MasterClass on ICT Support for Adaptiveness and (Cyber)Security in the Smart Grid DAT285B

The “Smart” Grid as Distributed Cyberphysical system

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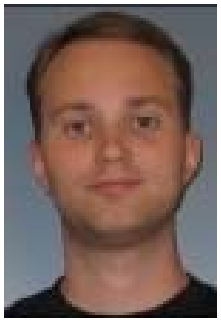
Briefly on research + education area of the supporting team


Daniel Cederman


Zhang Fu


G. Georgiadis


V. Gulisano

- Application domains: energy systems, vehicular systems, communication systems and networks

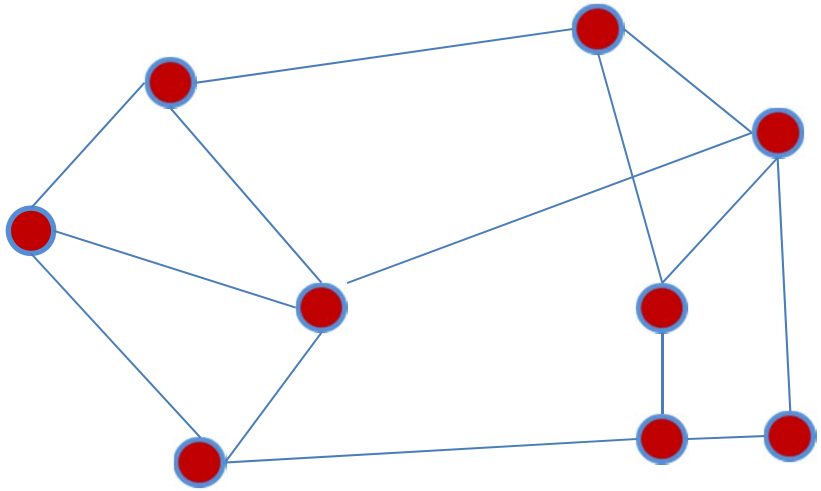

Magnus Almgren


M. Papatriantafilou


Olaf Landsiedel

A Distributed System

A set of computing&communicating processes, collaborating for acheiving local and/or global goals



A Distributed System

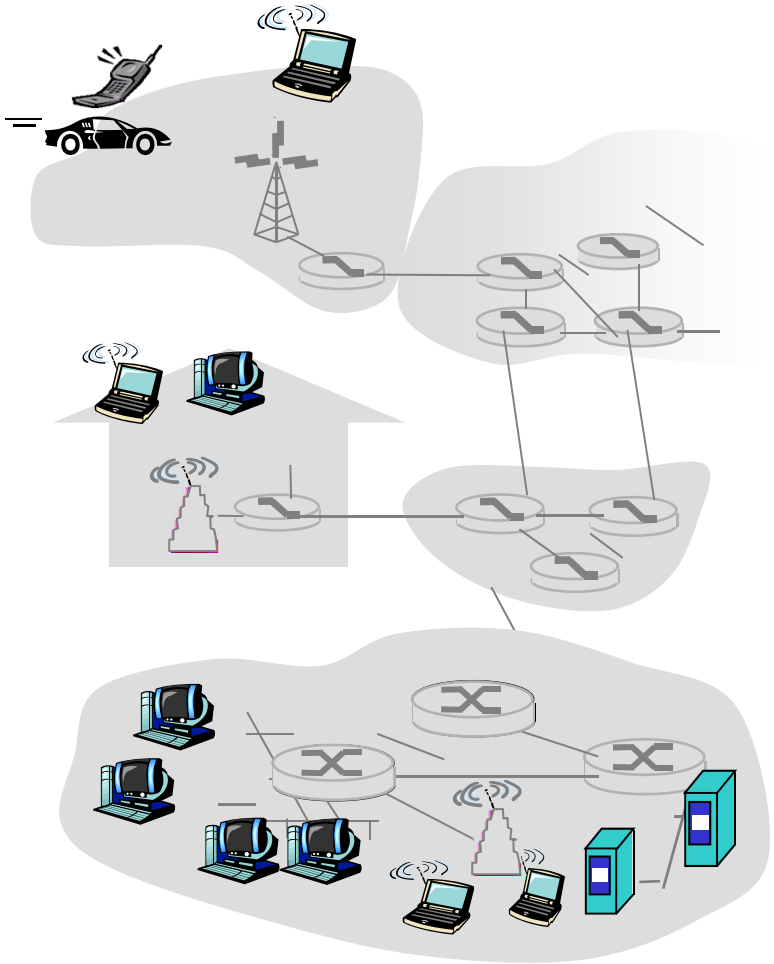


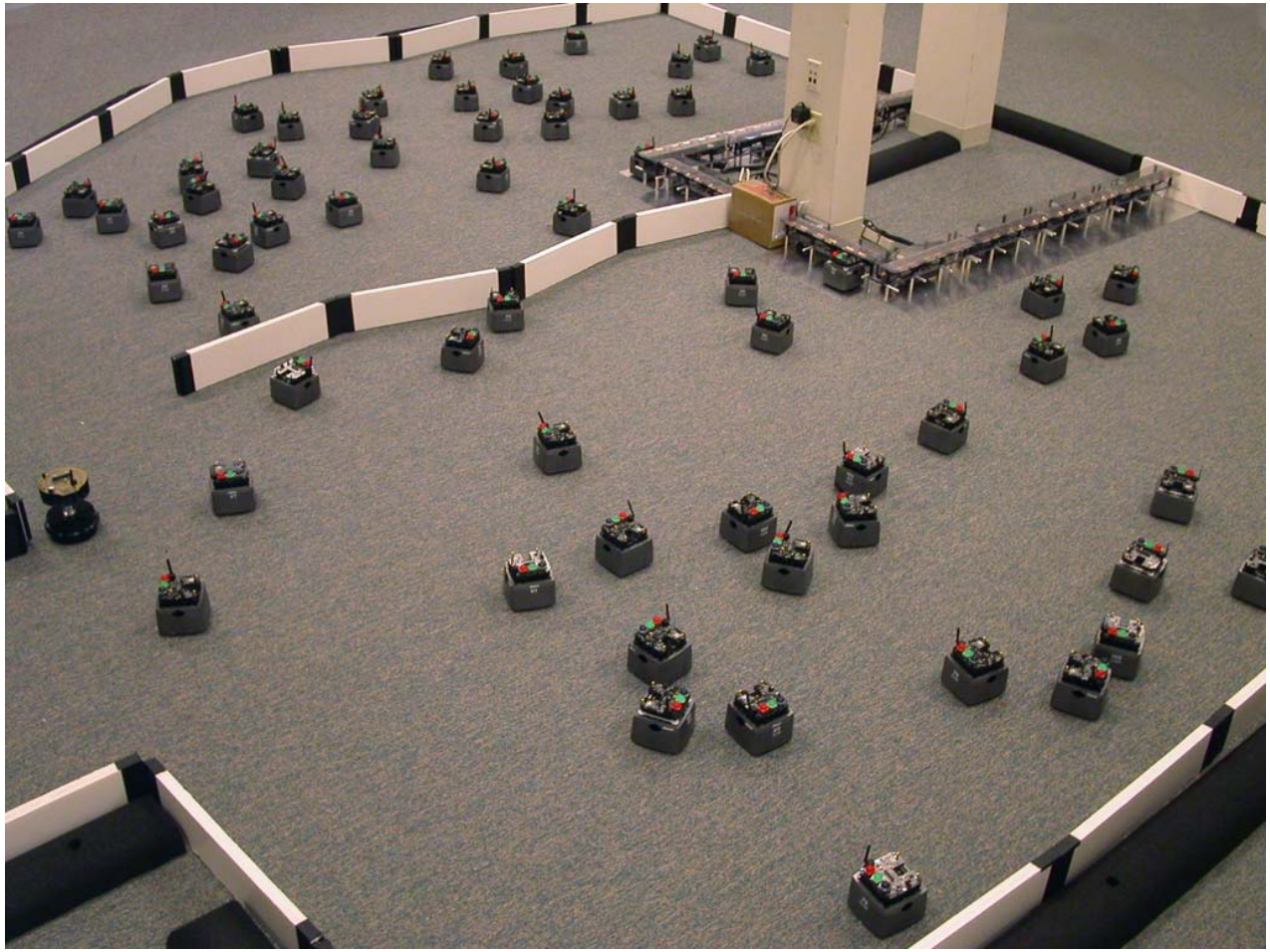
Figure: Computer Networking: A Top Down Approach , Jim Kurose, Keith Ross, Addison-Wesley.

