UNIVERSITY GRADUATE CENTER

University of Montenegro, 4.-6.Nov2015

Measurable Security as Driver for the Internet of Things Ecosystem

Josef Noll

Co Founder and Evangelist at **Basic Internet Foundation**
Prof. at **University Graduate Studies (UNIK), University of Oslo (UiO)**
Head of Research at **Movation AS**
Oslo Area, Norway

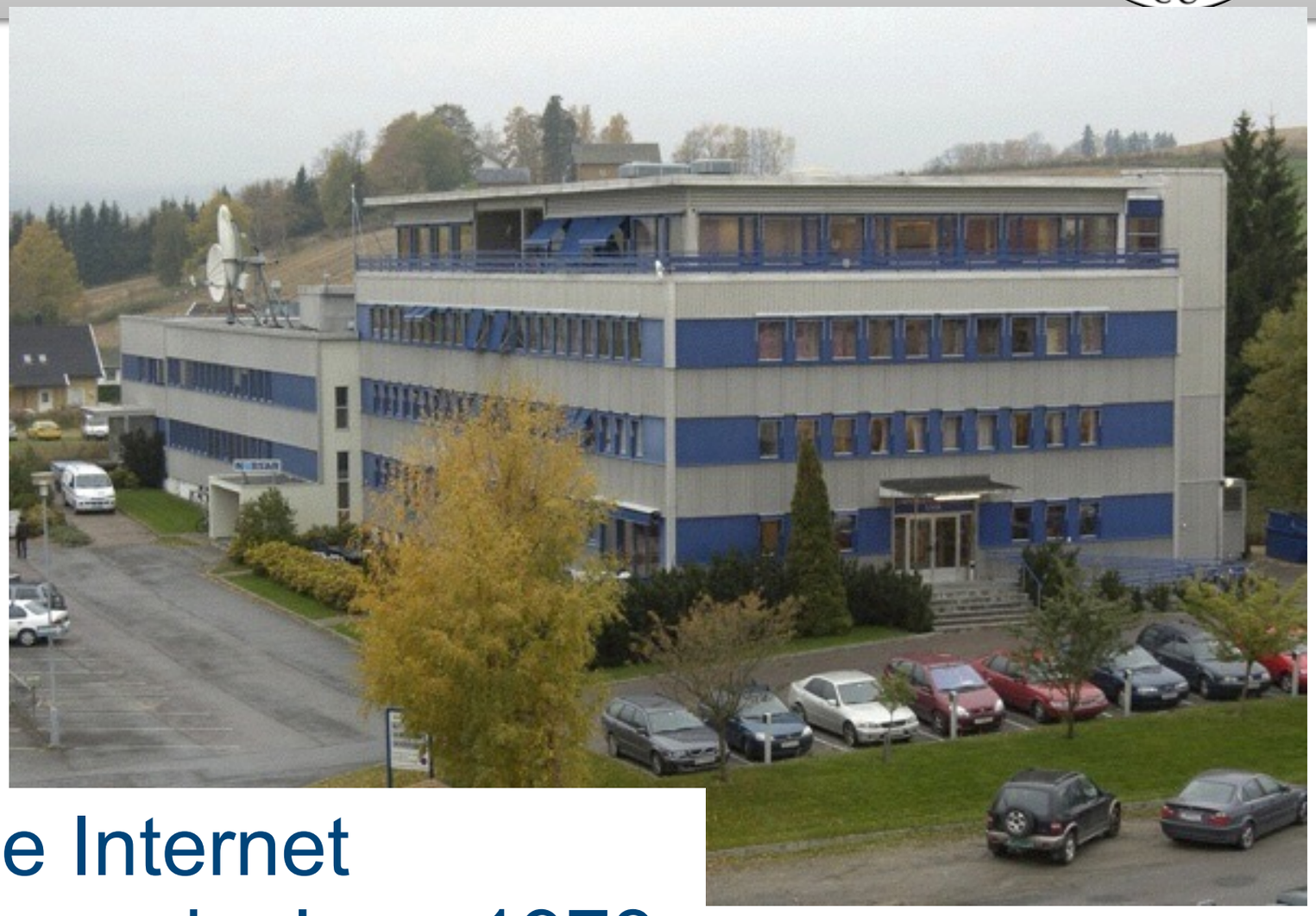
http://www.IoTSec.no, #IoTSec

Outline

- From Internet to Internet of Things (IoT)
  - ➡ Kjeller and the Internet
  - ➡ Autonomous systems
- From Mobile security to IoT security
  - ➡ the challenge of trust
  - ➡ binding IoT and social networks: Socialtainment
- Measurable security for IoT
  - ➡ IoTSec.no - Security for Smart Grid
  - ➡ Dependable access
- Innovation ecosystem
  - ➡ Digital innovation
  - ➡ Experiences from Innovation Stock Exchange
- Conclusions - Lessons learned

UNIK .... and the Internet

- Research and Education at Kjeller
- Close relation to FFI, IFE, NILU,...
- Professors from UiO (Oslo) and NTNU (Trondheim)



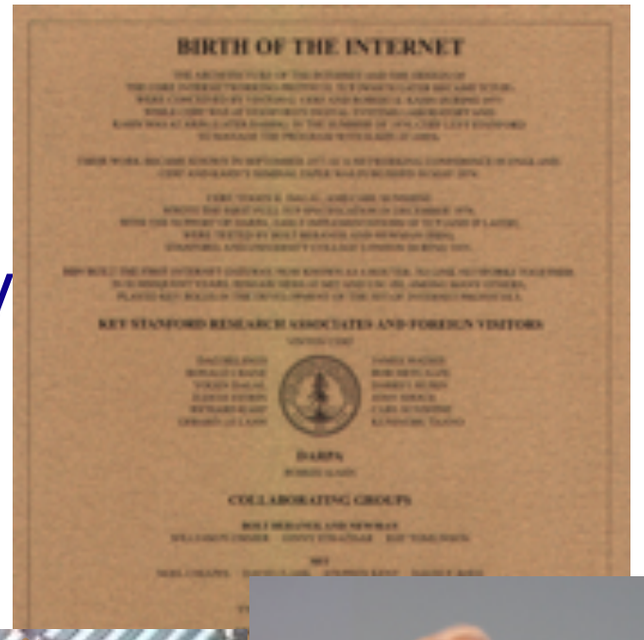
- The building where the Internet (Arpanet) came to Europe in June 1973

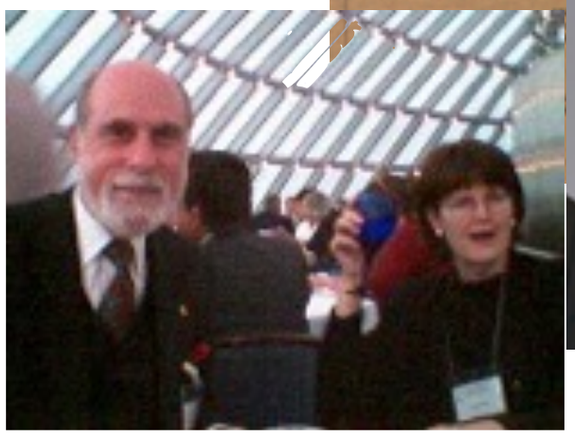
Source: Wikipedia

> 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.

The Internet and Scandinavia

- The first connection of Arpanet outside of the USA (and Hawaii) was to **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
  - Adaptation
  - ‘



