C-DAX:
A Cyber-Secure Data and Control Cloud for Power Grids

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SEVENTH FRAMEWORK PROGRAMME

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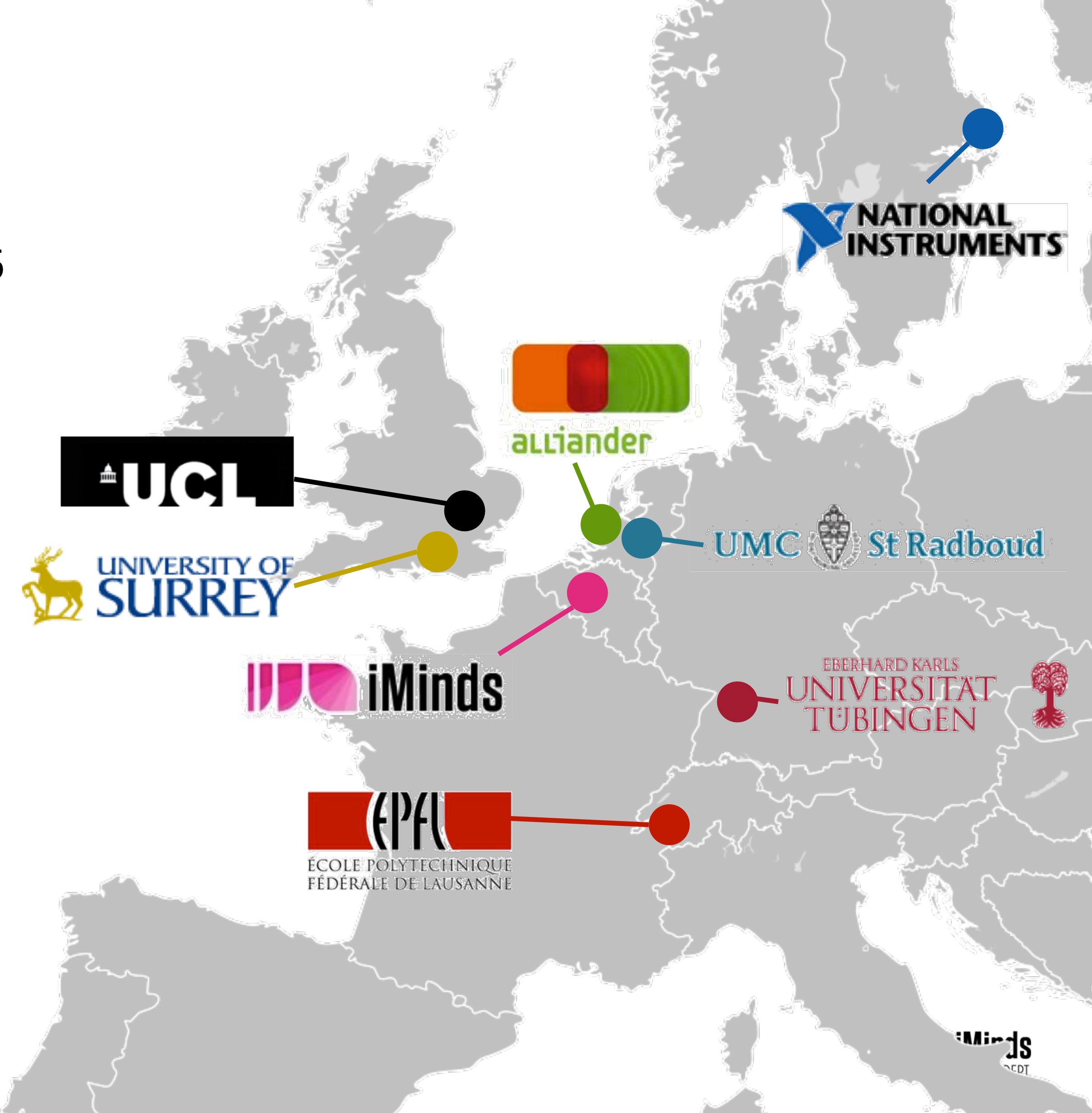
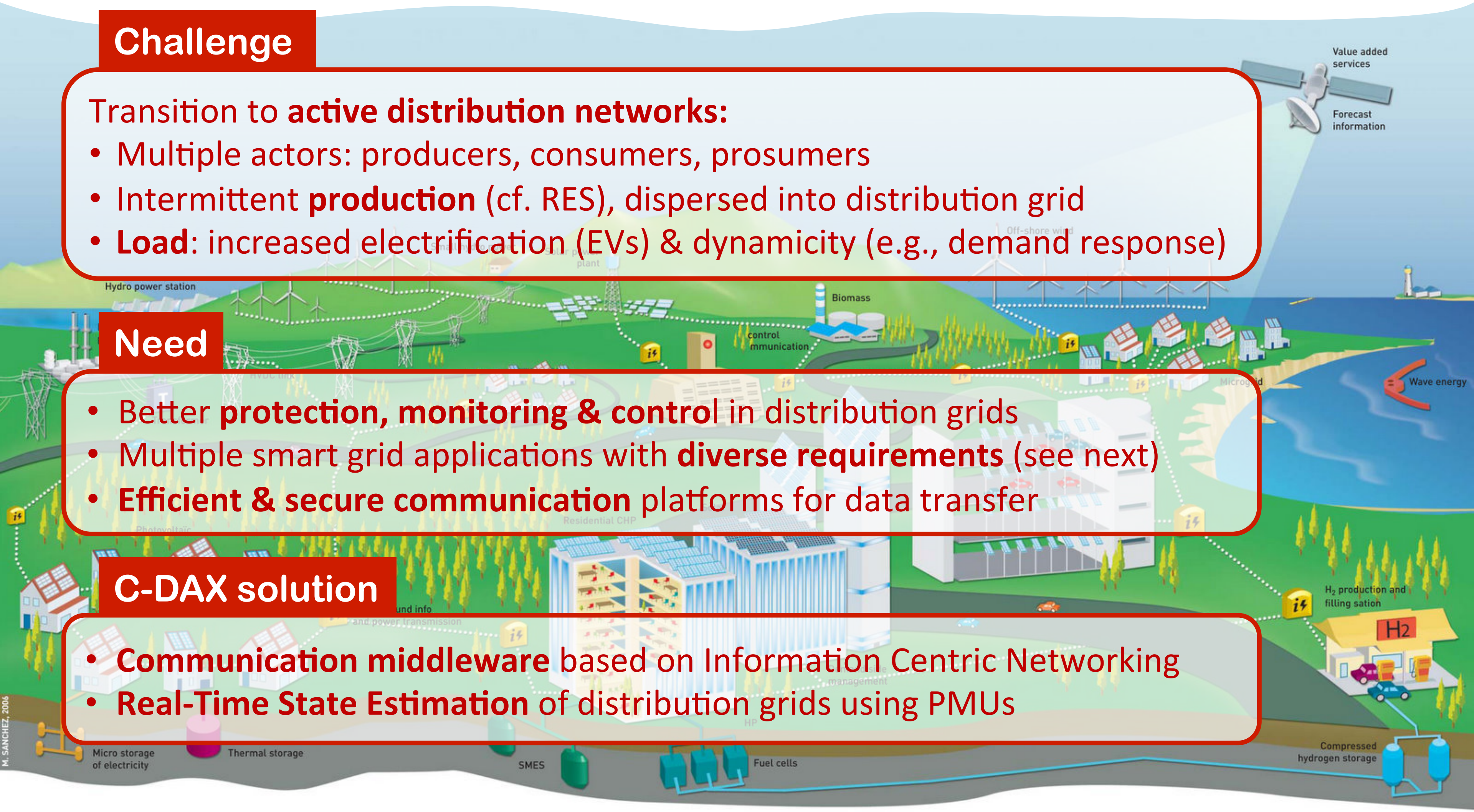
C-DAX