A Distributed System

Picture sourec:Wikipedia

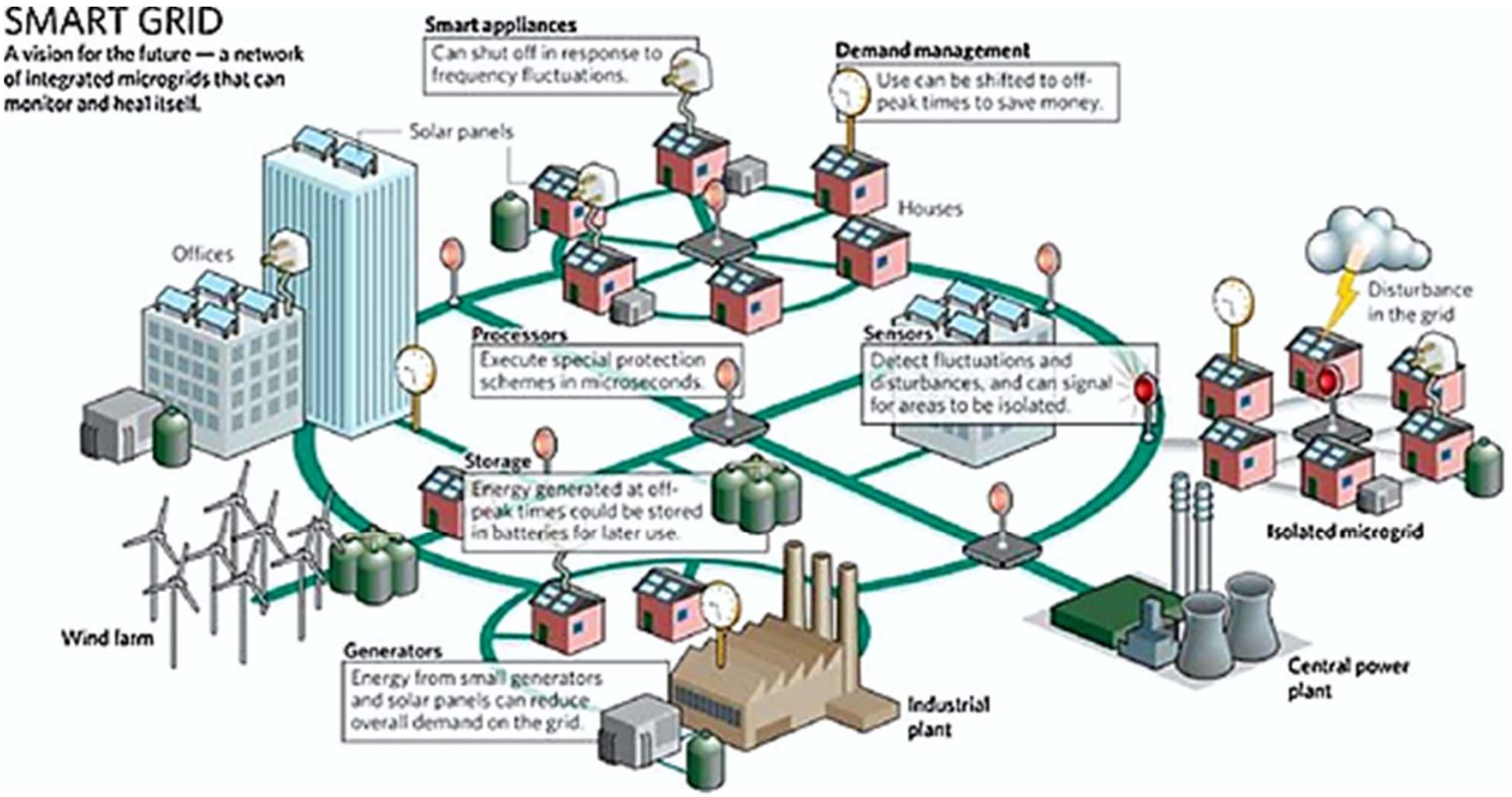
A Distributed System

A Distributed System



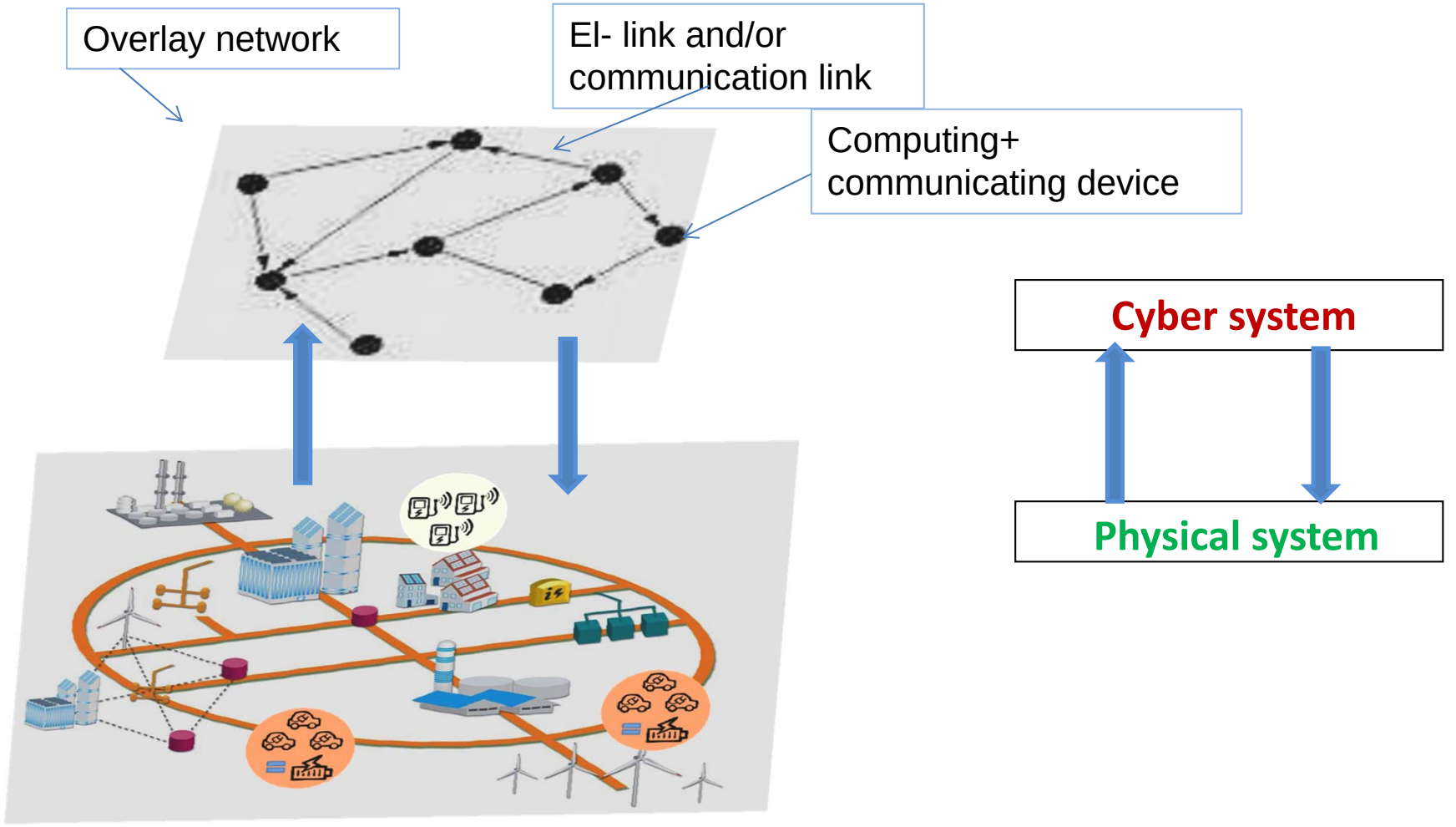
Pic. http://www.hatswitch.org/~sn275/courses/DSS/info.shtml

