UiO : Universitetet i Oslo

Mobility 2016, 22-26May2016, Valencia

Economics in IoT - Driver for 5G

Josef Noll

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Prof. at University Graduate Studies (UNIK), University of Oslo (UiO)
Head of Research at Movation AS
Norway

"Our Journey of Today"

- "The last time we were connected by wire was at birth!" [Motorola]
- The history of mobile, and the impact of mobile
- Upcoming challenges
  - ➡ Scalability in IoT
  - ➡ Security & Privacy
  - ➡ Co-operative access
- "*Some meat for discussion*"
  - ➡ Social responsibility: access for everyone
  - ➡ Basic Internet Foundation
 - iMVNO - invers Mobile Virtual Network Operator

Economics in IoT

JUST CLOSE YOUR EYES AND IMAGINE THE WIRE.

KOMARNICKI

How come these guys didn't think of security?

Basic Internet

1973 Kjeller

Steve Crocker

Jon Postel

1973: Internet to Kjeller/Europe

1994: Opera Software

Norge Norway

Kjeller

2014: Basic Internet «half a dollar is enough»

- The building where the Internet (Arpanet) came to Europe in June 1973

1972   Vir

1971 (at which point 23 hosts, at universities and government research centers, were connected to the ARPANET); 29 by August, 1972, and 40 by September, 1973.

At that point, two satellite links, across the Pacific and Atlantic Oceans to Hawaii and Norway (NORSAR) had been added to the network. From Norway, a terrestrial circuit added an IMP in London to the growing network.
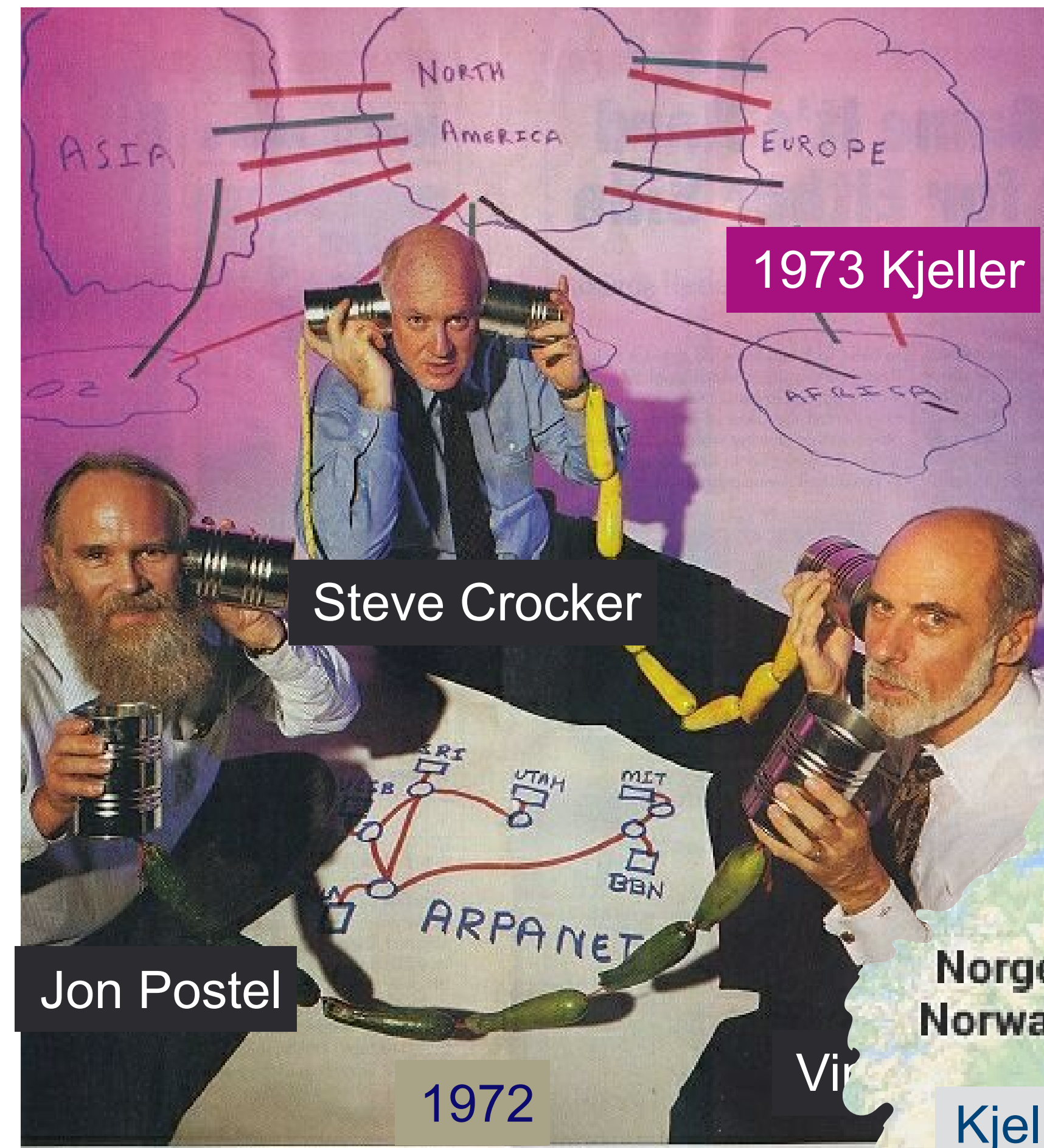
Source: http://www.michaelkaul.de/History/h

The Internet and Scandinavia

- The first connection of Arpanet outside of the USA (and **Scandinavia** (Kjeller, June 1973)

- List_of_Internet_pioneers [Wikipedia]
  - Yngvar Lundh, Paal Spilling

- Application development
  - .php, OpenSource, Linux, Skype, Spotify
  - OperaSoftware, FAST Search
  - Nokia, Ericsson
  - Telenor, TeliaSonera
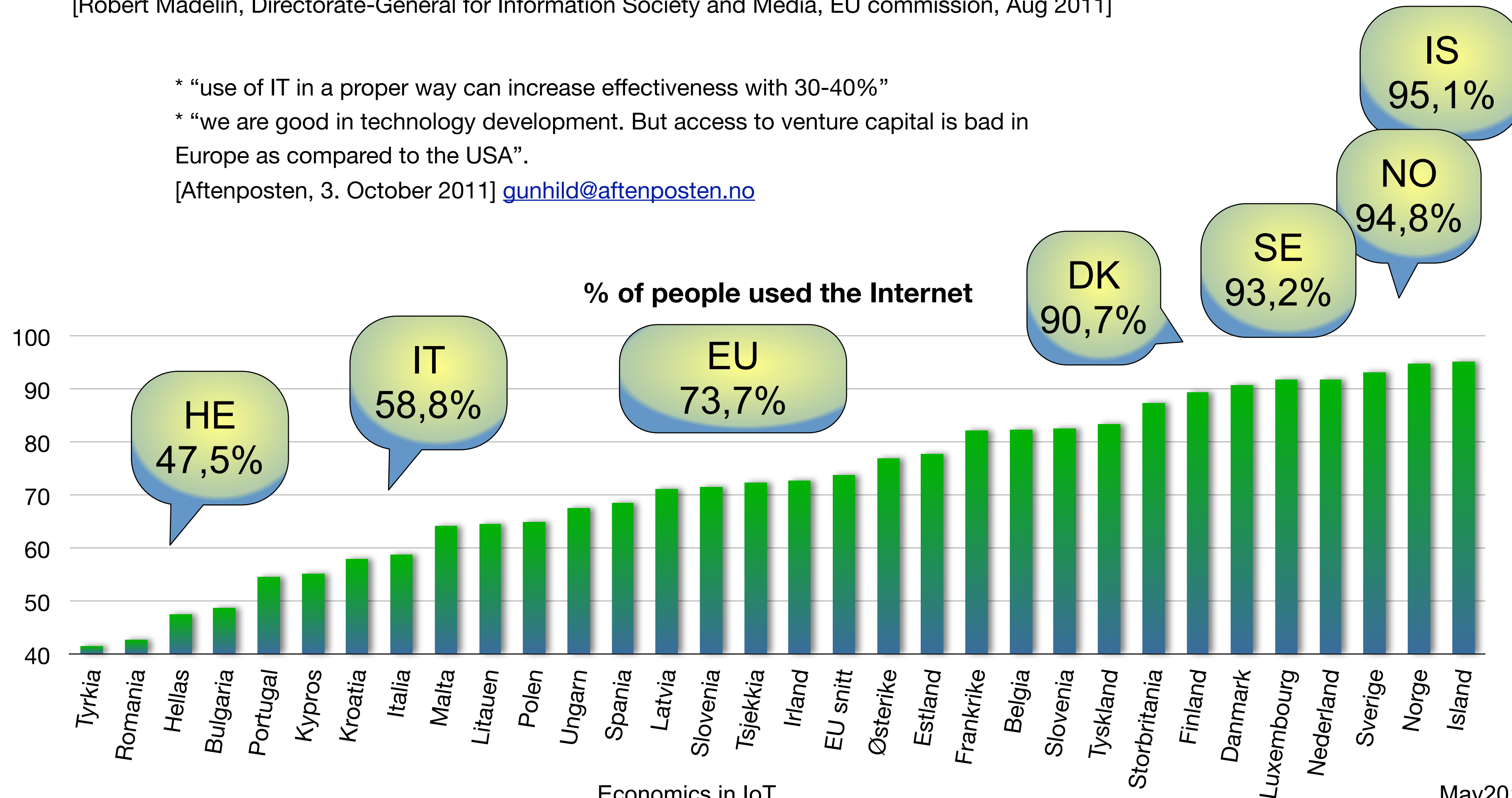
- Mobile Internet:
  GSM
  Service adaptation
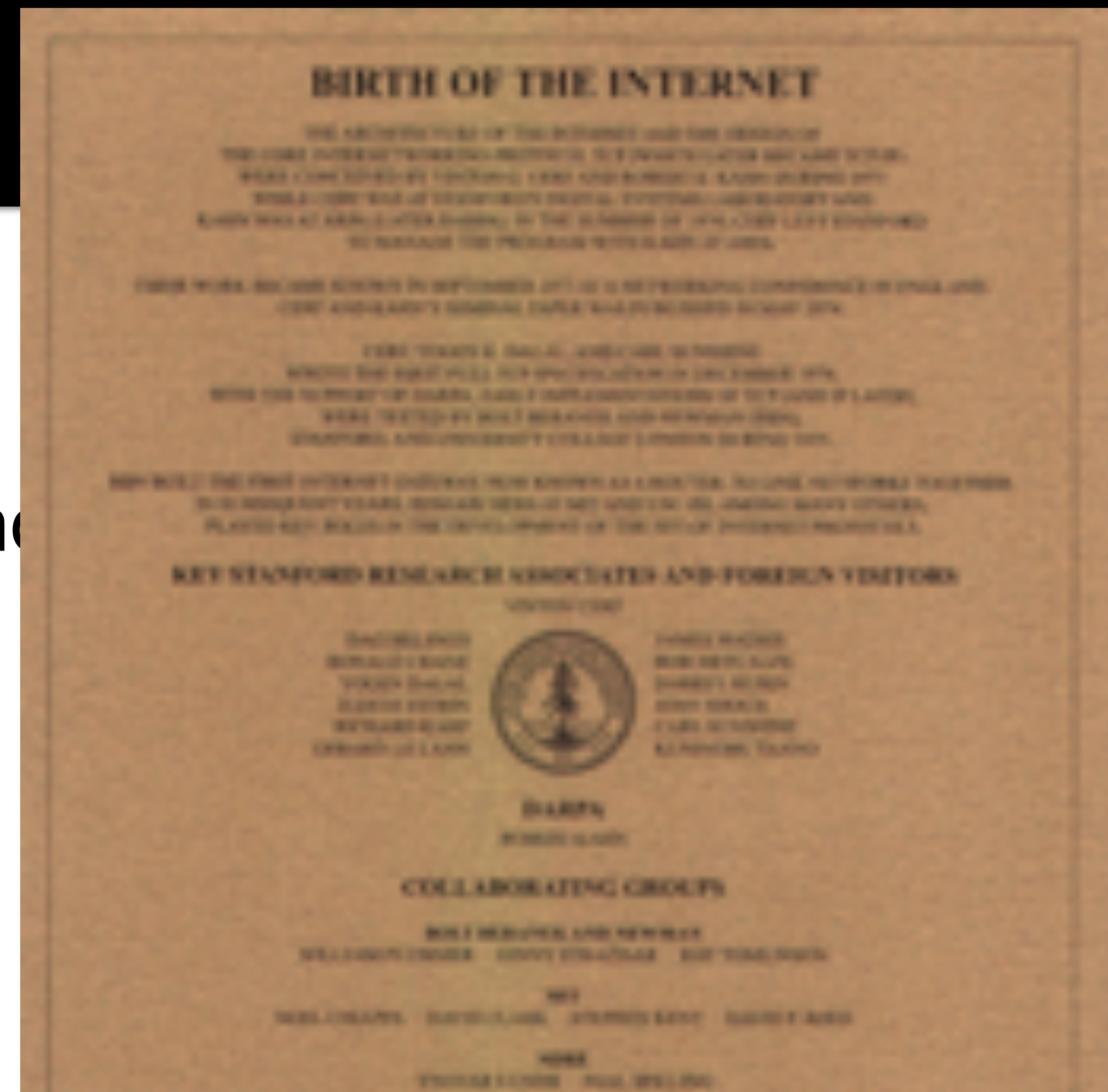
Internet usage in Scandinavia

[Robert Madelin, Directorate-General for Information Society and Media, EU commission, Aug 2011]

