Ecological transition in ICT: A role for open hardware ?

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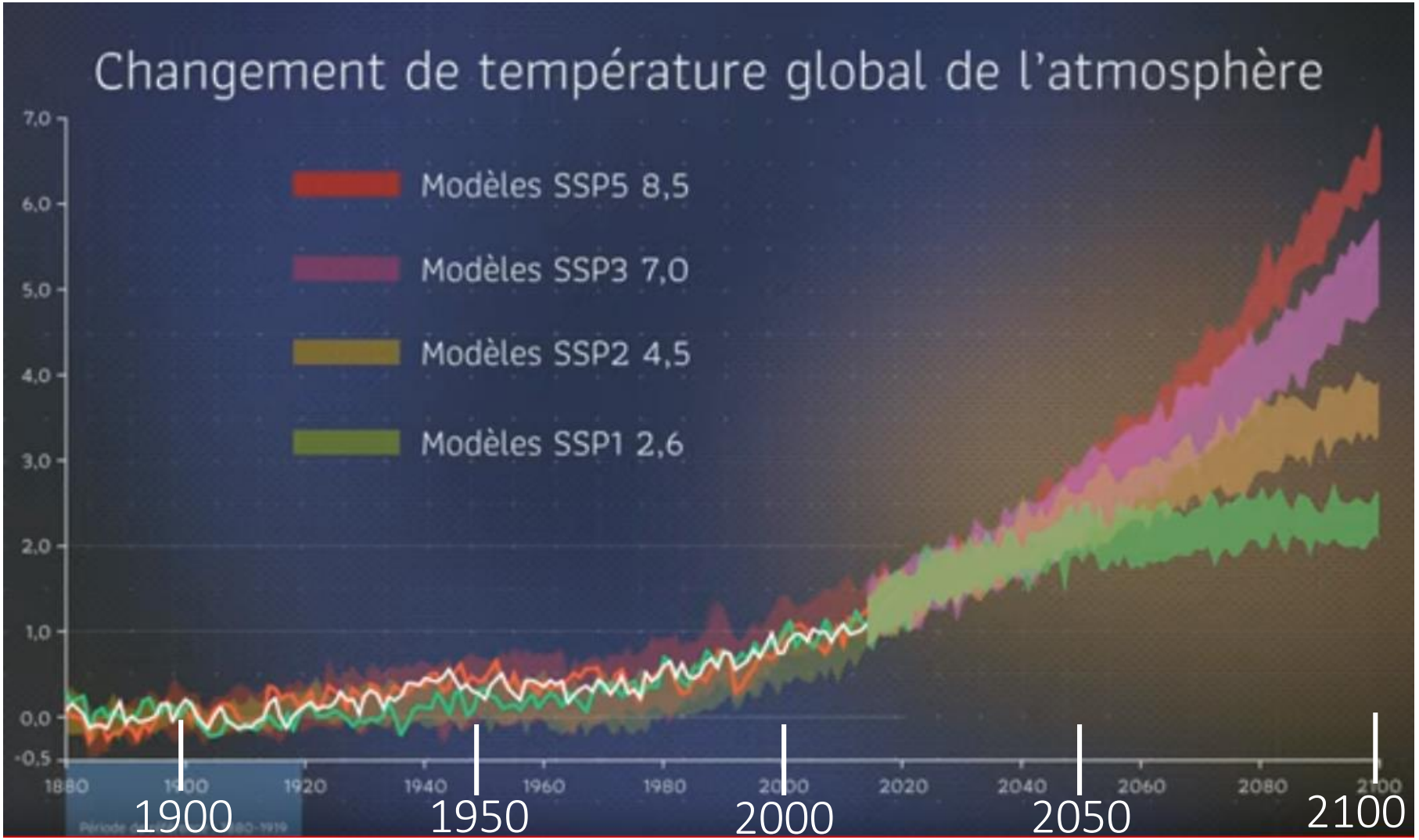
FEDER UNION EUROPEENNE Wallonie

LE FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL ET LA WALLONIE INVESTISSENT DANS VOTRE AVENIR

Recent climate change model update



Temperature rise [°C]

