

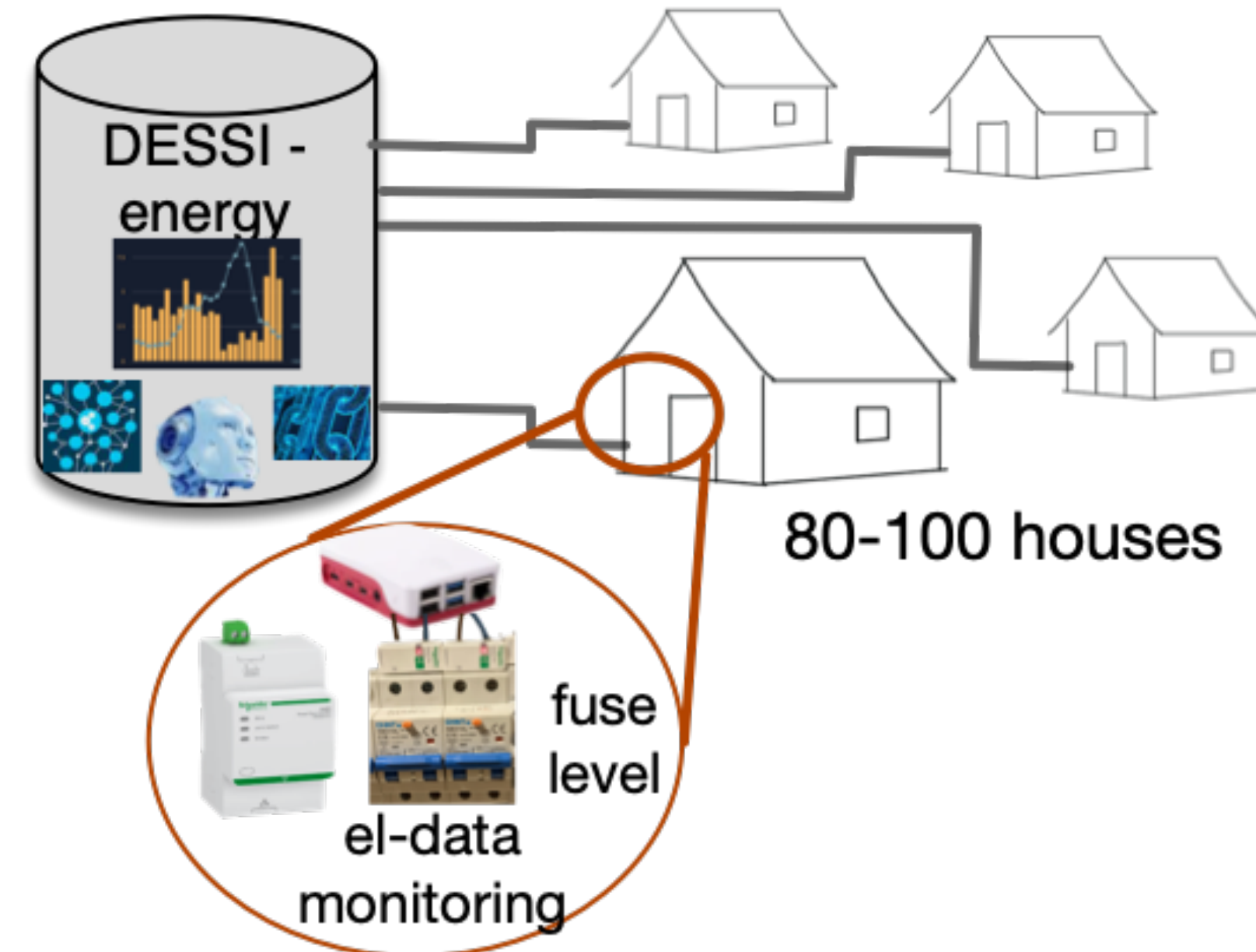
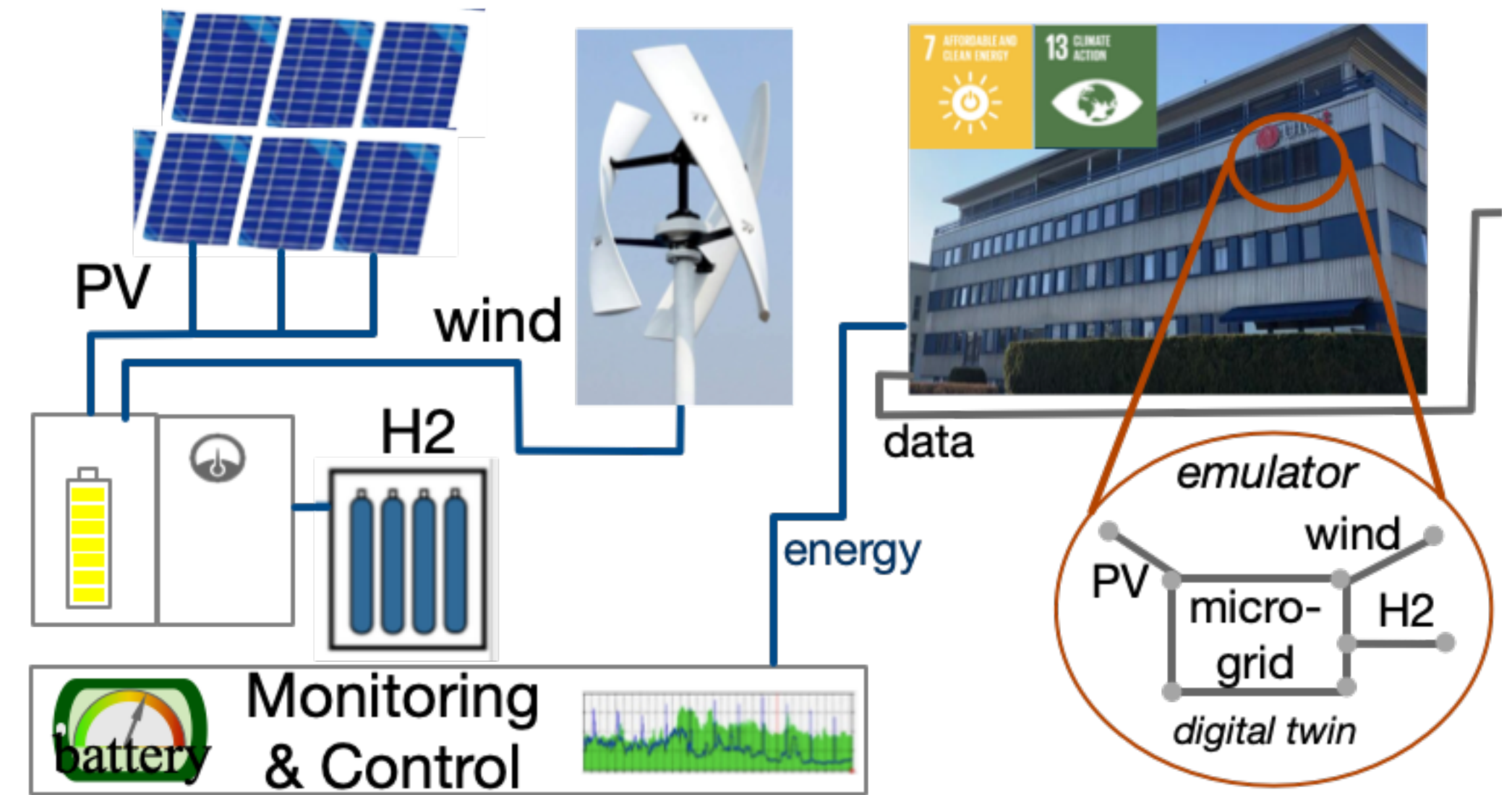
UNIVERSITY OF OSLO

TEK5530 Measurable Security for the Internet of Things

L2 Internet of Things

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Department of Technology Systems

UNIVERSITY OF OSLO

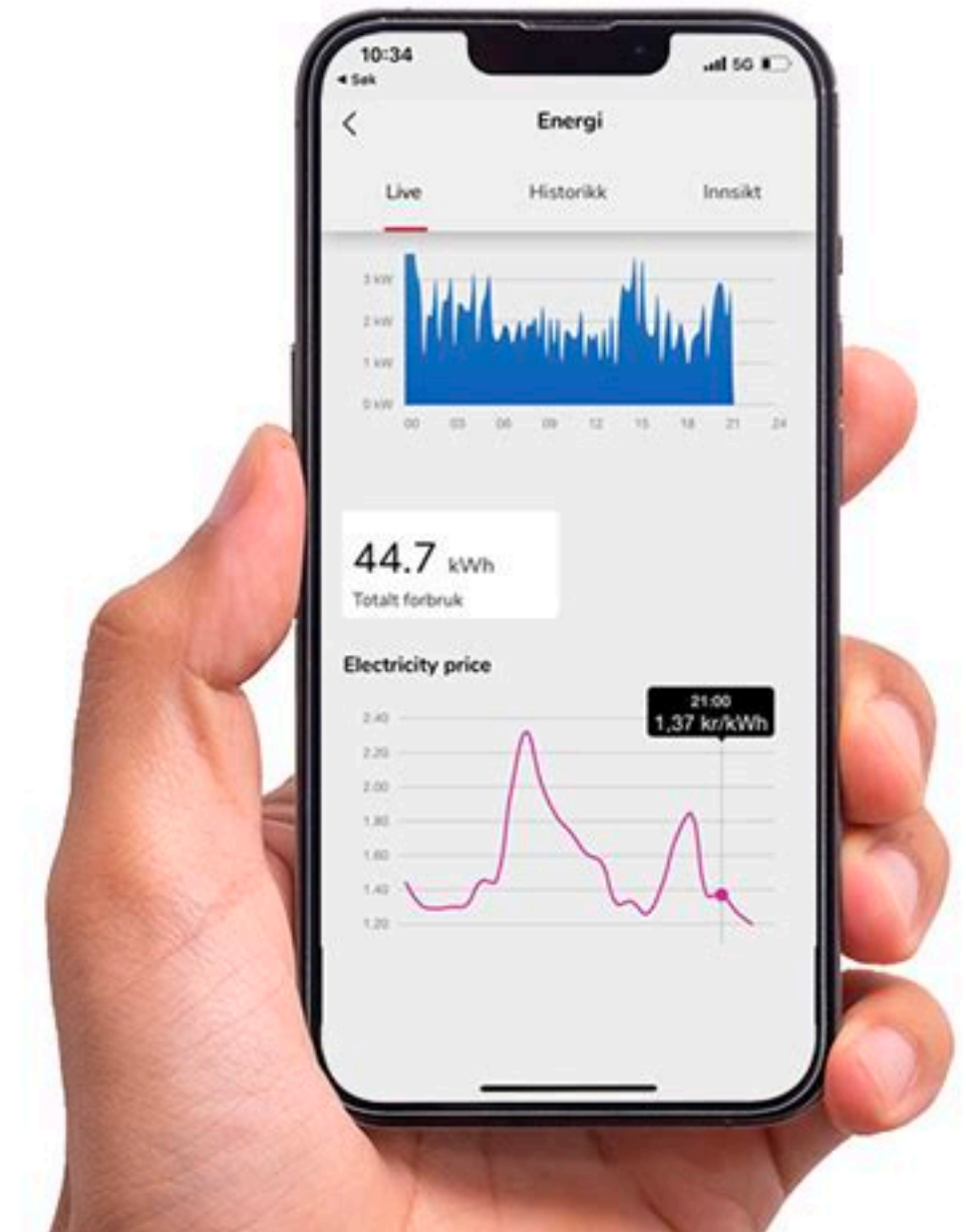


L2- Overview

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

Expected outcome:

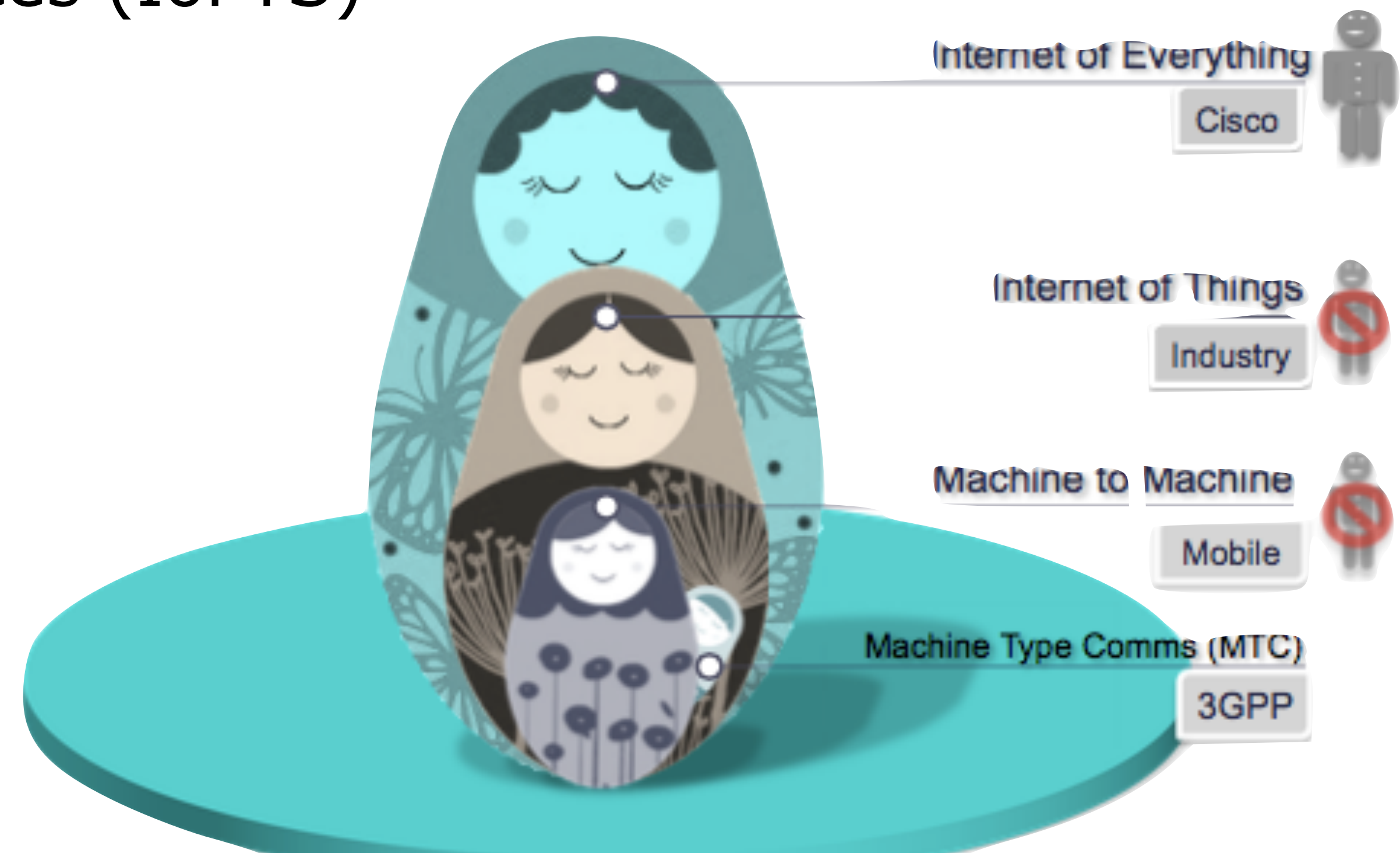
- Describe the domains being merged in IoT
- Provide examples of challenges in each of the domains
- Establish requirements for multi-owner service requests of “a thing”
- Analyse security and privacy requirements in an envisaged scenario



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

Internet of Things aspects

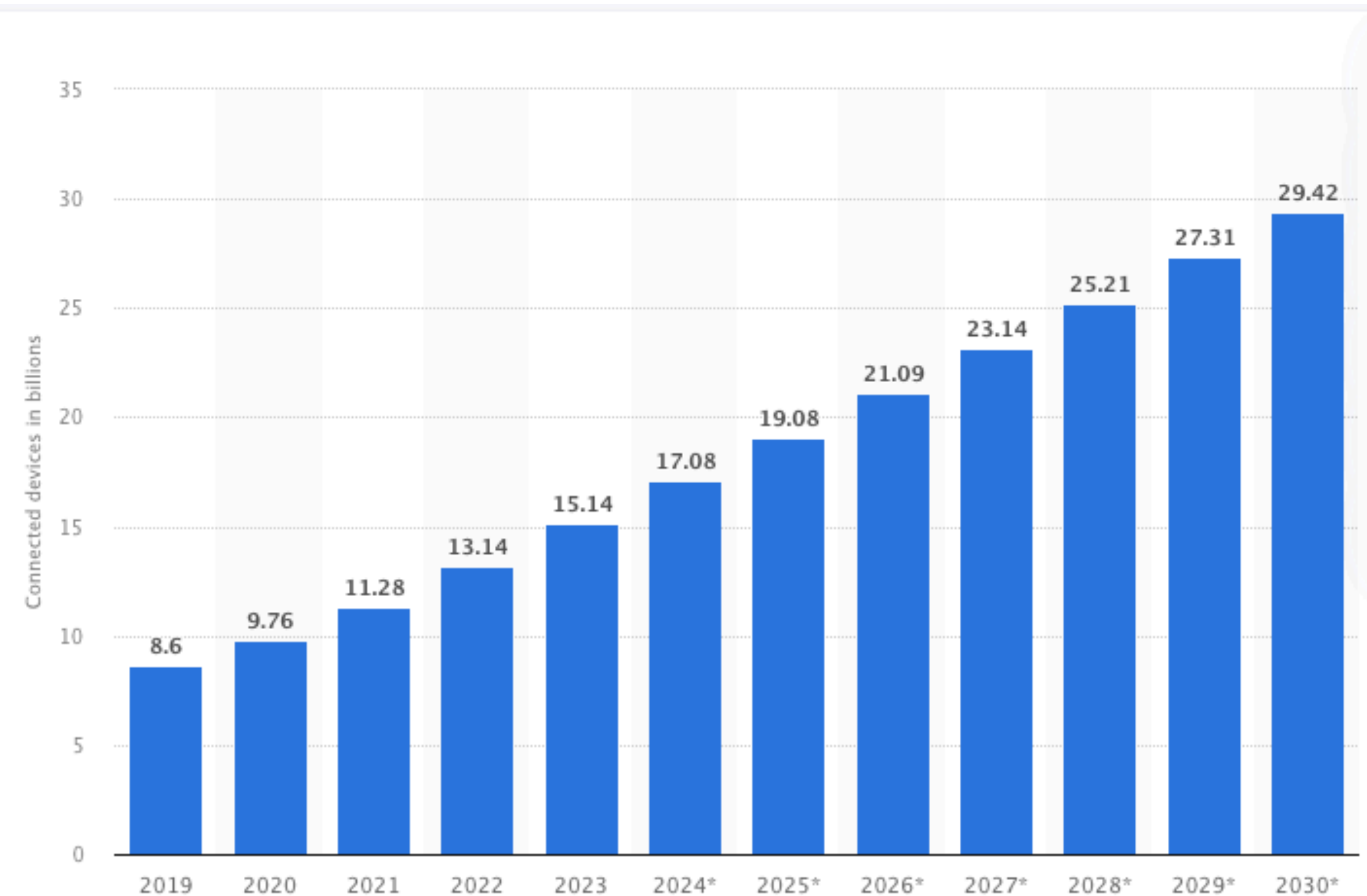
- ➔ The Internet of People Things and Services (IoPTS)
 - The Internet of Things (IoT)
 - The Internet of Everything (IoE)
- ➔ Identity in the IoT
 - Identity and trust between people
 - Identity in IoT
- ➔ Privacy and Security
 - Privacy, Context-awareness
 - Measurable Security
 - Innovation through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



[Source: Monique Morrow, Cisco]