* "use of IT in a proper way can increase effectiveness with 30-40%"
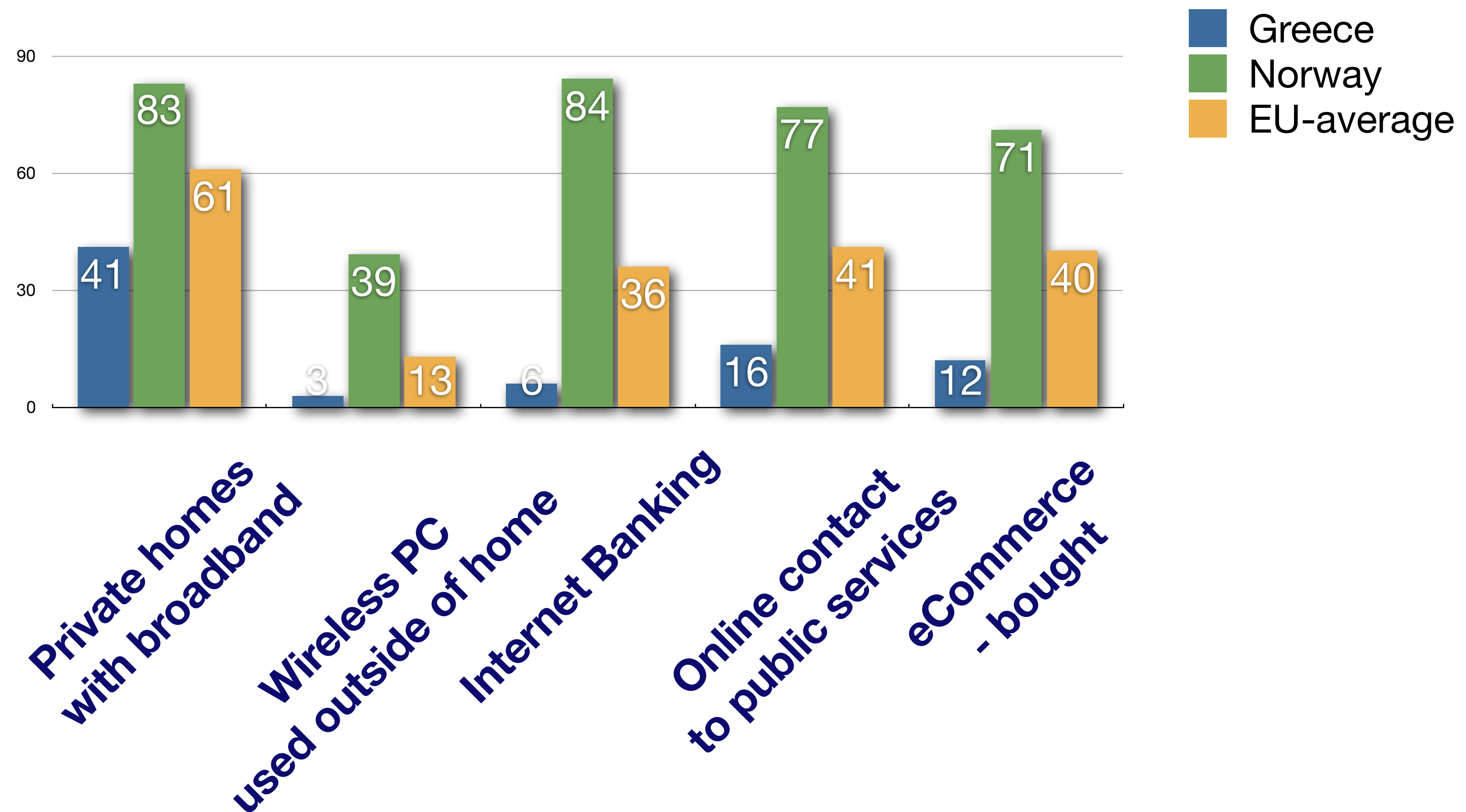* "we are good in technology development. But access to venture capital is bad in Europe as compared to the USA".
[Aftenposten, 3. October 2011] gunhild@aftenposten.no

% of people used the Internet

Economics in IoT

Internet service usage

[source: EU commission, Aug2011]

5G and IoT

what has happened
in the last 11 years?

Nordic Mobile Plansammling, 8Jun2005

telenor

4G and disruptive technologies

Josef Noll

Researcher, Telenor R&D, N-1331 Fornebu
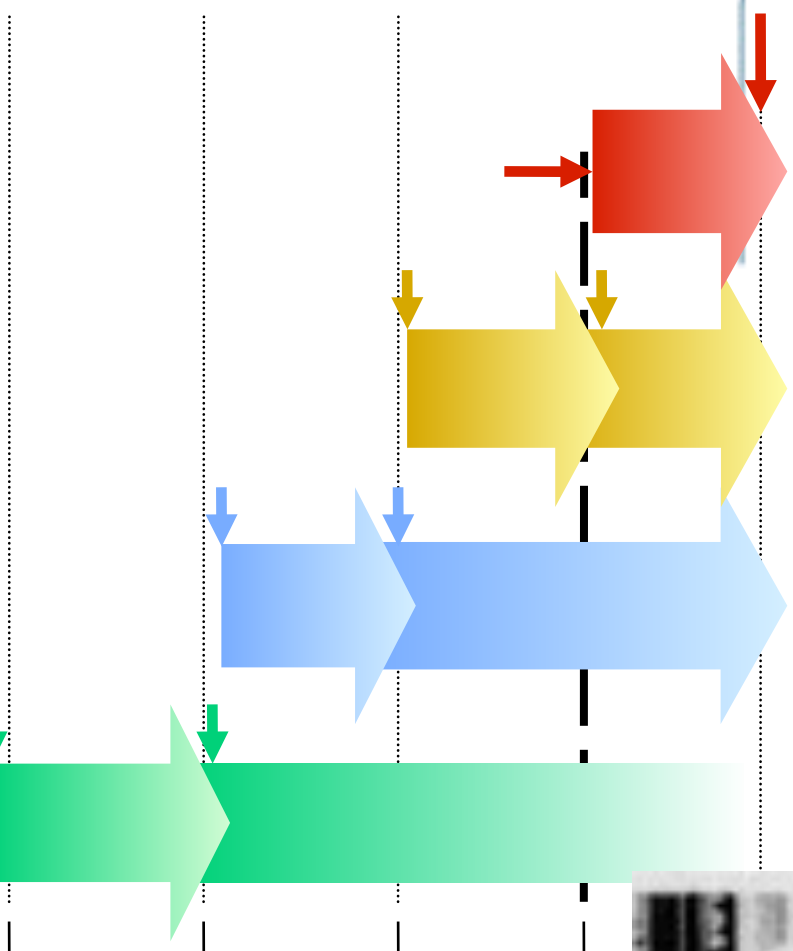
Prof. stip., Univ. graduate studies, UniK, N-2027 Kjeller

josef@unik.no

people.are.wireless.
communication.future.techn

and what is my
vision for 2026?

Postulations from 8Jun2005

Postulation 1:
Challenge yourself to survive: How can I kill my business?

Postulation 2:
The time for "generations" is over, the winner provides integrated service access
(still needs: seamless authentication, seamless service access)

Postulation 3:
HSPDA does not help you, you still need more and smaller cells.

Postulation 4:
Indoor high bandwidth coverage comes from indoor access →
Challenge Nokia/Ericsson on the price for indoor access (max 50 €)

Postulation 5:
Beyond 3G (or 4G) is the integration of access, and higher bandwidths access speed
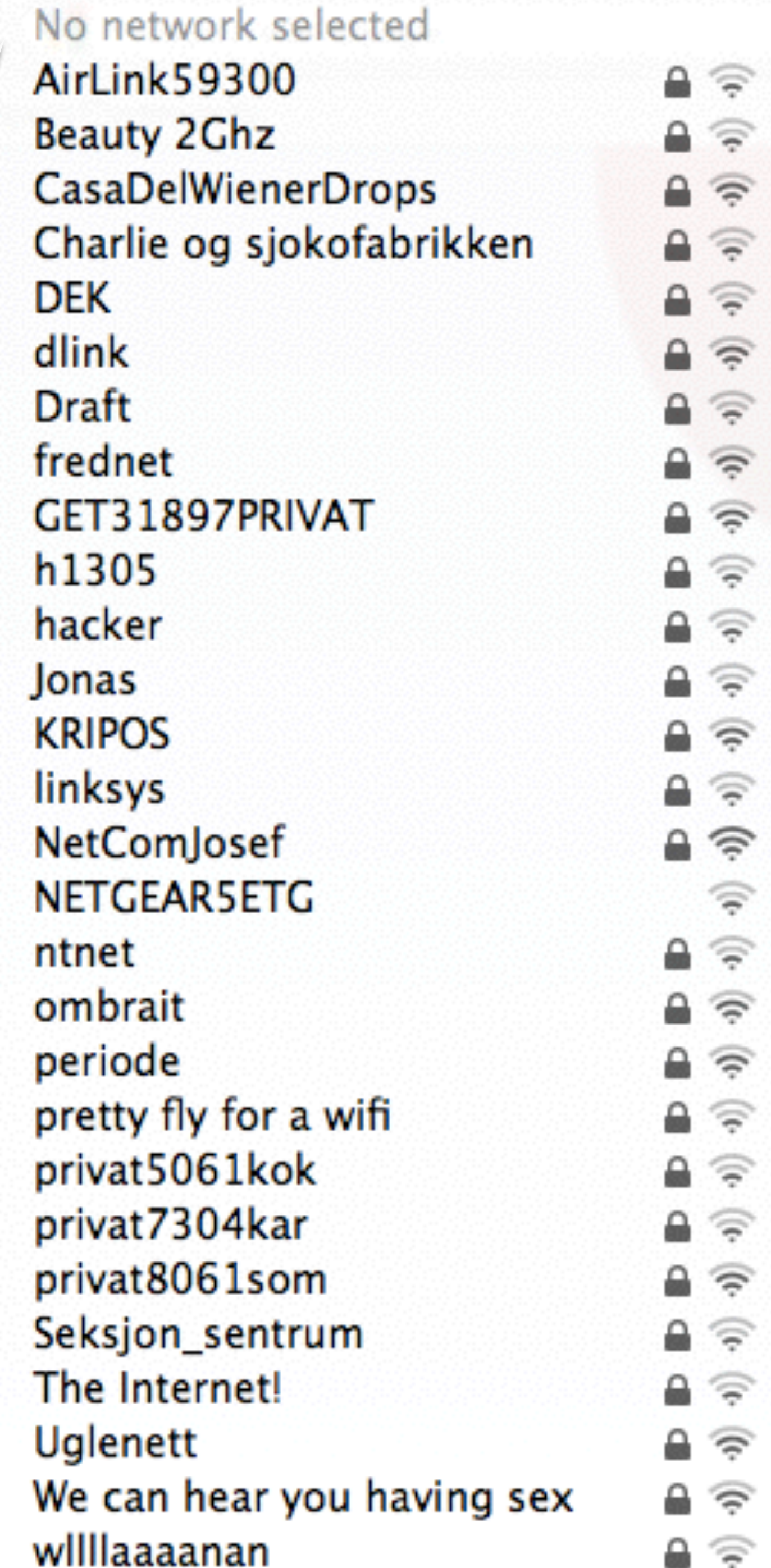
WLAN, Bluetooth download
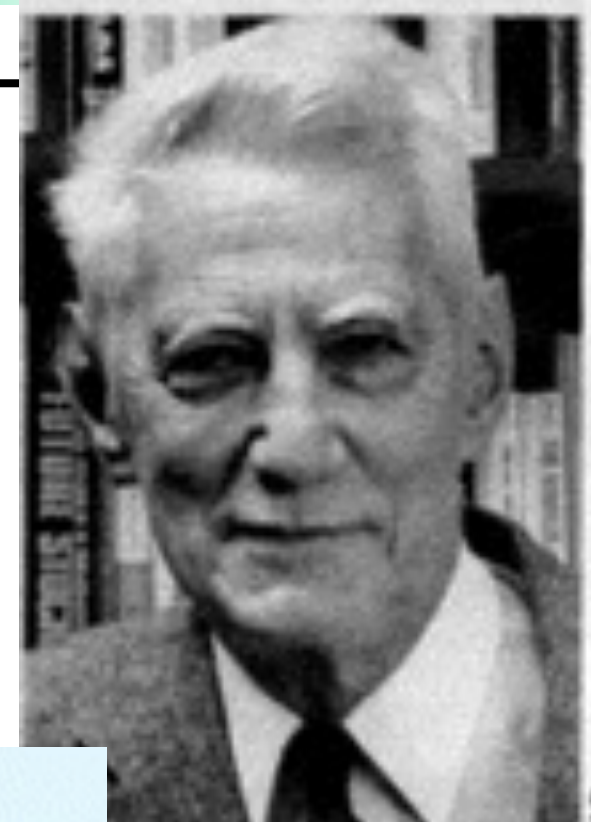
The world of 2016

Wifi at "Legevakten" Feb2011

- Interference-limited Wifi
  - ➡ increased demand on customer services
  - ➡ "meaningless discussions" on "Wifi"
- Operators in the need of becoming "Digital Companies"
  - ➡ Revenue, Investors?
  - ➡ Digital Ecosystem: Identity, Federation
- 5G dilemma
  - ➡ revenue versus costs
  - ➡ network infrastructure (core vs access network costs)
- Societal challenges
  - Energy, Health, "Internet for all"
  - Security, Privacy, "Digital Societies"

Economics in IoT

No network selected
AirLink59300
Beauty 2Ghz
CasaDelWienerDrops
Charlie og sjokofabrikken
DEK
dlink
Draft
frednet
GET31897PRIVAT
h1305
hacker
Jonas
KRIPOS
linksys
NetComJosef
NETGEAR5ETG
ntnet
ombrait
periode
pretty fly for a wifi
privat5061kok
privat7304kar
privat8061som
Seksjon_sentrum
The Internet!
Uglenett
We can hear you having sex
wIIIlaaaanan

Addressing the Threat Dimension for IoT

- Hollande (FR), Merkel (DE) had their mobile being monitored

- «and we believe it is not happening in Norway?

