



UiO : **Department of Technology Systems**
University of Oslo

Guest Lecture - MUHAS, 27Feb2020, Dar es Salaam

Digital transformation, Internet of Things (IoT) and Industry 4.0

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“The last time I was connected by wire was at birth”

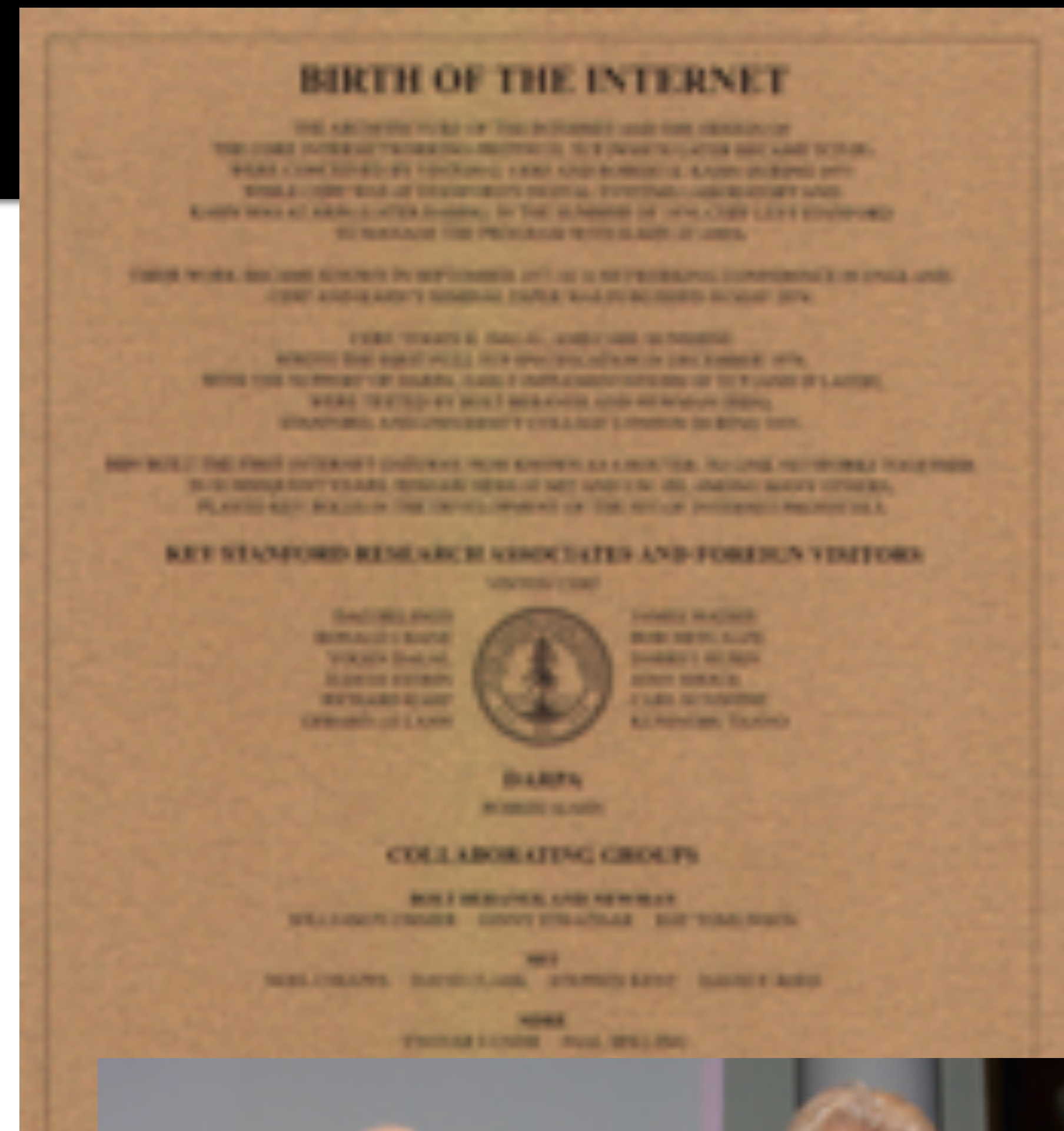
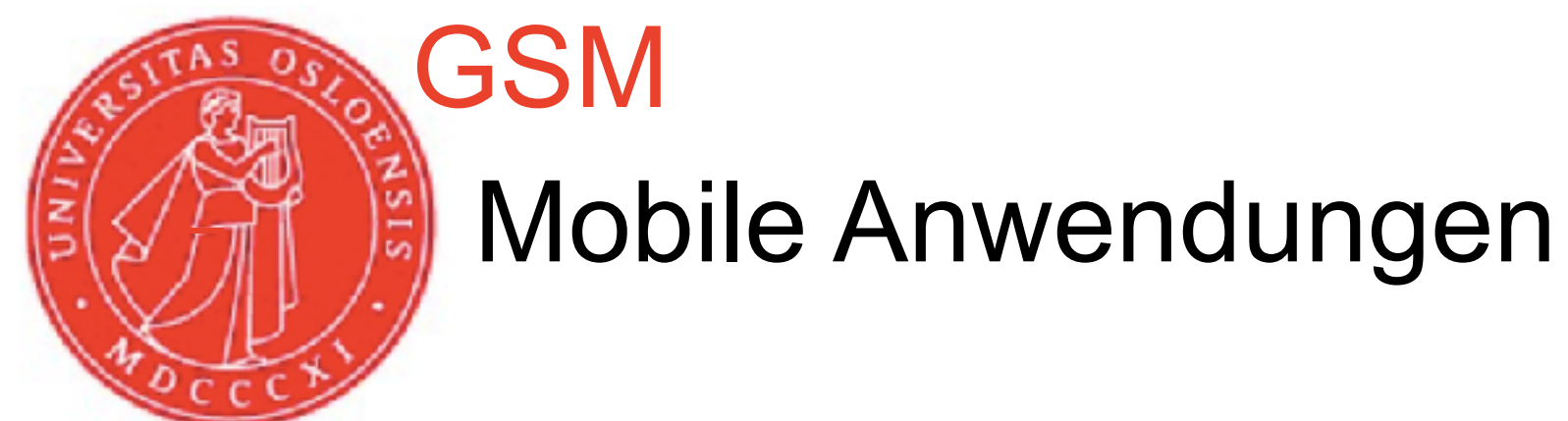
- Information Technology
 - ➔ From 1G to 5G (6G)
 - ➔ From Internet to IoT to Industry 4.0
- Grand challenges
 - ➔ Societal Security,
 - ➔ Resources, Climate
 - ➔ “The Divide”
- IoT and automated systems
 - ➔ Automation and societal aspects
- Sustainable Innovation
 - ➔ Digital Inclusion
 - ➔ Return on SDGs (RoSDGs)

Conclusions



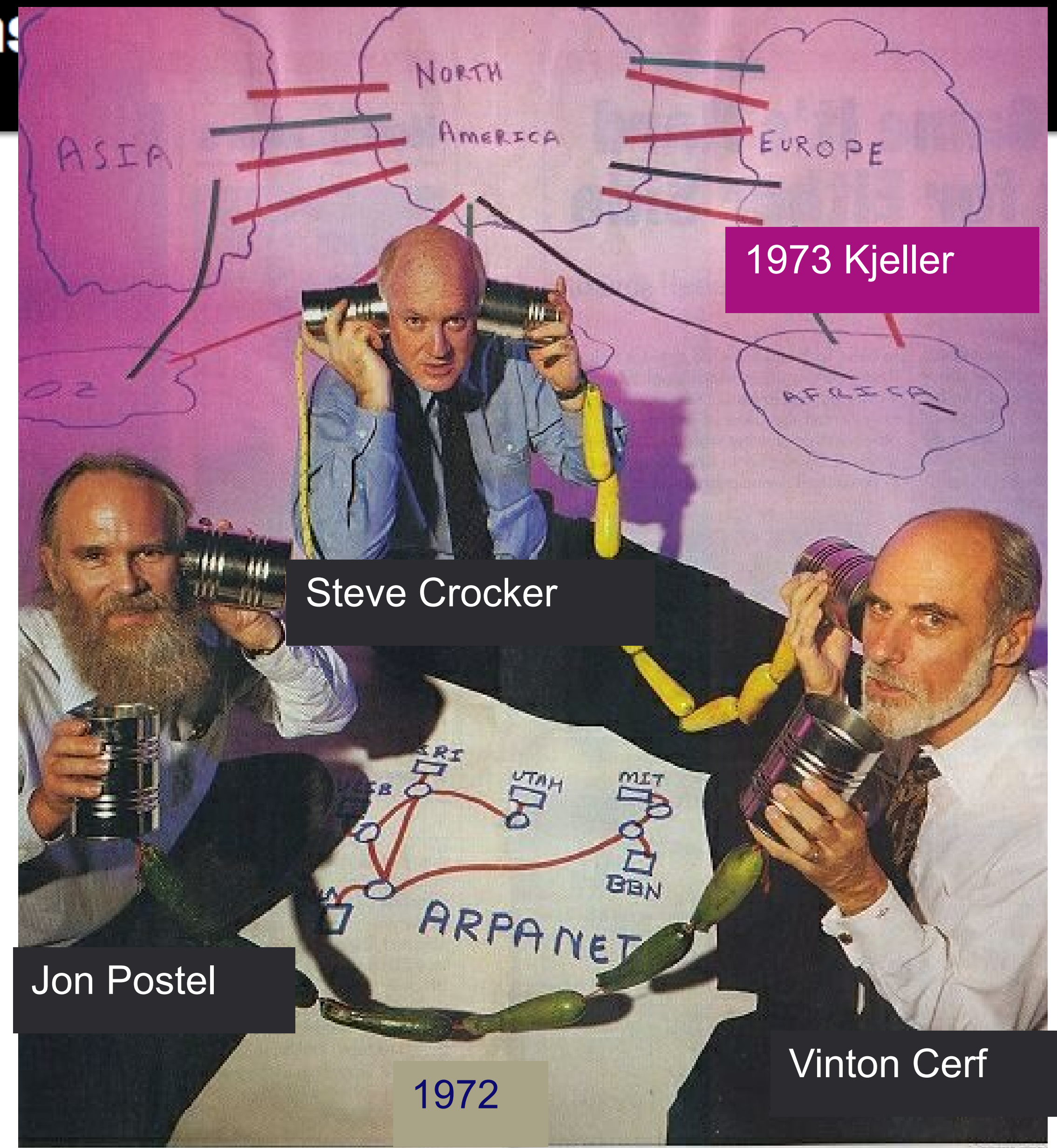
The Internet and the Nordics

- First Arpanet Connection to **Kjeller** (June 1973)
 - (except Hawai)
- List_of_Internet_pioneers [Wikipedia]
 - Yngvar Lundh, **Paal Spilling**
- Anwendungsentwicklung
 - .php, OpenSource, Linux, Skype, Spotify
 - **OperaSoftware**, FAST Search
 - Nokia, Ericsson
 - **Telenor**, TeliaSonera
- Mobiles Internet:



the Internet

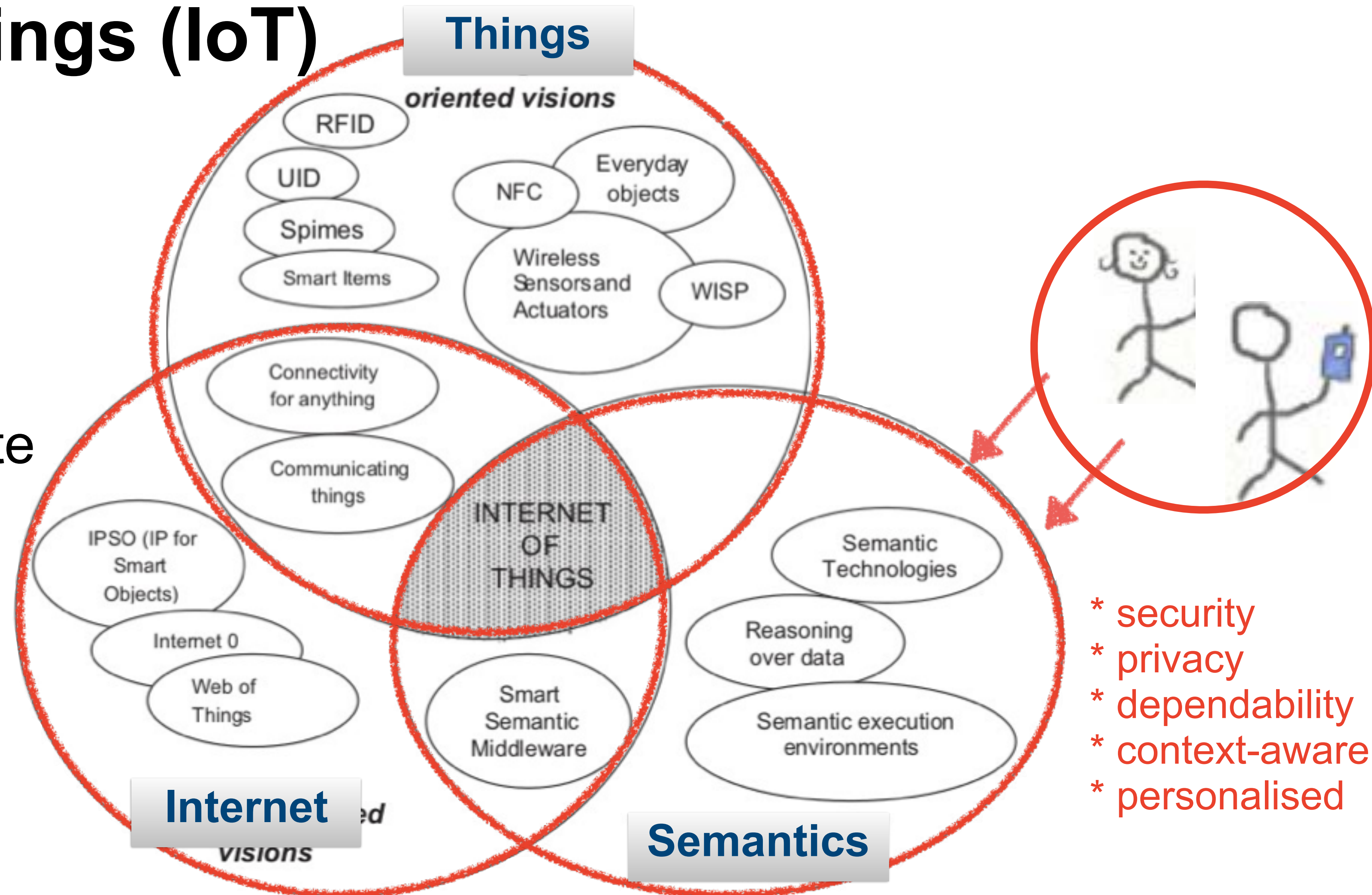
- uses Internet Protocol TCP/IP
 - ➔ http(s), (s)ftp, smtp, ssh
- Applications like
 - ➔ World Wide Web
 - ➔ electronic mail,
 - ➔ telephony
 - ➔ file sharing



Source: <http://www.michaelkaul.de/History/history.html>

The Internet of Things (IoT)

- IoT =
 - Things +
 - **Internet** +
 - Semantics
- Things that communicate
 - with Things: computer,
 - understand the meaning,
 - takes own decisions



Note:

Classification according to

a) distance

b) capacity (kbit/s, Mbit/s)

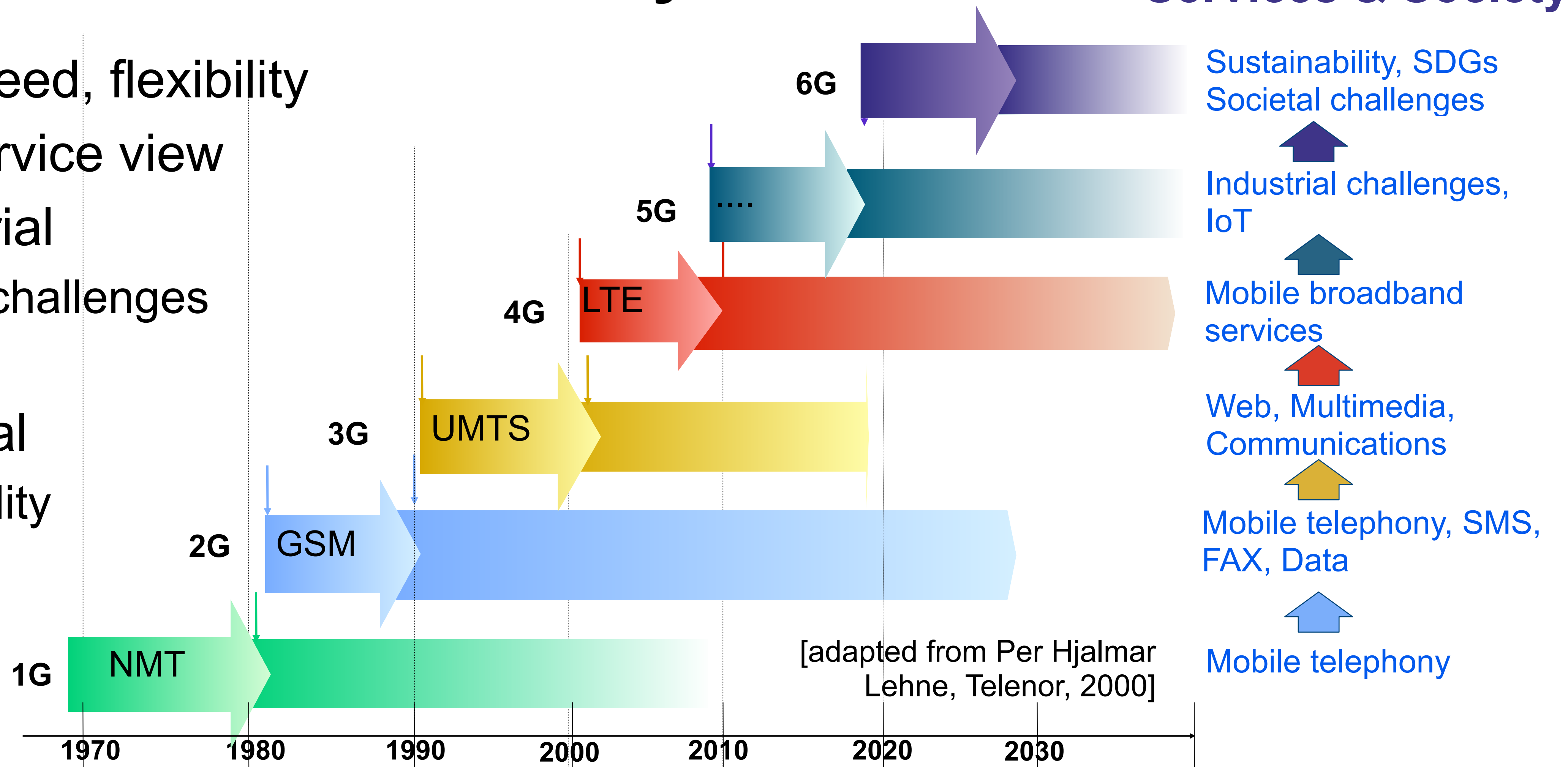
Internet connectivity

- Wired
 - ➔ Fibre
 - ➔ ADSL/VDSL
 - ➔ Broadband
- Wireless
 - ➔ Mobile (3G, 4G, 5G)
 - ➔ Wifi (802.11...)
 - ➔ Powerline communication
- Sensor Communications
 - ➔ Bluetooth
 - ➔ Ultra Wide Band
 - ➔ NB-IoT, LTE-M (eMTC)
- RFID, NFC



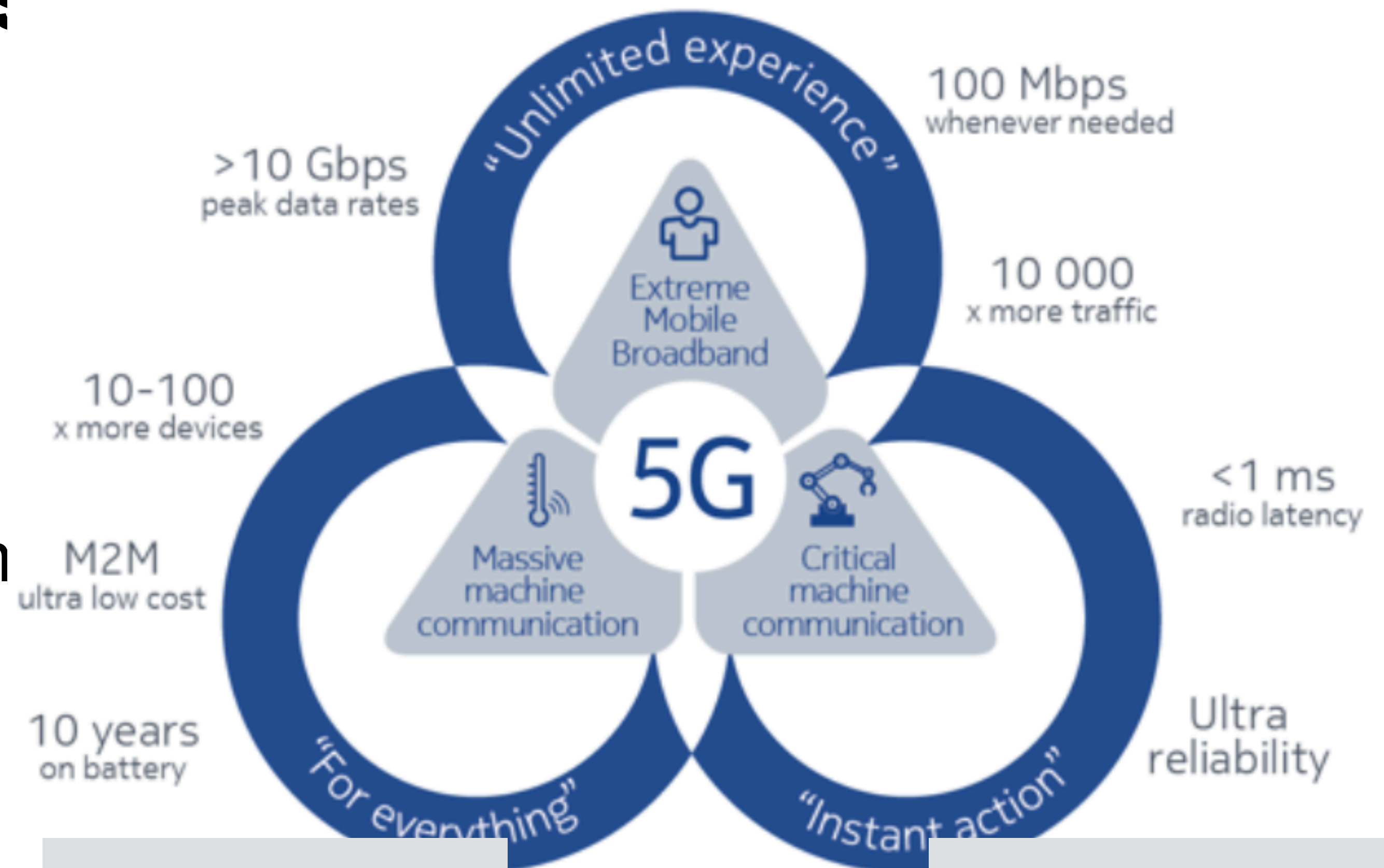
6G: Digitisation of the Society

- 1G-3G: Speed, flexibility
- 3G-4G: Service view
- 5G: Industrial
 - ➔ Business challenges
 - ➔ ownership
- 6G: Societal
 - ➔ sustainability