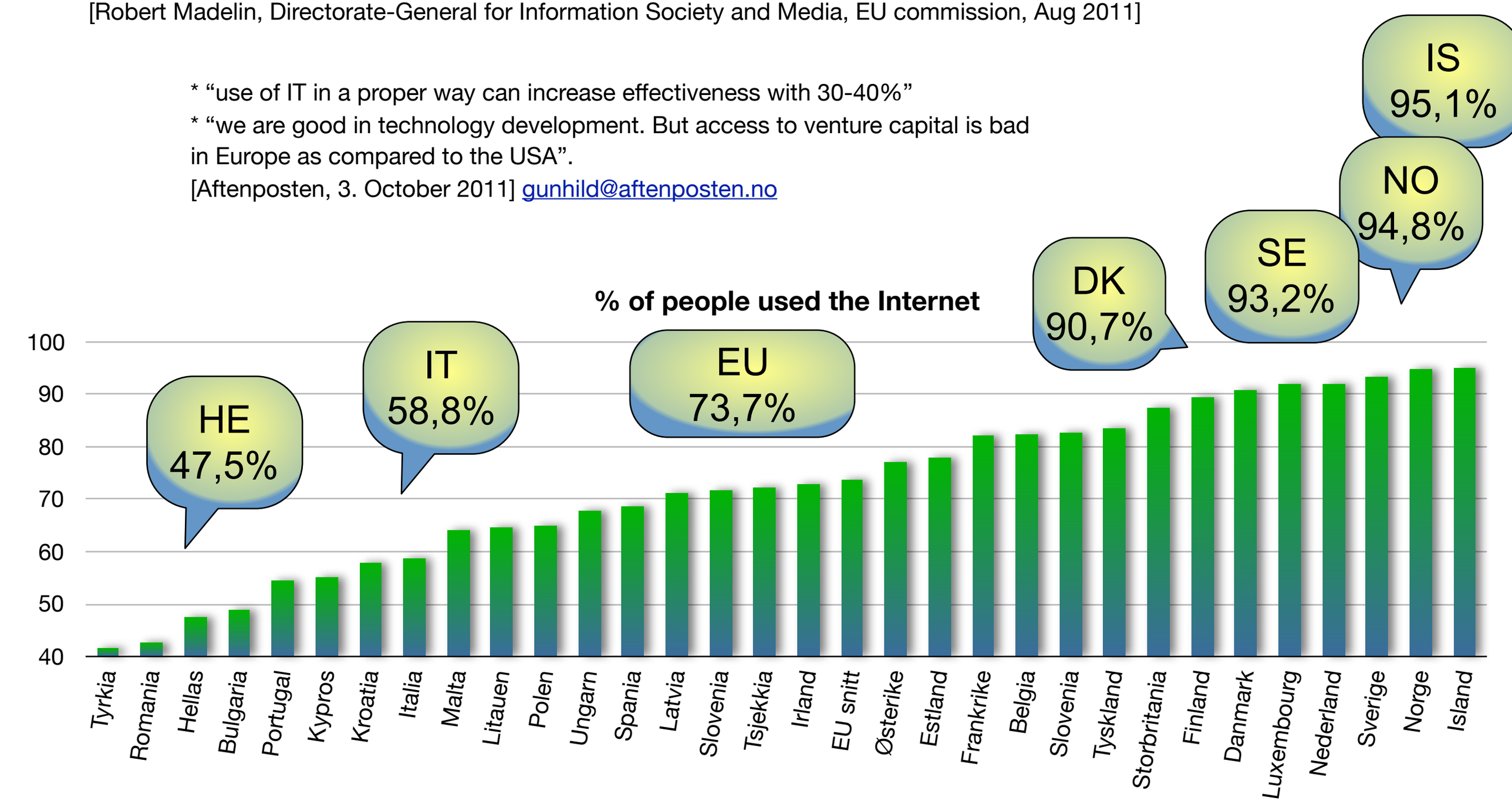


Internet usage in Scandinavia

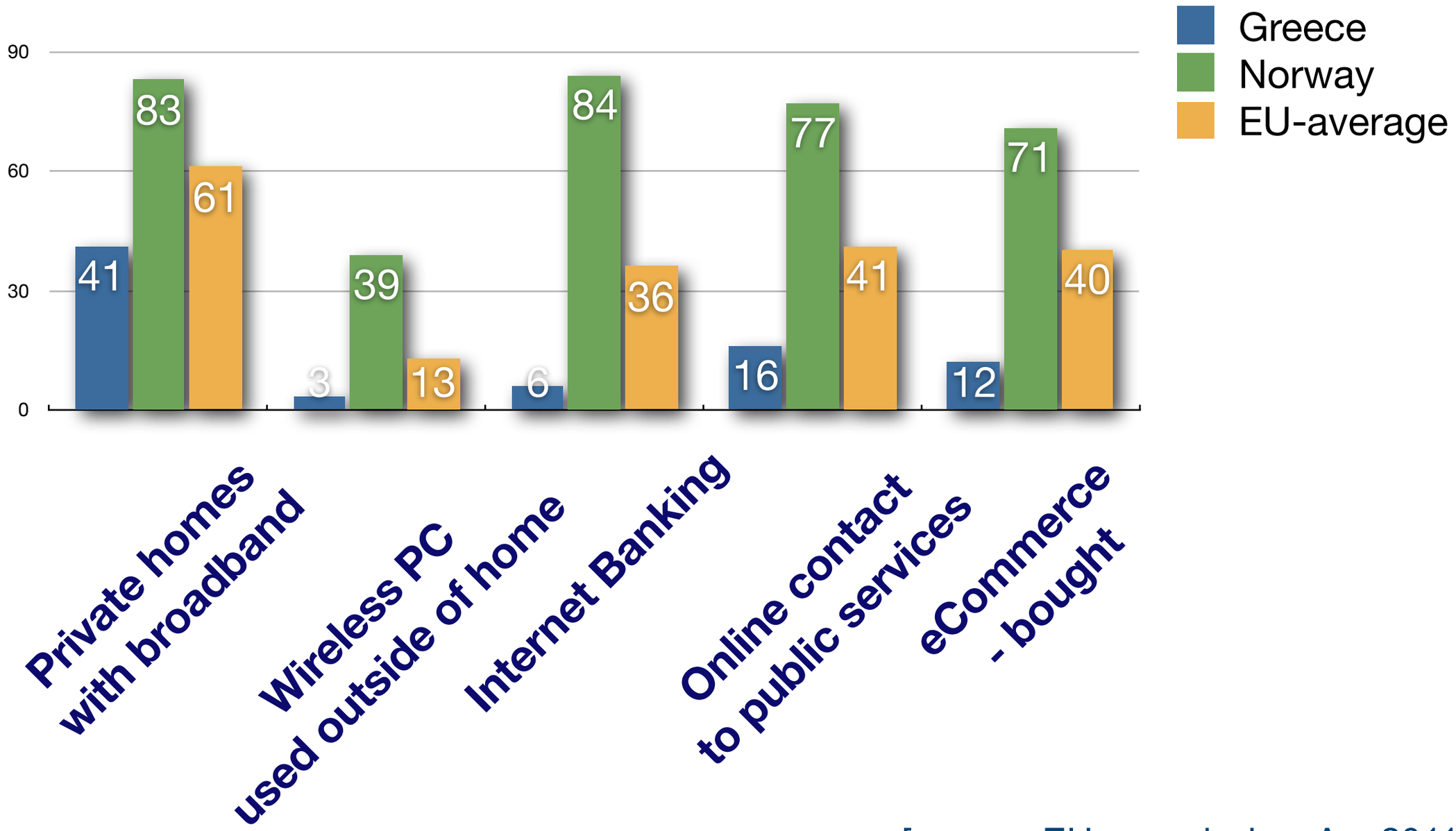
[Robert Madelin, Directorate-General for Information Society and Media, EU commission, Aug 2011]

* “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



Internet service usage



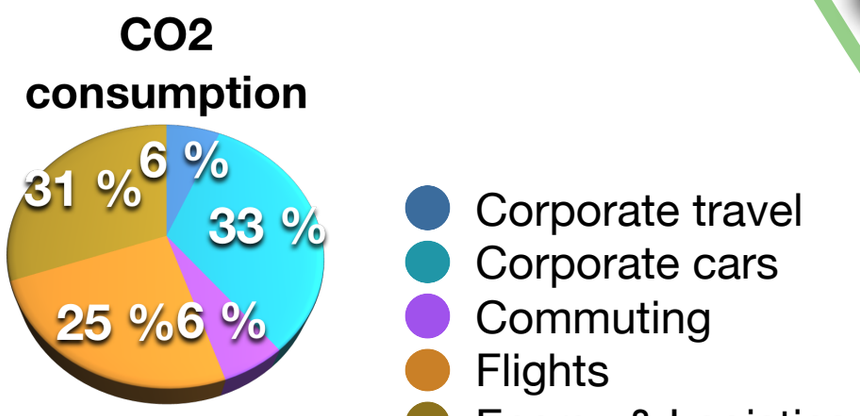
[source: EU commission, Aug2011]

