Smart Grid and the role of DSOs

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Overview

- Value chain and attack surface
- Electric grid
- Smart grid
- Smart metering
- Situation in Norway

Attack surface

- Based on the IoTSec-supported course UniK4750

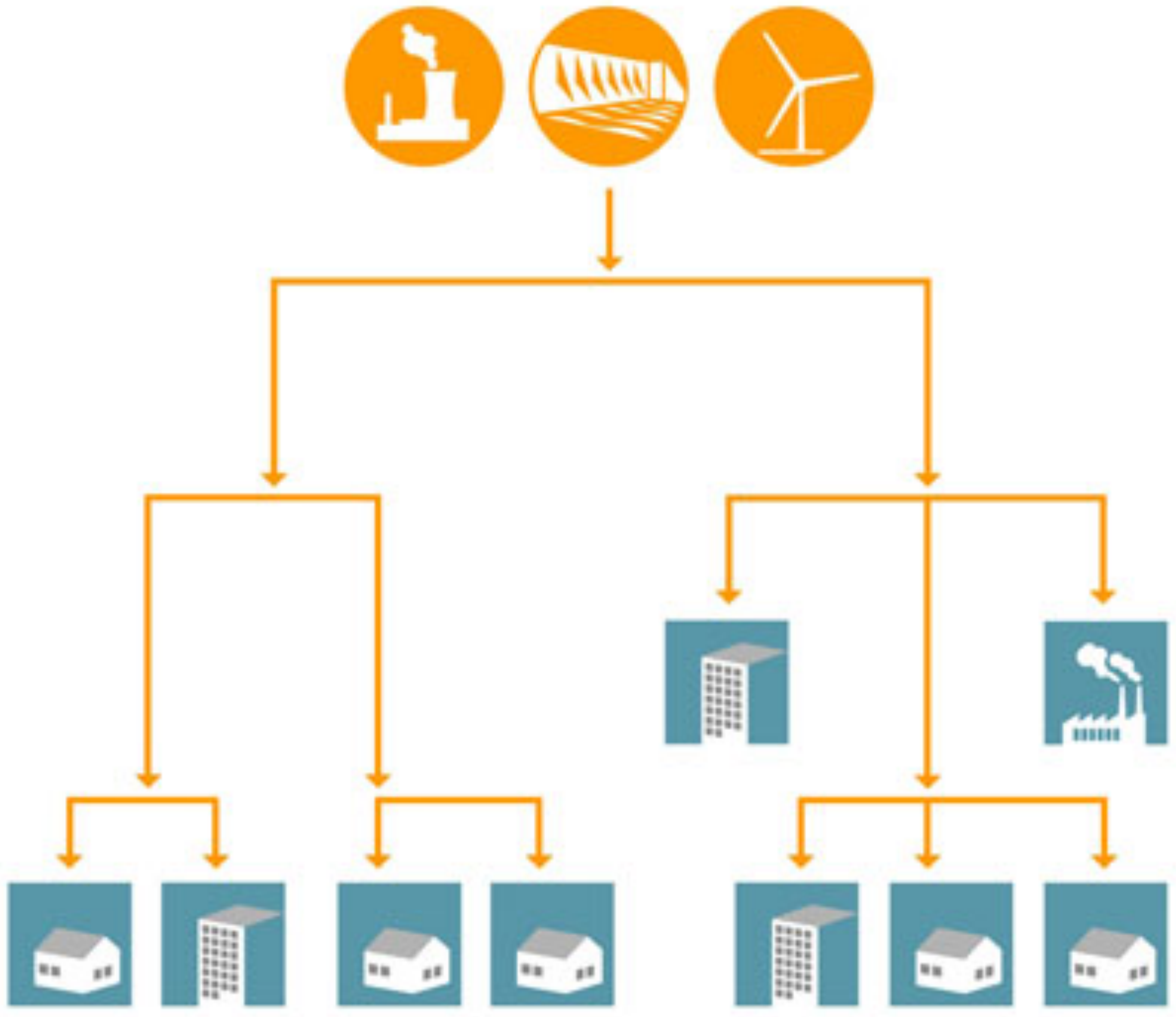
- Structured approach with well-known steps: e.g. securing a web interface, analysis and setup of protocol parameters (avoid fallback to weak crypto), analysis of data to select correct protection
- Insecure network services: unfortunately, typical for industrial applications
- Transport encryption: use appropriate technological solutions
- Cloud interface
- Mobile interface
- Appropriate granularity in security configuration: e.g. monitoring, logging, password and lockout parameters
- Insecure software
- Physical security

