

Smart Grid Demonstrator of a Future Office Prosumer

Denis Bytschkow (fortiss)

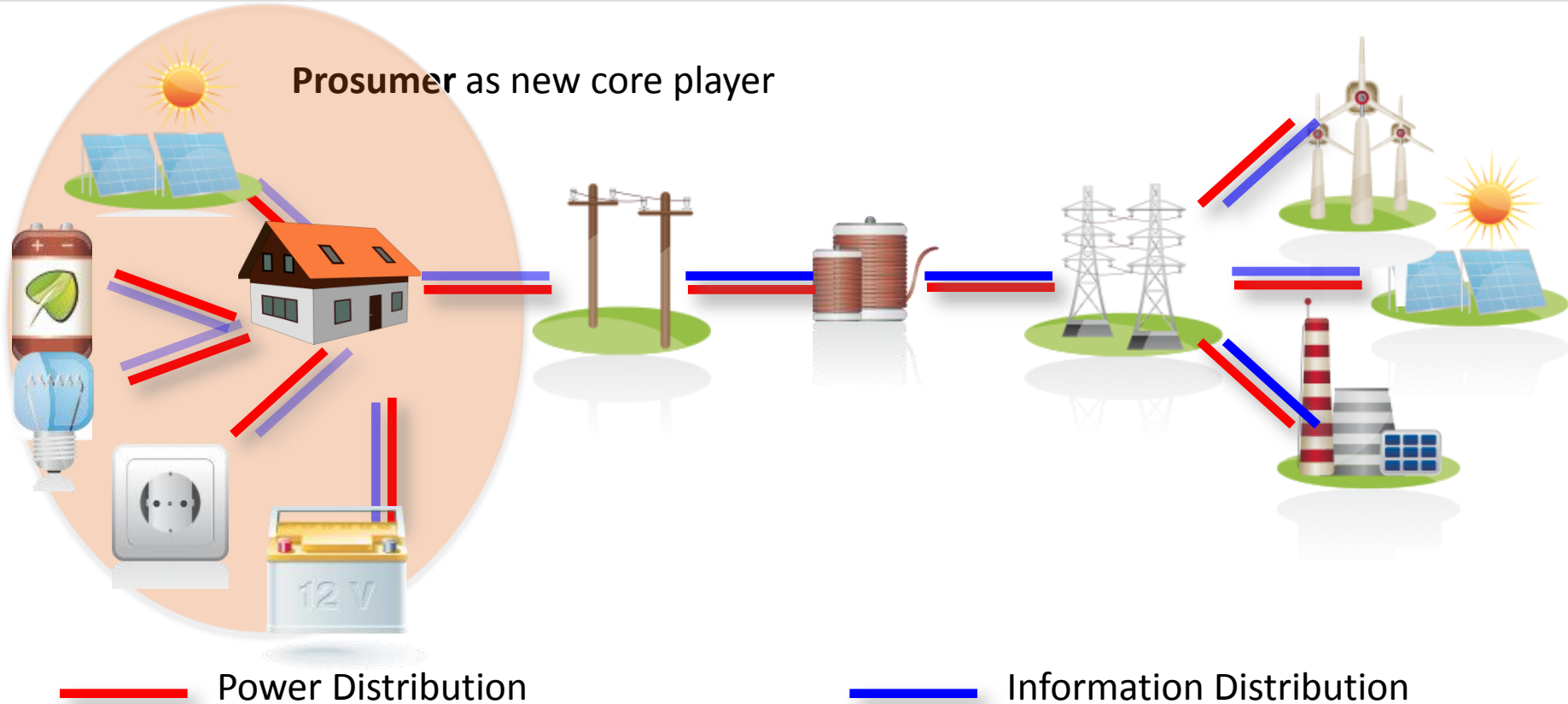


Demonstrator Group: Bernhard Schätz, Dagmar Koss, Pragma Gupta, Denis Bytschkow (fortiss GmbH)
Florian Sellmayr, Steffen Bauereiss (Technische Universität München)