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

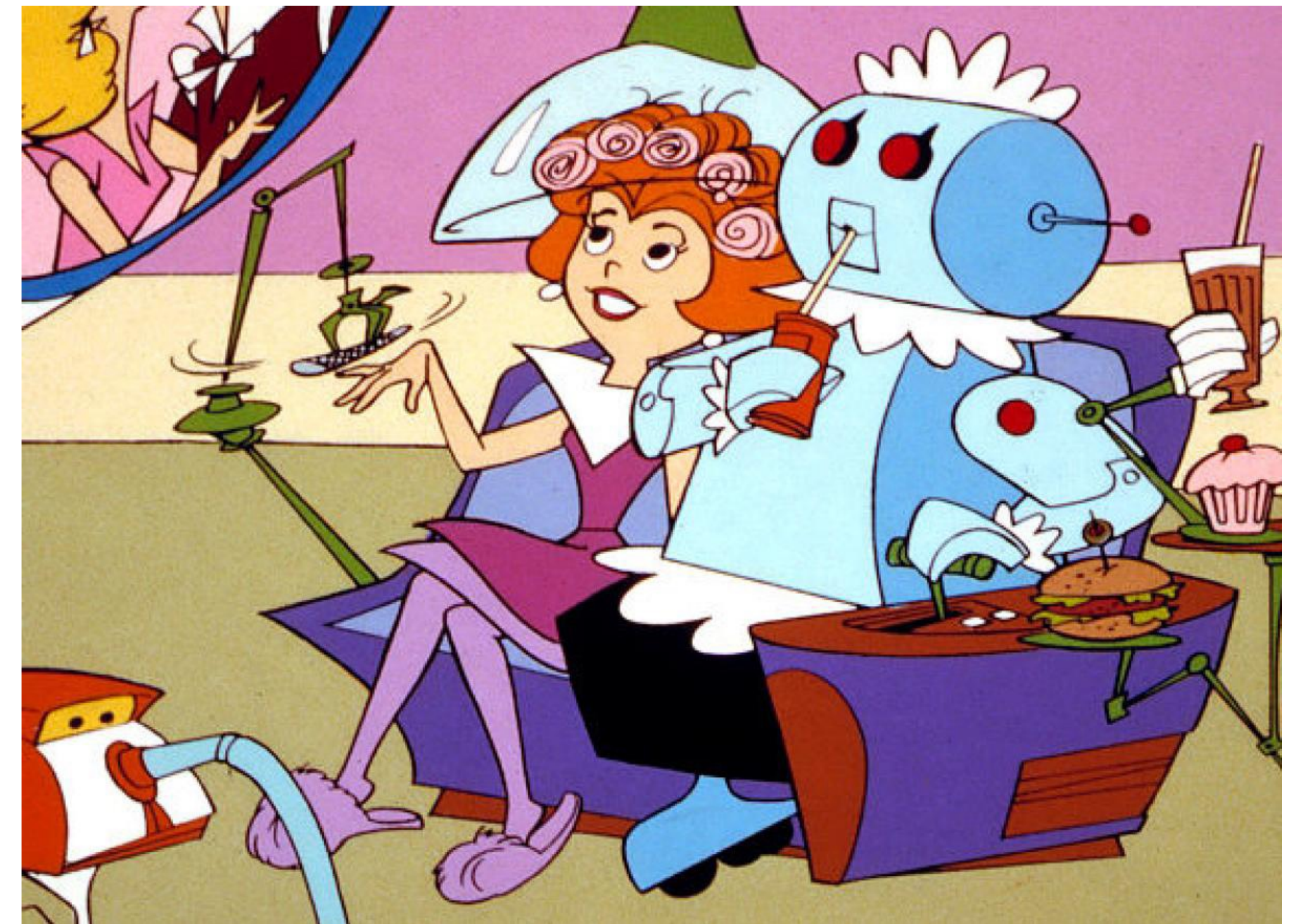


<https://www.statista.com/statistics/1183457/iot-connected-devices-worldwide/>

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

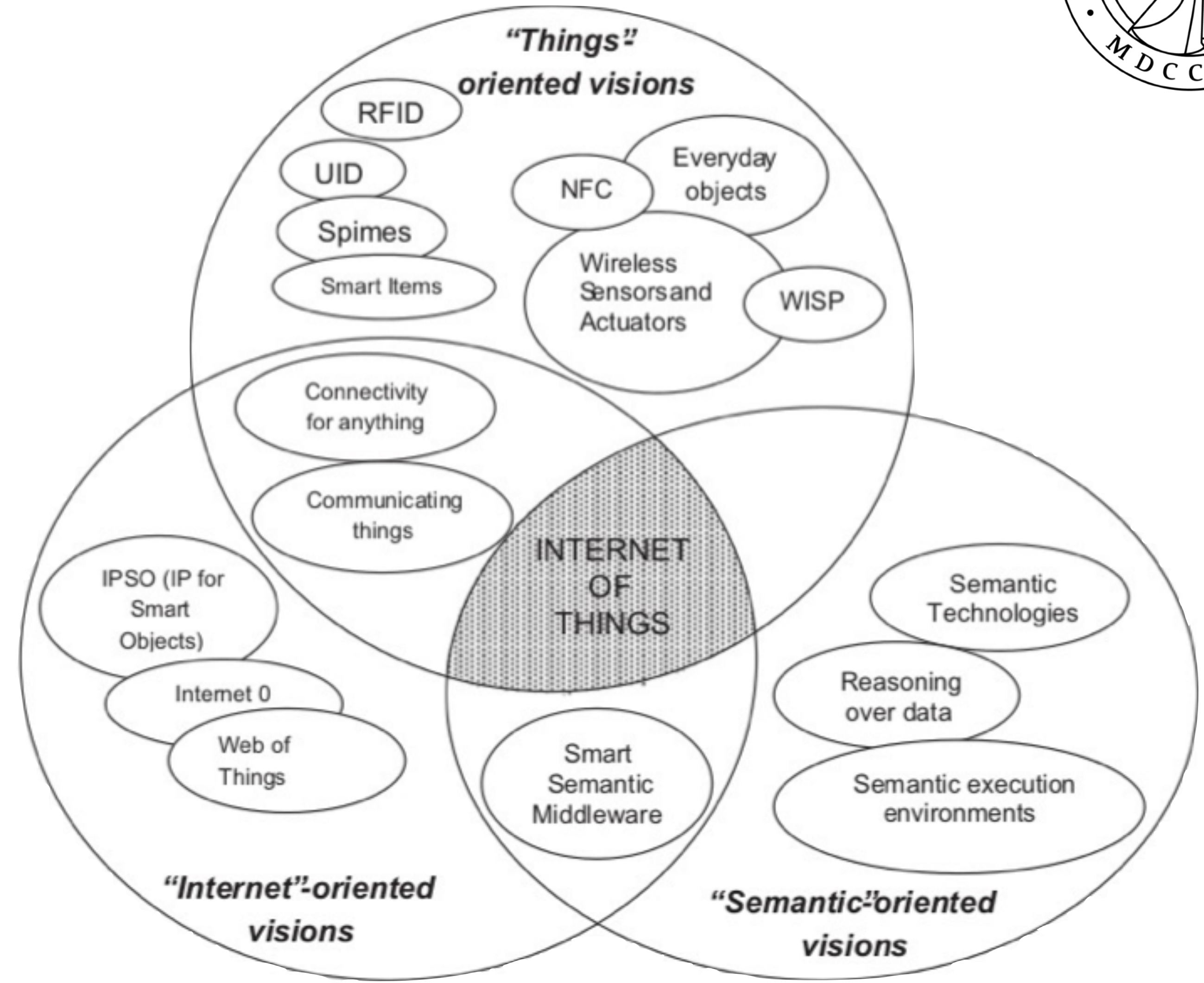


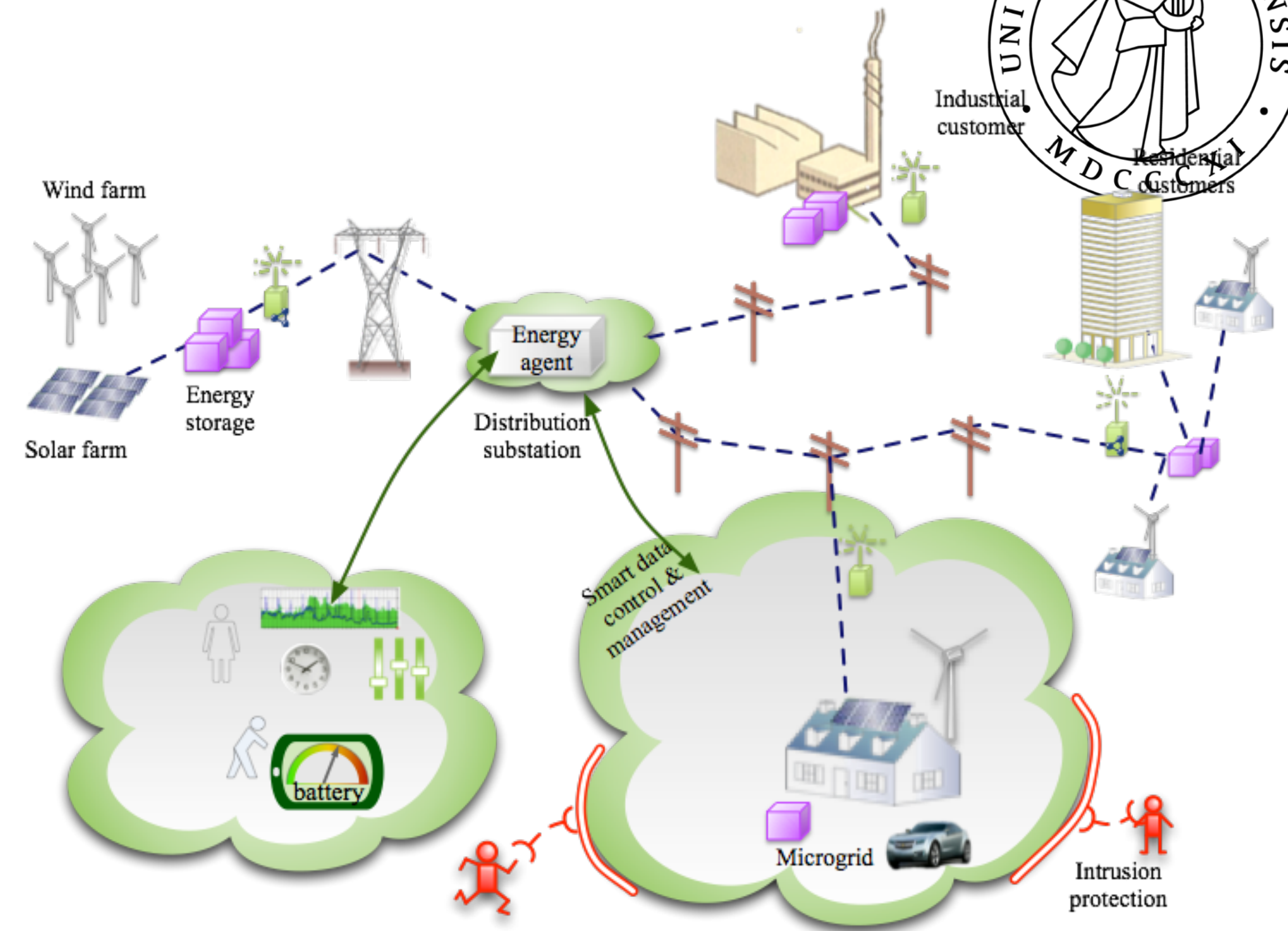
Fig. 1. "Internet of Things" paradigm as a result of the convergence of different visions.

Main drivers for IoT

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

Business drivers

- ➔ costs
- ➔ efficiency
- ➔ novel services

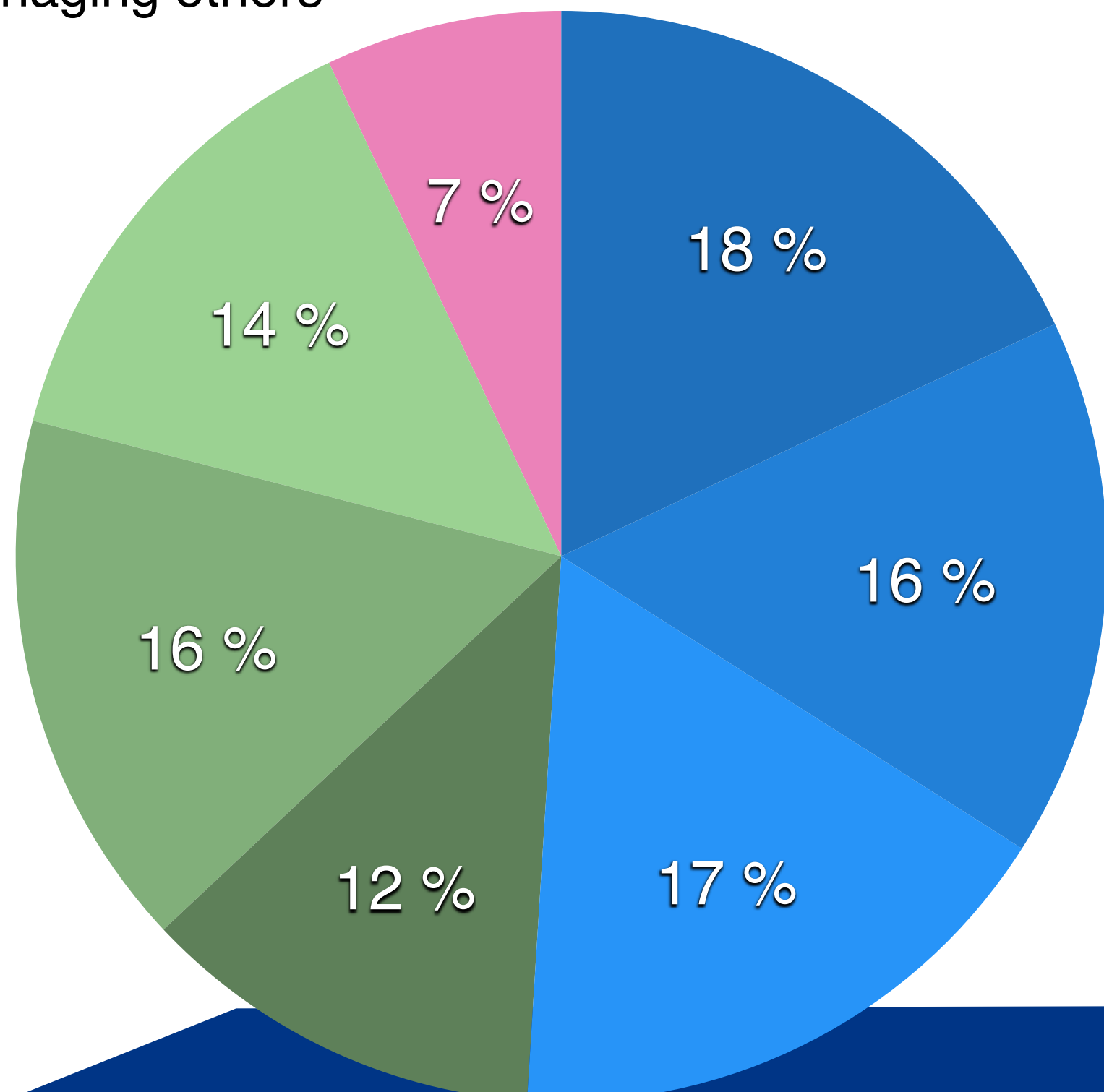


- smart grid
- various control mechanisms
- attack scenarios
- critical infrastructure

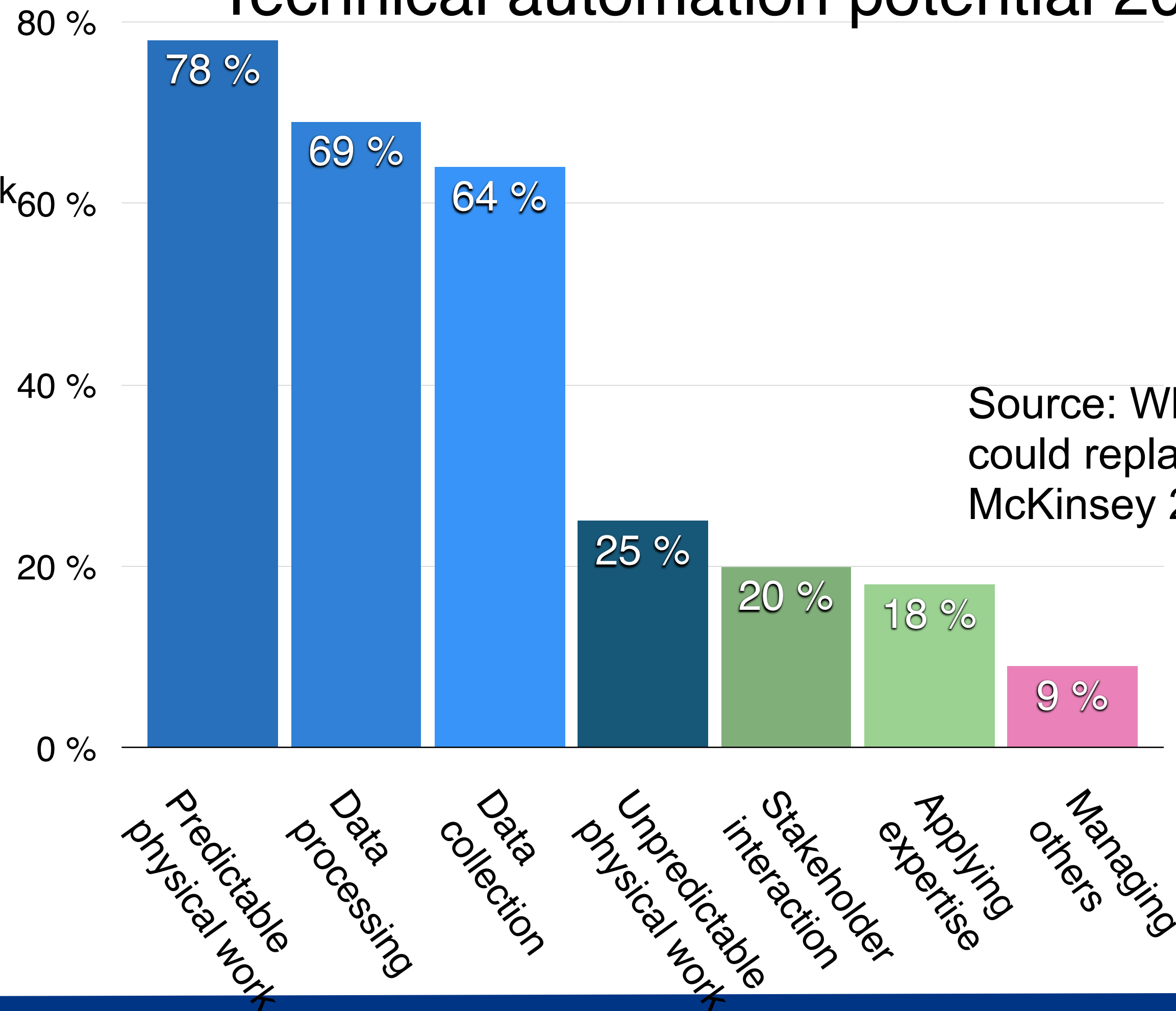
Automation will come

USA work force time spent [%]