5G: Industrial Challenges

- enhances Mobile Broadband
- massive IoT
- ultra Reliable, Low Latency communication



mIoT

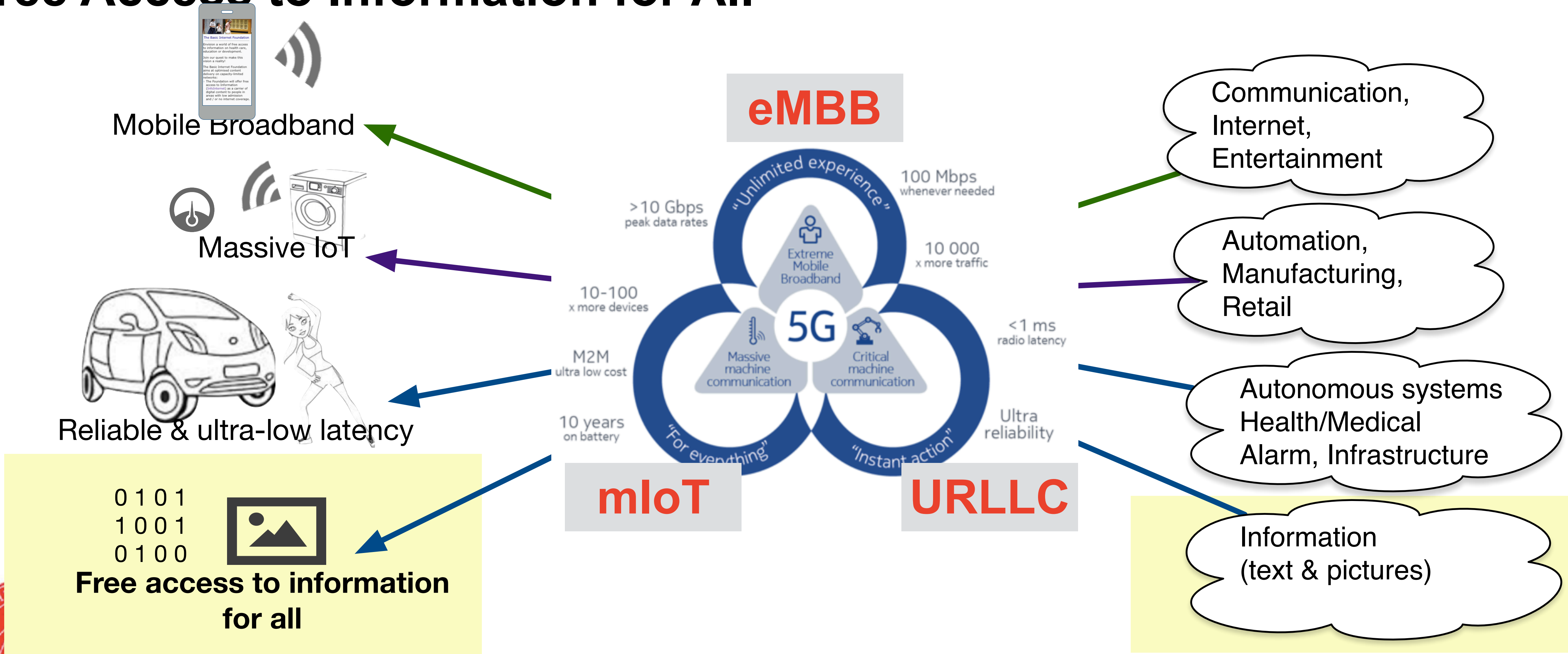
URLLC

[source: Nokia

]

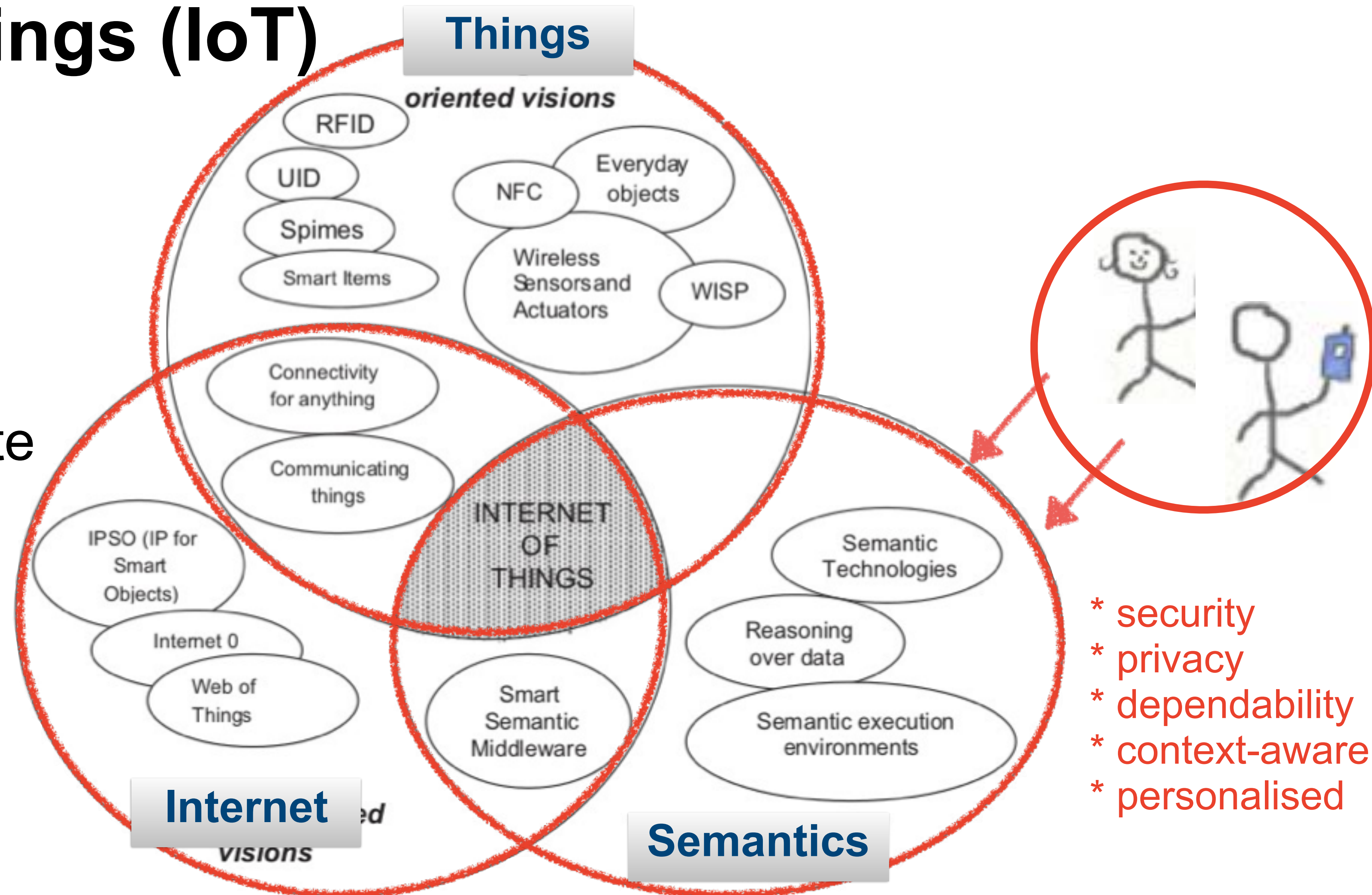


5G network slicing for Free Access to Information for All



The Internet of Things (IoT)

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 - ➔ Internet +
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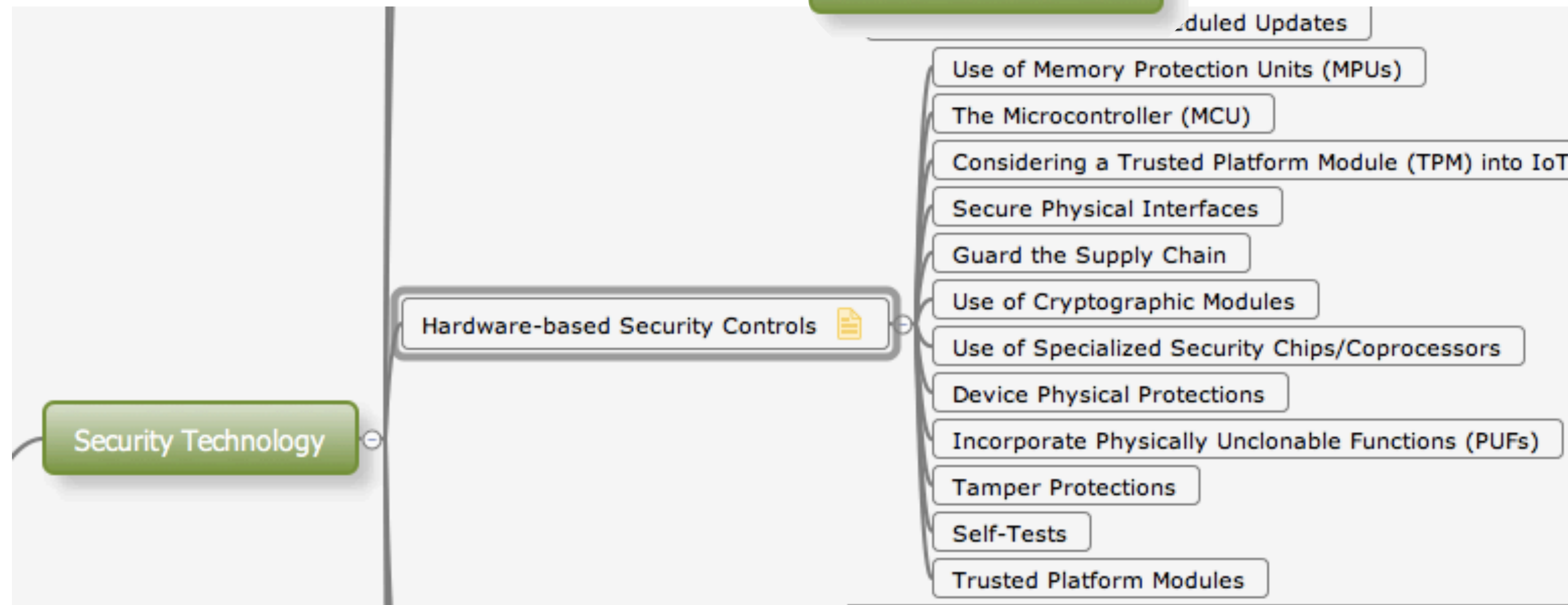
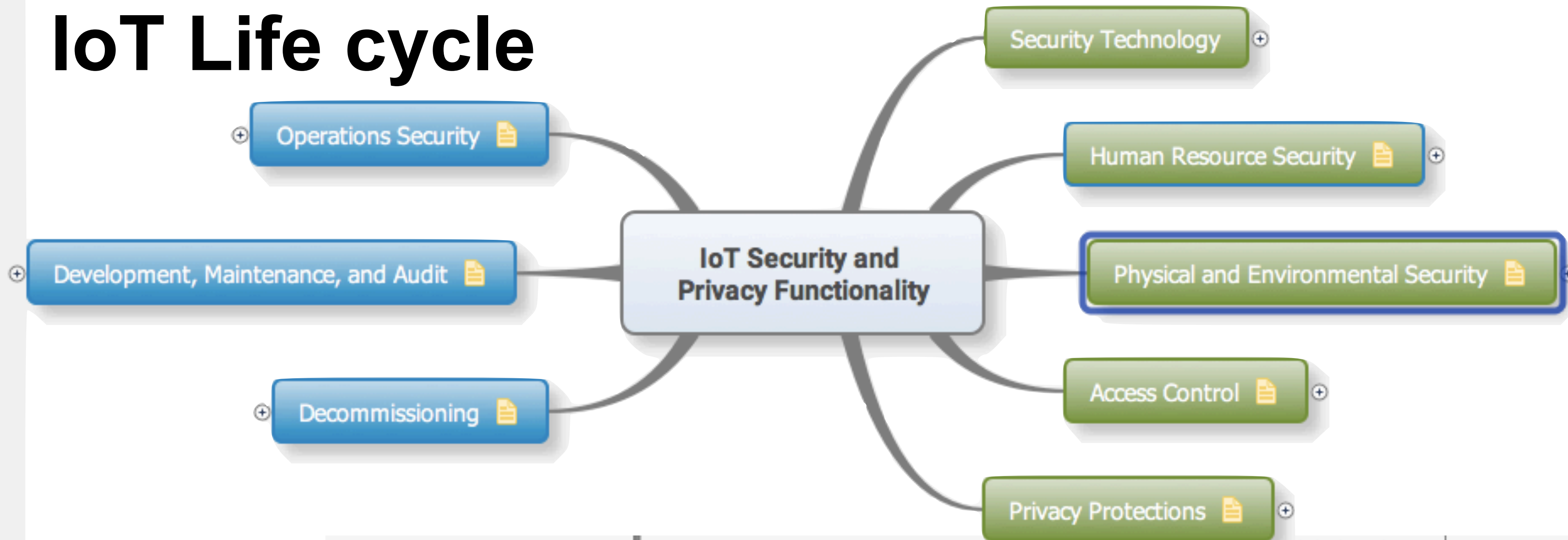


