

MasterClass on ICT Support for Adaptiveness and (Cyber)Security in the Smart Grid DAT300

The “Smart” Grid as Distributed Cyberphysical system

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Briefly on research + education area of the supporting team

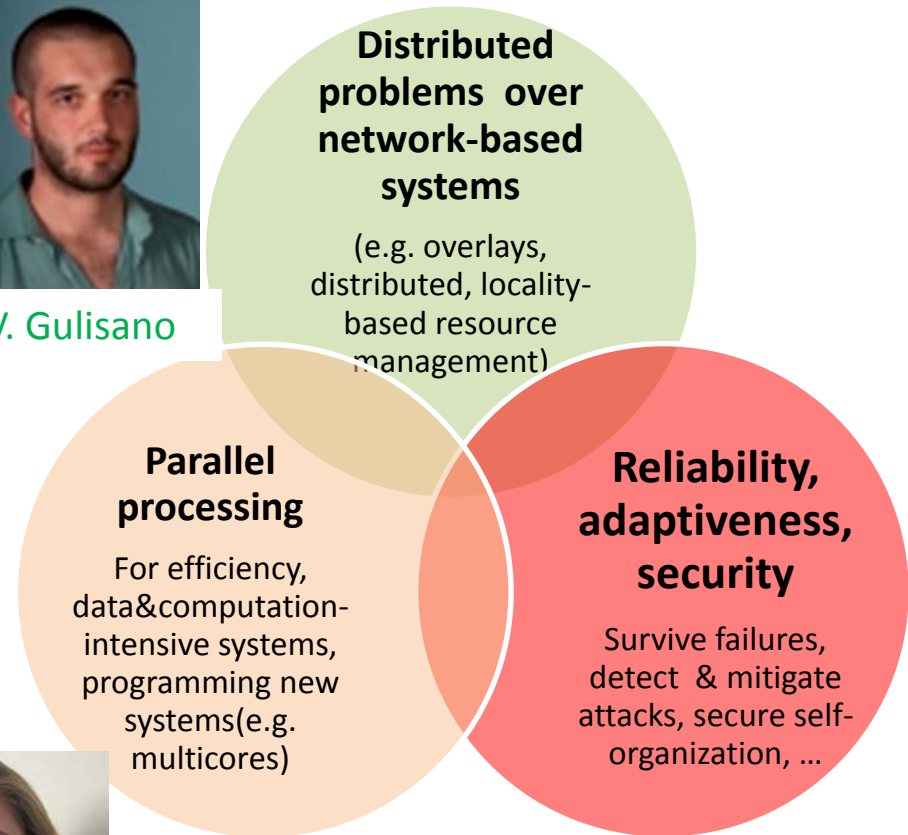


Zhang Fu

G. Georgiadis

V. Gulisano

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



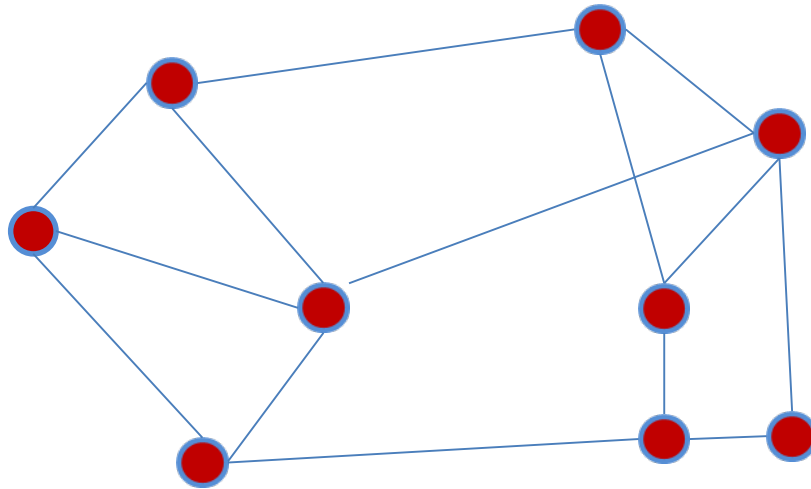
Magnus Almgren

Olaf Landsiedel

M. Papatriantafilou

A Distributed System

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



A Distributed System

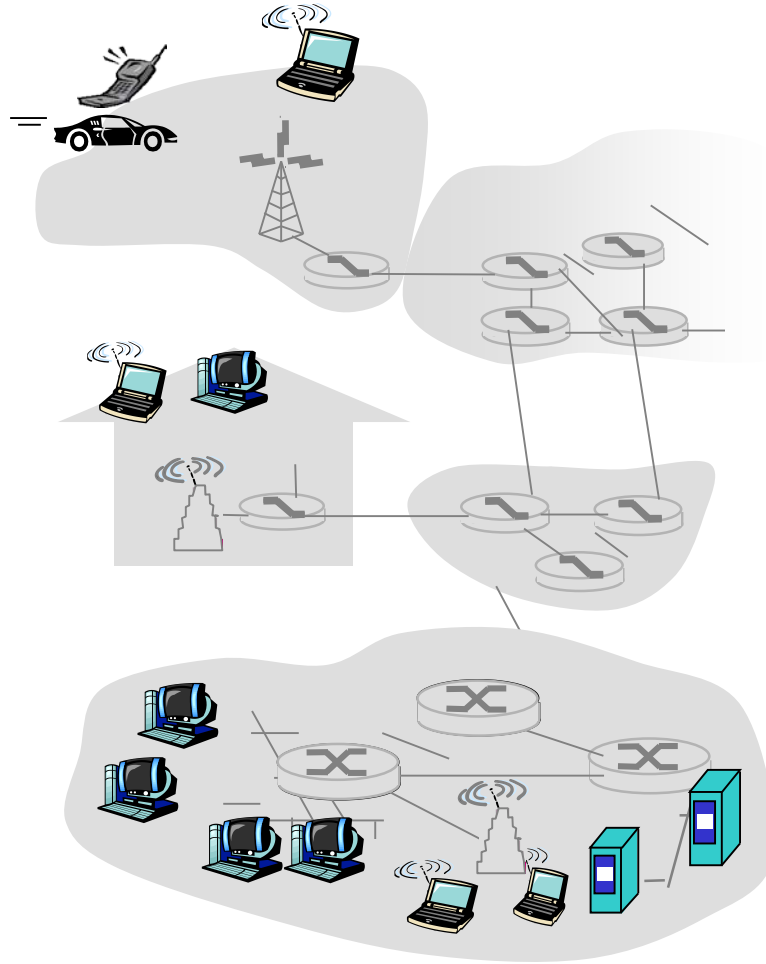


Figure: Computer Networking: A Top Down Approach , Jim Kurose, Keith Ross, Addison-Wesley.