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

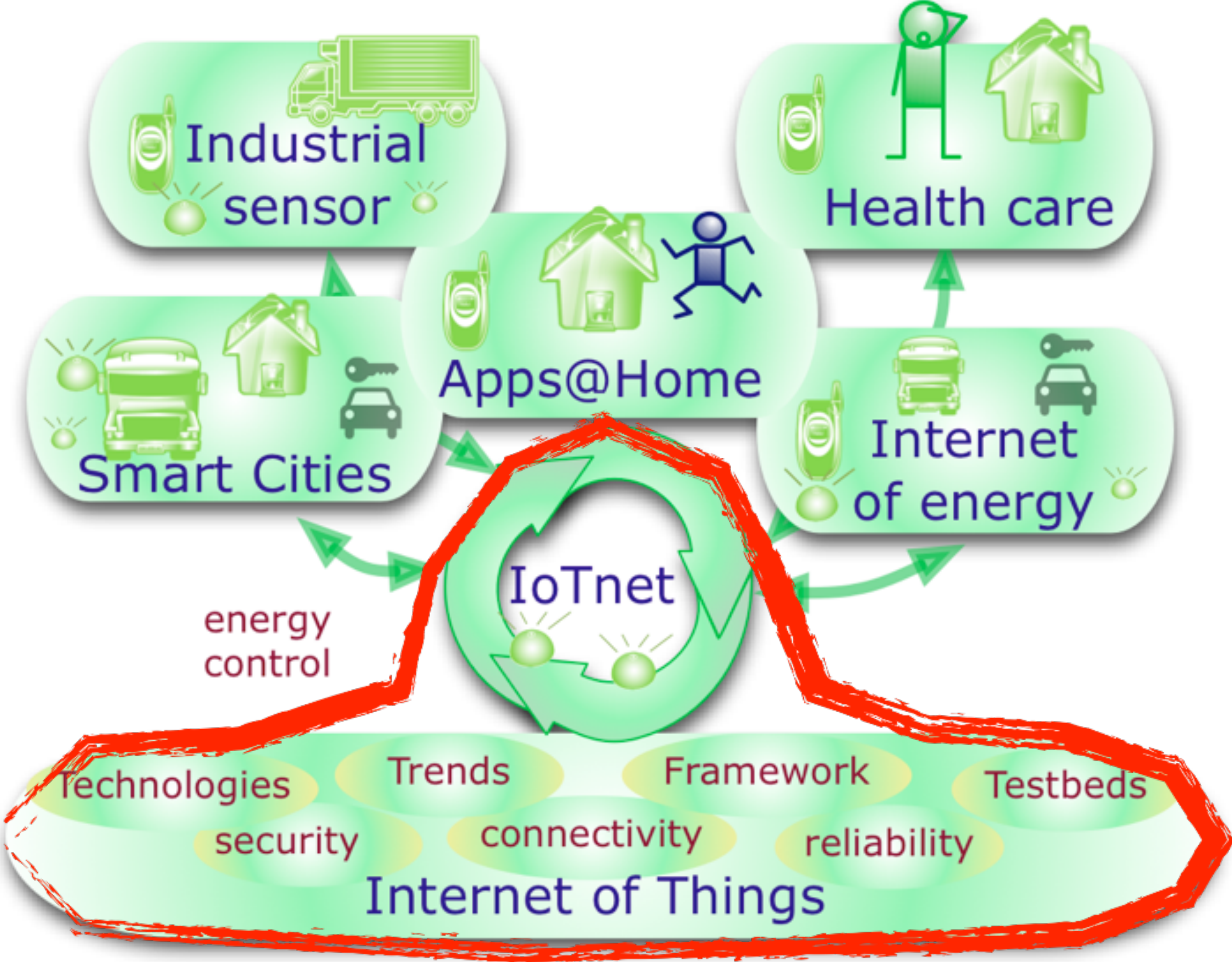


Technical automation potential 2016 [%]



Source: Where Machines could replace humans, McKinsey 2016

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

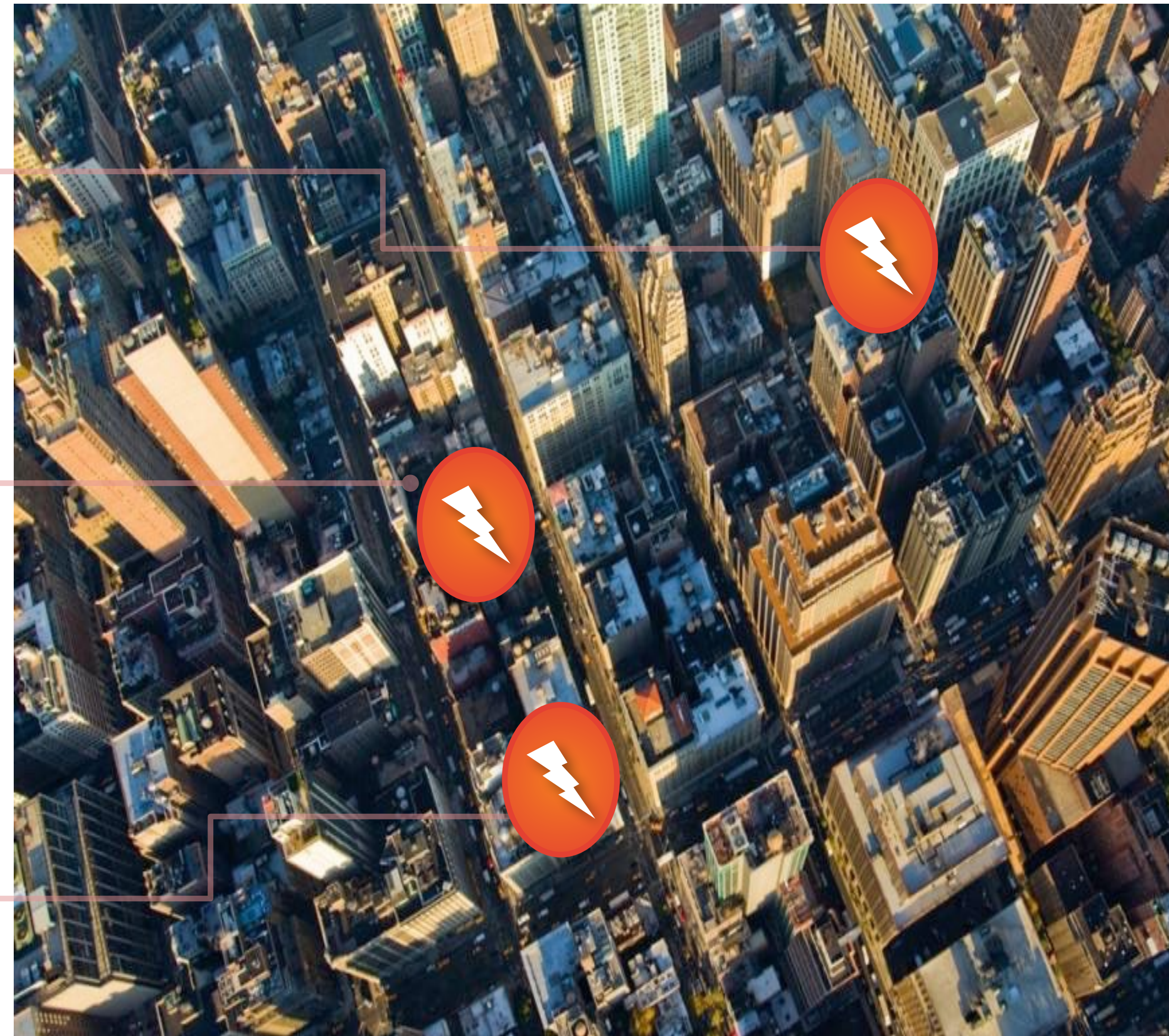
- Reduced congestion
- Improved emergency services response times
- Lower fuel usage

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

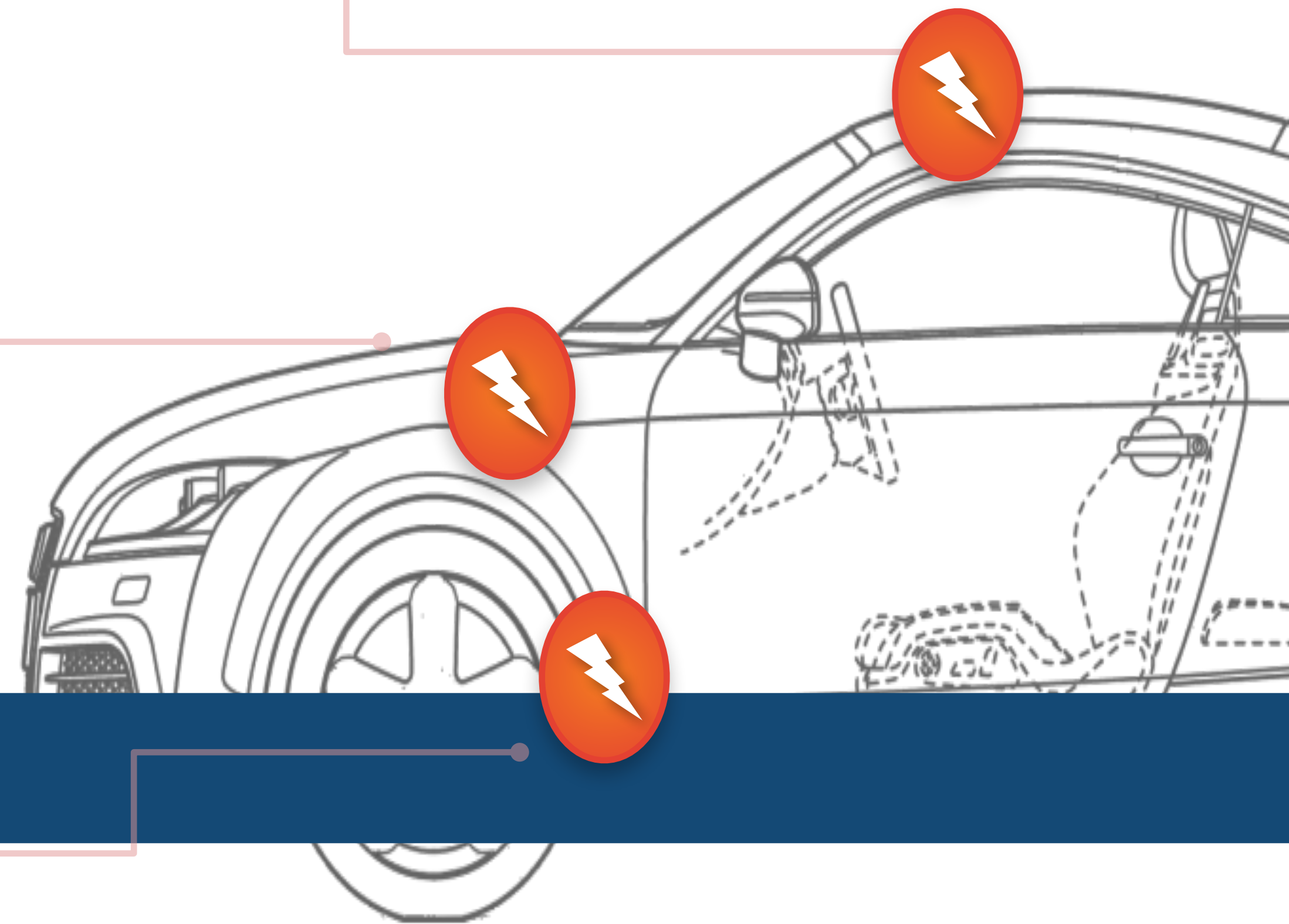
- Online entertainment
- Mapping, dynamic re-routing, safety and security

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

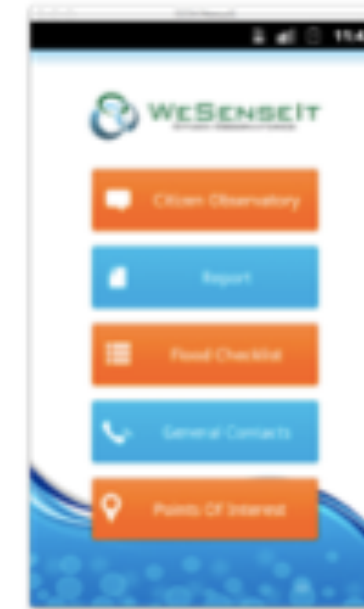
- A method, an environment and an infrastructure

- Supporting an information ecosystem

- For communities, citizens, and emergency operators/policymakers

- Where citizens and communities:

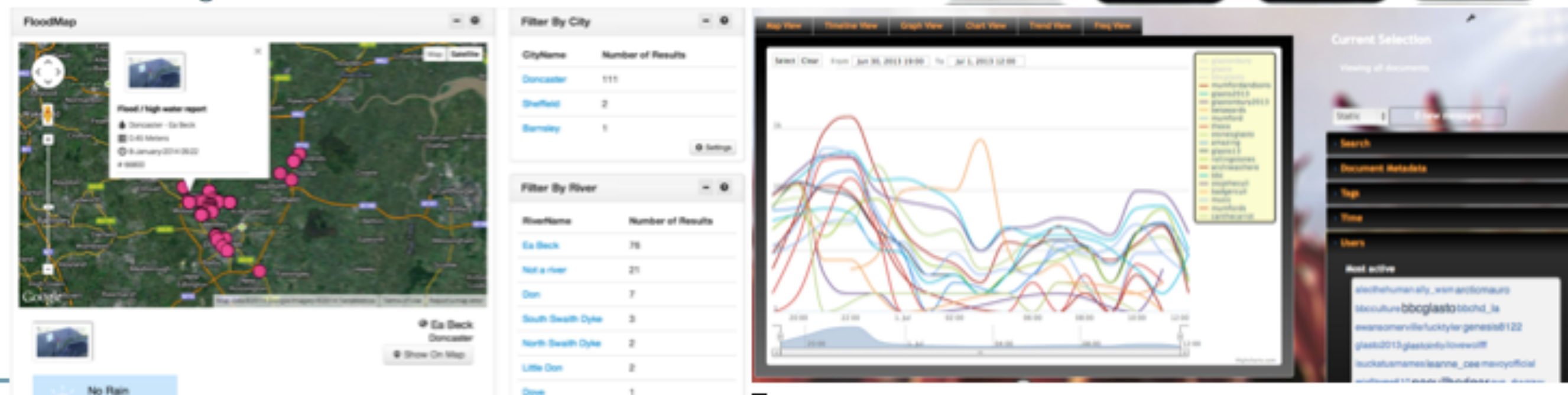
- Take on a new role in the information chain of water related decisions
- Constantly monitoring water resources to make sense of and react to sudden changes and/or emergencies



- 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 ...