IoT area 2 (“The Things”)

- **Integration of Sensors on pocket comp**
 - ➔ monitoring of a real-life wireless installation,
 - ➔ network impact of services and applications w
 - ➔ IoT energy system monitoring
- **IoT gateway**
 - ➔ Raspberry PI installation
 - ➔ Cloud integration (edge computing)



IoT Life cycle



References:

https://www.owasp.org/index.php/IoT_Security_Guidance

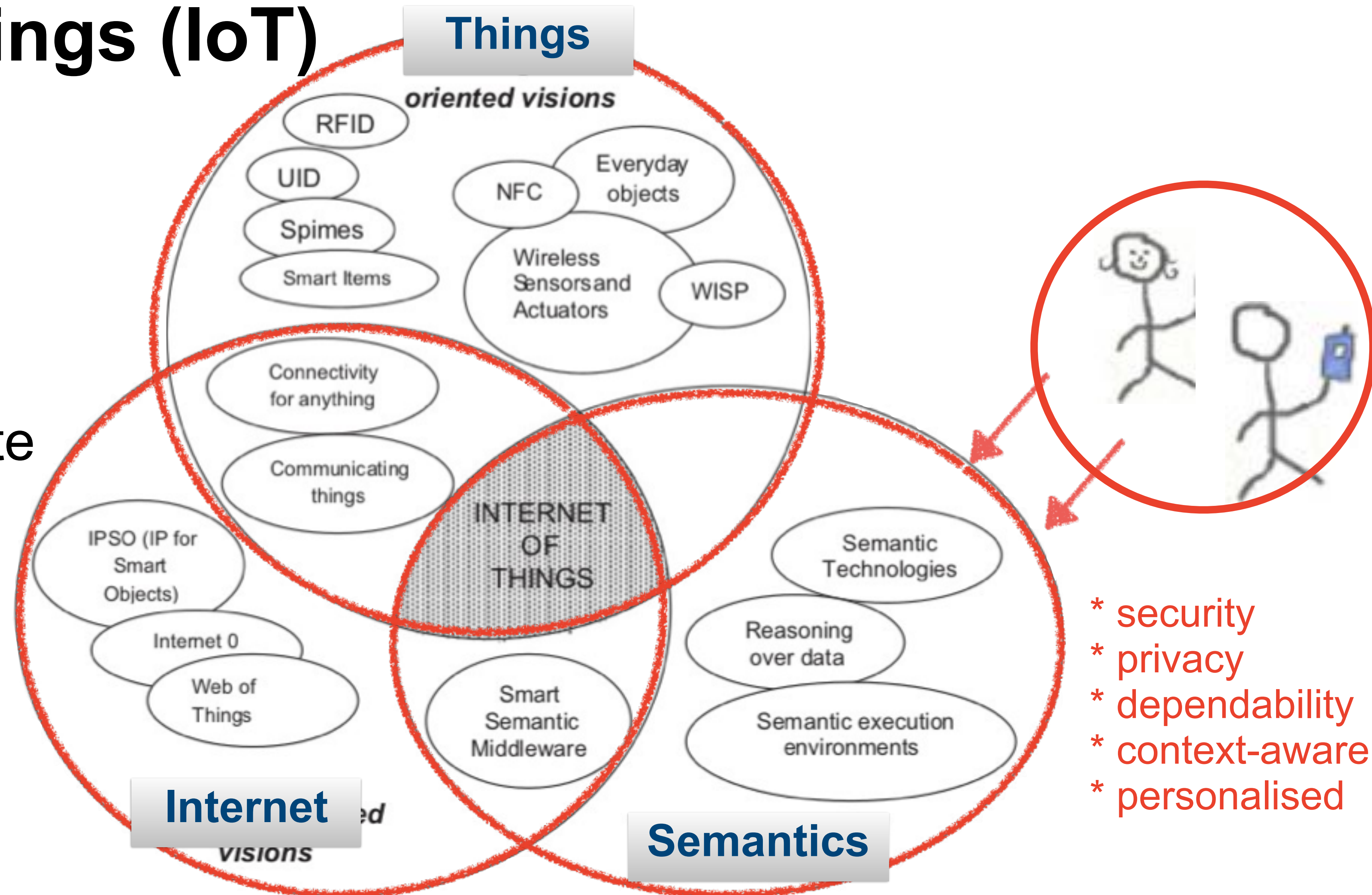
Industrial Internet of Things Volume G4: Security Framework, 2016

Future-proofing the Connected World - Cloud Security Alliance, 2016



The Internet of Things (IoT)

- IoT =
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 - ➔ Internet +
 - ➔ **Semantics**
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 - ➔ understand the meaning,
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Why Semantics?

• Syntax vs. Semantics

Arab



الهندسة فعلم التطور : الاسم
أسنسيون غومز بيرز : المؤلفون
السعر: \$74.95
الكتاب : المنتج

<الاسم>الهندسة فعلم التطور </الاسم><>
<المؤلفون>أسنسيون غومز بيرز </المؤلفون><>
<السعر>\$74.95 </السعر><>
<الكتاب>المنتج </الكتاب><>

English



Title: Ontological Engineering
Authors: Asunción Gómez-Pérez...
Price: \$74.95
Product: Book

<Title>Ontological Engineering</Title>
<Author>Asunción Gómez-Pérez...</Author>
<Price>\$74.95</Price>
<Product>Book</Product>

What do the tags **mean** for the machine?

Source: Juan Miguel Gomez, University Carlos III de Madrid



Why Semantics?

- Conceptual Level

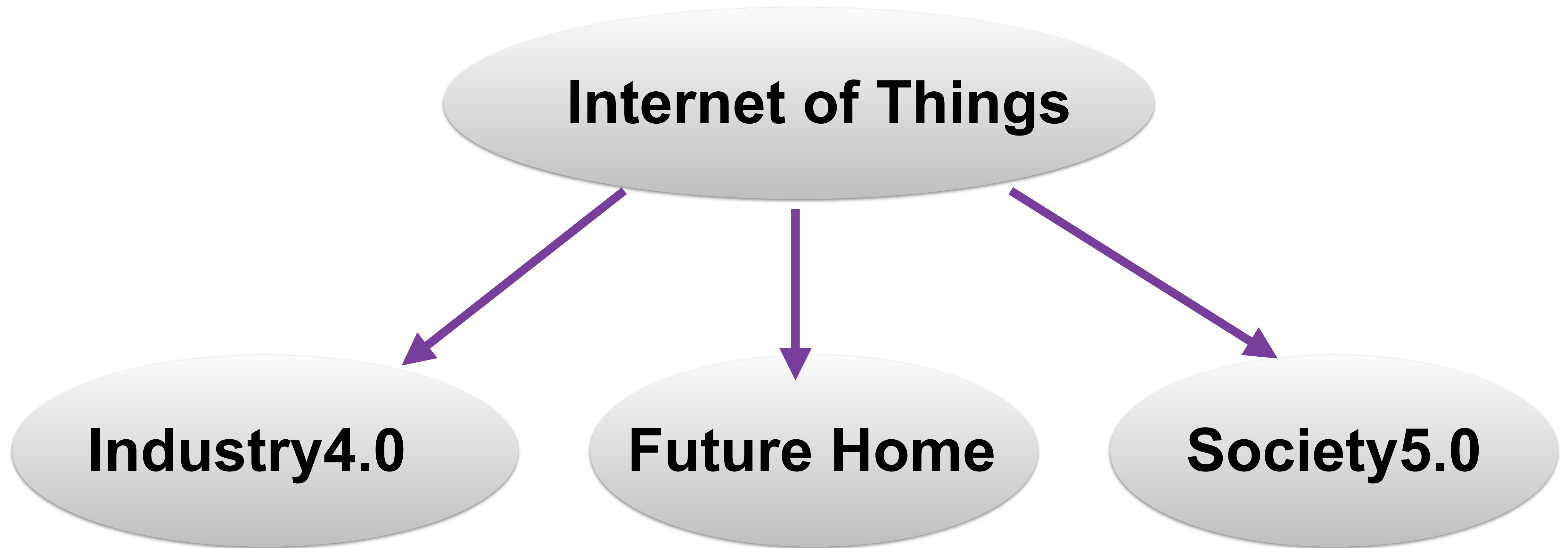


lunch (.no)



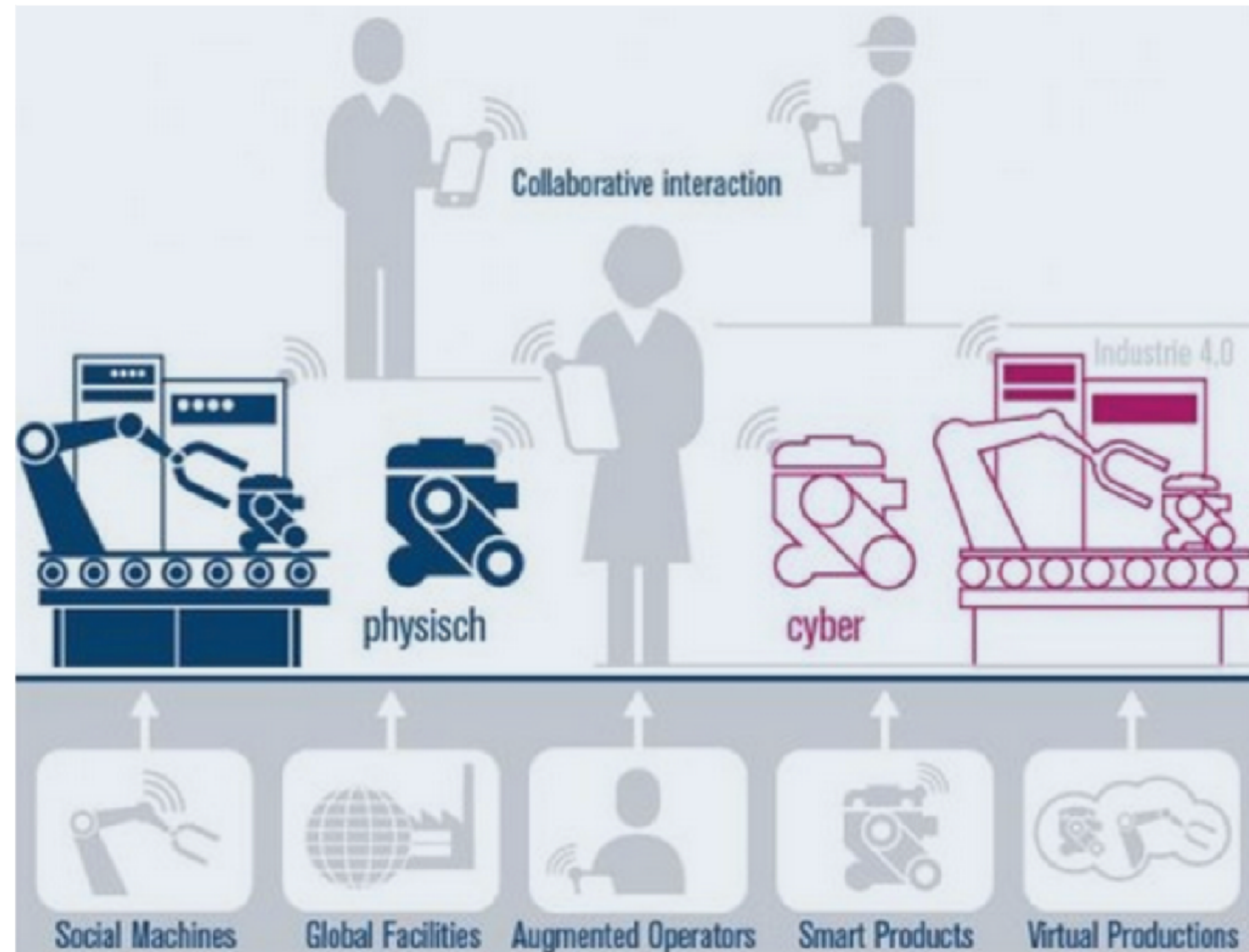
lunch (.es)