18. Dezember 2014, 18:14 Uhr   Abhören von Handys

So lässt sich das UMTS-Netz knacken

[source: Süddeutsche Zeitung, 18Dec2014]

[source: www.rediff.com]

Zwei Hacker zeigen
UMTS-Antenne lassen
sich knacken (Foto dpa)

IoTSec.no

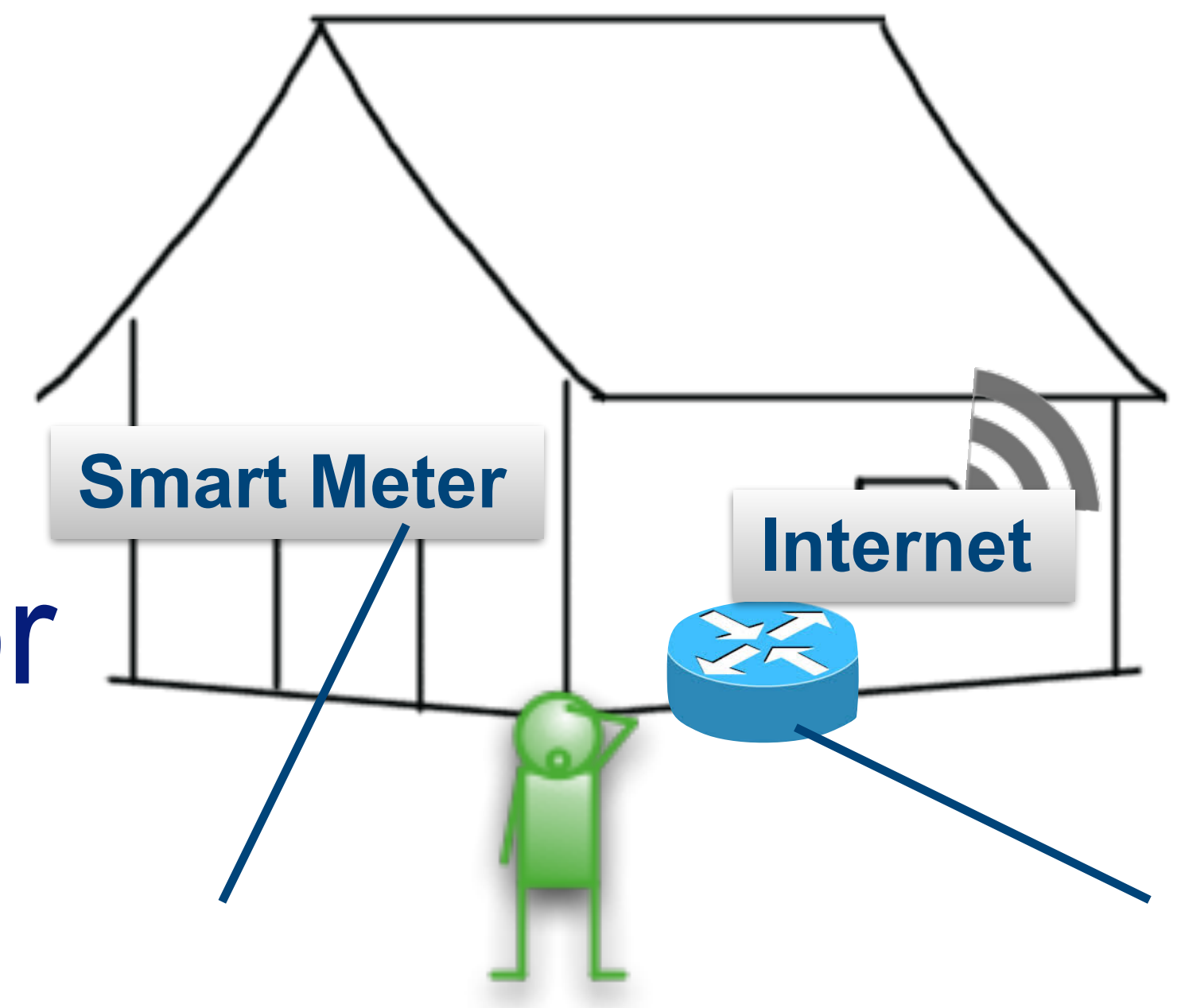"Research on IoT security"
"Building the national Security Centre for Smart Grid"

http://IoTSec.no

Smart Meter

Internet

Knowledge and collaboration space
IoTSec.no #IoTSecNO

| Home | Research Areas | Security Centre | Publications | About us |

The **IoTSec - Security in IoT for Smart Grids** initiative was established in 2015 to promote the development of a safe and secure Internet-of-Things (IoT)-enabled smart power grid infrastructure. The Research Project received funding from the Research Council of Norway (RCN) to contribute to a safe information society.

IoTSec addresses the basic needs for a reliable and efficient, uninterrupted power network with dynamic configuration and security properties. It addresses in addition the needs of businesses and end users of additional IoT services by exploring use cases for value-added services with the intent to design the building blocks for future services that consider the necessary security and privacy preconditions of successfully deployed large-scale services. IoTSec will apply the research in the envisaged Security Centre for Smart Grids, co-located with the Norwegian Centre of Excellence (NCE Smart).

About

The IoTSec initiatives drives Research for secure IoT and Smart Grids

#iotsecno

Josef Noll   Nov
@josefnoll

NCE Smart Partnerkonferansen @KristinHalvorsen og Nasjona... er for Sikkerhet i SmartGrid #IoT...
pic.twitter.com/FLLua94...

«Open World Approach»
everything that is not declared closed is open

Norge
Norway
Gjøvik
Kjeller
Oslo
Halden

Economics in IoT

Partners and Collaborations

- UiO
- UNIK
- NR
- Simula
- NTNU

Academia

- Smart Innovation Østfold
- eSmart Systems
- Fredrikstad Energi
- EB Nett
- Movation

Industry

- Smartgrid Centre
- Norw. Data Protection Auth.
- Forbrukerrådet

Interest Org.

- EyeSaaS
- mnemonic

Industry

- Mondragon Unibersitatea
- University of Victoria
- Universidad Carlos III
- La Sapienza
- COINS Research School
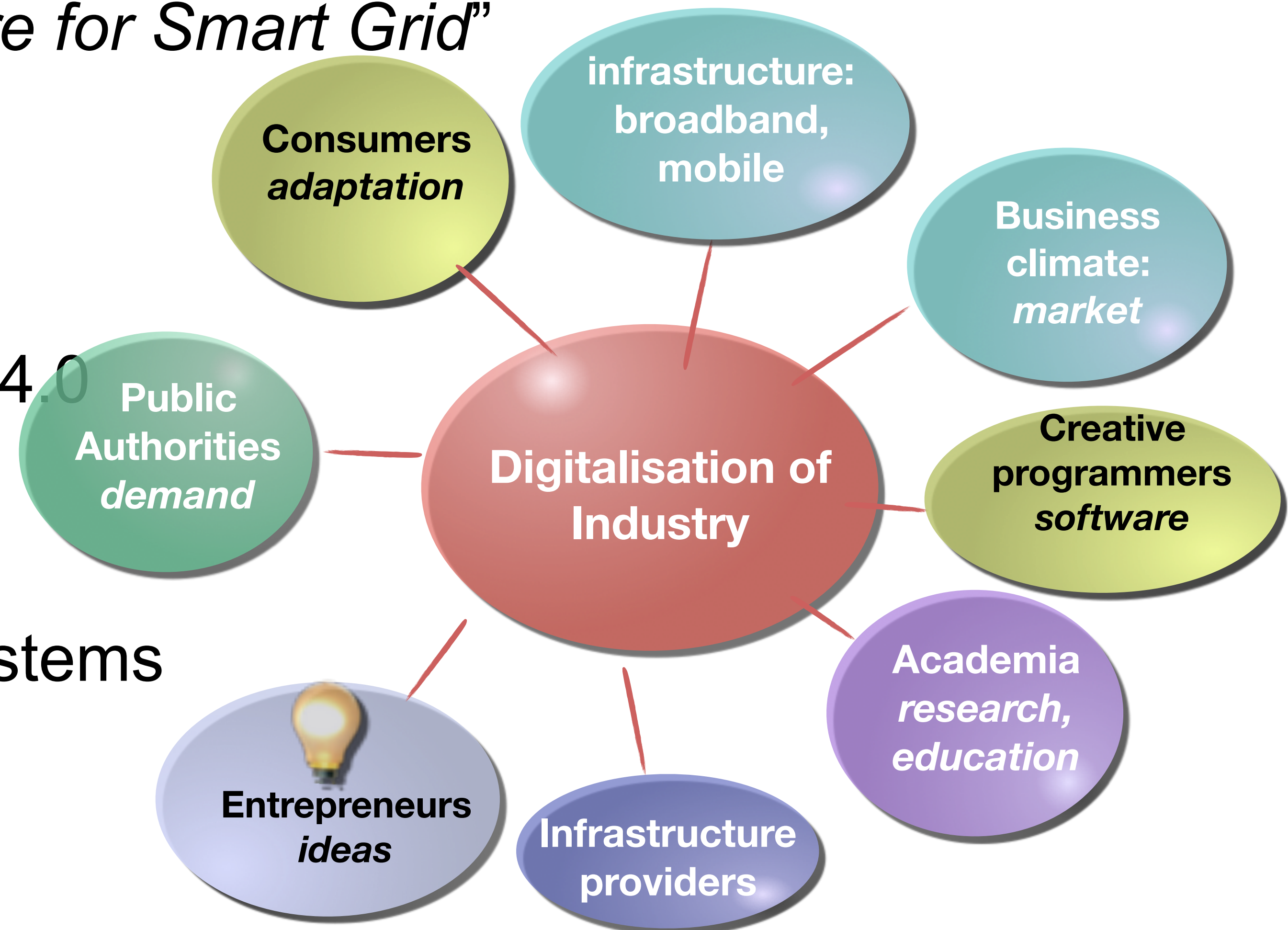- Nimbeo
- H2020 and ECSEL projects

International

Focus of IoTSec

based on: security & privacy for systems of systems

- "*we are building the Security Centre for Smart Grid*"
- Smart Grid infrastructure
  - ➡ towards Smart Homes, Smart Cities
  - ➡ towards Autonomous systems
- Security & Robustness of Industrie4.0
- Model System of Systems
- Networked Autonomous Systems
- Smart Grid enabled Distributed Systems

Consumers *adaptation*

infrastructure: broadband, mobile

Business climate: *market*

Public Authorities *demand*

Digitalisation of Industry

Creative programmers *software*

Entrepreneurs *ideas*

Infrastructure providers

Academia *research, education*

SC Magazine > News > IoT security forcing business model changes, panel says

Teri Robinson, Associate Editor

Follow @TeriRnNY

October 22, 2015

IoT security forcing business model changes, panel says

Share this article:

To secure the Internet of Things and to build trust with customers, the way that vendors approach manufacturing, distributing and supporting devices and solutions must change, a panel of security pros said Monday at the National Cyber Security Alliance's (NCSA's) Cybersecurity Summit held at Nasdaq.

"Business models will have to change. We used to build them [products], ship them and forget about them until we had to service them," said John Ellis, founder and managing director of Ellis & Associates. "We've moved to a new world where we have to ship and remember."

Noll et al.   **15**

Volvo to 'accept full liability' for crashes with its driverless cars

But decide on rules so we can make the dang vehicles

13 Oct 2015 at 06:04, OUT-LAW.COM

68   22   78

Volvo will "accept full liability" for collisions involving its autonomous vehicles, the company has confirmed.

, Noll et al.   **16**

Semantic attribute based access control (S-ABAC)

- Access to information
  - → who (sensor, person, service)
  - → what kind of information
  - → from where
- Attribute-based access
  - → role (in organisation, home)
  - → device, network
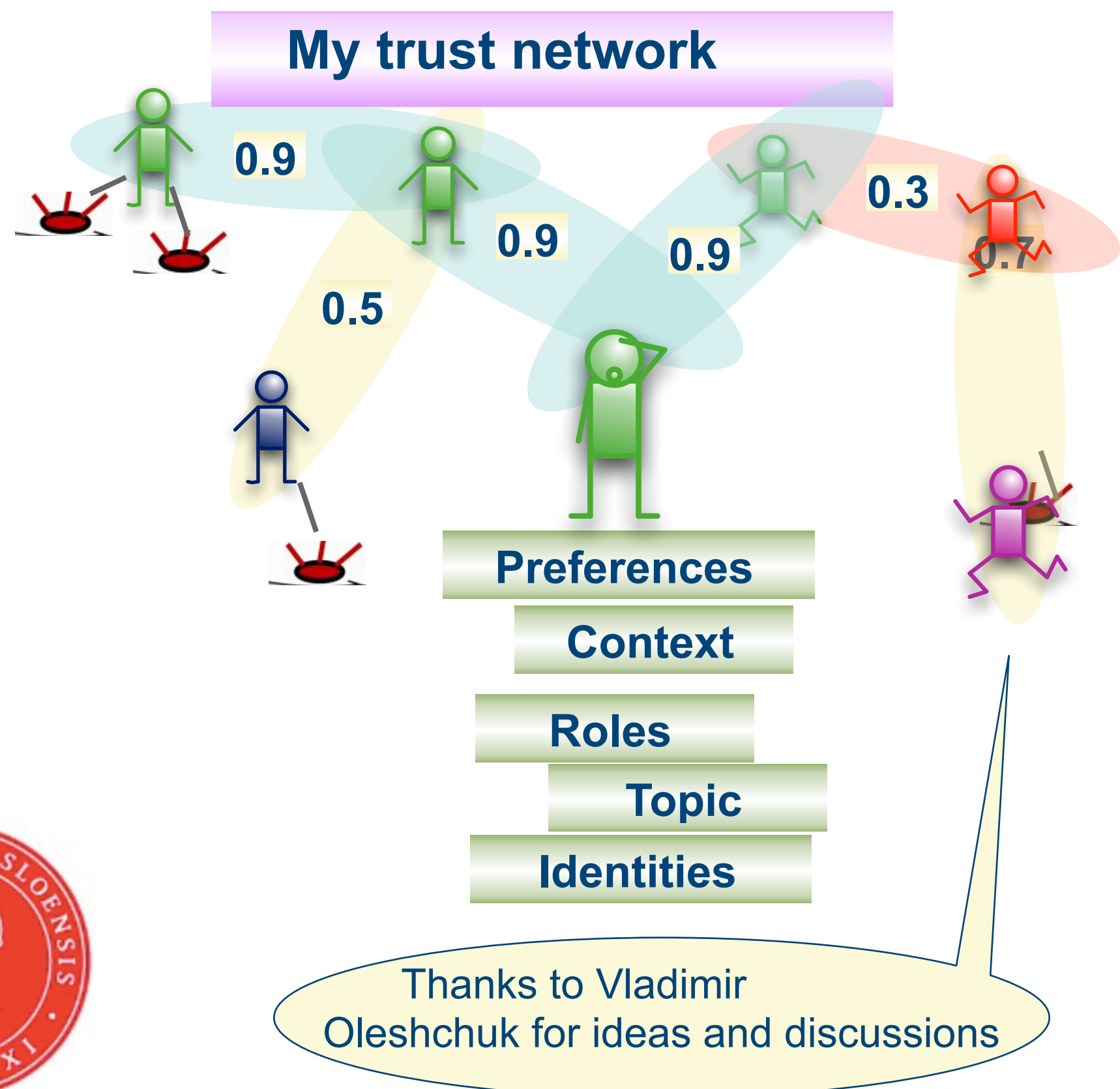 - → security tokens
- Rules inferring access rights
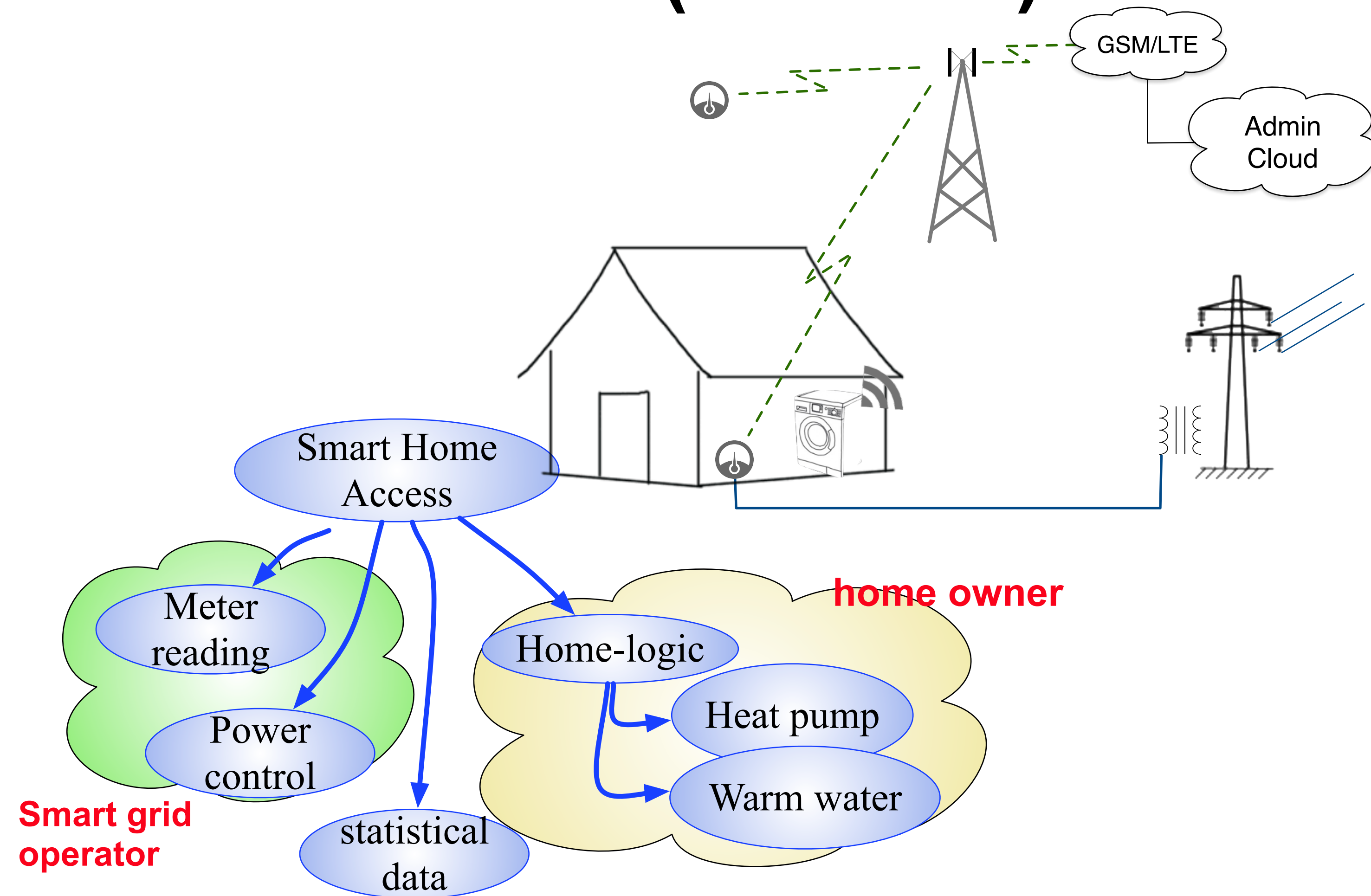
Attributes: roles, access, device, reputation, behaviour, ...