Electric grid

- Nation/continent-wide critical infrastructure
- Synchronized from production to consumer
- Key to most services of the society
- Reaches in practice every home and installation
- Very conservative (that’s very much ok!)
- Was always kind of smart, the difference is in:
  - ➡ Relation between the TSO and the DSOs
  - ➡ Resolution and timeliness of data
  - ➡ Use of IT
  - ➡ Ratio between consumers and producers

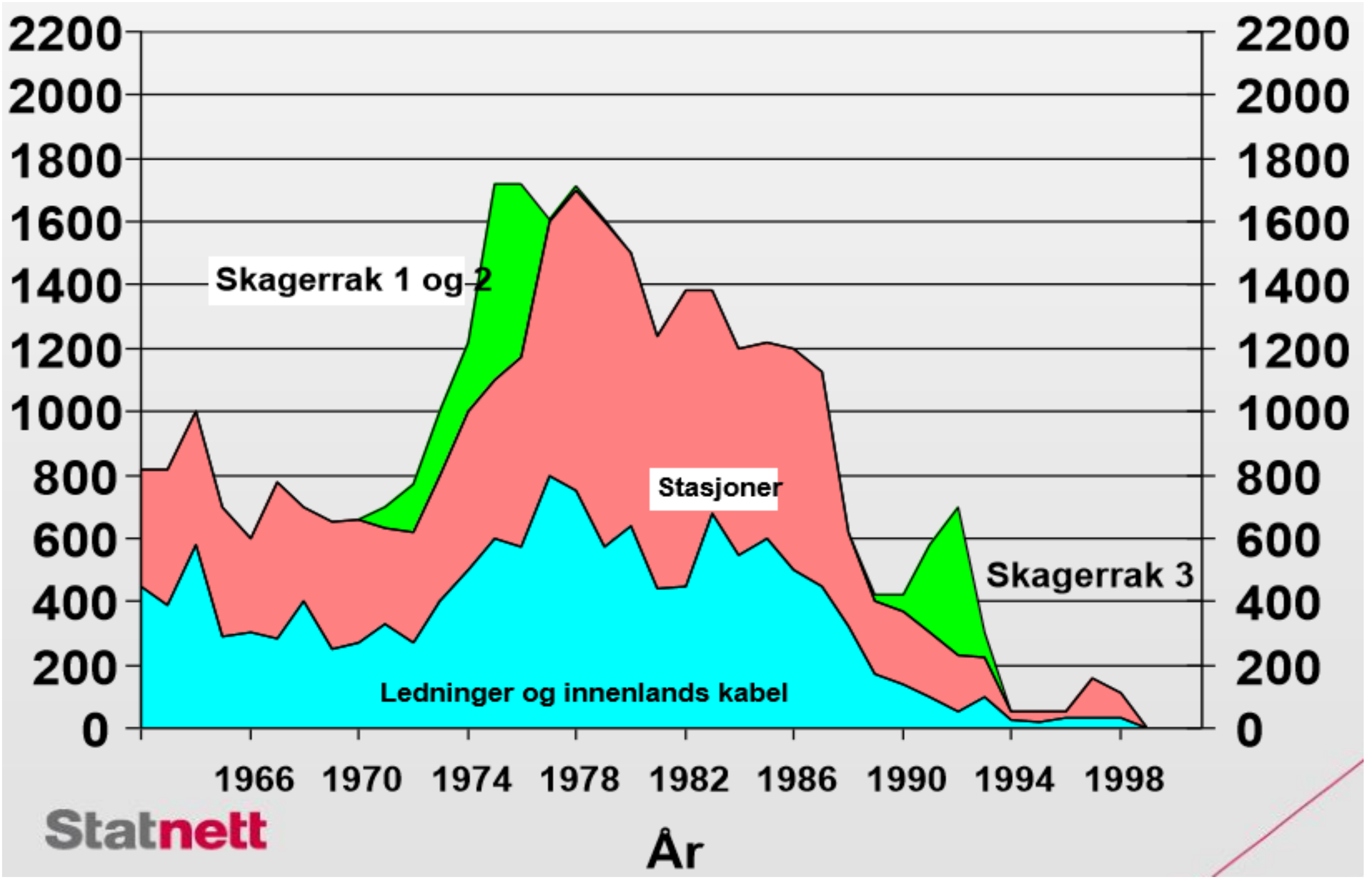
Electric grid – contd.

