

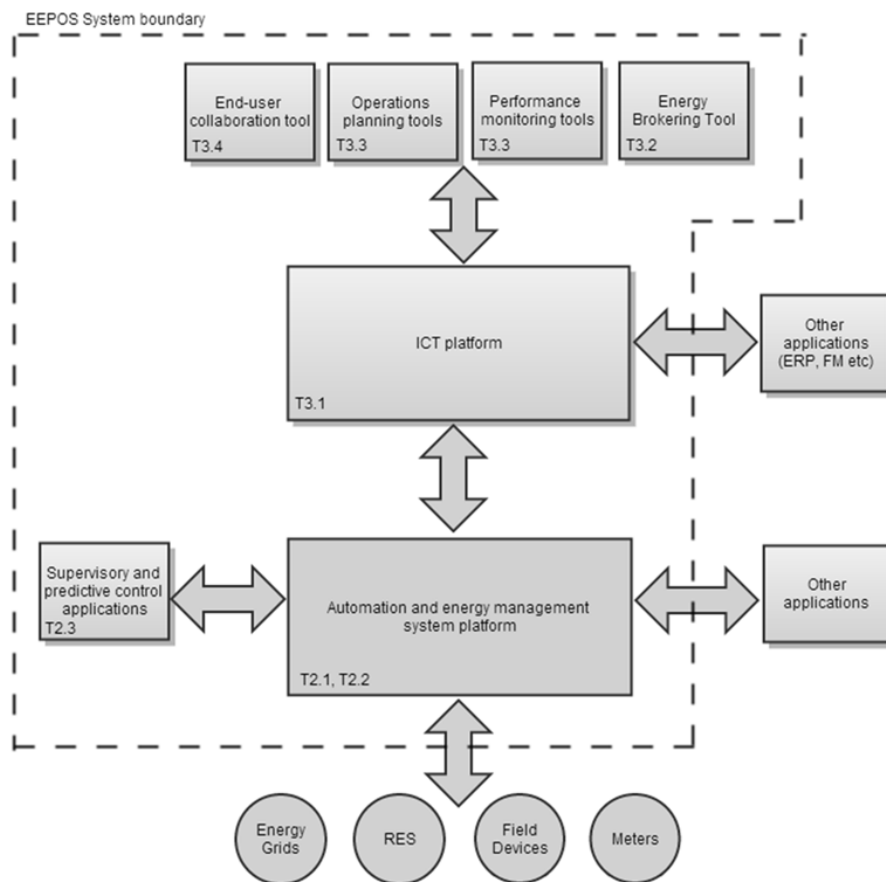
EEPOS - Energy management and decision support systems for energy positive neighbourhoods



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Overall EEPOS architecture specification



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1. PUBLISHABLE EXECUTIVE SUMMARY

This deliverable will define the technological starting point of the EEPOS project and give guidelines to future tasks.

In this document the key entities of the EEPOS solutions and briefly described how they will be included in the demonstrations. Connecting interfaces were identified and missing interfaces listed for future tasks.

An overall system diagram is presented in Figure 1. The system contains three levels. Lowest level contains building energy management system (BEMS / field level) which includes consumption meters, different sensors etc. The BEMSs will communicate with neighbourhood energy management system (NEMS) that will collect the data for neighbourhood level management. On top of all we have ICT platform which offers standard interfaces for higher level solutions to access the data (facility management, enterprise resource planning and applications within OGEMA).

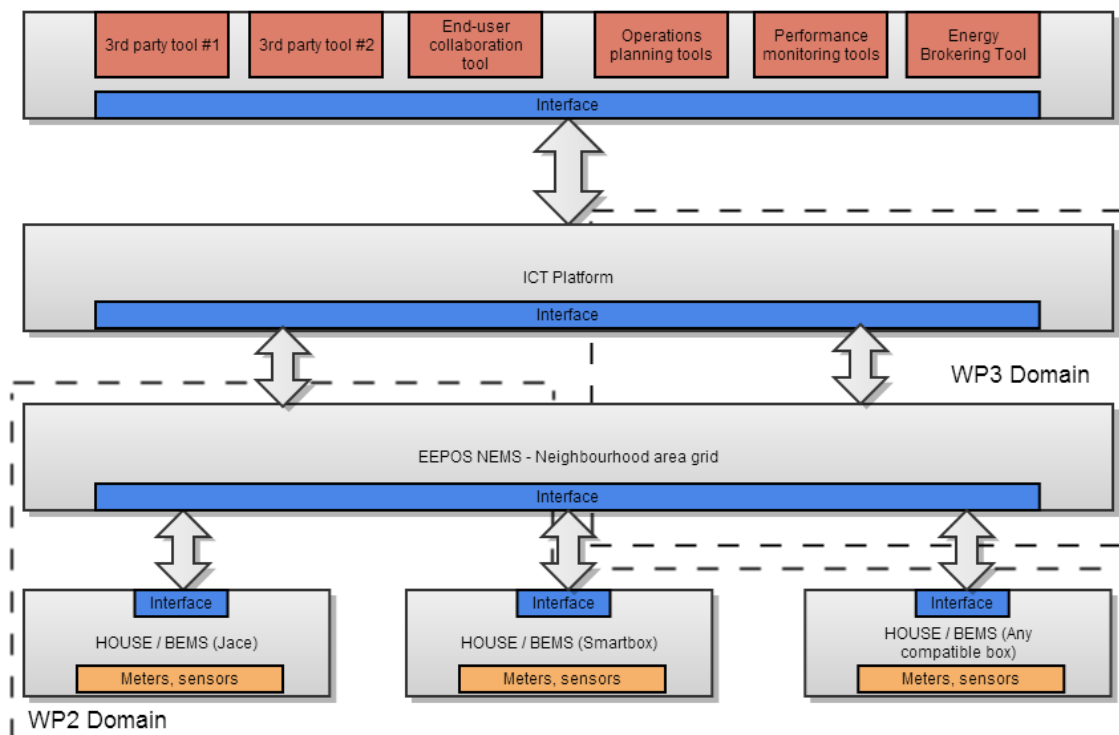


Figure 1. System diagram

D1.3 gives detailed overview of the starting point and it will be basis for all other tasks later.

2. INTRODUCTION

2.1 Purpose and target group

This document describes overall architecture of EEPOS project. It will combine requirements from all work packages into one document. Focus is to describe relations of different subsystems but not to go too much on detail. Detailed description is left for work package documentation. Purpose of the document is to describe the overall idea of the main subsystems, their functions, interfaces and services.

Target group for this document is the EEPOS consortium. It will be one of the most important documents that guide the work done in work packages later. Everyone has possibility to contribute their ideas and wishes they want to research and do later on the project.

2.2 Contributions of partners

Partners' contributions are shown in the table below.

Section / Chapter	Contributor
1, 2, 5.1, 7.1.3, 7.2, 7.2.2, 7.3, 8	FTM
3, 7.1.5	VTT
4.1, 6.3, 7.1.1, 7.2.1	DERlab
4.2, 5.3, 6.2, 7.1.2	ENO
4.3, 5.2, 6.1, 7.1.4	YIT
7.1.6	AIT

2.3 Relations to other activities

This report works as a baseline for all the other tasks especially for the tasks T2.1 and T3.1 defining the overall architecture of the EEPOS project. All the technologies used in the demonstrations will be described briefly in this document. Also some consideration is given to the subsystems and interfaces to be implemented later on this project.

