The Impact of Networking on the Environment

Or How I Learned to Stop Collecting Data and Love the (Micro) Sleep

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*) Only speaking for myself today

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How Networking Impacts the Environment

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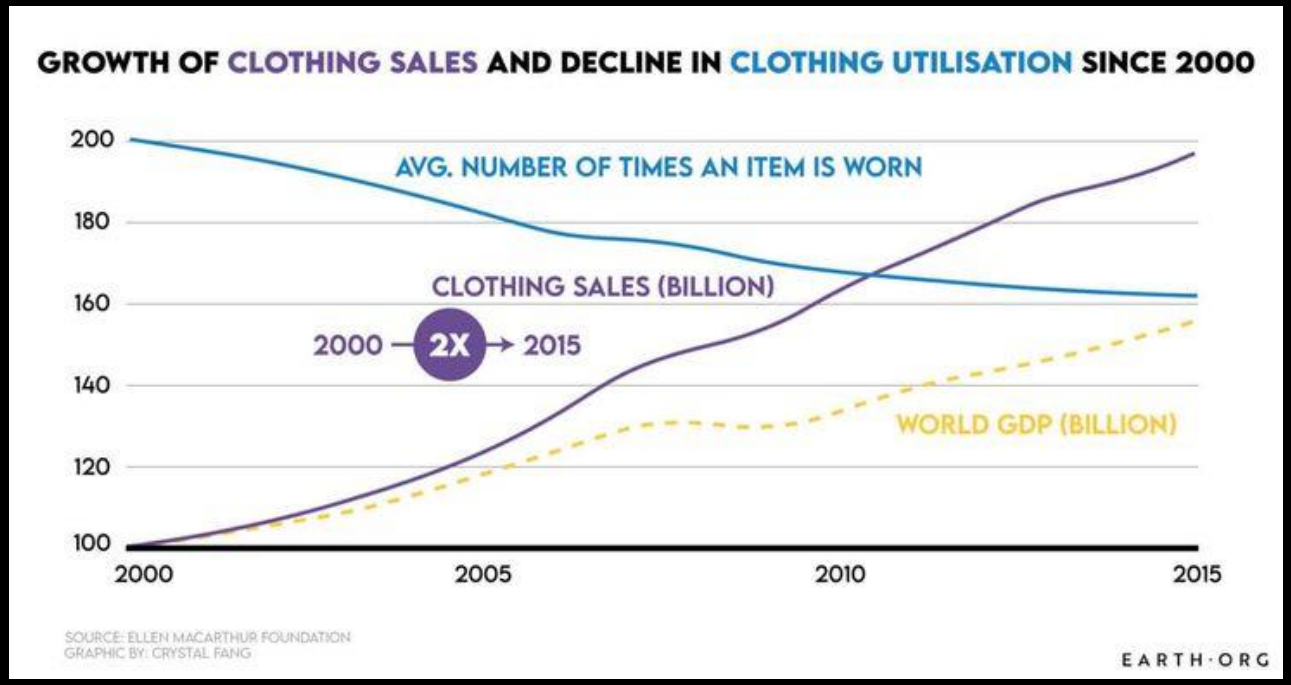
- It can be an enabler .. for the rest of the society to be more efficient
  (Ong et al. 2014: videoconferencing < 7% of in-person conf.)

How Networking Impacts the Environment

- It can be an enabler .. for the rest of the society to be more efficient
- … or for massive throw-away consumerism
  (Earth.org 2022: clothing item production has doubled since year 2000)



How Networking Impacts the Environment

- It can be an enabler .. for the rest of the society to be more efficient
- … or for massive throw-away consumerism
- It can also consume a lot of resources itself
  (Raw materials, water, labor, embedded carbon, energy in use. Welzl 2022: ICT is 3%, Internet 1%; growth predicts vary from Schooler, Malmodin, and Schien, 2022)

What is "the Internet"? Studies differ widely

- Age; considerations of: CPE; UE; embodied energy; data centers

Our IAB paper uses a few sources to arrive at a range of:
0.5% – 1.17%

One possible derivation:
"SMARTer2030 report" states that ICT has a CO2 "footprint" of 2.7% of global emissions in 2020

- **Numbers from 2012: telecom electricity = ICT / 3**
  [S. Lambert et al, "Worldwide electricity consumption of communication networks". Opt. Express, 20(26), Dec 2012.]
- If this relationship still holds, then roughly, worldwide 2020 GHG emissions from telecom: **0.9%**