A Distributed System

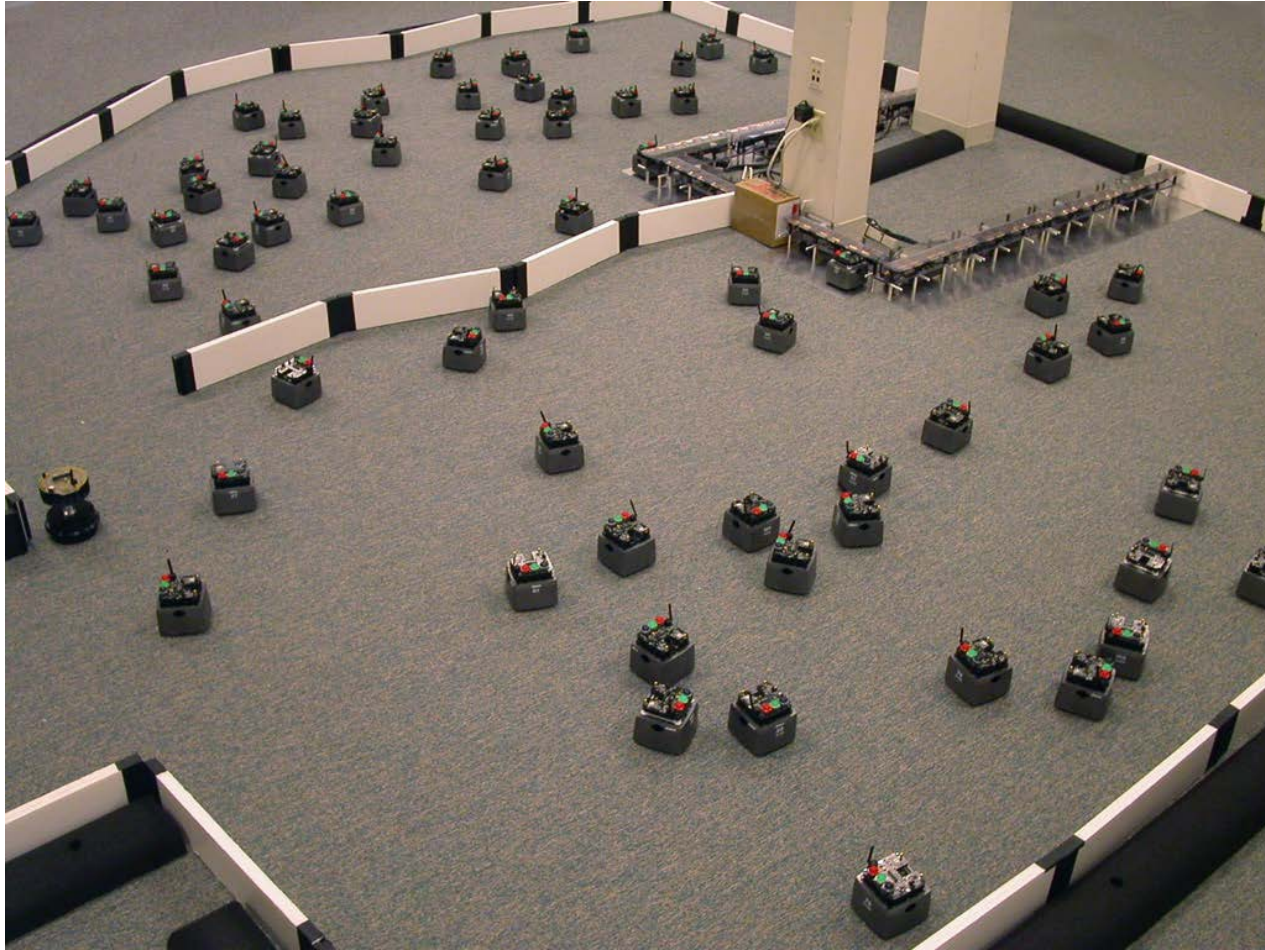


Picture source: Wikipedia

A Distributed System



A Distributed System

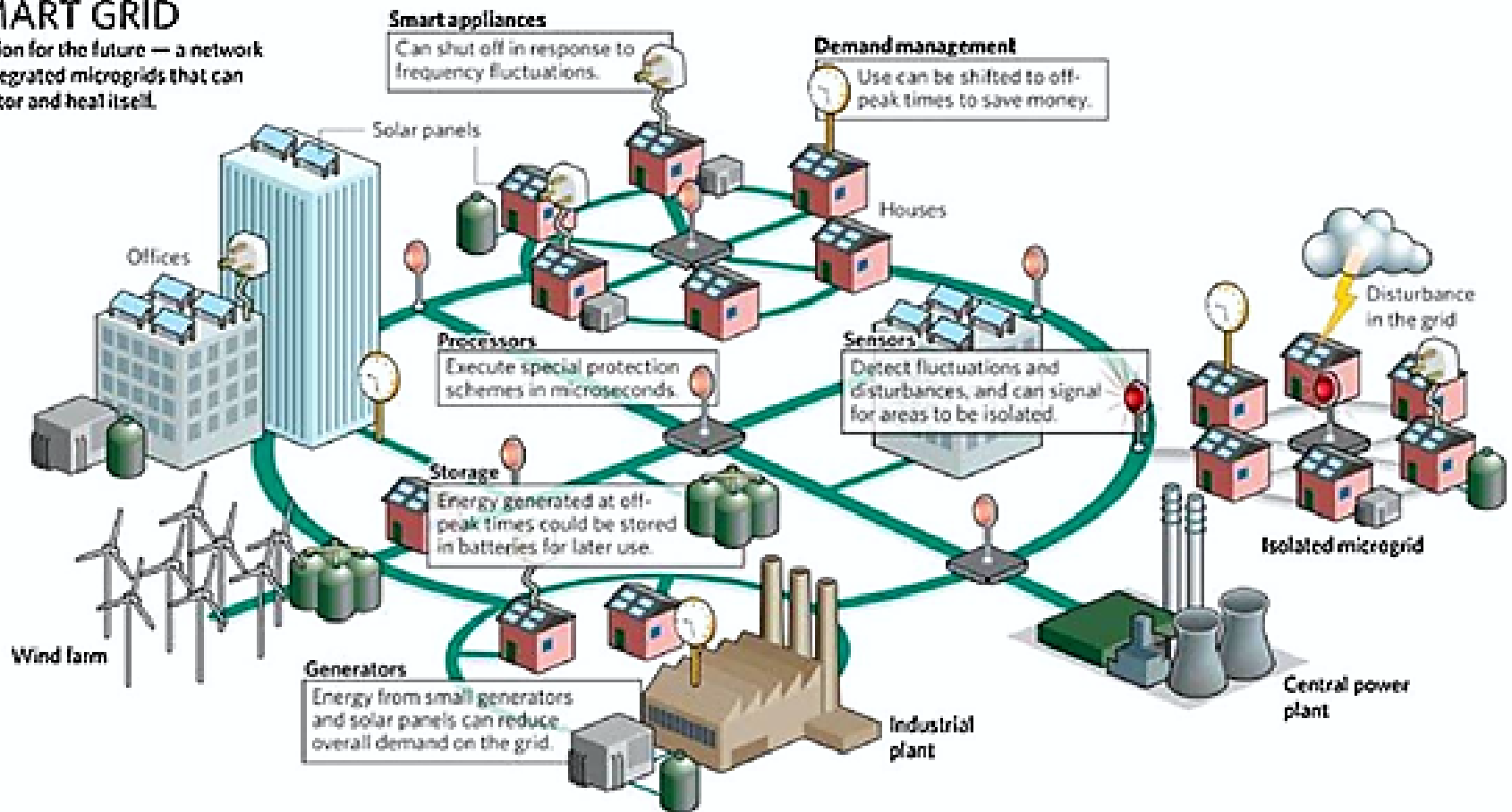


Pic. <http://www.hatswitch.org/~sn275/courses/DSS/info.shtml>

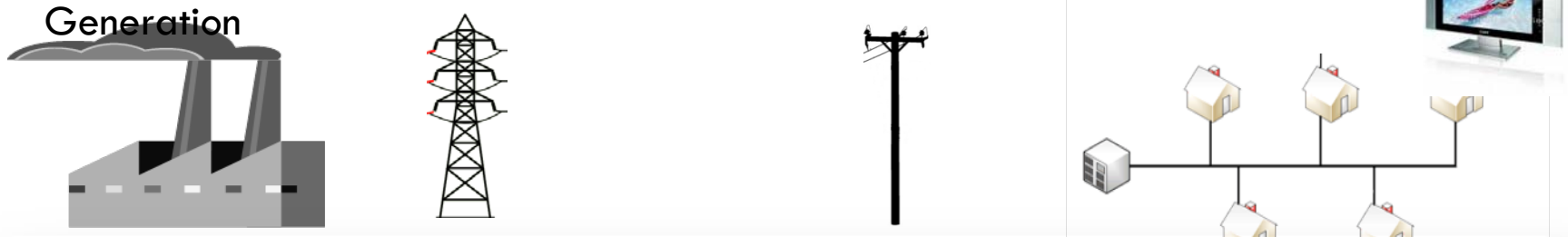
A Distributed Cyberphysical System

SMART GRID

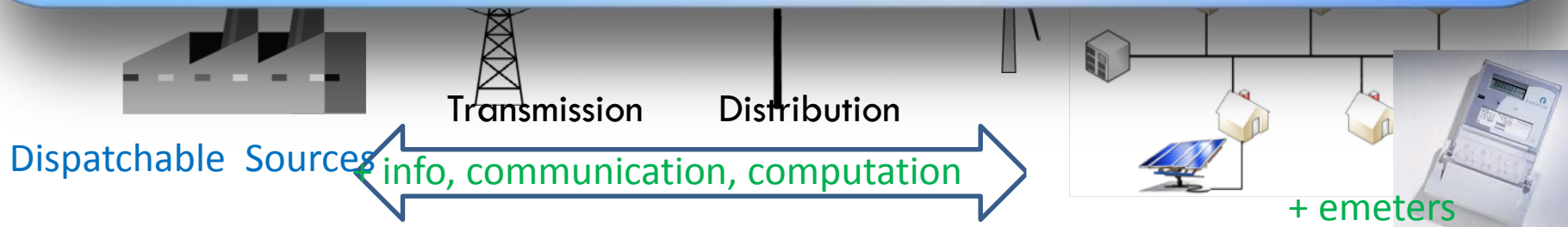
A vision for the future — a network of integrated microgrids that can monitor and heal itself.