Possible further development of the overall architecture will be made in co-operation between tasks *T2.1 Automation platform specification and implementation* and *T3.1 ICT platform specification and implementation*.

3. TECHNOLOGY AND STANDARDS BASELINE REVIEW

This chapter summarizes the current state-of-the-art of EEPOS related interoperability standards and technologies. The summary covers most used and most relevant building communication/control network protocols, smart consumption meters and related smart grid standards and building and neighbourhood related data models. Examples of main standards and technologies in their domain context are shown in Figure 2.

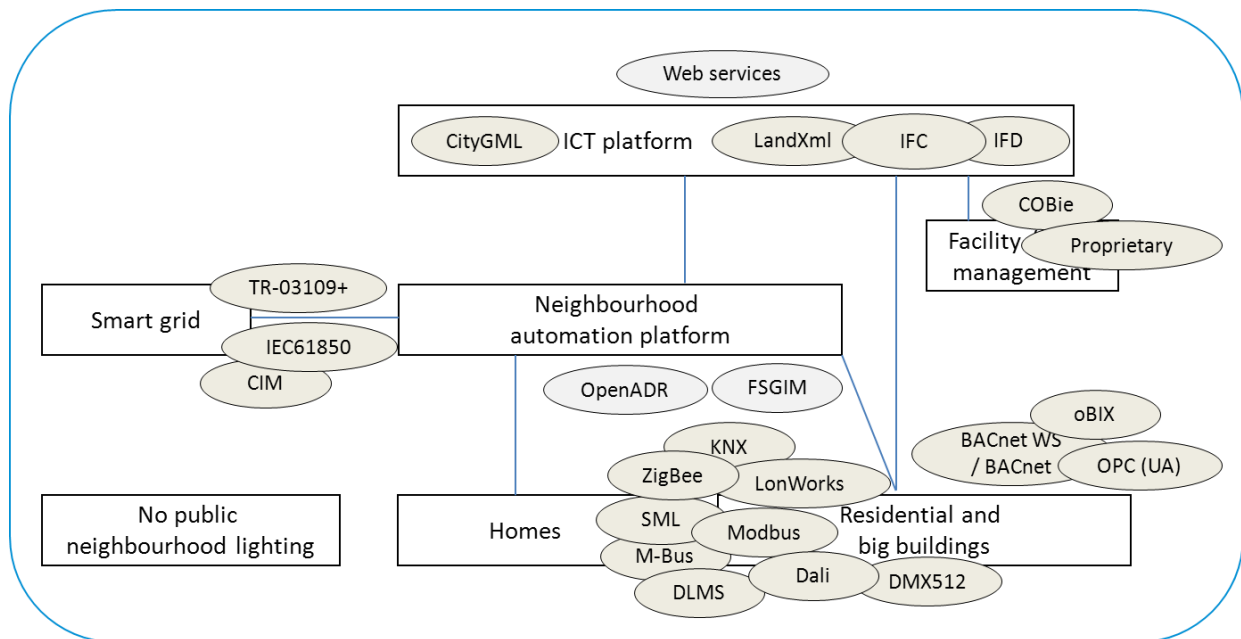


Figure 2. Examples of existing standards and technologies relating EEPOS scope

Most interesting standard and de-facto communication/control network protocols are described shortly in Table 1.

Table 1. Examples of standard and de-facto communication/control network protocols

Standard / technology	Description
BACnet: [1] CEN EN ISO 16484-5	BACnet is an ASHRAE, ANSI, and ISO standard communications protocol for building automation and control networks. It was designed to allow communication of building automation and control systems for heating, ventilating, and air-conditioning control, lighting control, access control, and fire detection systems and their associated equipment. BACnet support covers the Web Services interface enabling information exchange from BACnet networks between external ICT based systems.
LonWorks: [2][3] CEN EN 14908, ISO/IEC 14908-1, -2, -3 and -4	LonWorks (local operation network) is a platform built on a protocol created by Echelon Corporation for networking devices over various media (twisted pair, powerline carrier, fiber optics and wireless). It is an underlying control networking technology used for connecting products and solutions including lighting, HVAC, security and automation systems. LonWorks related interoperability standard is developed by a non-for-profit mutual-benefit trade association called LonMark International. One of the LonMark task group called “Utilities / Microgeneration / Energy / DR & DER” is focused to promote the use of interoperable products based on LonWorks technology in the utilities markets: electrical, heating gas, water, and others.

<p>KNX: [4] CENELEC EN 50090, CEN EN 13321-1, ISO/IEC 14543-3</p>	<p>KNX is a standard network communications protocol for intelligent buildings. It can be used in many home and building control applications like lighting, blinds & shutter control, security, energy management, HVAC, monitoring, alarming, water control, remote control, metering, household appliances and audio / video control. KNX supports several communication media like twisted pair, powerline, radio frequency and Ethernet. KNX systems can be mapped to BACnet objects (documented in the international standard ISO 16484-5) and can interface with the DALI technology. The KNX standard is administered by the KNX Association.</p>
<p>oBIX [5]</p>	<p>oBIX (Open Building Information Xchange) is a focused effort toward creating a standard XML and Web Services guideline to facilitate the exchange of information between intelligent buildings and enterprise application. Recent version of oBIX provides a publicly available web service interface specification and low level object model including typical building control system elements like Points, Alarming and Histories.</p>
<p>OPC and OPC UA [6]</p>	<p>Object Linking and Embedding (OLE) for Process Control, is a series of standards specification developed in 1996 by an industrial automation industry task force. The standard specifies the communication of real-time plant data between control devices from different manufacturers. OPC UA (Unified Architecture) is the next generation OPC standard specification that provides a cohesive, secure & reliable cross platform framework for access to real time & historical data & events including all levels of automation from the field level to the enterprise level. OPC servers are included in many building automation system as an integration solution to the other ICT systems.</p>
<p>OSGi [7]</p>	<p>The OSGi Service Platform specifications enable a Java based standardized service delivery and execution environment that enables any manufacturer, service provider or operator to develop and deploy a highly flexible service platform for any device and allows any developer to write application software for it.</p> <p>The OSGi specifications have been utilized in service gateways and in applications ranging from mobile phones to the open source Eclipse IDE. Application areas include automobiles, industrial automation, smart homes, building automation, e-health, PDAs, grid computing, entertainment, fleet management and application servers. Many open source projects are adopting the OSGi specifications.</p>
<p>DALI [8]</p>	<p>DALI (Digital Addressable Lighting Interface) is a protocol set out in the technical standard IEC 62386. DALI was developed by leading manufacturers and institutions in the field of digital lamp/luminaire control to provide easy to install digital lighting control solutions for rooms and smaller applications.</p>
<p>DMX512</p>	<p>DMX512 is a standard for digital communication networks that are commonly used to control stage lighting and effects. "Entertainment Technology—USITT DMX512-A—Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories", was approved by the American National Standards Institute (ANSI) in November 2004. It was revised again in 2008, and is the current standard known as "E1.11 - 2008, USITT DMX512-A", or just "DMX512-A".b Nowadays DMX512 is the most common way to control RGB Led lighting.</p>

Modbus [9]	Modbus is a de facto standard serial communications protocol published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). It is simple and robust openly published and royalty-free protocol developed for industrial applications so building automation related aspects has not been in the main focus of the developer. It is now the most commonly available means of connecting industrial electronic devices. Modbus is also much used protocol in electric, gas and water meters.
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Most interesting standard and de-facto protocols used in smart consumption meters are described shortly in Table 2.

