro

"Most talked about" Nature Photonics paper of similar age - #1
 #2 of all NPHOT papers
 Top-1.12% of all 22 mio papers
 Energi-efficient communications: hot!



Summary

- The internet is a key against climate change
- Energy-efficient communication technologies needed:
 - e.g. single-source for Pbit/s transmission: LoC 40 Pbyte in 3 minutes!
- Need for a standardised tool to evaluate competing solutions