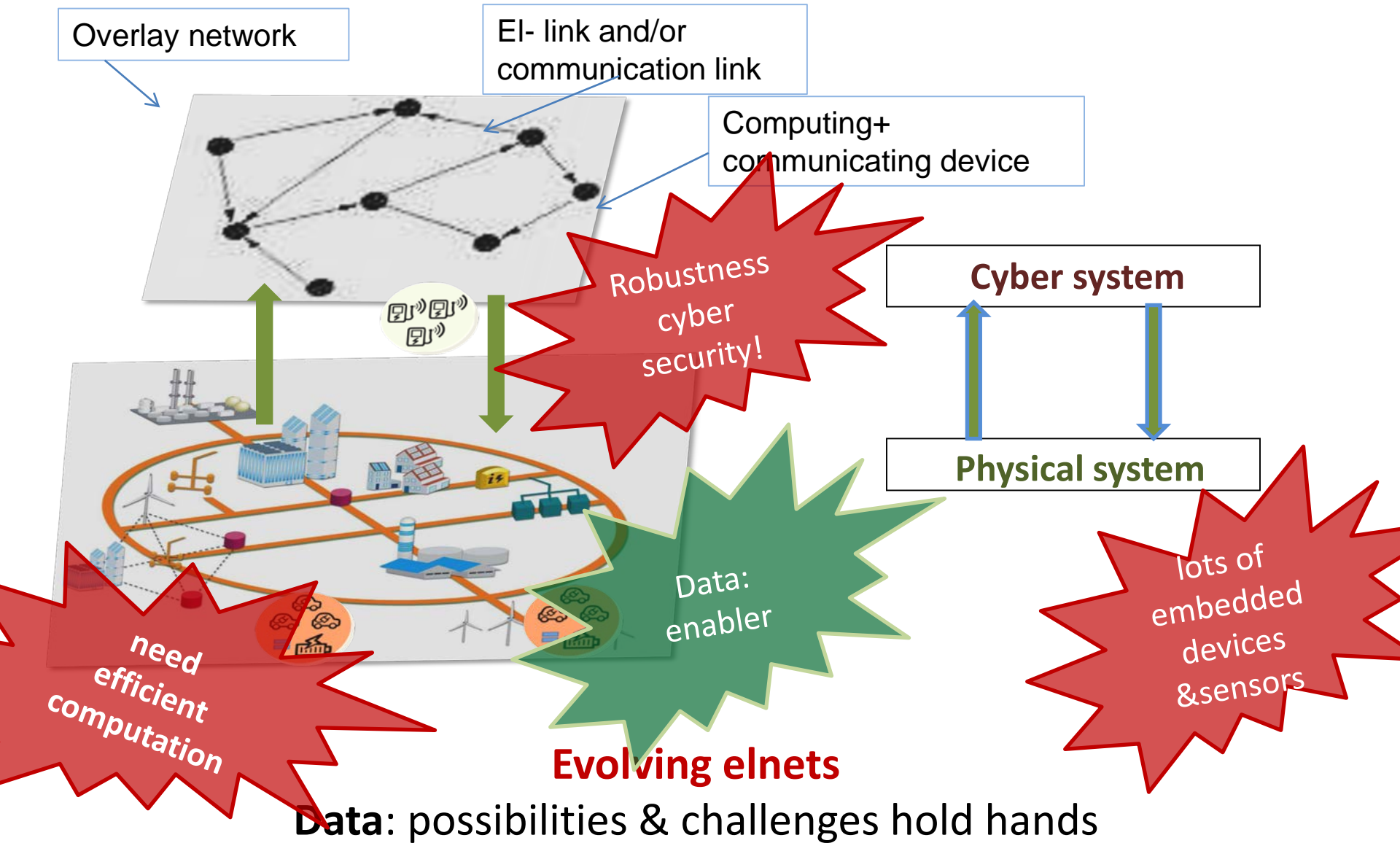
the story: in the traditional EI Grid...



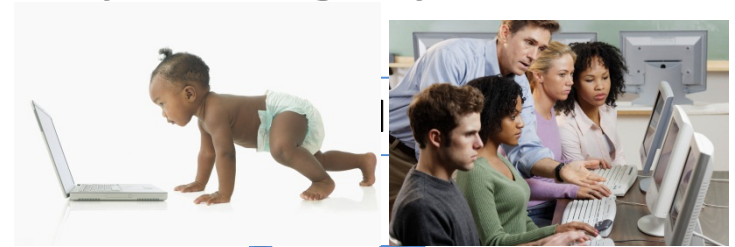
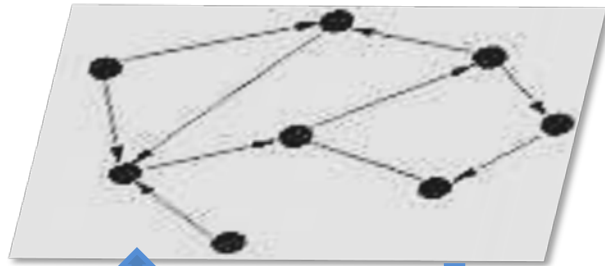
- paradigm shift:
 - from pre-planned broadcasting, to adaptive scheduling



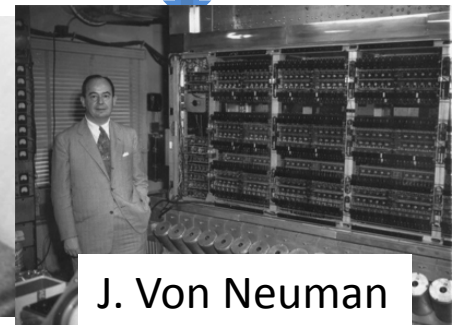
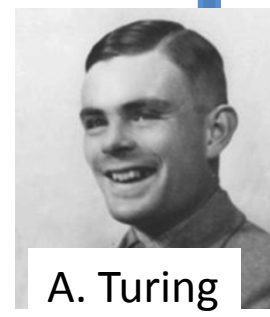
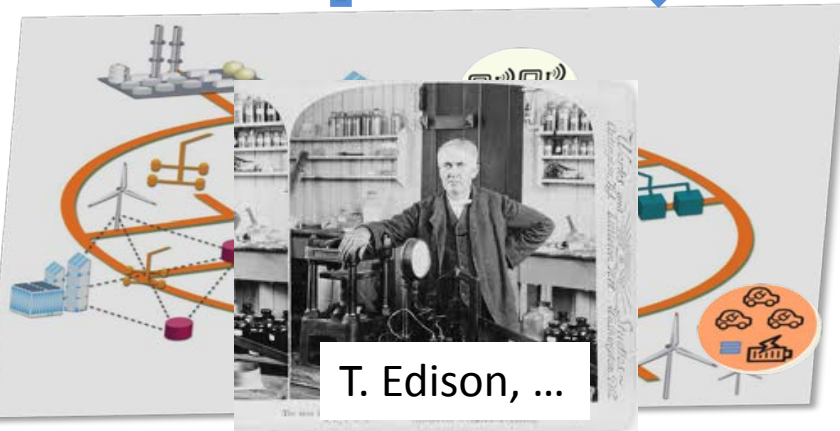
Cyberphysical systems



An analogy: layering in computing systems



Operating sys, apps

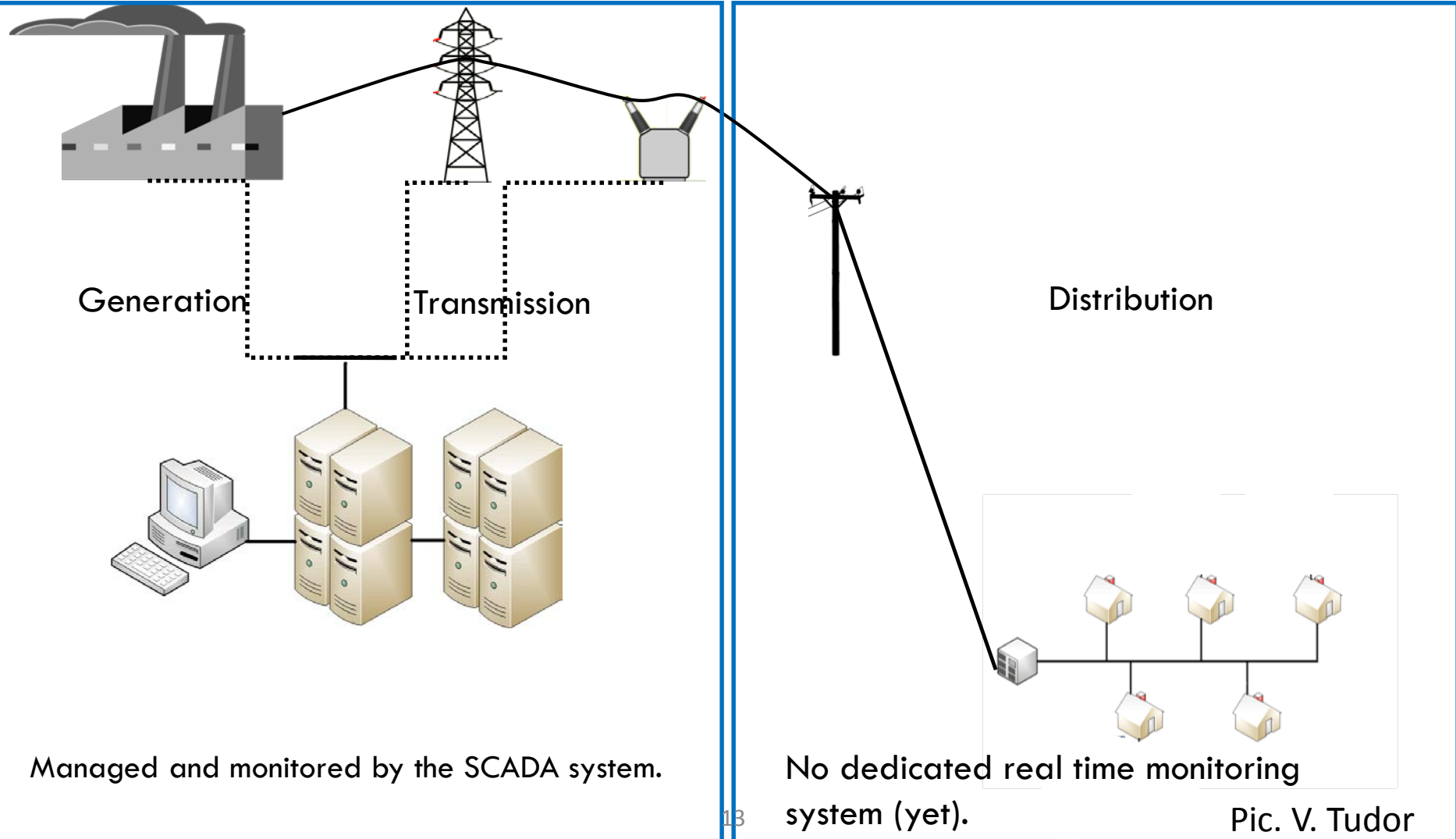


Similarities: provide services; shield from hardware/system details; manage resources