Security and Robustness of Industrie4.0 systems

- "Novel Security Paradigm for IoT"
 - ➡ sensor security need system control

My trust network

0.9
0.9
0.9
0.3
0.7
0.5

Preferences
Context
Roles
Topic
Identities

Thanks to Vladimir Oleshchuk for ideas and discussions

- Tasks
  - ➡ security model for system of systems
  - ➡ measurable security, privacy and robustness
  - ➡ observer capabilities ("digital police")
- Innovation opportunities
  - ➡ tools for "measurable security"
  - ➡ "observer sensors" in novel IoT services
  - ➡ open innovation landscape
    - ‣ Germany: Smart Meters earliest in 2035
    - ‣ USA: "privacy is just an illusion"
    - ‣ InDigO: "we create privacy-aware systems"

Modelling and Programming Systems of Systems

- System of sub-systems of components
  - ➡ (s,p,d) - security, privacy, dependability
 - ➡ measurable system analysis
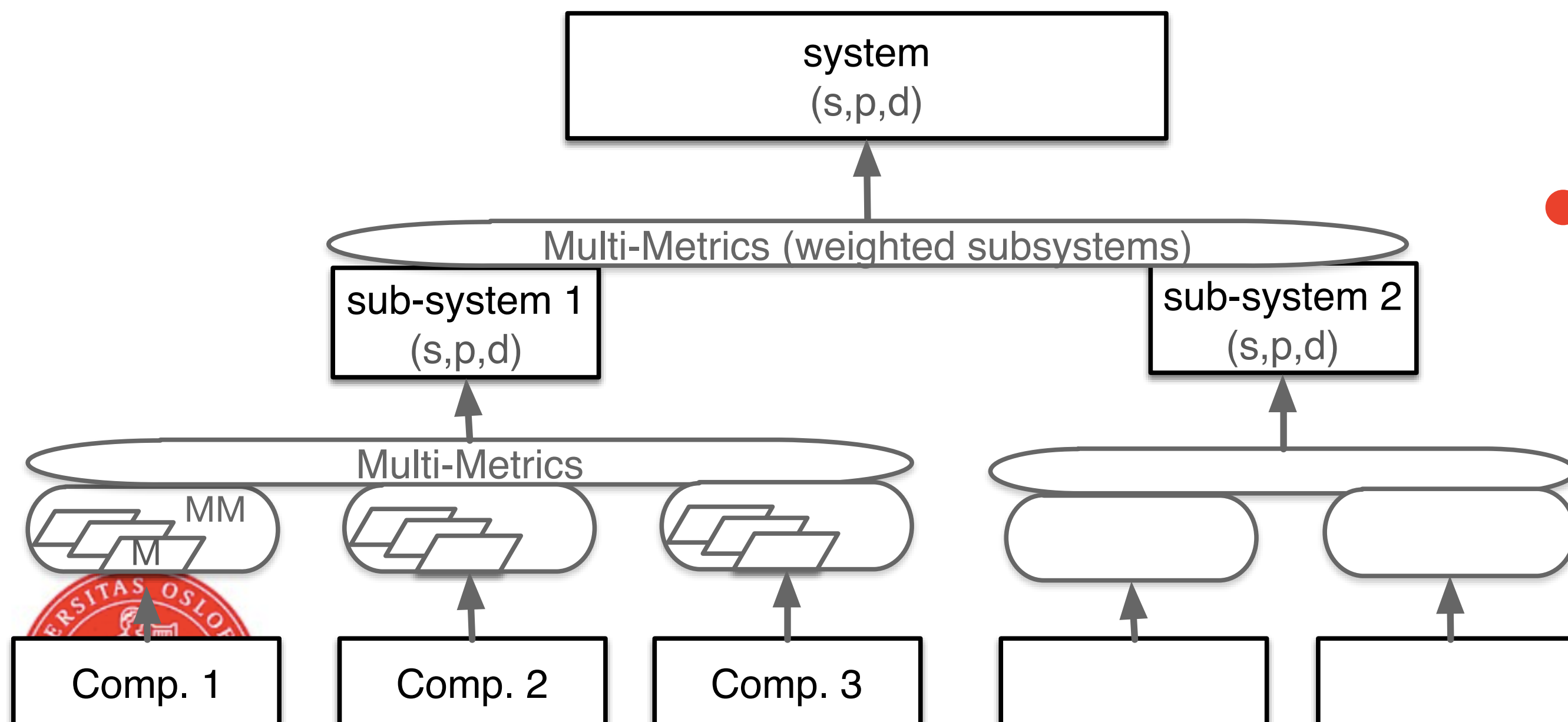
- Fokus
  - ➡ security model for system of systems (with PhD 1)
  - ➡ creating modelling constructs for systems of systems
  - ➡ programming security goals
- Innovation opportunities
  - ➡ tools for testing and analysis
  - ➡ applications in energy and smart homes
  - ➡ seamless integration of technologies

Home infrastructure Communications and Insight

- Distributed equipment
  - ➡ router, TV, mobile,…
  - ➡ authentication
  - ➡ traffic routing
  - ➡ service logics (where, what)
- Collaborative services
  - ➡ owner information
  - ➡ service data
  - ➡ statistics, e.g. urban,…
- Local decisions
  - ➡ knowledge cloud
  - ➡ fog computing

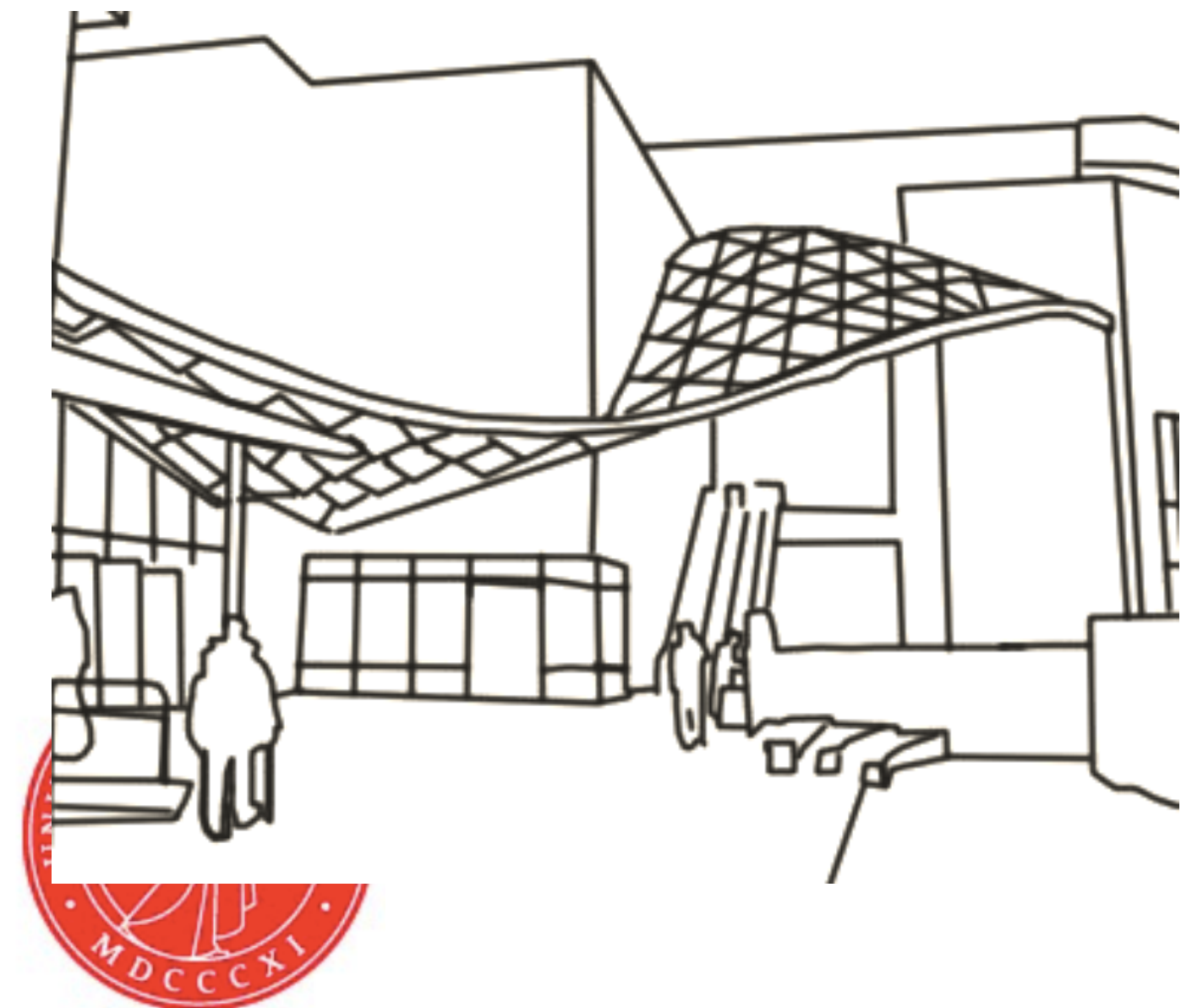**Challenges: Set-up, Connectivity**

eye SaaS

enivest
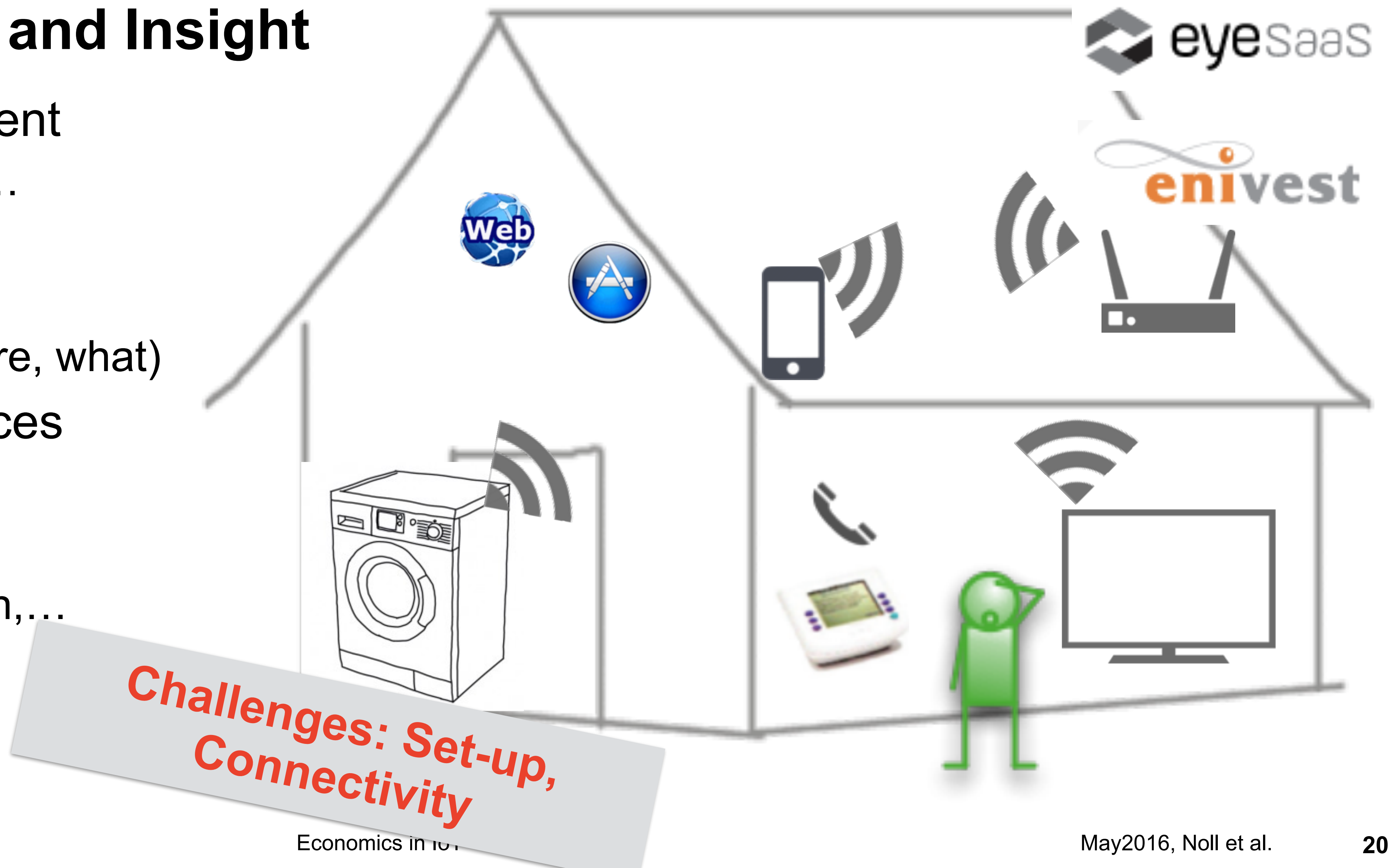
Addressing the challenges of IoT connectivity