Table 2. Examples of standard and de-facto protocols used in smart consumption meters

Standard / technology	Description
<i>HomePlug GreenPhy</i> [10]	A specification and certification profile of IEEE 1901, that allows products to use the already installed home wiring system to connect to each other and in turn to connect to the Internet. HomePlug GreenPhy is specifically designed for the requirements of the smart grid market. It has peak rates of 10 Mbps and is designed to go into smart meters and smaller appliances such as HVAC/thermostats, home appliances and plug-in electric hybrid vehicles, so that data can be shared over a Home Area Network (HAN) and back to the utility. For these applications, there's not a great need for high capacity broadband; the most important requirements are for lower power, robust, reliable coverage throughout the home, smaller size and less costly Bill of Materials.
M-Bus [11]	M-Bus (Meter-Bus) is a European standard (EN 13757-2 physical and link layer, EN 13757-3 application layer) for the remote reading of gas or electricity meters. M-Bus is also usable for other types of consumption meters. The M-Bus interface is made for communication on two wire, making it very cost effective. A radio variant of M-Bus (Wireless M-Bus) is also specified in EN 13757-4. [12]
ZigBee [13]	<p>ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed ad-hoc, with no centralized control or high-power transmitter/receiver able to reach all of the devices. Any ZigBee device can be tasked with running the network.[14]</p> <p>ZigBee is targeted at applications that require a low data rate, long battery life, and secure networking. ZigBee has a defined rate of 250 kbit/s, best suited for periodic or intermittent data or a single signal transmission from a sensor or input device. [14]</p> <p>The interoperability to other media such as low-power 802.11 and Powerline Communication (PLC), IP networking is being integrated, placing ZigBee over the IP stack for resource-constrained networks currently standardised at the IETF.</p> <p>From EEPOS point of view the most interesting ZigBee standards are ZigBee Building Automation™ (completed in 2011), ZigBee Remote Control™ (completed in 2010), ZigBee Smart Energy™ (available for review), ZigBee Home Automation™ (enhanced in 2009), ZigBee Input Device™ (completed in 2010), ZigBee Telecom Services™ (completed in 2009) and ZigBee Internet Gateway (introduced in 2011).</p>

	Applications include, electrical meters with in-home-displays, wireless light switches, traffic management systems and other consumer and industrial equipment that requires short-range wireless transfer of data at relatively low rates.
DLMS/COSEM [15]	DLMS (Device Language Message Specification, originally Distribution Line Message Specification) is the suite of meter data exchange standards developed and maintained by the DLMS User Association and has been co-opted by the IEC TC13 WG14 into the IEC 62056 series of standards. COSEM (Companion Specification for Energy Metering) defines the data model for utility meters. To be precise it includes a set of specifications that defines the Transport and Application Layers of the DLMS protocol. The COSEM object model, internationally standardised as IEC 62056-61 and 6-62 as well as EN 13757-1, and widely accepted today by the global market, has been developed to model a wide range of utility metering applications, for all energy types and for all application segments from high-end metering to residential mass applications. [15]

Some of the most interesting standard and de-facto data models and data dictionaries are described shortly in Table 3.

Table 3. Examples of EEPOS related existing and coming data models and data dictionaries.

Standard / technology	Description
IFC [16] ISO/PAS 16739	The purpose of IFC (Industry Foundation Classes) is to describe Building Information Model (BIM) supporting the sharing and exchanging the information over large building projects involving hundreds of participants, thousands of decisions, a huge volume of data, and evolving through different time-phases starting with an idea about a building, followed by feasibility, design, construction, and operations and maintenance phases. IFC have been endorsed by the International Standards Organisation as a Publicly Available Specification (PAS) under the ISO label ISO/PAS 16739. The IFC specification is developed by a non-for-profit organization buildingSMART.
IFD [16]	IFD, the International Framework for Dictionaries, is a standard for terminology libraries or ontologies. The concept for the IFD Library is derived from internationally-accepted open standards that have been developed by ISO (most importantly ISO 12006-3:2007). IFD Library is one of the core components of the buildingSMART technology, the others being IFC and IDM/MVD. IFD Library provides flexibility for an IFC-based BIM allowing for the link between the model and various databases with project and product specific data. IFD Library has been developed mainly in Norway and Neatherlands.
COBie [17]	COBie (Construction Operations Building Information Exchange) is an information exchange specification for the life-cycle capture and delivery of information needed by facility managers. COBie can be viewed in design, construction, and maintenance software as well as in simple spreadsheets. This versatility allows COBie to be used all projects regardless of size and technological sophistication. [18] In Dec 2009 the COBie team released the international COBie and the Facility Management Handover Model View Definition formats. The FM Handover MVD is only the second official MVD published through the buildingSMART international. COBie is now mandated for public building projects in the United Kingdom. [18]
CityGML [19]	CityGML is a common information model and XML-based encoding for

	<p>the representation, storage, and exchange of virtual 3D city and landscape models. CityGML provides a standard model and mechanism for describing 3D objects with respect to their geometry, topology, semantics and appearance, and defines five different levels of detail. Included are also generalization hierarchies between thematic classes, aggregations, relations between objects, and spatial properties. CityGML supports modelling not only individual buildings but also whole sites, districts, cities, regions, and countries. [19]</p> <p>CityGML allows users to share virtual 3D city and landscape models for sophisticated analysis and display tasks in application domains such as environmental simulations, energy demand estimations, city lifecycle management, urban facility management, real estate appraisal, disaster management, pedestrian navigation, robotics, urban data mining, and location based marketing. CityGML plays an important role in bridging Urban Information Models with BIMs to improve interoperability among information systems used in the design, construction, ownership and operation of buildings and capital projects. [19]</p> <p>CityGML is realised as an open data model is implemented as an application schema for the Geography Markup Language 3 (GML3), the extendible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211. CityGML can be used with the whole family of GML compatible OGC web services for data accessing, processing, and cataloging like the Web Feature Service, Web Processing Service, and the Catalog Service. CityGML is an open standard that can be used free of charge. [19]</p>
LandXML	<p>LandXML is an industry standard which goals are open design and survey data exchange and to specify a XML file format for civil engineering design and survey measurement data for the purposes of transferring engineering design data between producers and consumers, providing a data format suitable for long-term data archival and providing a standard format for electronic design submission. LandXML definitions includes civil engineering data, infra structures and networks. BuildingSMART has some actions to include modified LandXML as a part of the IFC specifications.</p>
FSGIM	<p>In US the National Electrical Manufacturers Association (NEMA) and ASHRAE have joined forces to develop an industry standard called Facility Smart Grid Information Model (FSGIM) [20]. The standard, being developed by ASHRAE Standard Project Committee 201P (SPC 201P) is in Advisory Public Review (July 2012).</p> <p>FSGIM model provides the basis for common information exchange between control systems and end use devices found in single - and multi-family homes, commercial and institutional buildings, and industrial facilities that is independent of the communication protocol in use. It provides a common basis for electrical energy consumers to describe, manage, and communicate about electrical energy consumption and forecasts. [21]</p> <p>The model defines a comprehensive set of data objects and actions that support a wide range of energy management applications and electrical service provider interactions including:</p> <ul style="list-style-type: none"> • On-site generation management • Demand response • Electrical storage management • Peak demand management • Forward power usage estimation • Load shedding capability estimation

	<ul style="list-style-type: none"> • End load monitoring (sub-metering) • Power quality of service monitoring • Use of historical energy consumption data • Direct load control [21] <p>The ASHRAE BACnet standard is an example of a target protocol standard that will make use of the FSGIM [20].</p>
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The IEC TC57 reference architecture for smart grid information exchange is shown in Figure 3. The architecture includes IEC identified relevant standards (object models, services, and protocols) for the development and maintenance of the smart grid. The smart grid development is outside of the EEPOS scope but the reference architecture is presented because it has some interfaces to EEPOS architecture.

