

Extension of a Smart Grid Test Facility with Building Energy Agent Technology

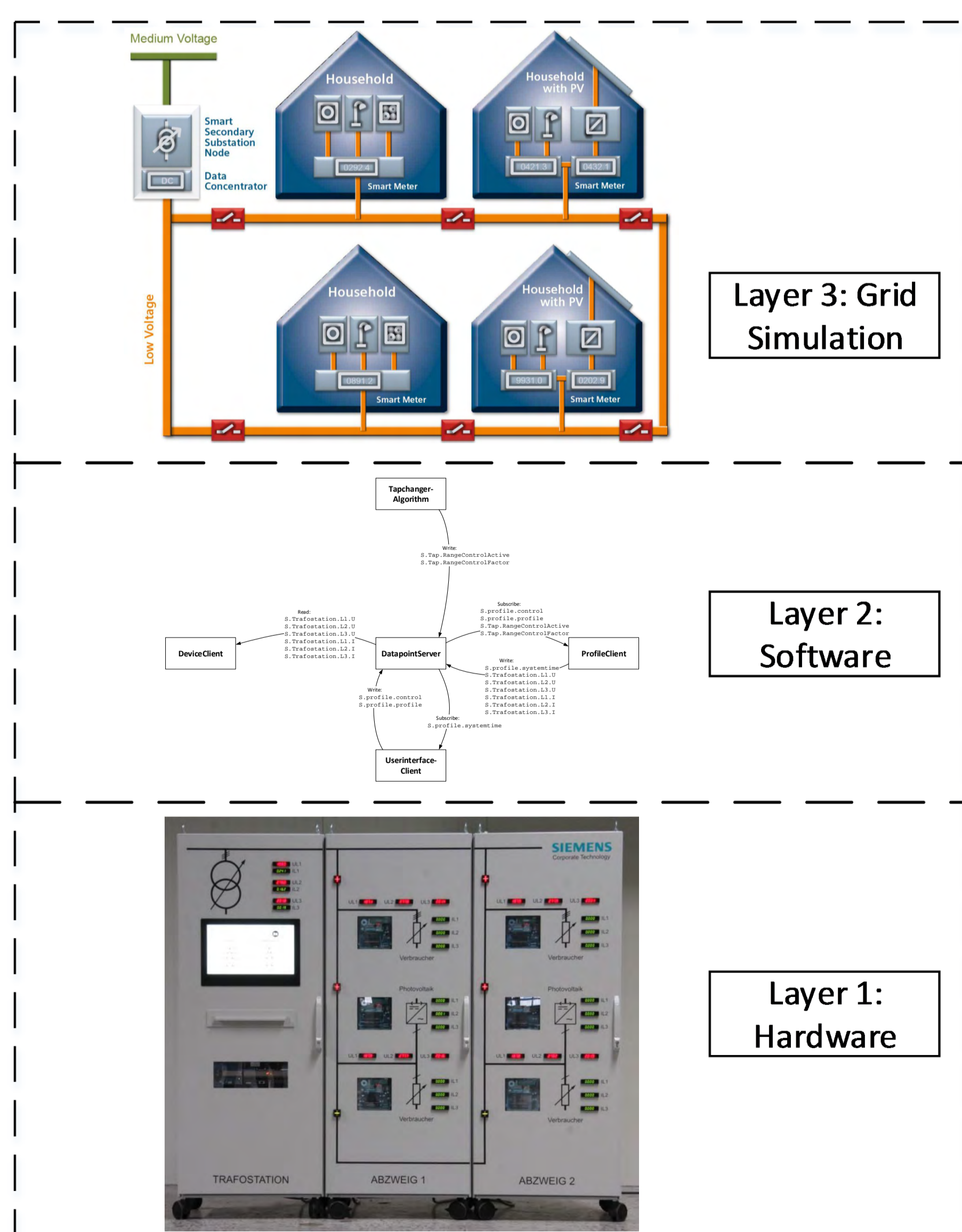
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Background and Motivation