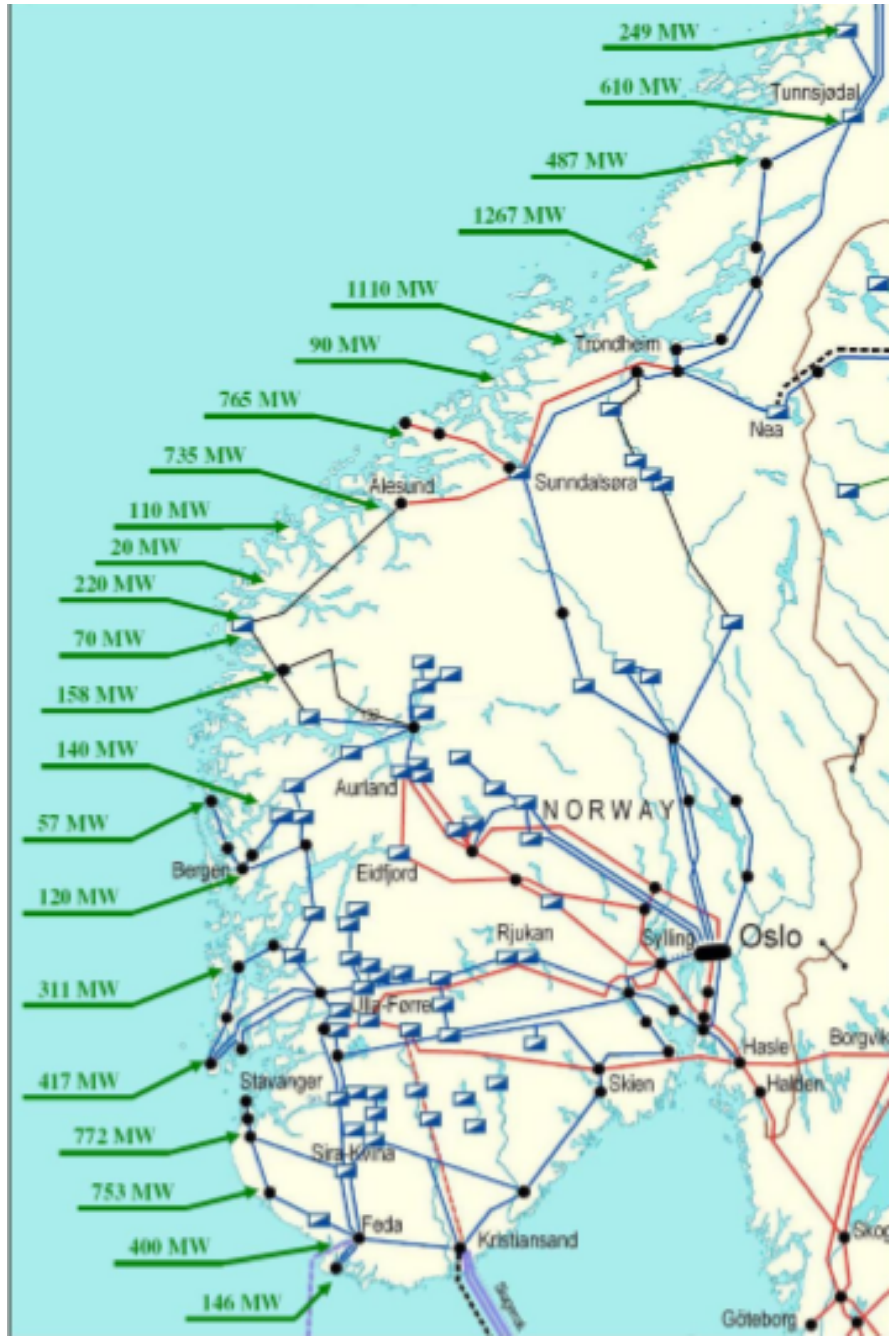
- traditional electric grid vs. smart grid, figure from ABB