A Distributed Cyberphysical System



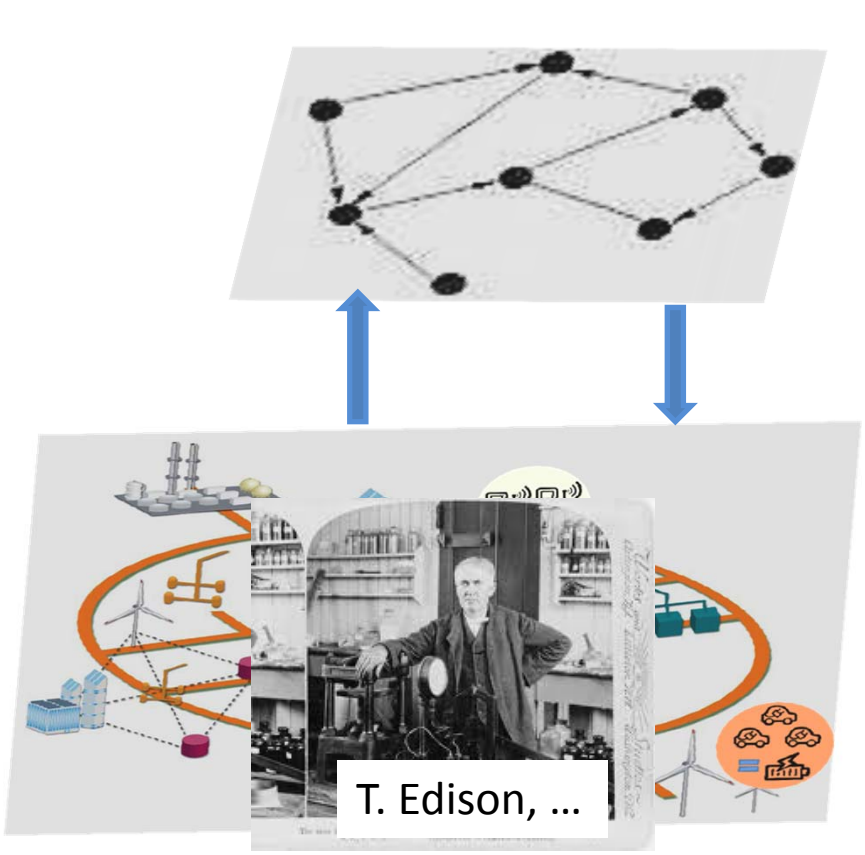
Picture source http://www.energy-daily.com/images/smart-grid-electricity-schematic-bg.jpg

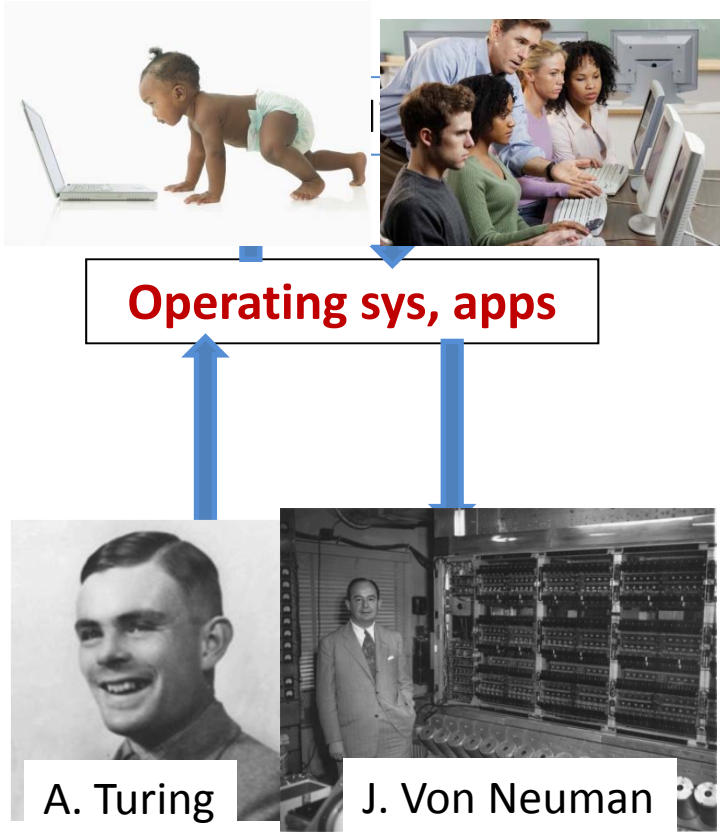
El-networks as distributed cyber-physical systems (*)



(*) cf also Course Chapter on Cyberphysical Systems, by O. Landsiedel

An analogy: layering in computing systems



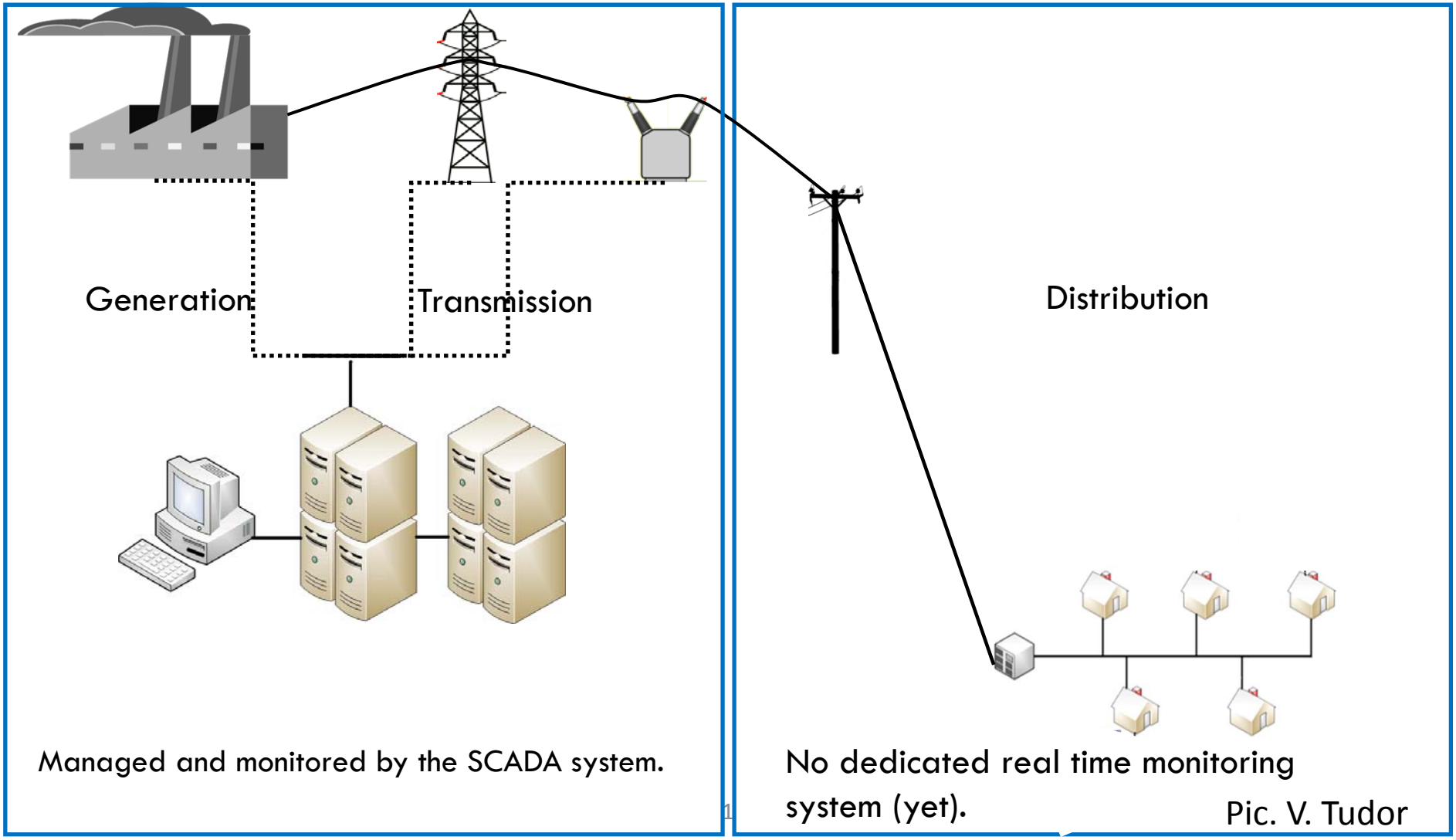


Similarities: provide services; shield from hardware/system details; manage resources

Differences: system/"hardware"; distributed; the "user" is part of the "system"; **critical infrastructure**!!

