National 5G Energy Hub

Brief Description of “Use Cases”

User Story: „Smart Grid“ and „Smart Building“

User Story

Smart Grid
Intelligent and *robust operation* of electrical power supply systems to enable *improvement of energy efficiency* and flexibility while maintaining reliability

Smart Building
Control of energy systems in buildings under various target functions, such as *energy efficiency*, reduction of CO2 emissions or increase of self demand share covered by renewable energies.

Use Case

Regional

PQ-Monitoring
Latency: not relevant — Data points: 3x25x300

Voltage Regulation MV-grid
Latency: < 1 s — Data points: approx. 3x300

Building-Monitoring
Latency: < 30 s — Data points: < 8000

Regional Virtual Power Plant (Regional-VPP)
Latency: < 350 ms — Data points: < 150.000

State Estimation LV-grid
Latency: 100 ms adressed — Data points: 3x300

Cloud Control of Energetic Systems
Latency: < 200 ms — Data points: < 8000

Grid Protection Support (fault detection)
Latency: 1 ms adressed — Data points: 3x300

Local

Motivation:

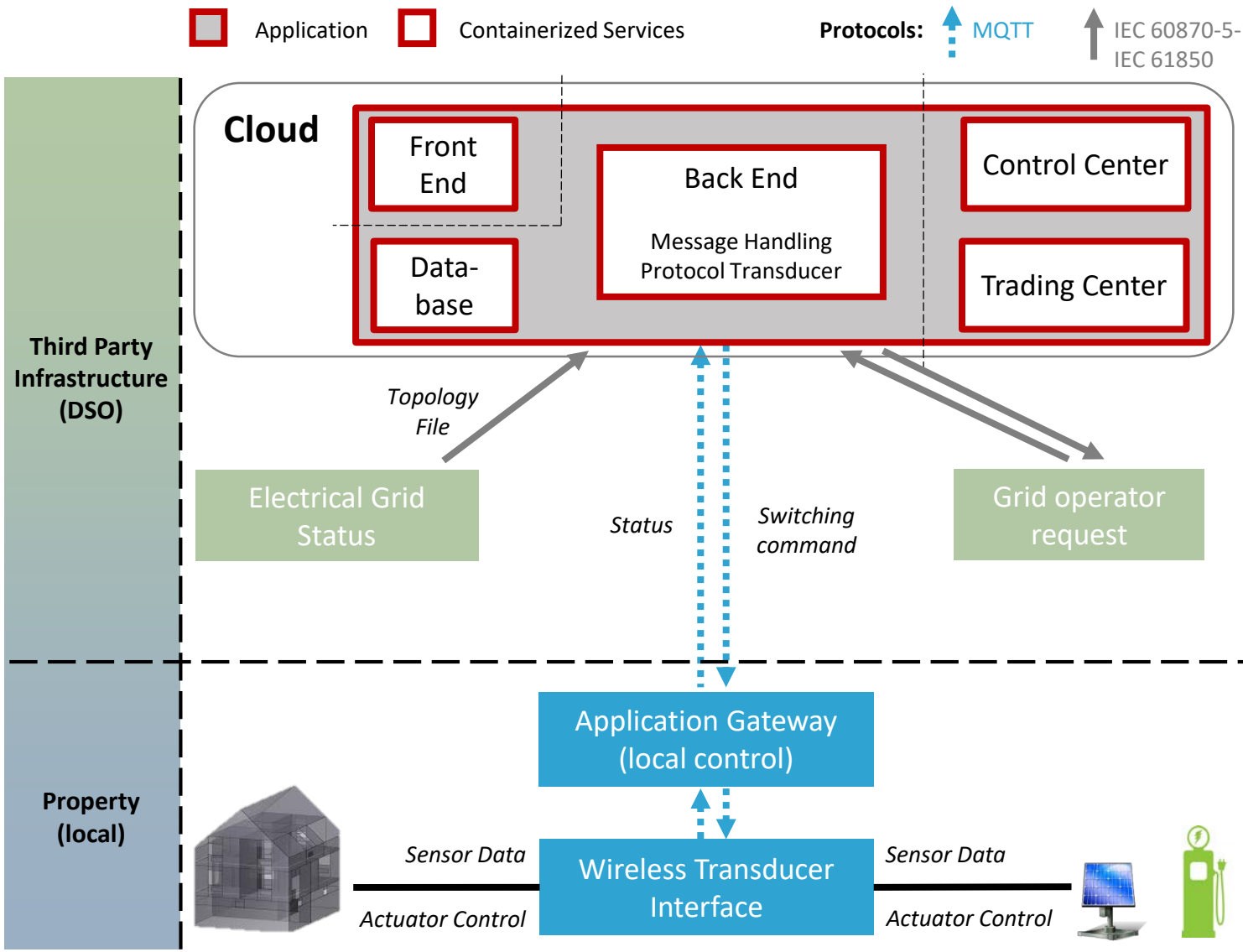
- PV systems and CHPs in particular are connected at the LV and MV levels
- Grid-compatible operation of the decentralised producers through the use of thermal flexibilities (sector coupling)
- Participation in energy trading possible through information technology bundling of facilities
- Use of the structure for control and monitoring