Source: CNRS, CEA & Météo-France, 17/9/2019

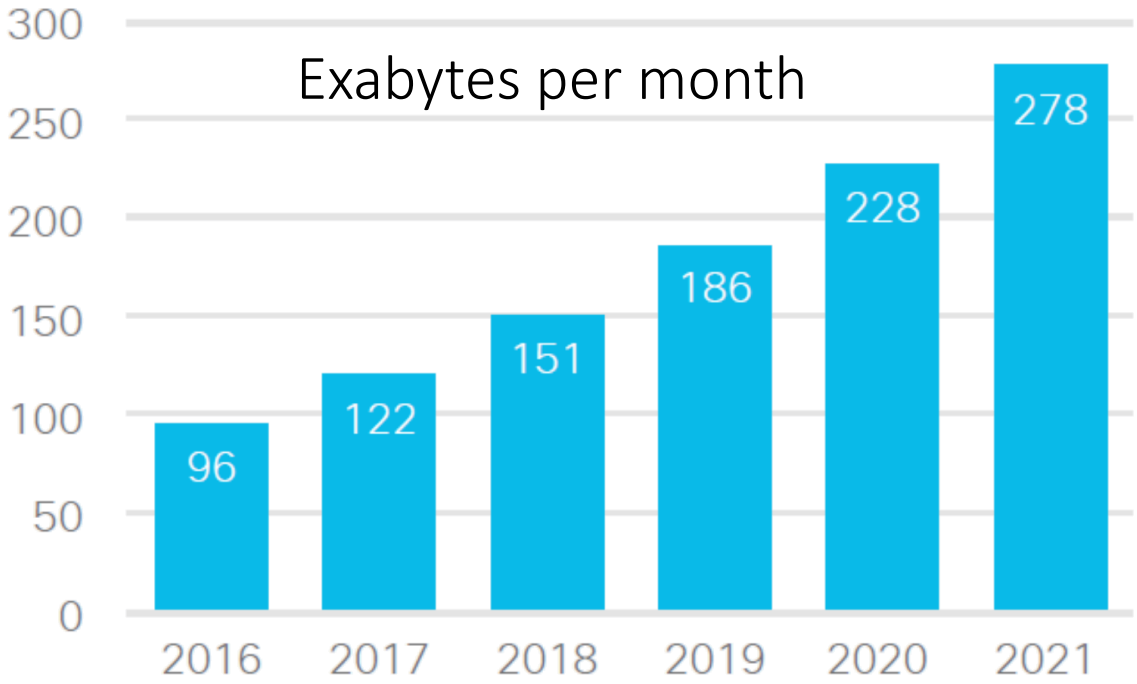
Outline

- Context:
  global socio-ecological crisis
- What about ICT ?
- Socio-ecological transition

Growth in Internet data traffic

<u>Global growth rate 2016-2021:</u>
+ 24% / year

Source: CISCO, VNI, 2017



<u>Growth rate:</u>

for smartphone communications: + 48% / year

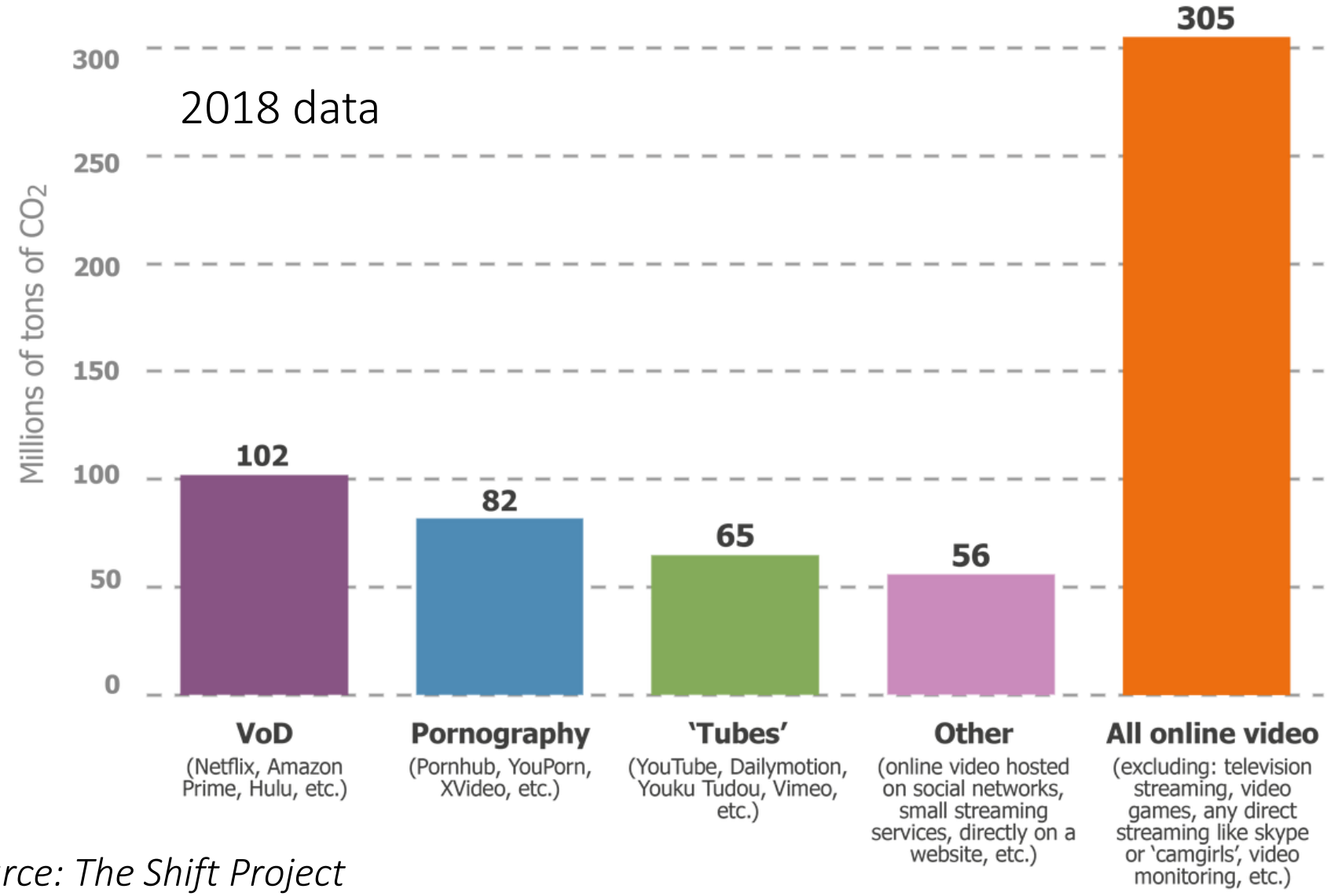
for M2M (IoT) communications: + 70% / year

Internet energy consumption model

	Electrical energy consumption per data transfer [1,2,3]
2018 status	0.35-1 kWh/GB
Change rate	~ -10% / year