Device ownership

- who owns the device
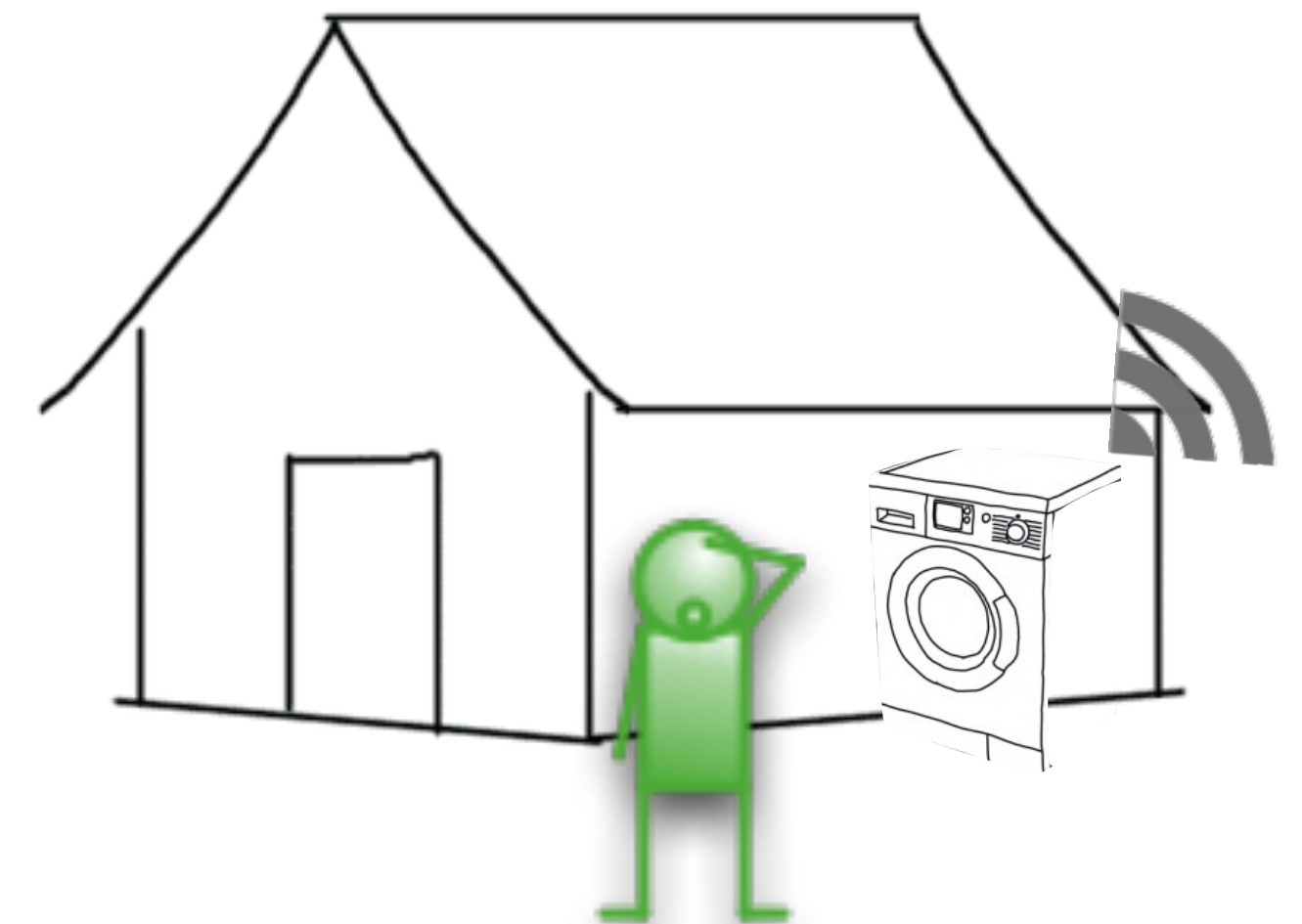- which data are going to whom
  - ➡ maintenance

Easyness Setup

- 1. step ownership
- take control

Scalability

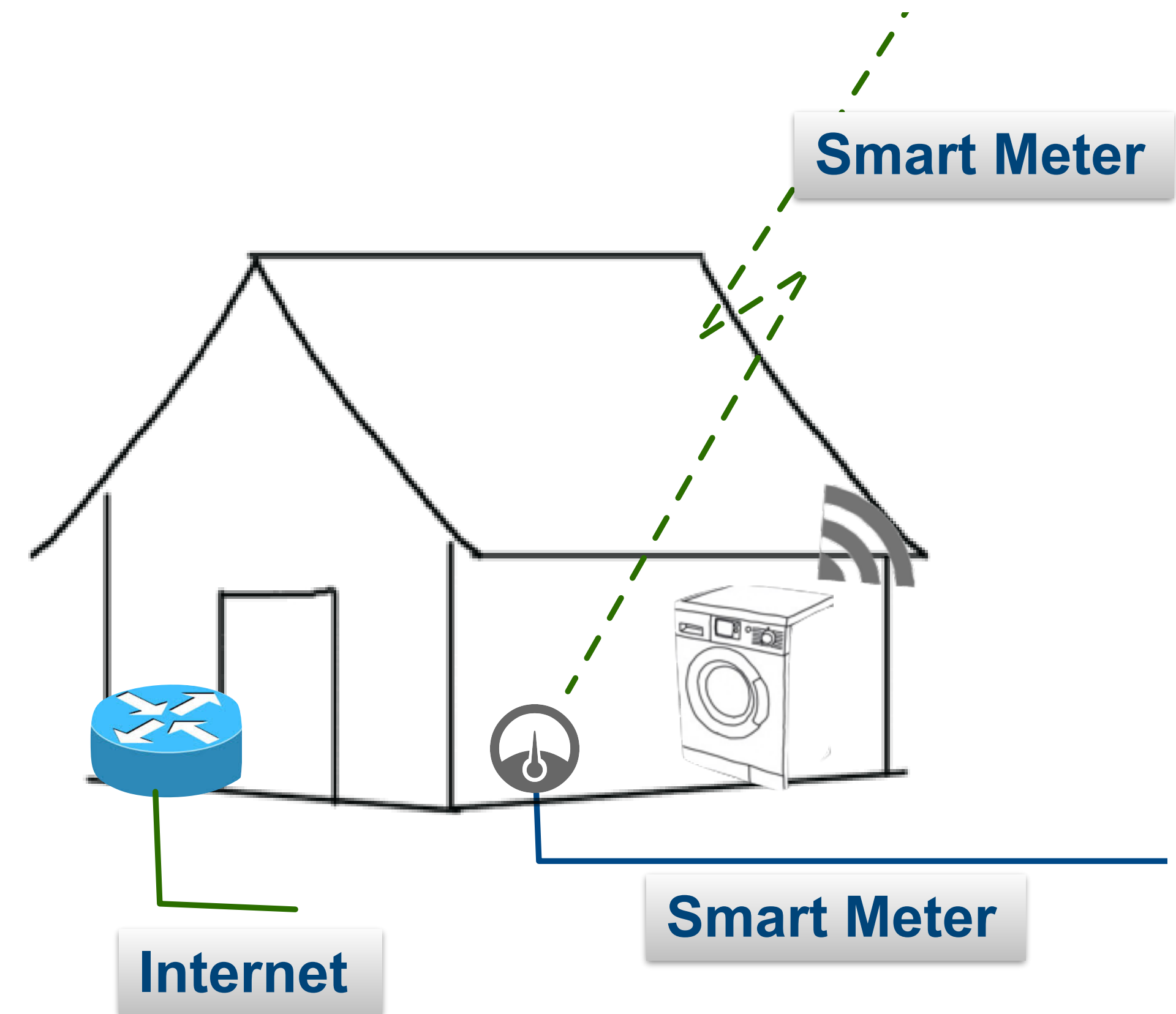- business model for SIM/device not scalable
- free wireless for IoT data

Upcoming Infrastructure

- Smart Meter
  - ➡ read and control
  - ➡ logic?

- Smart Home
  - ➡ intelligent devices
  - ➡ on-demand regulation

- Challenges
  - ➡ Logic: Centralised <—-> Fog
  - ➡ Smart Meter: Information <—> Control
  - ➡ Smart Grid Information <—> Internet Info

Smart Meter

Smart Meter

Internet

WWRF vision for 2017; "7 trillion wireless devices serving 7 billion people by 2017",

The vision of 2026

or

- "Digital and Inclusive Society"
- Networks adopting to service needs
  ➡ Security, privacy, dependability
- "the Road Network Infrastructure"
- Low-capacity Internet
  ➡ free and open access
- Broadband services
  ➡ authenticated access

Digital share of GDP (2015 - 2020)

