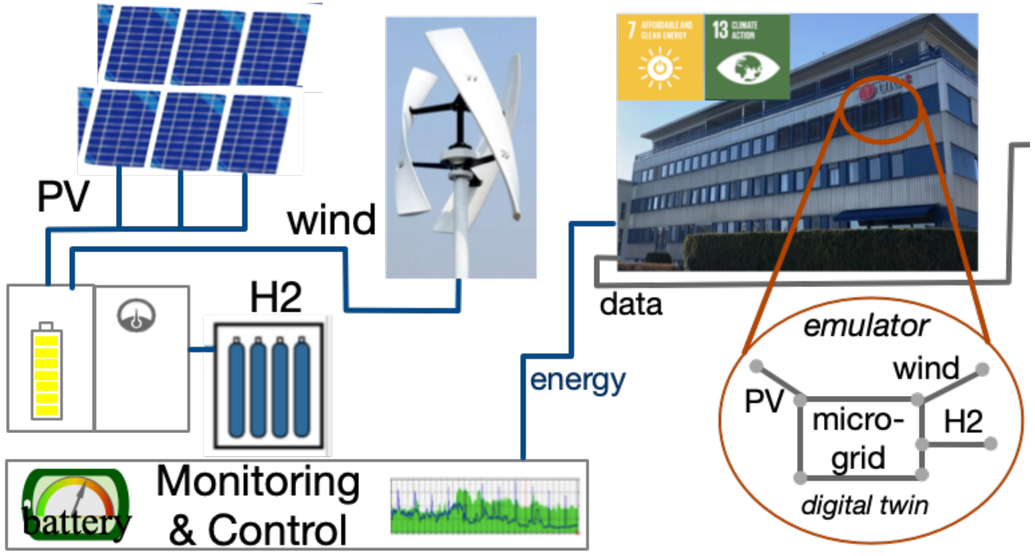
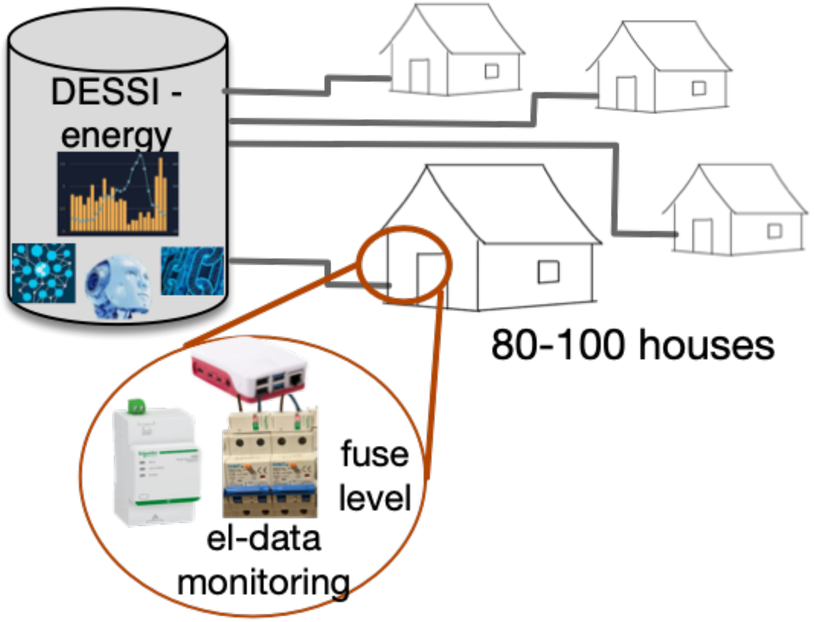
UNIVERSITY OF OSLO

TEK5530 Measurable Security for the Internet of Things

L2 Internet of Things





Josef Noll
Professor
Department of Technology Systems

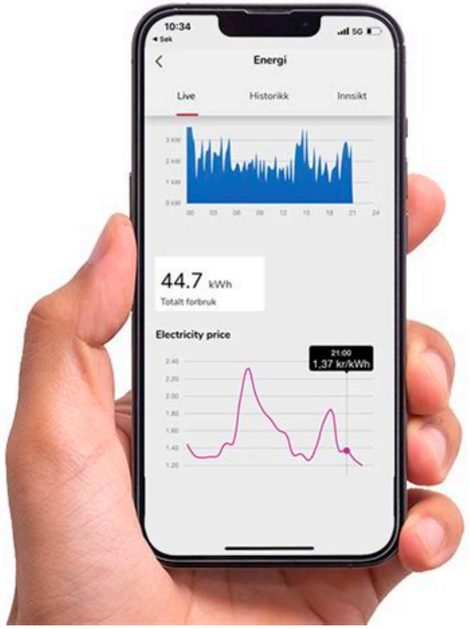
UNIVERSITY
OF OSLO

L2- Overview

- History of Internet of things (IoT)
- Merging several domains
  - Things
  - Semantics
  - Internet
- What about?
  - Security
  - Privacy
  - Multi-owner requirements

Expected outcome:

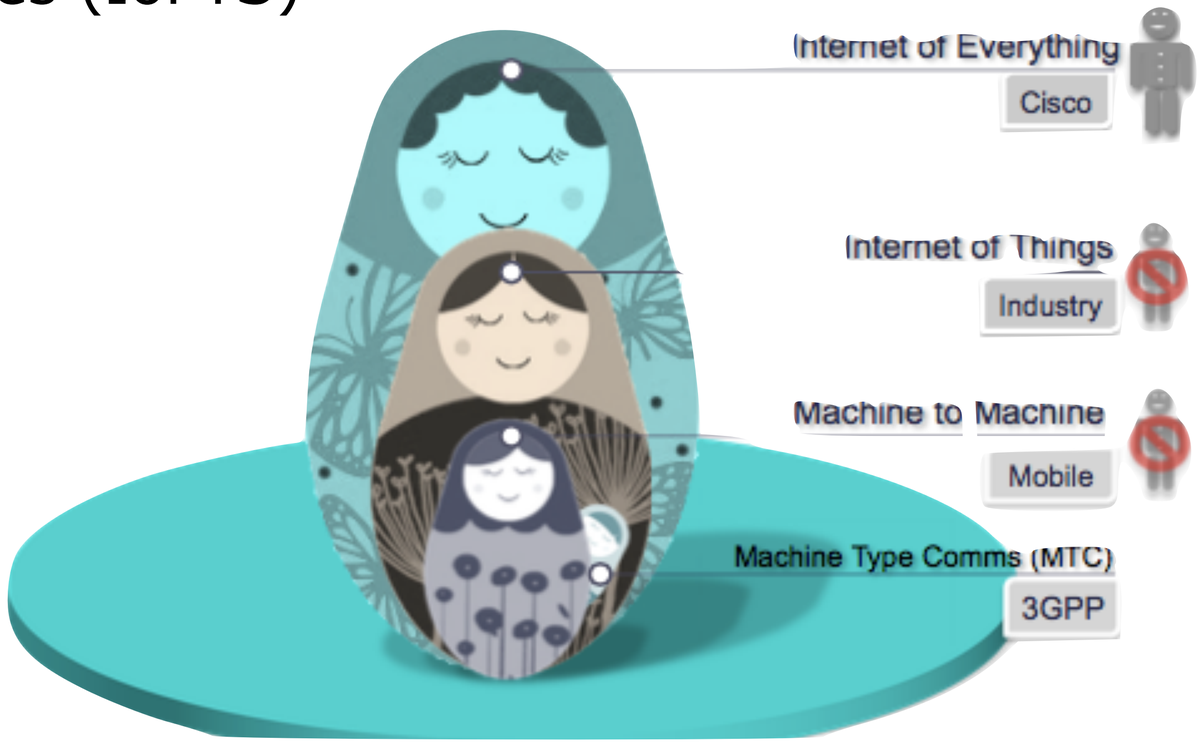
- Describe the domains being merged in IoT
- Provide examples of challenges in each of the domains
- Establish requirements for multi-owner service requests of “a thing”
- Analyse security and privacy requirements in an envisaged scenario



[Source: http://elkosmart.elko.no]

Internet of Things aspects

- The Internet of People Things and Services (IoPTS)
  - The Internet of Things (IoT)
  - The Internet of Everything (IoE)
- Identity in the IoT
  - Identity and trust between people
  - Identity in IoT
- Privacy and Security
  - Privacy, Context-awareness
  - Measurable Security
  - Innovation through Measurable Security



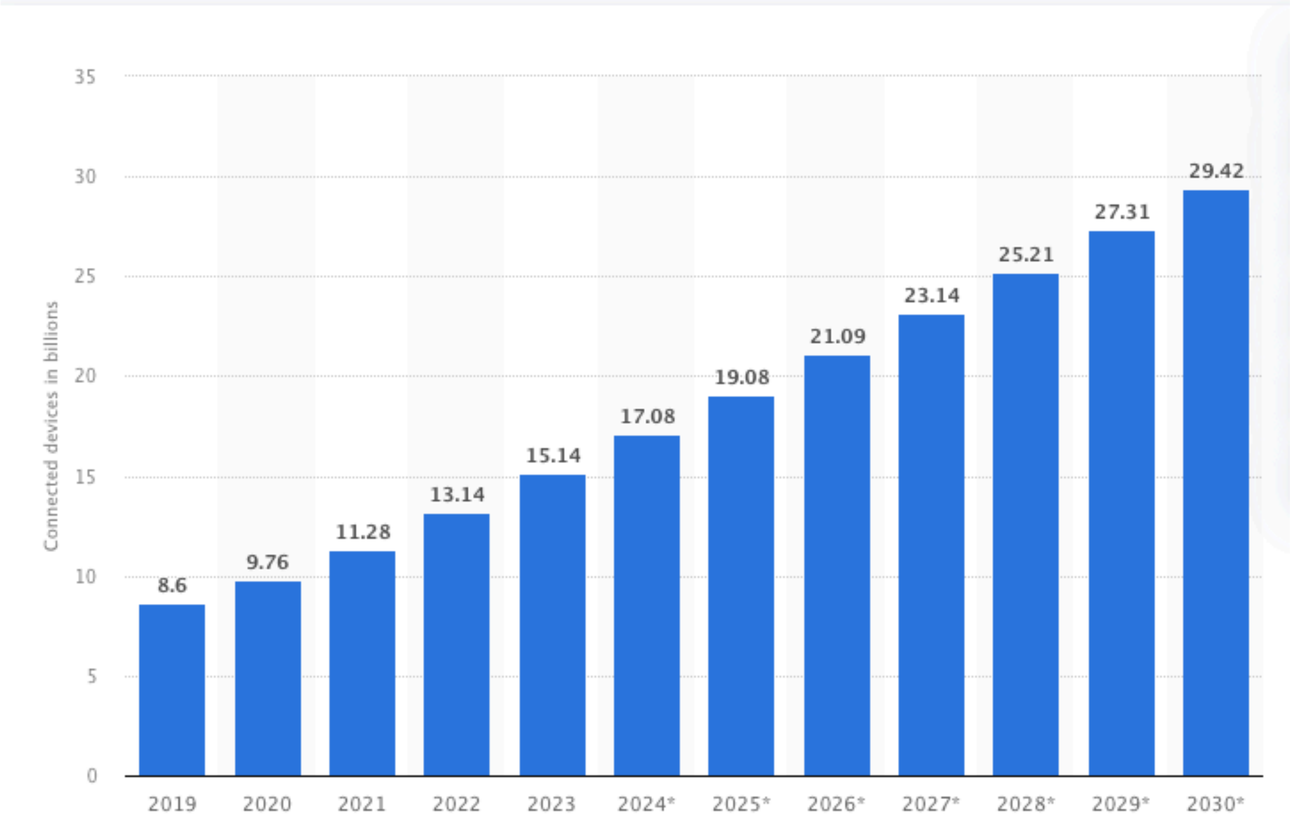
[Source: Monique Morrow, Cisco]