Joint work with Siemens CT & EIT ICT Labs

Motivation

Prosumer as new core player



- **Prosumers = Producers + Consumers**
- Decentral but stable network
- New reliable energy mgmt. solutions and IKT infrastructure

Goals

- Build a real prosumer experimental platform
- Real-world experience and co-simulation
- Implementation of extendable reference architecture
- Behaviour of an office building as smart grid prosumer



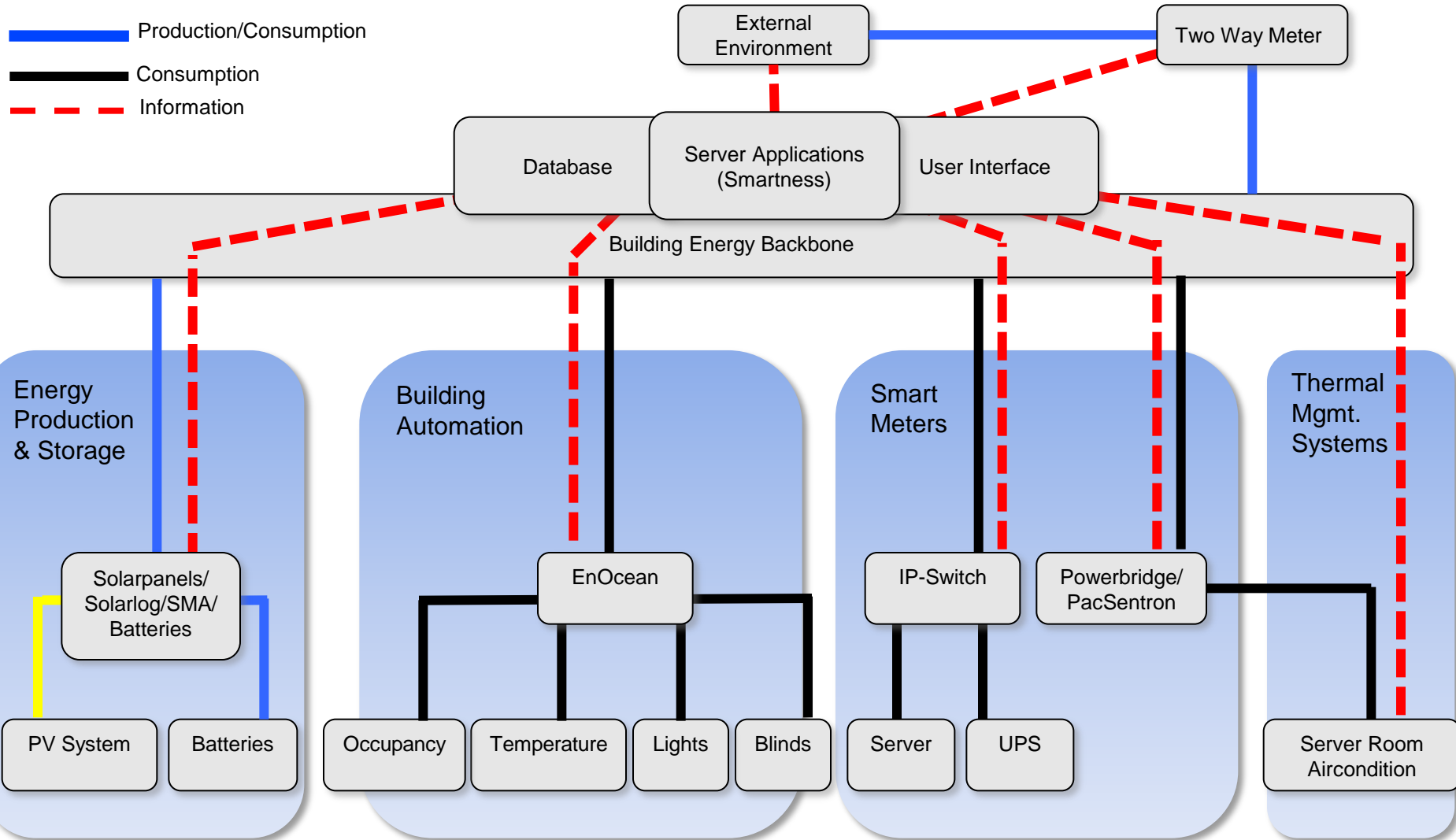
Overview of Devices in the Demonstrator

Production

Production/Consumption

Consumption

Information



Following SOA Principles

Control Service Layer:

- ▶ Node Management
- ▶ Planning Services
- ▶ Execution Services
- ▶ Billing Services
- ▶ Maintenance Services

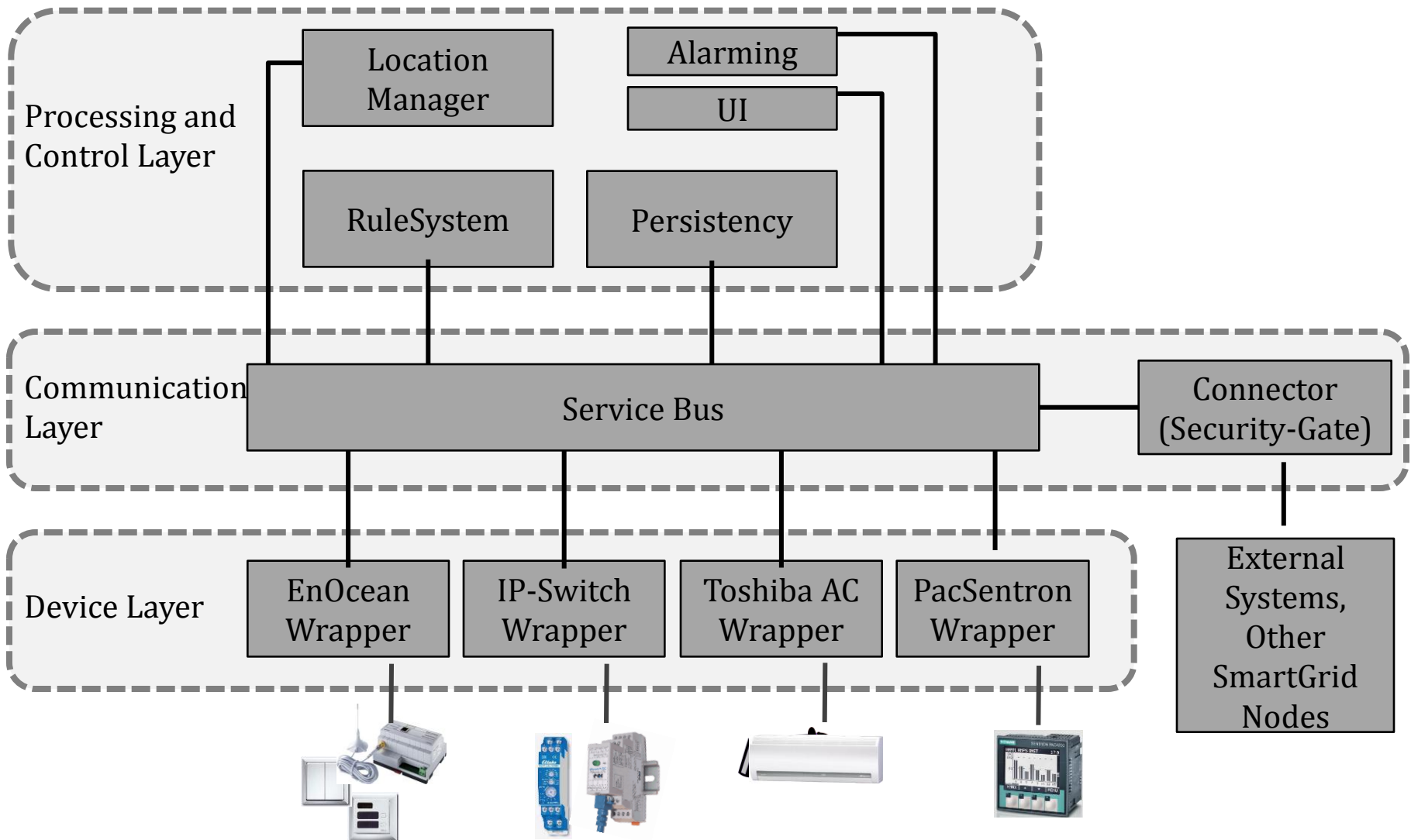
Function Service Layer:

- ▶ Service Coordination
- ▶ Service Orchestration
- ▶ Security Mechanisms
- ▶ Automatic Adaption
- ▶ Data Management
- ▶ Event Management

Device Service Layer:

- ▶ Sensors/Actors
- ▶ Communication
- ▶ Config./Parameterization
- ▶ Identification
- ▶ Diagnosis

Technical Architecture



iSOA: Integrated Services for Holistic Energy Management

Control Service Layer:

- ▶ Node Management
- ▶ Planning Services
- ▶ Execution Services
- ▶ Billing Services
- ▶ Maintenance Services

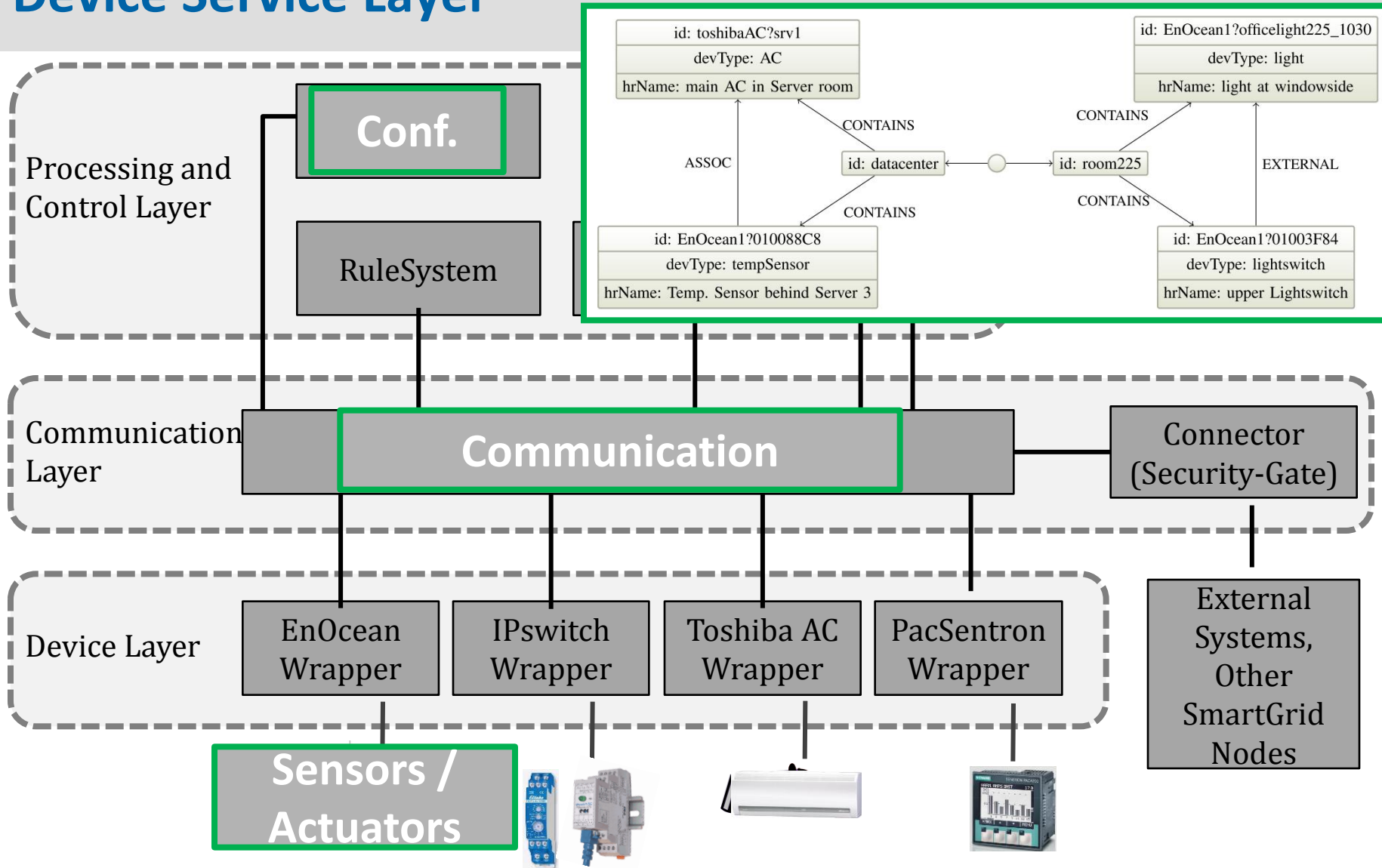
Function Service Layer:

- ▶ Service Coordination
- ▶ Service Orchestration
- ▶ Security Mechanisms
- ▶ Automatic Adaption
- ▶ Data Management
- ▶ Event Management

Device Service Layer:

- ▶ Sensors/Actors
- ▶ Communication
- ▶ Config./Parameterization
- ▶ Identification
- ▶ Diagnosis

Device Service Layer



iSOA: Integrated Services for Holistic Energy Management

Control Service Layer:

- ▶ Node Management
- ▶ Planning Services
- ▶ Execution Services
- ▶ Billing Services
- ▶ Maintenance Services

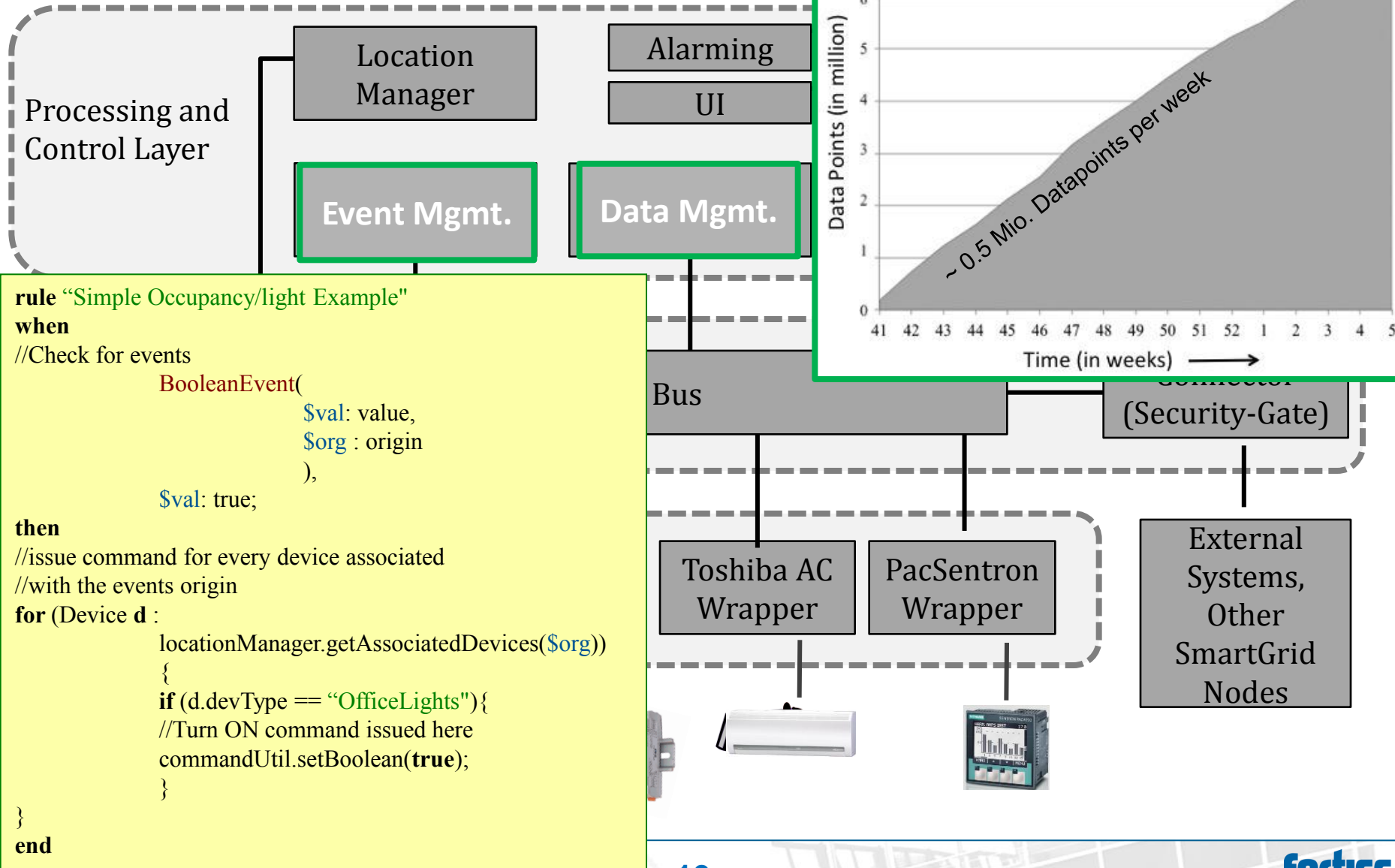
Function Service Layer:

- ▶ Service Coordination
- ▶ Service Orchestration
- ▶ Security Mechanisms
- ▶ Automatic Adaption
- ▶ Data Management
- ▶ Event Management

Device Service Layer:

- ▶ Sensors/Actors
- ▶ Communication
- ▶ Config./Parameterization
- ▶ Identification
- ▶ Diagnosis

Function Service Layer



rule "Simple Occupancy/light Example"

when

//Check for events

```
BooleanEvent(
    $val: value,
    $org : origin
),
```

\$val: true;

then

//issue command for every device associated

//with the events origin

for (Device d :

```
locationManager.getAssociatedDevices($org))
{
    if (d.devType == "OfficeLights"){
        //Turn ON command issued here
        commandUtil.setBoolean(true);
    }
}
```

}

end

iSOA: Integrated Services for Holistic Energy Management

Control Service Layer:

- ▶ Node Management
- ▶ Planning Services
- ▶ Execution Services
- ▶ Billing Services
- ▶ Maintenance Services

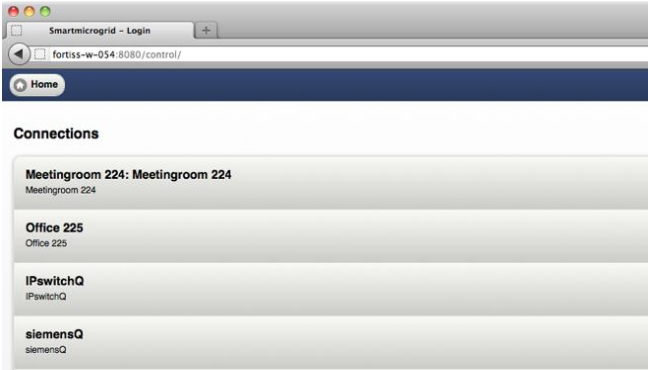
Function Service Layer:

- ▶ Service Coordination
- ▶ Service Orchestration
- ▶ Security Mechanisms
- ▶ Automatic Adaption
- ▶ Data Management
- ▶ Event Management

Device Service Layer:

- ▶ Sensors/Actors
- ▶ Communication
- ▶ Config./Parameterization
- ▶ Identification
- ▶ Diagnosis