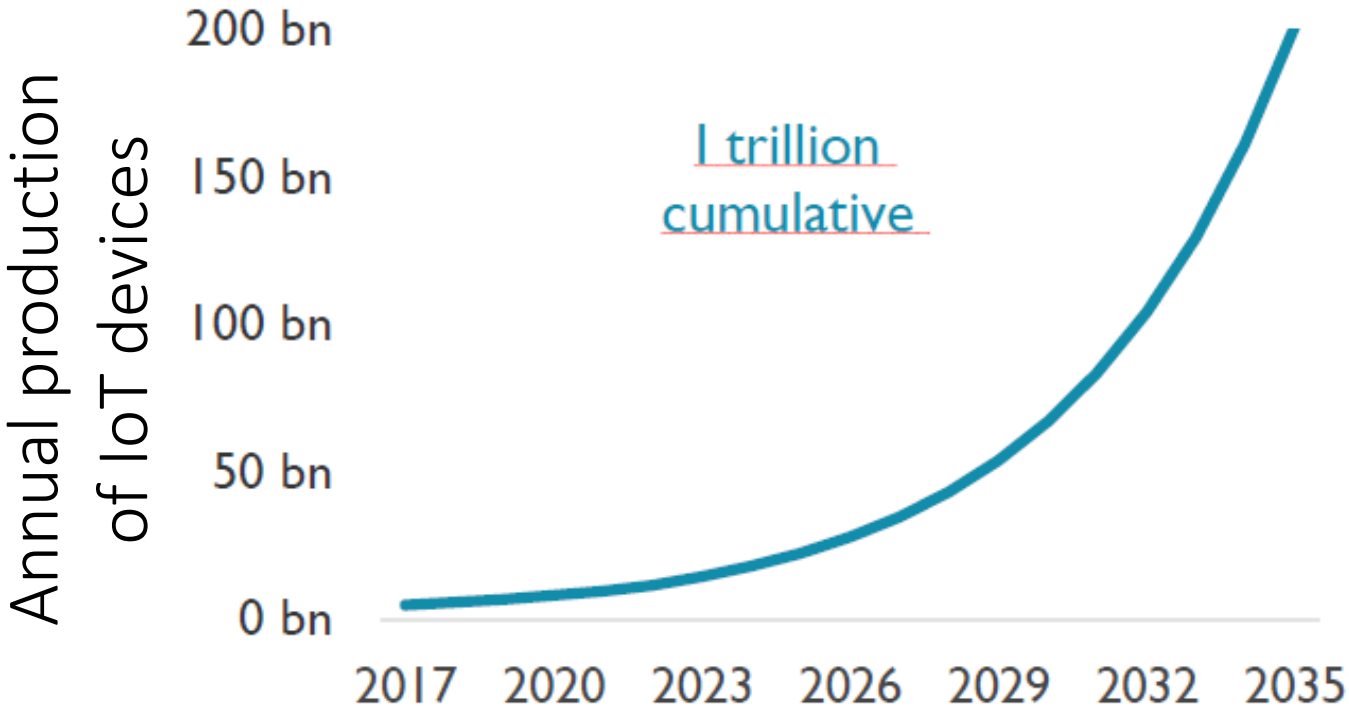
[1] S. Baudoin, "Modélisation de la consommation énergétique de l'Internet selon une approche ascendante", TFE (Supervision: D. Bol), UCL, 2013. [2] E. Taylor, "The environmental impact of smart grids communication systems: a case-study approach", TFE (Supervision D. Bol and E. De Jaeger), UCL, 2015. [3] The Shift Project, Lean ICT material: the 1byte model", 2018. [4] Ibidem, "Lean ICT report", 2019.

GHG emissions from online video



Source: The Shift Project

Trend in IoT device market



Source: ARM and SoftBank

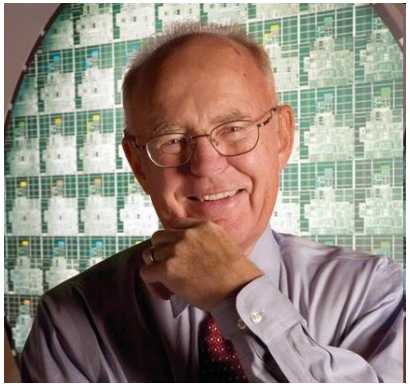
The edge will eat the cloud […]
the edge is coming and it's going to be big
– Thomas Bittman, Gartner Blog Network