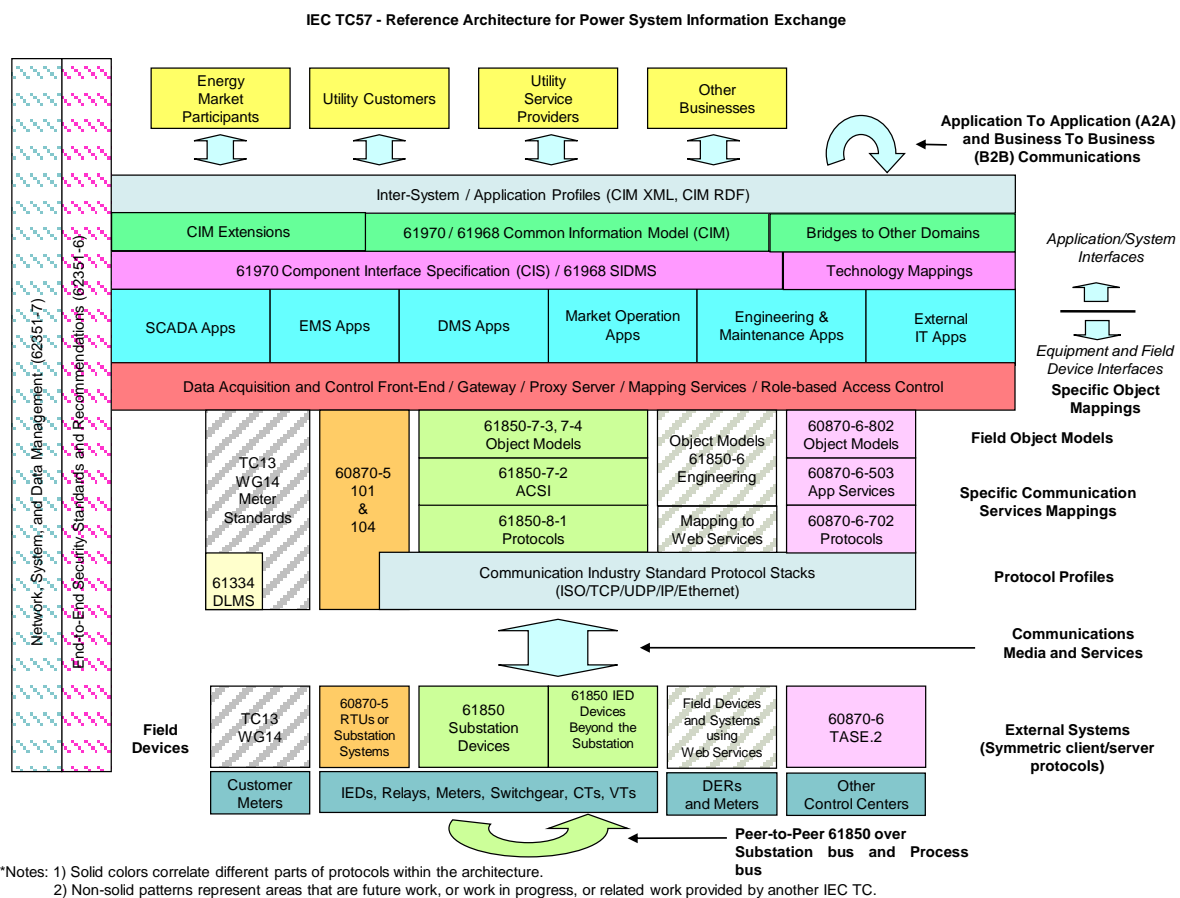


Figure 3. IEC TC57 reference architecture for smart grid information exchange [22]

Some other interested standard and de-Facto protocols developed for smart grid related buildings are described shortly in Table 4.

Table 4. Interested standard and de-Facto protocols for smart grid related buildings not included in the IEC TC57 reference architecture.

Standard / technology	Description
OpenADR [22]	Open Automated Demand Response (OpenADR) is a research and standards development effort for energy management led by North American research labs and companies. The typical use is to send information and signals to cause electrical power-using devices to be turned off during periods of high demand.

4. BUILDING AND NEIGHBOURHOOD ENERGY MANAGEMENT SYSTEMS BASELINE

4.1 OGEMA & Pool BEMI

OGEMA

OGEMA is open software platform for energy management provided by the Open Gateway Energy Management Alliance (OGEMA). The OGEMA Energy Management Gateway (EMG) acts as a firewall between the public and the private communication systems allowing only certain interactions between the systems as defined by the gateway configuration. The OGEMA EMG is characterized by a modular structure that consists of the following layers (cf. Figure 4):

- Services as for instance resource administration, device management or user / web interface
- Resources: standardized data models for connected devices, for control and supervision of devices inside the customers' premises as well as for smart grid information such as variable energy prices, metering data or control signals
- Applications as for instance least cost routing or emergency power reduction
- Communication drivers that enable the communication with field devices