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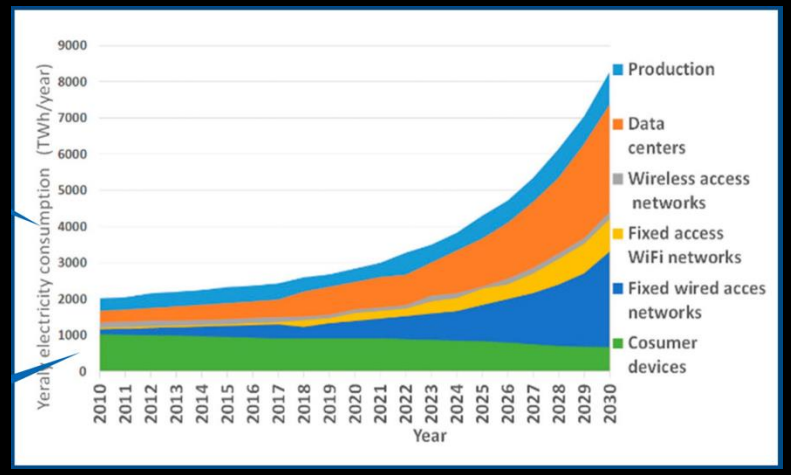
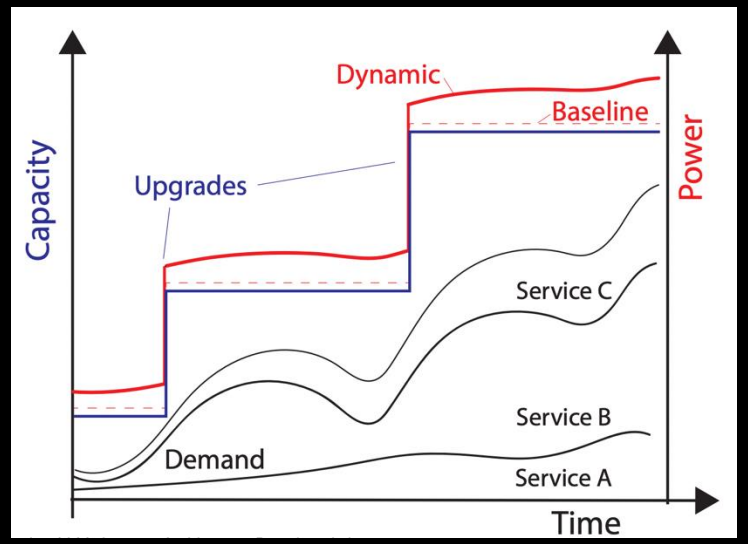
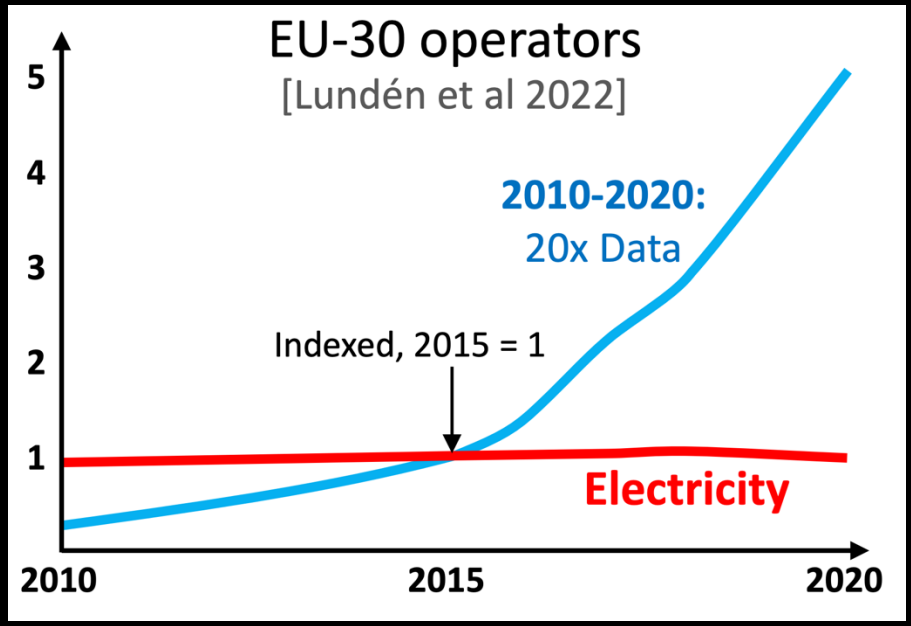