Objective:

- Control of decentralized consumers and producers
- Coupling of electricity and heating market
- Energy and cost optimal operation local/overarching

Users:

- local energy companies
- network operator (electrical network / gas and district heating network)
- energy service
- building owner



- Back End (Cloud) with coupling to systems of grid operators or energy service providers
- Network operators or energy service providers can specify control conditions and receive monitoring information via standardized interfaces

- Sensor signals are aggregated and preprocessed in Gateway
- Gateway can also take over basic control functions independently from the cloud

Motivation:

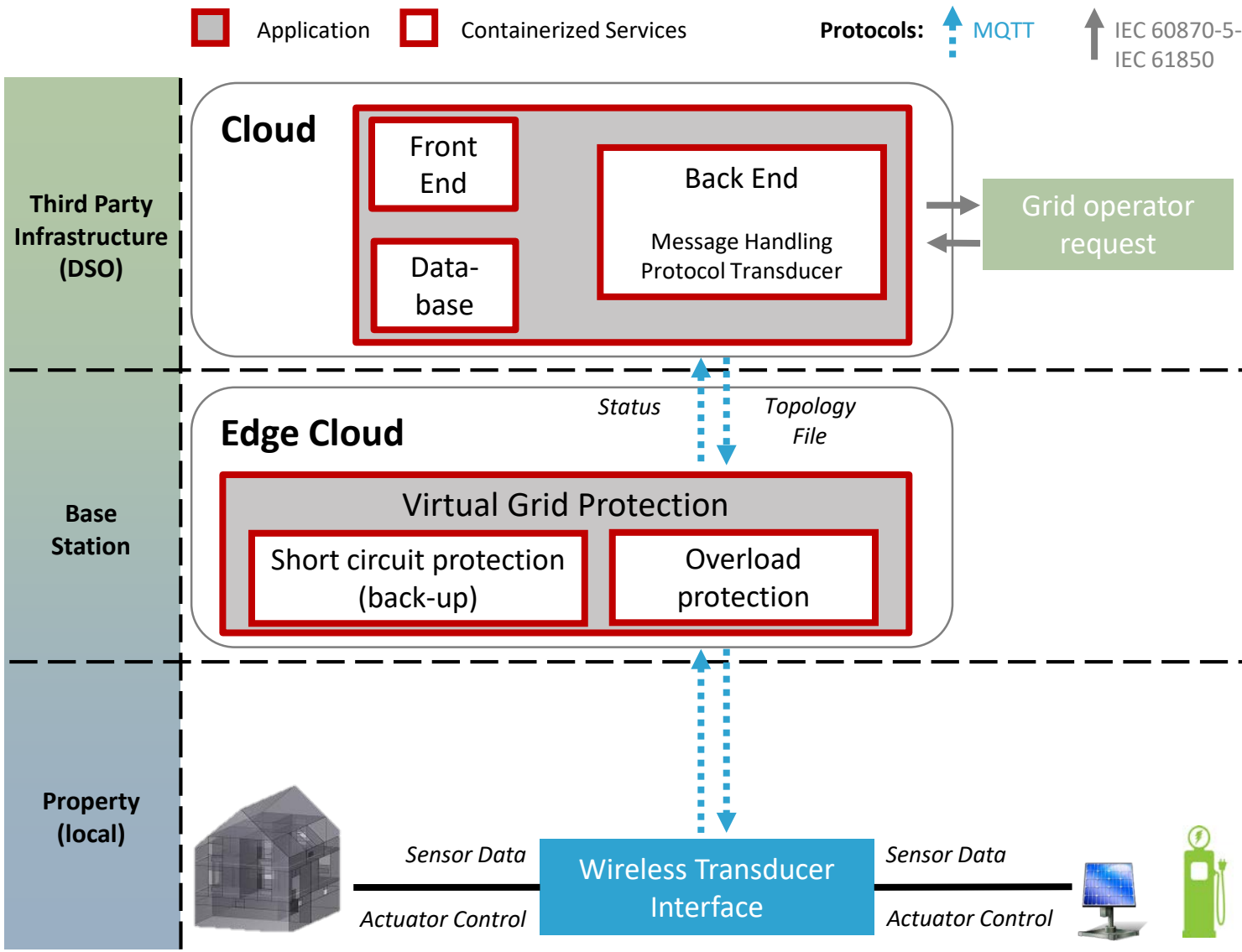
- PV systems and CHPs in particular are connected at the LV and MV levels
- The will to increase resource efficiency and cost pressure motivate the development towards a more decentralised energy distribution
- The LV and MV levels, however, have only a rudimentary protection concept
- Implementation of grid protection with the help of the Smart Meter Gateway (SMG) open
  → depending on the SMG administrator