DNV report 2013, DNV GL report 2014

Technology Outlook 2020 / Transformative Technologies

- Technology applications in Maritime, Renewables & Electricity, Health Care, Oil & Gas and Food & Water industries
  - sensors will drive automated data management
  - from passive data to automated decisions
  - automated decision tools by 2020

- Maritime: «policy driven»
- Health care: «trust» on sensor and mobile apps

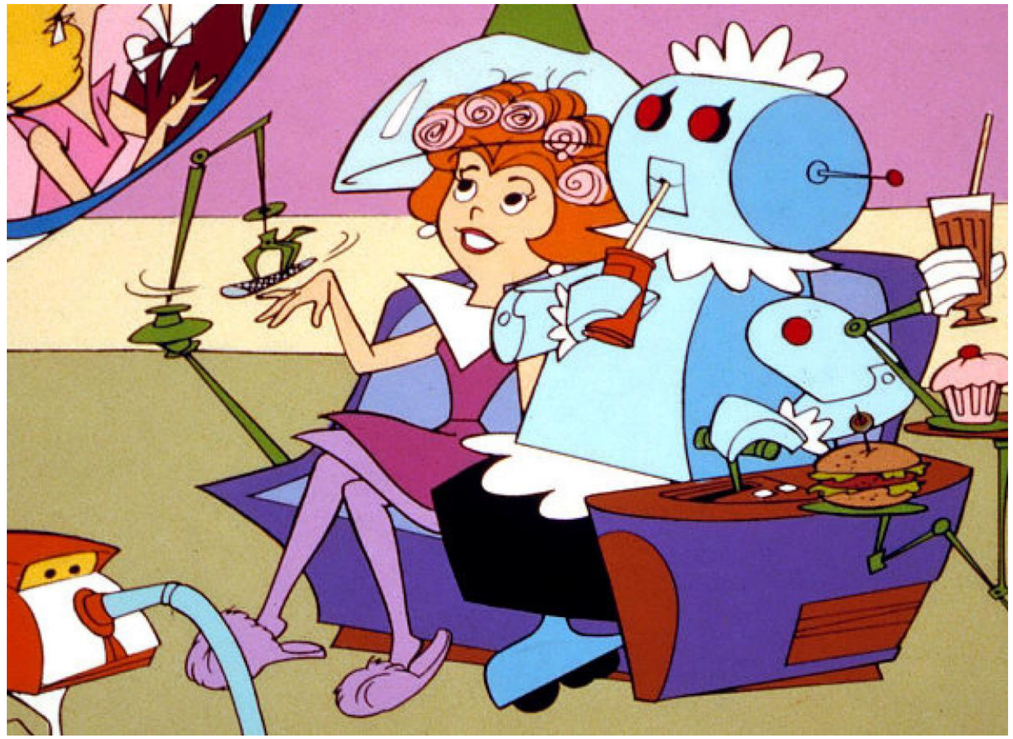


https://www.statista.com/statistics/1183457/iot-connected-devices-worldwide/

Internet of Things – Life, Jetsons style

- From "Internet of PCs" towards the "Internet of Things" with 20-30 billion devices connected to the Internet by 2020
- Intelligence hidden from the user
- «Seamless» operation
- Adaptive and personal

- Inability to manage full depth
- Multi-owner situations
- Depth and breadth of services are in direct tradeoff with privacy and security



Paper analysis:
The Internet of Things

- Paper: L. Atzori et al., The Internet of Things: A survey, Comput. Netw. (2010),
  - link on the http://its-wiki.no/wiki/TEK5330 page