A bit of info on the el-network

The traditional Electrical Grid

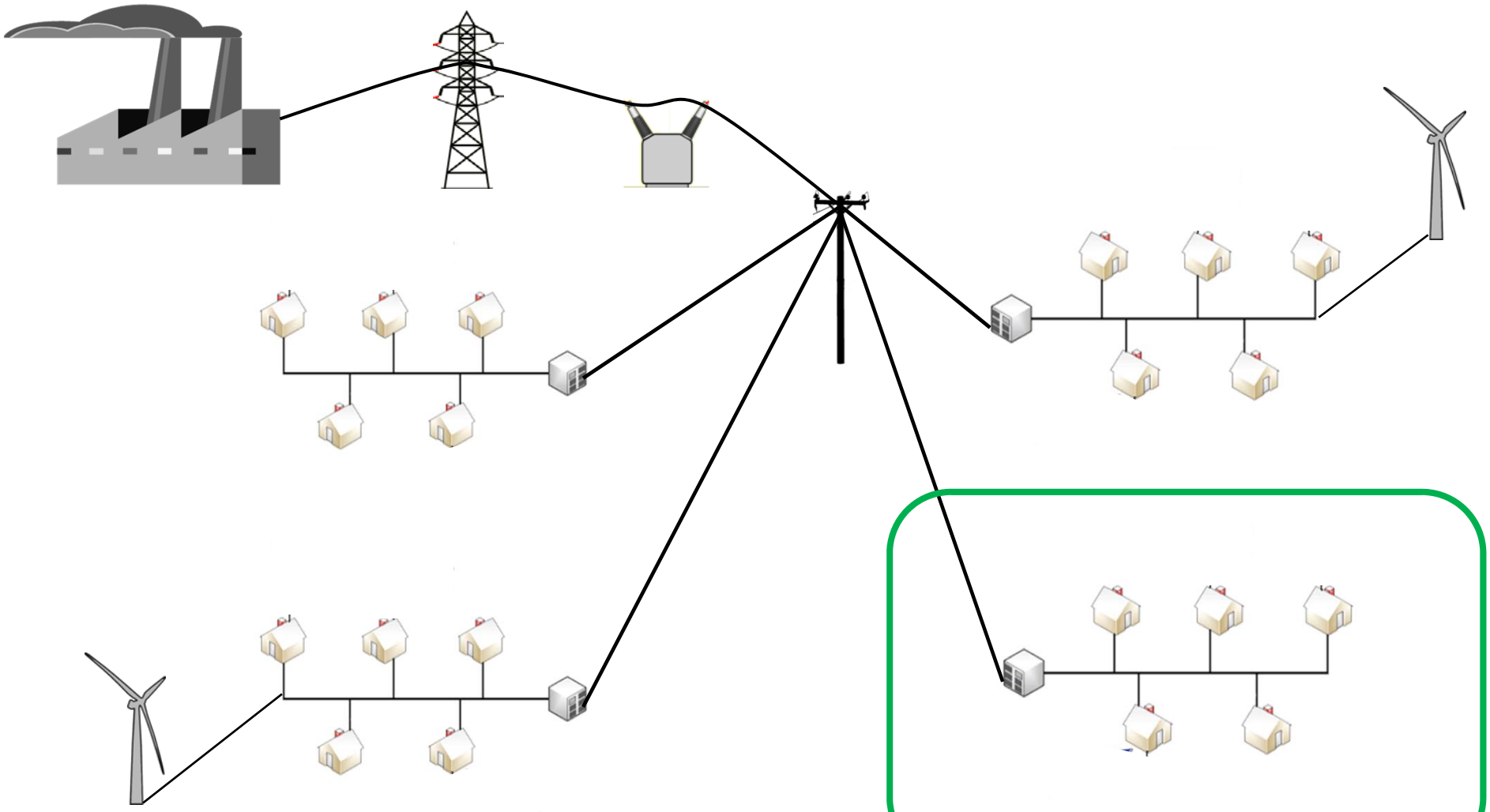


Managed and monitored by the SCADA system.

No dedicated real time monitoring system (yet).

Pic. V. Tudor

From centralized to distributed generation

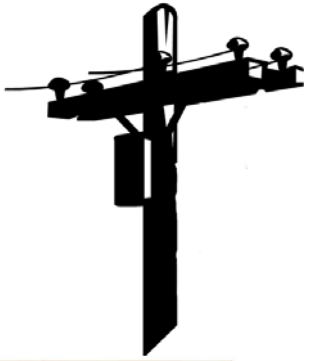


Pic. V. Tudor

One of the enabling components: Smart Meter (Advanced Metering Infrastructure)

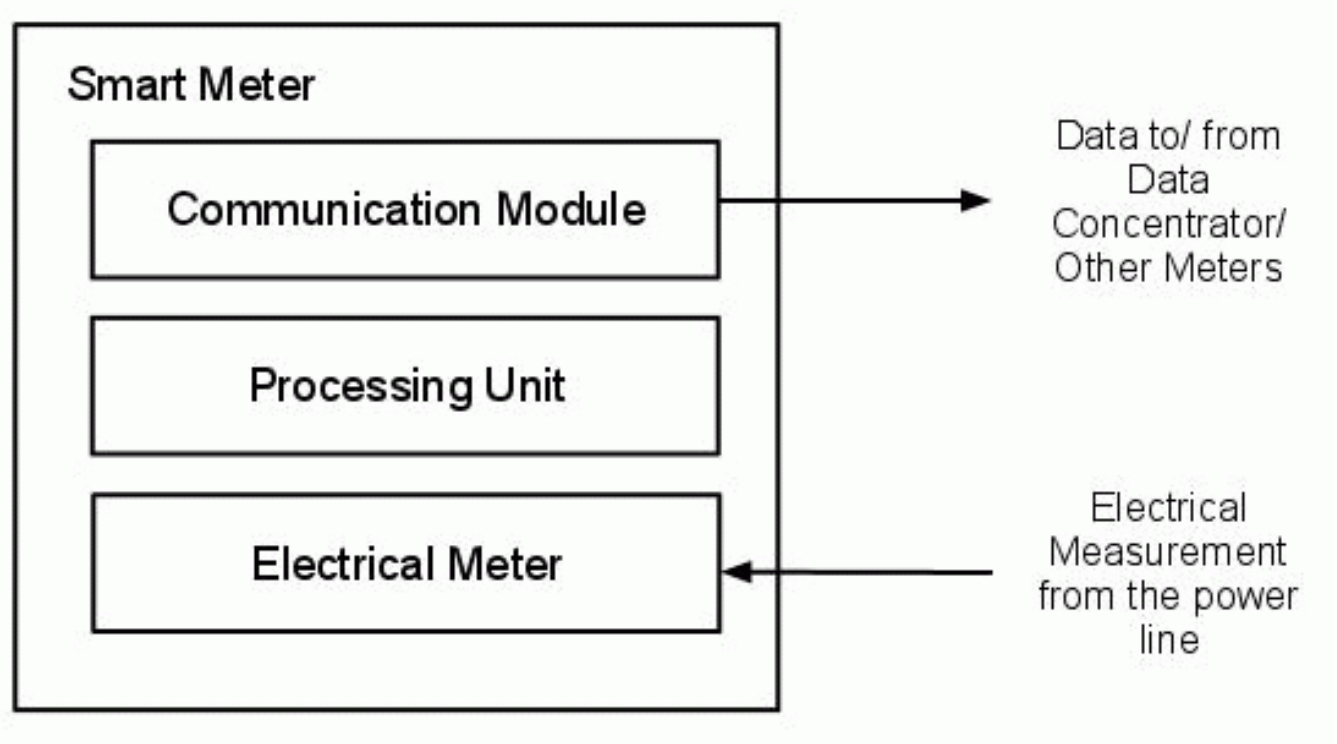
A “Smart” Meter:

- is a small embedded system
- automates (consumption) index readings
- instantaneous consumption
- in-door display
- time of use tariffs
- the base for the Advanced Metering Infrastructure



Pic. V. Tudor

Smart Meter components



Pic. V. Tudor

In the Power Grid cyber-layer

Selected topics:

- Adaptiveness: Distributed resource management
- Enabling “tools”: Communication, Data, information
- Orthogonal and utterly important: cyber-security

In the Power Grid cyber-layer

Selected topics:

- Adaptiveness: Distributed resource management
  - Demand-side management: load balancing, load shifting (users)
  - Routing, aggregation (network)
- Data, information
- Orthogonal: cybersecurity

Demand-side management

household/neighborhood-scale and more

Problem: Fine-grained align supply & consumption; continuous decisions based on info on load, availability, constraints, possibilities ((non)shiftable load, thermal or other storage…)

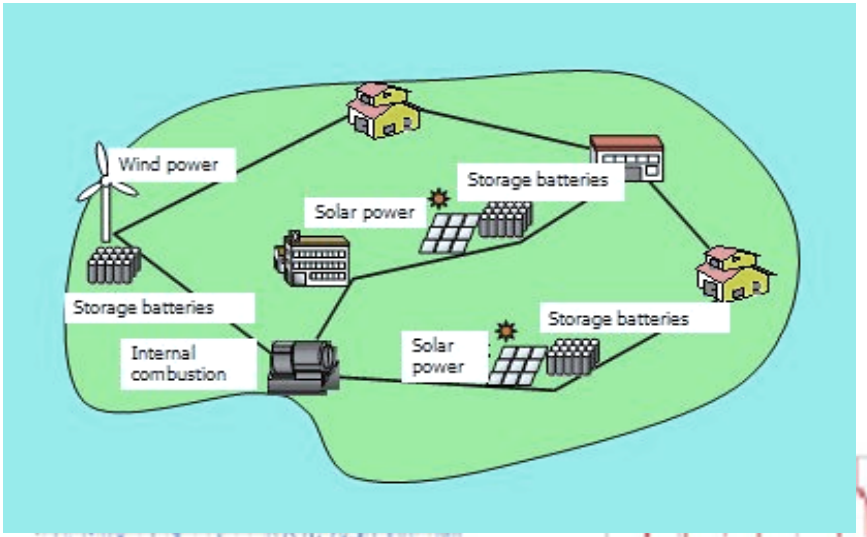
Project supported by EoN
Interaction with Power Engineering Dept

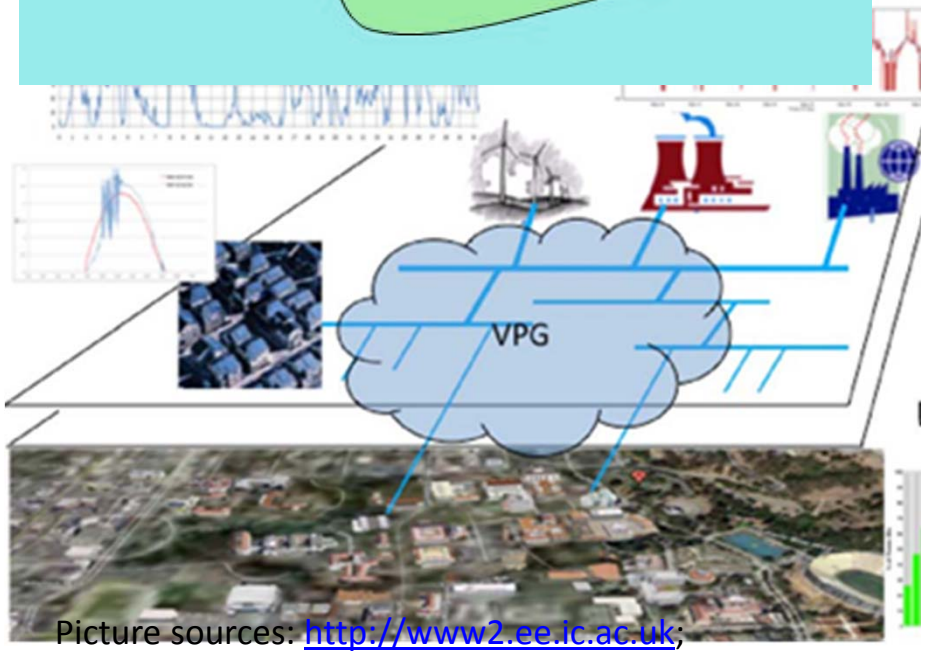
Vision for microgrids

for better use of renewables: Virtual Private Grids/microgrids

- communicating supplies and loads
- cooperating for 0-net energy or mixed use of renewable and other sources
- adaptive loads, to draw power when renewables provide it

- ie connect to the aforementioned methods are for, plus
  - **Power routing** ([NKGPLB10] and aggregation
  - **Information!....**





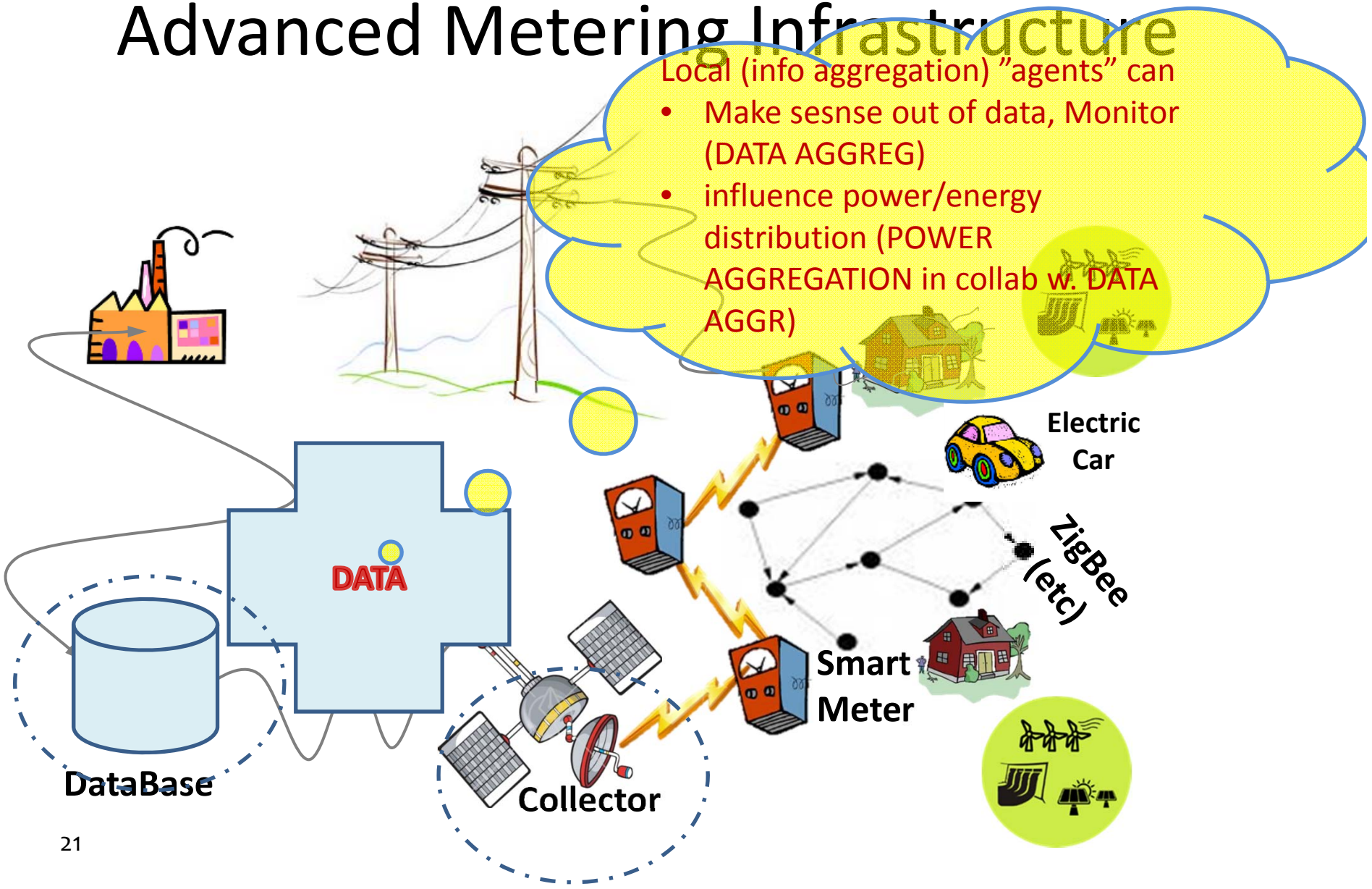
Picture sources: http://www2.ee.ic.ac.uk;
Katz etal, Sustainable computing, 2011