Smart Grid

- Motivation to build a smart grid: save on investments, higher profit rate, better stability, renewables, some cost reduction in emloyees
- Possible new services based on acquired data (big data)
- Operational stability
  - ➡ Integration of the volatile production of renewables
  - ➡ Synchrophasor operations
  - ➡ Micrograids – possibility for island operation – internet-like operation
- Higher electricity price for households
  - ➡ Can lower the pressure on the network for consumer peak hours
  - ➡ Can enable new services to be delivered by the utility
- Relevance for Norway:
  - ➡ Easy-controllable hydro plants
  - ➡ Low investment since 25 years





Smart Grid – contd.

- Measurement and data management at the DSOs
  - ➡ An explosion in number of endpoints and amount of data at the DSO
- Technological points:
  - ➡ Network control has continous and real time picture of the network (compare to IT networks)
  - ➡ Multi-directional power flow – in practice it might not, implementation-dependent, but for sure a lot of generation plants compared to traditional grid, most of renewables and micro-generation shows up in the DSO grid (LV/MV)
  - ➡ Not just monitoring, but direct control down to the end nodes
- Risk analysis and management
  - ➡ Clear, real time data with high resolution – this is new
  - ➡ Big data with correlation to e.g. weather, measurement data from neighbours, renewable prediction
  - ➡ Soft (price) and hard (switch off) measures to deal with high risk situations
  - ➡ Clear, high resolution, processed documentation of grid history – potentially high value
- Economics
  - ➡ Until now, small consumers were saved from the swings in the power-spot price
  - ➡ Cutting peaks reduces investment needs in distribution (DSO) and core (TSO)
  - ➡ Might lead to some reduction in price (I don’t expect that)
  - ➡ Has a social aspect with e.g. prepaid power, free hours etc.

Smart Grid – technology challenges

- Time synchronization
  - ➡ Key in protection, control, monitoring
  - ➡ GPS or distributed signal
- Communication
  - ➡ Wired in parallel with the core network
  - ➡ Partly also with the distribution
  - ➡ Wireless or powerline to consumer – active research area: multihop, 5G
  - ➡ Licensed or unlicensed band, mesh, zigbee, 6LoWPAN
  - ➡ Quality of Service
    - Translation of engineering requirements to nework metrics
- Security and privacy
  - ➡ Remote switch-off is required functionality – annoying if a bot is doing it
  - ➡ High resolution data with unlimited history on use
  - ➡ Not core competence of DSO or TSO – availability and safety before security and privacy, inflection point?
  - ➡ DSO to interface with TSO to supply aggregated data

Advanced Metering Systems

- History: smart metering was present for big consumers since more than a decade, power factor corr.
- Now moving to the household, required by law (in Norway)
- Adds new possibility for load control: consumer (AMS), generation, big consumers, energy storage
  - ➡ Operations central (at grid control) [load control] – operations central (at local power utility) [load control] – consumer [smart meter with remote switch-off]
- Assumes IPv6 – ref. to L3 – problems with firewalls
- Meter components
  - ➡ Tamper resistance is key (both for utility and consumer)
  - ➡ CPE with potentially one interface in home network (home automation) and utility (reporting)
  - ➡ Firewall? Future proofing? Ownership on traffic? Availability requirements?
  - ➡ Health-Safety-Environment

Advanced Metering Systems – assessment

- CPE: not within secured perimeter from the utility viewpoint, access needs cooperation from consumer
- consumer has no control on communication towards the utility
- Disassembly and probing already possible with a few hundred EUR investment
  scope, logic analyzer, a bit better soldering iron, cables, devel. circuit board – nothing what a student can't have at home
- In addition: analysis of the communication, analysis of the radio spectrum (if radio is used)
- From communication side: CLI, webinterface, multiple communication interfaces, limited resources in the device, will be the same for a decade or more
- Potentially millions of devices of same type
- Services (maybe the main point for customer satisfaction):
  - ➡ Opens communication with the AMS through the internet
  - ➡ Maybe also third party
  - ➡ Breaches here _will have_ a physical dimension