Cyber-secure Data And Control Cloud for power grids

- Project FP7-ICT-2011-8
- Oct. 1, 2012 – Feb. 19, 2016
- Budget: 4.3M EUR
  EU-funding: 2.9M EUR
- More info:
  http://www.cdax.eu



Context & Cause



Challenge

Transition to **active distribution networks:**

- Multiple actors: producers, consumers, prosumers
- Intermittent **production** (cf. RES), dispersed into distribution grid
- **Load**: increased electrification (EVs) & dynamicity (e.g., demand response)

Need

- Better **protection, monitoring & control** in distribution grids
- Multiple smart grid applications with **diverse requirements** (see next)
- **Efficient & secure communication** platforms for data transfer

C-DAX solution

- **Communication middleware** based on Information Centric Networking
- **Real-Time State Estimation** of distribution grids using PMUs

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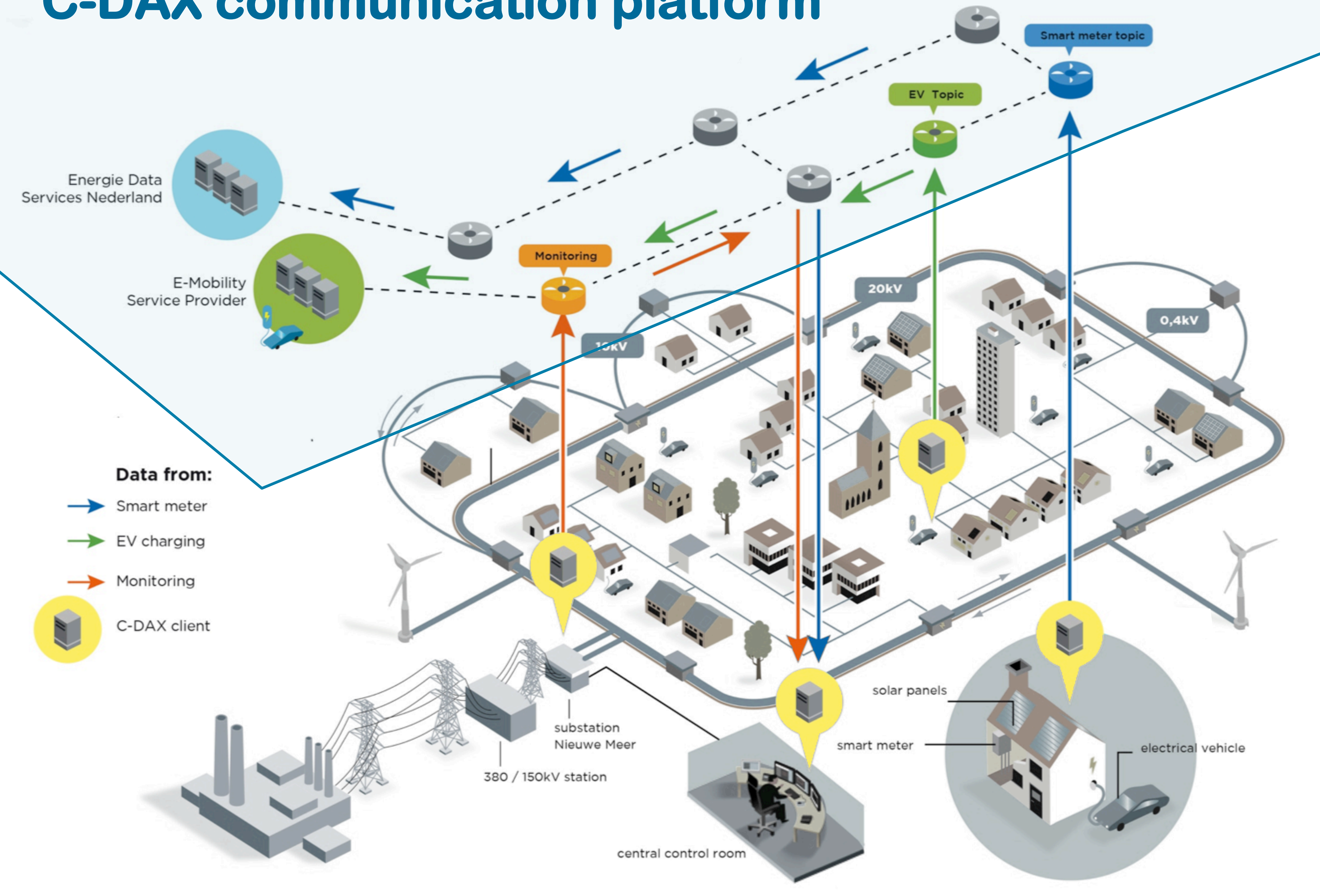
Smart grid communication pattern variation

- **1-to-1**: e.g., control messages for specific assets
- **1-to-M**:
  - *Broadcast*: e.g., energy offers in demand response schemes
  - *Anycast*: e.g., offer for voltage regulation by any suitable subset of EVs located in a certain area
- **M-to-1**: e.g., energy consumption reports in demand response or smart metering
- **M-to-N**: e.g., multiple charging offers from different charging stations to multiple EVs
- **Asynchronous** communication in dynamic scenarios:
  e.g., EVs come and go, retrieve/deliver data while connected to the network