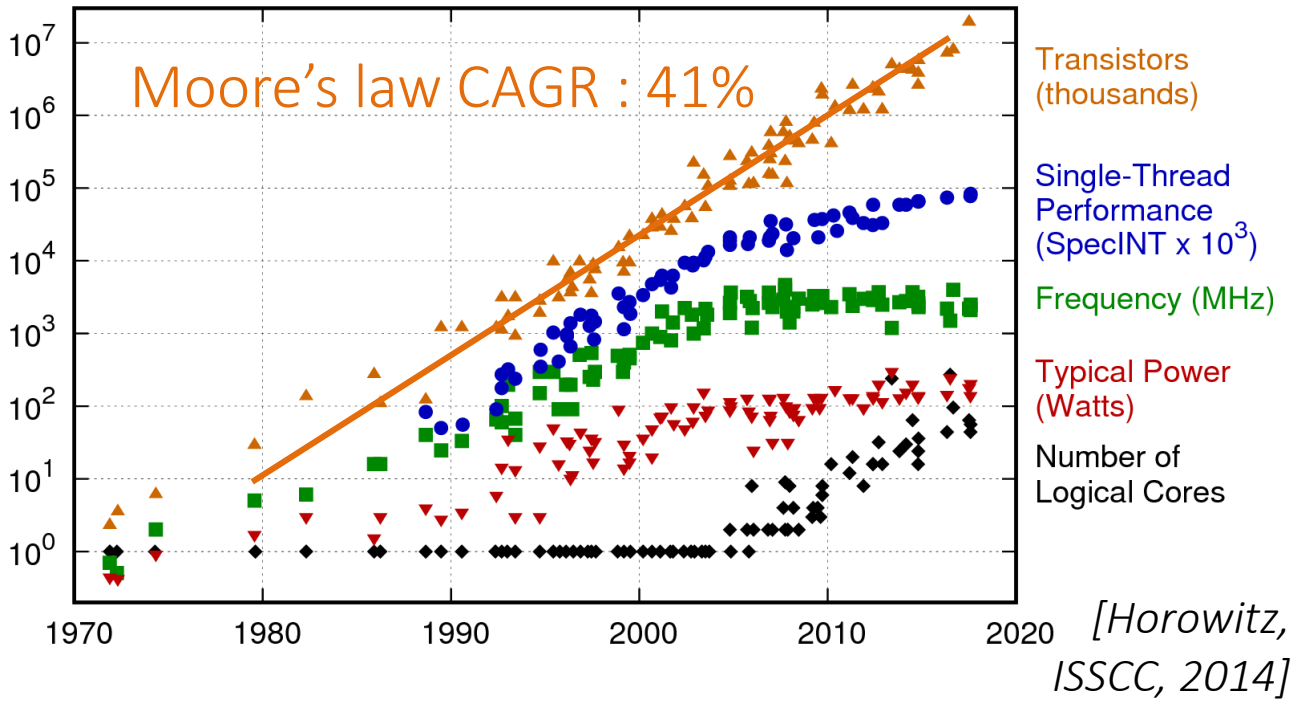

nest

Energy footprint – Home camera

- 10 HD cameras always-on:
  - 3900 GB / month
  - Generates 50% of the household electrical energy consumption in the cloud
- Engineering solutions:
  - local event detection though AI/ML inference
    → Edge computing
  - More efficient network
    → 5G

Moore's law

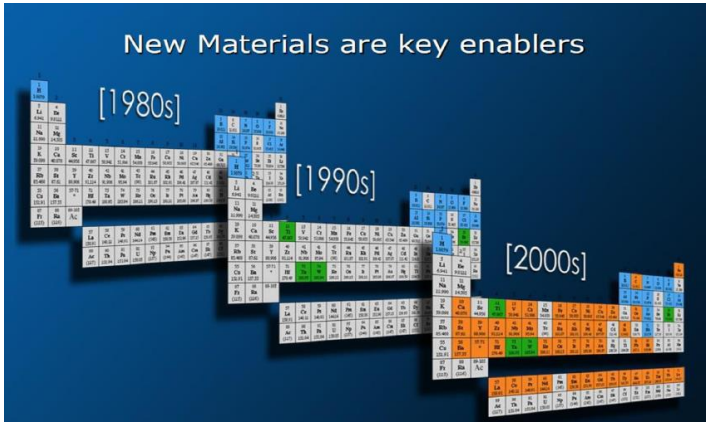




[Horowitz, ISSCC, 2014]

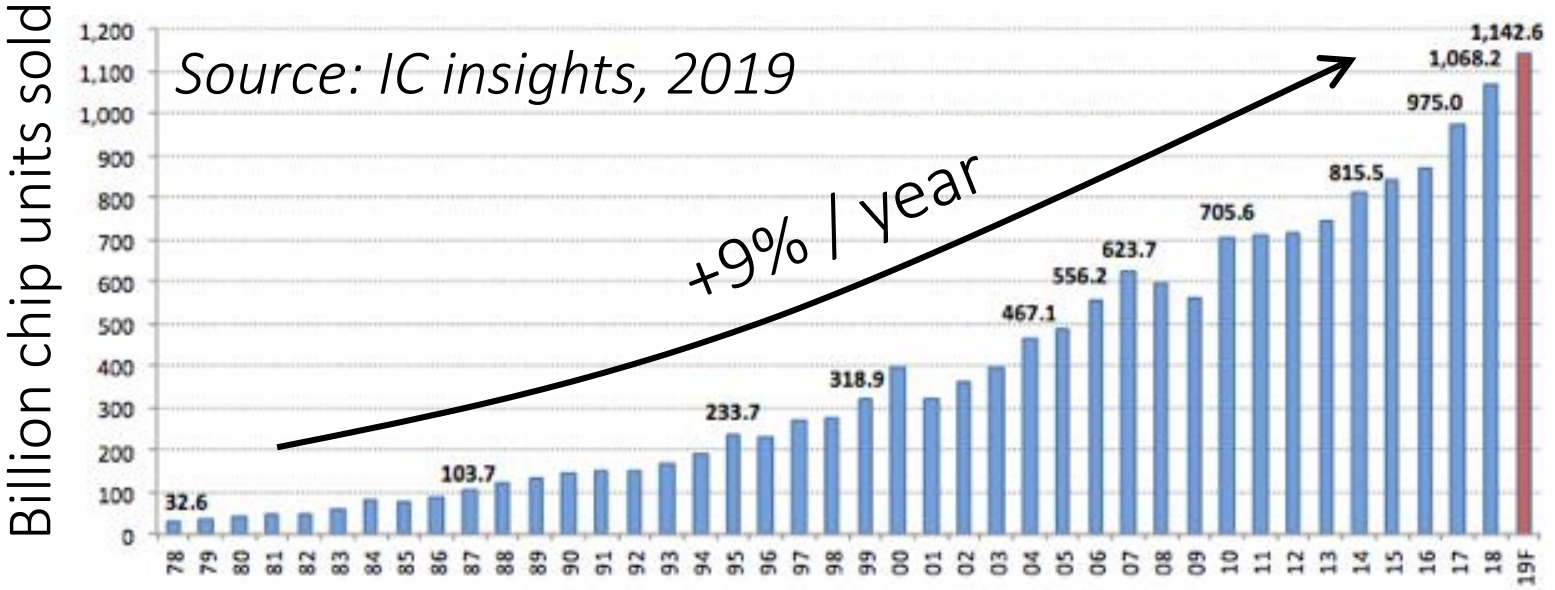
Increasing transistor density by shrinking the feature size

- ✓ Better performance and energy efficiency
- × More complex manufacturing: more energy and more material



Source: Intel

Energy footprint of chip fabrication



Chip unit sale: +9%/year (thanks Steve !)