Source: Juan Miguel Gomez, University Carlos III de Madrid



Industry 4.0 - Automation

- EU is pushing¹ **Industrie4.0**
 - ➔ digital innovation hubs,
 - ➔ leadership in digital platforms,
 - ➔ closing the digital divide gap
 - ➔ providing framework conditions
- Cyber-Physical Systems
 - ➔ interactivity people-machines
 - ➔ virtual machines
 - ➔ virtual sensors
 - ➔ automated factories



¹ http://europa.eu/rapid/press-release_SPEECH-15-4772_en.htm

Internet of Things (IoT)

- Interconnected power systems

- ➔ measure:

- Voltage,
- Frequency variation

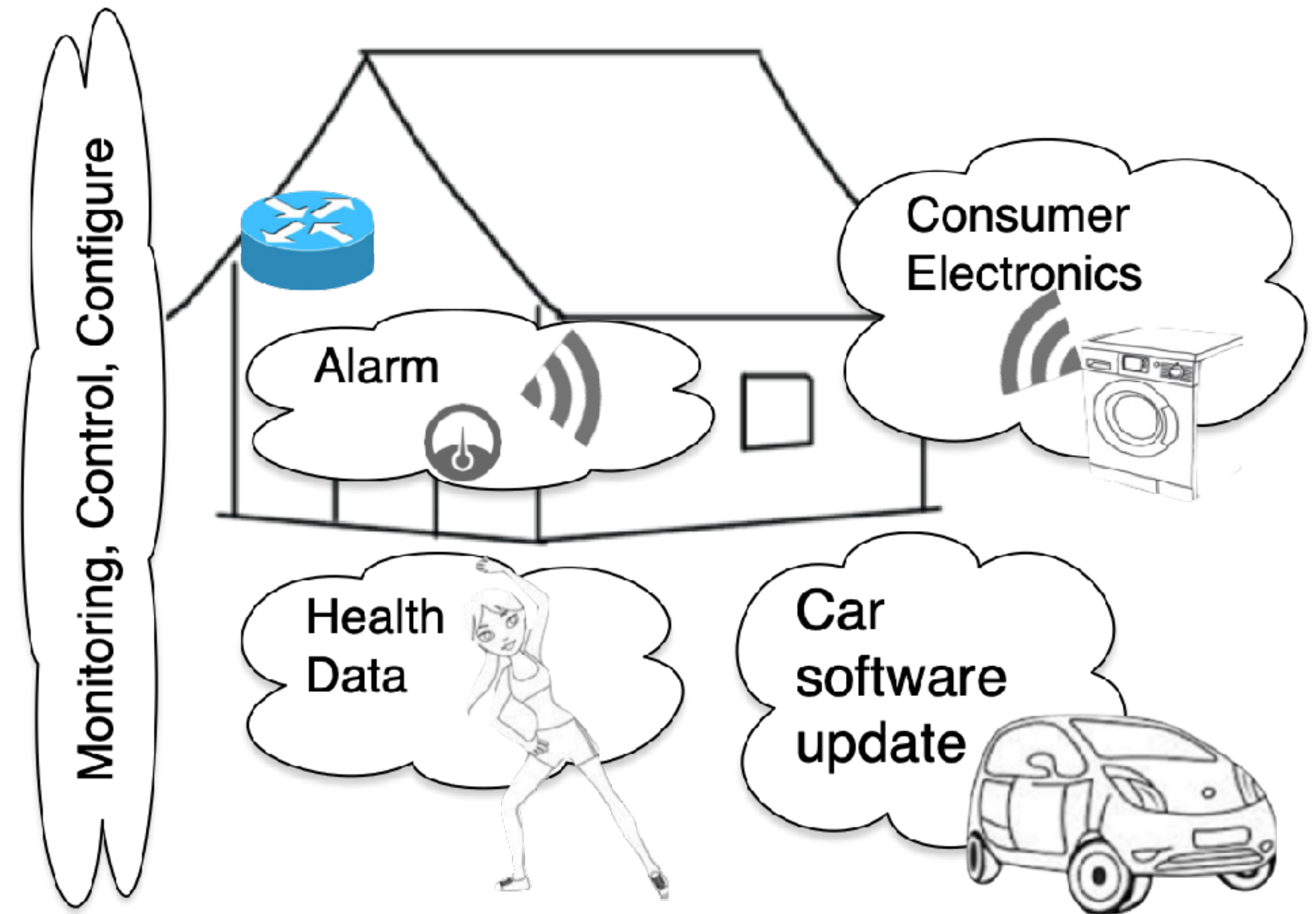
- ➔ automatic control

- Controlling home appliances

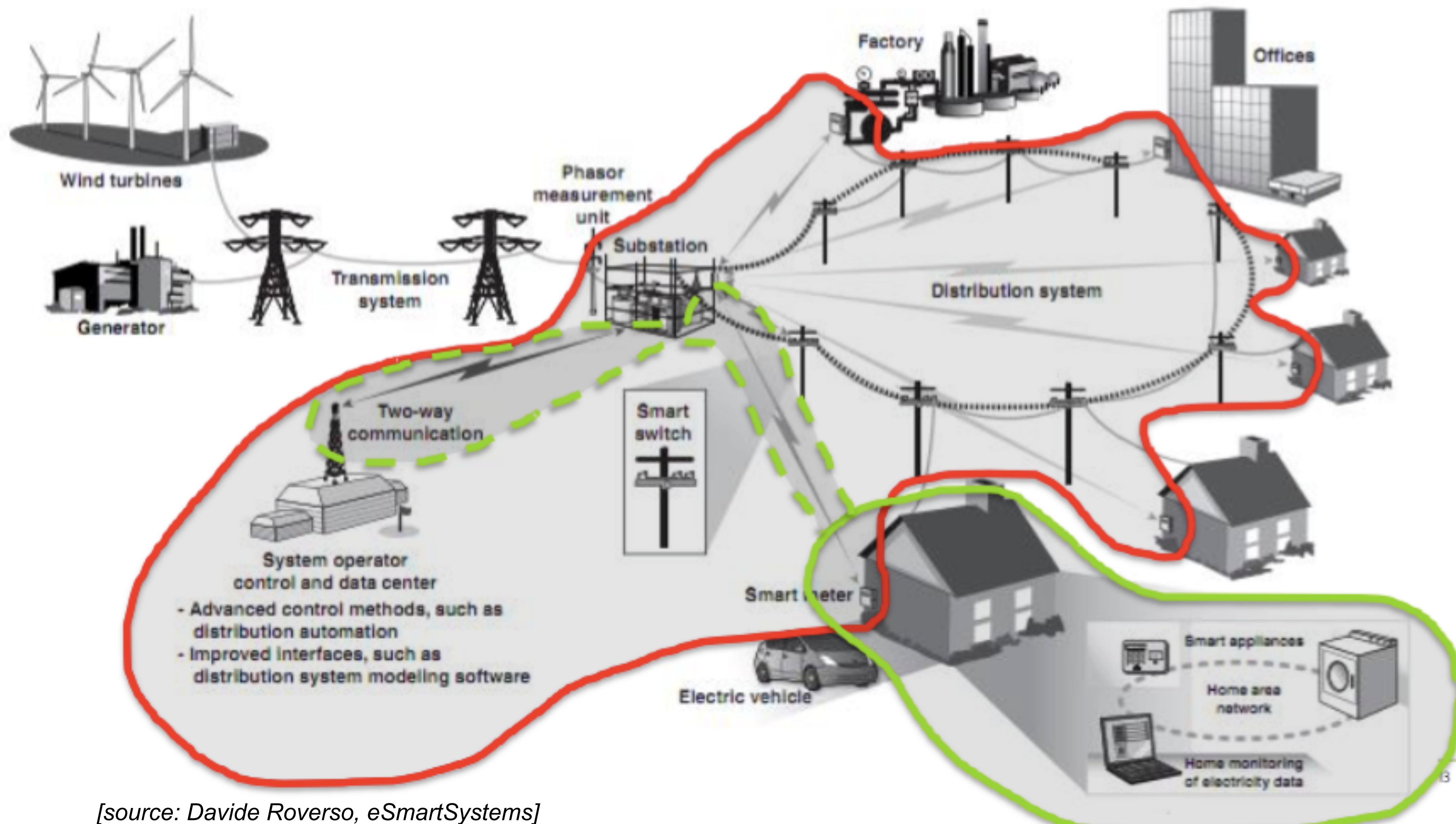
- ➔ Power consumers:

- heat pump, water heater
- car charger
- washing machine, dish washer

Convenience & Security



Smart Home vs Smart (Distribution) Grid focus



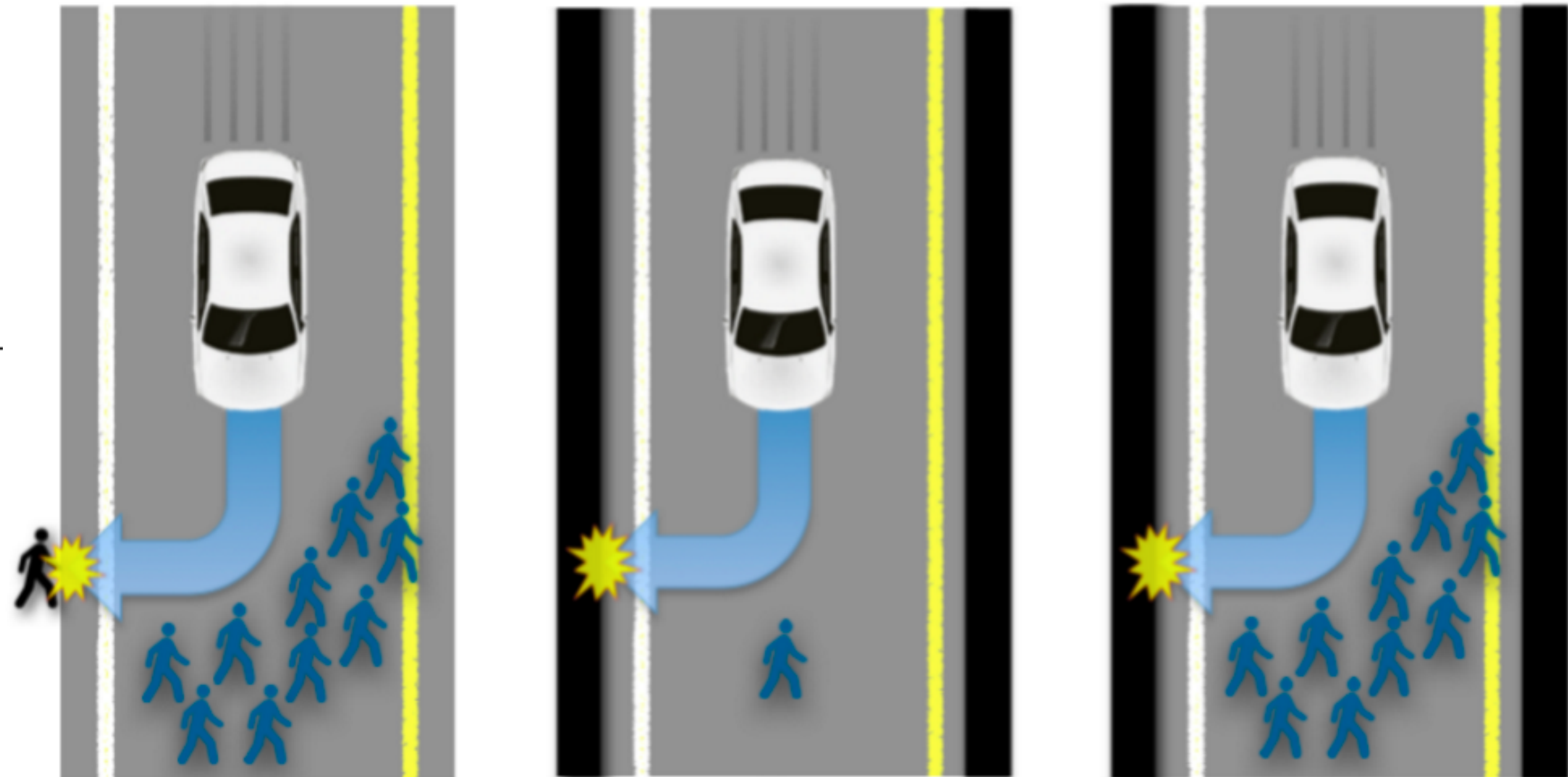
[source: Davide Roverso, eSmartSystems]

IoT challenges - “programmed to kill”

Why Self-Driving Cars Must Be Programmed to Kill

Self-driving cars are already cruising the streets. But before they can become widespread, carmakers must solve an impossible ethical dilemma of algorithmic morality.