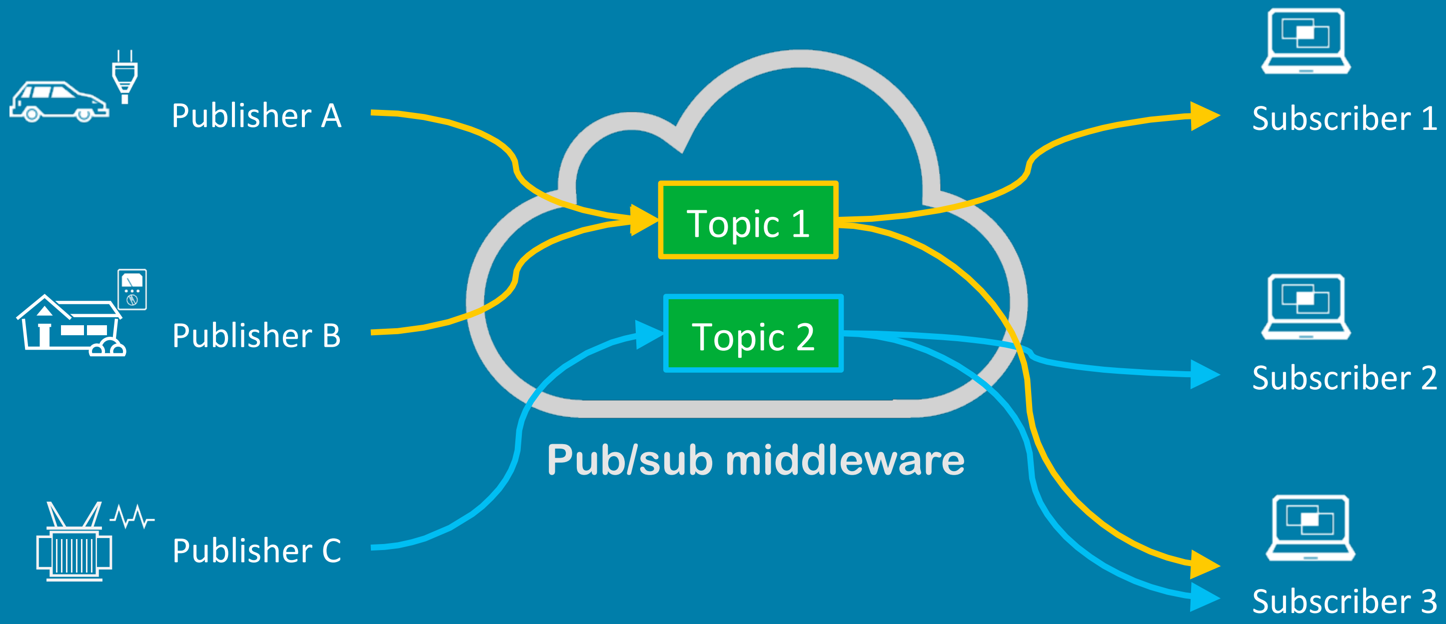
ICN = Information Centric Networks

- Alternative for Point-to-point networks
  - … where information flows from producer to predefined consumers via explicit point-to-point connections → e.g., need to know/config all IPs
- ICN paradigm = based on **topic** rather than IP address
  - Consumers "pull" or "subscribe to" the data "topics" they need regardless of who produced the information, or when, or where it is stored
  - Decoupling of producers/consumers
- Advantages:
  - Inherent **security**: hosts do not know each other's network and physical locations (publish – subscribe communication)
  - Overlay network **management**:
    - Management of IP connections, optimal placement of the data within the cloud, resilience…
    - In-network management and processing (e.g., caching, aggregation, filtering, rate adaptation, traffic engineering …)