Objective:

- Establishment of a separate reserve protection in the LV and MV level
  advantages: radio-supported, retrofittable, cost-effective, diversity compared to SMG
- Reliable detection of faults through reserve protection in the LV network
- Evaluation of grid states (e.g. short-term overload) as support for grid protection in the MV grid

User:

- Local energy companies
- Electrical network operators (distribution network / local network)



- Back End (Cloud) with coupling to the systems of the grid operator
- Grid operator will run his own cloud resp. can hire managed cloud

- Radio network operator will provide fee-based access to Edge Cloud
- Services can be shifted to Cloud if Edge Cloud is not available
- Different protection algorithms can be deployed

- Plug‘n play sensor systems will provide instantaneous values of current
- Time synchronicity of transducers is very important
- An application gateway should not be necessary

Motivation:

- The integration of different sensor and actuator types in building automation systems is a complex task:
  - High cabling effort
  - Low interoperability of different bus systems
- Maintainability of the automation software on local controllers is difficult

=> Cloud-based building automation by using 5G

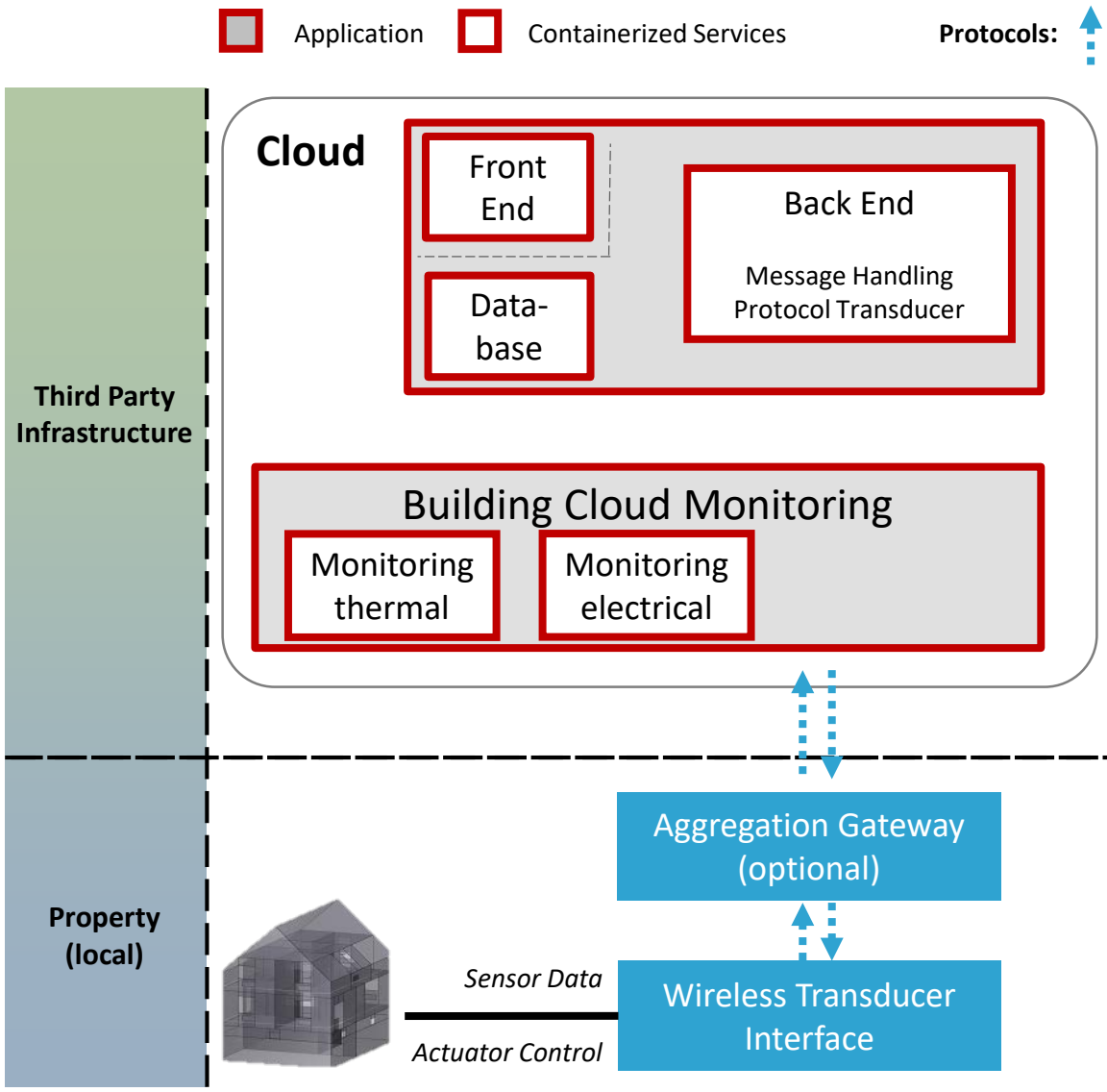
Objective:

- Thermal and electrical system monitoring
- Control and optimization of building energy systems

User:

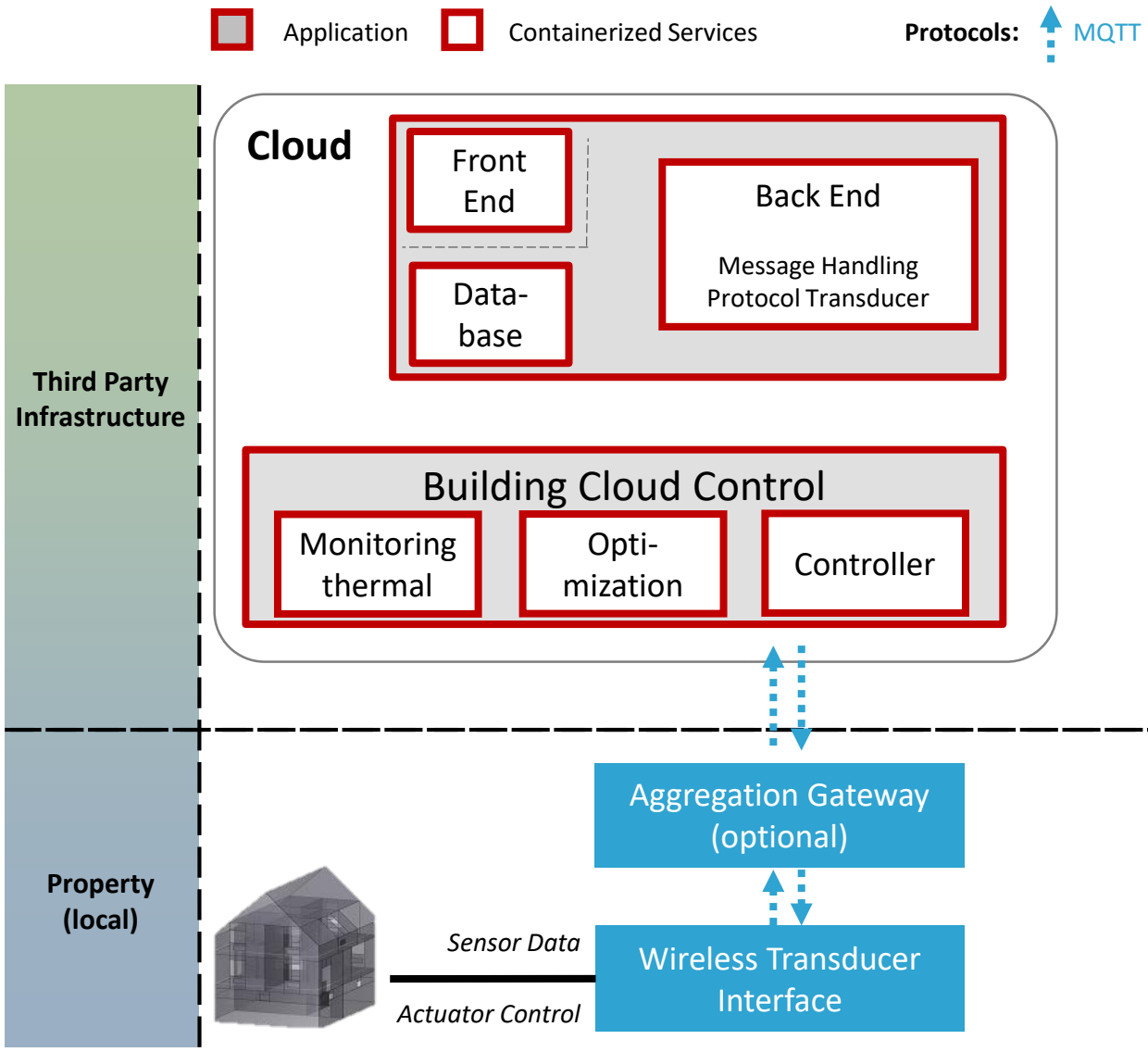
- Building operator/owner
- Building user
- Energy supplier
- Contractor

Building Cloud Monitoring



- Visualization and data analysis of the building operation
- Collection and storage of sensor data
- Transducer interface connects sensors with the cloud via 5G

Building Cloud Closed Loop Control (incl. Monitoring)



- Management, visualization and analysis of the building operation
- Control algorithm runs in the (Edge) Cloud
- Actuator signals are sent back to the building
- Transducer interface connects sensors and actuators with the cloud via 5G

Motivation:

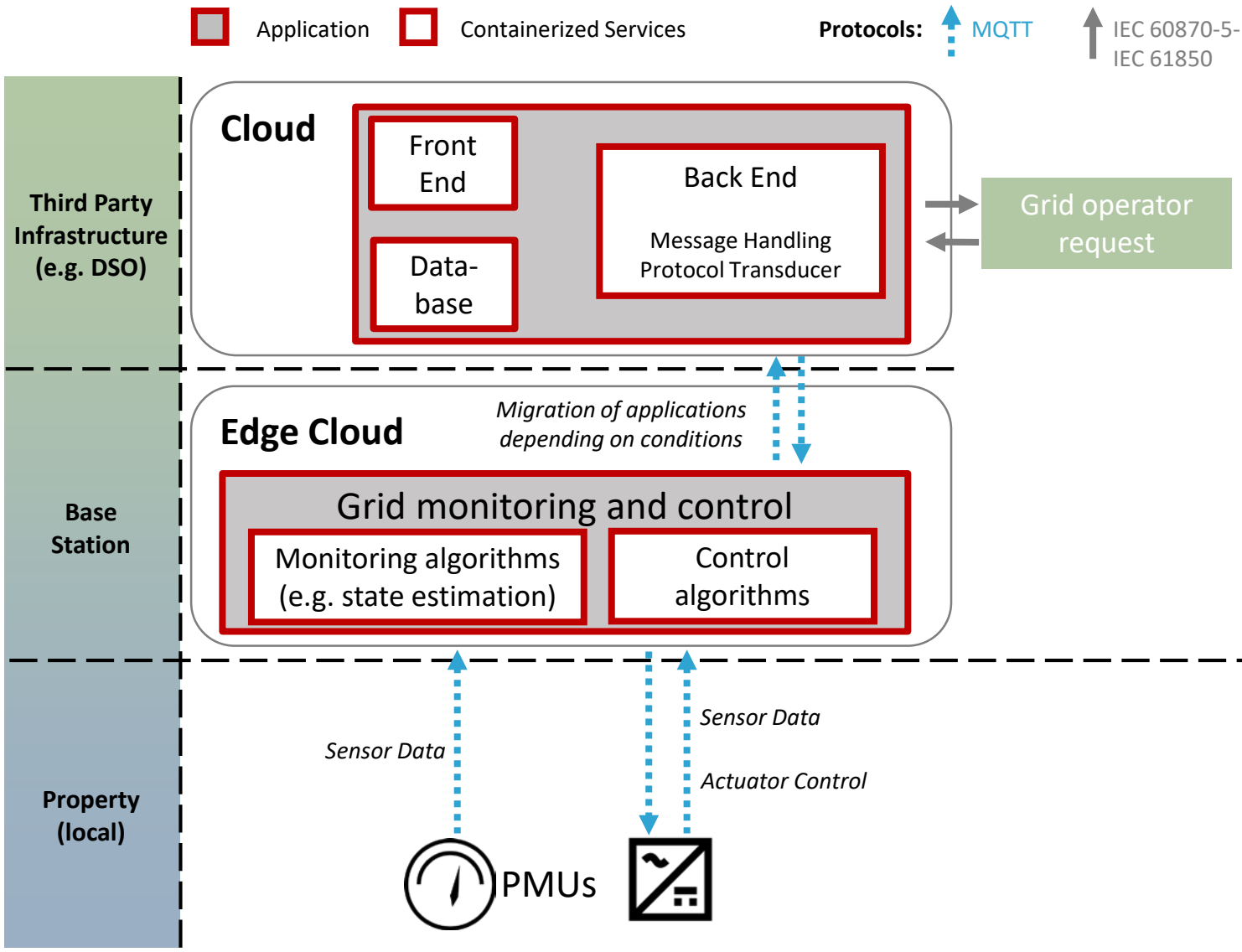
- Enhancement of DSO grid management (limiting operational costs) through improvements in grid monitoring and in the algorithms based on grid monitoring
- Better management and control of islanded microgrids under disturbance though low-cost PMU in presence of mobile edge cloud

Objective:

- Development of the grid monitoring based on the low-cost PMU hardware and implementation of the algorithms utilizing the hardware with the features of increased reporting rate and lower latency between the measurement and the final output of the monitoring and control algorithms (e.g. state estimation algorithm as well as subsequent algorithms e.g. based on optimal power flow).
- Development of control and management of the islanded microgrid through the monitoring based on PMUs and potential of running services in the edge cloud under blackout conditions of the bulk power system

User:

- Electrical network operators (distribution network / local network)
- Aggregators / VPPs or microgrid operators



- The applications for grid monitoring and control run in either core or edge cloud
- The performance of algorithms is assesed after implementation of improved low-cost PMU, also under more dynamic conditions.

- Under conditions of a blackout, when the core cloud is unavailable, the applications should run only in the edge cloud and the control algorithms should be ready for such scenario

- Low-cost PMUs hardware as the basic device to monitor the grid
- Other devices, also actuators are virtualized in the simulation environment