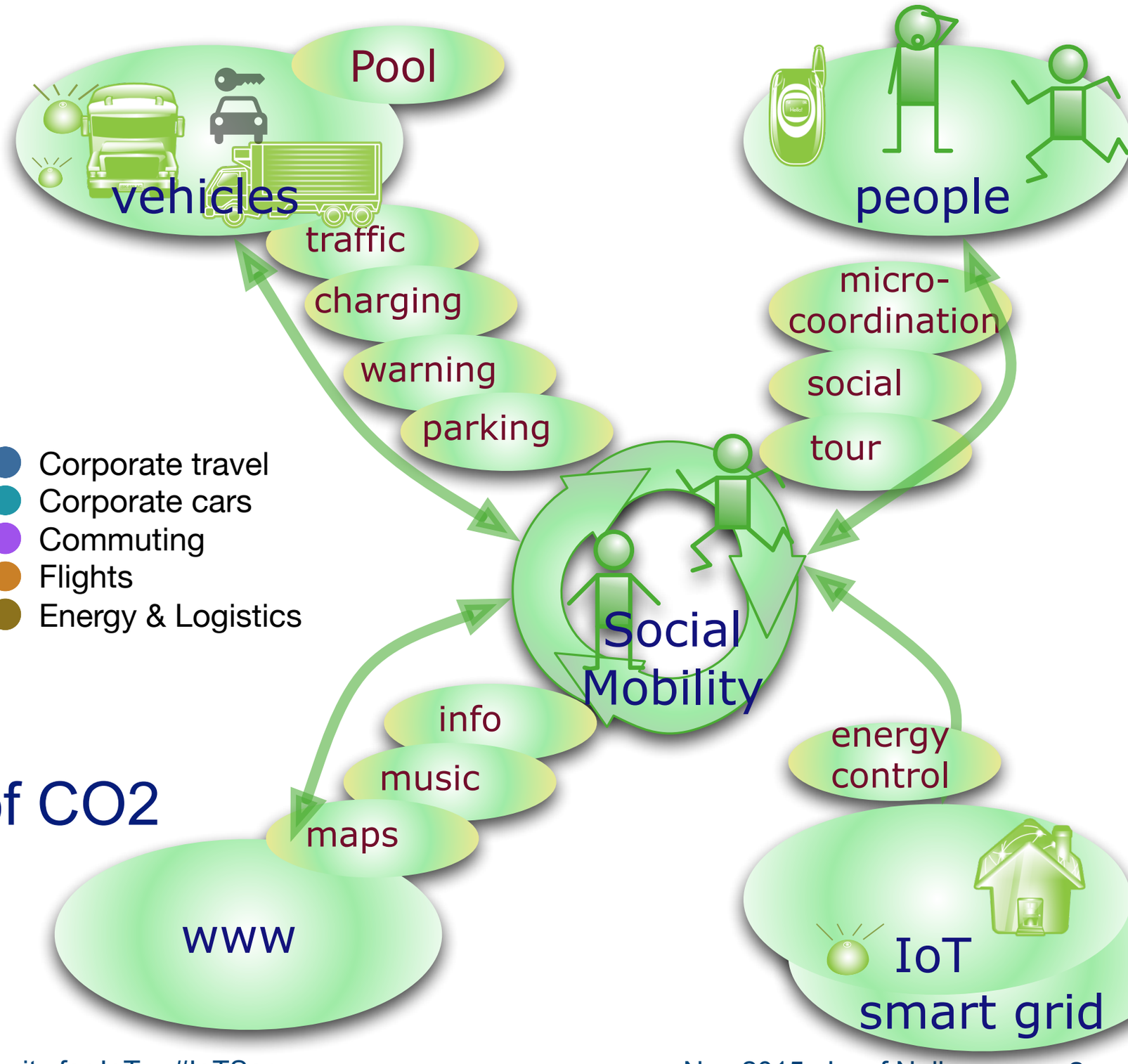
Discussion:
- Internet usage creates welfare?
- Welfare increases Internet usage?

Towards Internet of Things
- The role of security and privacy

IoT Application & Socialtainment

- From Entertainment to Socialtainment
- Social mobility through inclusion of social networks





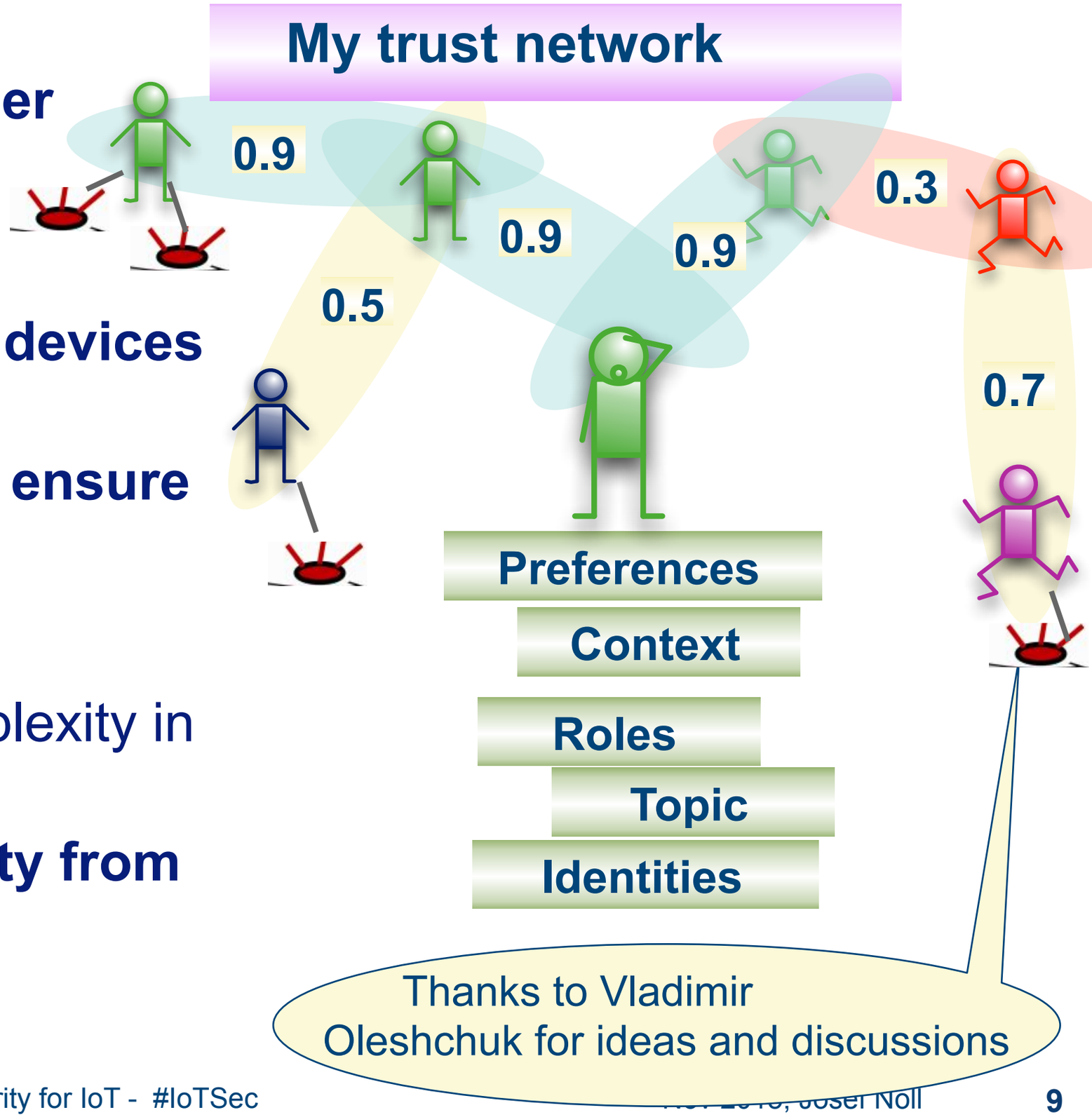
- Answering the need of CO2 reduction in transport
  - (SAP 45% - 2009)

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**



The threat dimension

- Hollande (FR), Merkel (DE) had their mobile being monitored
- «and we believe it is not happening in Norway?

[source: www.rediff.com]

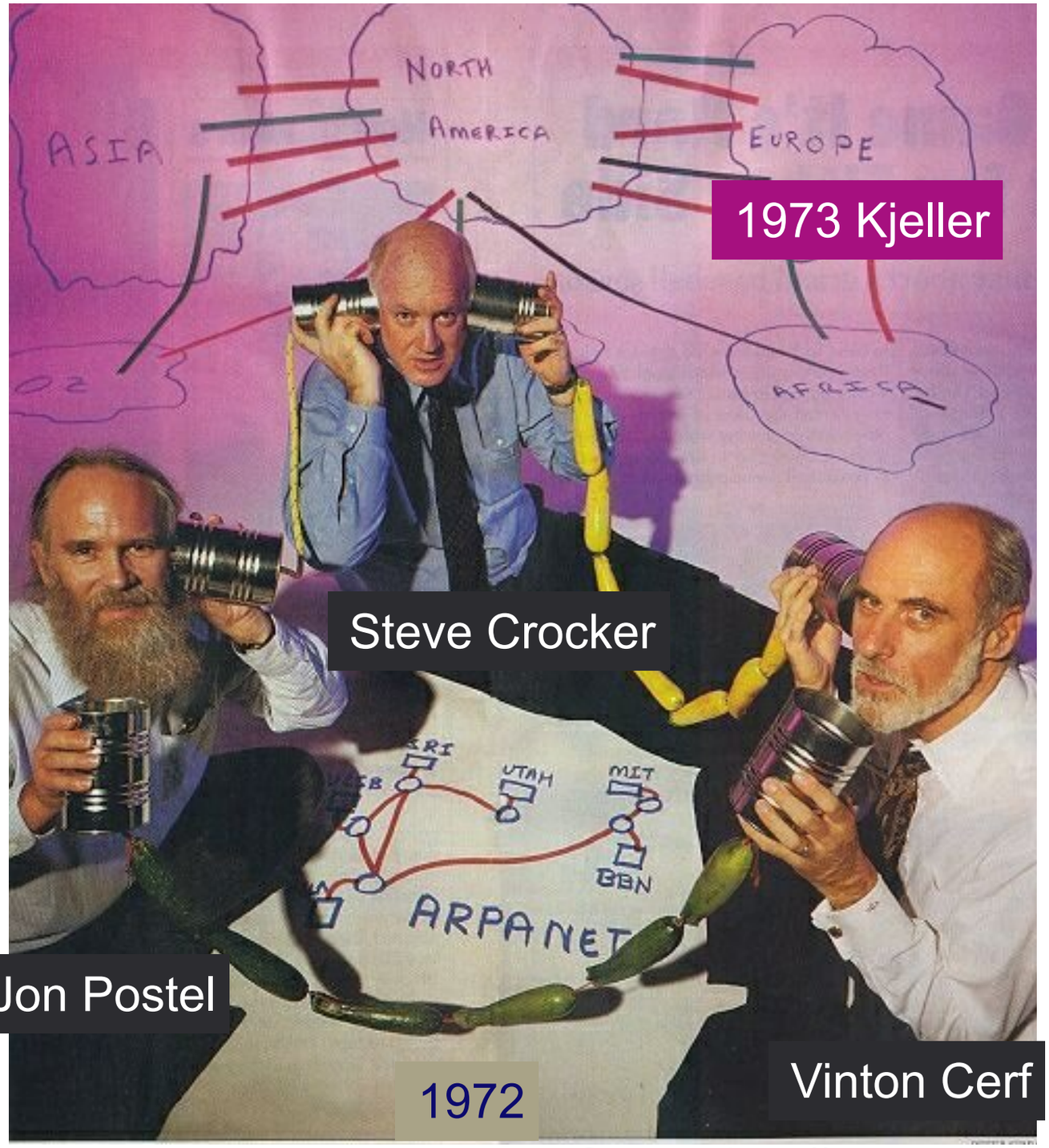
18. Dezember 2014, 18:14 Uhr Abhören von Handys

So lässt sich das UMTS-Netz knacken

[source: Süddeutsche Zeitung 18Dec2014]

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

How come these guys didn't think of security?