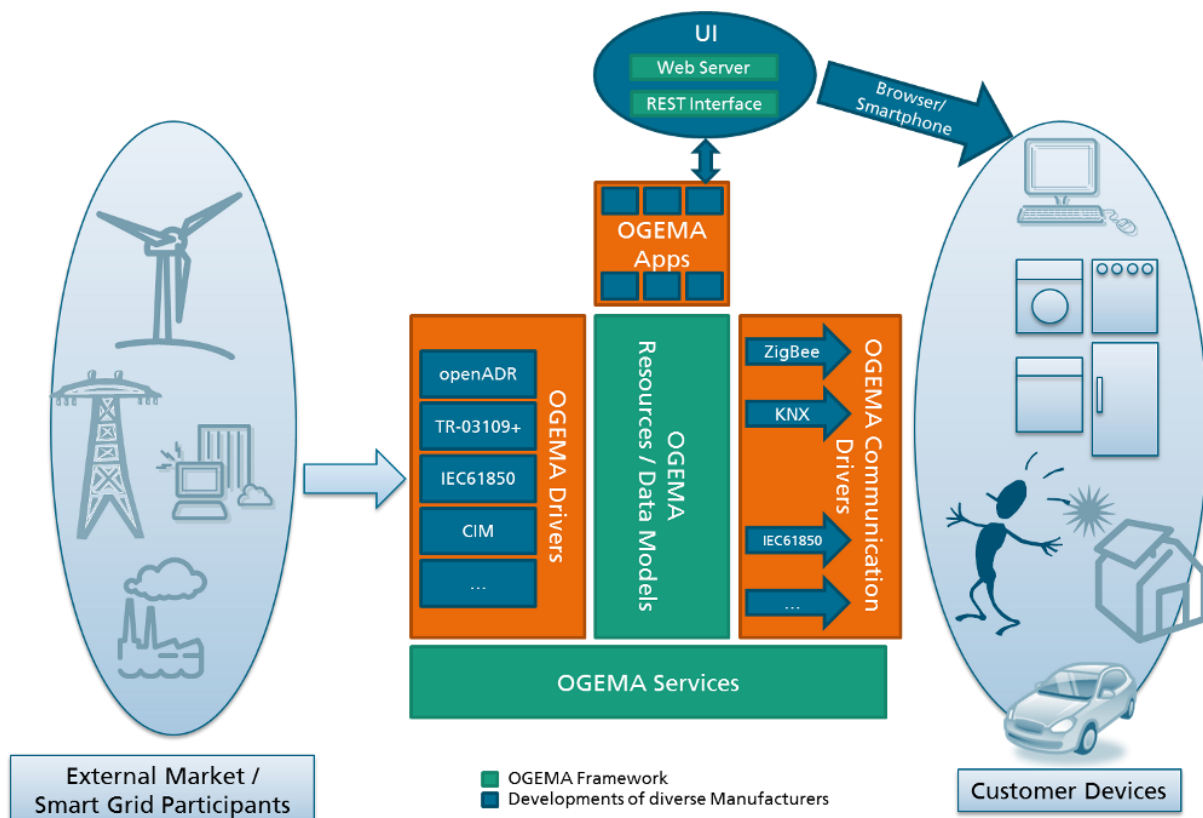


Figure 4. Overview of the OGEMA framework architecture

Both OGEMA applications and drivers connect to data models that are defined by the publicly available OGEMA specification [24]. These data models act as a hardware abstraction layer allowing both applications and drivers to be developed against this open interface definition. OGEMA uses Java and OSGi as widely accepted software standards that

provide a cross-platform execution environment. OSGi provides the functionality to execute different applications in parallel. In this way, software applications from various sources can be executed on an embedded computer, the “gateway”, running an OGEMA framework. OGEMA connects to home and building automation systems as well as to Wide Area Networks (WAN).

Thus, OGEMA is to a high extent independent of both specific manufacturers and hardware. In principle, any home automation communication system or protocol system can be connected to an OGEMA gateway by the installation of appropriate software drivers. Additional applications or hardware communication drivers can easily be added by operators, system designers, energy service companies or other third parties by providing appropriate Java classes.

OGEMA Interfaces

The entire Application Programming Interface (API) of the OGEMA framework including interfaces for software applications and communication drivers is made public on the OGEMA web site [1]. Additionally, sample source code for applications and communication drivers is provided as Open Source software.

In this way, additional applications or hardware communication drivers can be developed by any third party and as any type of open or closed source software. The license used by OGEMA allows to offer commercial applications and drivers without restrictions. However, for putting the OGEMA logo on a new product, certification is required.

OGEMA Services

The OGEMA framework provides clearly defined services needed to register/unregister device types. The interface definition for hardware/communication drivers allows for various levels of automated device detection and installation of new devices depending on communication system capabilities

The OGEMA device models use flexible components allowing for communication drivers and applications to be developed specifically for certain device elements that occur in various device types such as sensors, storage elements, switches etc.

The management agent brings together applications and available devices: Applications register the types of devices that they are able to connect to. As soon as a suitable device is available, the application is notified by the OGEMA framework and connected to the device. New device types can be installed by adding new data structures to the framework, which can be read and written by the standard framework API. No extension of the framework itself is necessary to add device types.

Furthermore, services for Plug & Play-functionality, application runtime control, logging and getting information on registered components and methods for reading and writing device data are included into the OGEMA API.

Pool BEMI

According to Ringelstein [25], the concept of the pool Bidirectional Energy Management Interface (BEMI) envisages the following aspects: A pool BEMI is a technical facility, which bundles the functionalities and properties of several BEMIs into a single energy management system on an upper level. In the EEPOS system, the automation and management platform (T2.1) will represent the pool BEMI while the energy management systems on the household level (Smartbox, JACE or OGEMA) will represent the BEMIS.

Individual BEMIs, which are connected to the pool BEMI, can send offers as well as information on free resources (e.g. present energy production or peak load shifting potentials)

to the pool BEMI and thus play an active role. On the basis of this collection local information combined with further central information (e.g. on energy markets), the pool BEMI decides on the activation (e.g. by the use of tariff signals) of the resources offered by individual BEMIS.

Furthermore, the pool BEMI provides metering and system services to the distribution system operator (DSO). Accordingly, the pool BEMI represents a technical gateway between the DSO and the BEMI system. In this way, it supports and enables the technical integration of distributed energy resources (DER) into the mains operation. The pool BEMI can also be used to aggregate measurement data from the BEMIs or to carry out forecasts of customer reactions. Communicating with the pool BEMI, the BEMIs take over the control of the customers' energy consumption or production devices and provide information on the energy tariffs to the prosumers.

The concept of the pool BEMI does not allow for the direct participation of the consumer in energy trading. In addition, the local decision of the BEMI on the operation of DER is retained, the direct control of DER by the pool-BEMI is reserved for emergency cases.

4.2 Smartbox

General structure of the EM solution:

The ennovatisSmartbox is the “heart” of the energy management solution in the German EEPOS demonstrator buildings and will be one important part of the whole EEPOS system. It collects all data of all connected measurement devices as well as from the sub metering system. Additionally temperature sensors (inside and outside) as well as humidity sensors are connected to the Smartbox. The stored data will be transmitted via TCP/IP cable internet connection to the energy data management server (EDM server) which is located at the Ennovatis head office in Großpösna, Germany. The software ”ennovatis Controlling” will be used for data management, assessment and further processing. All the data which is stored in the Controlling system can be accessed also by other systems. Figure 5 shows the concept of the communication structure.