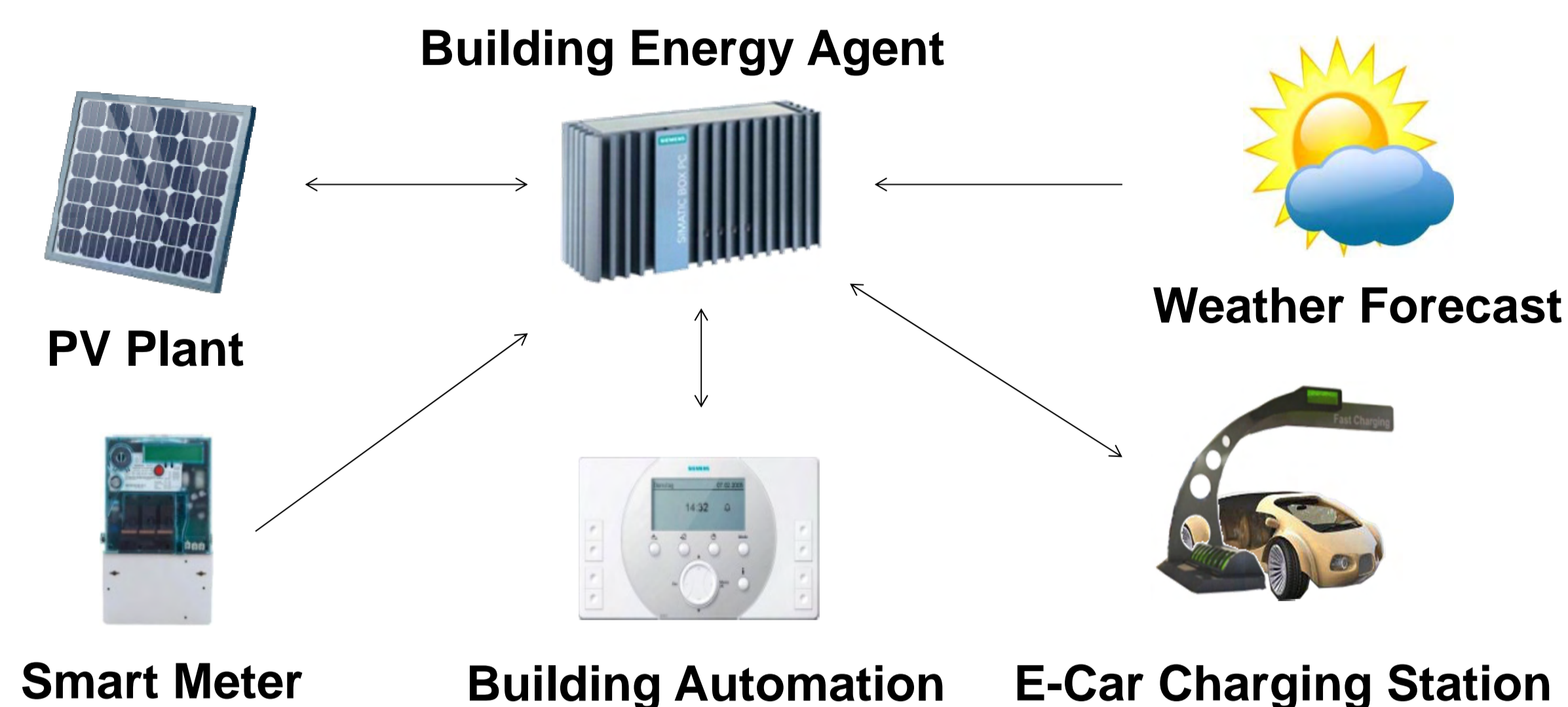
- Background: Existing Smart Grid lab infrastructure (two switchable 3-phase branches; emulated secondary substation with OLTC; emulated households and PV generation) is extended by a building automation agent.
- Motivation: Develop and test functionality of a “Building Energy Agent”
- Problem:
 - Risky and expensive to test concepts in real grids
 - Hard to get a realistic test environment with simulator
- Solution: Extension of test facility “Intelligent Low Voltage Grid”
 - Emulate LV power grid (two 3-phase branches with ring option)
 - Emulate single hardware components like PV and EV
 - Extension by “Building Energy Agent” (BEA) rack representing a household and BEA functionality to be tested
- New Use cases:
 - Island mode – No external power supply
 - V2G/G2V – Integration of EVs into grid
 - Load shifting – Demand Side Management
 - Load reduction – Reduce grid load on critical external events

Infrastructure

- Layer 1: Hardware
 - Transformers STT800 for PV and local MV/LV transformers
 - Current sinks IS100 as variable loads for EVs and households
 - Smart Meters at critical measurement points in the grid
- Layer 2: Software
 - Central server for managing data exchange via “datapoints”
 - Clients as gateways, user interfaces, algorithms, profile generators
- Layer 3: Model
 - 3-phase LV power grid
 - Topology: (1) two branches, (2) one long branch or (3) closed ring
 - MV/LV grid transformer
 - two households with PV, two households without PV
 - Emulation of 24 h within 2 min by real hardware components