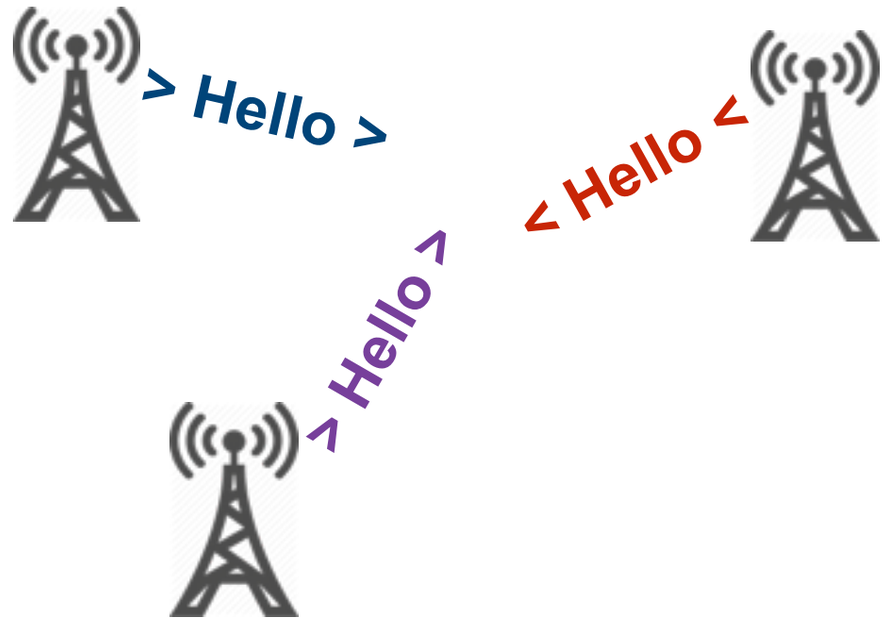


Source: http://www.michaelkaul.de/History/history.html

Security measures

Solution oriented

- Network monitoring
  - ➡ why does only a mobile phone listen?
  - ➡ every basestation listens



- Small (Femto) Cells
  - ➡ man in the middle
  - ➡ My base station is 5 m away

[source: seminarsonly.com]

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

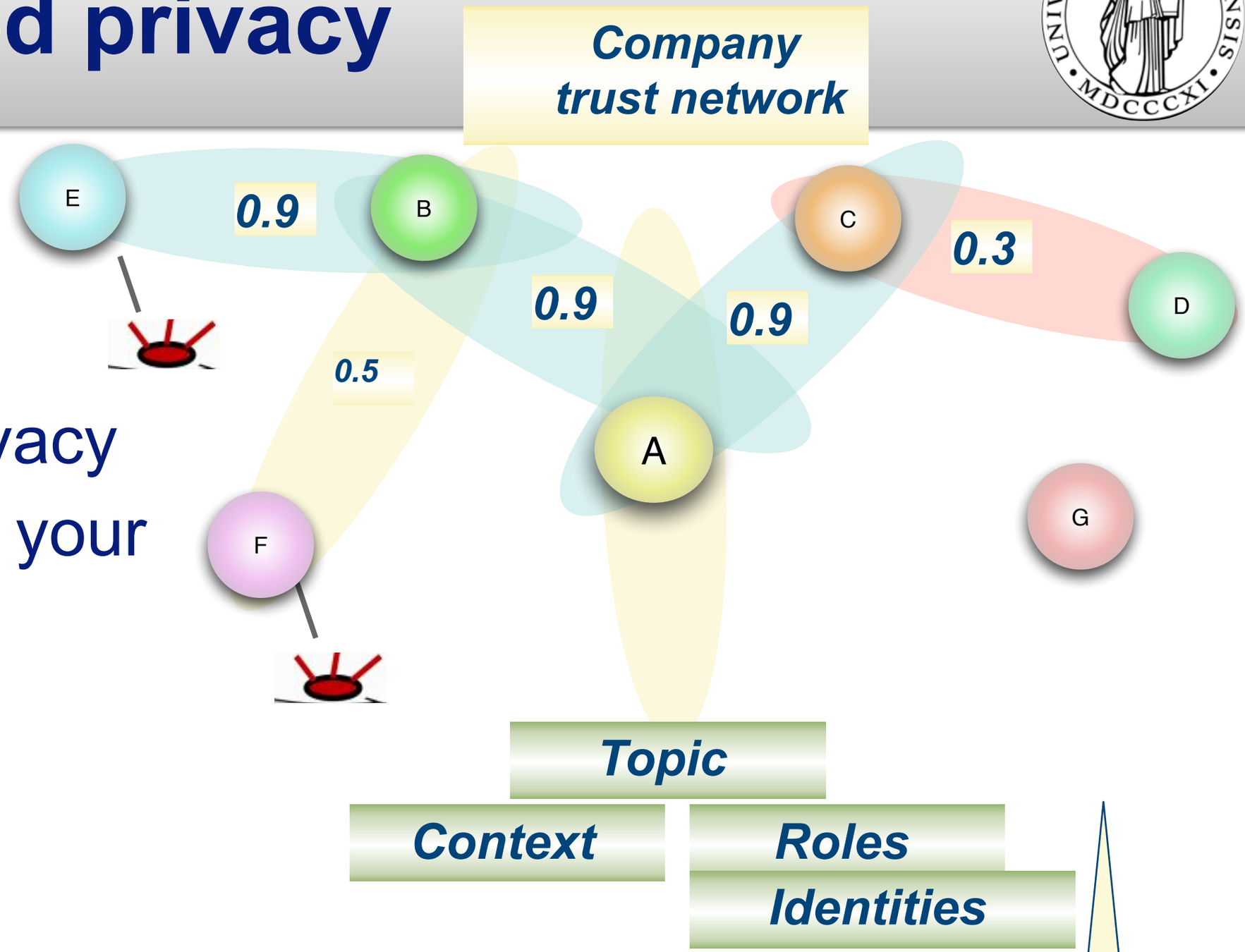
- Maritime: «policy driven»
- Health care: «trust» on sensor and mobile apps

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

"In any change management process, the challenge is communicating risk," (Peter Bjerager, DNV GL)

Trust-based privacy

- "With whom to collaborate?"
- Share data?
- Trust-based privacy
- Information and your social life



- *Measurable trust? Transient Trust?*
- *Value chains: from sensors to systems*

Thanks to Vladimir Oleshchuk for ideas and discussions

Internet of Things Security

Energy sector tops list of US industries under cyber attack, says Ho

12 March, 2015 at 6:38 PM Pos

Washington, DC. March 1:
issued today by the US De
Homeland Security says th
Industrial Control Systems
Response Team (ICS-CEI
245 incidents reported by
industry partners.

The energy sector, says J
all others again in 2014 wi
incidents, followed by man
and worryingly healthcare
incidents. ICS-CERT's cor
with the Energy sector rep
collaborate on incident res

Power Grid Cyber Attacks Keep the Pentagon Up at Night

A detailed look at why computers running the U.S. electrical infrastructure are so vulnerable to digital threats

By Michael McElfresh and The Conversation | June 8, 2015

The following essay is reprinted with permission from The Conversation, an online publication covering the latest research.

It's very hard to overstate how important the US power grid is to American society and its economy. Every critical infrastructure, from communications to water, is built on it and every important business function from banking to milking cows is completely dependent on it.