× Chip unit fab energy: +8%/year (thanks Gordon!)

= Global chip fabrication energy footprint: +17% per year

It’s not only about energy

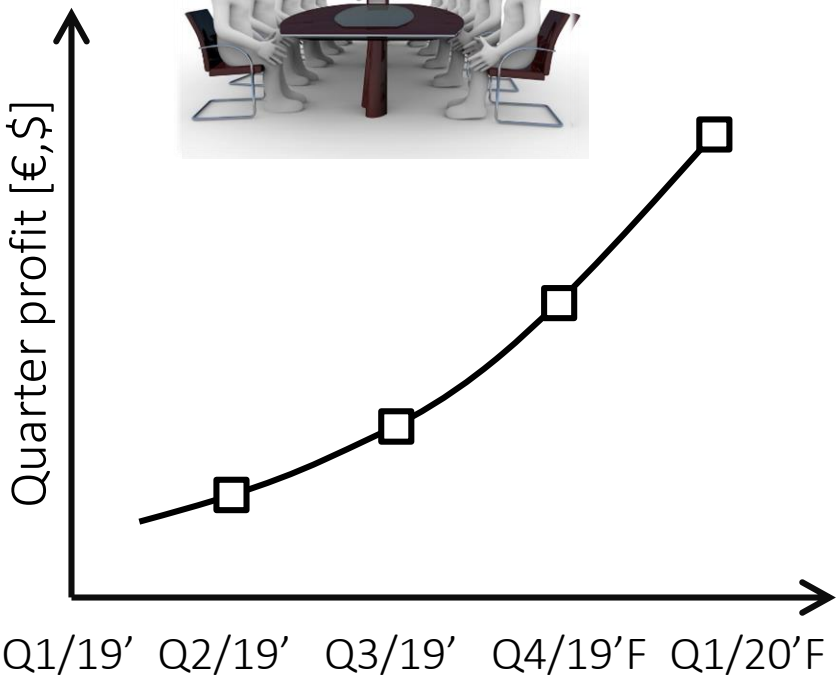
Coltan mine in North Kivu (Congo)
Copyright: Stefano Stranges

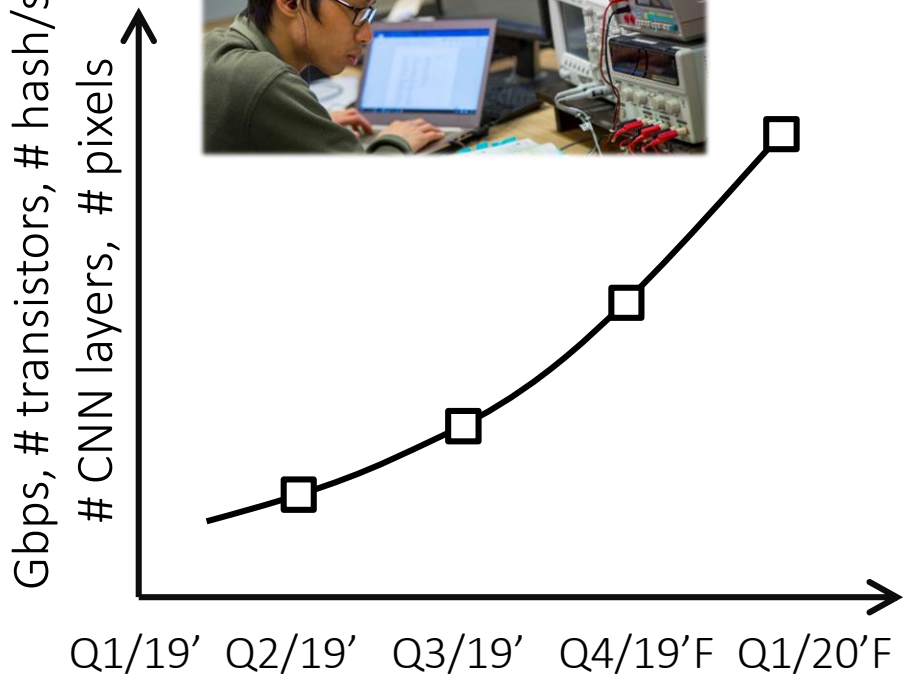
E-waste informal recycling area in Guiyu (China)