In the Power Grid cyber-layer

Selected topics:

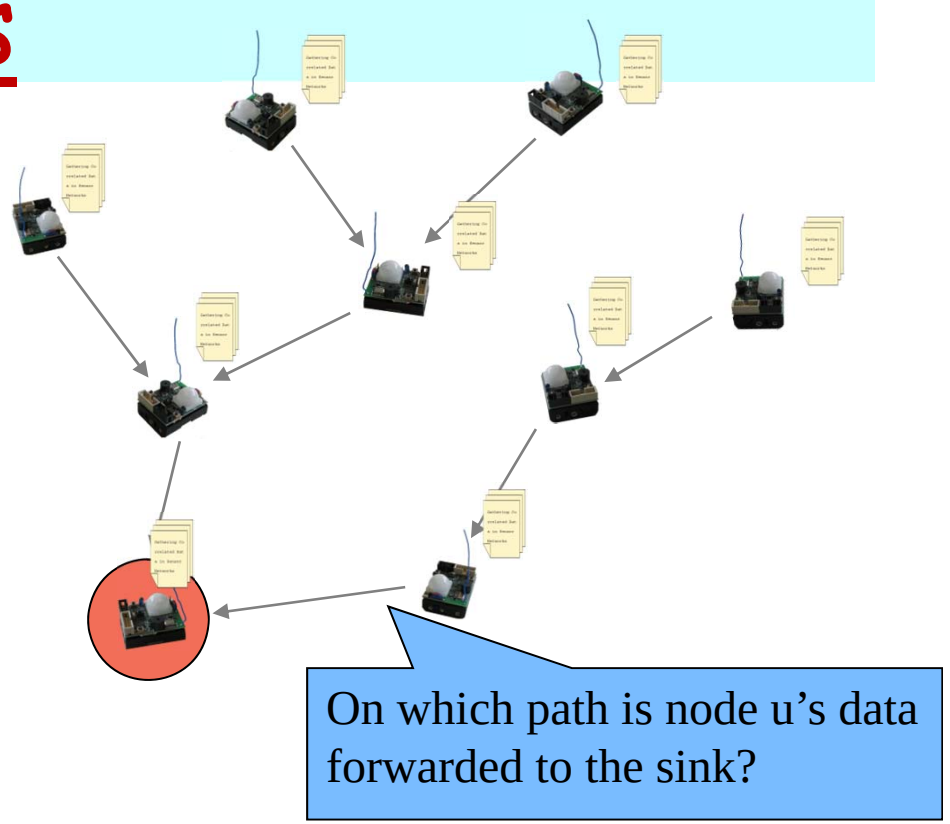
- Distributed resource management
- Enabling “tools”: Communication, data, information
  - Distributed sources & processing
  - Monitoring, facilitating resource services
- Orthogonal and utterly important: cybersecurity

Information&Communication, Advanced Metering Infrastructure



Data gathering/processing in Sensor Networks

- nodes produce relevant information about their vicinity periodically.
- Data is conveyed to an information sink for further processing.
- ....

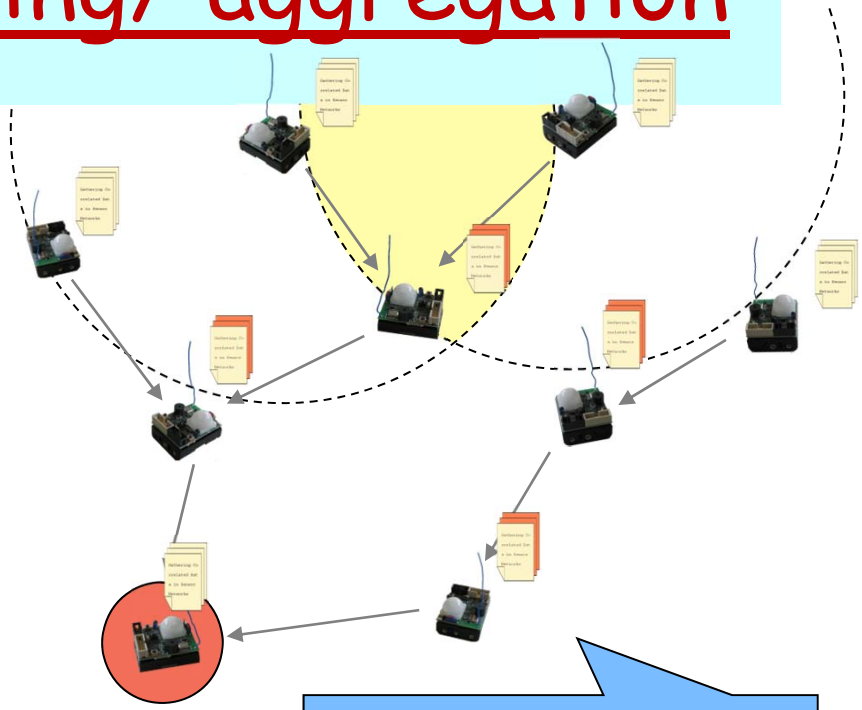


Routing

Slide source: rel w book AdHoc&Sensor Networks by Wagner & Wattenhoffer

Processing/streaming/ aggregation

- … data can be processed as it is routed to the collector/aggregator (sink).



Where/how is u's data processed?