Scott Wylie/Flickr

http://www.scmagazine.com/iot-security-forcing-business-model-changes-panel-says/article/448668/

Teri Robinson, Associate Editor

Follow @TeriRnNY

October 22, 2015

IoT security forcing business model changes, panel says

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

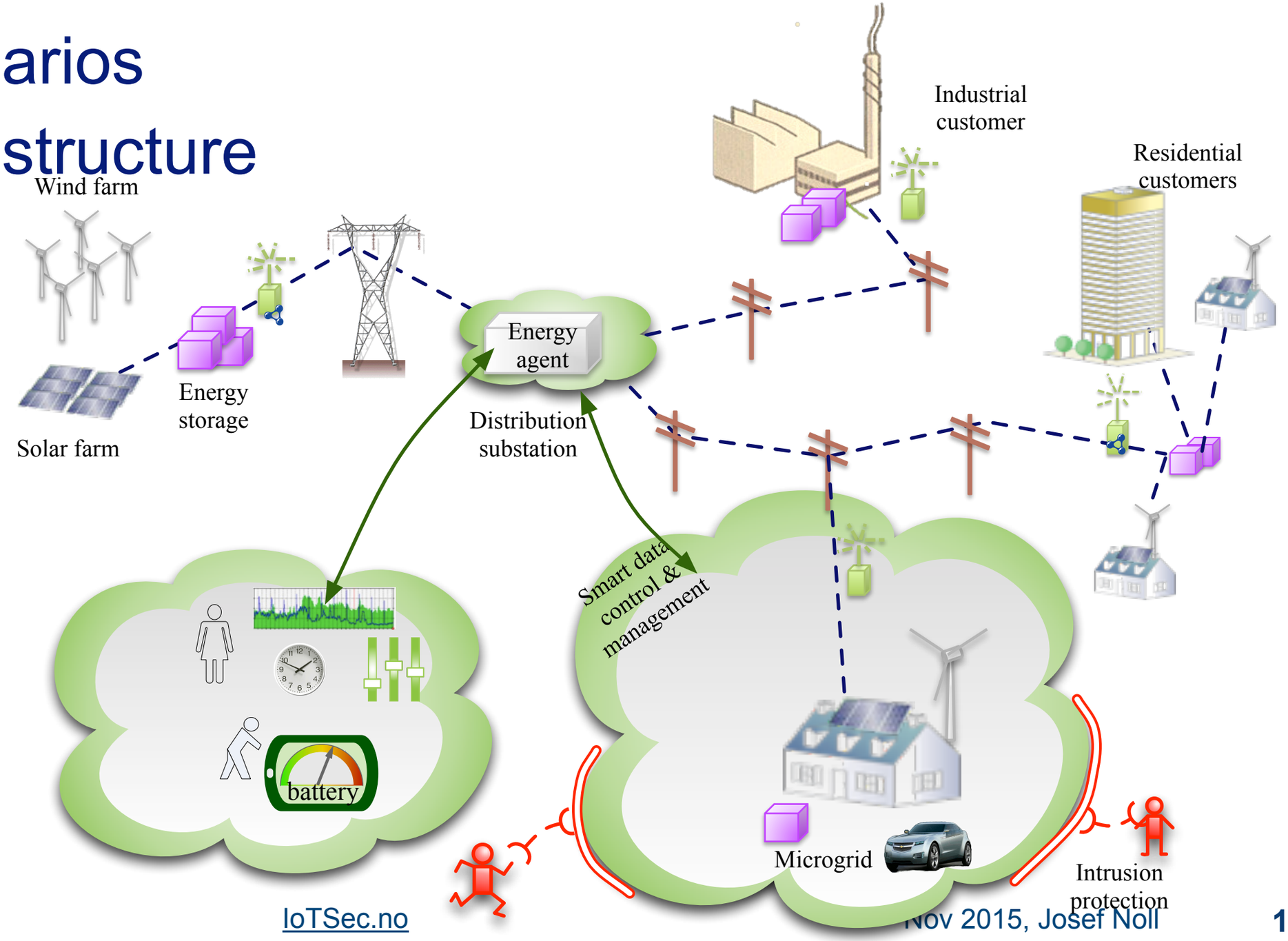
Volvo will "accept full liability" for collisions involving its autonomous vehicles, the company has confirmed.

Discussion on Threat Scenario in IoT
- Automated processes
- How to protect values?

Towards IoT Ecosystem
- Example: IoTSec initiative
- Measurable Security and Privacy

The Smart Grid in the close future

- Smart grid with prosumers
- various control mechanisms
- attack scenarios
- critical infrastructure



IoTSec.no facts

- Research Initiative: Security in IoT for Smart Grids
  - applicable for Internet of Things (IoT)
  - focussed on Smart Grid security
- Facts
  - 1Oct2015 - 30Sep2020, 25 MNOK budget
  - 10 founding partners,
  - 18 partners (Aug2015)
- Main outcome
  - Research in Security for Smart Grid
  - Industrial Smart Grid Security Centre

Partners

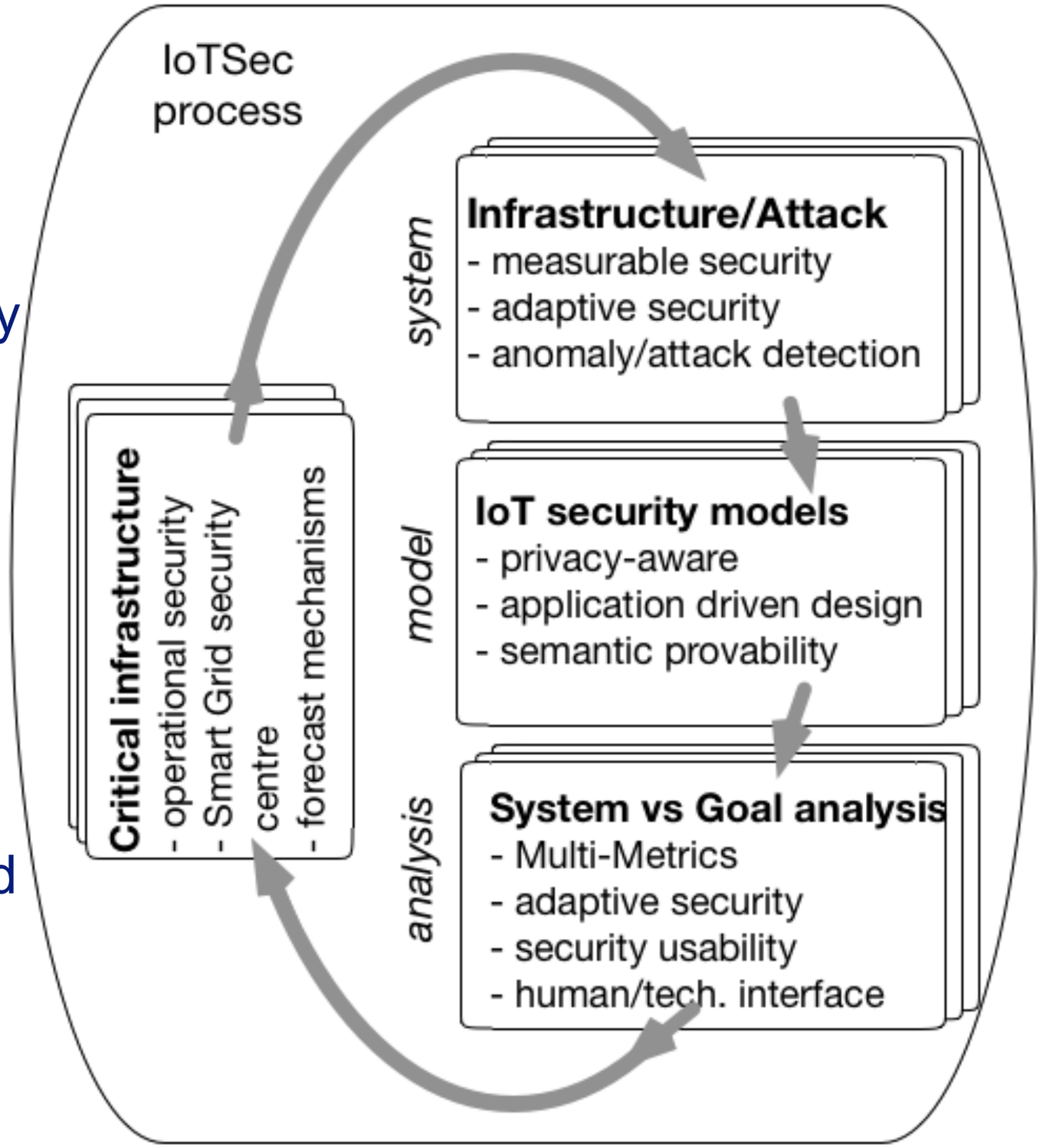
- Founding partners
  - University of Oslo (UiO) through the Institute for Informatics (Ifi) and the University Graduate Centre (UNIK),
  - Norwegian Computing Centre (NR)
  - Simula Research Laboratory (SRL)
  - Gjøvik University College
  - NCE Smart Energy Markets (NCE Smart)
  - eSmart Systems (eSmart)
  - Frederikstad Energi (FEN)
  - EB Nett (EB)
  - Movation (MOV)
- Associated Academic Members
  - Mondragon Unibersitatea, Spain
  - University of Victoria, Canada
  - Universidad Carlos III de Madrid, Spain
  - University of Roma La Sapienza, Italy
- Associated Industrial Members
  - Mondragon Unibersitatea, Spain
  - Fredrikstad kommune
  - EyeSaaS
  - Nimbeo
- H2020 and ECSEL projects
- COINS Academic Research School

Research Topics

- Tailoring «security challenges» to targeted research
- Measurable Security, Privacy and Dependability
- Semantic modelling and provability
- Adaptive security
- Security in IoT Ecosystem

Operational requirements

- Operational security
- Forecast mechanisms
- Operation Centre (from Smart Grid Smart City)



Example of research:
Semantic access control

Define home energy system through ontologies

Define access to home energy system

infrastructure ontology

Home

consumer | prosumer | producer

Battery
- storageSize: 400 kWh
- loadLevel: 40%
- maxCurrent: 64 A/h

access ontology

energy access

reading | manage

Statistics
- maxProvision: 82 A/h
- totalProvision/d: 1.2 kW
- maxCurrent: 64 A

Regulate
- HeatPump: *off for 1h*
- drainBattery: *down 20%*
- carCharge: *off*

semantic access criteria

SecurityToken
- issueTo: *Person*
- withAttributes: ...