- Internet
- Things
- Semantics

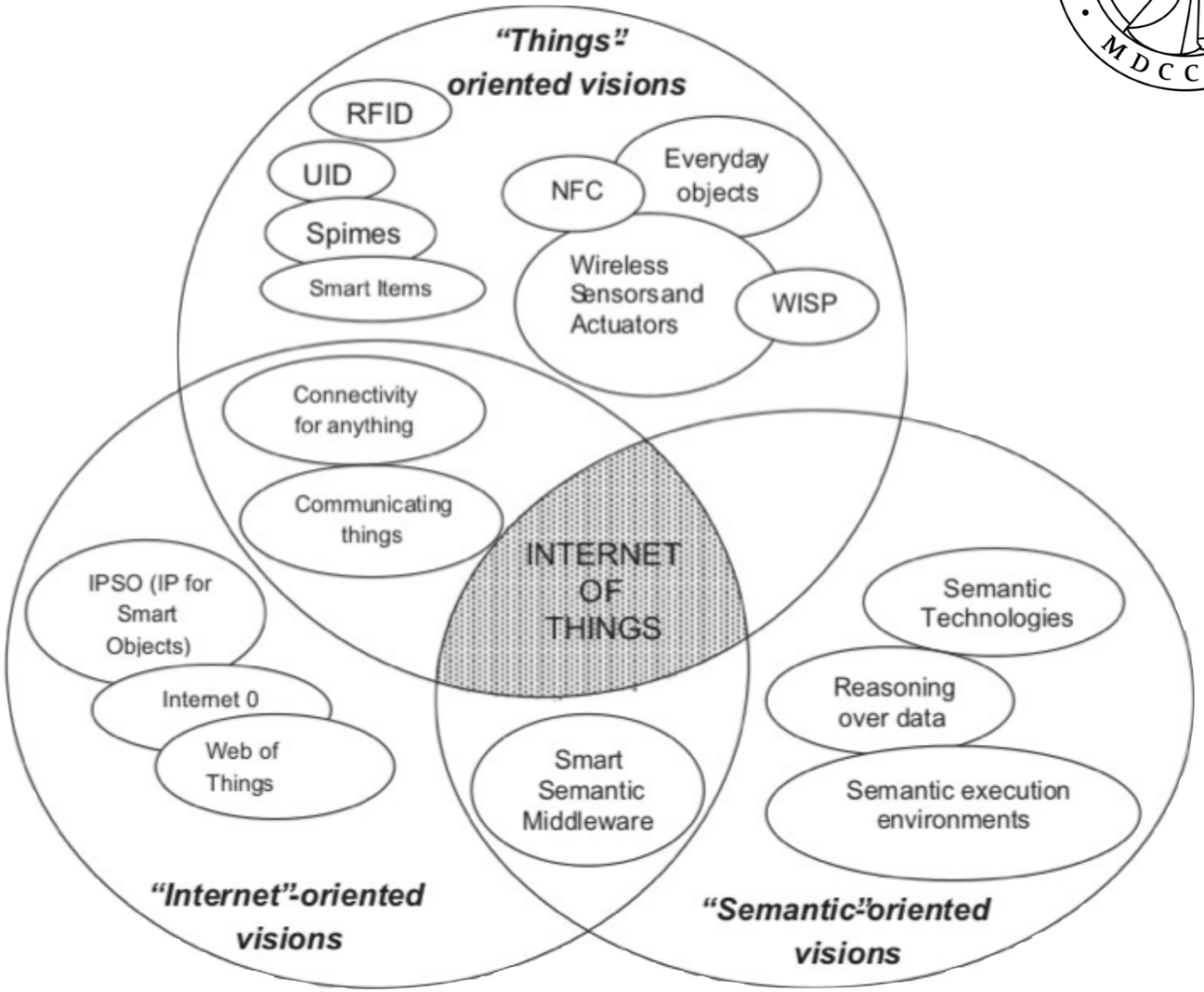


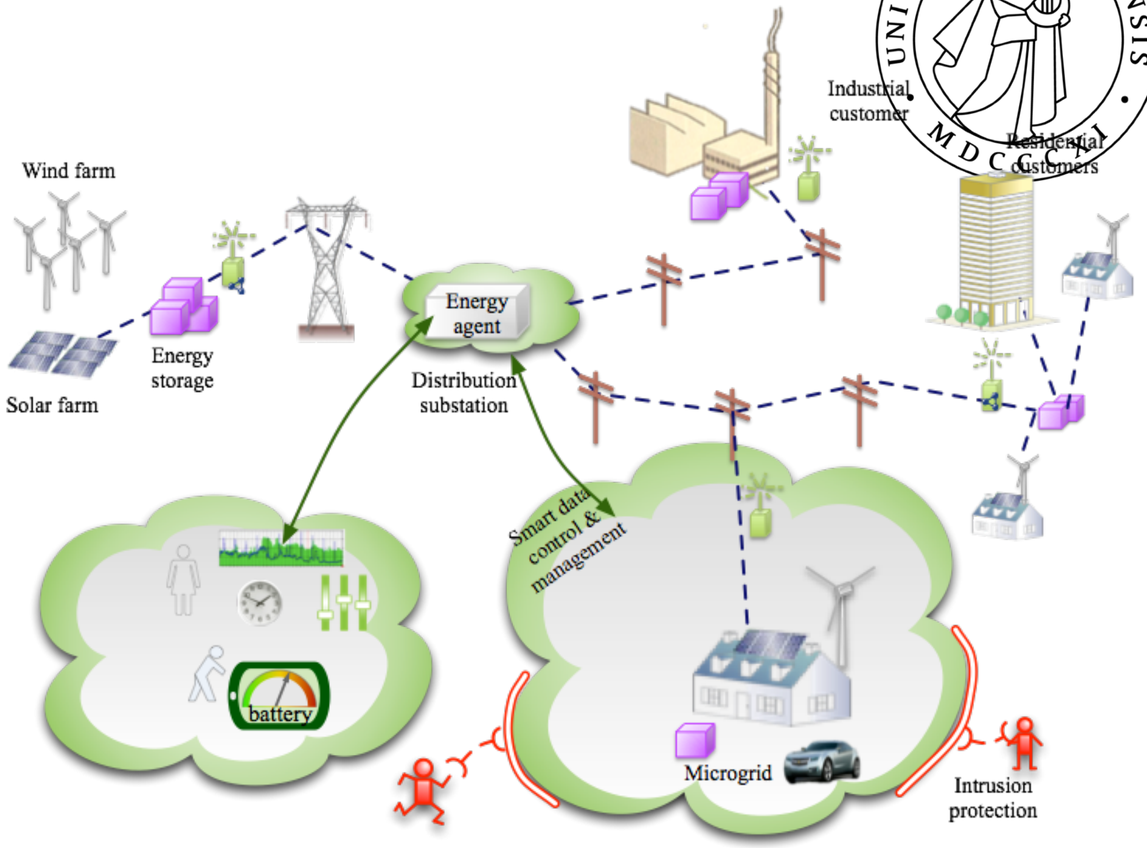
Fig. 1. "Internet of Things" paradigm as a result of the convergence of different visions.

Main drivers for IoT

- Cheap sensors
- Wireless connectivity
- Apps
- on-time monitoring

Business drivers

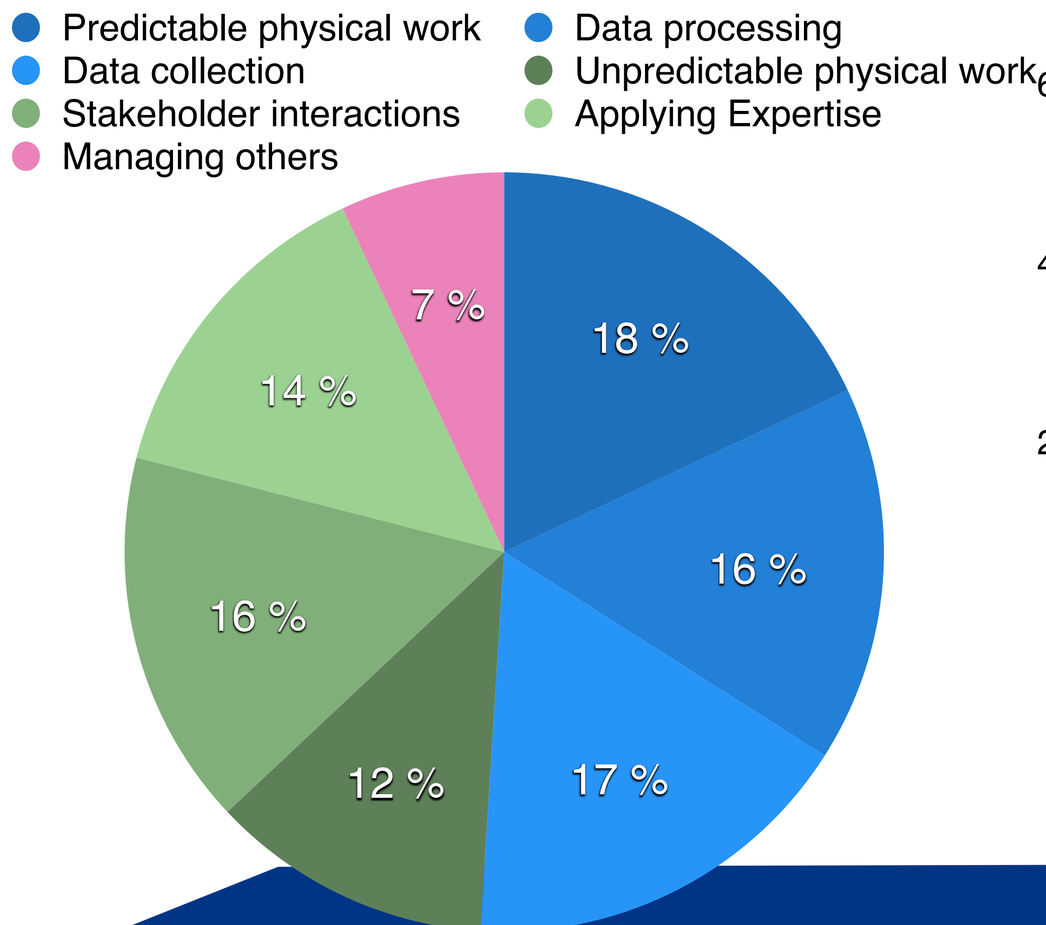
- costs
- efficiency
- novel services



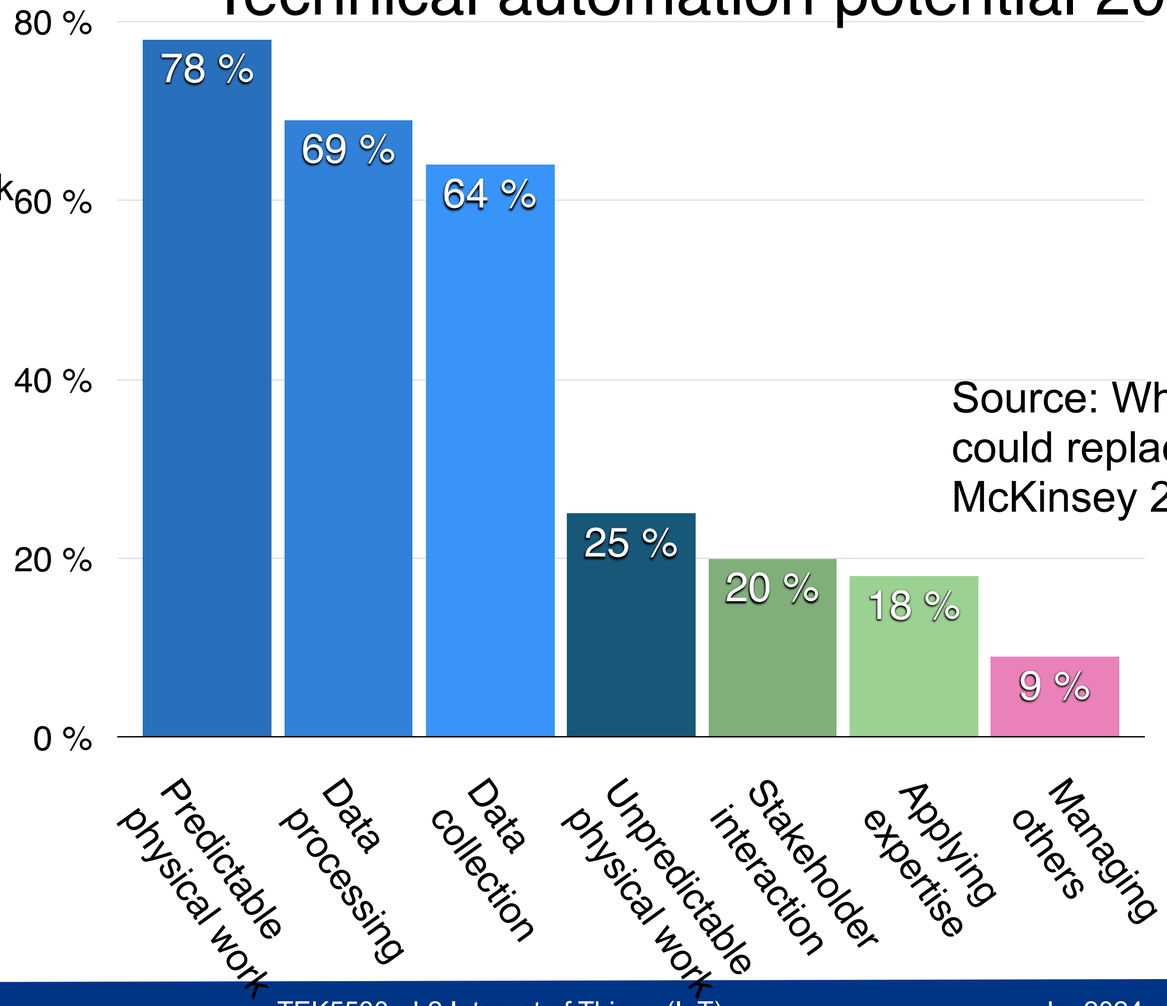
- smart grid
- various control mechanisms
- attack scenarios
- critical infrastructure

Automation will come

USA work force time spent [%]