October 22, 2015



<https://www.technologyreview.com/s/542626/why-self-driving-cars-must-be-programmed-to-kill/>



Change in Business Models due to IoT

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."



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.

Grand Challenges

- Grand Challenges

- ➔ Climate
- ➔ Resources (radio, minerals)
 - Kobald (East - DR Congo)
- ➔ Societal Security, Divide

- Digitisation

- ➔ Mobile Networks
- ➔ IoT
- ➔ Automation

“Internet had the ability to
dismantle the divide.
Internet failed miserably, the
divide is bigger than ever.”
Kate Gilmore, Human Rights, UNO



~~Challenge 1: Climate~~

not today

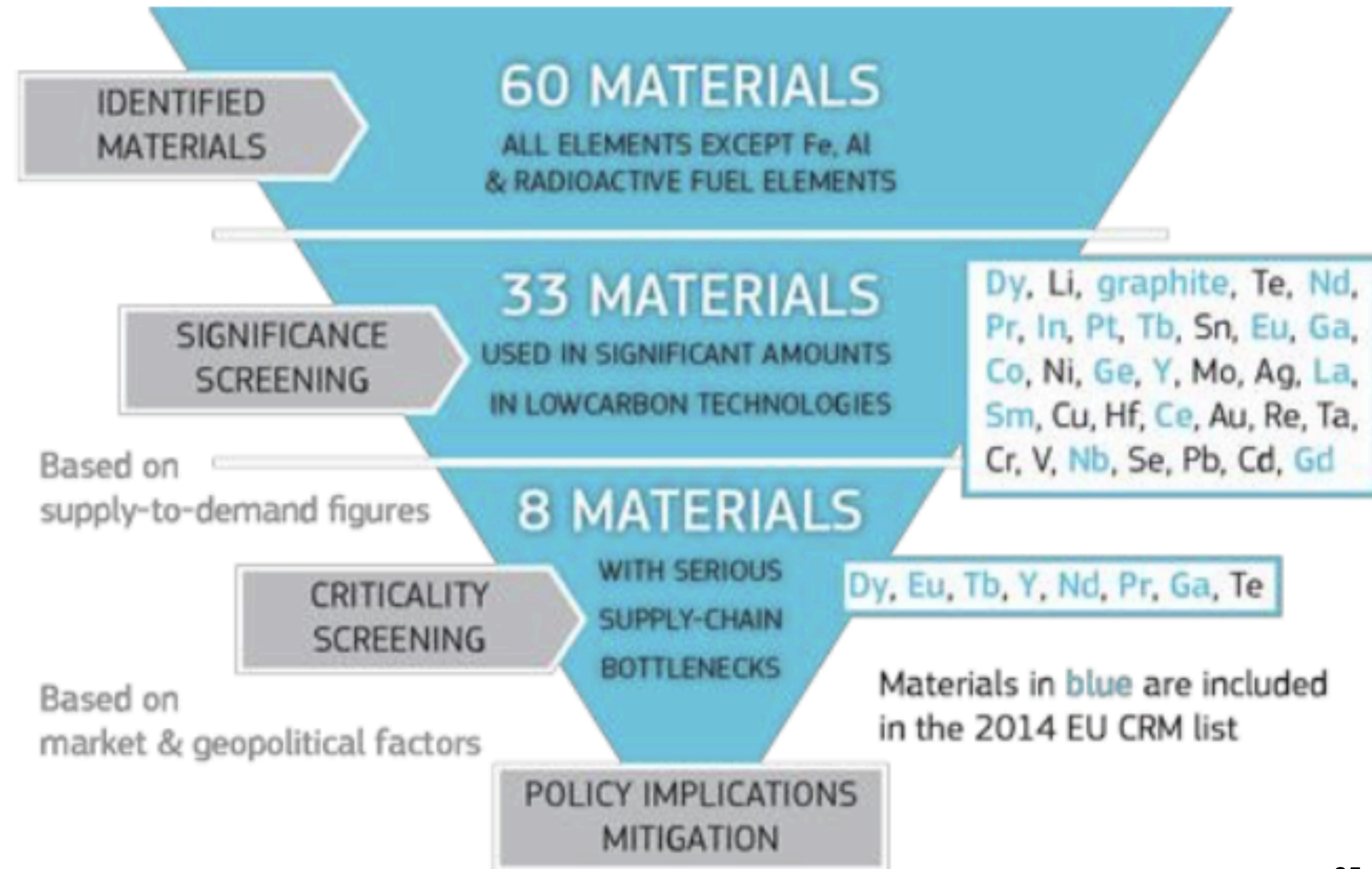


Challenge 2: Resources



Resources: Shortage of Materials

- EU critical materials in Energy Technology
- REEs terbium, neodymium, dysprosium




Resources: Recycling rates of Metals

- 30+ elements have <1% recycling rate

Ref: T. E. Graedel, B. Reck, M. Buchert, C. Hagelüken et al. "Recycling rates of metals", United Nations Environment Programme, (UNEP edits.) 2011



1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	** 	104 Rf	105 Db	106 Sg	107 Sg	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uug	115 Uup	116 Uuh	117 Uus	118 Uuo
* Lanthanides			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
** Actinides			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr



Source: HyProS Arena Meeting UiO, 6Dec2018

A sustainable Future?

WWRF Vision in a nutshell (1)

7 trillion wireless devices
serving **7 billion** people
by **2020**

Internet of Things Forecasts



enocean alliance
No Wires. No Batteries. No Limits.

30 Billion

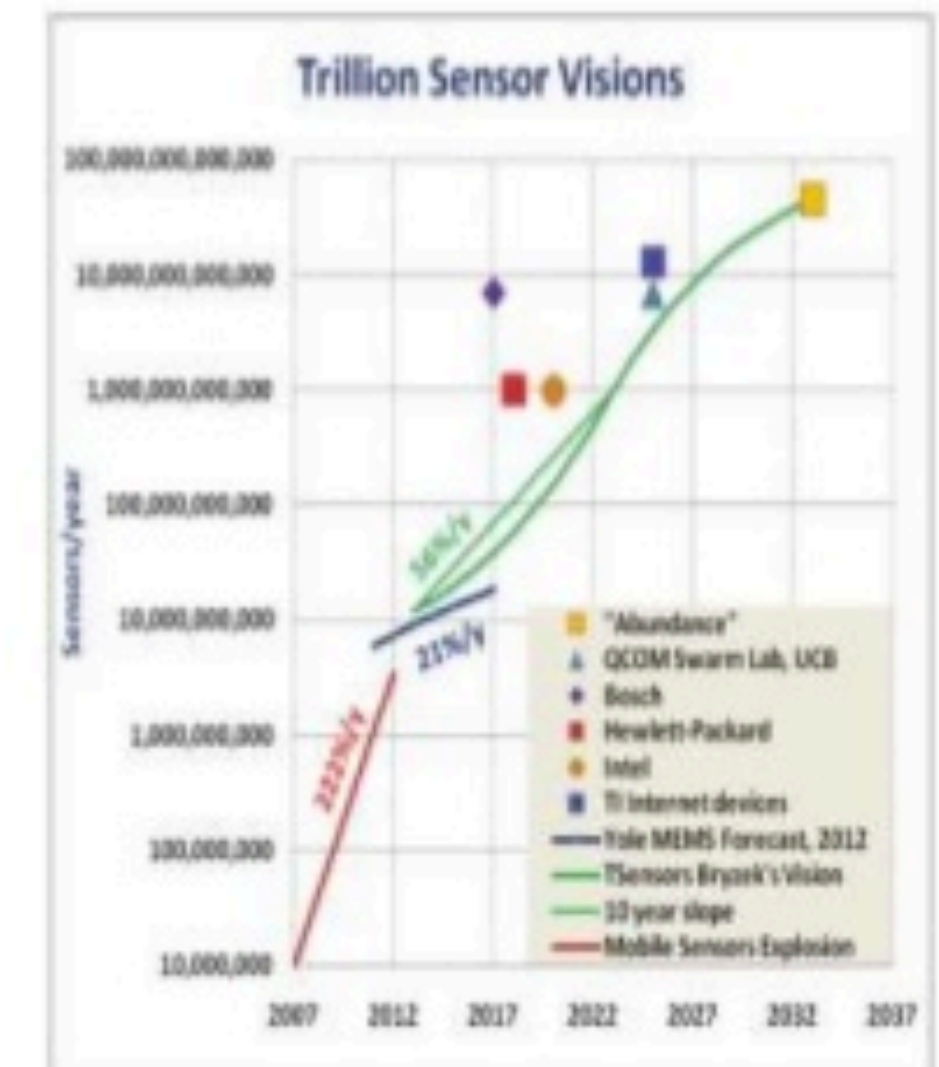
permanently connected things by 2020

Source: Gartner, 2014.

50 Trillion

connected sensors by 2032

Source: TSensor Summit Oct 2013



How are we going to power and connect
trillions of sensors?



Challenge 3: Societal Security, here: the Digital Divide



Digitalisation of the Society



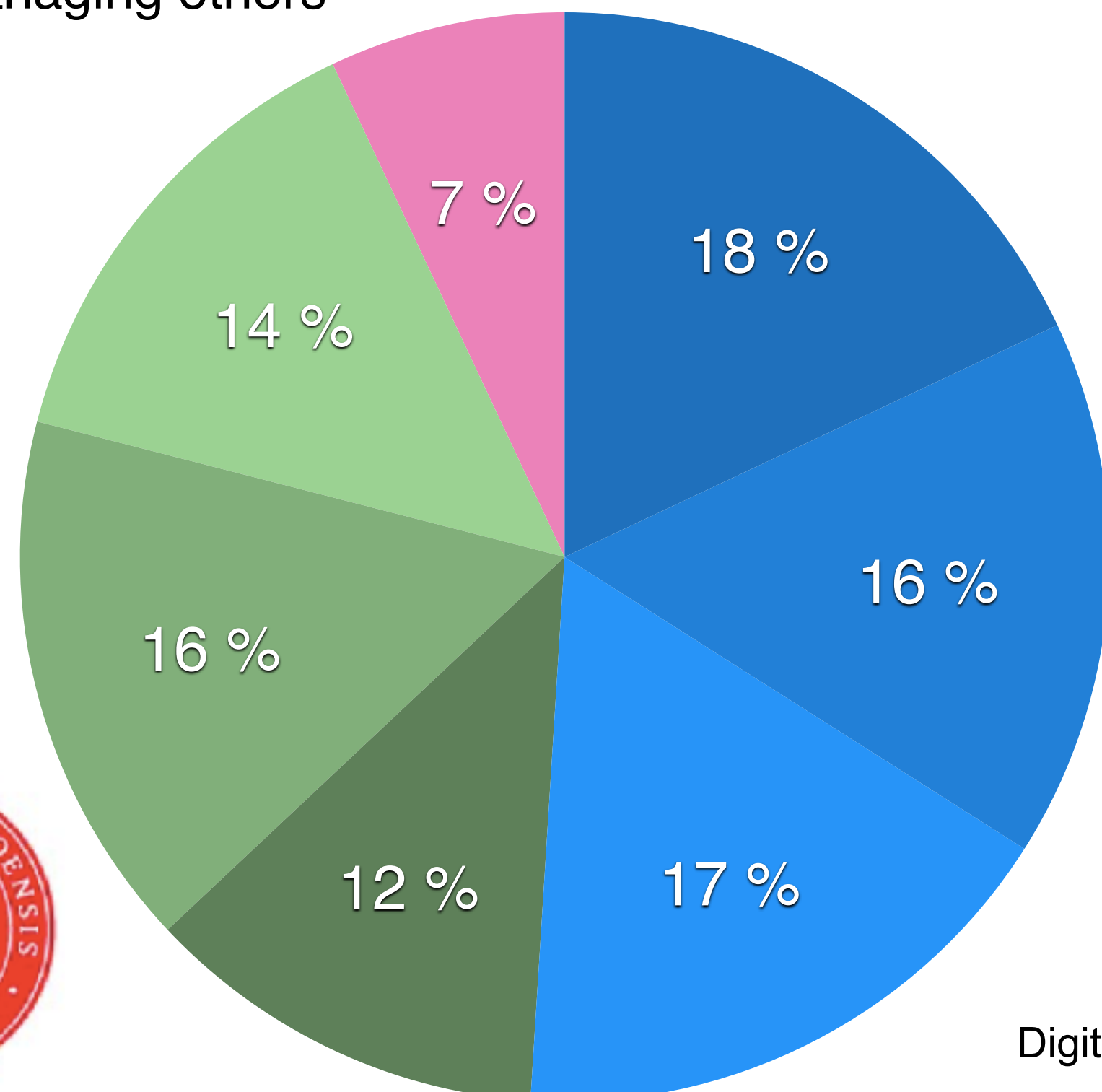
Source: EU commission,
<https://www.youtube.com/watch?v=BK-UuUnQaIM&feature=youtu.be>