C-DAX communication platform



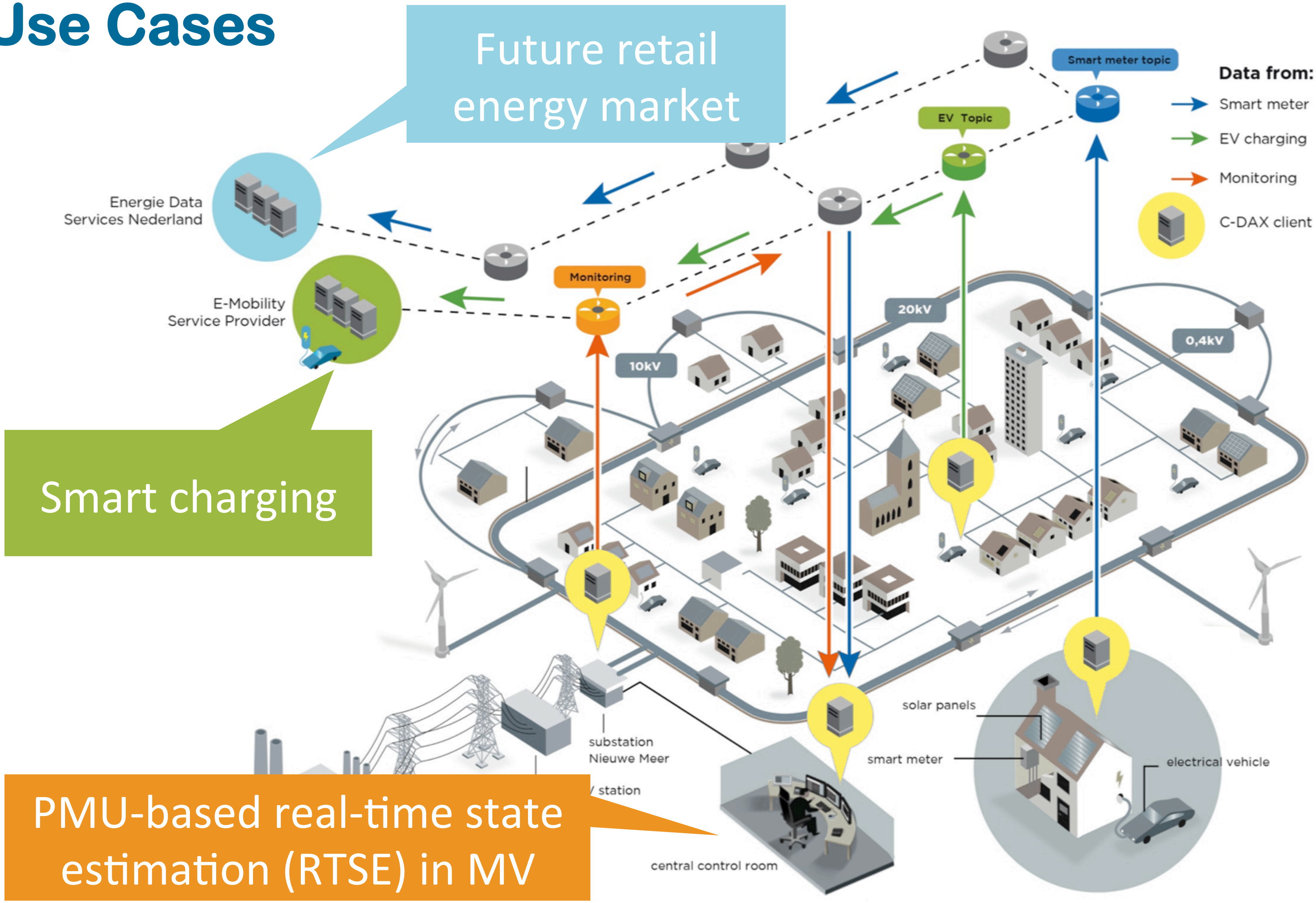
Topic-based Communication



Benefits of decoupling publishers and subscribers

- Communication partners do not need to know each other
- Asynchronous communication possible
- Facilitating extensibility, management and configurability