How Networking Impacts the Environment

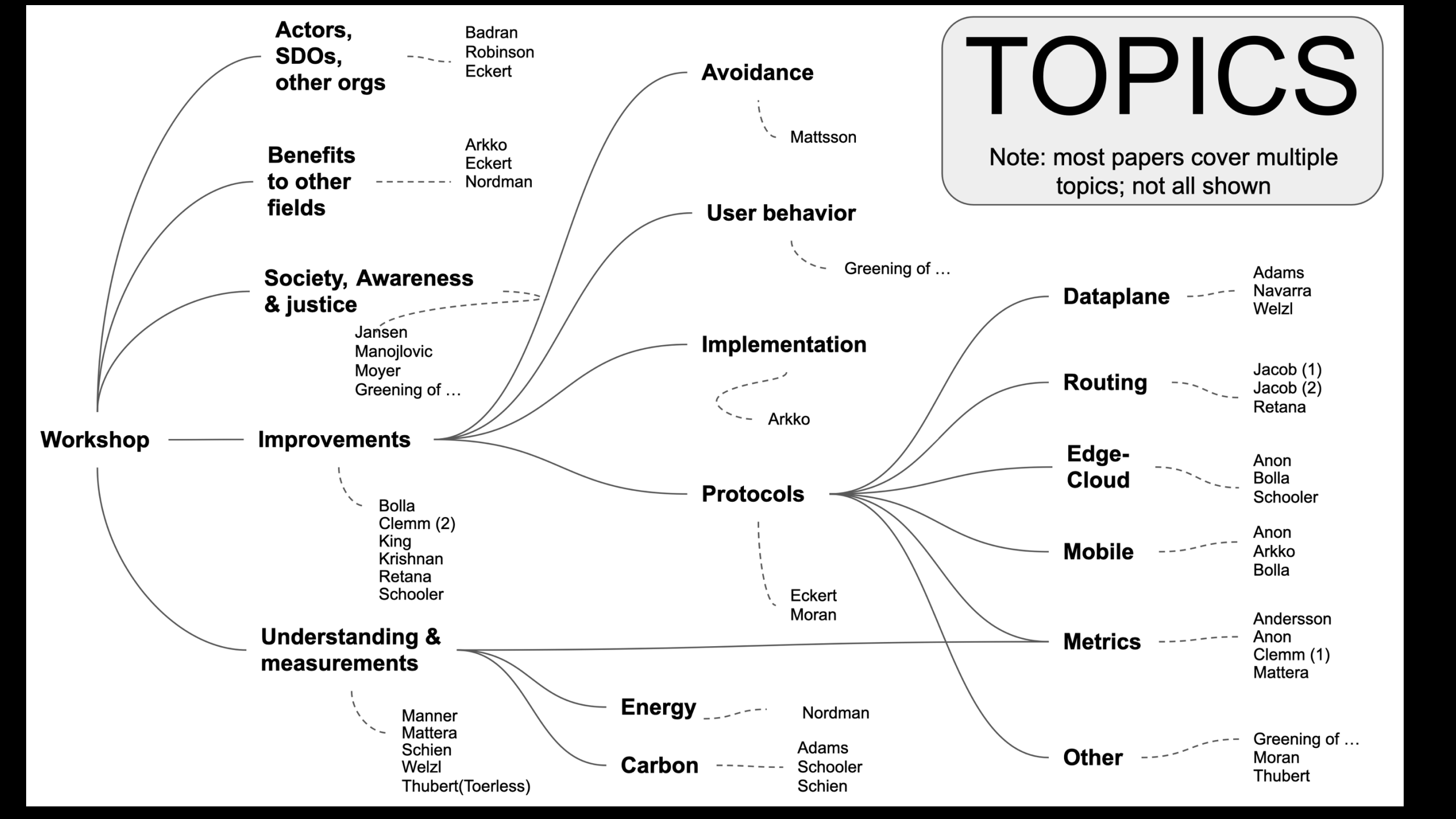
- It can be an enabler .. for the rest of the society to be more efficient
- … or for massive throw-away consumerism
- It can also consume a lot of resources itself
- It can also be made much more efficient (Malmodin, 2022)



How Networking Impacts the Environment

- It can be an enabler .. for the rest of the society to be more efficient
- … or for massive throw-away consumerism
- It can also consume a lot of resources itself
- It can also be made much more efficient
- But networking can also be a basic human need

What Can We Do?