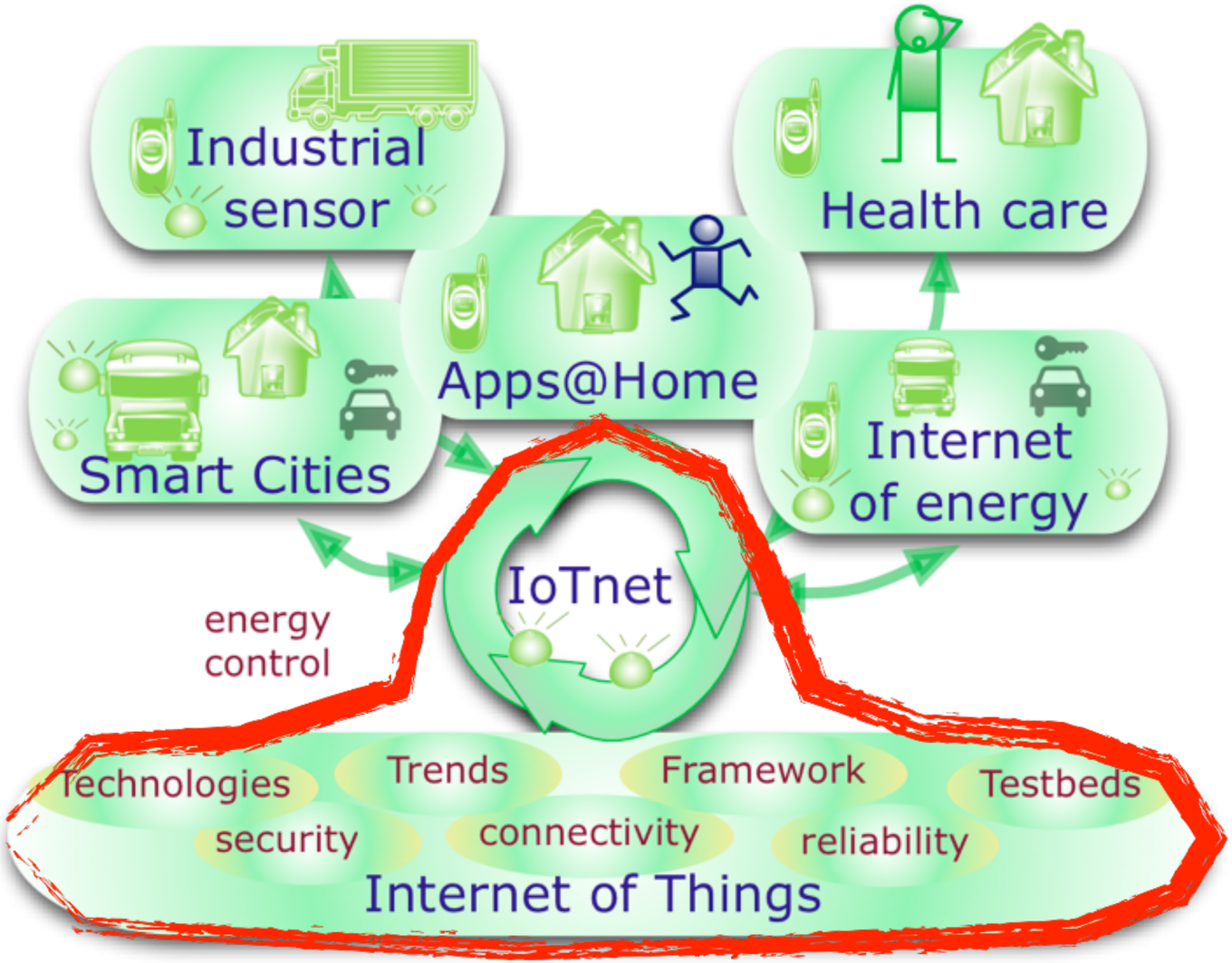


Technical automation potential 2016 [%]



Source: Where Machines could replace humans, McKinsey 2016

IoT technology and application domain



Connected Rail Operations

PASSENGER SECURITY
- In-station and onboard safety
- Visibility into key events

ROUTE OPTIMIZATION
- Enhanced Customer Service
- Increased efficiency
- Collision avoidance
- Fuel savings

CRITICAL SENSING
- Transform “data” to “actionable intelligence”
- Proactive maintenance
- Accident avoidance

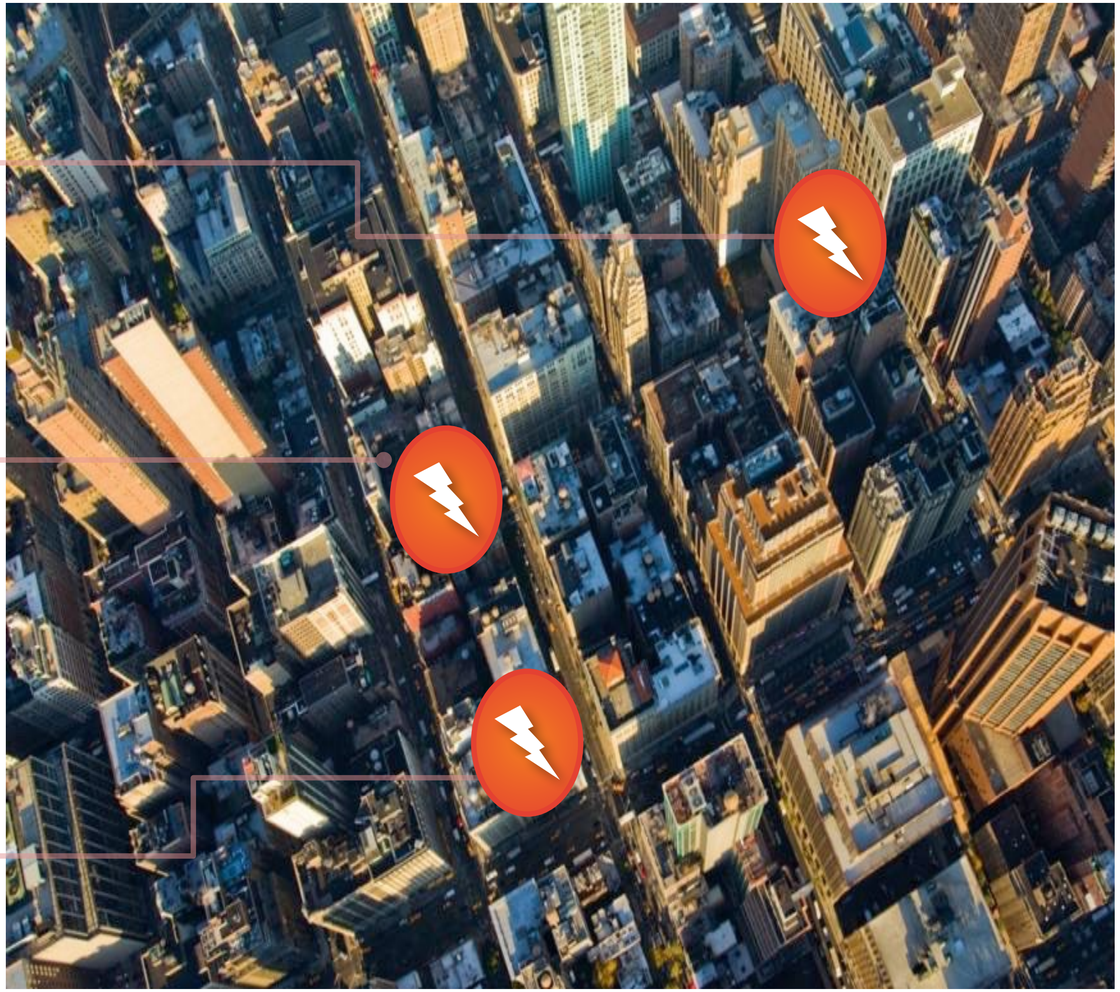
[Source: Cisco, Mikhail Kader, DSE, Cisco, ITU Workshop on “ICT Security Standardization for Developing Countries”]

Smart City

CONNECTED TRAFFIC SIGNALS
- Reduced congestion
- Improved emergency services response times
- Lower fuel usage

PARKING AND LIGHTING
- Increased efficiency
- Power and cost savings
- New revenue opportunities

CITY SERVICES
- Efficient service delivery
- Increased revenues
- Enhanced environmental monitoring capabilities



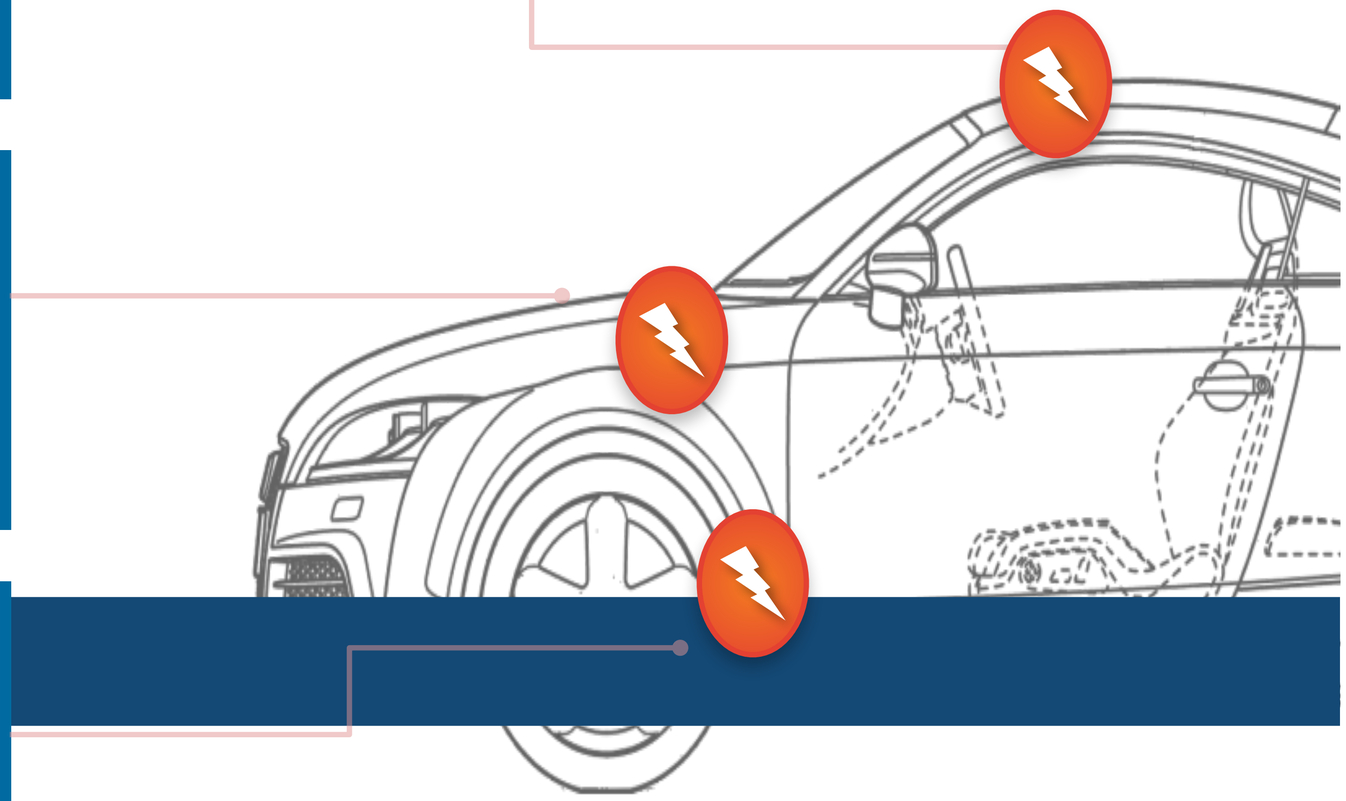
[Source: Cisco, Mikhail Kader, DSE, Cisco, ITU Workshop on “ICT Security Standardization for Developing Countries”]