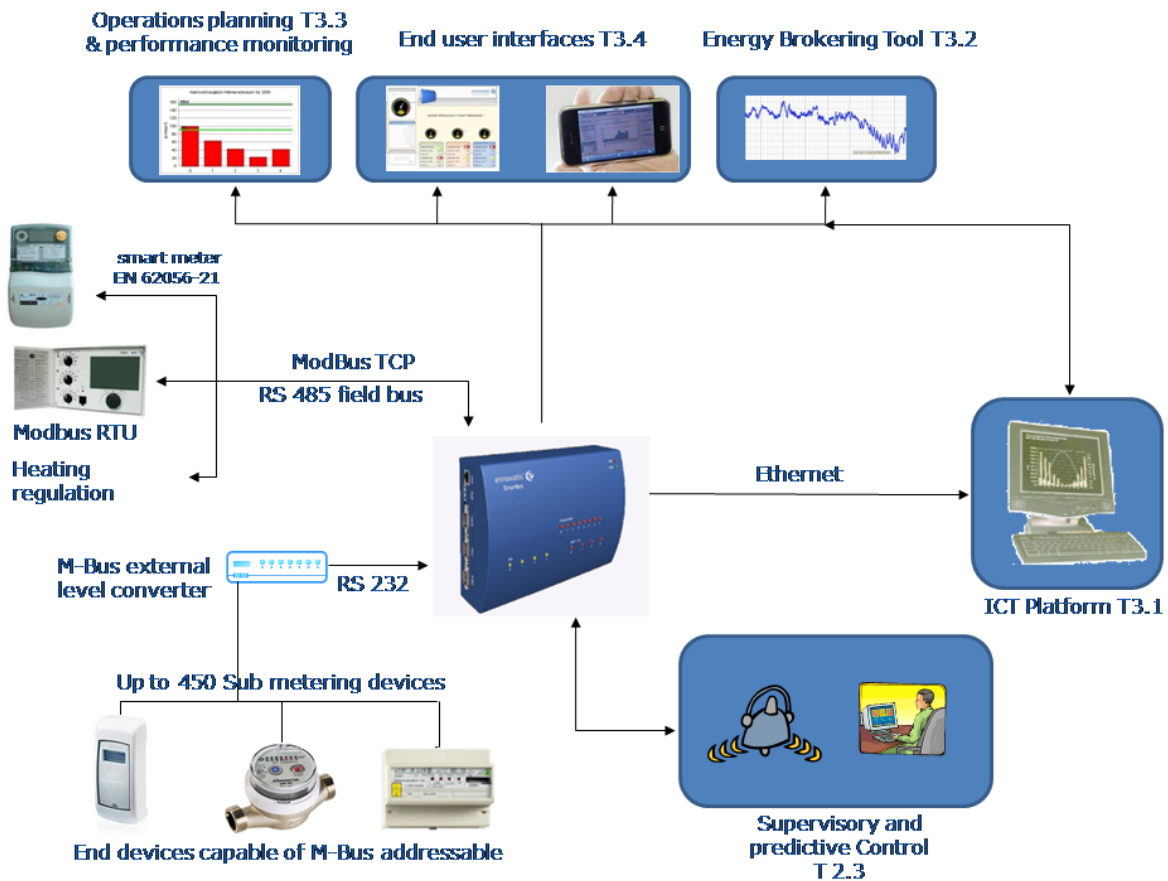


Figure 5. planned EEPOS demonstration Setup with ennovatisSmartbox

Communication protocols:

Main meters (water, heat) to Smartbox: M-Bus

Main electricity meters to Smartbox: M-Bus or EN 62056-21 (smart meters)

Sub metering meters to gateway: radio 868 MHz

Sub metering system to Smartbox: M-Bus

Radio temperature and humidity sensors to gateway: 868 MHz

Gateway (for temperatures) to Smartbox: Modbus-RTU

Heating regulation units to Smartbox: Modbus-RTU

Smartbox to EDM server: TCP/IP

4.3 YIT Niagara

General description:

YIT NIAGARA is Tridium Niagara Framework environment utilizing web-based service software, which is designed for building automation and energy management needs.

Separate HVAC systems, acquired from property based **YIT NIAGARA** software, can be integrated into a single web-browser manageable entity. Regardless of manufacturer-specific, closed systems, the **YIT NIAGARA** opens the possibility for real-time monitoring of building technical systems via standard Internet browser. Management and supervision of building technical systems is possible to divide among different specialist-organisations independently from the hardware location or integration level. Systems are managed by the

same user interface using a standard LAN connected PC workstation without the need for user licenses.

YIT NIAGARA is software scalable according to the service needs of customer. It can be utilised in large-scale commercial and office-buildings that have demanding processes requirements as well as in modest residential buildings, which can be formed into integral regional control systems.

YIT NIAGARA is vendor independent on field bus level. Substation, control and field equipment is not restricted by one specific manufacturer or supplier. Best suited high quality equipment can be chosen according to the needs of specific site.

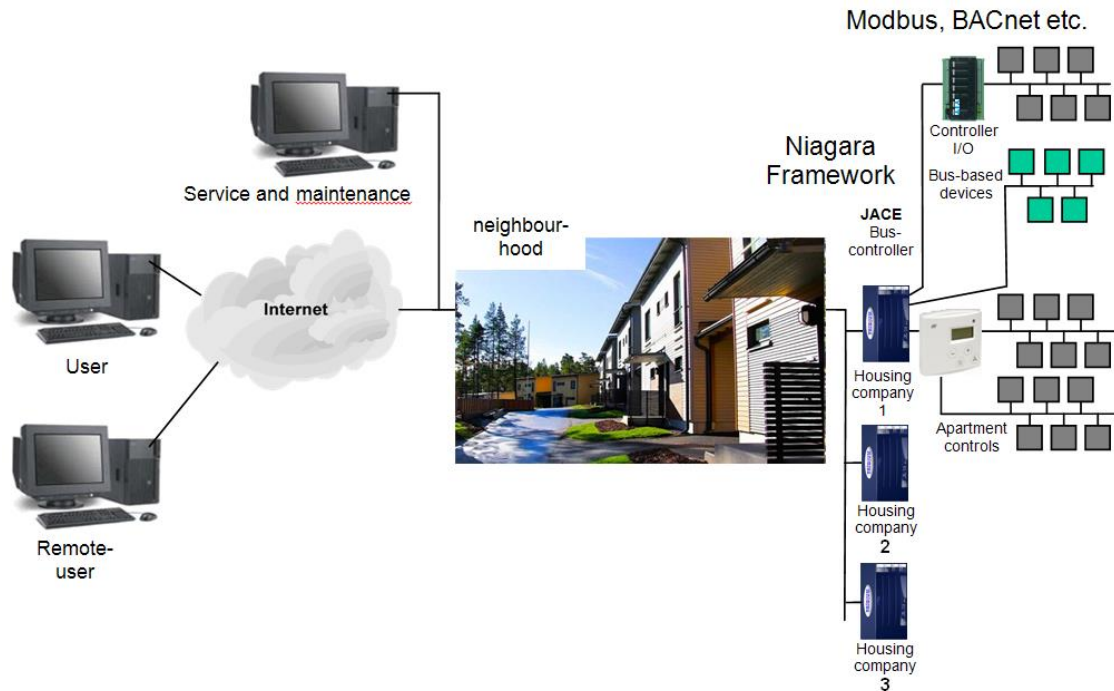


Figure 6. **YIT NIAGARA** building automation system's principal structure

Communication protocols:

Main meters (water, heat) to JACE: M-Bus

Main electricity meters to JACE: Modbus-RTU (or M-Bus)