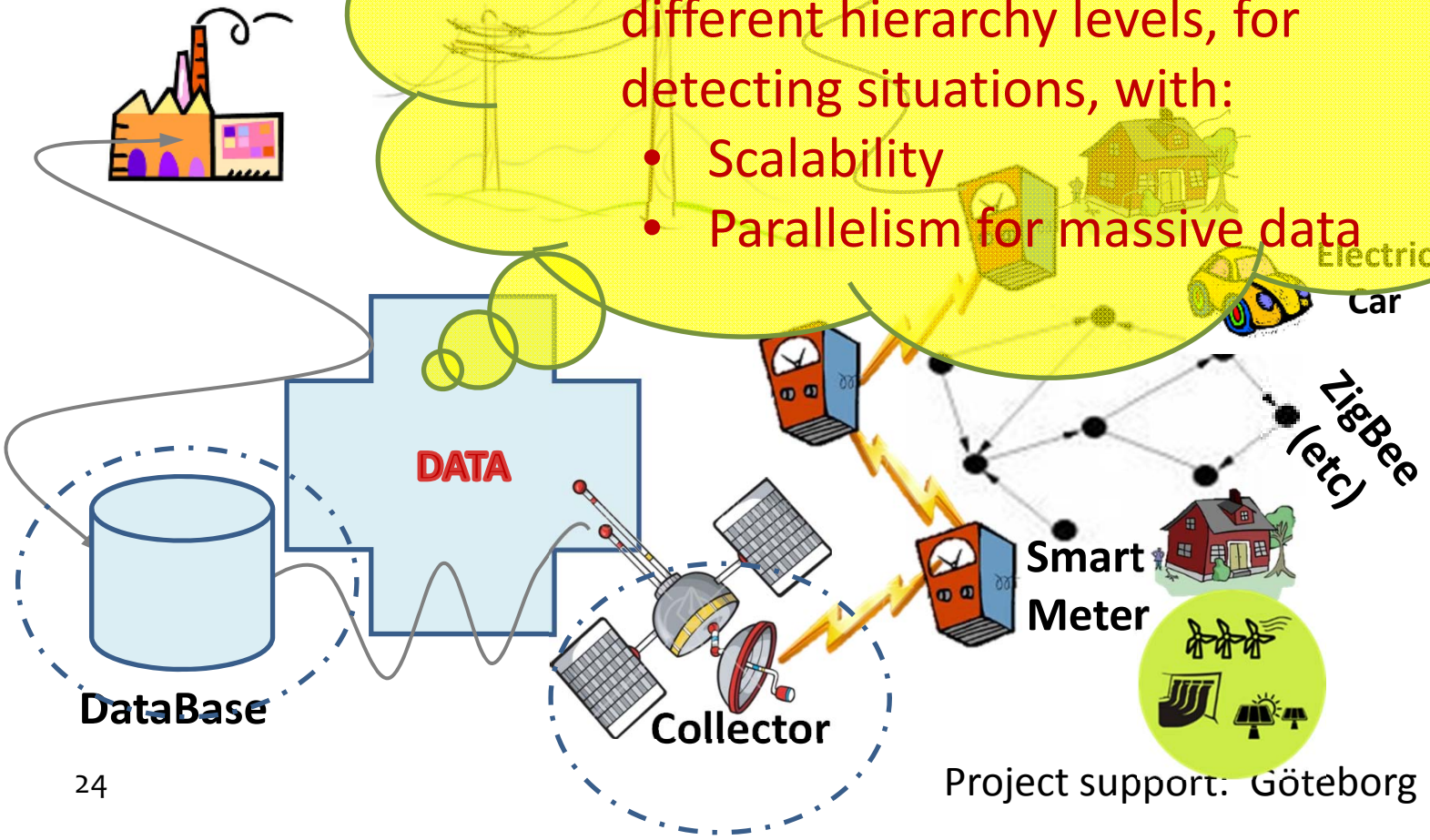
➡ In-network aggregation/streaming/processing

Work with routing, streaming, coding, processing schemes to deliver needed info to the sink (care also for privacy).

Slide source: rel w book AdHoc&Sensor Networks by Wagner & Wattenhoffer

Information/Communication

- Distributed methods for data-network reliability
- Aggregate distributedly, at different hierarchy levels, for detecting situations, with:
  - Scalability
  - Parallelism for massive data



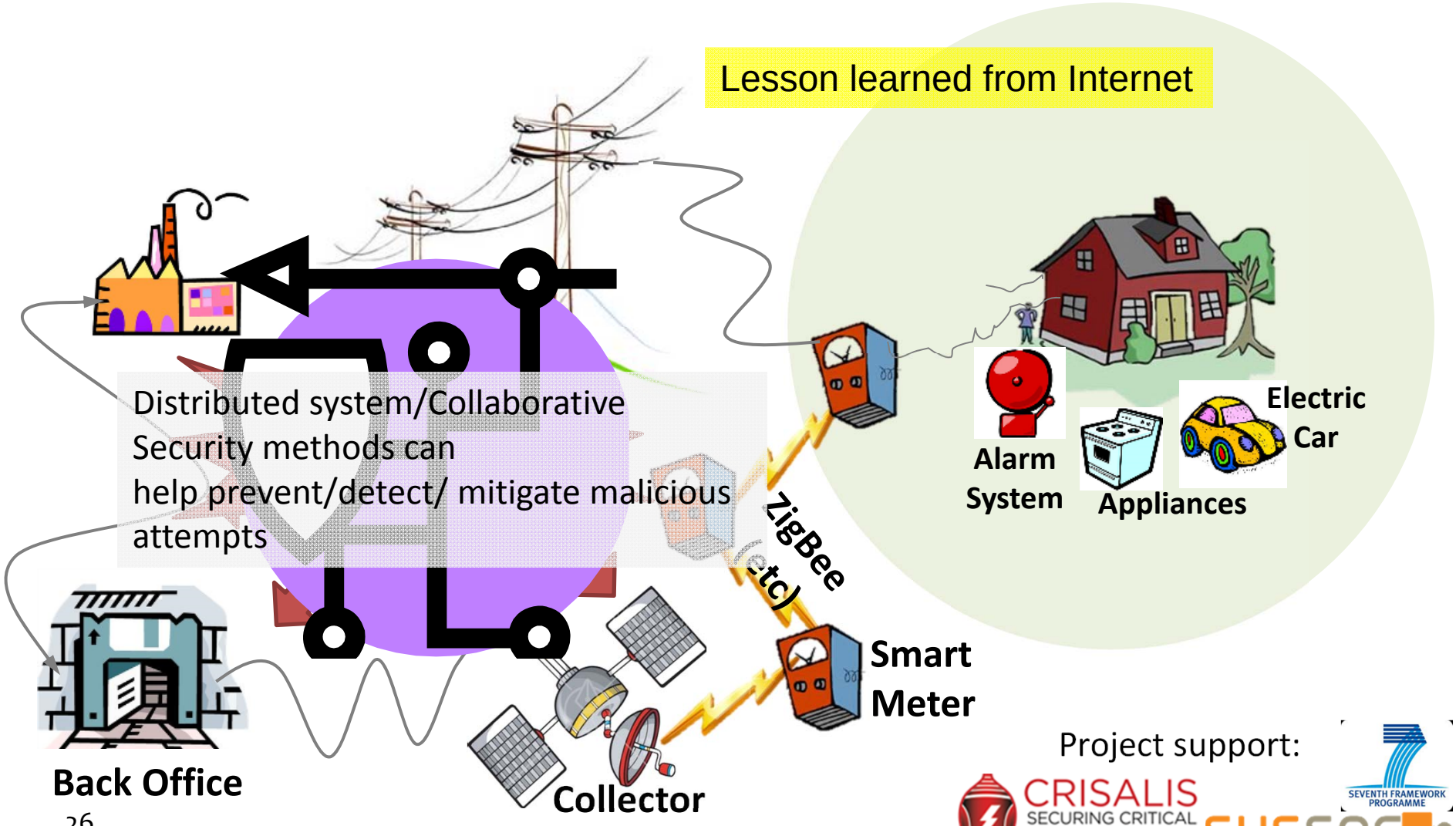
Project support: Göteborg Energi

In the Power Grid cyber-layer

Selected topics:

- Distributed resource management
- Communication, information
- Orthogonal issues: cyber-security
  - Extra important for overall system reliability

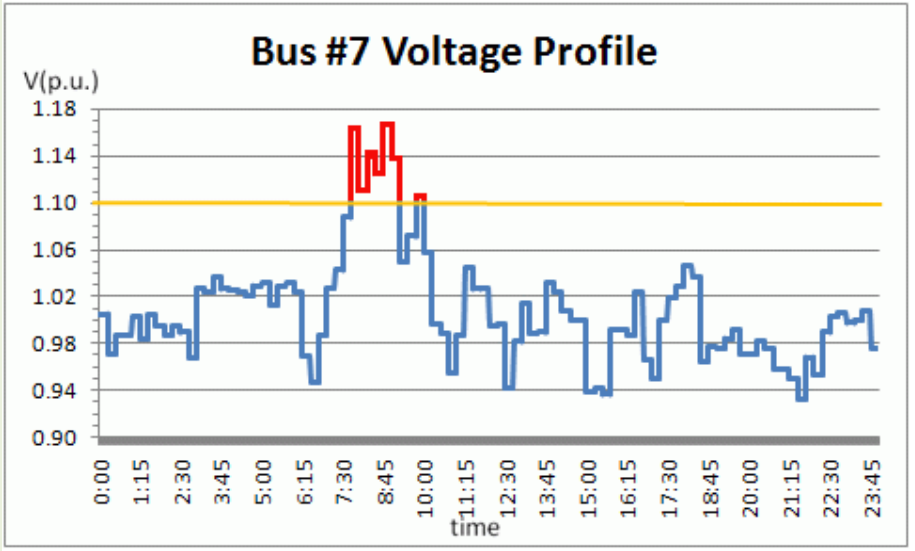
Imperative to address cyber security from the start! [F10]