The Connected Car

WIRELESS ROUTER
- Online entertainment
- Mapping, dynamic re-routing, safety and security

CONNECTED SENSORS
- Transform “data” to “actionable intelligence”
- Enable proactive maintenance
- Collision avoidance
- Fuel efficiency

URBAN CONNECTIVITY
- Reduced congestion
- Increased efficiency
- Safety (hazard avoidance)



[Source: Cisco, Mikhail Kader, DSE, Cisco, ITU Workshop on “ICT Security Standardization for Developing Countries”]

Examples of IoT applications

WSI Citizen Observatories

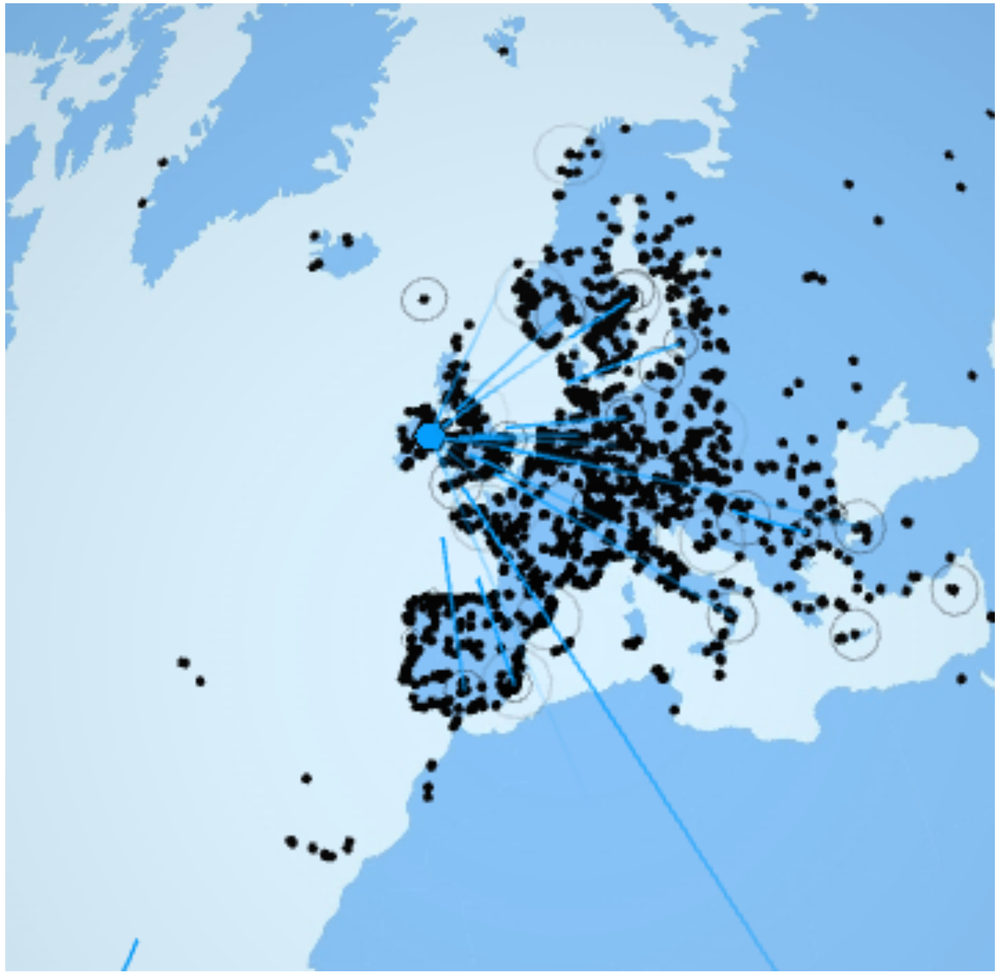
- Create and deploy
  - A method, an environment and an infrastructure
    - Supporting an information ecosystem
      - For communities, citizens, and emergency operators/ policymakers
  - Where citizens and communities:
    - Take on a new role in the information chain of water related decisions
    - Constantly monitoring water resources to make sense of and react to sudden changes and/or emergencies

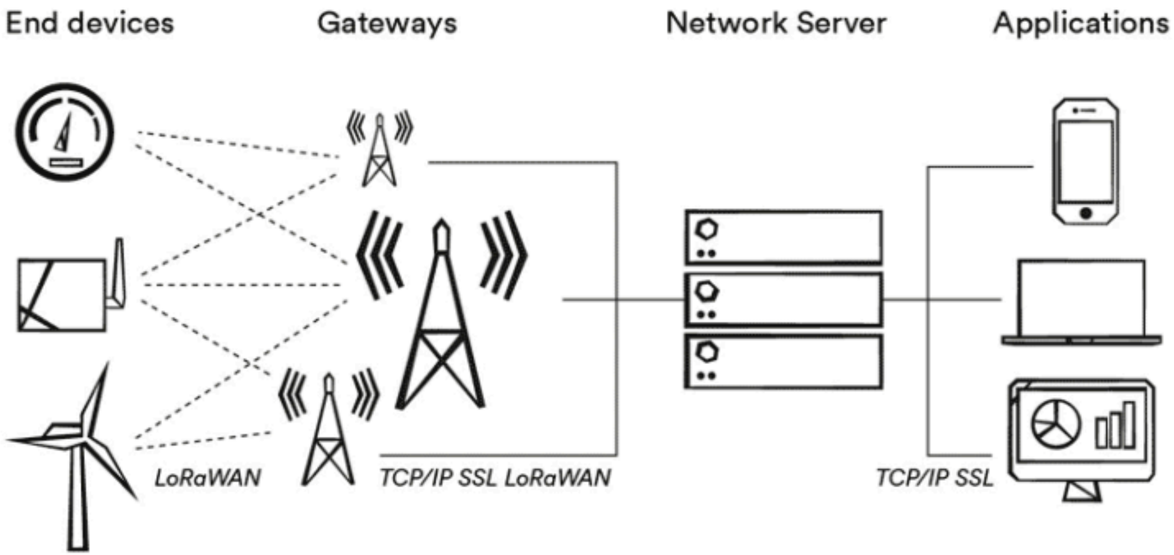
- Cost reduction by an order of magnitude
  - from €10k to €1k, from €1k to €100, from €100 to €20
- Sensors:
  - Weather stations, Soil moisture probes, Gauge boards, Radar sensor flow gauges, Disdrometers …

© WeSenseIt Consortium

The Things Network

http://thethingsnetwork.org





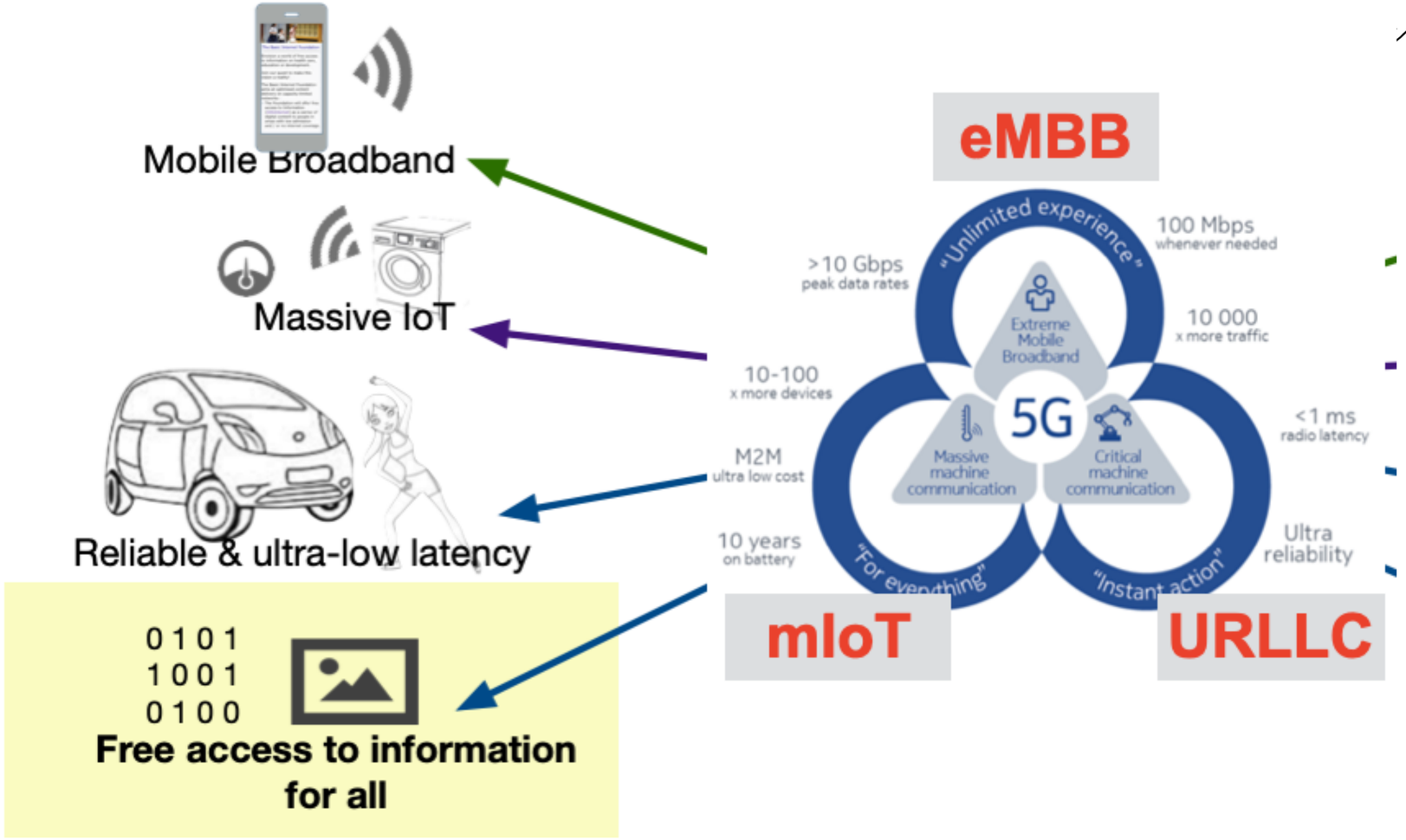
https://www.actility.com/lorawan-network-server/