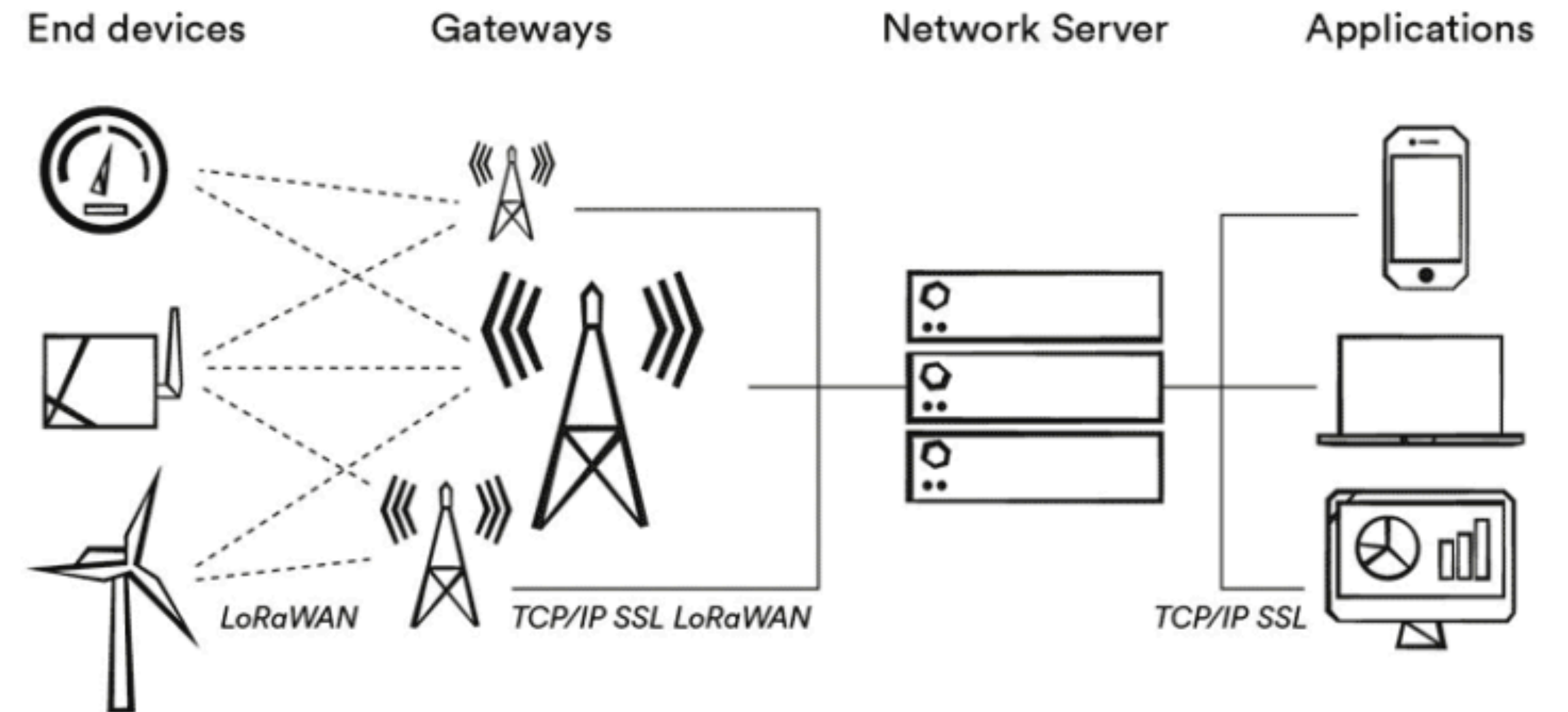
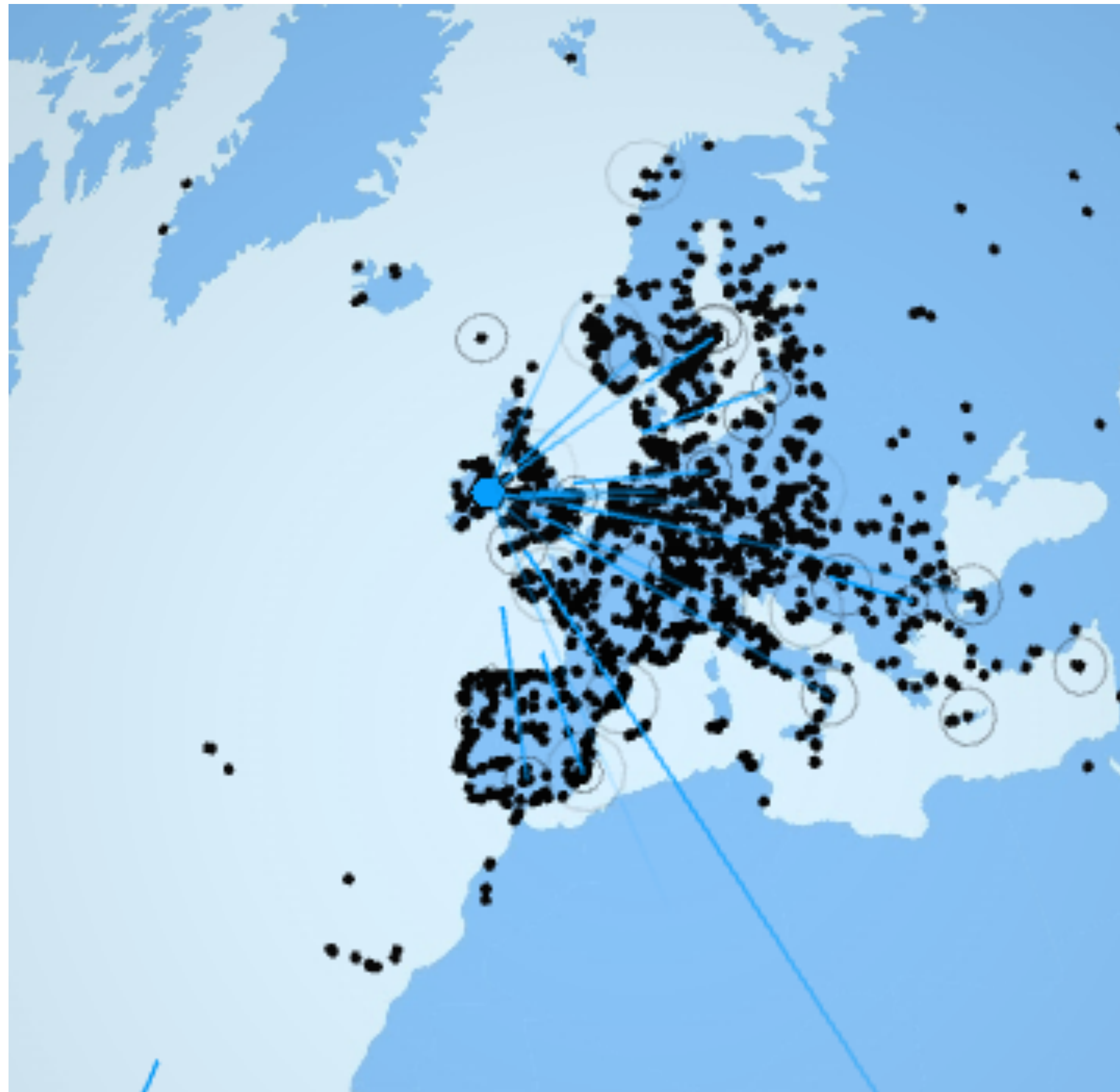


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The Things Network

<http://thethingsnetwork.org>



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

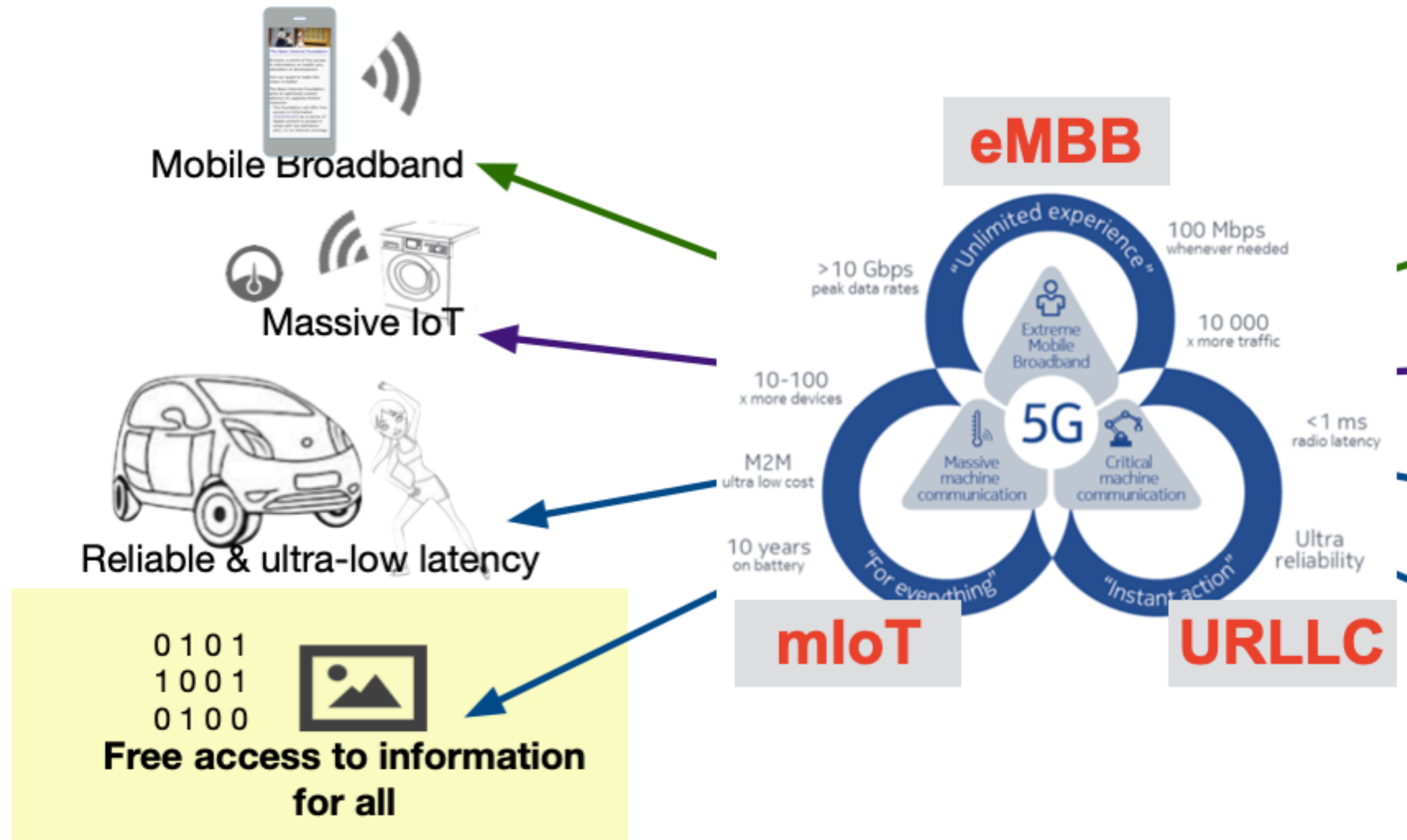
We are a global collaborative Internet of Things ecosystem that creates networks, devices and solutions using LoRaWAN®.