- Accenture Strategy & Oxford Economics, 2016

- Today: USA, 33% og GDP due to digital

- Financial Services 57% digital
  Business Services 54%
  Communications 47%

- 22% of global retail from digital,
  28% in health,
  20% in consumer goods

- digital achievements: *technology, skills, accelerators*

Figure 1. Country-by-country digital share of gross domestic product (2015 and 2020) showing Compound Annual Growth Rate under optimized scenario* (right hand axis)
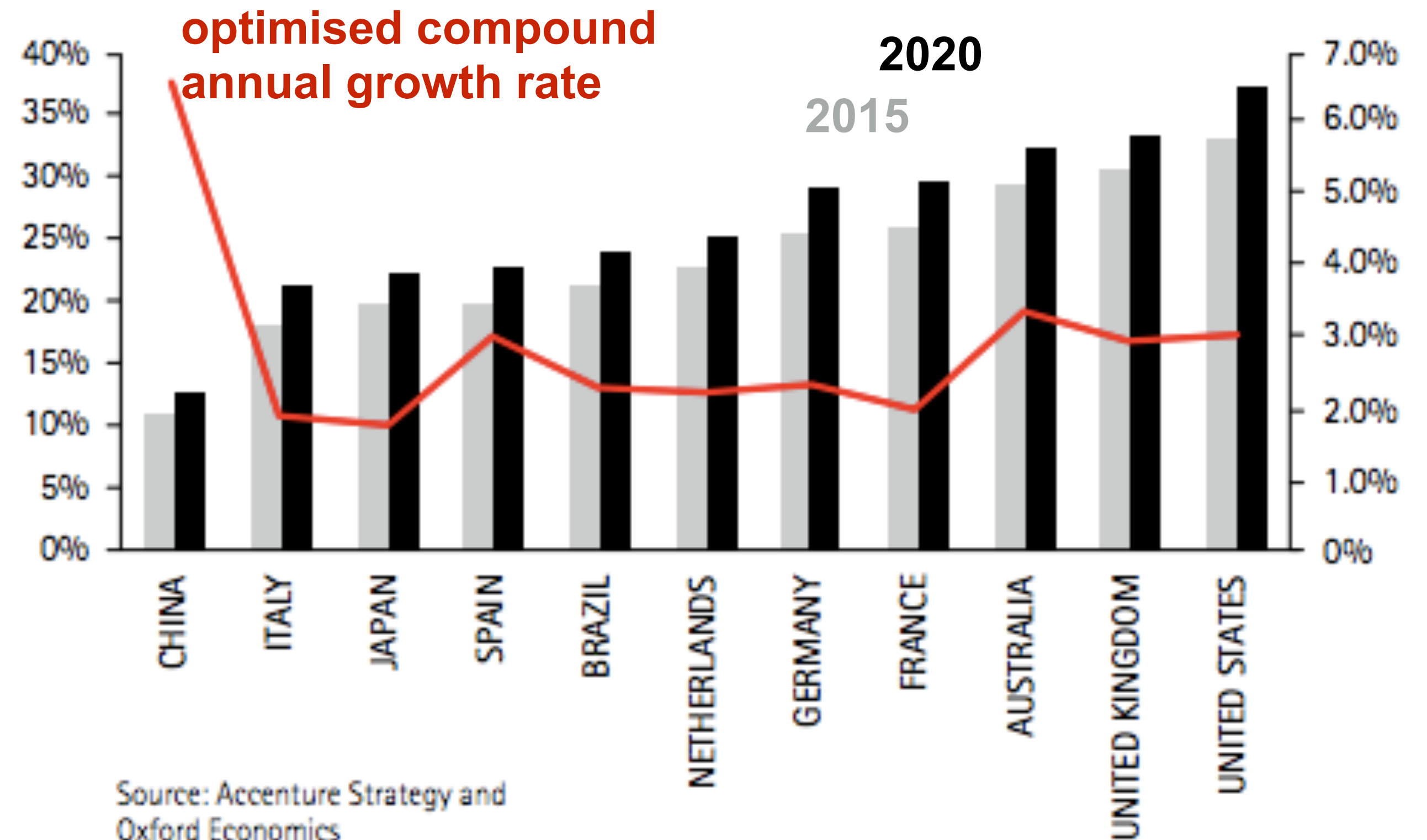
Source: Accenture Strategy and Oxford Economics
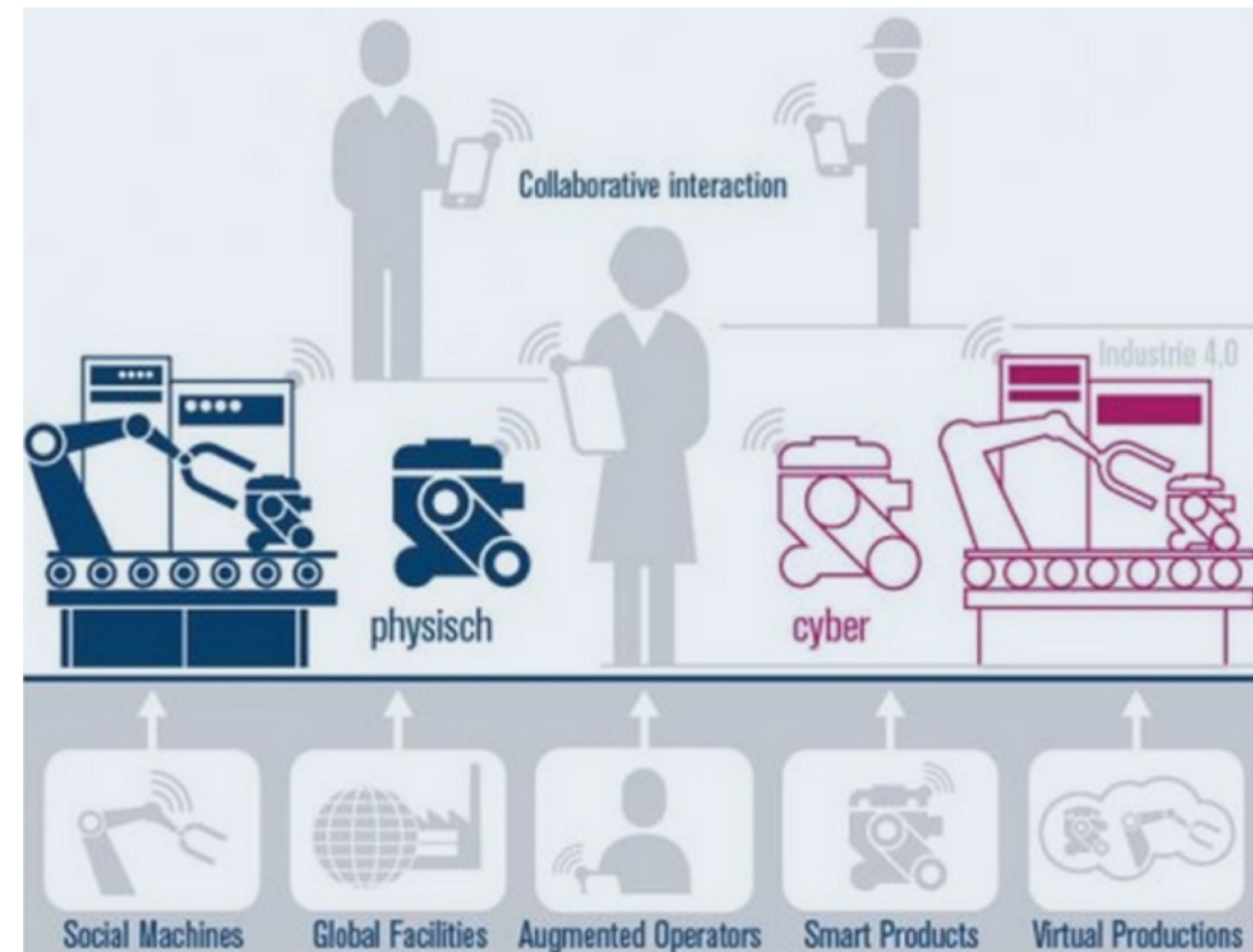
[Source:Accenture, "Digital Disruption Growth" 2016]

Background: Digitalisation of Industry

- EU has introduced[1] Industrie4.0
  - ➡ digital innovation hubs,
  - ➡ leadership in digital platforms,
  - ➡ closing the digital divide gap
  - ➡ providing framework conditions
- Norwegian Government has established[2] "Klyngene som omstillingsmotorer" (Sep2015)
  - ➡ NCE Smart Energy Markets on "**Digitalisation of Industry**"
  - NCE Systems Engineering på Kongsberg og NCE Raufoss on Productivity and Innovation

Source: Trumpf / Forschungsunion
Wirtschaft & Wissenschaft

[1] http://europa.eu/rapid/press-release_SPEECH-15-4772_en.htm
[2] http://abelia.no/innovasjon/klyngene-skal-omstille-norge-article3563-135.html

May2016, Noll et al.   25

IoT expected impact

- Smart home appliances, "wearables", smart metering, autonomous vehicles,…

- 10 billion (2013) -> 19 - 40 billion (2019)

- total global impact: US$ 2.7 - 14.4 trillion by 2025

- **~3/4** of devices from IoT++ ~1/4 from tablet, mobile,…
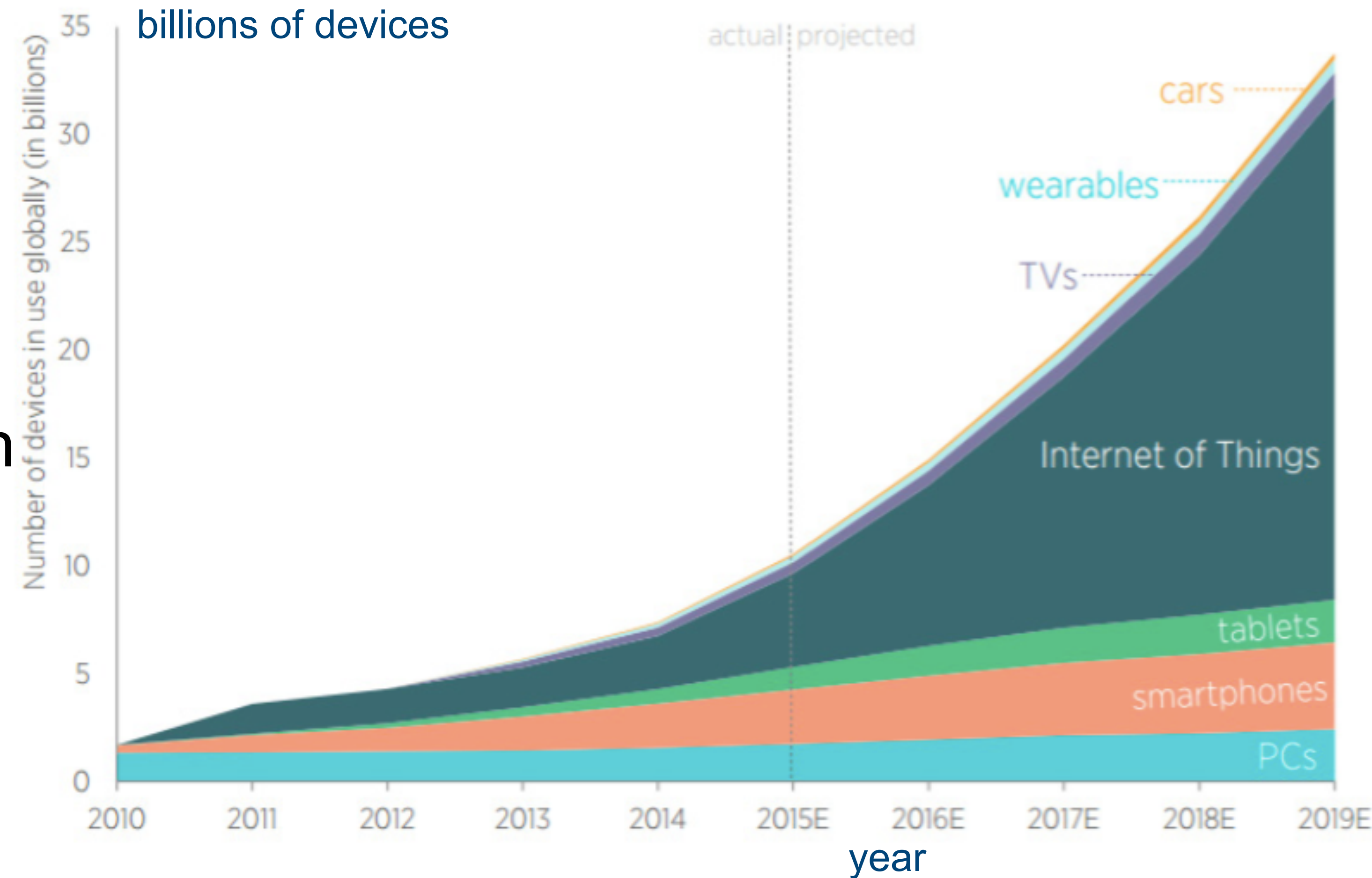
Source: John Greenough, "The Internet of Everything 2015," *Business Insider Intelligence*. Produced by Adam Thierer and Andrea Castillo, Mercatus Center at George Mason University, 2015.

Digitalisation of the Society

A DIGITAL SOCIETY IS MADE OF
DIGITALLY–SKILLED CITIZENS

OF
EUROPEANS 40%
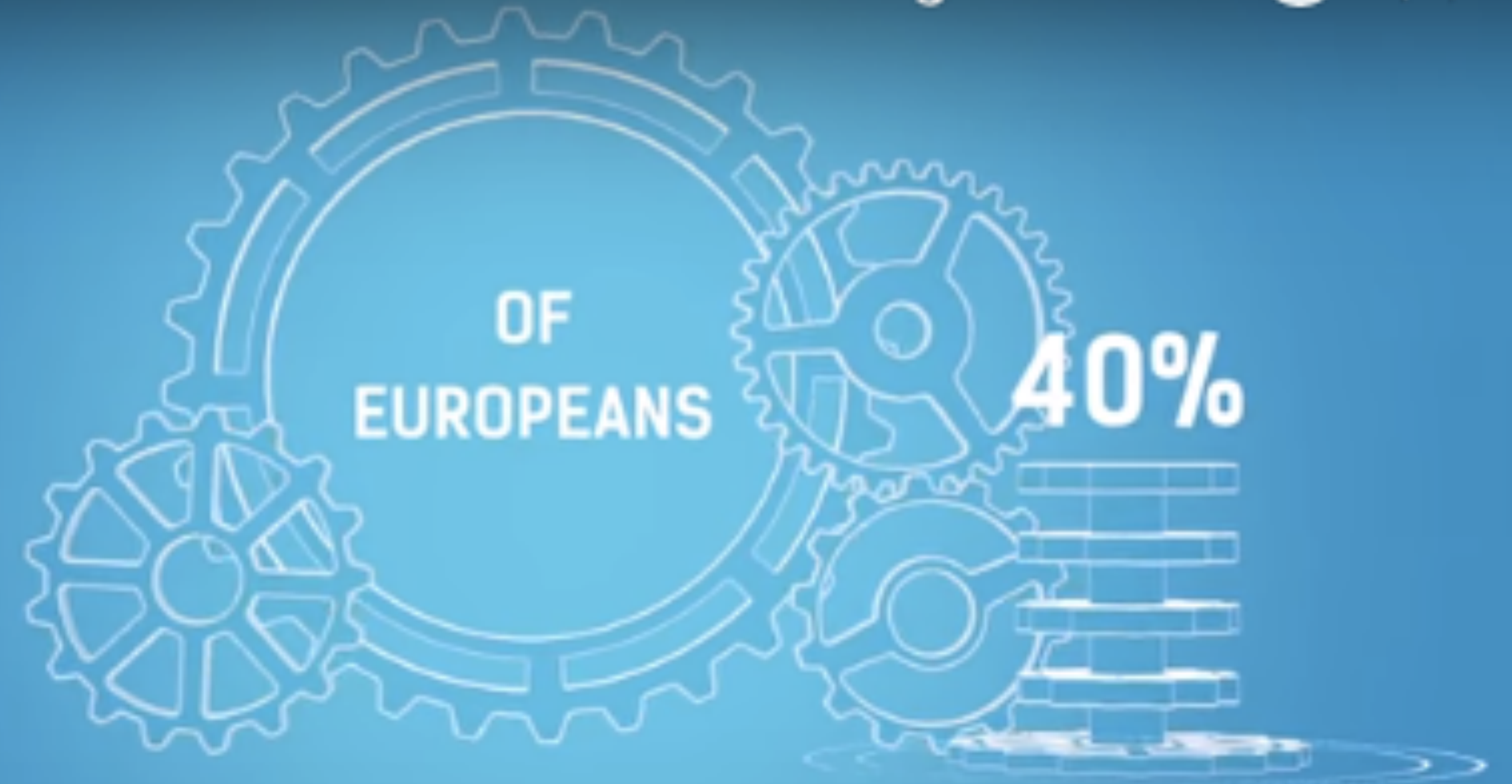
DON'T EVEN HAVE BASIC DIGITAL SKILLS

Source: EU commission(?)