We are a global collaborative Internet of Things ecosystem that creates networks, devices and solutions using LoRaWAN®.

https://www.thethingsshop.com

5G opportuniti

- mIoT
  - massive IoT
  - eSim in every device
- URLLC
  - ultra reliable, low latency communication
  - car platooning
- eMBB
  - enhanced Mobile Broadband
  - Fixed-Wireless (fibre replacement)
- missed opportunity
  - Societal responsibility



https://www.digi.no/artikler/5g-nettet-er-til-fordel-for-teleoperatorene-ikke-forbrukerne/491288 (2020)

Let’s move (roof, Makerspace)

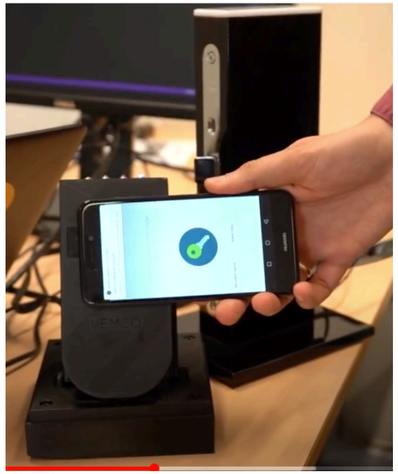
Smart Grid Services in the home

Internet

[source: seminarsonly.com]

- Example: automatic meter reading (AMR) and -system (AMS)
- Billing
- Alarm (temperature, security, fire, water)
- Health (surveillance of people and infrastructure)
  - Fridge with open door
  - Person who has fallen

    https://www.youtube.com/watch?v=r9VnE2F3Kn0
- Electricity (monitoring, securing supply)



"Virtual fall sensor"
- measure water & electricity
- profile the user
- estimate: probability of an accident

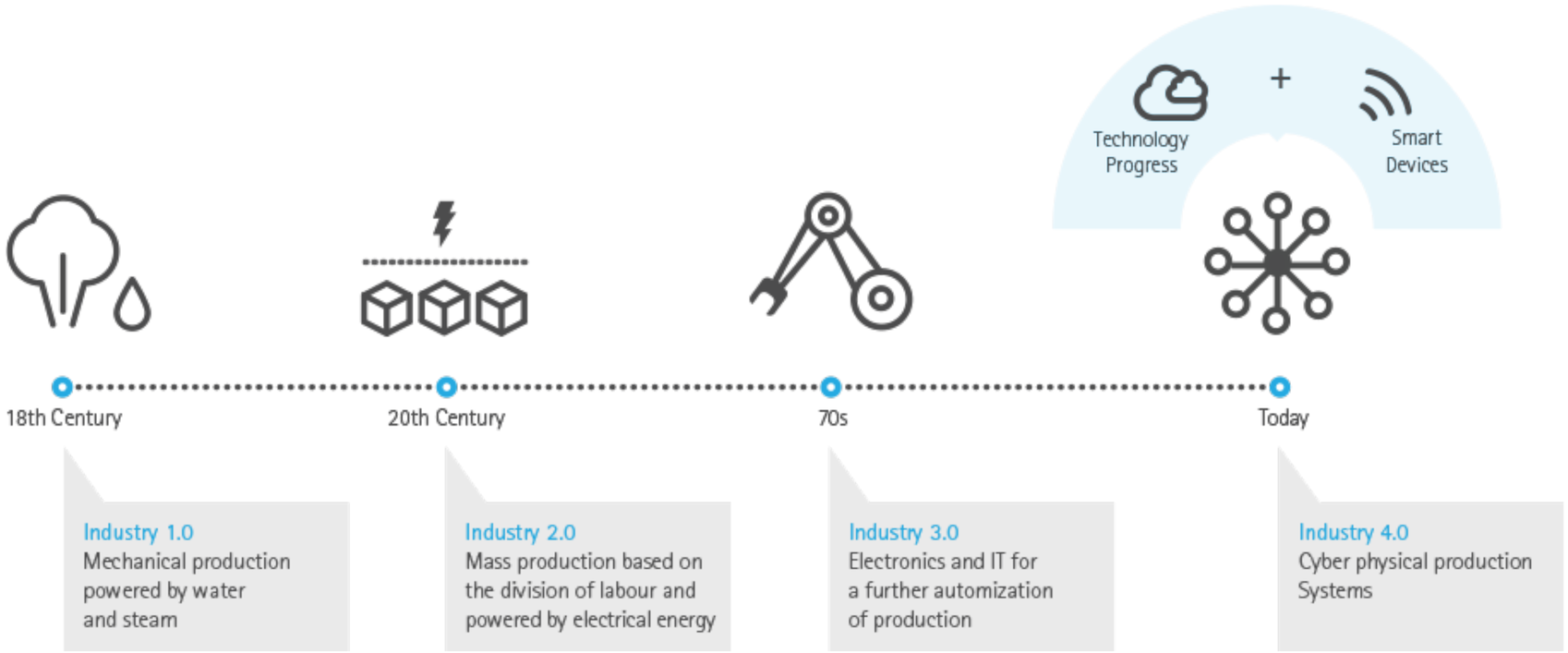
IoT services

- Enabled by wide scale data gathering
- Monitoring of massive systems
- Real-time insight to processes
- Observation of systems
- Performance measurement and optimisation

- Proactive and predictive methods
- To serve the automation goals, the services provided must be:
  - scalable,
  - distributed,
  - have a real reference to the physical world (e.g. time),
  - must ensure security and privacy of the users
- Just using existing security solutions is not leading to secure IoT deployments
- Composed by IT, operations and the IoT enabled objects

Merging sensors with industrial production
Generating Data and Services

- Internet is the infrastructure – sensor, actuator, controller not on the same physical network any more
- ”dissolves” the automation system in the internet
- Automation processes run over an unknown communication infrastructure
- Network communication gets physical impact
- Automation meets Internet
- The real value of IoT: data. Cloud and big data will enable new services



http://prd.accenture.com/microsites/digital-industry/images/digital/industrial-infographic-large.png

The Security and Trust Dimension

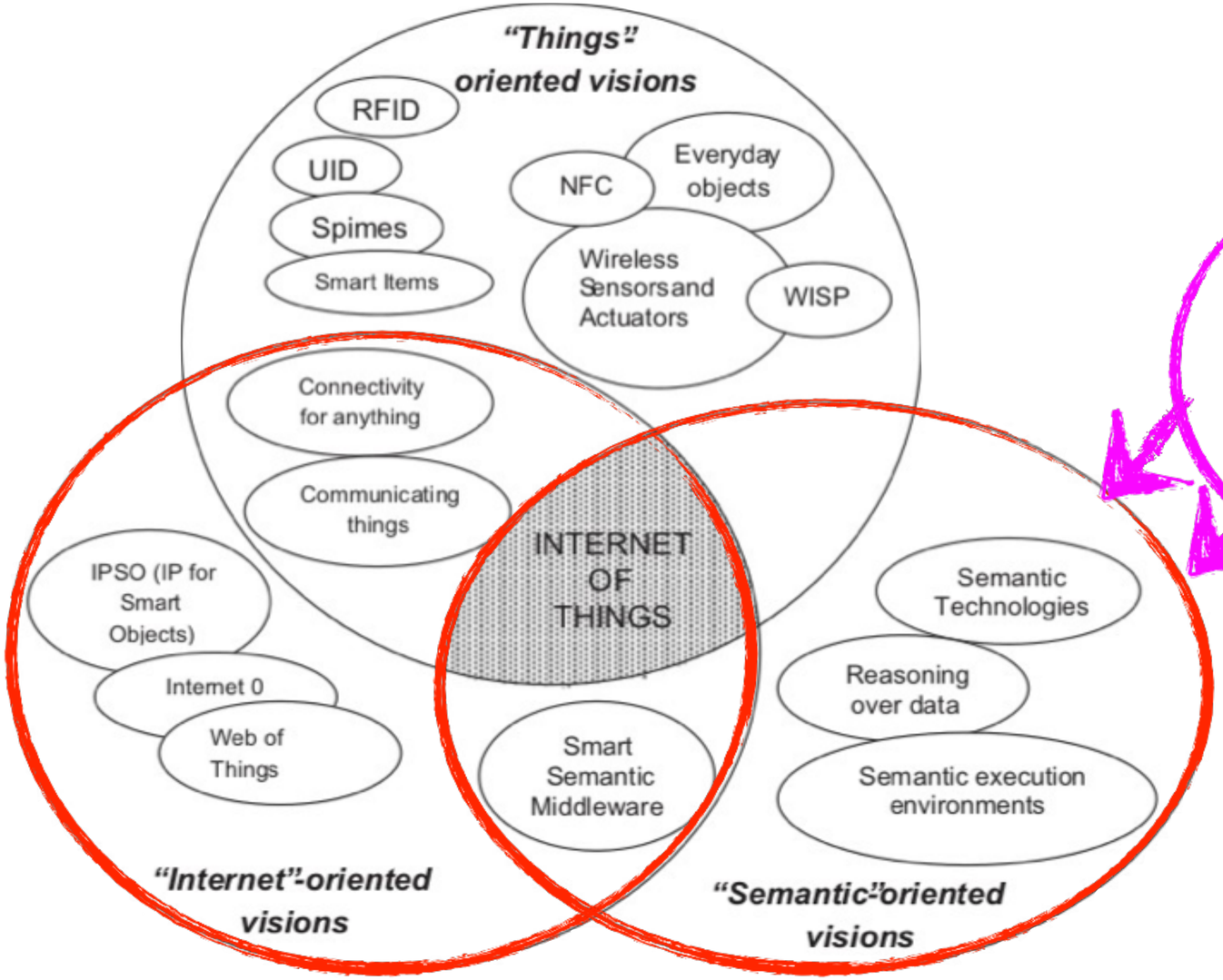


Fig. 1. "Internet of Things" paradigm as a result of the convergence of different visions.