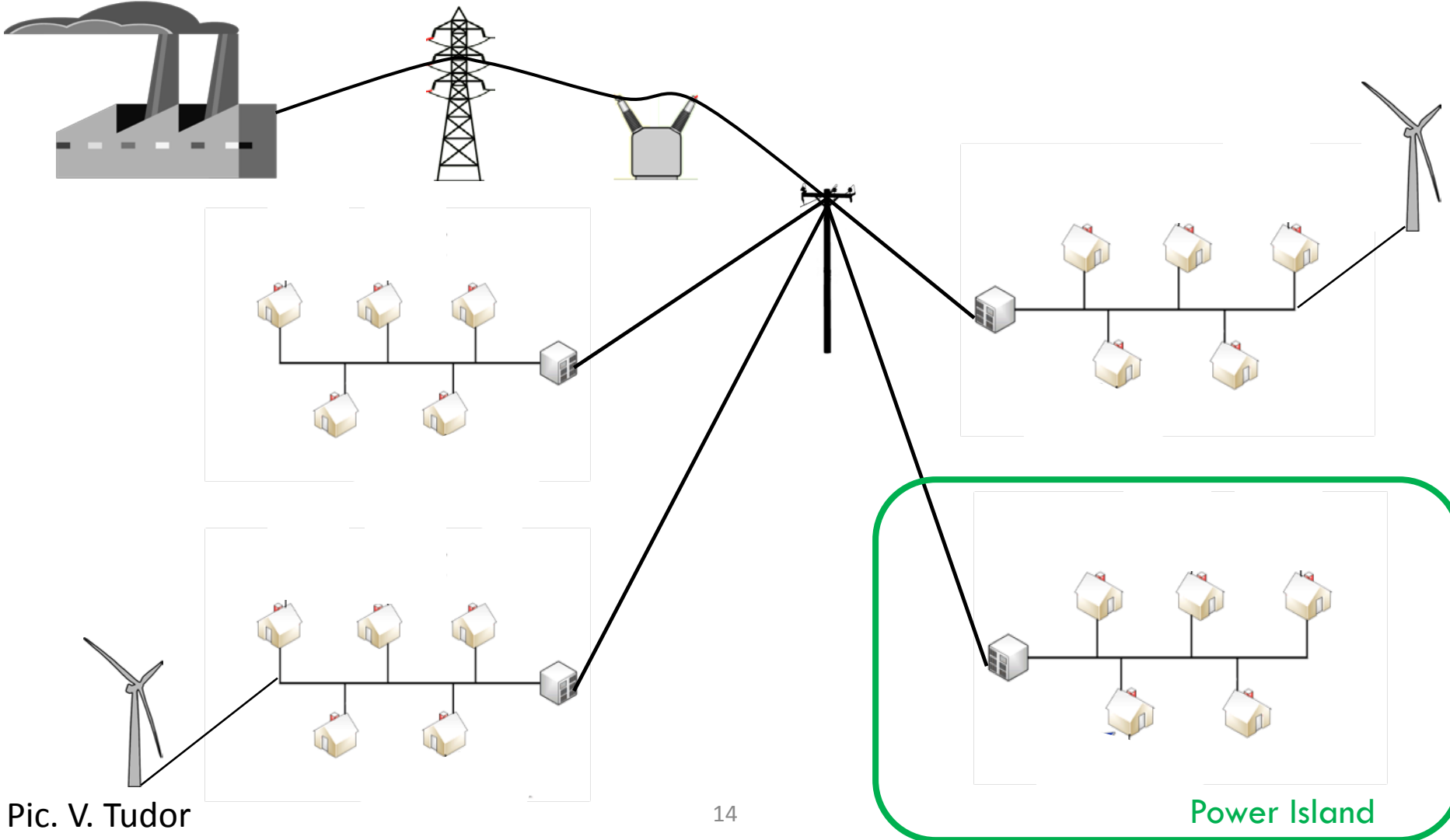
Differences: system/"hardware"; distributed; the "user" is part of the "system"; **critical infrastructure!!**

A bit of info on the el-network

The traditional Electrical Grid



From centralized to distributed generation

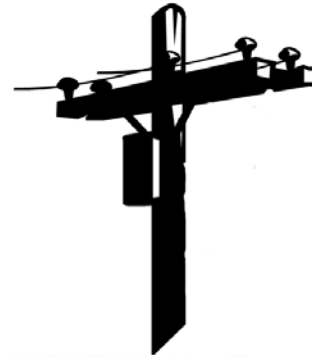


Pic. V. Tudor

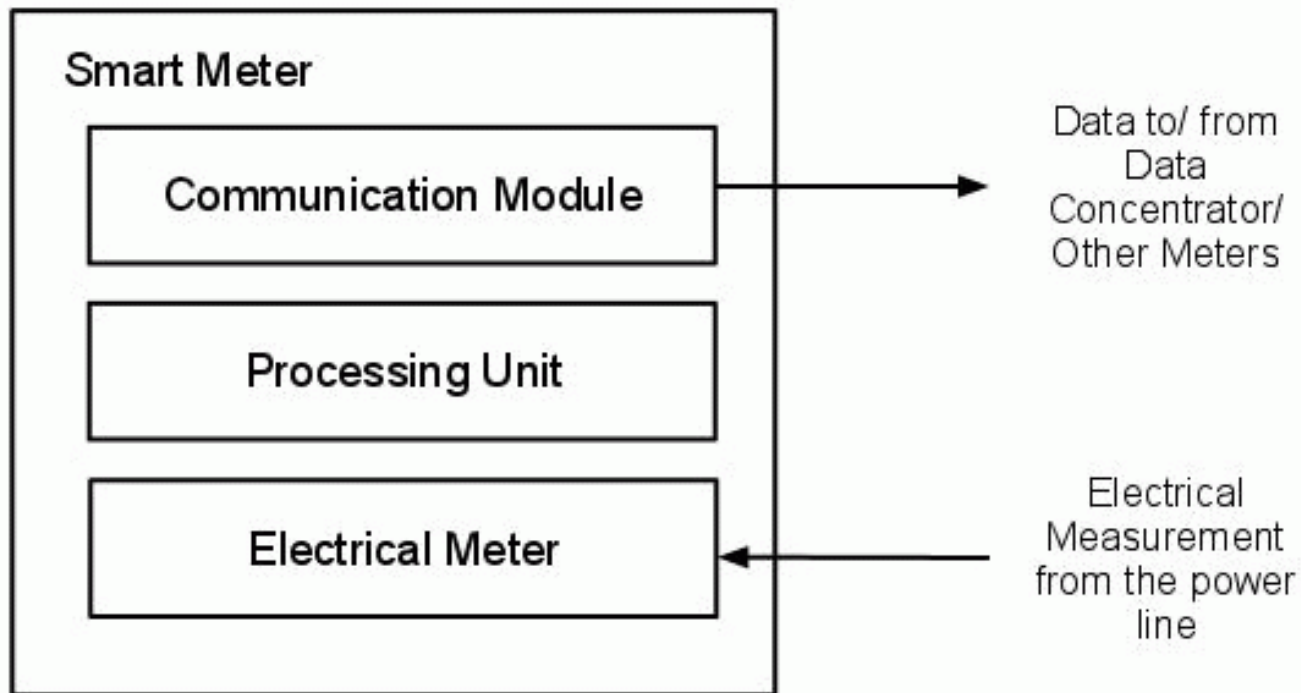
One of the enabling components: Smart Meter (Advanced Metering Infrastructure)