Control Service Layer

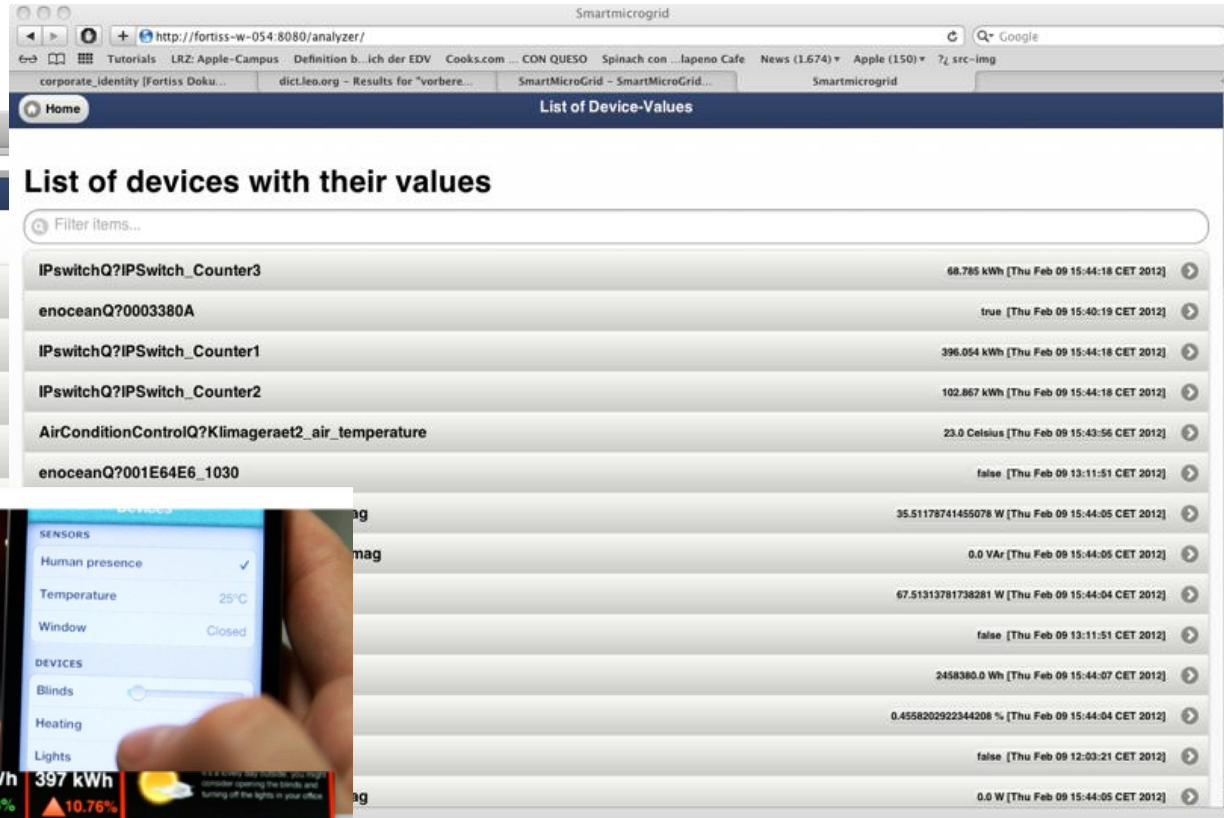


Smartmicrogrid - Login
fortiss-w-054-8080/control/

Home

Connections

- Meetingroom 224: Meetingroom 224
Meetingroom 224
- Office 225
Office 225
- IPswitchQ
IPswitchQ
- siemensQ
siemensQ



Smartmicrogrid
http://fortiss-w-054-8080/analyzer/

List of Device-Values

List of devices with their values

Filter items...