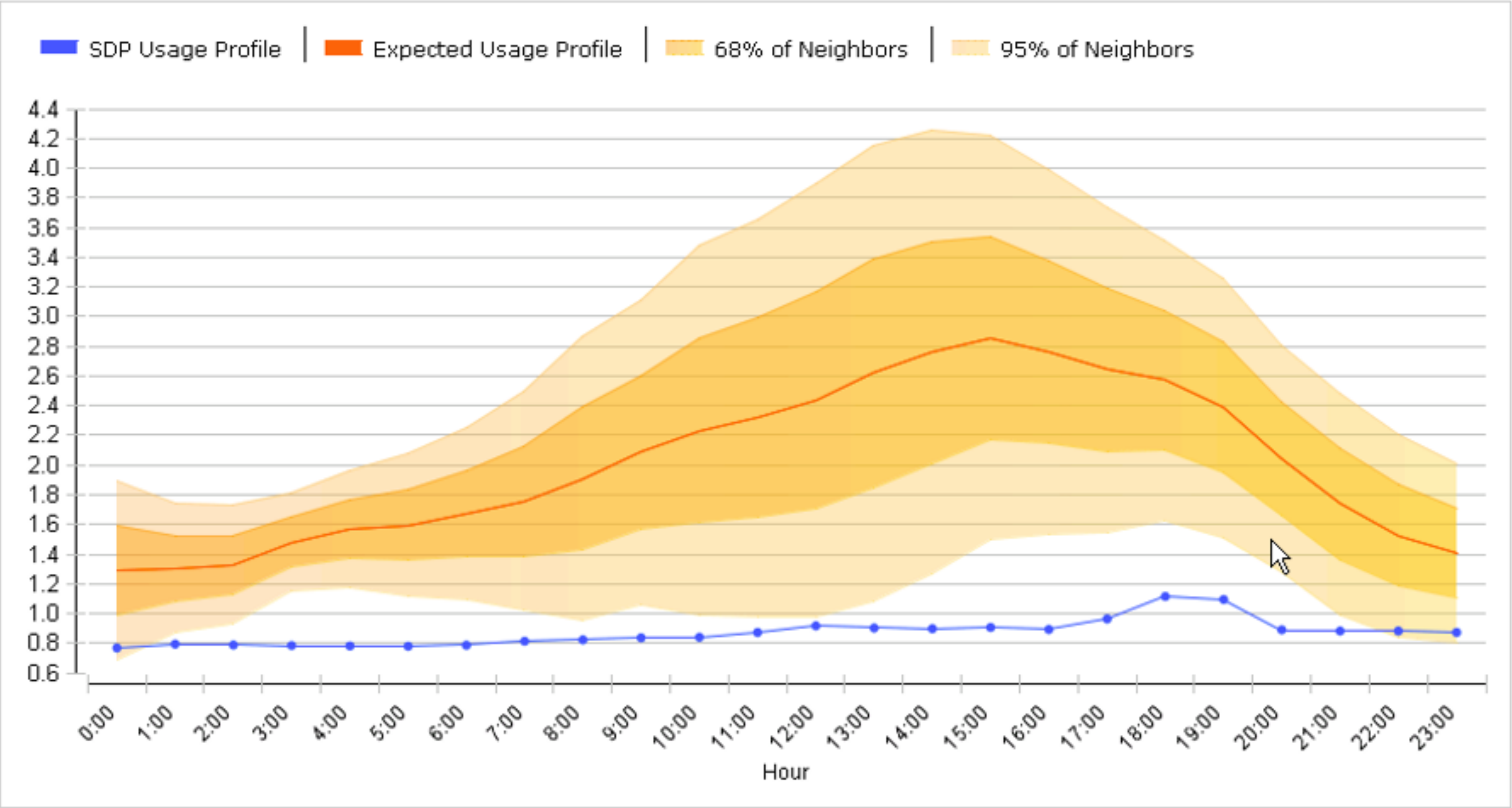


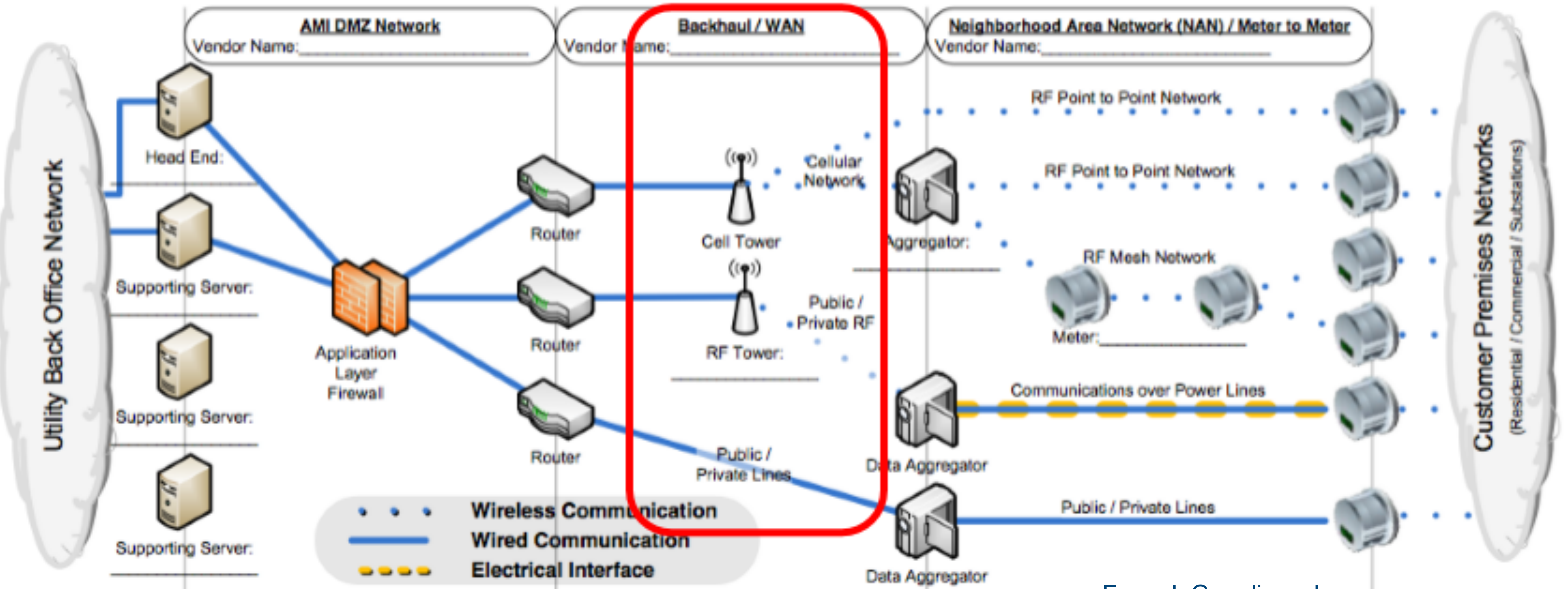
Figure from Siemens

Advanced Metering Systems – Network security

- Utility and consumer can’t trust eachother
- Communication policies and configuration – segmentation, firewalling, patching
- Who owns the network?
- How to run an IDS/IPS in this infrastructure?
- How to monitor the whole system?

- Incident handling with heuristics
- Trusted external provider and/or detailed SLAs

- Attack surface again: CLI, webif, remote management, home automation, consumer services, data history