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



Smart Meter components



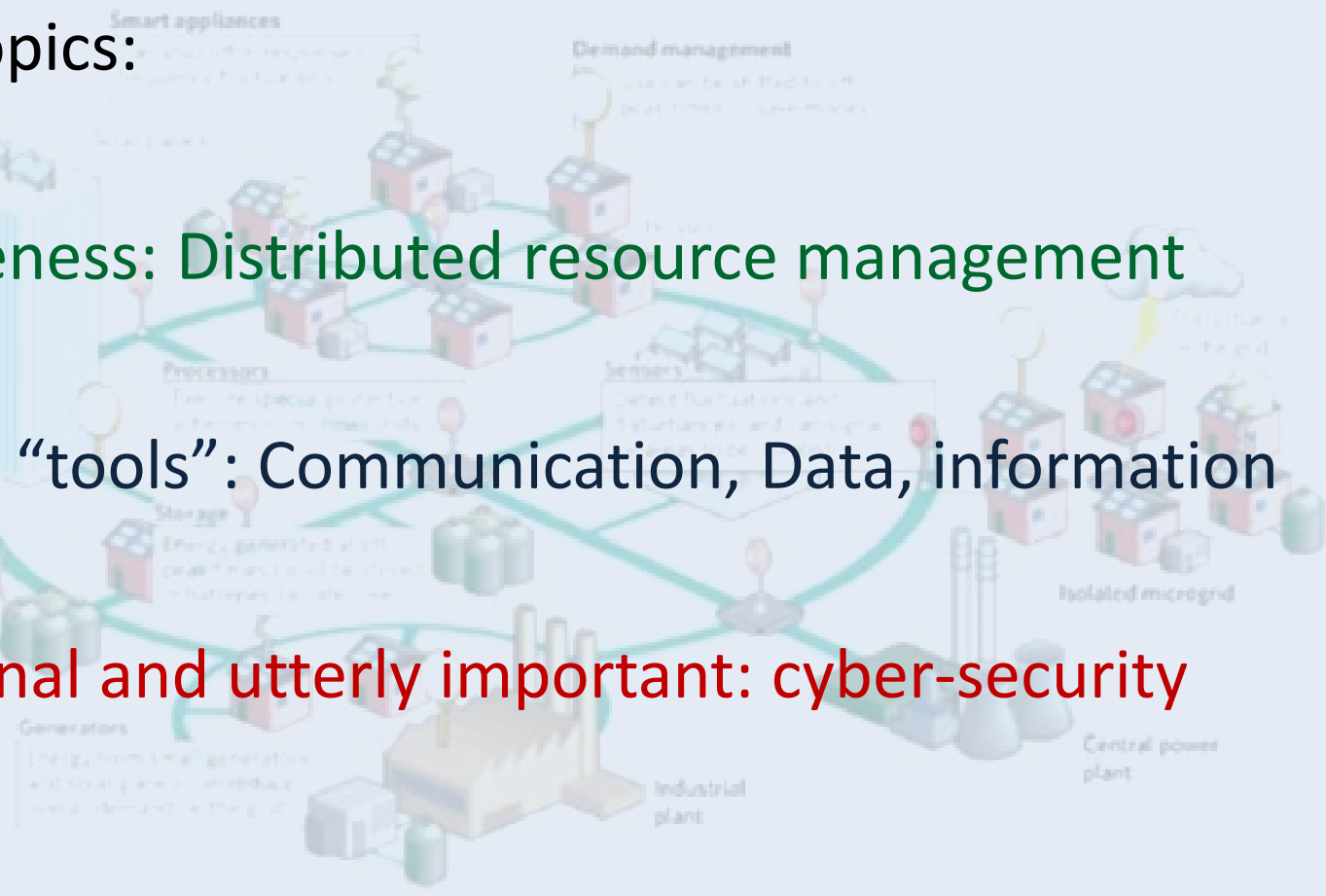
In the Power Grid cyber-layer

SMART GRID

A vision of integrated microgrids that can monitor and heal itself

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)
- Communication, Data, Information
- 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...)



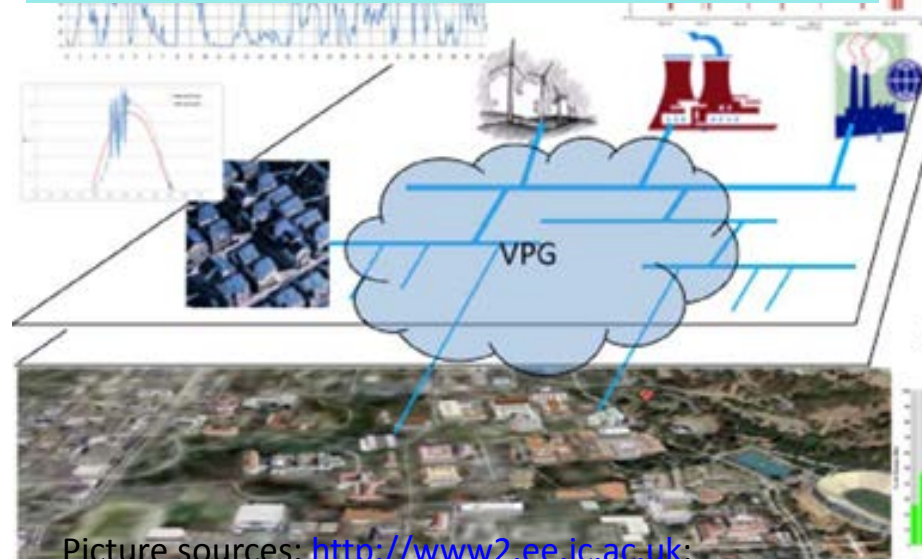
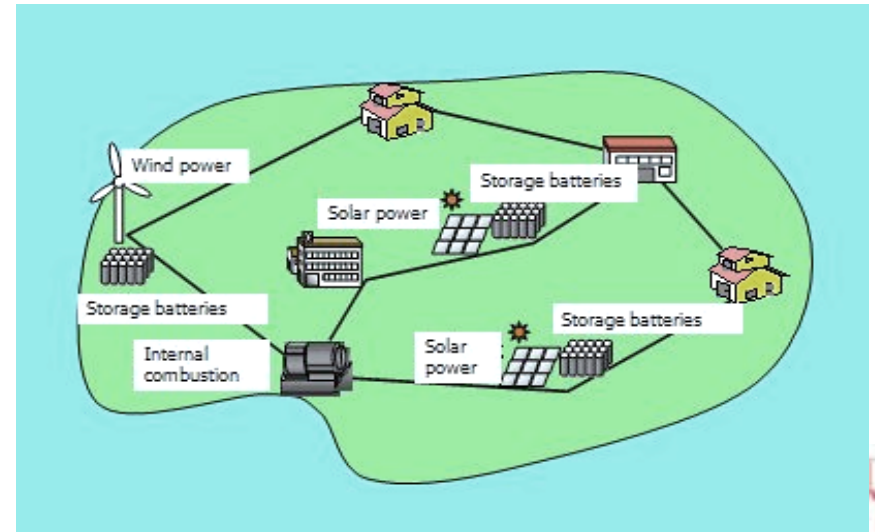
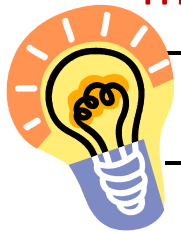
Vision for microgrids

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 et al. Sustainable computing 2011

In the Power Grid cyber-layer

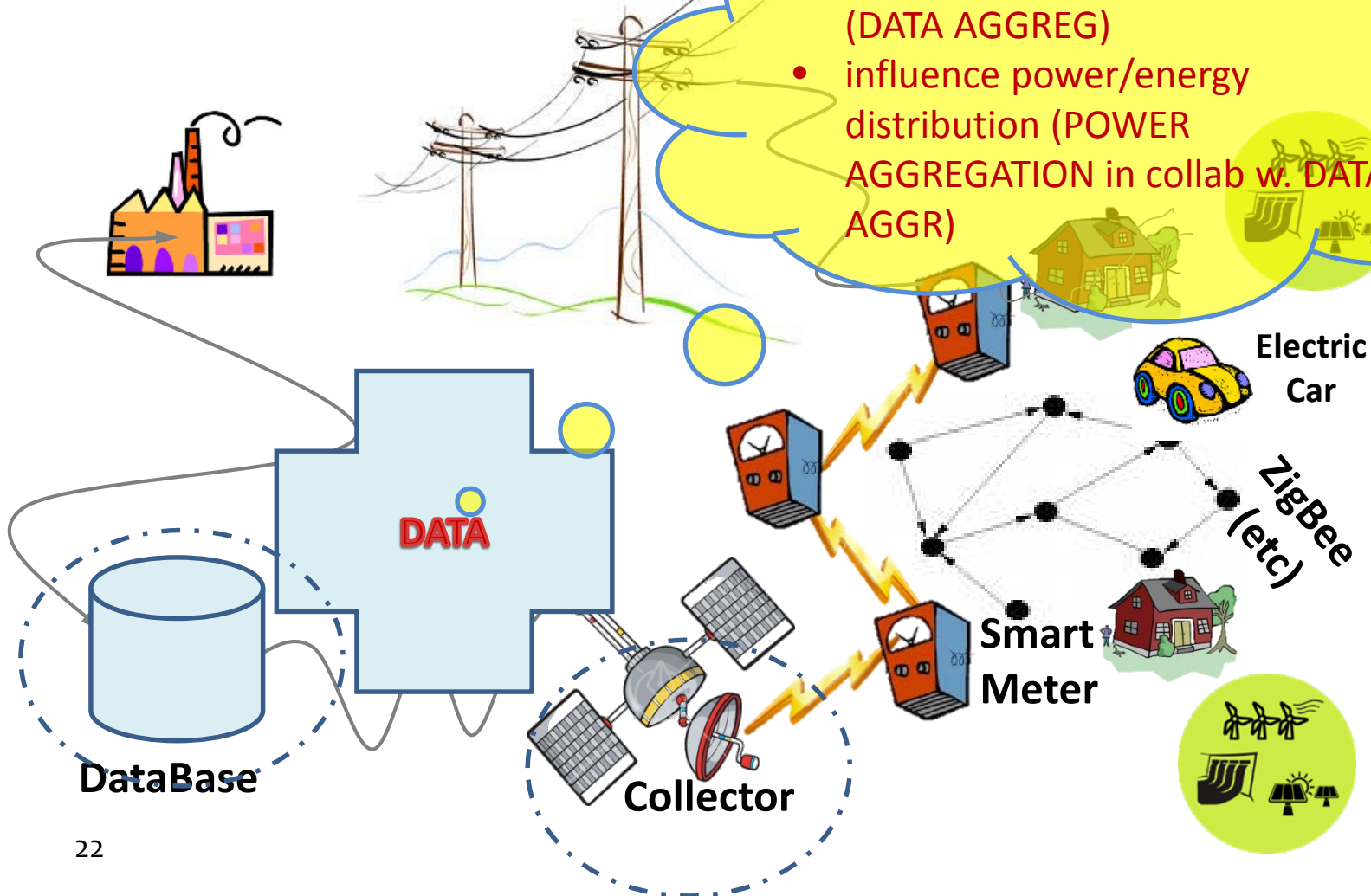
Selected topics:

- Distributed resource management
- Enabling “tools”: Communication, data, information
 - Distributed sources & processing
 - Wireless/sensor networks
 - Monitoring, facilitating resource services
- Cybersecurity

Information & Communication, Advanced Metering Infrastructure

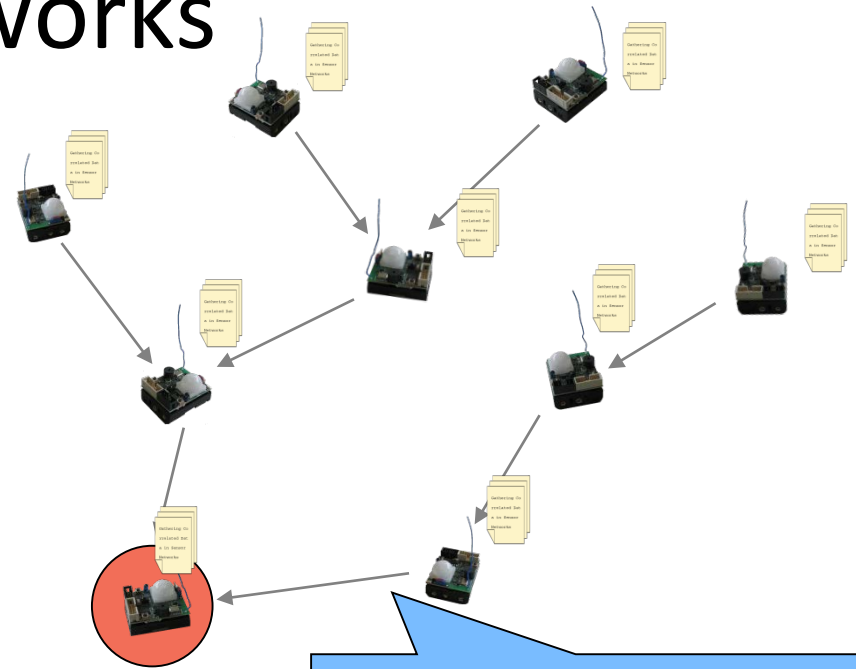
Local (info aggregation) "agents" can

- Make sense out of data, Monitor (DATA AGGREG)
- influence power/energy distribution (POWER AGGREGATION in collab w. DATA AGGR)



Data gathering/processing in Sensor Networks

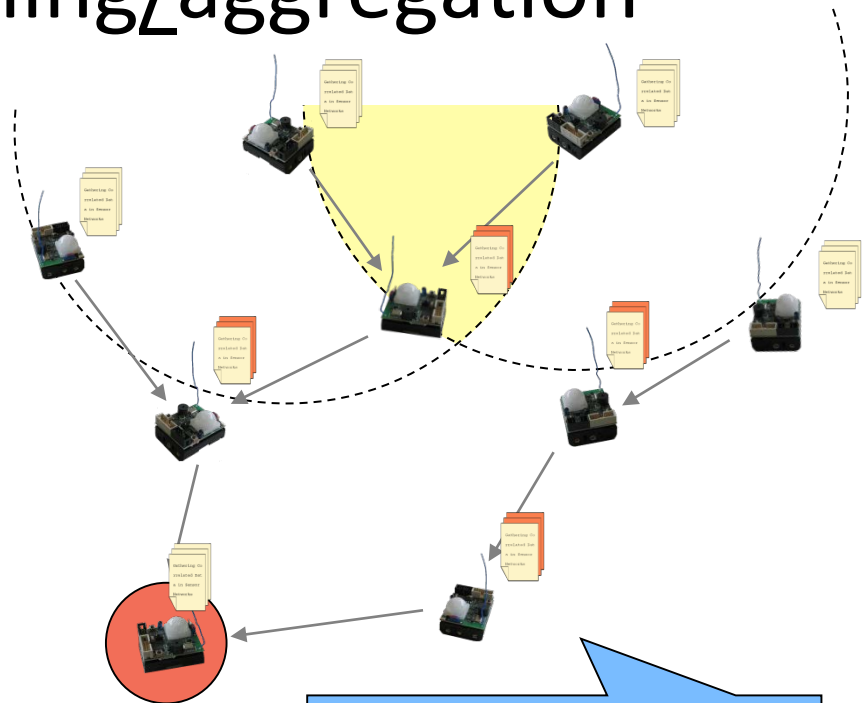
- nodes produce relevant information about their vicinity periodically.
- Data is conveyed to an information sink for further processing.
-



 Routing

Processing/streaming/aggregation

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



➔ In-network aggregation/streaming/processing

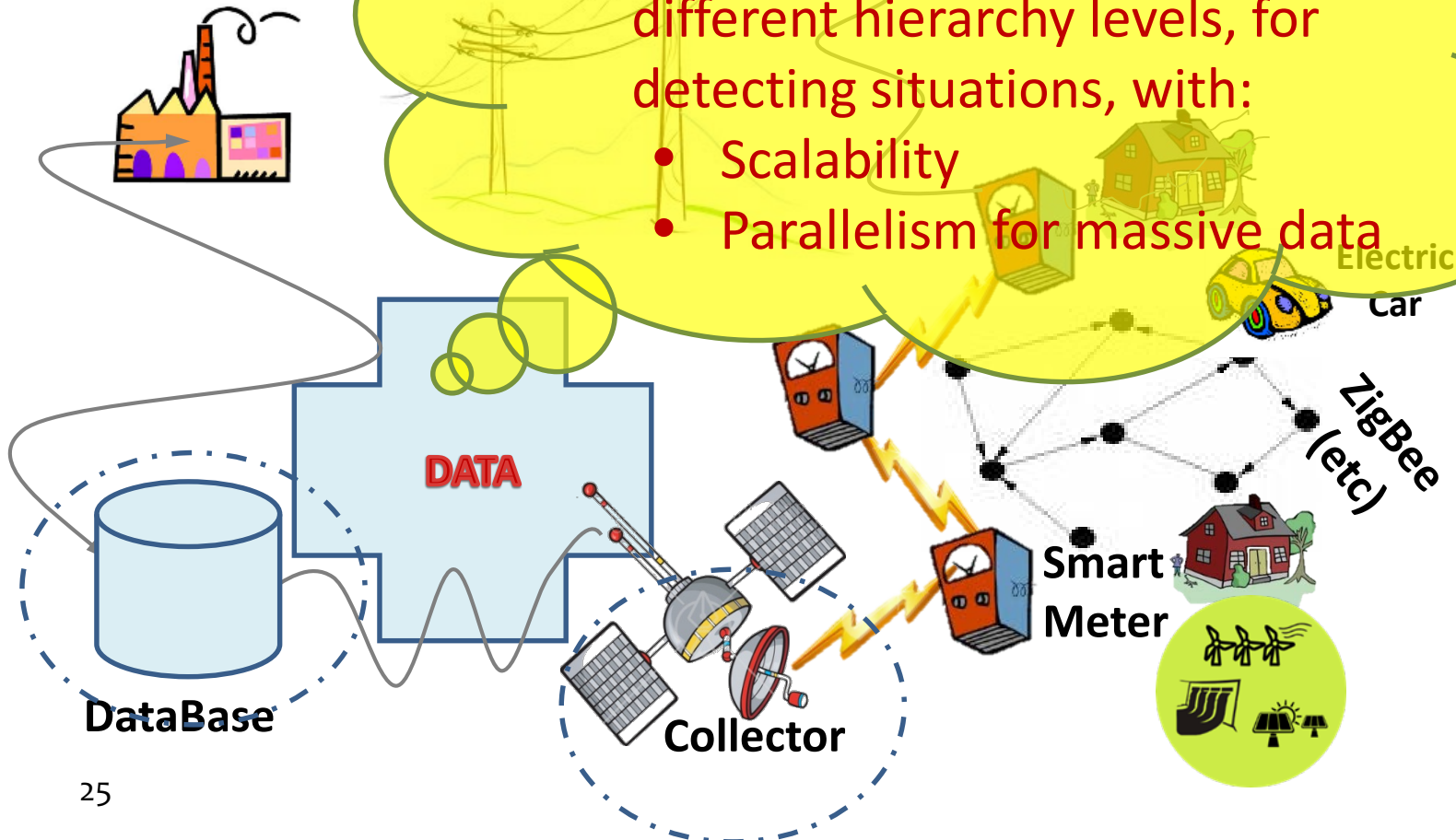
Where/how is u's data processed?