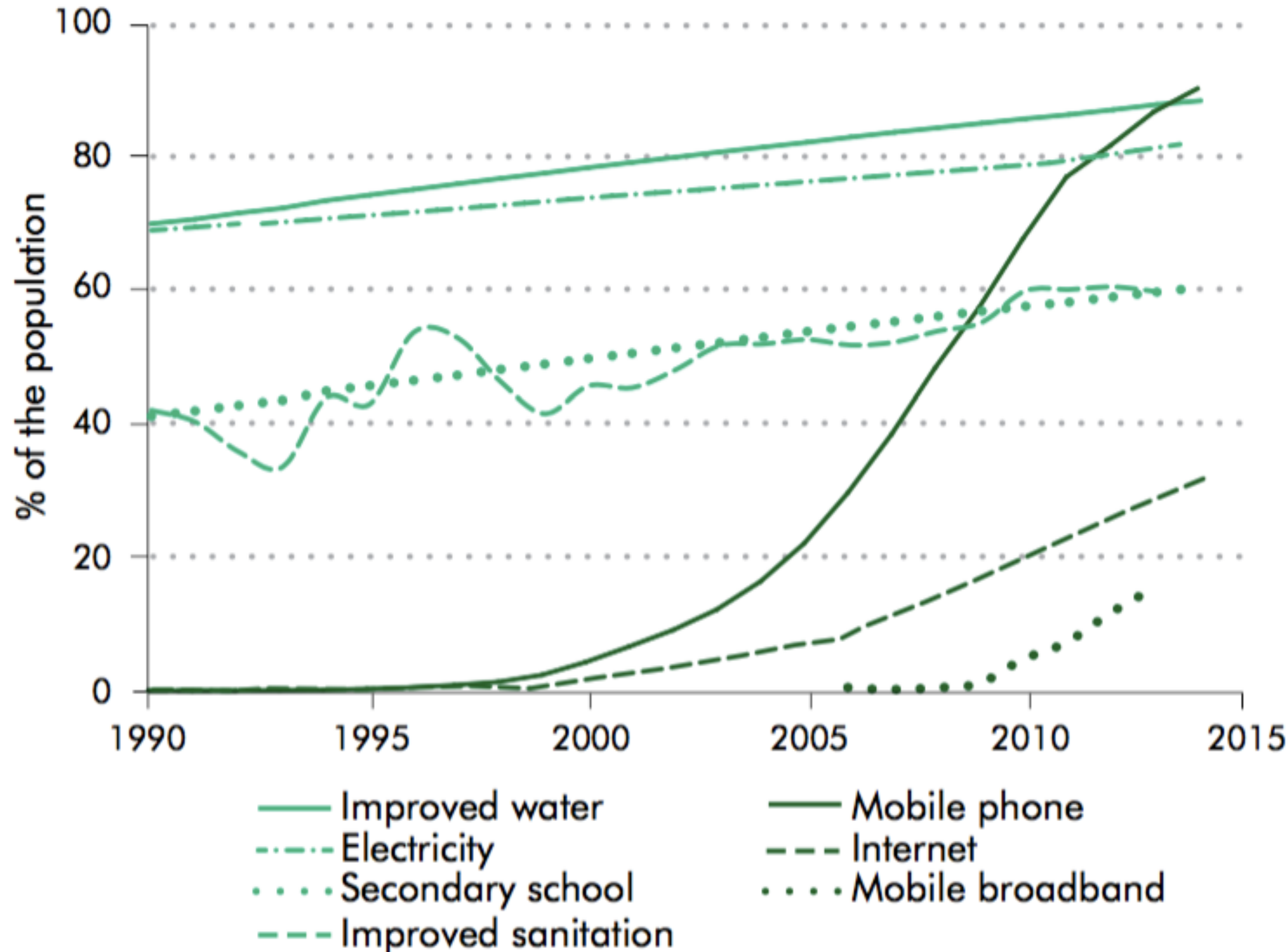# Internet is a basic human right

- Is Internet access and online freedom of expression a basic human right?

- "All people should be allowed to connect to and express themselves freely on the Internet."

- The United Nations' Human Rights Council unanimously backed that notion in a resolution on 5July2012. All 47 members of the Human Rights Council including China and Cuba signed the resolution.

a. Digital technologies are spreading rapidly in developing countries

Legend:
- —— Improved water
- —·—· Electricity
- ·····Secondary school
- — — — Improved sanitation
- —— Mobile phone
- — — Internet
- ·· ·· Mobile broadband

[Source: World Development Report 2016]

Connectivity & Affordability

- Mobile supported development
- Affordability (costs of data)
- industrial perspective (Ind4.0)

The Unconnected Market Landscape

Unique Mobile Internet Users

Population 15+ (bn)	Total		BMI	NMI	Unconnected	
Developed World	0.9		0.6	0.1	0.3	
Developing World	4.3		1.0	0.8	2.5	3.3
Total	5.2		1.6	0.9	2.8	

Penetration 15+ (%)	Total		BMI	NMI	Unconnected	
Developed World	100%		64%		27%	
Developing World	100%		23%	18%	59%	77%
Total	100%		30%	17%	53%	

Source: GSMA Intelligence; figures reflect position at end of 2014
BMI = Broadband Mobile Internet (3G/4G); NMI = Narrowband Mobile Internet (<3G)

no use

Access + Need/desire + Ability

"I have never been on the Internet.
I don't know what you are talking about."
– Rickshaw driver, Dhaka, Bangladesh

limited use

Understanding of what's possible + Ability to navigate and control + Ability to critically assess content

"I only use Facebook and WhatsApp."
– Student, Nairobi, Kenya

leverage

Desire to use authoring tools + Ability to use existing platforms + Inspiration & Confidence

"Internet is my teacher.
I learn everything on YouTube."
– Painter, Tamil Nadu, India

creation

"I'm currently learning python and HTML so I can
make a website for my parents' business."
– Student, Pune, India

[Source: GSMA, Nov2015]

Poverty and stability

- >2 billion people with less than 3 US$/month, ~1 billion people with less than 1.5 US$/month [World Bank, 2016]

- 80% GSM coverage, but only 20% mobile broadband (0.4% cable broadband)

- "Everything is connected": social, politics, climate and economy

- "money is not the decisive faktor" [@Civita]

      "security/rights, peace and development"


Number of people in extreme poverty (millions)
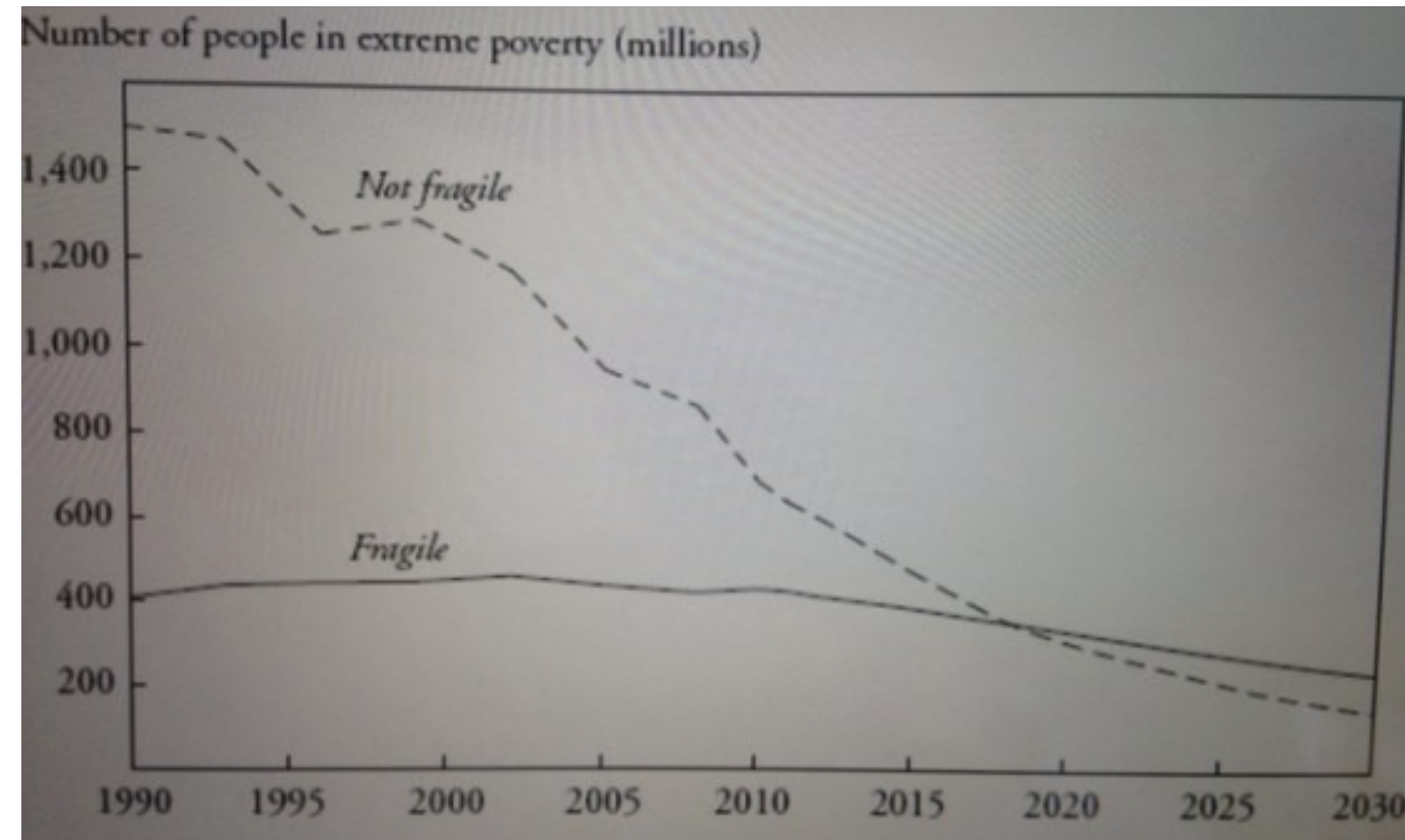
[source: Nikolai Hegertun, Civita_10_2016 report]

Background

- Internet provision to various parts of DRC
  - ➡ operations since 2011
- Connection to a.o. University of Lisala
- Experiences from Internet provision
  - ➡ Expensive access
  - ➡ Requirement for self-sustainable infrastructure