<https://www.thethingsshop.com>

5G opportunities

- ➔ 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)

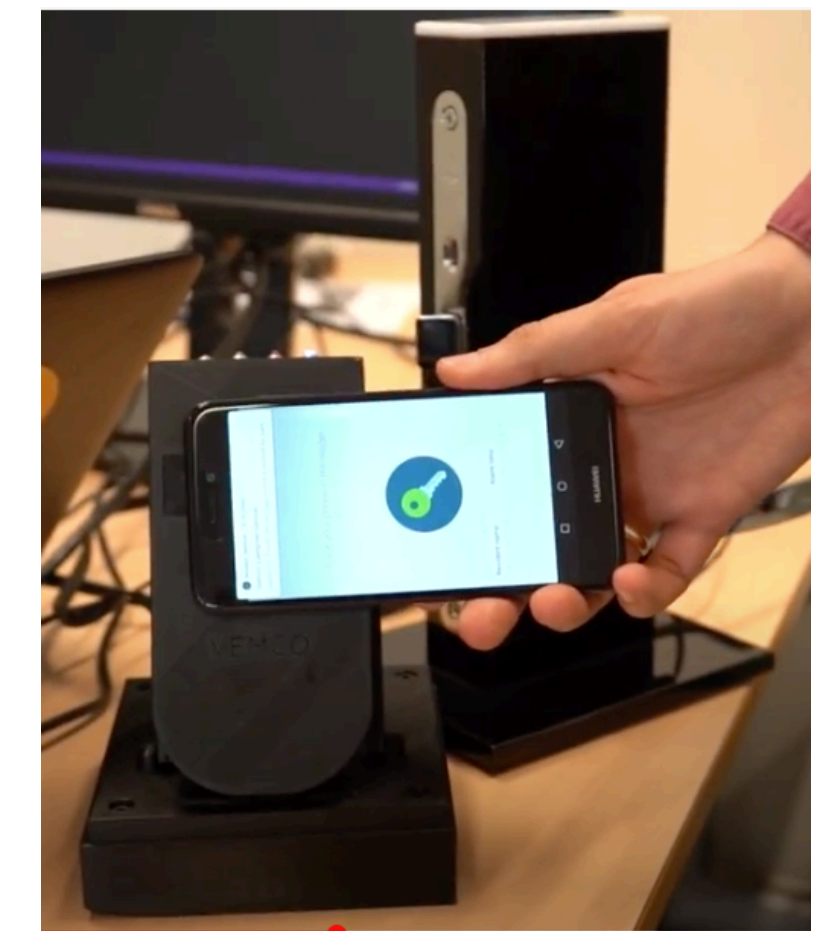
Smart Grid Services in the home

- 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
- Electricity (monitoring, securing supply)

<https://www.youtube.com/watch?v=r9VnE2F3Kn0>



[source: seminaronly.com]



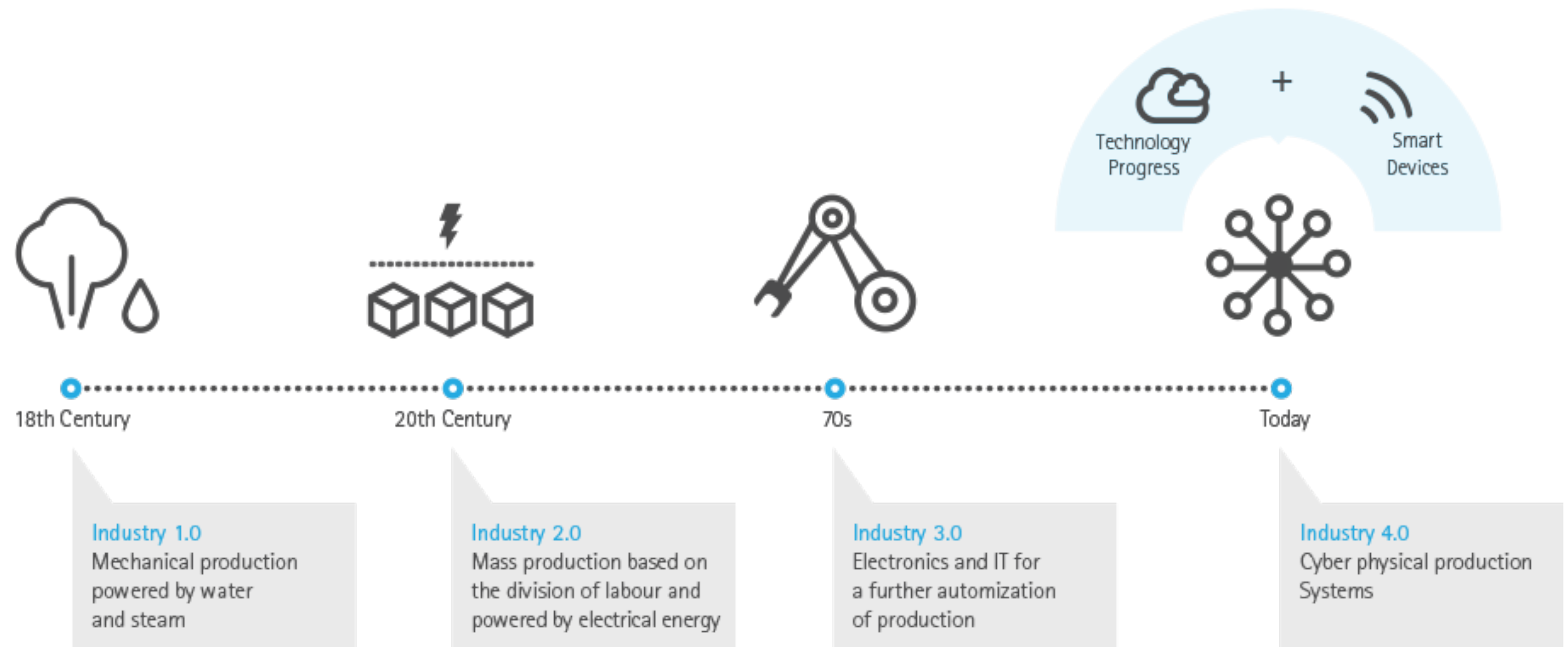
- “Virtual fall sensor”
- measure water & electricity
 - profile the user
 - estimate: probability of an accident

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

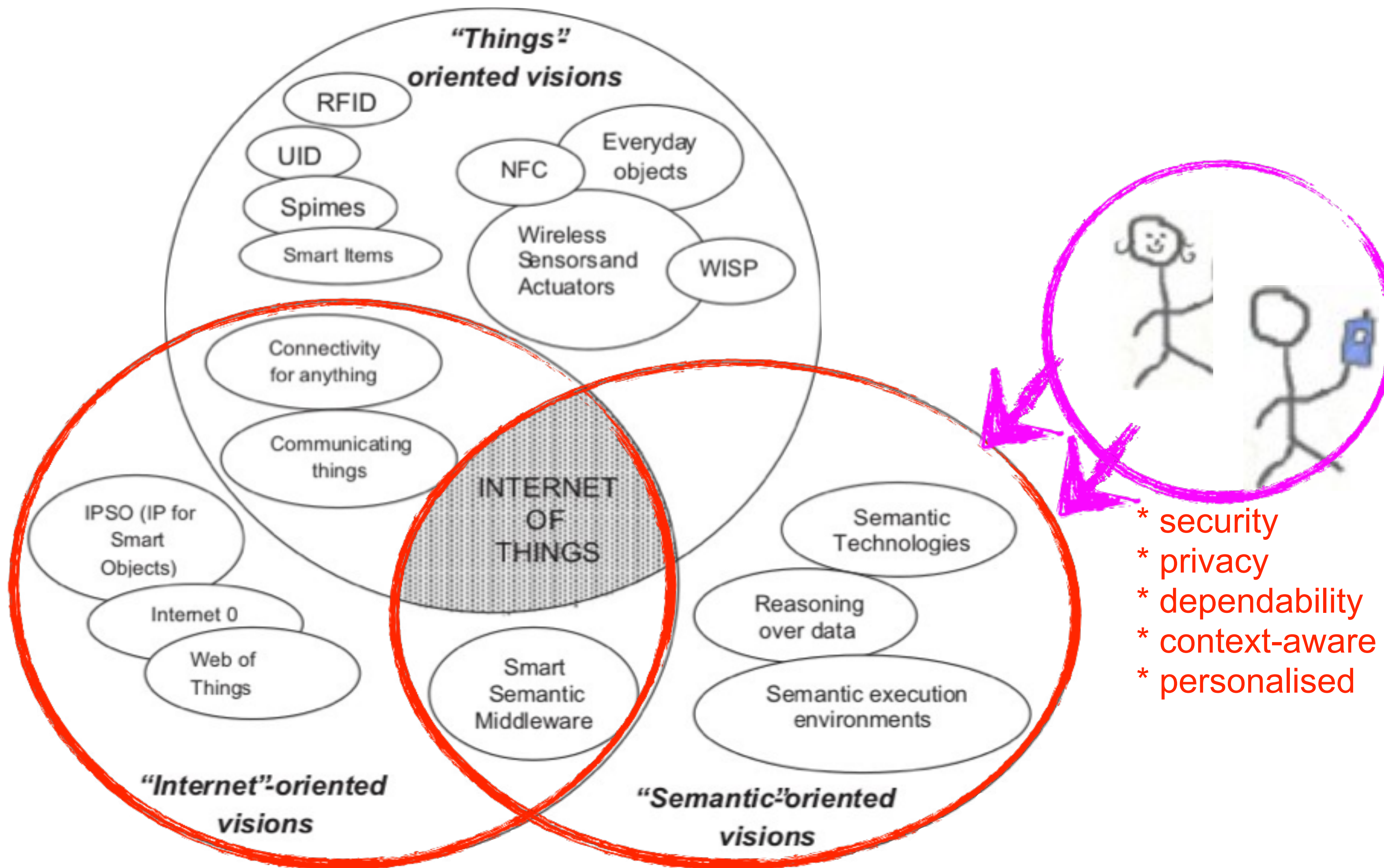
- ➔ Internet is the infrastructure – sensor, actuator, controller not on the same physical network any more
- ➔ “dissolves” the automation system in the internet
- ➔ Automation processes run over an unknown communication infrastructure
- ➔ Network communication gets physical impact
- ➔ Automation meets 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

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



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

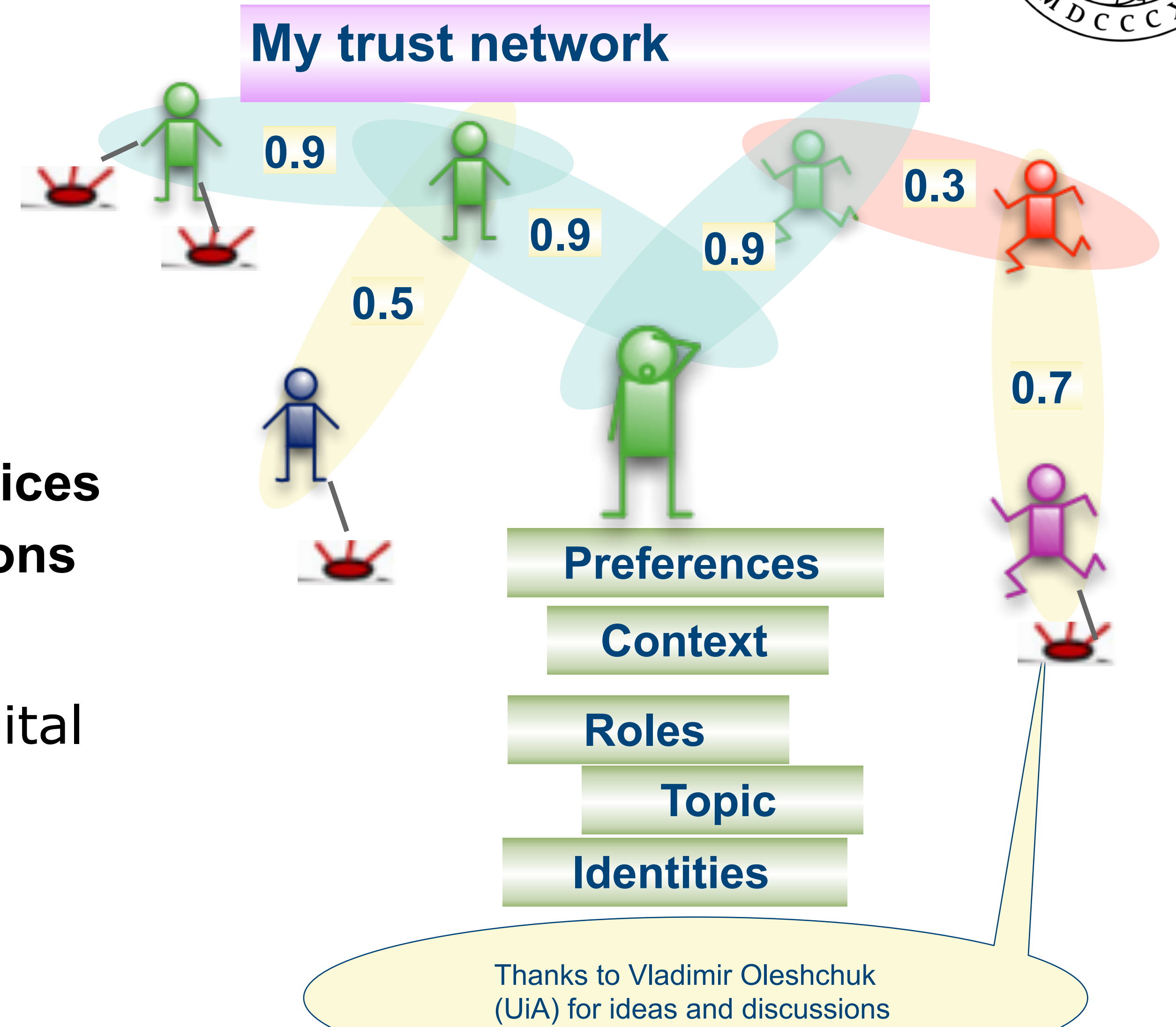
Fig. 1. "Internet of Things" paradigm as a result of the convergence of different visions.