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



Information/Communication

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



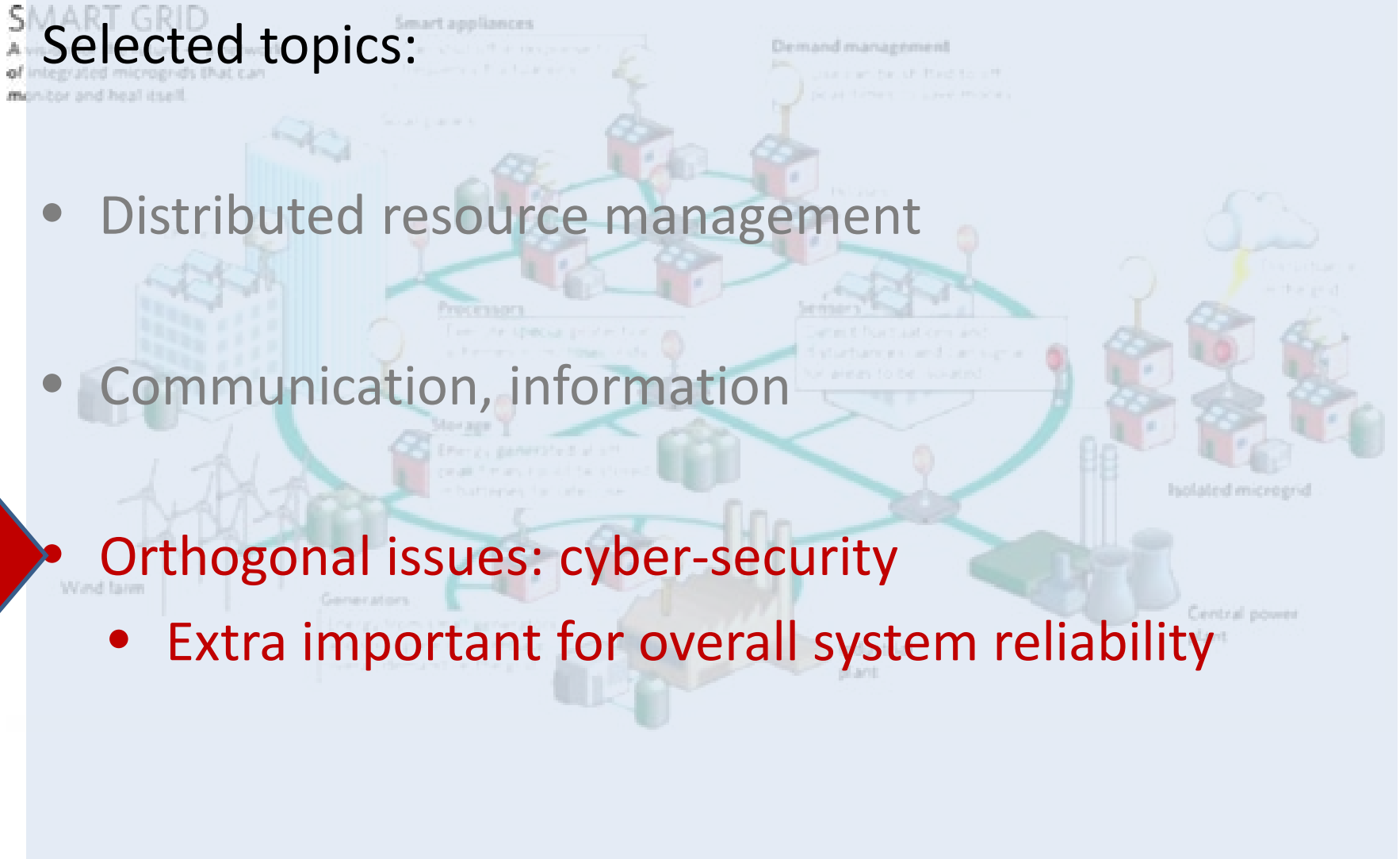
In the Power Grid cyber-layer

SMART GRID

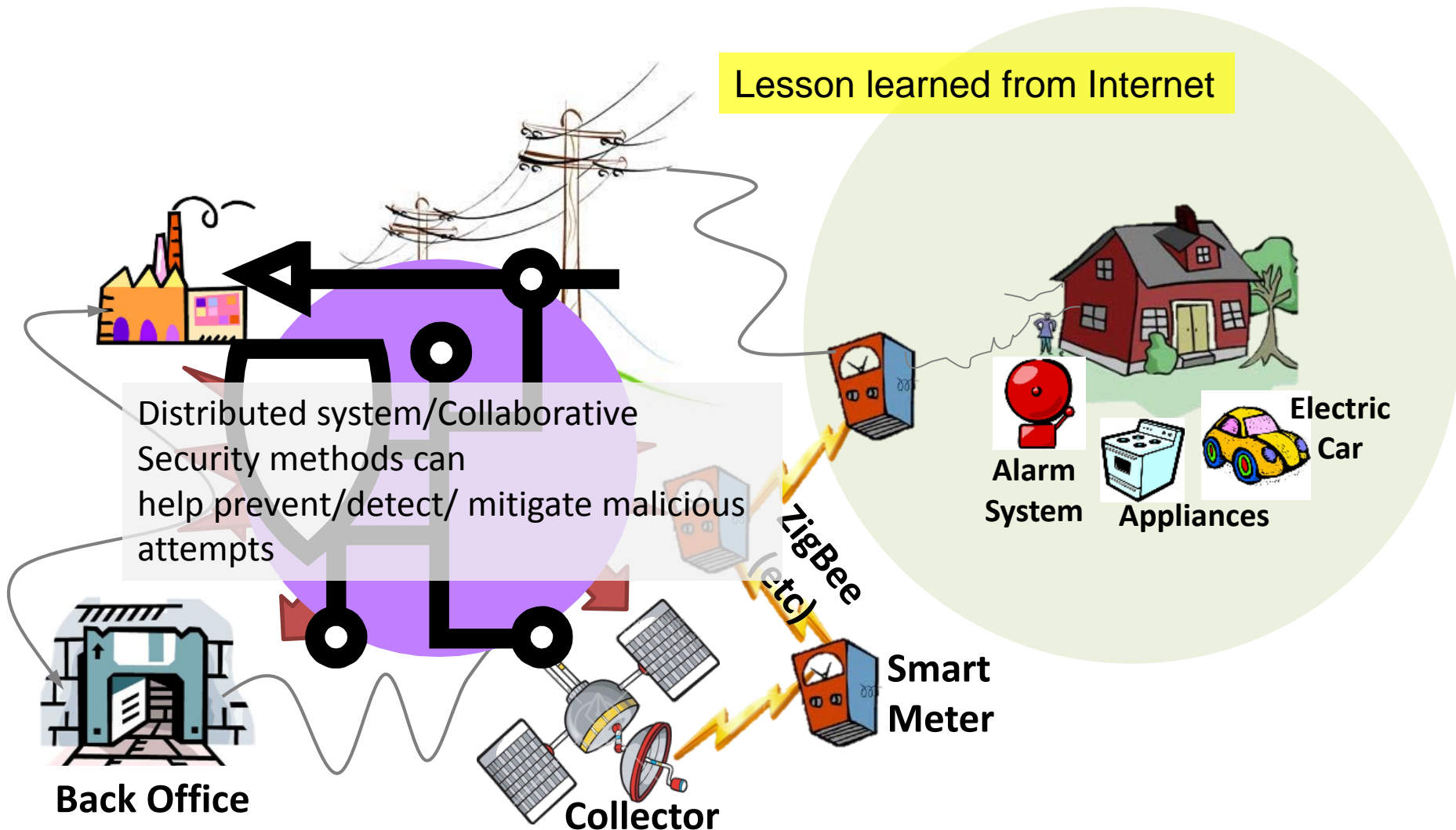
A vision of integrated microgrids that can monitor and heal itself.