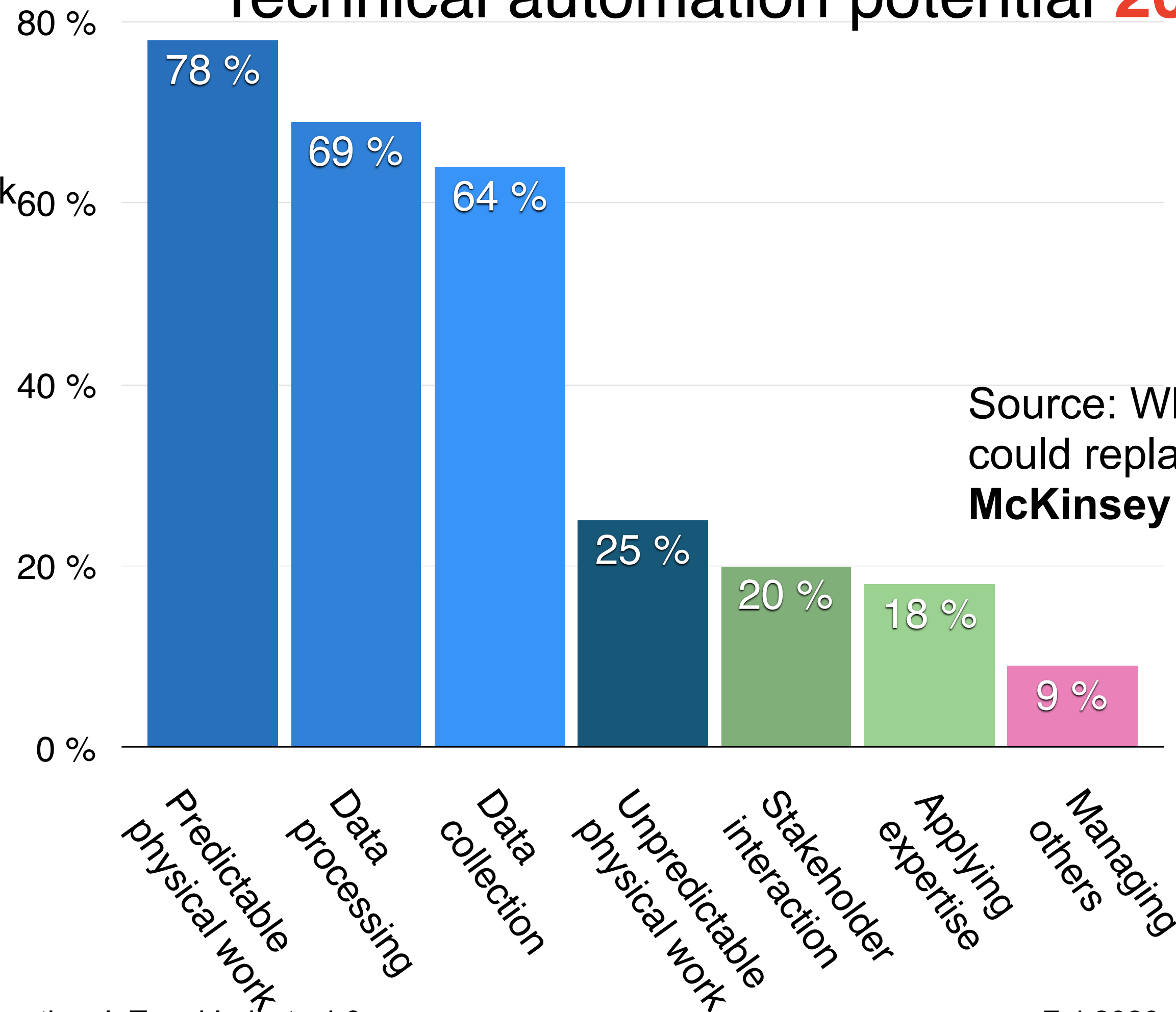
Automation will come

USA work force time spent [%]

- Predictable physical work
- Data collection
- Stakeholder interactions
- Managing others
- Data processing
- Unpredictable physical work
- Applying Expertise



Technical automation potential **2016** [%]



Source: Where Machines could replace humans, **McKinsey 2016**



Starting Point:

JOSEPH E. STIGLITZ
WINNER OF THE NOBEL PRIZE IN ECONOMICS



THE PRICE OF ~~ON~~ INEQUALITY

HOW TODAY'S DIVIDED SOCIETY
ENDANGERS OUR FUTURE



And what about IoT?

FREEDOM OF EXPRESSION

We can't reach the U.N. goals for sustainable development without the internet

22 JUNE 2017 | 11:40 AM



Tweet



Share

It's become common wisdom that the United Nations' ambitious "Global Goals for Sustainable Development" aren't just for the U.N., or even governments, to implement. Launched in September 2015, the 17 goals and 169 targets are "a series of ambitious targets to end extreme poverty and tackle climate change for everyone by 2030" (hence the alternative moniker, the "2030 Agenda for Sustainable Development").

Replacing the more arcane "Millennium Development Goals," these Sustainable Development Goals (SDGs) are everyone's goals, crowd-sourced to completion and promoted by companies and civil society alike. (Cue the hip, auto-playing video on the website.)



STEPHEN HAWKING CARES MOST ABOUT #GOAL 9 INDUSTRY, INNOVATION & INFRASTRUCTURE #GLOBALGOALS

Smartly, the goals, especially Goal 17, emphasize that **access to technology underpins every one of these commitments** to the eradication of extreme poverty.

However, not all connectivity is the same, nor yields the same benefits to societies in terms of economic, social, or cultural development. As we told the International Telecommunication Union (ITU), only **stable, secure, and open access** to broadband internet will ensure success for the U.N. SDGs. That's something civil society and our partners will continue to make clear, and we'll need to work in legislatures to get the point across, not simply at aid and development banks.

To reach the SDGs, we need civil and political advocacy

Traditionally, information and communications technology (ICTs) have not been a major recipient of aid funding. That's one reason this crucial technology is "under-represented" in the SDGs and appears in only four of the 169 targets. It's assumed that telecommunications will take care of itself, having been largely deregulated and privatized in the 1980s and 1990s. Yet **more than half the world's population is not using the internet**, a statistic showing the failure of local, national, and global governance with economic, political, and moral implications.



PETER MICEK
[@lawyerpants](#)

FREEDOM OF EXPRESSION

GLOBAL

#ITU4SDG

#KEEPITON

CONNECTIVITY

ITU

SDG

SUSTAINABLE DEVELOPMENT GOALS

UNITED NATIONS

RELATED

Beyond connectivity: building an inclusive U.N. agenda for internet development [Read More >](#)

Access Now welcomes new report on economic impact of shutdowns [Read More >](#)

<https://www.accessnow.org/cant-reach-u-n-goals-sustainable-development-without-internet/>



Access to information to reach the Sustainable Development Goals

- Access to Information
 - ➔ only in 4 of the 169 targets
 - ➔ transferred from 2020 -> 2030 goals
 - ➔ repeated by the High-Level Panel
 - ➔ Under-communicated by Aid & Development



Tilgang til informasjon

– en avgjørende faktor for å oppnå FNs bærekraftsmål

Oktober 2018



Challenges

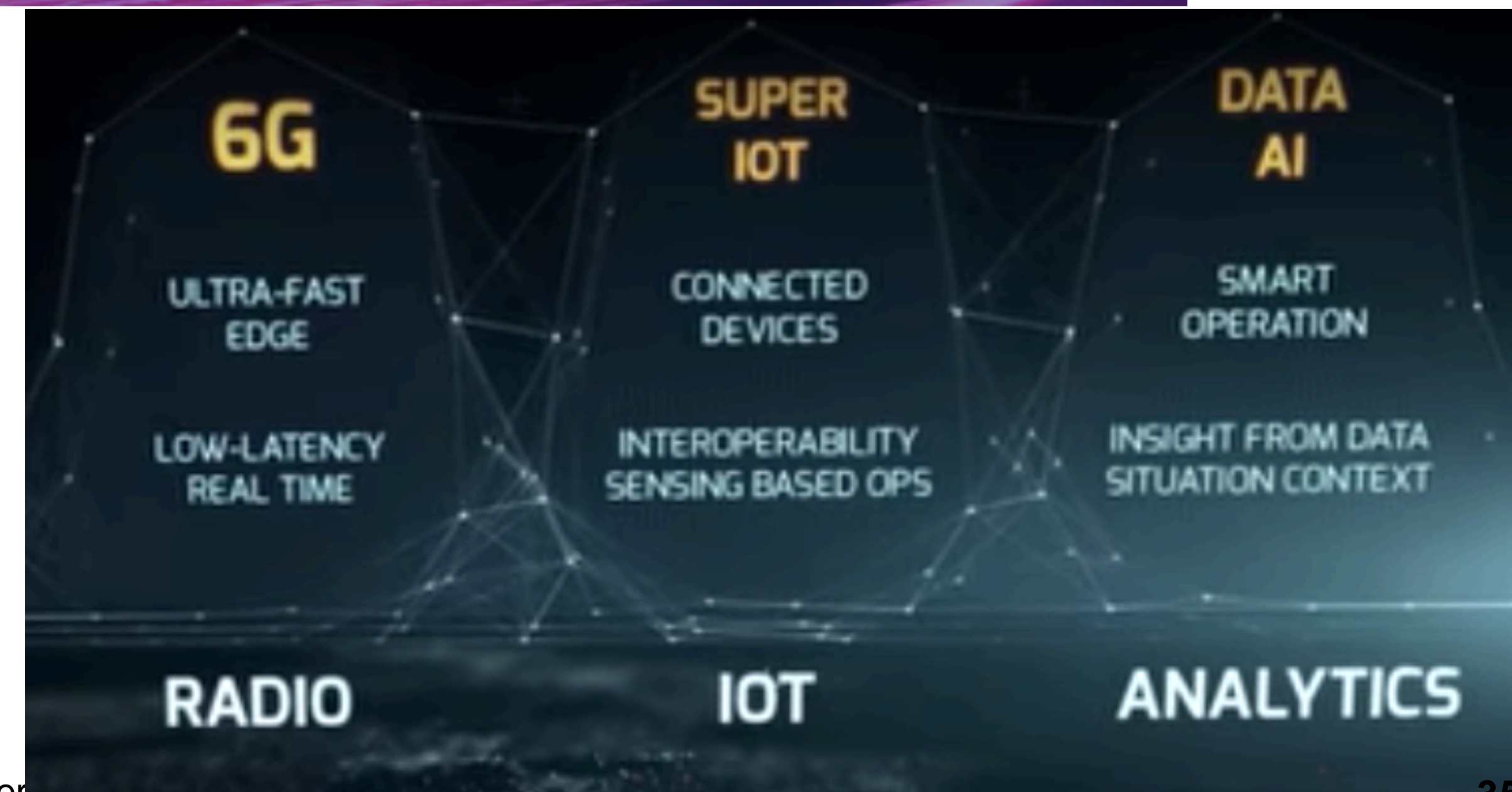
- Costs of Access
 - ➔ School connectivity (SDG indicator 4.A.1)
 - ➔ Digital Health for primary health facilities
 - ➔ Community involvement/digital transformation
- Digital Content
 - ➔ School/Health/Community info
 - ➔ Uganda Knowledge Portal (UKP)
 - ➔ Digital Public Goods (UN, UNICEF)
- Free access to Uganda Knowledge Portal