Paradigm change for The Internet of the Real World and IoT

- Trust related privacy
 - > Representing the user adequately

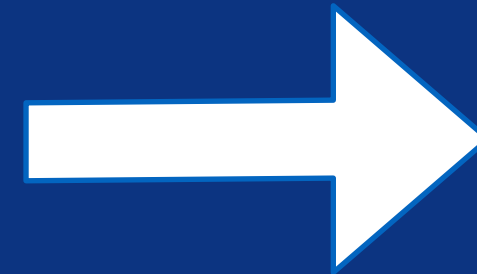
- Connecting to sensors, devices and services
 - > Provide privacy and ensure trust relations

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



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.

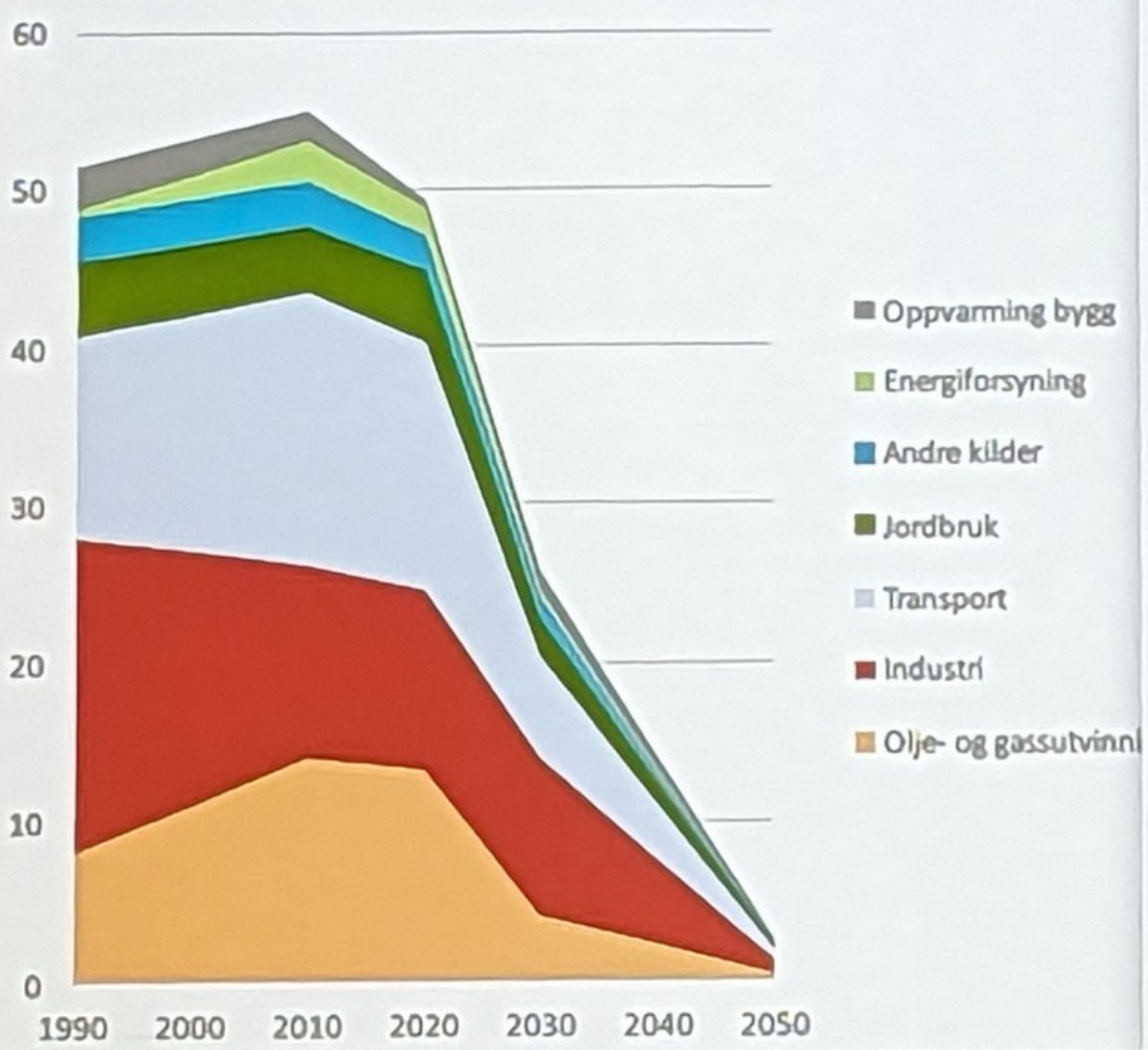


Sustainability and electrification

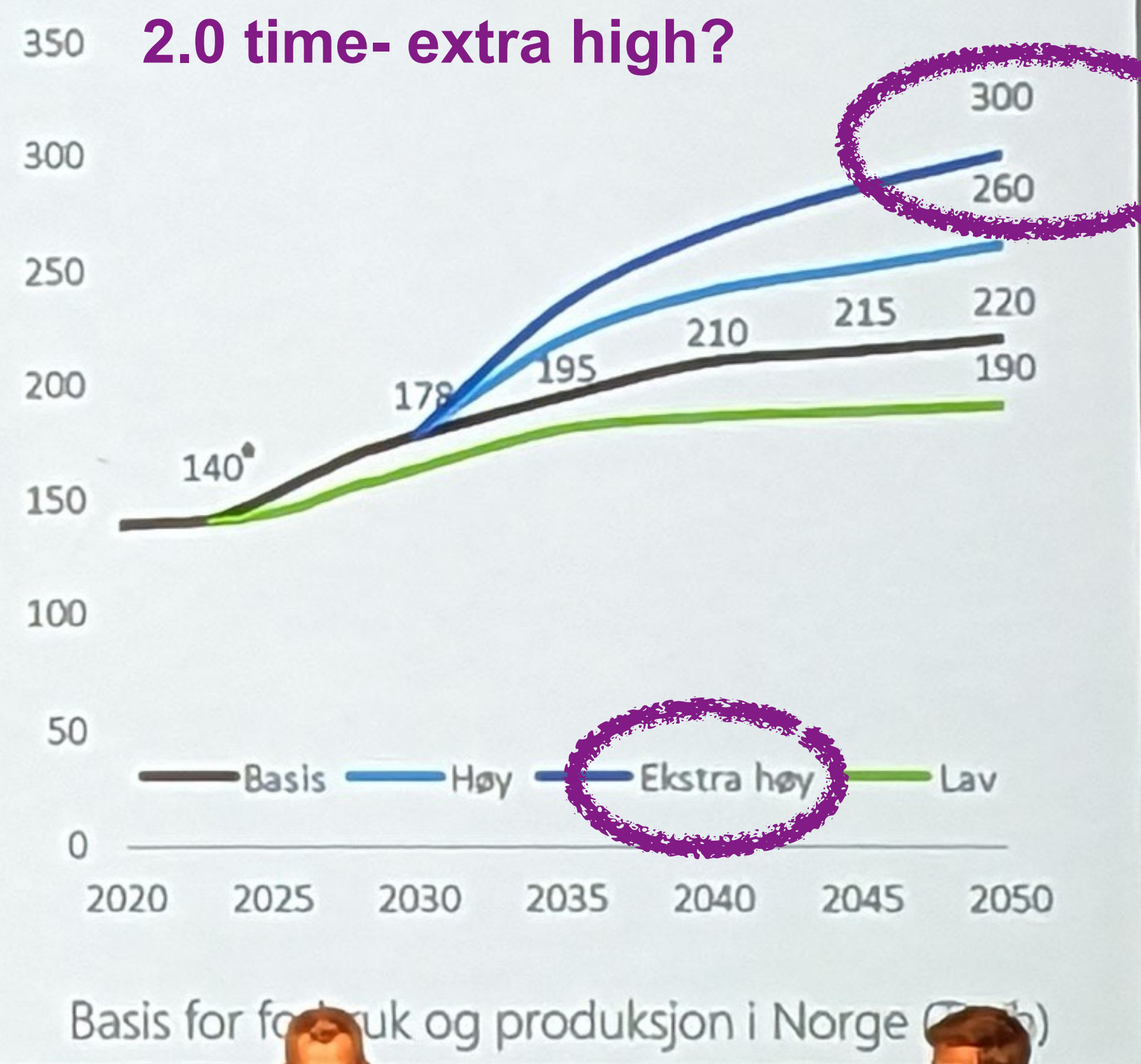
Source: Statnett LMA 2022



Klimagassutslipp til luft i Norge, millioner tonn CO2-ekvivalenter*



Ulike scenario for forbruksutviklingen i Norge (TWh)



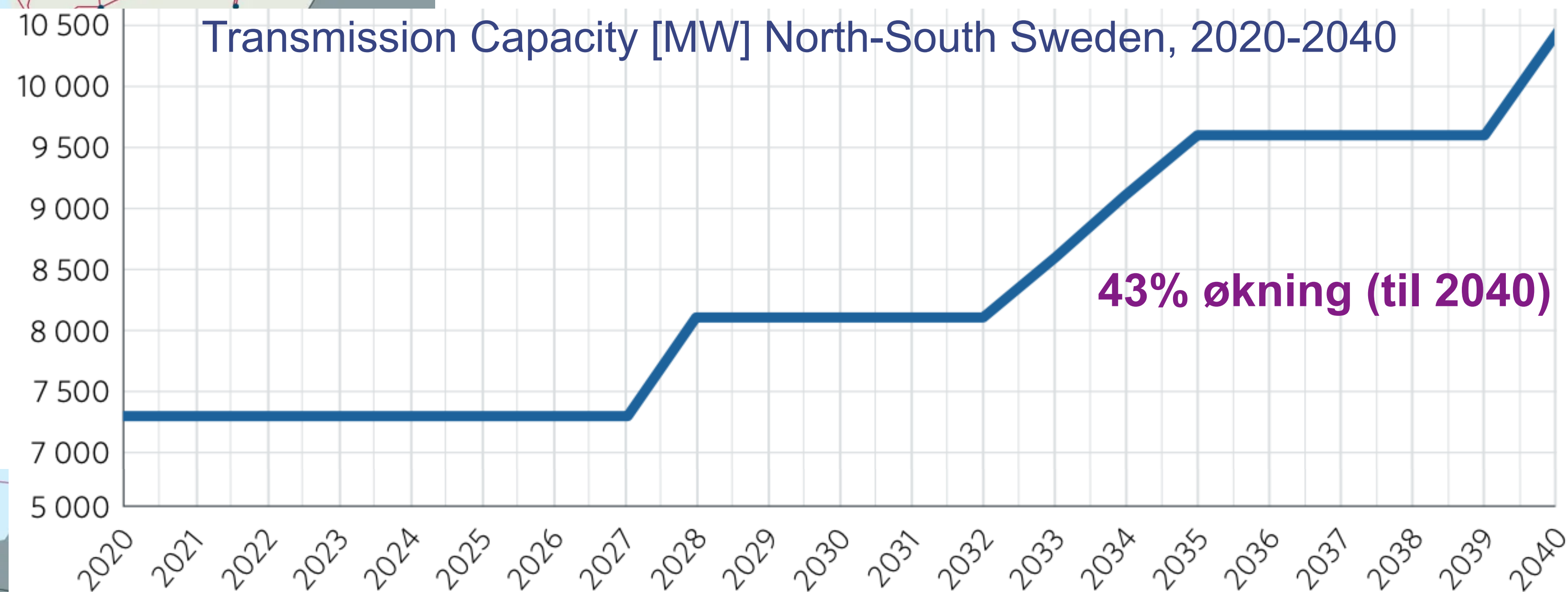
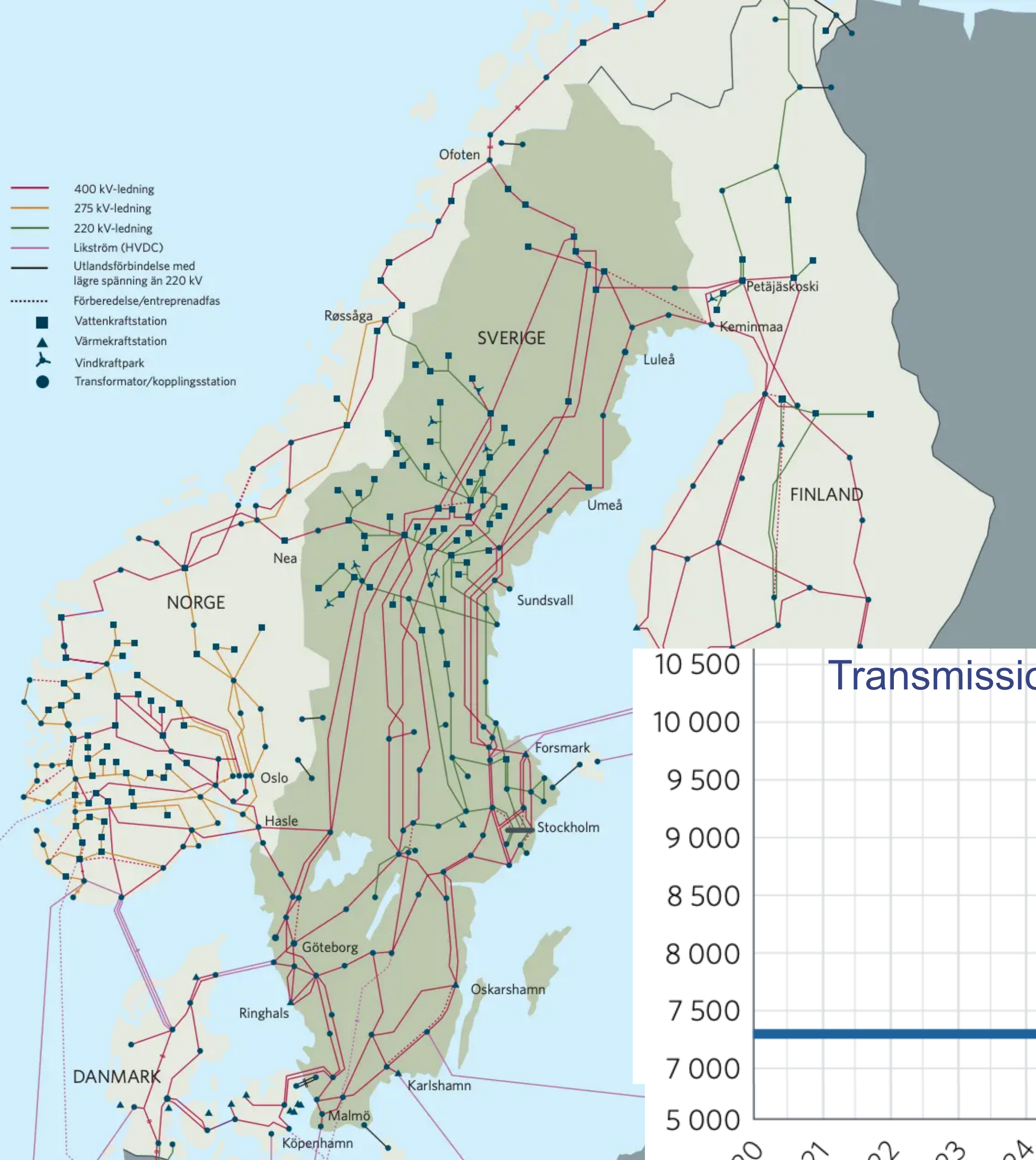
[Source: SmartGrid Conference 27Sep2023]