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]



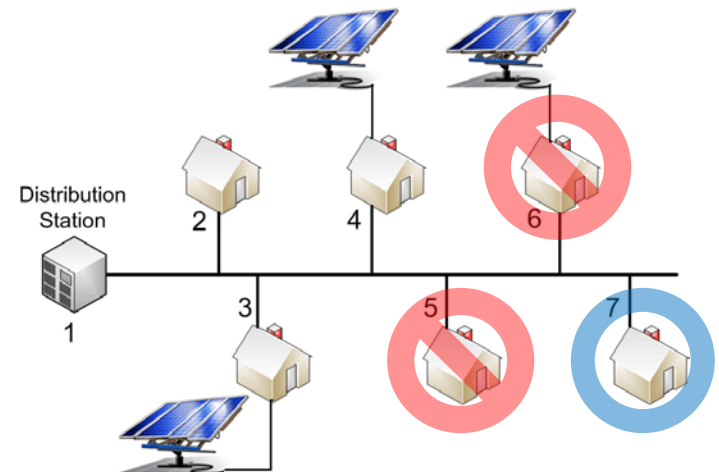
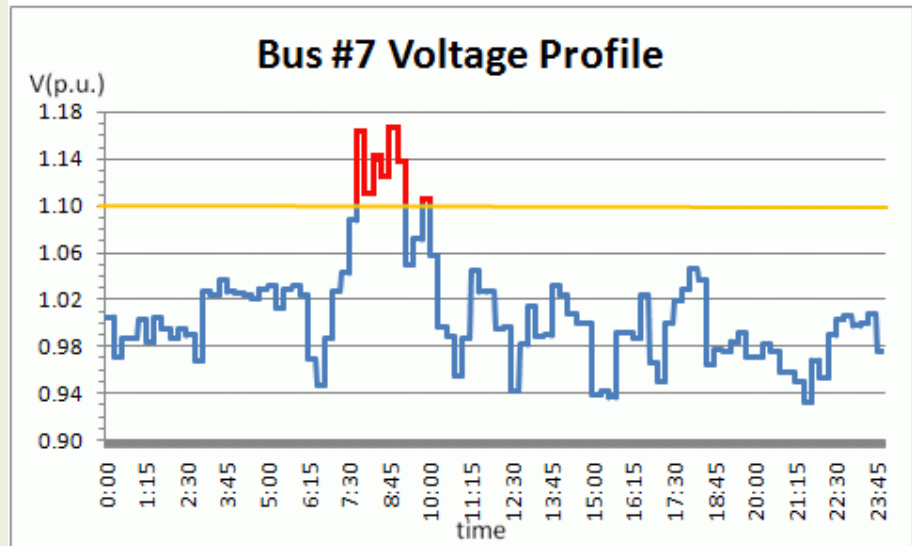
Cybersecurity aspects

□ Case studies

- Possible to destabilize parts of the system by inappropriate access to e.g. remote on/off possibilities [TKAPS11]

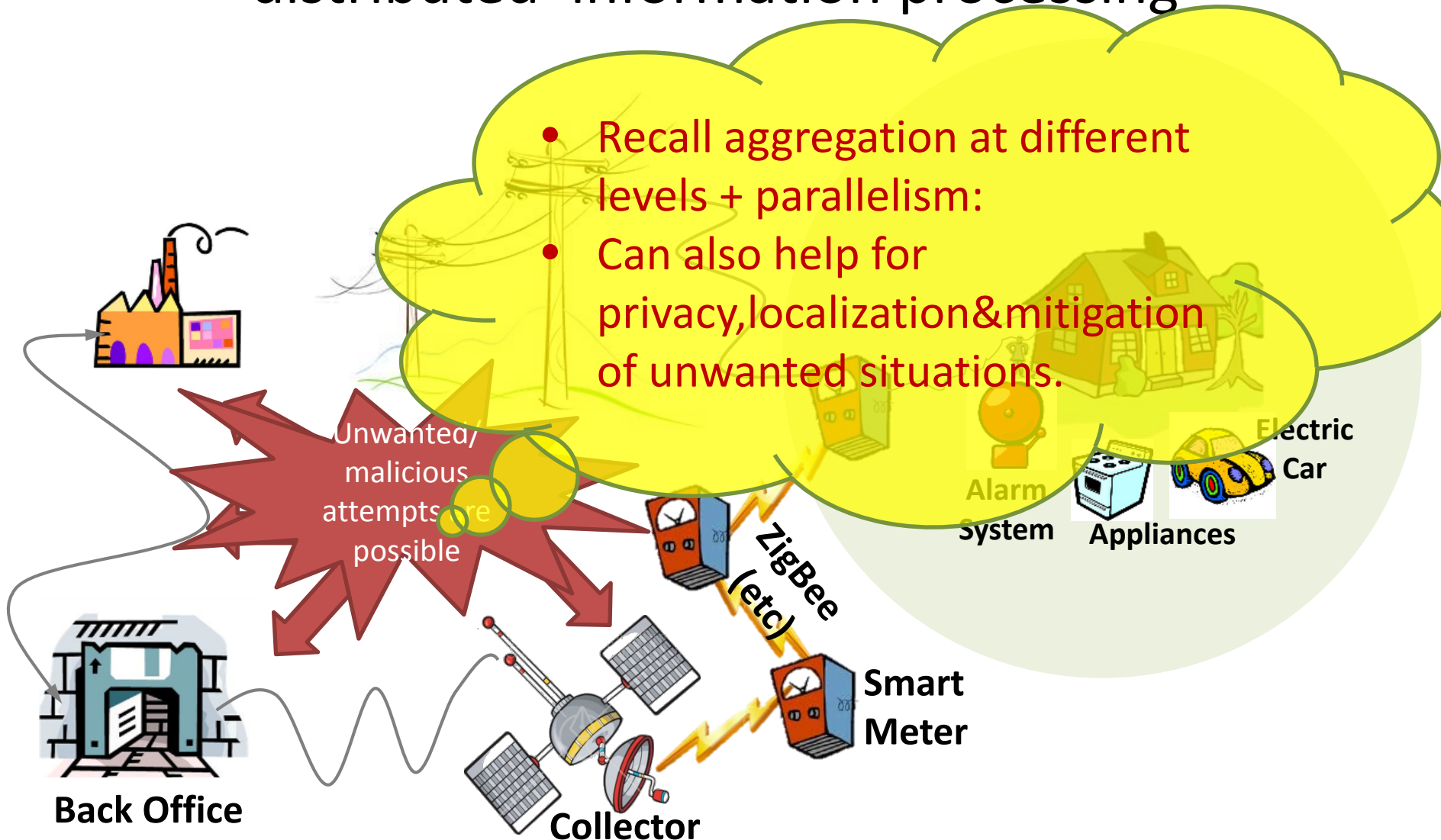
□ Avoid the Internet examples of defacto standards

- info-security from the start
- Distributed/collaborative security methods can help to deal with scale



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

- Recall aggregation at different levels + parallelism:
- Can also help for privacy, localization & mitigation of unwanted situations.



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]

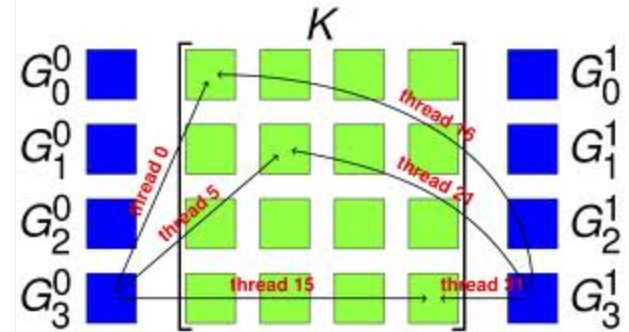
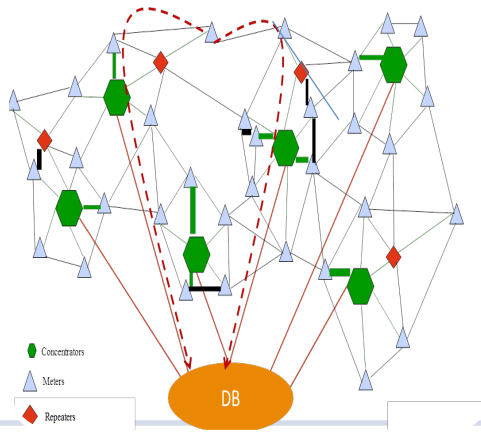
Strategic relevance for research and education?

- 
- 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 and Security in the core of the cyberphysical infrastructure

Our related research projects in a nutshell



Advanced Metering Infrastructure

- Metropolitan-scale networks
- Data validation
- Extracting info from the data, detect unwanted situations
- Security: strengthen, work with encrypted data

Demand-response

Resource management, load shaping, with/out storage&forecasts
WesternHarbor/Hyllie
Info/data to enable possibilities

Energy/efficient computation

improvements in energy efficiency for computing systems:
HPC-centers
&embedded devices
est savings 30-70%%

Computation/big data

Projects' support & collaboration



Course/Masterclass: ICT Support for Adaptiveness and Security in the Smart Grid (DAT300)

- 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.

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**
- **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**