Impact of financial economy on ICT innovations

- Pitfall #1: buzz-word driven innovation

Impact of financial economy on ICT innovations

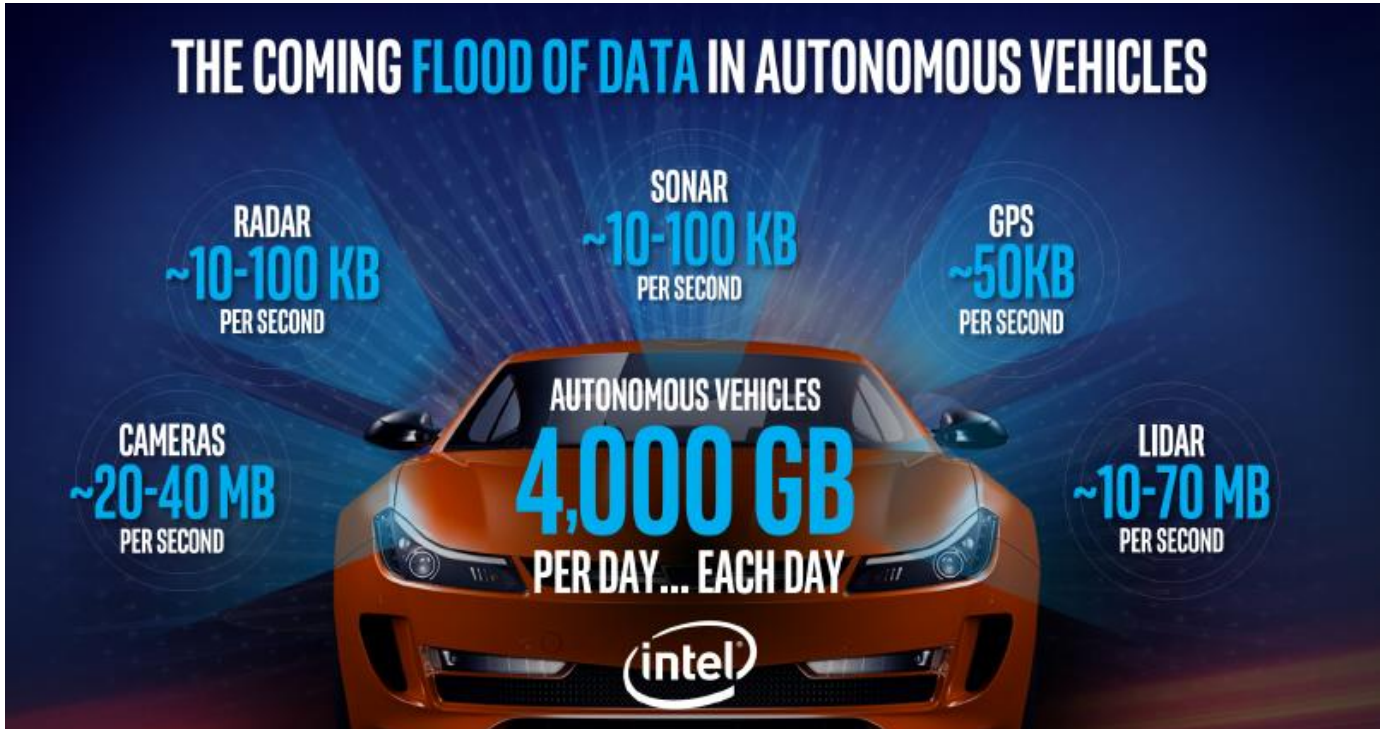




- Pitfall #1: Buzz-word driven innovation
- Pitfall #2: KPI-driven innovation

What will we use 5G for ?

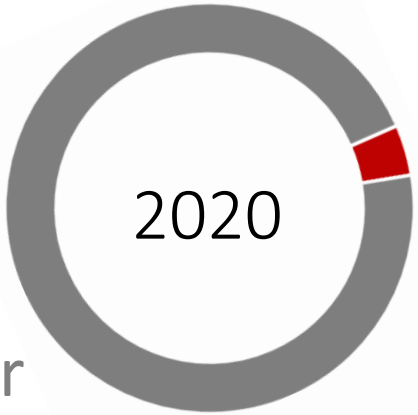
The case of AV and 5G



- A lot of sensor data → a lot of power in the cloud
- A lot of ICs and batteries → a lot of rare metal
- Rebound effect: how to say no to 100-km commuting
- Systemic effect: driver becomes a consumer