Role
- memberOf: *string*
- roleContext: *string*

Context
- hasLocation: *lat/lon*
- networkDevice: *phone*

semantic access control

Home energy system

Criteria

Descriptive logic reasoning

Home energy access

Policies

Semantic access policies

Service requirements

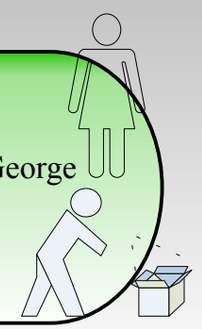
requireSecurityToken(?service,?token)∩ withHold(?token,?attributes) → hasAttributes(?service,?attributes)

User token

canOwn(?person,?attributes)∩ withHold(?token,?attributes)∩ Person(?person)→ SecurityTokenIssueTo(?token,?person)

Service	Token
readMaxProvision	authenticatedPerson
readTotalProvision	authenticatedPerson
switchOffHeatPump	owner
drainBattery	energyAgent, owner
chargeBattery	energyAgent, owner

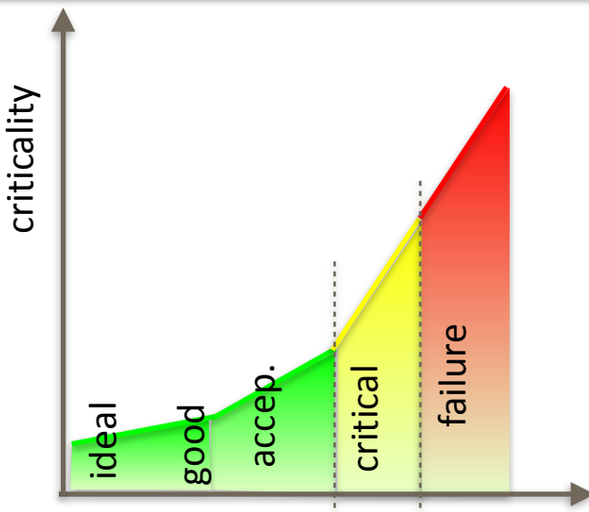
Token	Person
authenticatedPerson	Bob
owner	Alice, George
energyAgent	Carol

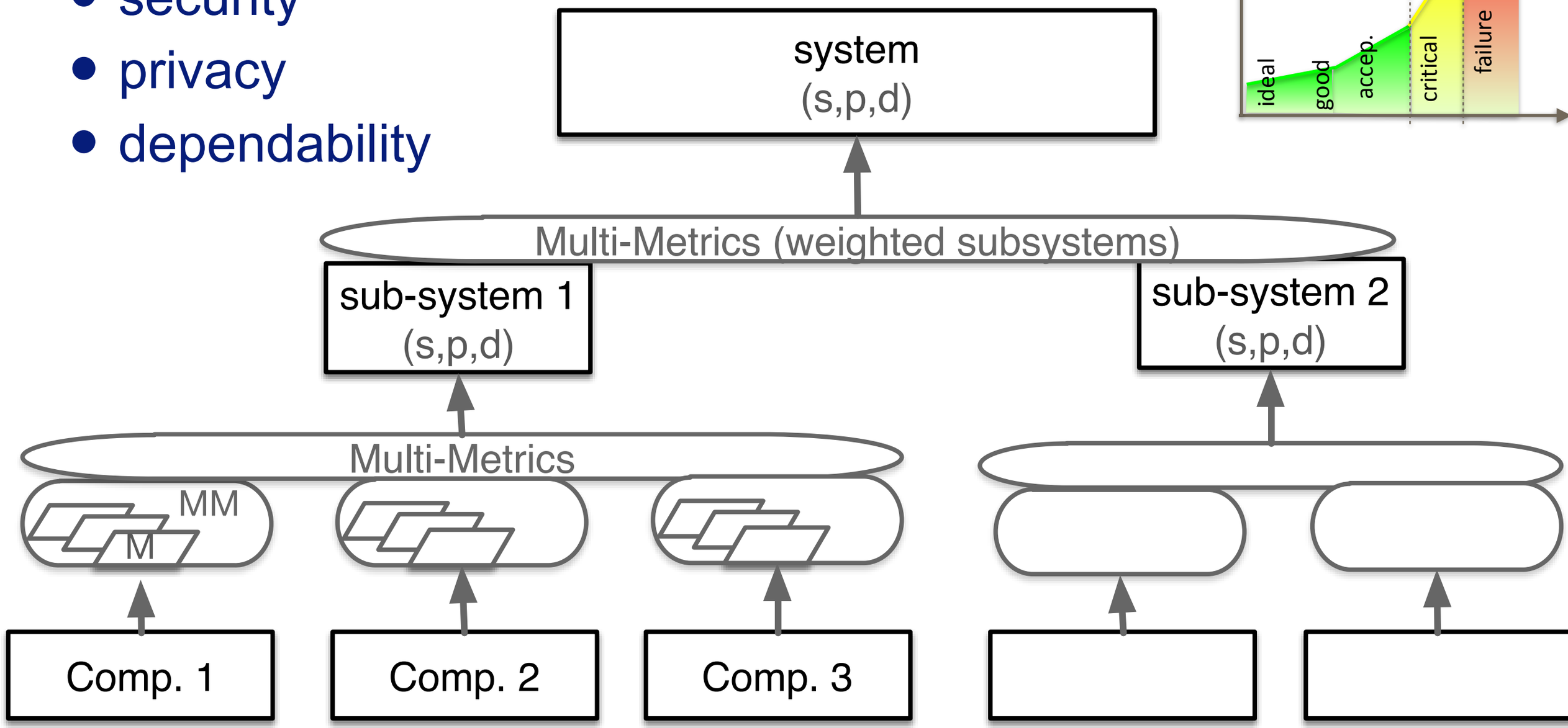


Example of Research:

Multi-Metrics$_{v2}$ - system composition

- System consists of sub-systems consists of components
  - security
  - privacy
  - dependability



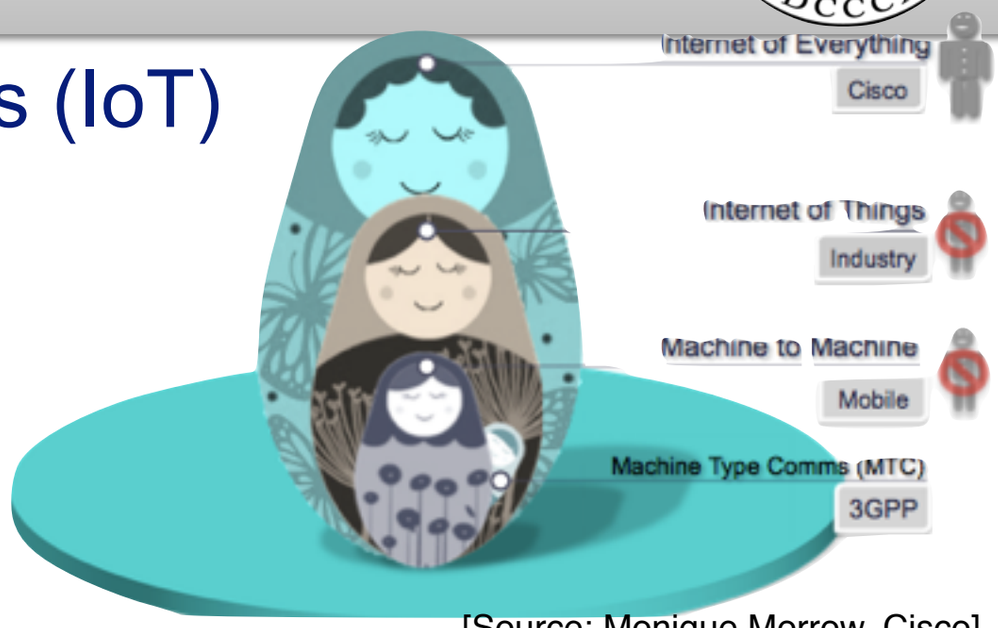


Main expected
Outcome of IoTSec

- Robust research community
  - ➡ after 2 years 7 international projects, 2 succeeded
- PhD education
  - ➡ 15 ongoing PhDs
- International involvement
  - ➡ workshops with international partners/1 conference
- Industrial impact, Security Centre @ NCE Smart
  - ➡ Security analyses of existing smart grid infrastructure and technologies
  - ➡ Simulations of cyber-attacks
  - ➡ Security systems of protecting smart grid against cyber-attack