Sub metering system to JACE: M-Bus

Radio temperature and humidity sensors to gateway: 868,30 MHz

Gateway (for sensors) to JACE: Modbus-RTU

Heating regulation units to JACE: Modbus-RTU

Operation panel for ventilation unit to JACE: Modbus-RTU

JACE to BEMS server: TCP/IP

BEMS server to NEMS server: TCP/IP

JACE to operation services: TCP/IP

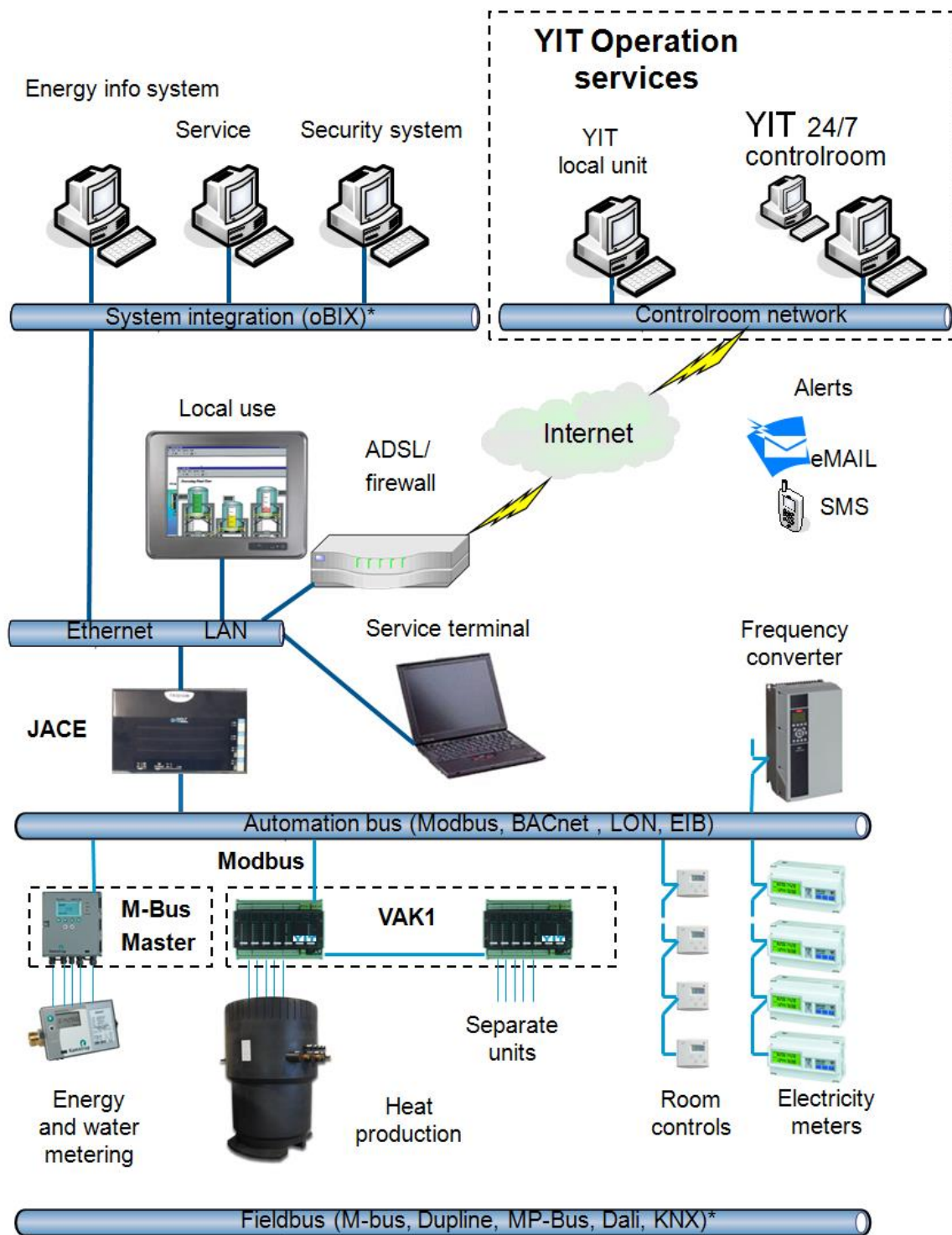


Figure 7. User levels of YIT NIAGARA building automation system

5. ICT BASELINE

This section describes existing ICT solutions and software that is going to be used in the project.

5.1 Facility Management systems

OrigoXRP – system assembles all information regarding the properties in one place. All the data is accessible in digital form and it can be smoothly integrated with the other systems.

Software is designed for property management, workplace management, facility and maintenance management, safety management and environmental management.



Figure 8. OrigoXRP solution from Fatman Oy

Main functionalities and features are:

- Facility Management
 - Energy audits
 - Maintenance system
 - Condition assessments
 - Environmental audits
 - Other services
- Real Estate ERP
 - Property management
 - Workplace management system
 - Building management and maintenance systems
 - Safety management
 - Environmental management
- System Integration
 - Programming
 - Data mining
 - Analysis
 - Monitoring
 - Building information modelling

System is usually as a service using SaaS service model. It is a total solution for property management and usually customers want some customizing regarding interfaces and user interfaces which is possible.

System diagram - Interfaces

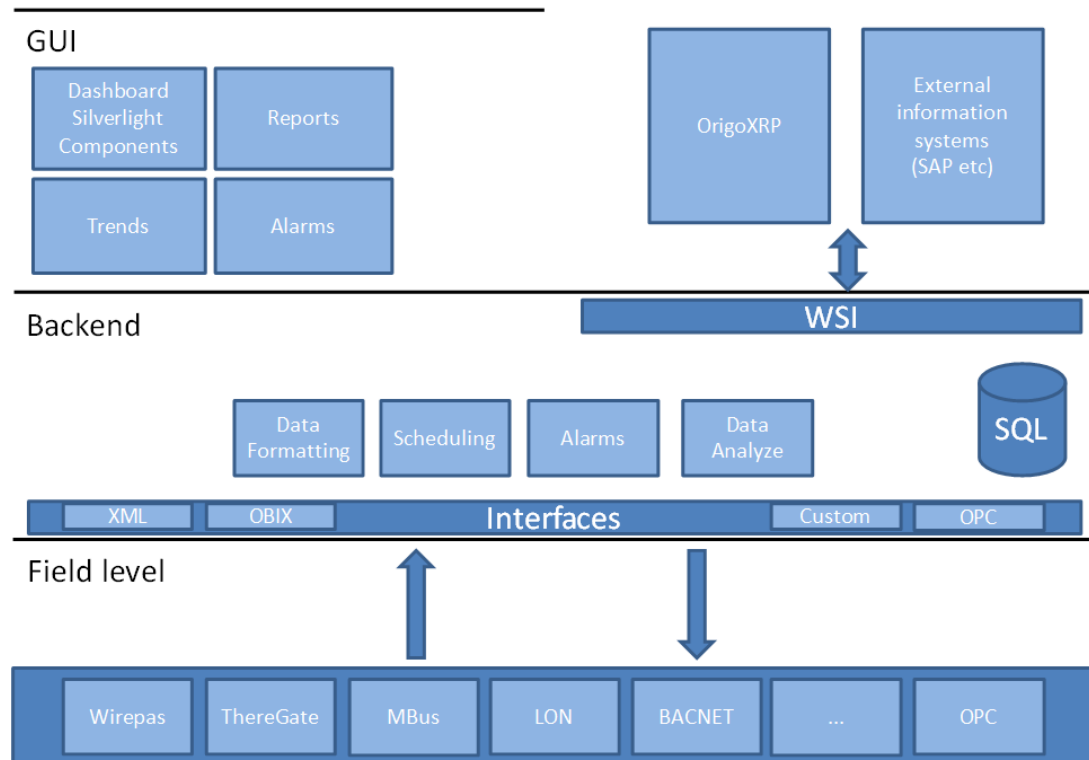


Figure 9. OrigoXRP integration diagram

5.2 Continuous Commissioning and Demand Based Maintenance

YIT Control Room Operation Services are offered to customers that own and operate in complex building environments. Traditionally this service has focused on commercial and industrial customers and is a part of YIT's ServiFlex Service concept. The purpose of the service is to reduce the maintenance costs of customers' properties and assure the optimum operations at all time. This is done by monitoring the building technical systems operations and reacting (if necessary) to alerts that the systems presents.

General operations

When YIT Control Room receives an alert from the property through the building's automation system an operator will define the alert according to the characteristic and agreement. Depending on the severity, if the issue behind the alert cannot be solved via remote control a dispatch squad or a duty officer will be sent to location to resolve the issue.

YIT Control Room is able to adjust all parameters of building technical system that are connected to Niagara based automation system. Duty officer will be dispatched only in the case of equipment malfunctions. Each alert will be reported to the customer as well as the results of the actions.