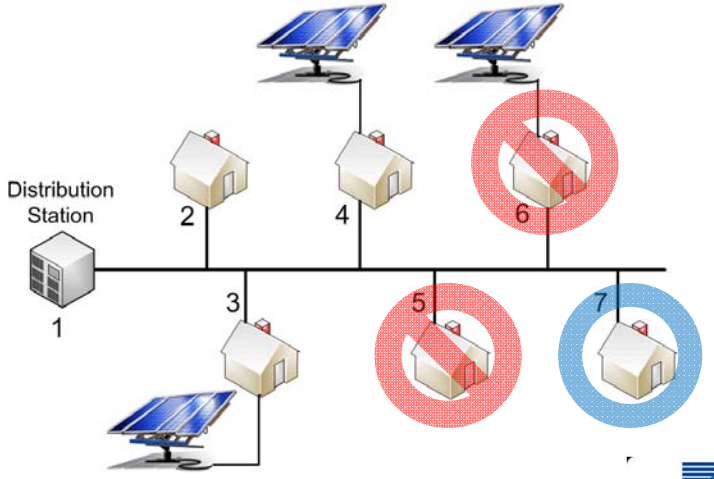


Project support:

Cybersecurity aspects

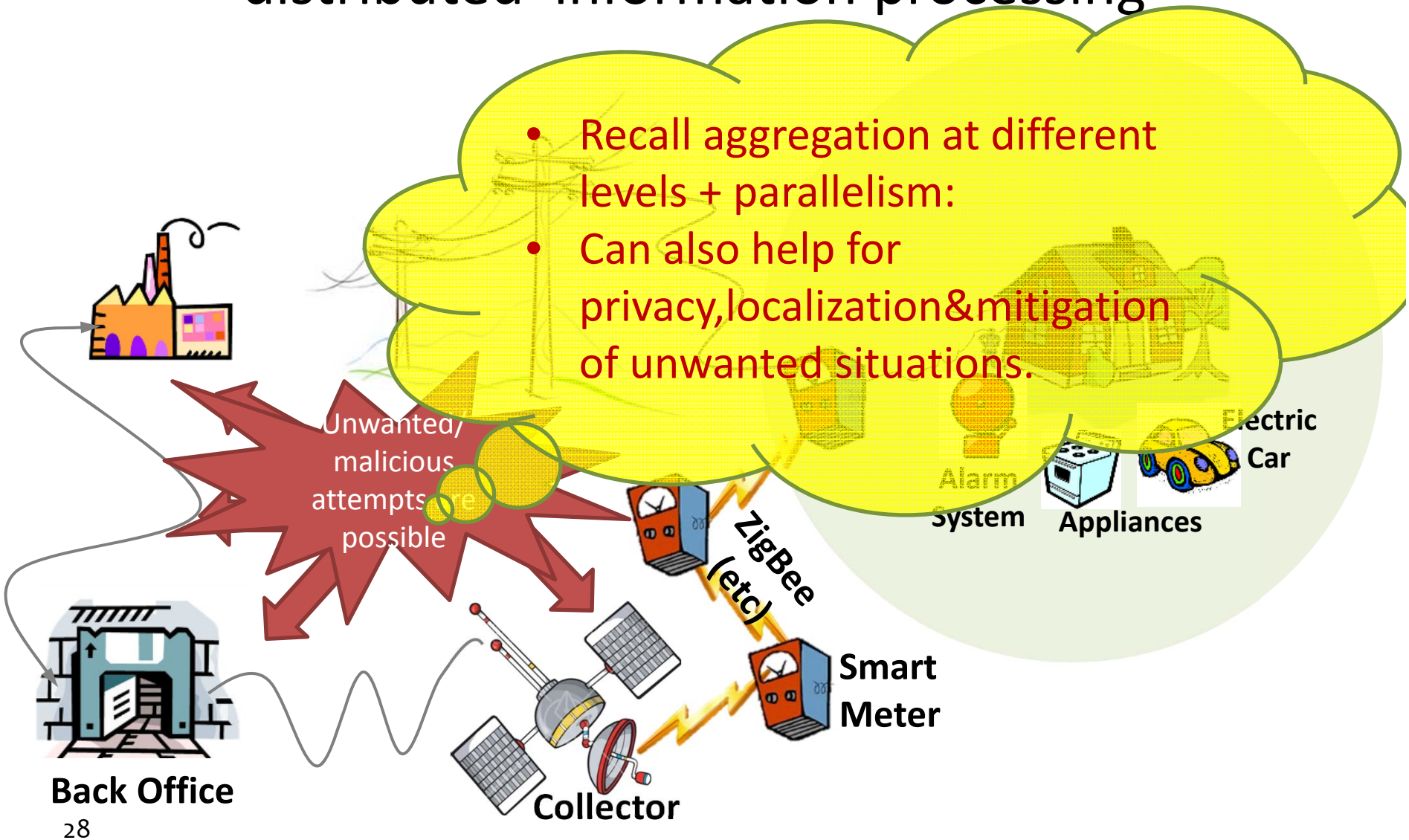
- **Case studies**
  - Possible to destabilize parts of the system by inappropriate access to e.g. remote on/off possibilities [TKAPS11]
- Avoid the Internet examples of defacto standards
  - info-security from the start
  - Distributed/collaborative security methods can help to deal with scale





Projectssupported by EU FP7: SysSec, Crisalis

One of the ideas/hypothesis: cyber security and distributed information processing



Strategic relevance for research and education?

"… area of strategic importance … advances fast, technologically & commercially…

Cisco expects the Smart Grid communication network will be 100 eller 1000 times larger than the Internet"

[Vinnova, "SmartaNät" 2011]and references therein

"… any vulnerability within this software-intensive critical system will attract attention from hostile groups …"

[MSB, "If one goes down all goes down?", 2010]

Strategic relevance for research and education?

- large investments
- off-the-shelf info/software solutions are not there

- careful, informed, multidisciplinary expertise needed in deployment
- cf. lessons learned from Internet

- Distributed computing and systems in the core of the cyberphysical infrastructure

Course/Masterclass: ICT Support for Adaptiveness and Security in the Smart Grid (DAT285B)

- Goals
  - students (from computer science and other disciplines) get introduced to advanced interdisciplinary concepts related to the smart grid, thus
  - building an understanding of essential notions in the individual disciplines, and
  - investigating a domain-specific problem relevant to the smart grid that need an understanding beyond the traditional ICT field.

Two instances of DAT285

- LP2 = Autonomous and Cooperative Vehicular Systems
- ***LP4 = ICT Support for Adaptiveness and Security in the Smart Grid***

Idea

- Based on both the present and future design of the smart grid.
  - How can techniques from distributed systems be applied to large, heterogeneous systems where a massive amount of data will be collected?
  - How can such a system, containing legacy components with no security primitives, be made secure when the communication is added by interconnecting the systems?
- The students will have access to a hands-on lab, where they can run and test their design and code.

In this course:

Topics:

- Adaptiveness: Distributed resource management
- Enabling “tools”: Communication, Data, Information processing
- Orthogonal and utterly important: cyber-security

Structure, todo’s:

- Projects
- Guest lectures by the supporting team + industry and related parties
- Self-study and presentations

How?

- Cf class memo – handover to Magnus here