Source: L. Atzori et al., The Internet of Things: A survey, Comput. Netw. (2010), doi:10.1016/ j.comnet.2010.05.010

* security
* privacy
* dependability
* context-aware
* personalised

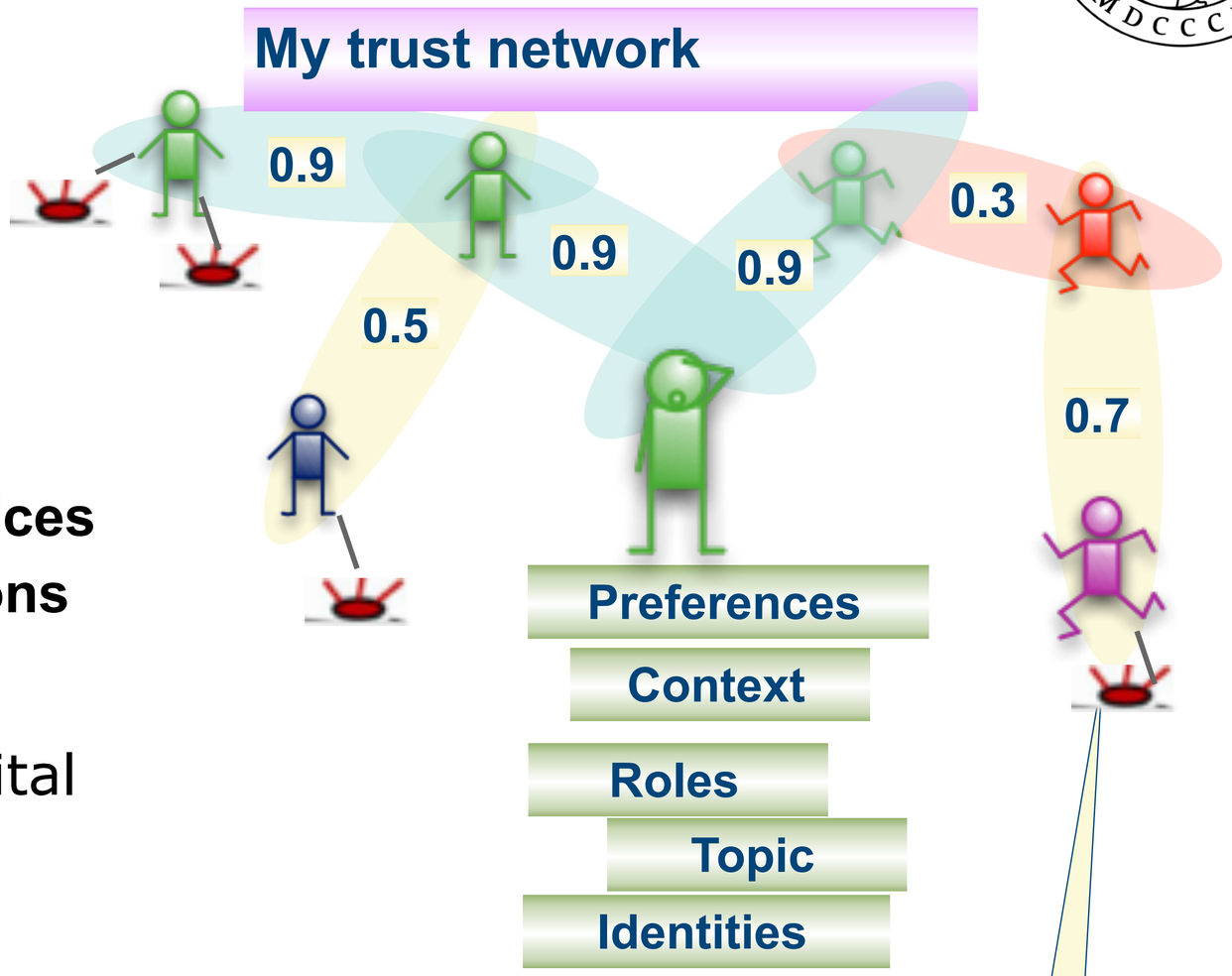
"Only 59% of the public trust the energy industry," (Edelman Trust Barometer 2013)

Paradigm change for
The Internet of the Real World and IoT

- Trust related privacy
  -> **Representing the user adequately**

- Connecting to **sensors, devices** and **services**
  -> **Provide privacy and ensure trust relations**

- An ever increasing complexity in the digital environment
  -> **Hiding the complexity from the use**



Thanks to Vladimir Oleshchuk (UiA) for ideas and discussions

Data & Electricity consumption how are they connected?

"Only 59% of the public trust the energy industry," (Edelman Trust Barometer 2013)

2023

22/05/2023 | at 15:30 POLICY & TRADING

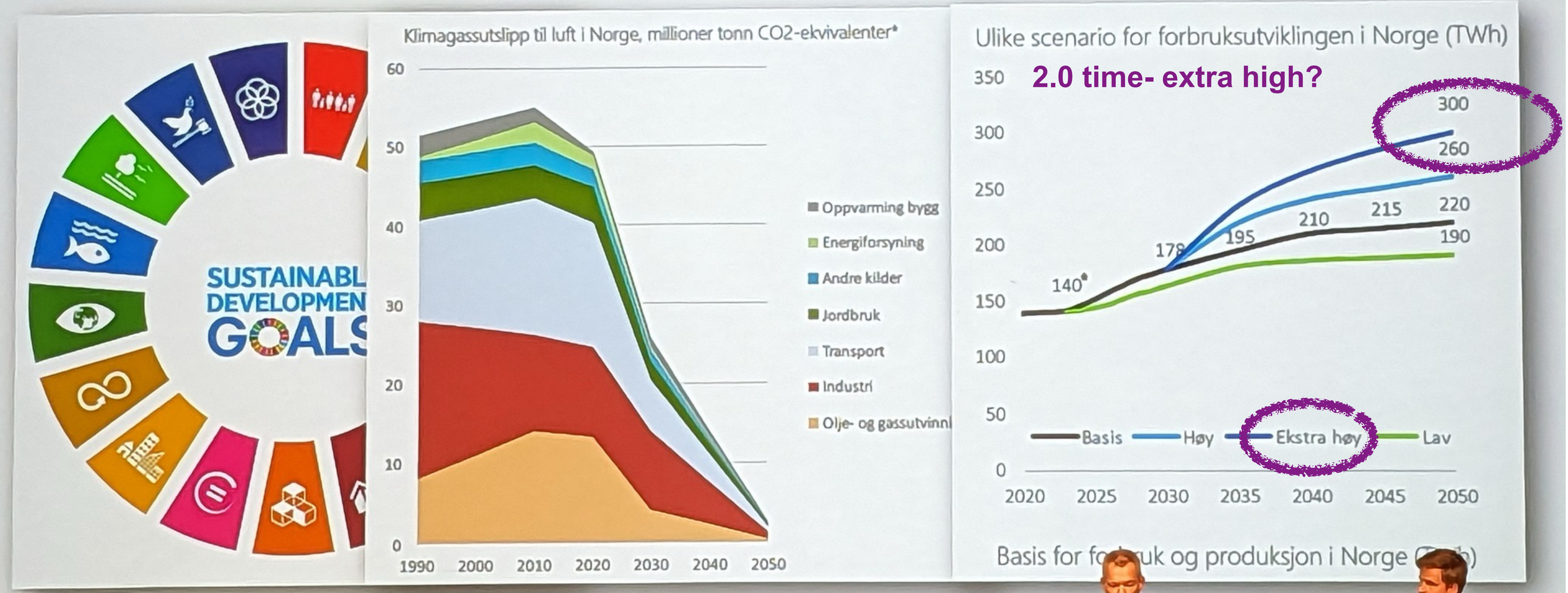
New study: The trust in Europe's energy sector is declining

Consultant thinks that the trust in Danish utility companies is at risk of disappearing.