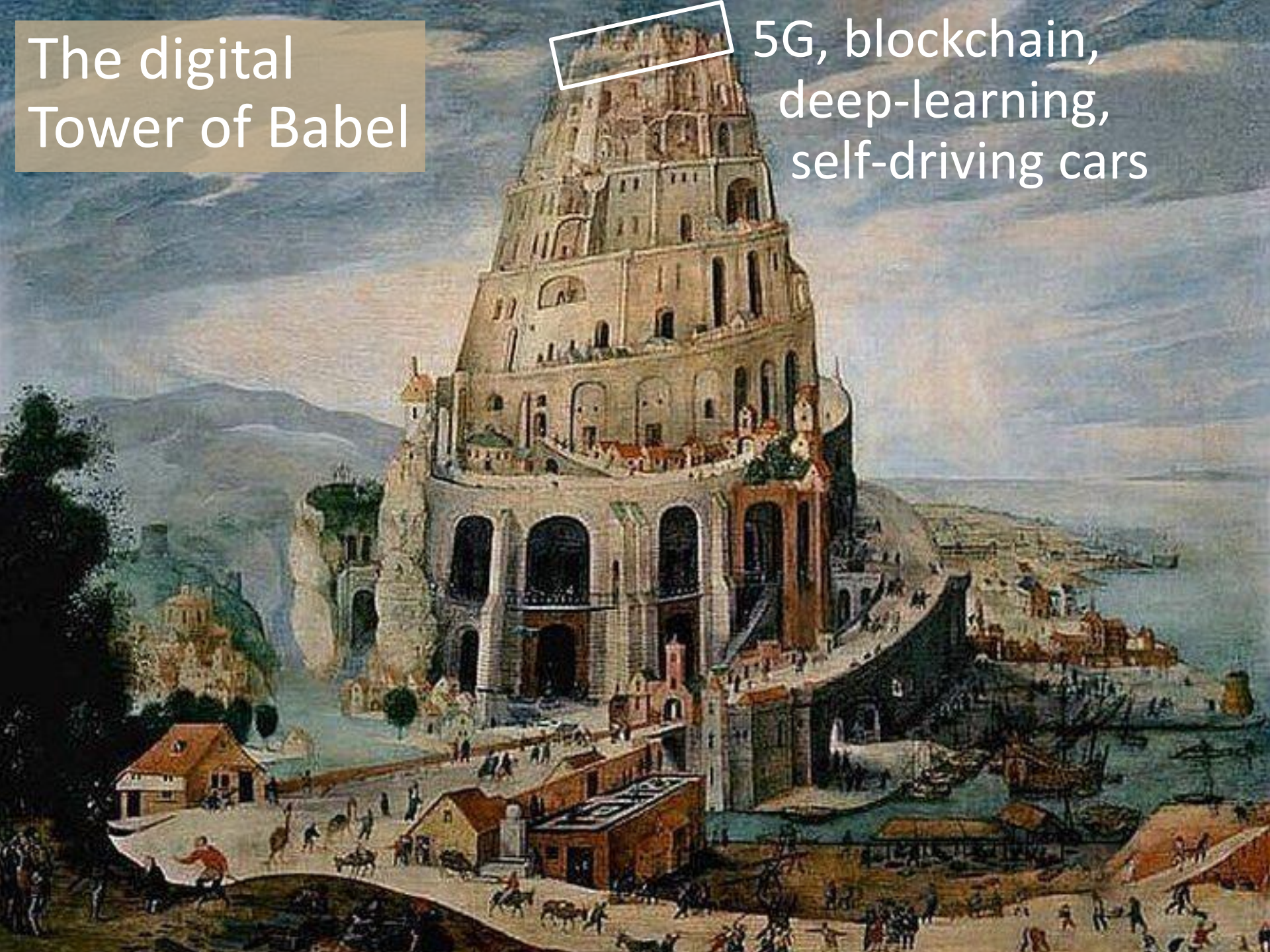
The technological illusion

Total = 42 $GTCO_2$/year



24 $GTCO_2$/year

N. Moreau, S. Guérit, P.-Y. Gousenberger, B. Pairet, « L'illusion techno-optimiste », La Libre, 10/5/2019.


The digital
Tower of Babel
5G, blockchain,
deep-learning,
self-driving cars

No exponential is forever …
but forever can be delayed.

– Gordon E. Moore

Socio-ecological transition

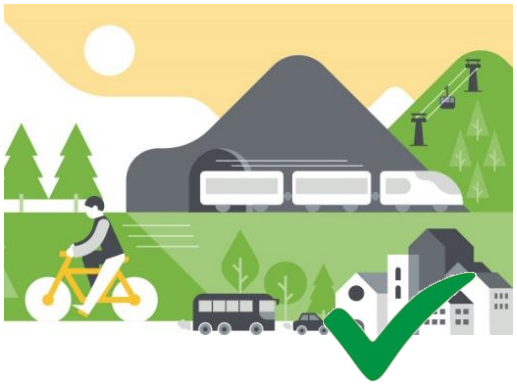
- *[…] Transition initiative […] refers to grassroot community projects that aim to increase self-sufficiency to reduce the potential effects of peak oil, climate destruction, and economic instability. [Wikipedia]*

- *The social-ecological transition answers environmental change with social progress.*

– Prof. E. Laurent, 2015

How do we apply these principles to ICT engineering ?

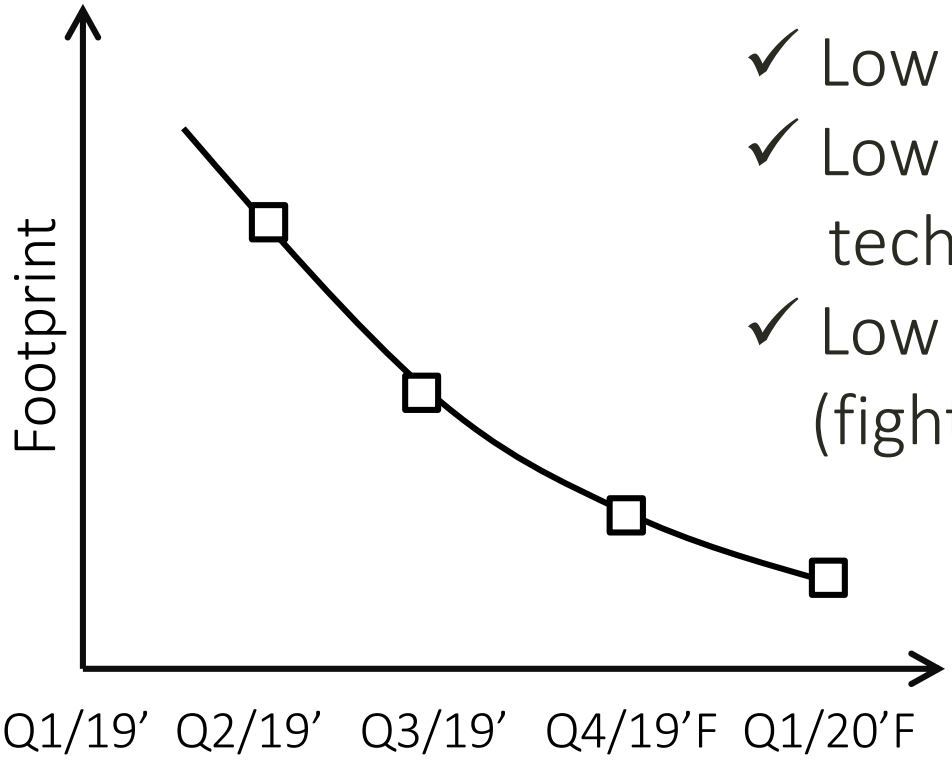
Socio-ecological transition in ICT



Social link

1. Focus innovation on fundamental needs
   Requires human interaction
   with the rest of the world (i.e. non engineers)

Socio-ecological transition in ICT



- ✓ Low power
- ✓ Low die area / low impact technologies
- ✓ Low replacement rate (fight obsolescence)