IPswitchQ?IPswitch_Counter3	68.785 kWh [Thu Feb 09 15:44:18 CET 2012]
enocanQ?0003380A	true [Thu Feb 09 15:40:19 CET 2012]
IPswitchQ?IPswitch_Counter1	396.054 kWh [Thu Feb 09 15:44:18 CET 2012]
IPswitchQ?IPswitch_Counter2	102.867 kWh [Thu Feb 09 15:44:18 CET 2012]
AirConditionControlQ?Klimageraet2_air_temperature	23.0 Celsius [Thu Feb 09 15:43:56 CET 2012]
enocanQ?001E64E6_1030	false [Thu Feb 09 13:11:51 CET 2012]
	35.51178741455078 W [Thu Feb 09 15:44:05 CET 2012]
	0.0 Var [Thu Feb 09 15:44:05 CET 2012]
	67.51313781738281 W [Thu Feb 09 15:44:04 CET 2012]
	false [Thu Feb 09 13:11:51 CET 2012]
	2458380.0 Wh [Thu Feb 09 15:44:07 CET 2012]
	0.4558202922344208 % [Thu Feb 09 15:44:04 CET 2012]
	false [Thu Feb 09 12:03:21 CET 2012]
	0.0 W [Thu Feb 09 15:44:05 CET 2012]



Statistics
Your consumption has increased by 20kWh / day this week. Consequently, your carbon dioxide emission have increased by 12%.

SENSORS

- Human presence
- Temperature 25°C
- Window Closed

DEVICES

- Blinds
- Heating
- Lights

Gridlife
The lights in your office are still on. If you turn them off, you'll earn 10 pts.

460 kWh **397 kWh**
▲ 5.43% ▲ 10.76%

Your consumption
298.7 kWh ▲ 30.7%

Your building
298.7 kWh

Suggestions
Leaving the window open for no more than 10 min will keep the air fresh, while saving 15% of heating energy.
We can turn off the lights at desk 4 because there seems to be nobody there. This will save 80W per hour.

Implementation details

□ Technical Infrastructure

- Service Bus - ActiveMQ, JMS, SOAP
- Component Platform – OSGi

□ Generalized data & events

- double event
- boolean event
- toggle event
- string event

□ Interfaces

- External communication with IEC 61850 / 61400 standards
- Wrapper end-point address?device ID (e.g. enoceanQ?010088C8)

Adding Functionalities

- ❑ **New services** extending the system (e.g. decision system)
- ❑ **External data**: market prices, weather forecast
- ❑ **Prediction** of power usage
- ❑ **User interface & data visualization** (smart phones, tablets, web)
- ❑ **Security**, fault management mechanism
- ❑ **Machine learning** (configuration automation)
- ❑ **Connection** to the grid and other demonstrators
- ❑ **Co-Simulation** framework

Conclusion

□ Demonstrator Environment

- System is running several months
- Flexible architecture
- Plug & play
- Heterogeneous device handling
- Interconnection with EU Demonstrators (KIT, DAI, Imperial, Delft, ...)
- External communication based on standards - IEC 61850 / 61400

□ Challenges faced

- Hardware pitfalls
- Amount of data
- Efficiency of communication protocols
- Basic data-type Interface

Contacts

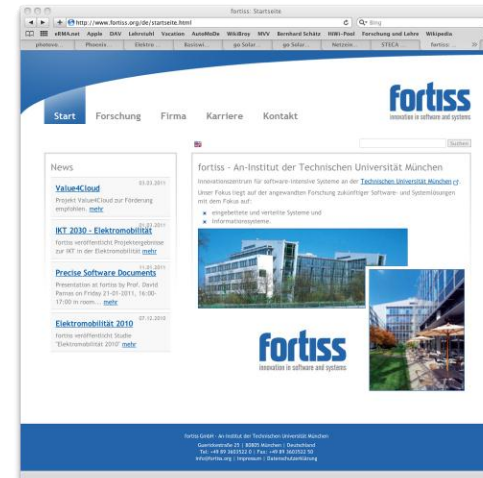
<http://www.fortiss.org/research/projects/smart-micro-grid.html>

More Infos...

fortiss
innovation in software and systems



live at fortiss



www.fortiss.org

Smart Grid Research Initiative: <http://smartgrid.in.tum.de>



Collaboration with Software and System Engineering Group (Prof. Broy)