TOPICS
Note: most papers cover multiple topics; not all shown
Workshop
Improvements
Bolla
Clemm (2)
King
Krishnan
Retana
Schooler
Actors, SDOs, other orgs
Badran
Robinson
Eckert
Benefits to other fields
Arkko
Eckert
Nordman
Society, Awareness & justice
Jansen
Manojlovic
Moyer
Greening of …
Avoidance
Mattsson
User behavior
Greening of …
Implementation
Arkko
Protocols
Eckert
Moran
Understanding & measurements
Manner
Mattera
Schien
Welzl
Thubert(Toerless)
Energy
Nordman
Carbon
Adams
Schooler
Schien
Dataplane
Adams
Navarra
Welzl
Routing
Jacob (1)
Jacob (2)
Retana
Edge-Cloud
Anon
Bolla
Schooler
Mobile
Anon
Arkko
Bolla
Metrics
Andersson
Anon
Clemm (1)
Mattera
Other
Greening of …
Moran
Thubert

What Can We Do?

Improvements can come in many different forms:

- 2nd order impacts of enabling the rest of the society to act in new ways
- Energy sources
- Implementations
- Technology, e.g., protocols
- Better awareness, measurements and transparency
- Avoiding obviously bad mechanisms

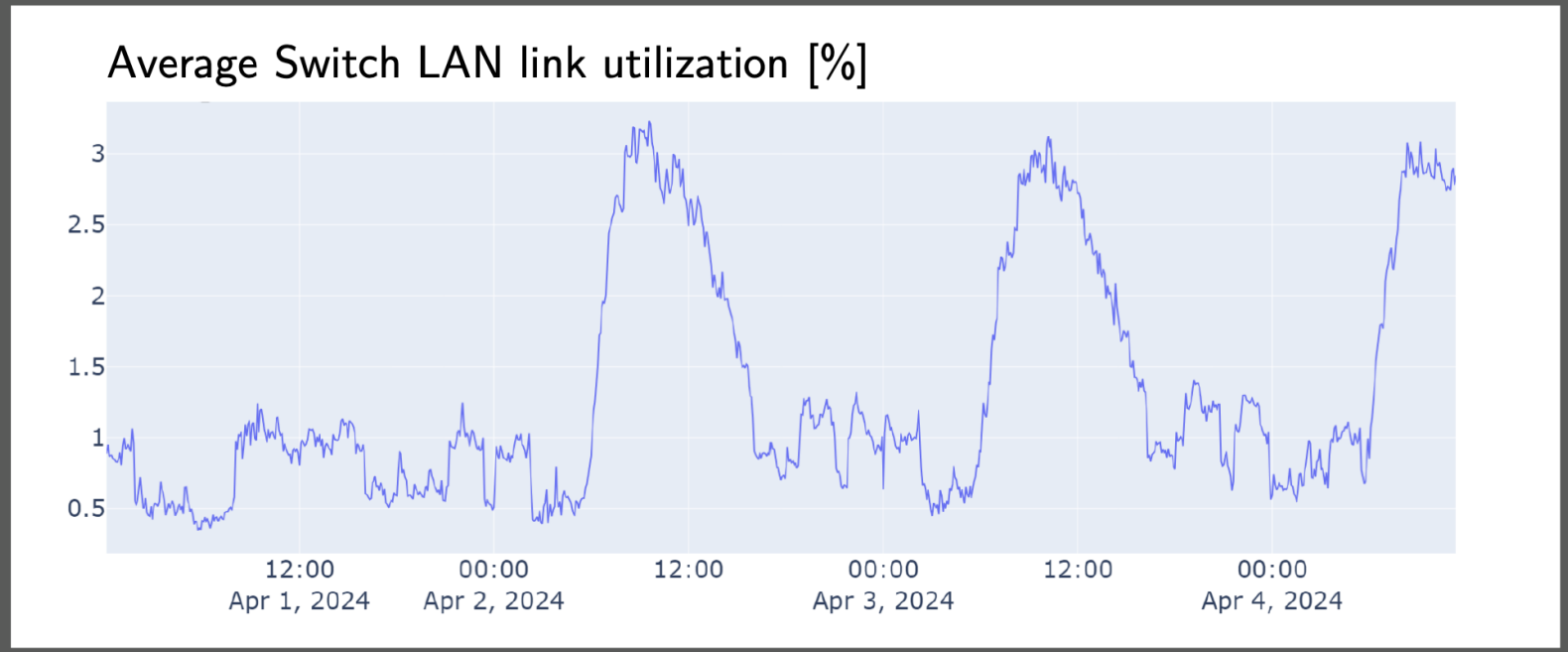
The Importance of Sleep

Research indicates that our networks and systems often spend a large fraction of their time idle