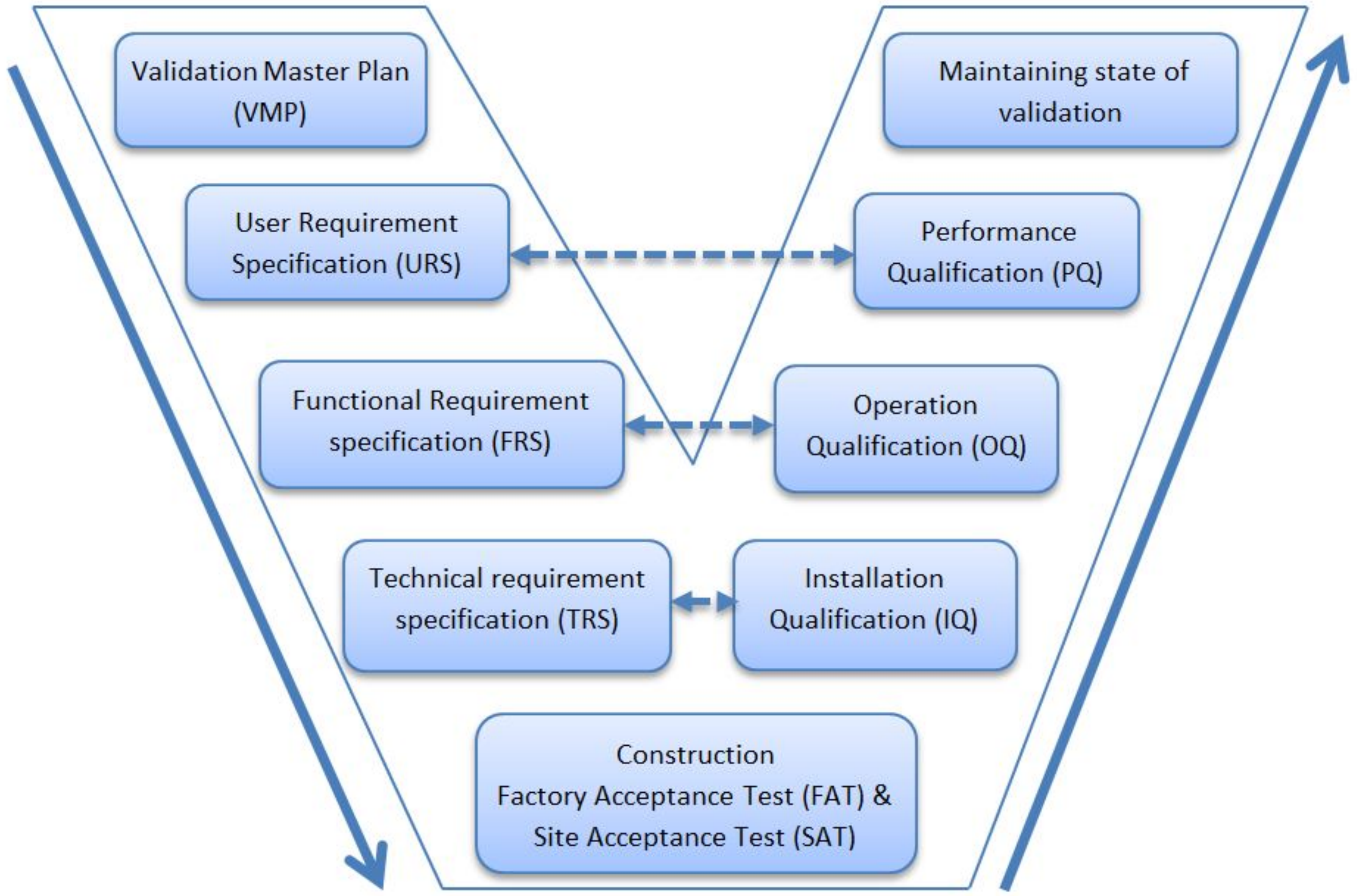


From: InGuardians, Inc.

Advanced Metering Systems – Network security contd.

- Mitigation:
  - ➡ Engineering teams need to be extended with IT security members – see on the safety example!
  - ➡ Some kind of transformation solution for requirements between engineering and IT
  - ➡ Software Development Life-Cycle change
  - ➡ External entity monitoring security compliance

  - ➡ Tamper resistance
  - ➡ VPN/MPLS/overlay networks
  - ➡ Crypto
  - ➡ Traffic shaping



Advanced Metering Systems – Risk management

- Analyze vulnerabilities
  - ➡ They are not unique (see L3): CLI, web interface, SQL injection, cross-site request forgery – all the typical things one is getting when testing a web service
- Mitigate risk
  - ➡ Again, crypto, but this is not a universal answer
  - ➡ Data processing
  - ➡ Development and operation life-cycle

Conclusions

- Converged infrastructure
- IoT expands the attack surface
- Security requirements do also depend on type of data processed
- Devices with multiple intefaces present a risk
- End-to-end security and life-cycle support is key
- Privacy
- Why is this all good for the user?