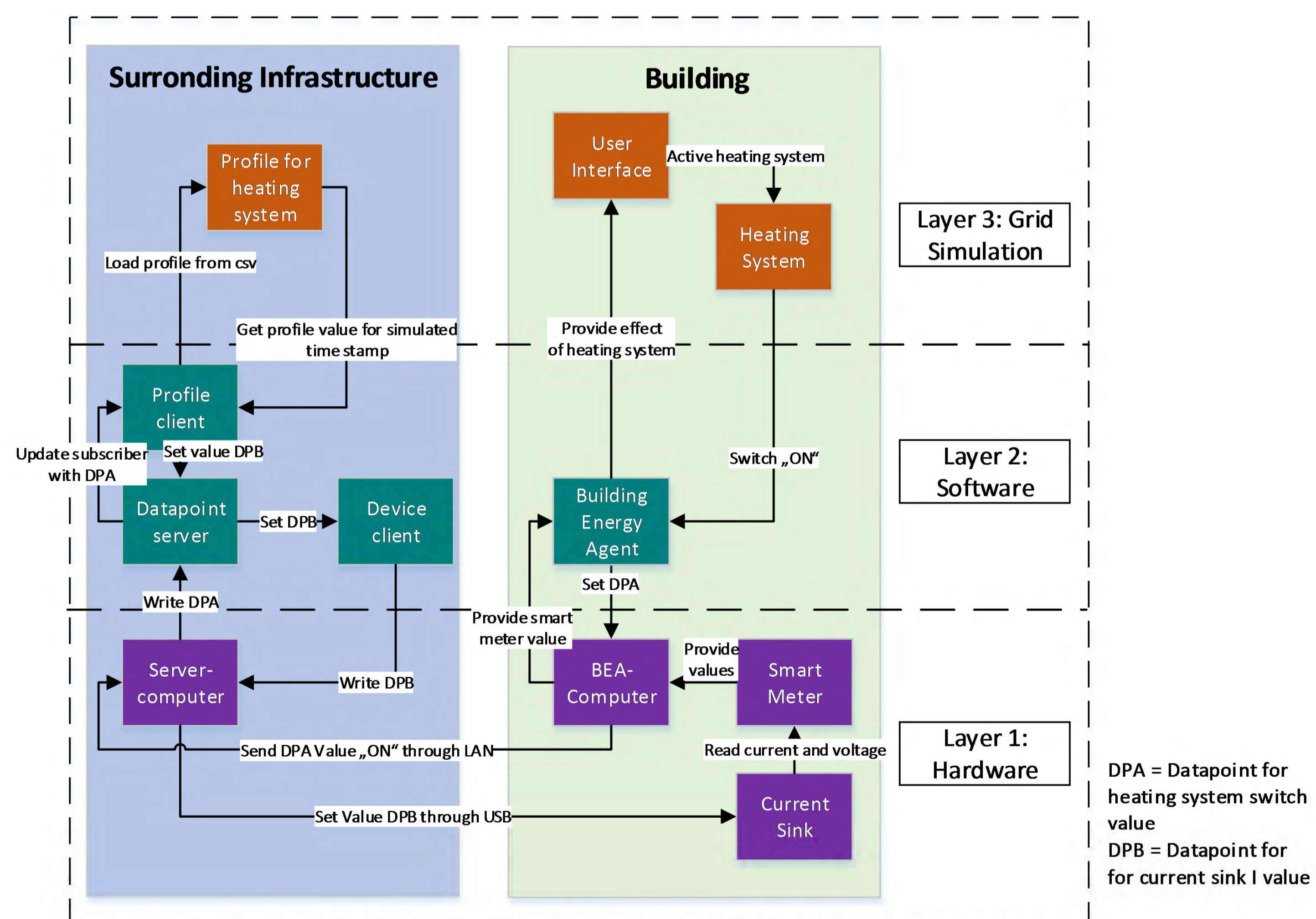


Building Energy Agent



- BEA functionalities:
 - Maximize self-consumption of produced energy inside the building (e.g. from photovoltaic plants)
 - Generate accurate load and generation forecasts for grid operation and energy procurement optimization
 - Offer flexibilities (e.g. load shifting) for energy retailers, Virtual Power Plants (VPP) and grid operators
- Connected devices and services:
 - Smart Meter, E-Car charging station, photovoltaic inverter, building automation systems, external weather forecast provider
- Information exchanged with infrastructure:
 - The BEA receives P(U) and Q(U) characteristics in order to reduce consumption or generation in case of voltage band violations
 - Control signals from the building automation system are connected to the simulation system (see next section)

Integration of BEA in the Infrastructure



- Activate simulated heating system on BEA through switch
- Switch state “ON” passed to interface of BEA to datapoint server
- Datapoint “BEAHeatingSystem” in server set to “ON”
- Profileclient gets datapoint “BEAHeatingSystem” and receives “ON”
- Current-profile for a heating system loaded from csv-file
- Datapoint “BEACurrentLoad” set with value according to profile
- Profile current value set in a current sink in the BEA rack
- Value measured by smart meter
- Smart Meter values provided to the BEA and user