(Jacob, 2024)

2.1%

over 2.5 months of data, internal links only



The Importance of Sleep

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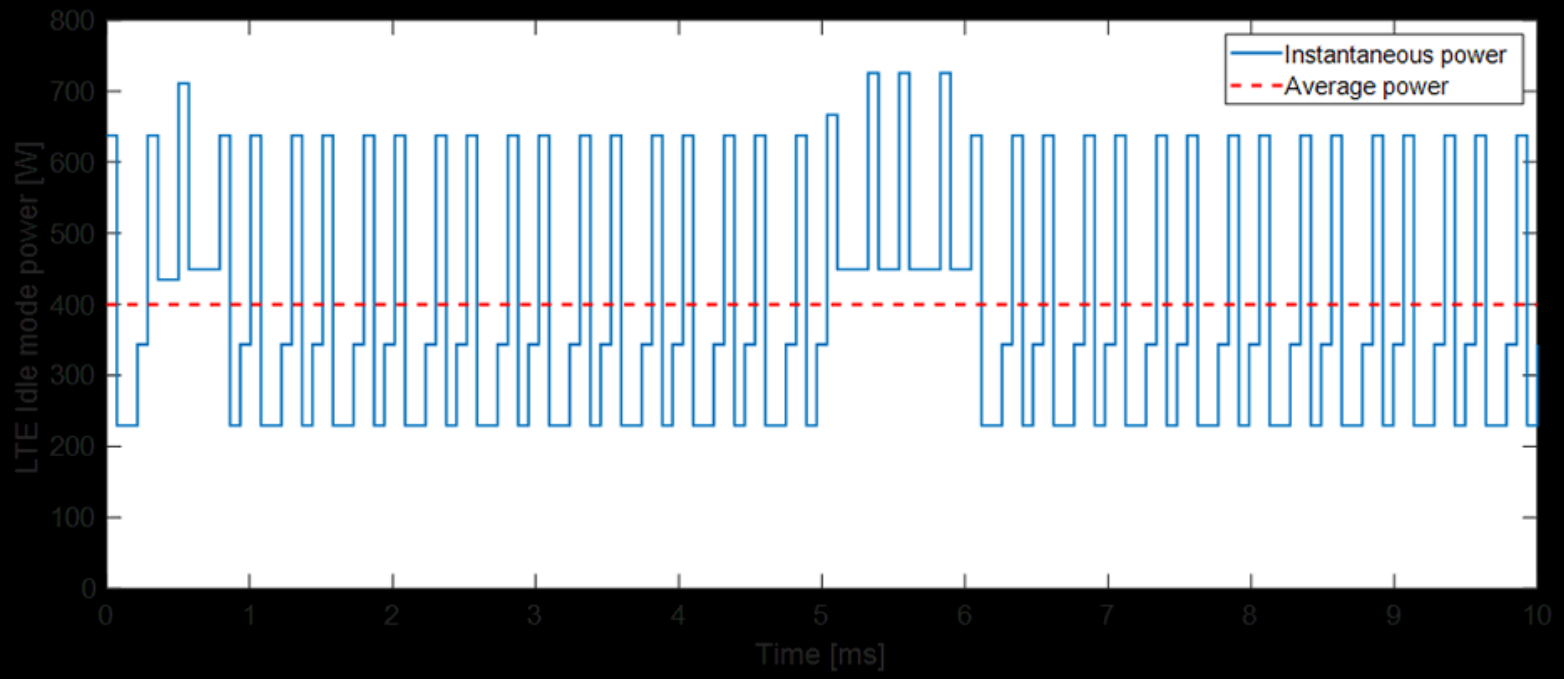
There are opportunities for reducing the effects of this: energy proportionality