Environment preservation

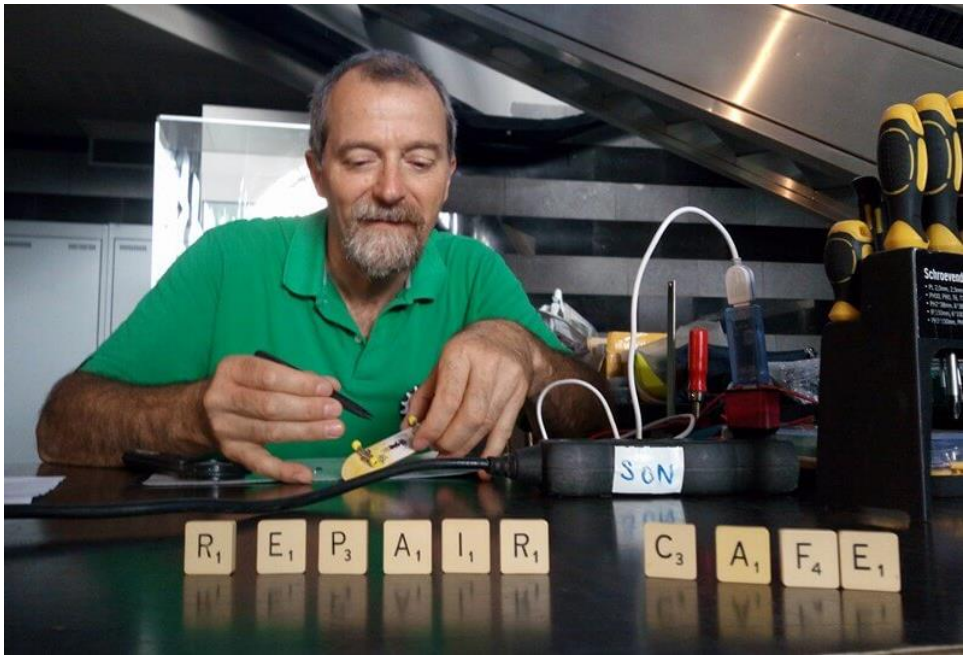
2. Replace KPI by reduction in carbon / resource footprint (caution: ≠ efficiency !!!)

Socio-ecological transition in ICT

Sobriety

3. Appropriate technology (low/mid tech is cool)

Socio-ecological transition in ICT

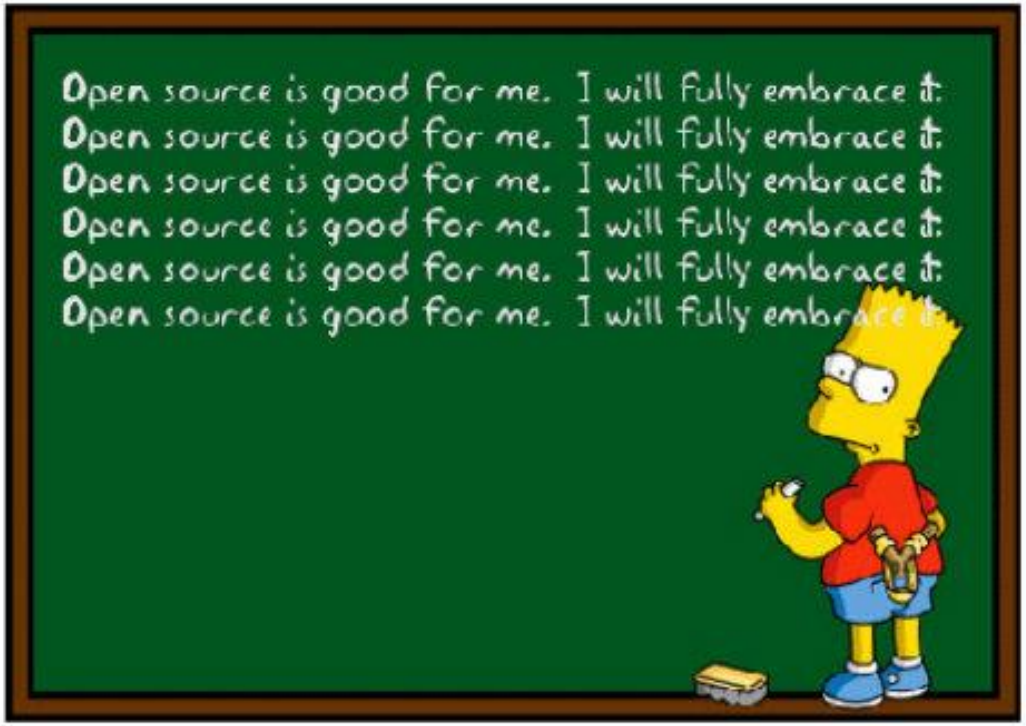


4. Resiliency is a key target

Local organization

Resiliency

A role for open hardware ?



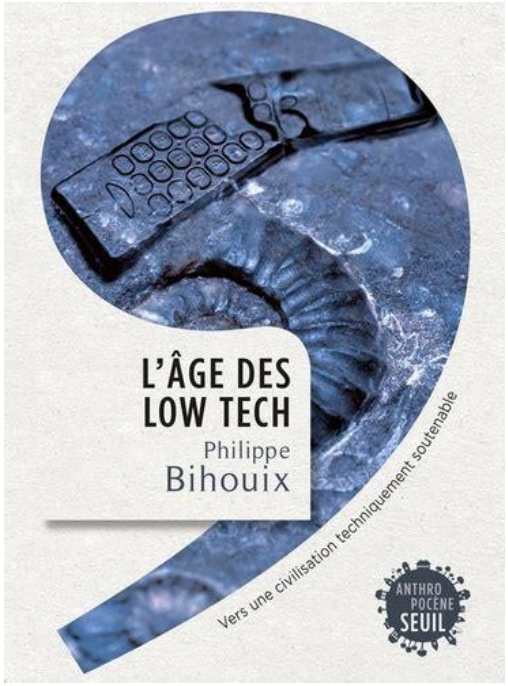
Local organization

Resiliency

open-source code
open-source hardware
open-source EDA tools
+ open semiconductor fabs
= resilient ICT

Sobriety in academic research

A Tsunami of paper – Dr M. Pelgrom, 2015



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Sobriety in the use of ICT

- Do not waste data traffic
- Consume data locally
- Fight electronic obsolescence (protect, repair, question the replacement)