Use Cases



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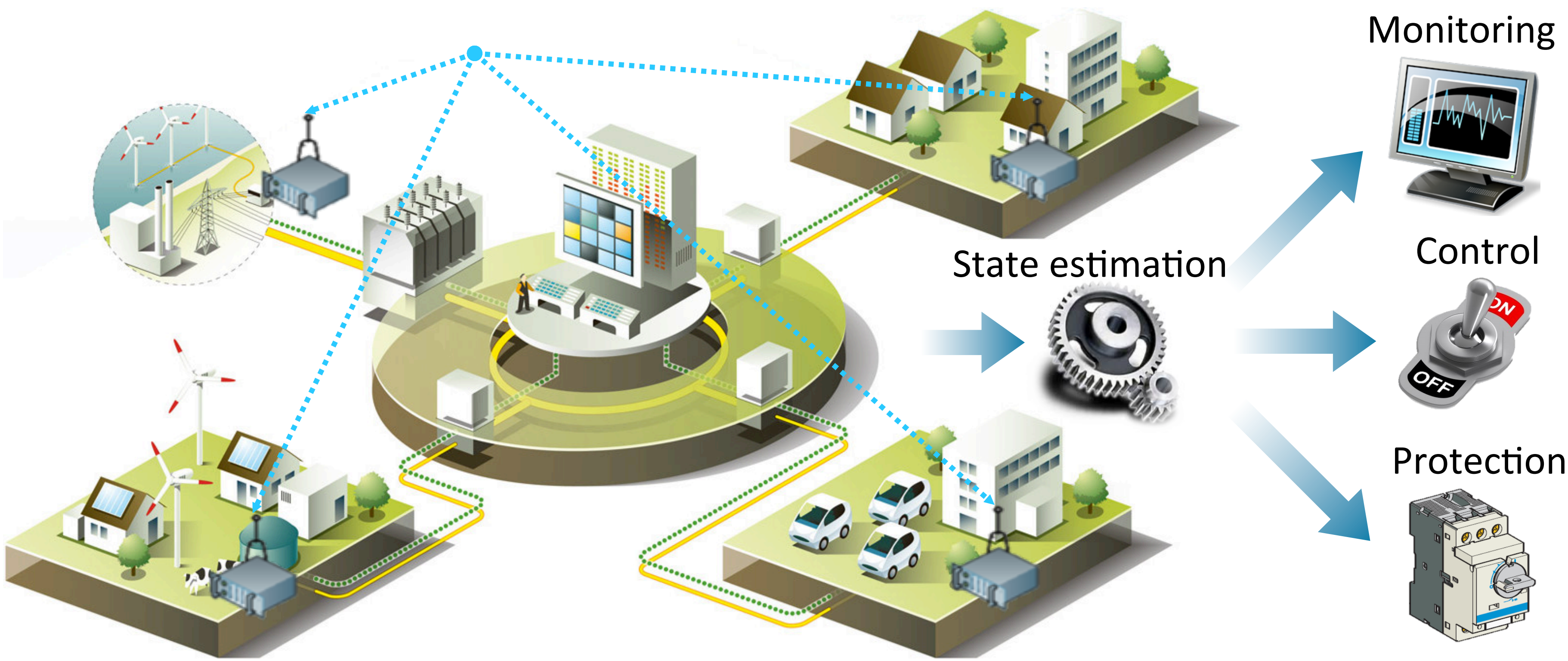
Use Case: Real-time state estimation of ADNs



Network in ***normal*** operation:

- Congestion management
- Optimal V/P control
- Optimal dispatch of DER

Network in ***emergency*** conditions:

- Islanding detection
- Fault identification
- Fault location

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Use Case: Real-time state estimation of ADNs

Need observability of the grid
to assure stability, power quality, voltage regulation, etc.

Solution: install Phasor Measurement Units (PMUs) for regional/local area measurement, protection and control

Challenge for C-DAX platform :
support the stringent latency requirements

Use Case: Retail energy transactions

- Consumer ↔ supplier: demand response negotiations, billing and settlement, …
- Focus on **demand response**
  1. Architectural analysis for support of smart charging in the Netherlands

     Efficient & secure distribution of data to all relevant parties?
  2. Smart charging for parked electric vehicles

     Demand shaping for grid operators (e.g. peak shaving), energy suppliers (balancing), energy market players, etc.
  3. Smart charging for on-the-move electric vehicles

     Timely serving of customers & distribution of the load over charging stations
- Main challenge: scalability – Delay requirements are less stringent
  - High number of participants (end users, flexible loads, distributed energy sources, …)
  - Flexibility to configure users & guarantee secure data exchange

Benefits for utilities

- Single communication platform for heterogeneous applications → **cost-efficient**
  - No duplicated investments of infrastructure per application
  - Better utilization of available communication
- **Secure and reliable** grid operations
  - Secure, timely and resilient delivery of measurement & control
  - Inherent resilient cyber-security layer w/ end-to-end authentication, privacy, and integrity
- **Scalable** platform
  - supports growing number of power grid entities (flexible loads, EVs, distributed energy sources)
  - Streaming, query and point-to-point communication
  - Plug-and-play addition and removal of publishers, subscribers, topics and existing and future applications (which reduces operational costs)
- **Support for existing smart grid protocols** and legacy software and hardware

Thanks. Any questions?

Q&A

- Project coordination & dissemination
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