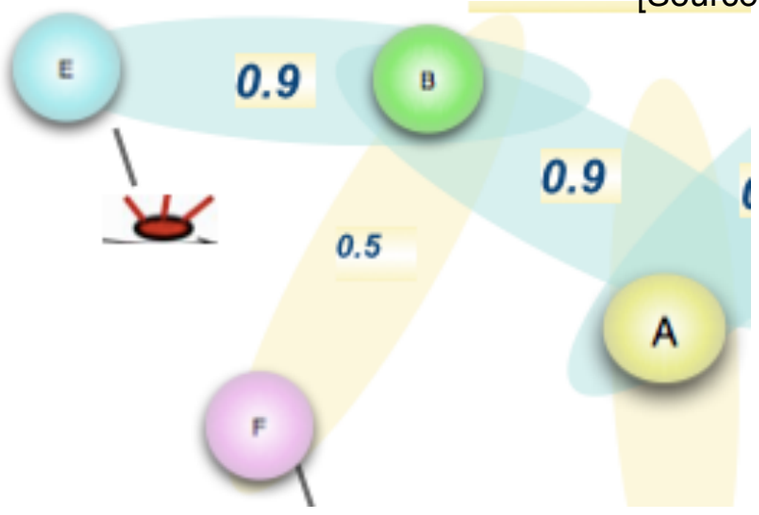
Conclusions for Security in IoT

- Paradigm chance in the Internet of Things (IoT)
  - Automated processes by 2020
  - measures of criticality
  - Industrial Applicability

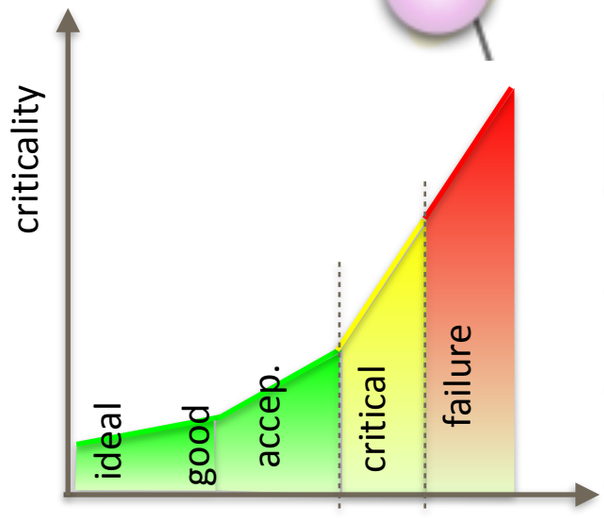


[Source: Monique Morrow, Cisco]

- Trust, Security, Privacy in the IoT
  - No trust without privacy
  - Novel privacy paradigm



- Measurable Security&Privacy
  - Trust entities
  - Methods for Measurable Security
  - Innovation through Measurable Security



SPD level	SPD vs SPD_{Goal}
(67,61,47)	(●,●,●)
(67,61,47)	(●,●,●)
(31,33,63)	(●,●,●)

Discussion on Measurable Security
- Can you measure security?
- Units of security?

Business Ecosystem

Internet-driven services

- App economy
  - «All services» come through mobile devices
  - from «parts» to services
- Ambient Assisted Living (AAL)
  - Sensors supporting care information
  - Proactive Health professionals
    - call if you have not taken your medicine
    - call if your blood pressure is too high
- Hospital access
  - BasicInternet at 5 hospitals
- Producing sensors vs analysing data
  - sensor producers don't see the use of their sensors
- Information providers (Google)
  - become industry suppliers

«Free basic access for low capacity services»
The Basic Internet Vision @Basic4all

MIT and the global GDP

- 50% of U.S. economic growth after 1945 attributed to technological innovation

MIT alumni startups (2011 numbers)

- 25,800 active companies
- 3.3 million people employed
- $2 trillion gross domestic product
- 10th world rank in GDP
- 19% higher per capita income than California (27% higher than USA)

25 largest economies
by GDP (PPP) in 2015 in Billions

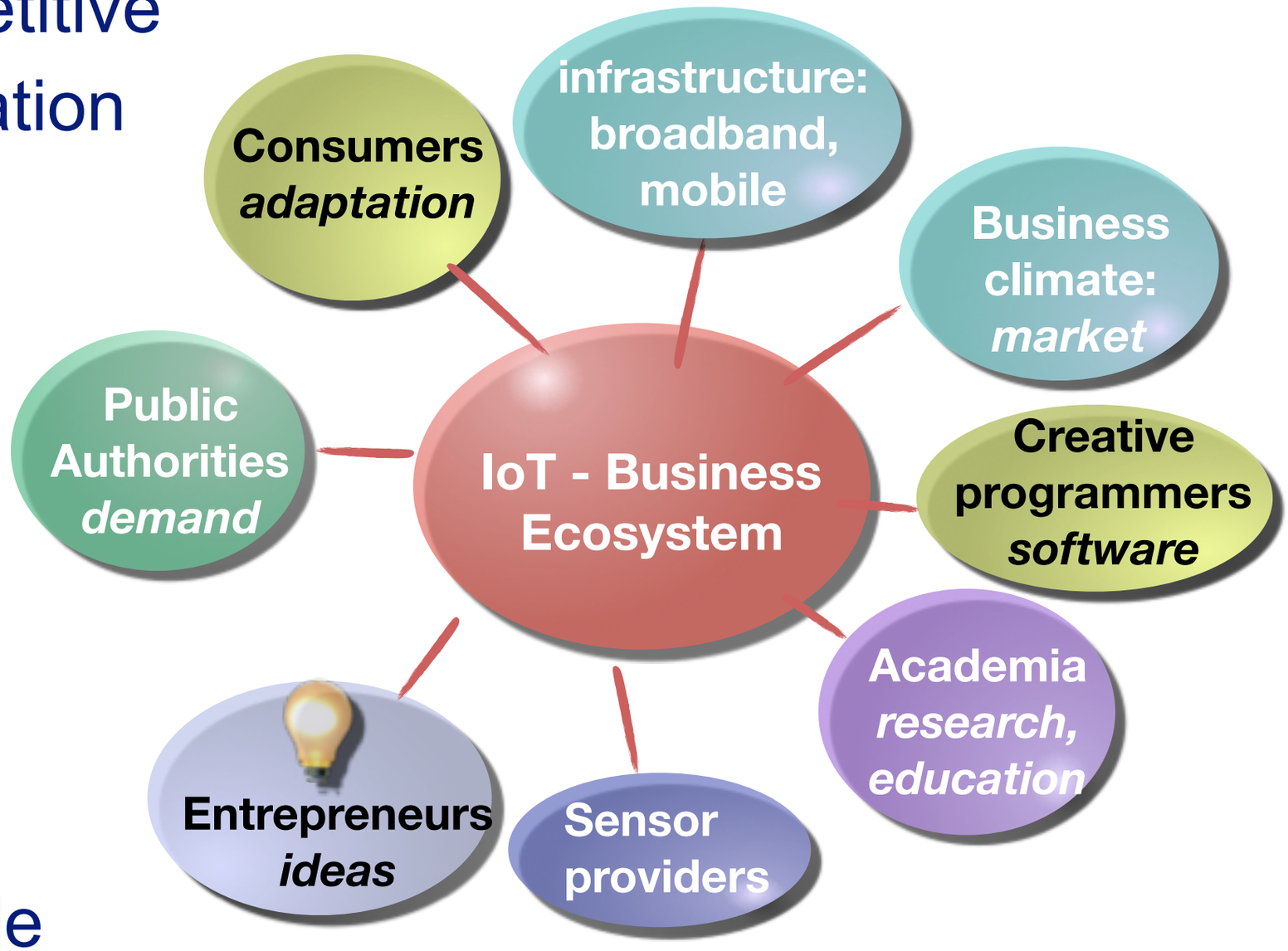
1	China	18,976
2	United States	18,125
3	India	7,997
4	Japan	4,843
5	Germany	3,815
6	Russia	3,458
7	Brazil	3,259
8	Indonesia	2,840
9	United Kingdom	2,641
10	France	2,634