https://energywatch.com/EnergyNews/Policy___Trading/article15856818.ece

Sustainability and electrification

Source: Statnett LMA 2022

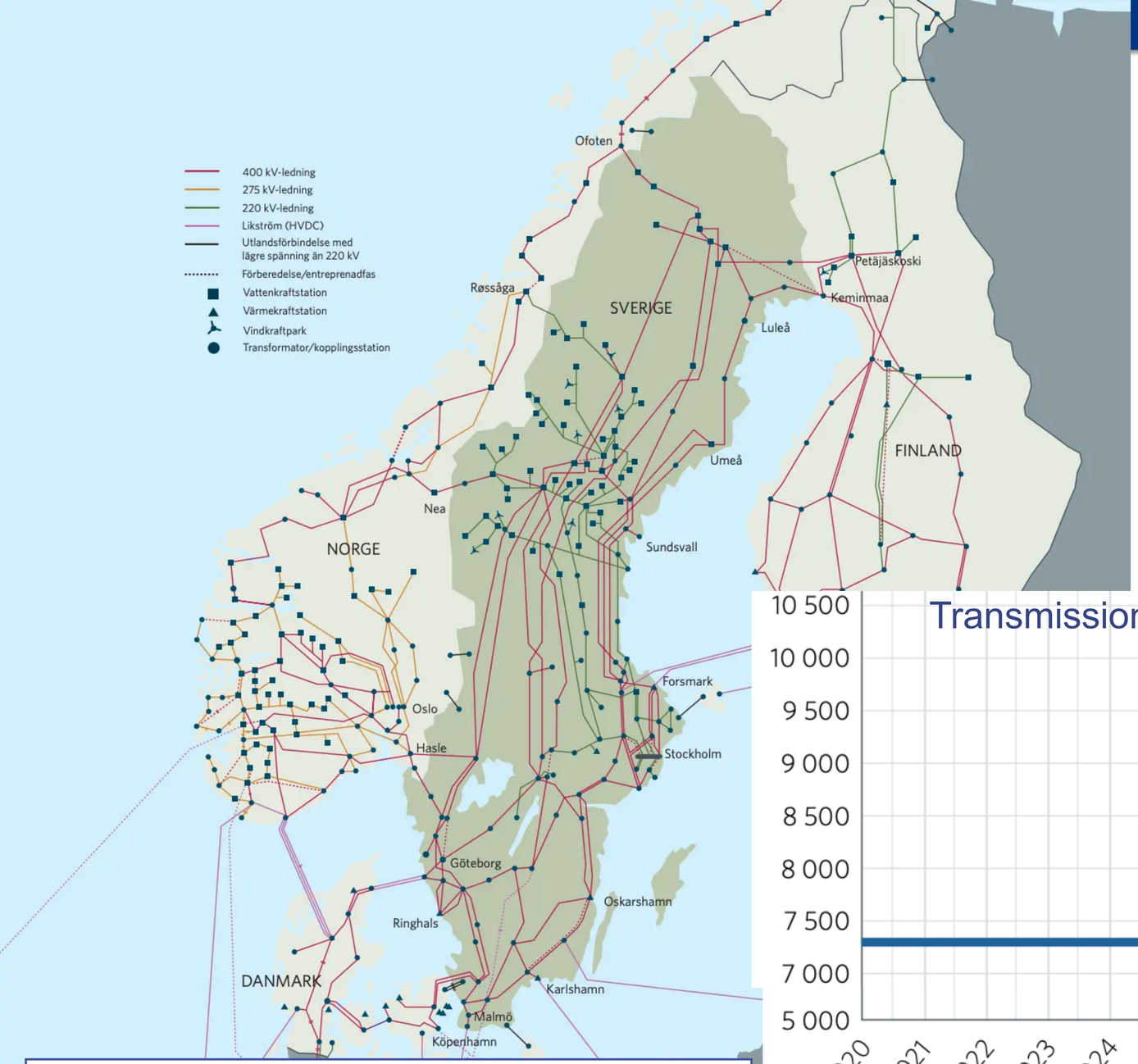


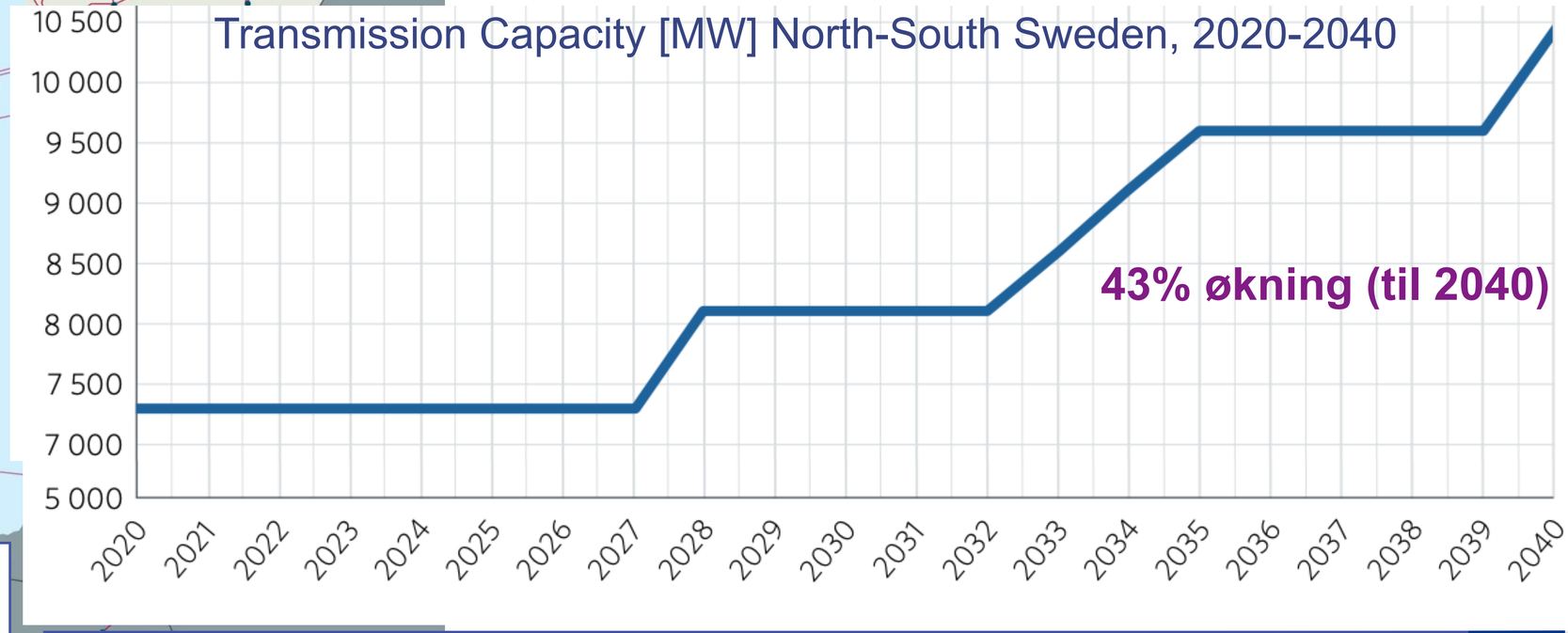
[Source: SmartGrid Conference 27Sep2023]

Per-Oddvar Osland
GlitreNett.no

Simon Koopmann
Envelio.com

Grid utviklingen





https://www.aftenposten.no/norge/politikk/i/z7vWJw/statnett-vil-ha-mer-flyt-av-kraft-mellom-nord-og-soer-men-det-vil-ikke-sp-og-sv-ap-er-i-tenkeboksen

https://www.svk.se/siteassets/om-oss/rapporter/2021/svk_systemutvecklingsplan_2022-2031.pdf

The Power is at the Edge
of the grid

Just Transition
Emission
Low
High
Green Jobs
Participatory transition
Digital Empowerment
Market place
Neighbourhood

Energy Twins struktur og deltagelse

Energy Twin layers	Kommune/Mediators
Mission Planning	55% by 2030, 90-95% by 2050
Reporting	
Operation Planning	Sector specific goals & incentives: housing, …
Control, AI, ..	
Energy Management	Municipality buildings
twin layer interface	
energy distribution	
Energy-, Component-, Electrical Health	Component monitoring & control

Verdineutral reduksjon
- *value-based transition*
- *normative integrity of energy transition*

Kommune profil
- hightech
- green
- justice
- rettferdighet

ESG - environment, social, governance

The power is at the edge
of the grid

The green transition
of society is about reducing greenhouse gas emissions, preserving and restoring nature, reversing environmental degradation and ensuring that the energy of the future comes from renewable sources.

The digital transition
of society consists all processes at all levels in society producing and applying infrastructure, services, applications and human behaviour that depend on digital representation of knowledge and computer power.

and municipalities & intermediaries
can empower citizens to participate

Sociable Internet of Things

- Things become socially intelligent
  - yes, without doubts
  - requires new trust model
  - measurable security
- Growing Internet of Things (IoT) market
  - broad connectivity
  - essential openness of smart "*everything*"
  - security, privacy, dependability
-

Imagine a world where things are connected, but unsociable. Every interaction would have to be explicitly scripted or it wouldn't happen. Oh wait, you don't have to imagine it. That's the current model for the IoT, and it won't scale.

http://www.linuxjournal.com/content/true-internet-things

IoT Expands Security Needs

Increased Attack Surface

Threat Diversity

Impact and Risk

Remediation

Protocols

Compliance and Regulation

Converged, Managed Network

Resilience at Scale

Security

Distributed Intelligence

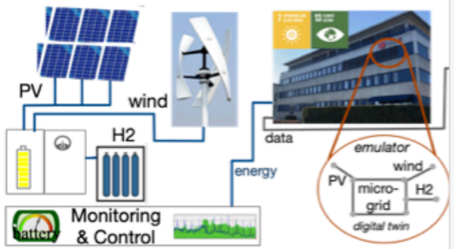
Application Enablement

IoT CONNECTIVITY

Opportunities for group work

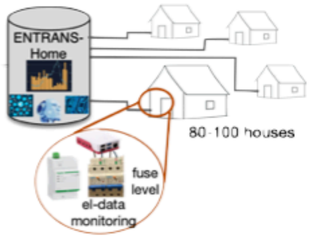
Problem 1: Energy Monitoring & Controlling

- UiO@Kjeller building
  - Smart campus management
  - Energy consumers
  - Meter data
  - Analyze saving possibilities
  - Potential for renewables or efficent use of spill heat/combined energy usage
  - Building automation and communication between buildings



Problem 2: Home automation

- Home energy costs are expected to rise
- Consumption is relatively non-flexible (schedule, convenience, insurance)
- Heterogenous installation with equipment from random vendors
- Smart plugs, meters, app-controlled lamps, heating elements
- Key in large consumers – largest possible benefit:
  - Electric car charging
  - Heat pumps (generally heating, hot water)
- Integration of renewables



Problem 3: Security and Privacy in Home automation

- Challenges to analyze:
  - Identify large consumers, integrate meter readings and introduce some kind of actuators or invest in «smart» device
  - Standards 10 years ago and 10 years from now: future proofing?
- Control beyond «on-off»?
  - How to integrate e.g. solar panel production and energy storage
  - Smart Meter monitoring & Home Automation & controlling

Problem 4: Building safety

- This time focus only on car charging
  - Lithium batteries are in practice inextinguishable once caught fire
  - Parking cellars, houses are specially at risk
- Sensors for monitoring the charge process:
  - Meters, temperature sensors, charge profile, prediction
  - Alarms, active measures (reduction, cutoff of electric power, CO2)
- Communication
  - Cellars are usually bad for wireless

Your area of interest?

- for group work evaluation

L2- Conclusion

- What we mean with IoT
- Domains being addressed
  - Things
  - Semantics
  - Internet
- Security and privacy challenges
  - Security
  - Privacy
  - Multi-owner requirements
- Architecture components
- Services and Ecosystem

- Describe the domains being merged in IoT
- Provide examples of challenges in IoT with focus on services, security and privacy
- Multi-owner service requests
- Analyse security and privacy requirements in an example scenario