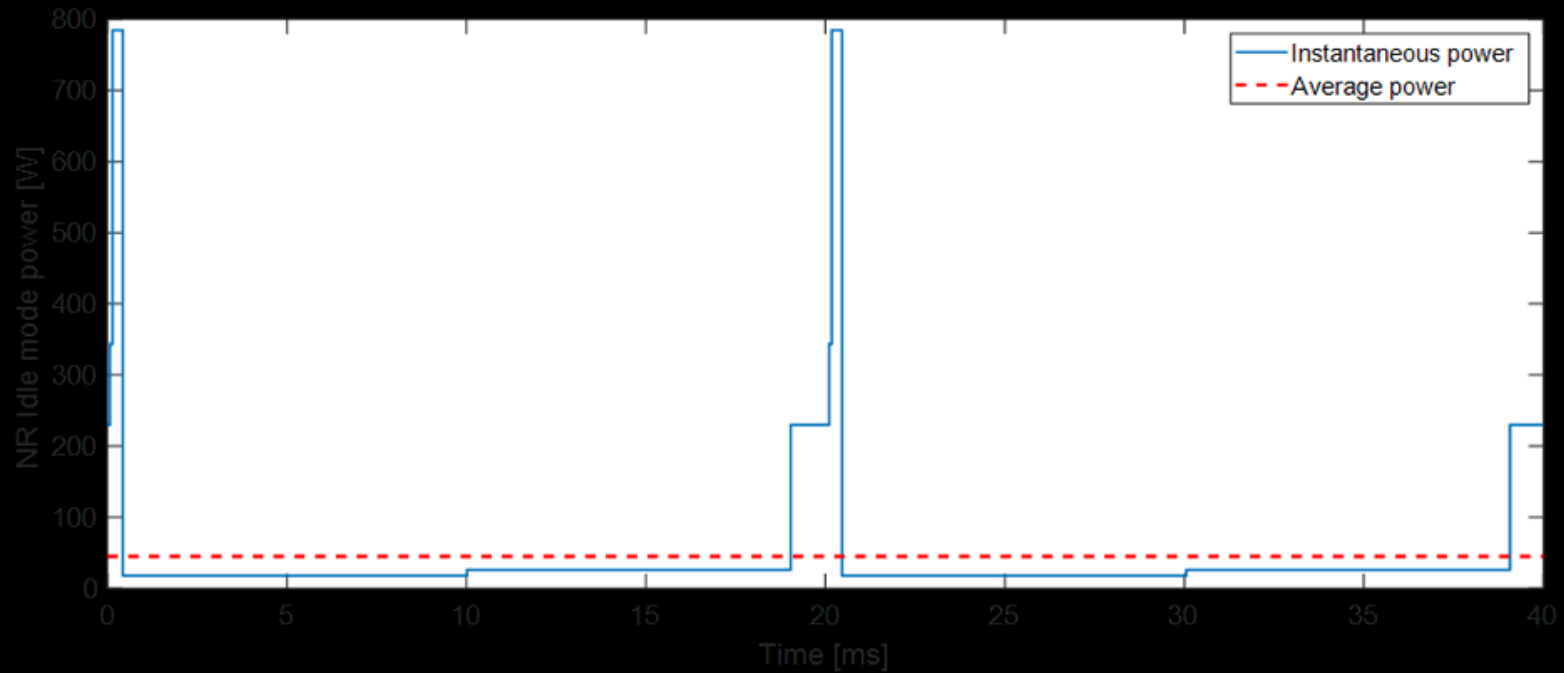
We can achieve this in multiple ways

- Better load shifting
- Better equipment implementations
- Ability to turn off components
  - Microsleep in router implementations (Johansson et al, 2022), network management control capabilities from IETF GREEN WG (2024), lean 5G radio design, microsleep TX, and power amplifiers, etc.
- Turning off entire systems
- Must manage tradeoffs and impacts, e.g., on latency and jitter

4G



5G



Frenger (Ericsson, 2021)

The Importance of Minimal Data Sets

It also matters how much data we send or receive …

- The growth of web page size, advertisements, Javascript, video

Large data size has many negative consequences:

- Energy consumption, latency is rending results on user’s screen
- For data that we send, data misuse by the data collector, the data holder becomes a target for attacks and surveillance, competion becoming harder without data, …

What can help:

- Privacy techniques such as IETF’s PPM WG’s measurement mechanisms
- Better compression (binary over text, regular compression, AI-based ”semantic compression”)
- Design systems and protocols with data only on ”a need to know basis”

Thank you