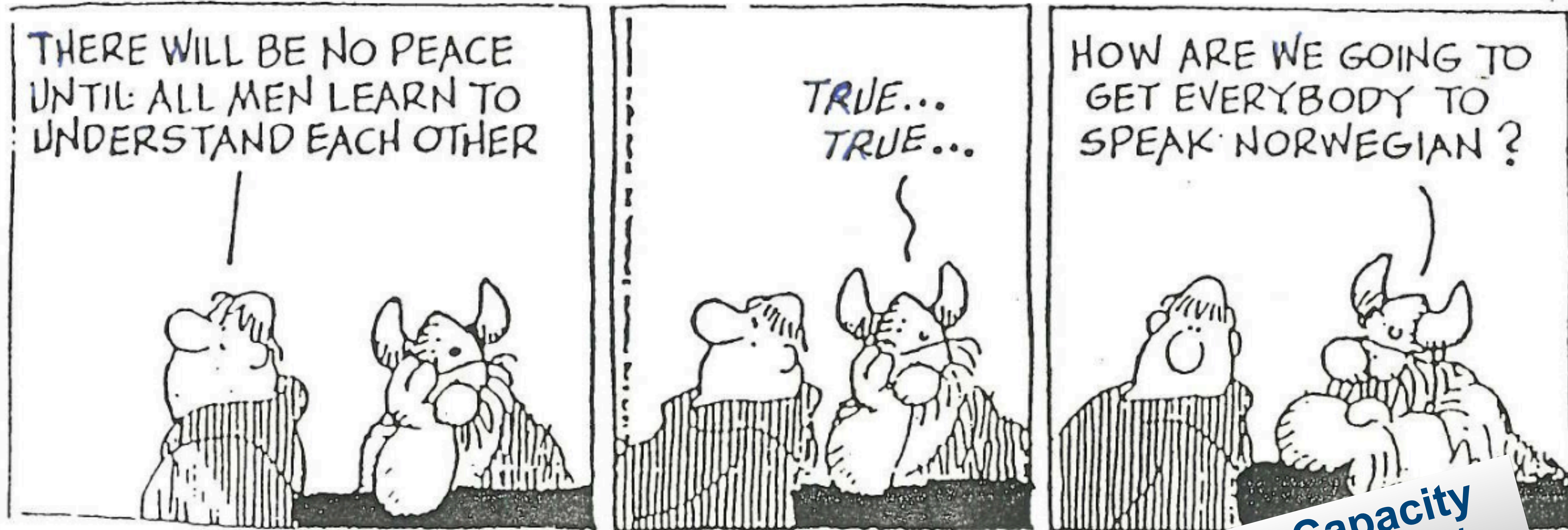




6Genesis.com by Oulu University

- Lighthouse project in Finland
 - ➔ 251 M€ funded
- Goals
 - ➔ Support industry in finalization of 5G
 - ➔ Develop the fundamental technology needed to enable 6G
 - ➔ Speed up digitalization in society
- Focus on Sustainable Development
 - ➔ FI, SE, NO, DK academic collaboration





Inclusiveness - Trust - Capacity
United Nations High Level Panel on Digital
Cooperation 2019

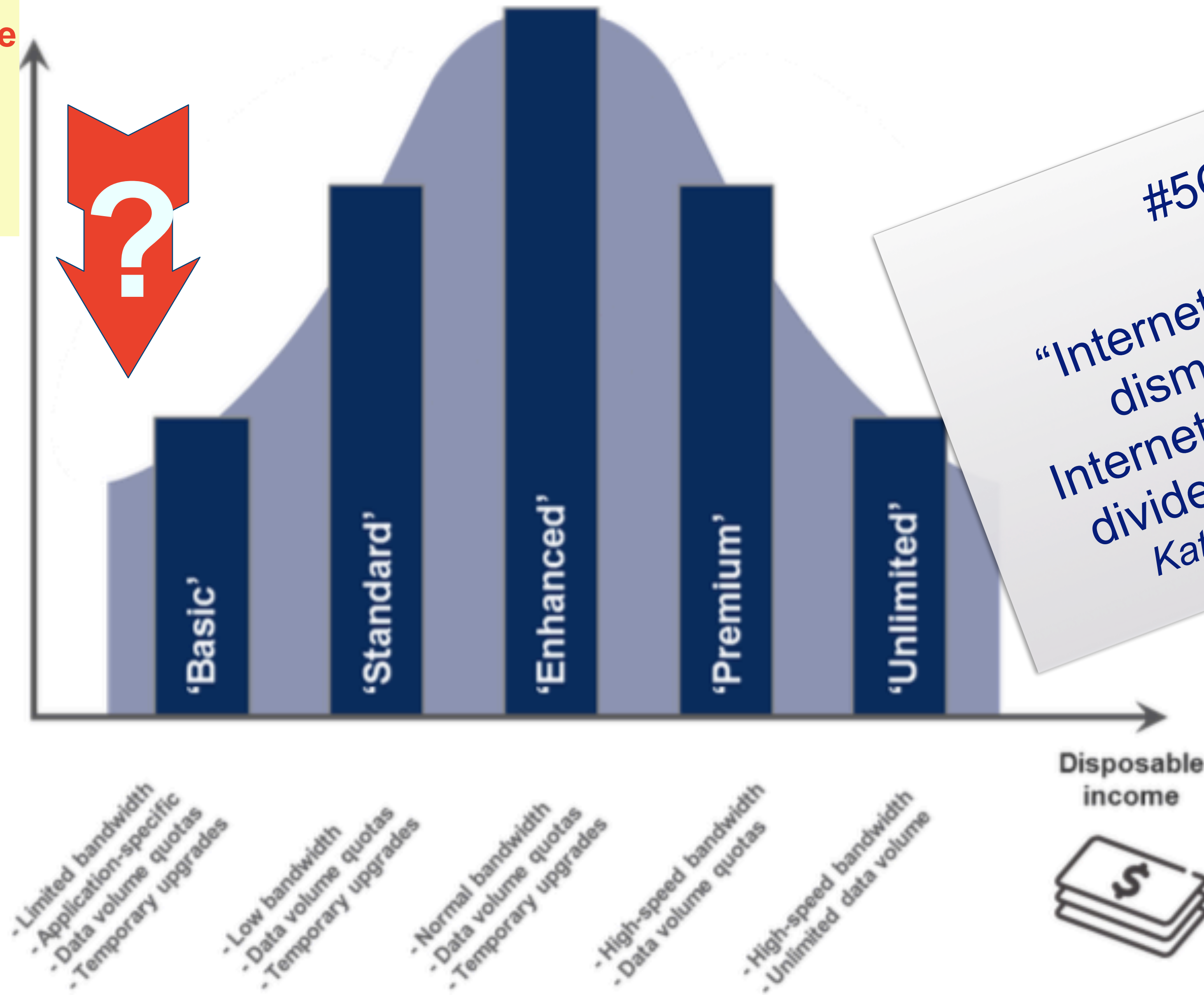


Challenge 4: Existing Business Models



Telecom view on digital inclusion

Addressable
Market

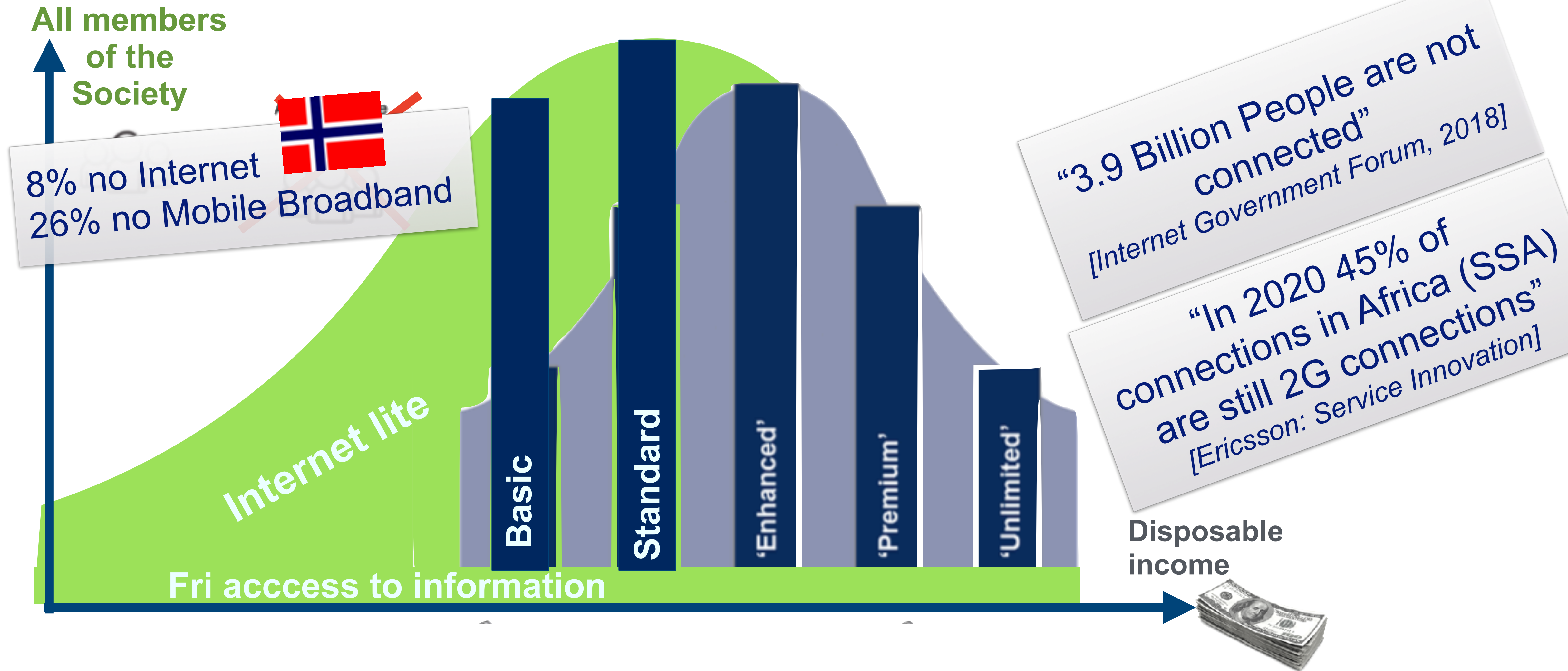


#5Gfor All?

“Internet had the ability to dismantle the divide. Internet failed miserably, the divide is bigger than ever.”
Kate Gilmore, Human Rights, UNO

Source: Service Innovation through Smart Networks, Ericsson,
<https://www.ericsson.com/assets/local/networks/documents/service-innovation-through-smart-networks.pdf>

6G (#5GforAll) for digital inclusion



[Adapted from: Service Innovation through Smart Networks, Ericsson, 2018]

Conclusions

- Sustainability & IoT - technology driven
- #1 Climate
- #2 Resources:
Trillions of Sensors vs Waste/Recycling
- #3 Digital gap vs digital partnership
 - ➔ “Nobody should be left out from the Digital Society”
 - ➔ Give everyone **access to digital information & IoT**
 - ➔ **Freemium** model for access
- #4 Regulatory framework for digital inclusion