- Developed network infrastructure
  - ➡ low-cost establishment of local hot-spots
  - ➡ remote core infrastructure (in Norway)
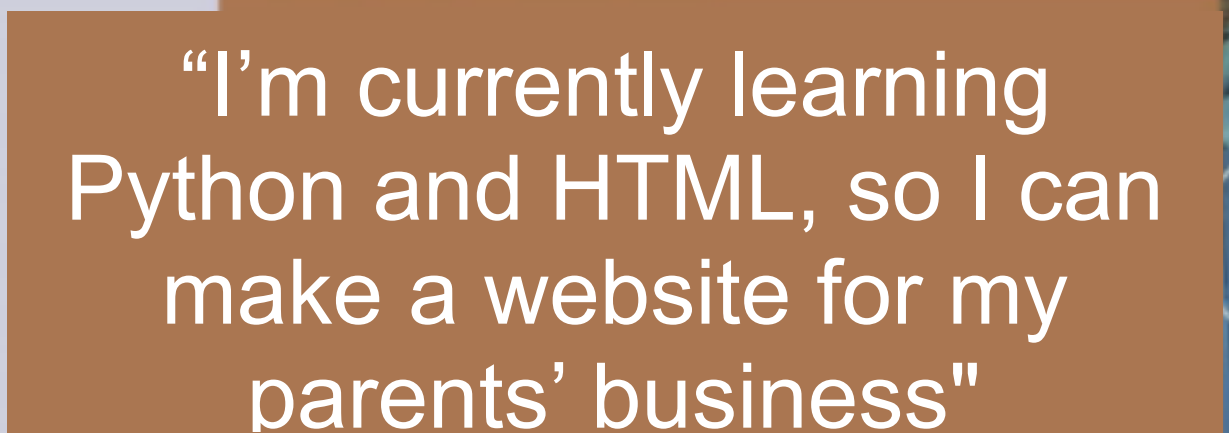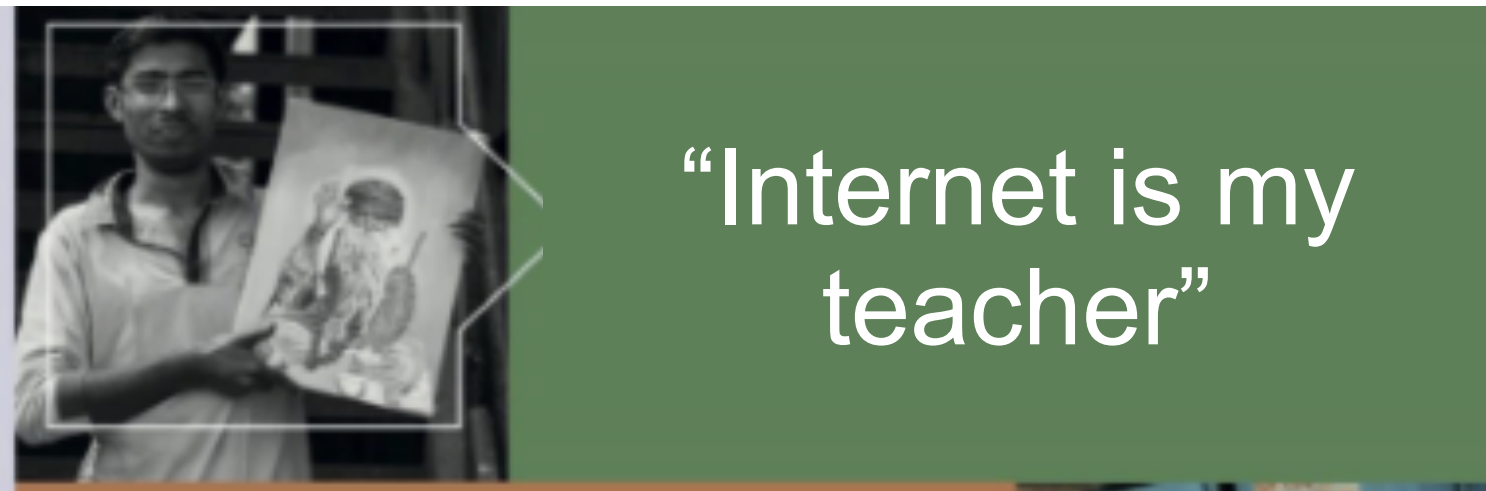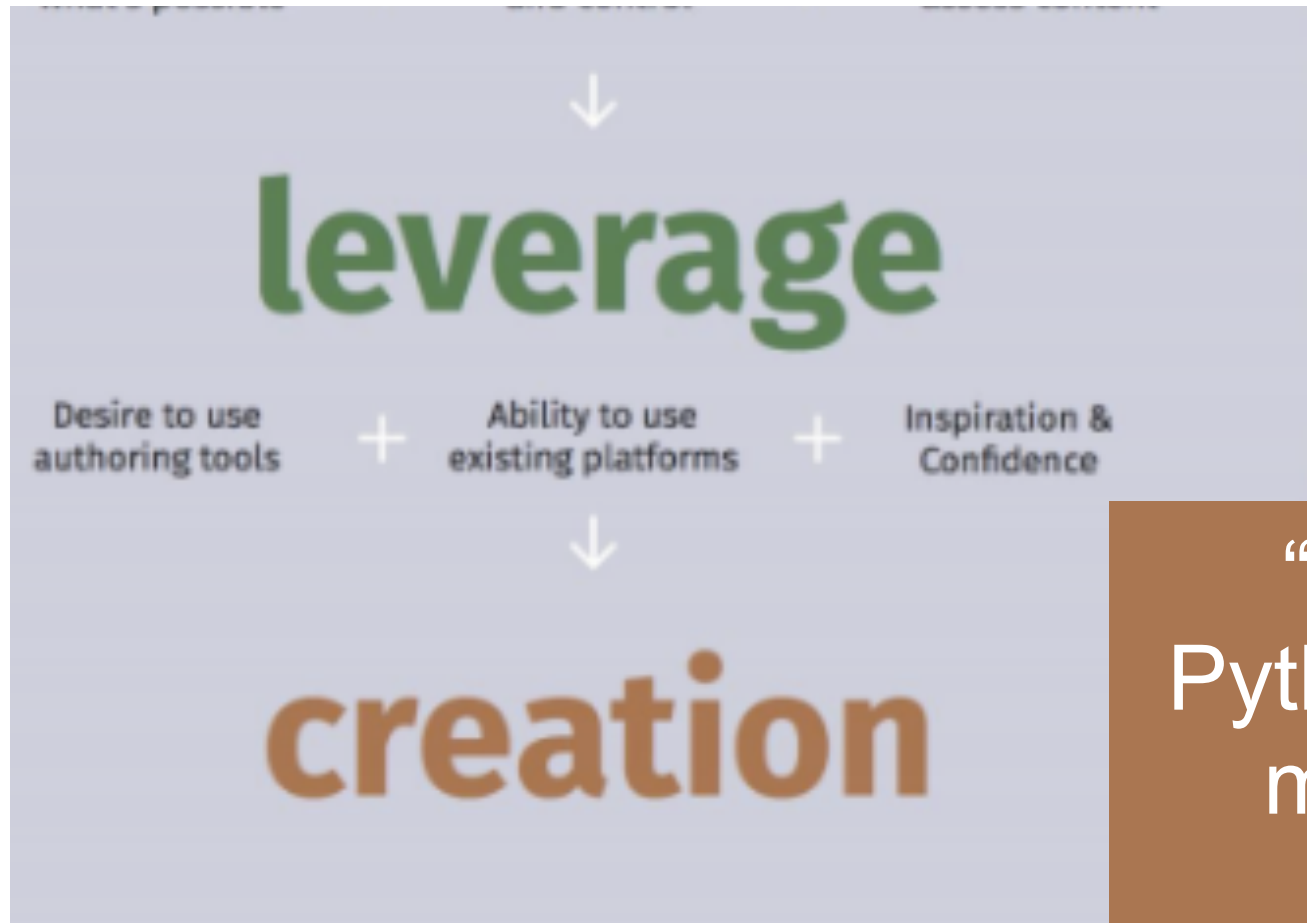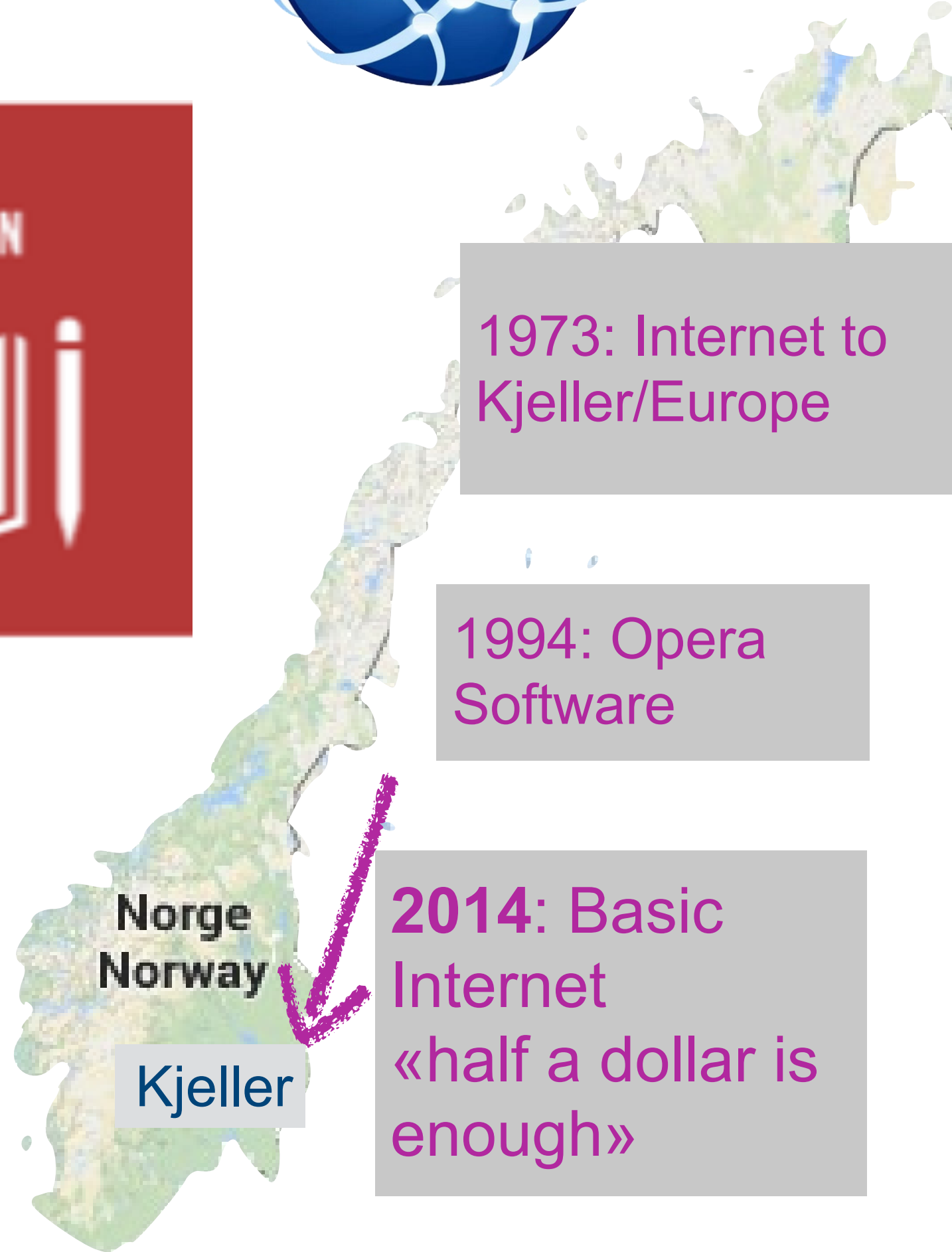 - ➡ based on experiences from Internet history at UiO/UNIK
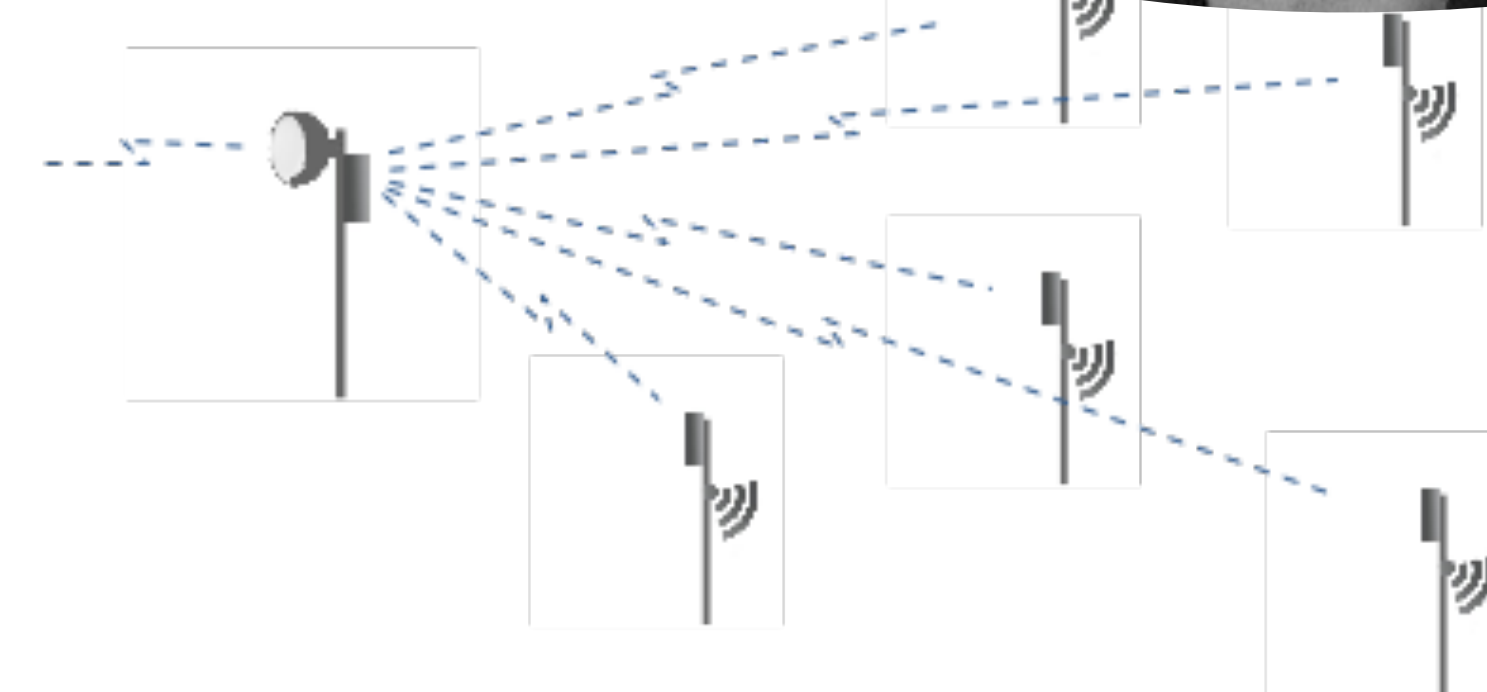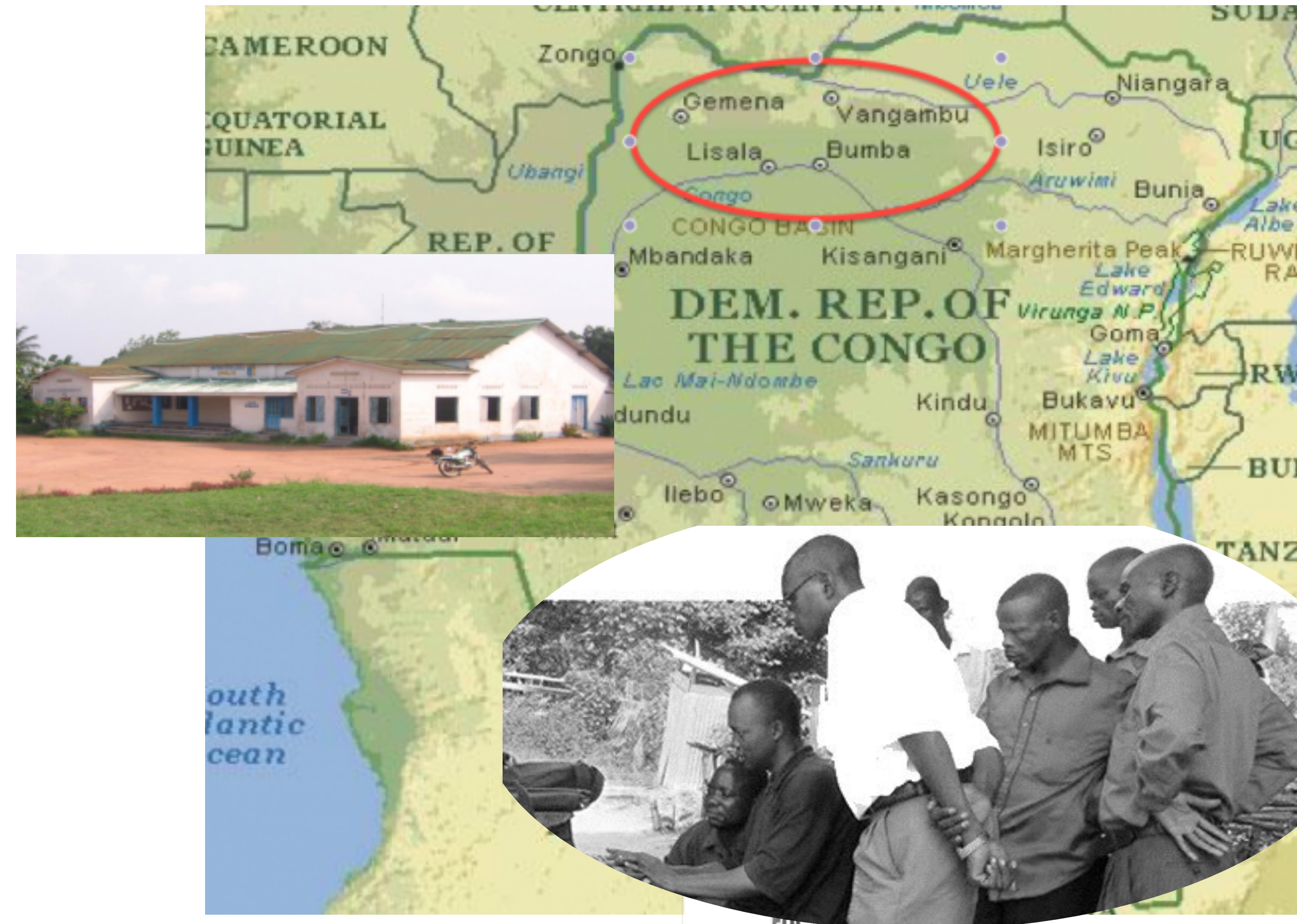
Motivation:
"Need to close the digital gap"

- The Global Goals:
  Norway is the secretariat for
  Quality Education

- Internet history
  - 1973 Europe through Kjeller
  - 1994 Opera Software
  - 2014 Basic Internet Foundation

Basic Internet

THE GLOBAL GOALS
For Sustainable Development

4 QUALITY EDUCATION

1973: Internet to Kjeller/Europe

1994: Opera Software

2014: Basic Internet «half a dollar is enough»

leverage

Desire to use authoring tools + Ability to use existing platforms + Inspiration & Confidence

creation

"Internet is my teacher"

"I'm currently learning Python and HTML, so I can make a website for my parents' business"

Norge Norway

Kjeller

Conclusions

- Internet of Things (IoT) is a game changer
  - ➡ Unfair advantage in the Nordics
  - ➡ Converting Trust into IoT
- Collaborative approach for a (more) secure society
  - ➡ partnership for secure and privacy-aware applications
  - ➡ heterogeneous infrastructure integration
- Vision 2026
  - ➡ networks adapting to service needs
  - ➡ free and open "low-capacity Internet"
  - "peage" for speed and service quality