Role of education

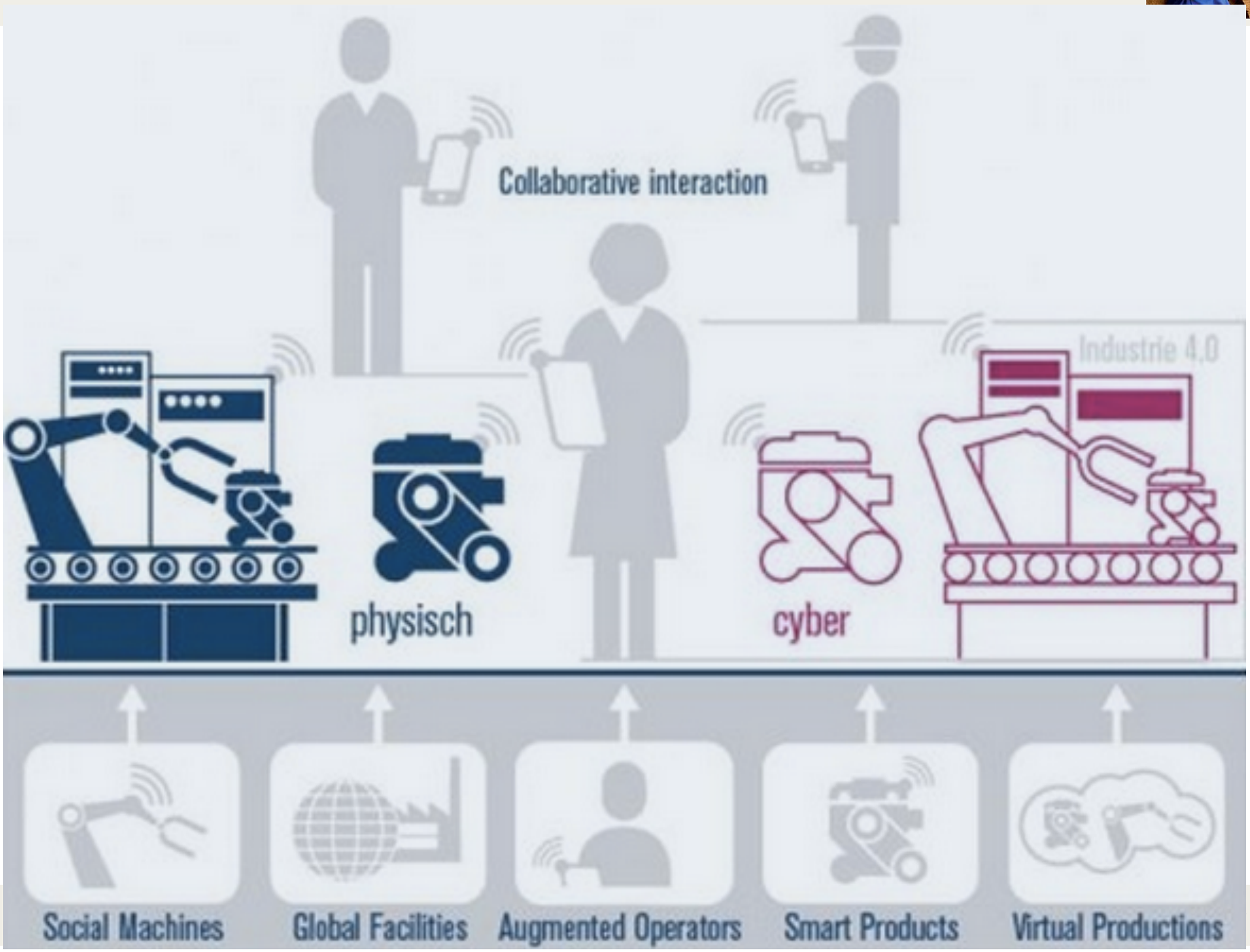
- 75% of the world's GDP growth in developing countries

Human perspective in
The IoT ecosystem

- Creating business
  - openness, competitive
  - climate for innovation
- Public authorities
  - trust, confidence
  - demand
- **Consumers**
  - **(early) adapters**
  - **education**
- Infrastructure
  - broadband, mobile
  - competition



Industrie 4.0 vision



Source: Trumpf / Forschungsunion Wirtschaft & Wissenschaft

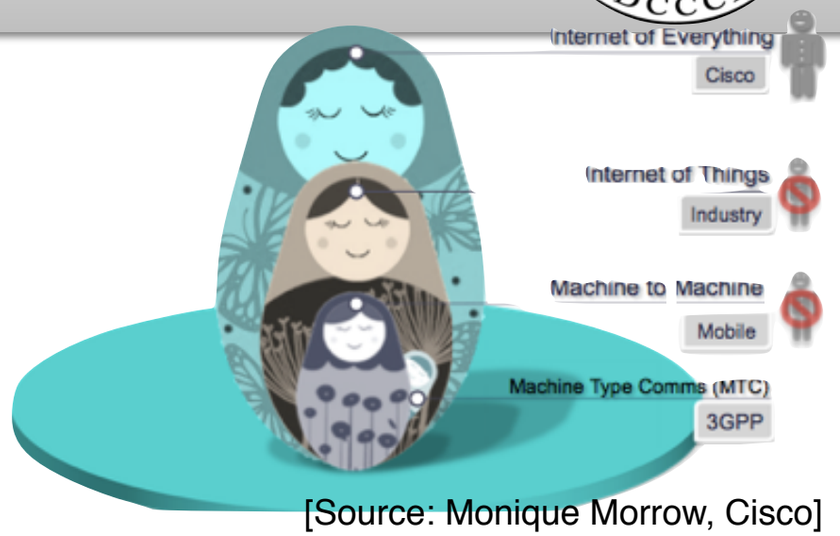
EU Commission activities

- Four focus areas for Industrie 4.0
  - Digital Innovation Hubs
  - Leadership in digital platforms
  - **Closing the digital divide gap**
  - Providing framework conditions
- Collaboration with regional/structural funds (ESIF) and Juncker package (EPIF)
- Connectivity is the challenge both in terms of
  - Availability/Security and
  - Affordability

Experiences from the Innovation Stock Exchange - innobors.no
(see: Presentation on InnoBors Experiences)

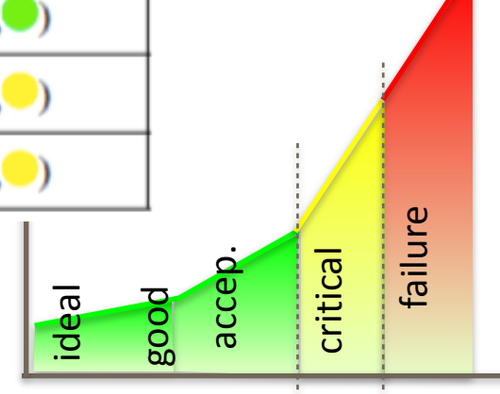
Conclusions

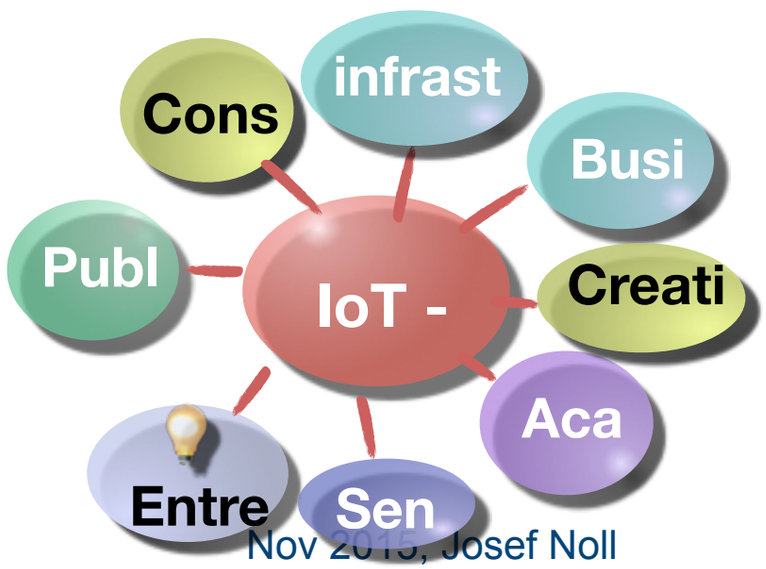
- Internet of Things (IoT) is a game changer
  - ➡ Unfair advantage in the Nordics
  - ➡ Autonomous systems, Critical Infrastructure
- Collaborative approach for a (more) secure society
  - ➡ trust is not enough, need for measurable
  - ➡ partnership for security: threats, measures, counter activities
- Measurable Security and Privacy for IoT
  - ➡ IoTSec.no - Security for Smart Grid
  - ➡ Dependable access
  - ➡ Industrial impact: Security Centre for Smart Grid
- Innovation ecosystem
  - ➡ Digital innovation
  - ➡ Experiences from Innovation Stock Exchange



[Source: Monique Morrow, Cisco]

SPD level	SPD vs SPD_{Goal}
(67,61,47)	(●,●,●)
(67,61,47)	(●,●,●)
(31,33,63)	(●,●,●)





My special thanks to

- Silica Pejanovic-Djurisic for the opportunity to present
- Per Anders Johansen, Andreas Bakke Foss and Aftenposten for putting their effort into security
- Rune Rækken and my colleagues from Telenor for the education in 2G, 3G and beyond
- Hans Christian Haugli for the focus on Internet of Things (IoT)
- Andrea Fiaschetti for the invitation to SHIELD - measurable security
- JU Artemis and the Research Councils (Trond Espeli) for support
- Przemyslaw Osocha and Cecilia Coveri for running the SHIELD projects
- Sarfraz Alam, Zahid Iqbal and Mushfiq Chowdhury (UNIK) for the semantics and demos
- Habtamu Abbie (NR) for the good discussions on measurable security
- Iñaki Garitano and Seraj Fayyad for the papers on measurable security
- and all those I have forgotten to mention