Per-Oddvar Osland
GlitreNett.no

Simon Koopmann
Envelio.com

Grid utviklingen

- 400 kV-ledning
- 275 kV-ledning
- 220 kV-ledning
- Likstrøm (HVDC)
- Utlandsforbindelse med lägre spänning än 220 kV
- Förberedelse/entreprenadfas
- Vattenkraftstation
- ▲ Värmekraftstation
- ⚡ Vindkraftpark
- Transformator/kopplingsstation

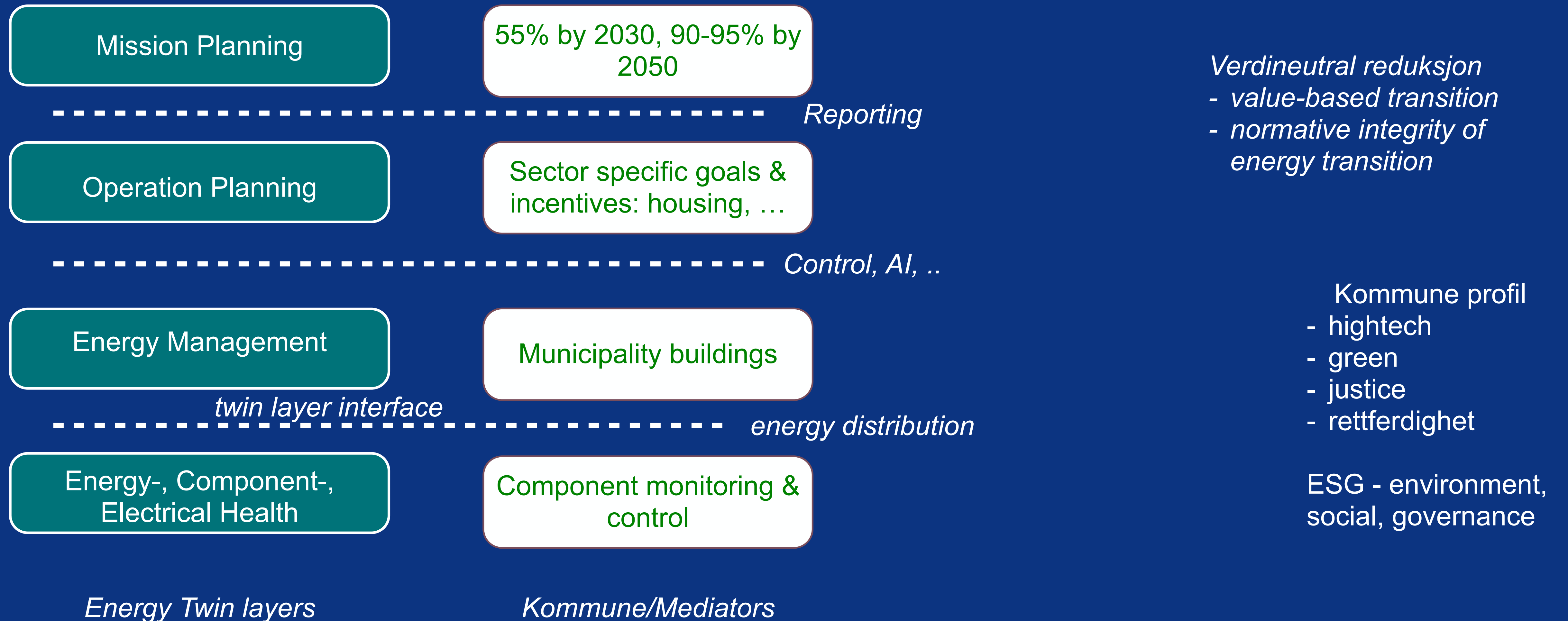


<https://www.aftenposten.no/norge/politikk/i/z7vWJw/statnett-vil-ha-mer-flyt-av-kraft-mellom-nord-og-soer-men-det-vil-ikke-sp-og-sv-ap-er-i-tenkeboksen>

The Power is at the Edge
of the grid



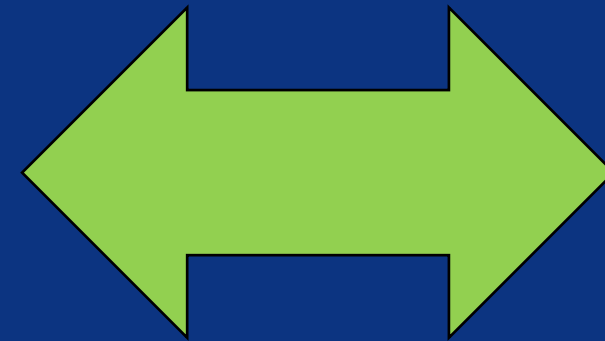
Energy Twins struktur og deltagelse



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

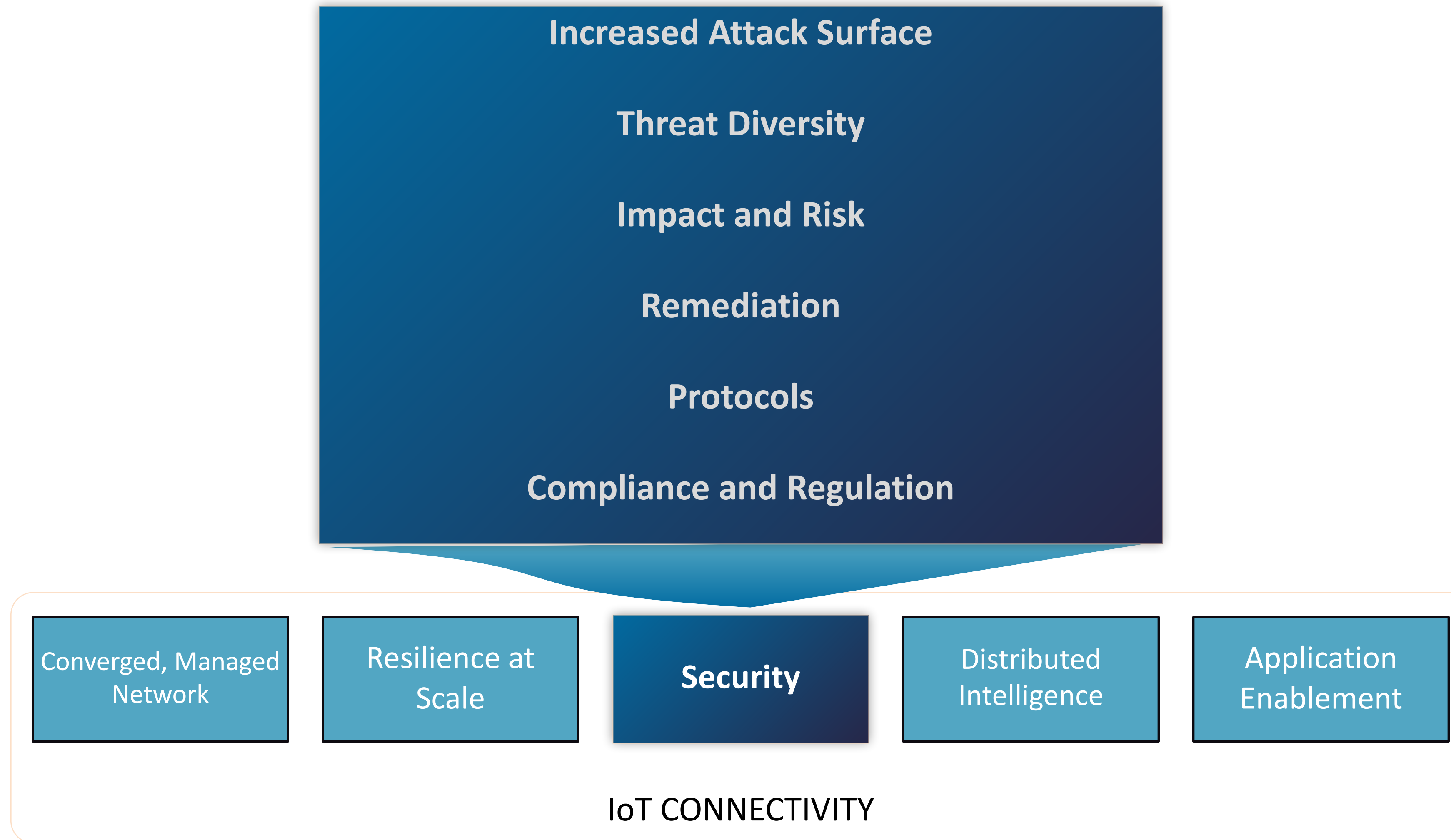
Sociable Internet of Things

- 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>

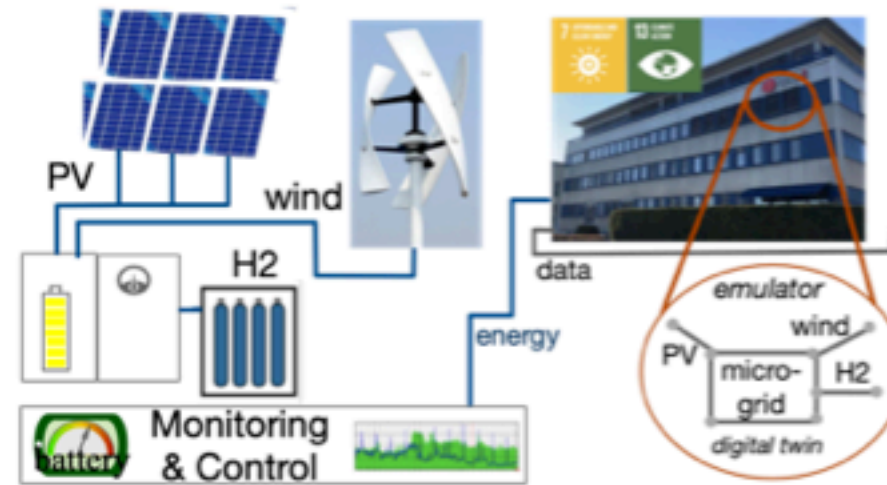
IoT Expands Security Needs



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 efficient use of spill heat/combined energy usage
- Building automation and communication between buildings



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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

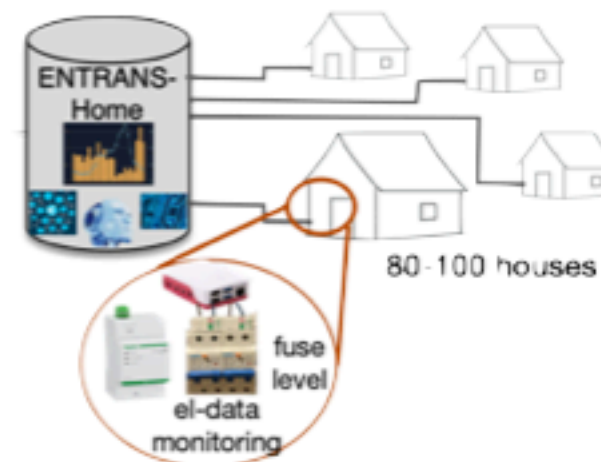


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Problem 2: Home automation

- 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



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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

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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