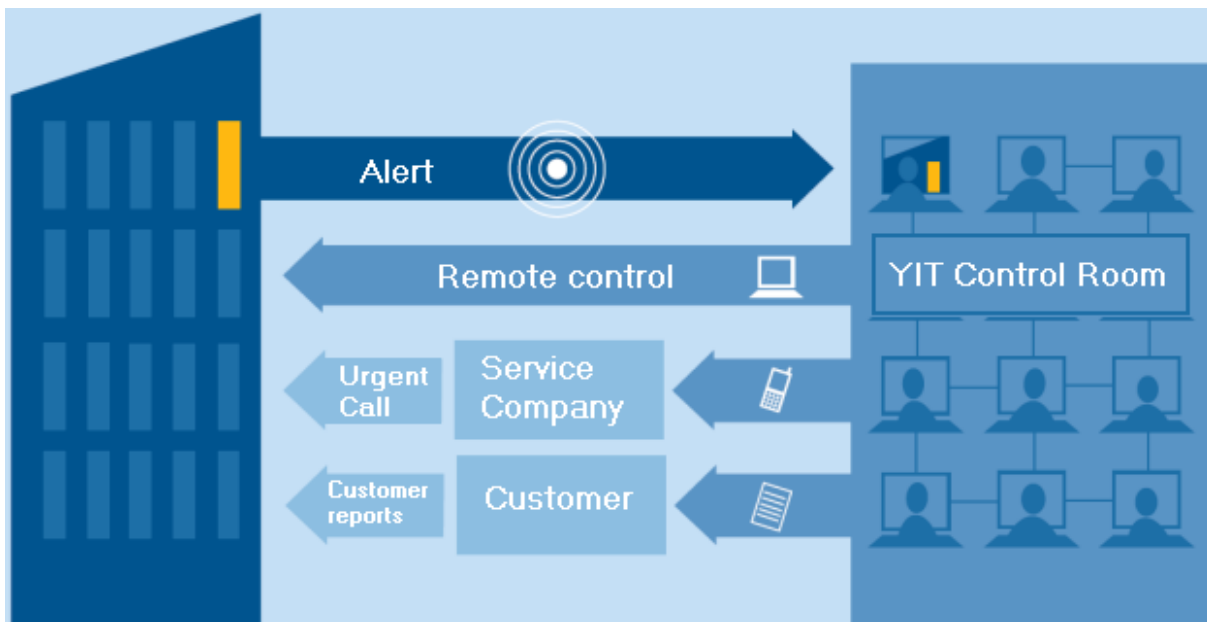


Figure 10. YIT Control Room process

There is an established routine for scheduled building technical system check. This is conducted two or four times a year, depending on the complexity of the property and customer demands. Routine check enables to detect improper process adjustments, malfunctioning actuators or over consuming processes. All work and adjustments are documented and forwarded to the serviceman responsible for the property.

Within the context of EEPOS, these processes are meant to be automated as much as possible to increase the efficiency of the maintenance processes and reduce the operating costs of the services offered as well as properties maintained.

5.3 Energy management & monitoring

The ennovatis energy management system for buildings is mostly limited of simple data storage from meters and other sensors (e.g. heat, gas, water, or power consumption). The data will be saved on a data logger, treated and then transferred via GSM, GPRS-data connection or internet on a data server. Figure 11 explains the used technology in the described case.

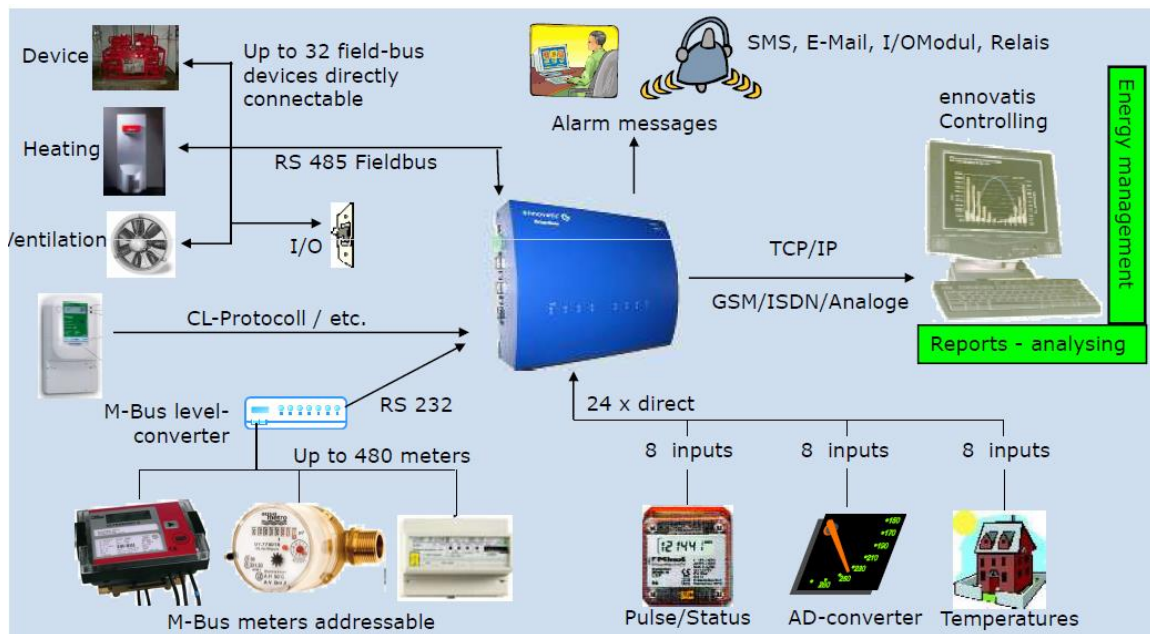


Figure 11. Interfaces of the ennovatis Smartbox

The stored data can be used on one hand for billing purposes. Because of the high definition of the data (15-minutes) they can use also for more detailed examinations. For this reason the measured data will be treated with a special Energy-Controlling-Software and could evaluate in diagrams. In October 2012 the ennovatis energy management system “Controlling” received a certificate of the TÜV-Süddeutschland AG which proves the compliance with the requirements of the DIN EN ISO 50001 in terms of control, measurement and analysis of all relevant energy management data. With the appropriate expertise like for example an engineer at the area of supply and building technology has, it is possible to use the measured data from meters and sensors to relate to the functionality of a facility. Hence, improvements can be suggested for the operating characteristic. Such energy reports are compiled with a summary of service measures recommended to the customer, which can be implemented at the concerned facility. After realization of these measures it is helpful to do a continuous energy monitoring of the attained energy savings and maintain the efficient system operation. The described procedure is based on the Plan-Do-Check-Act as described in the DIN EN ISO 50001:2011 and serves the implementation from energy management systems in companies. Since the implementation of the bus-technology in the electrical engineering the possibilities of the measurement and control technology improved a lot in non-residential buildings. The introduction of wireless technologies offers now these possibilities also for older already existing buildings, which certainly reduced many obstacles for the introduction of energy management systems.

An intelligent management of household appliances is being realized today mainly only in research projects and laboratory examinations, because affordable solutions are not yet

available. Additionally, too few devices are currently equipped with the necessary interfaces, which could be used by different energy management systems. Because of the big amount of operation systems and protocols, which could be used for an expansion of the interfaces, it needs to be expected how the producers will focus on specified solutions in the future. Nowadays, also in the industry sector the efficient operation of systems is not standard. The focus is mainly on functionality and the energy costs are mostly just accepted. With the increase of costs for energy consumption the flexible and intelligent management will certainly improve.

For an automatical energetic improvement of a central heating system of a building the ennovatis Smartbox provides a PID-regulation module, which can replace an existing heating regulation system. If all necessary data sources (e.g. flow and return temperature sensors, room temperature sensors, connection to pumps and valves etc.) are connected to the Smartbox, the regulation of the heating system can be managed with remote access.

6. APPLICATION DOMAINS

6.1 Demonstration in Finland

The following is a description of principal structure of Nupurinkartano's Building Automation System and Neighbourhood Energy Management System.

6.1.1 System diagram

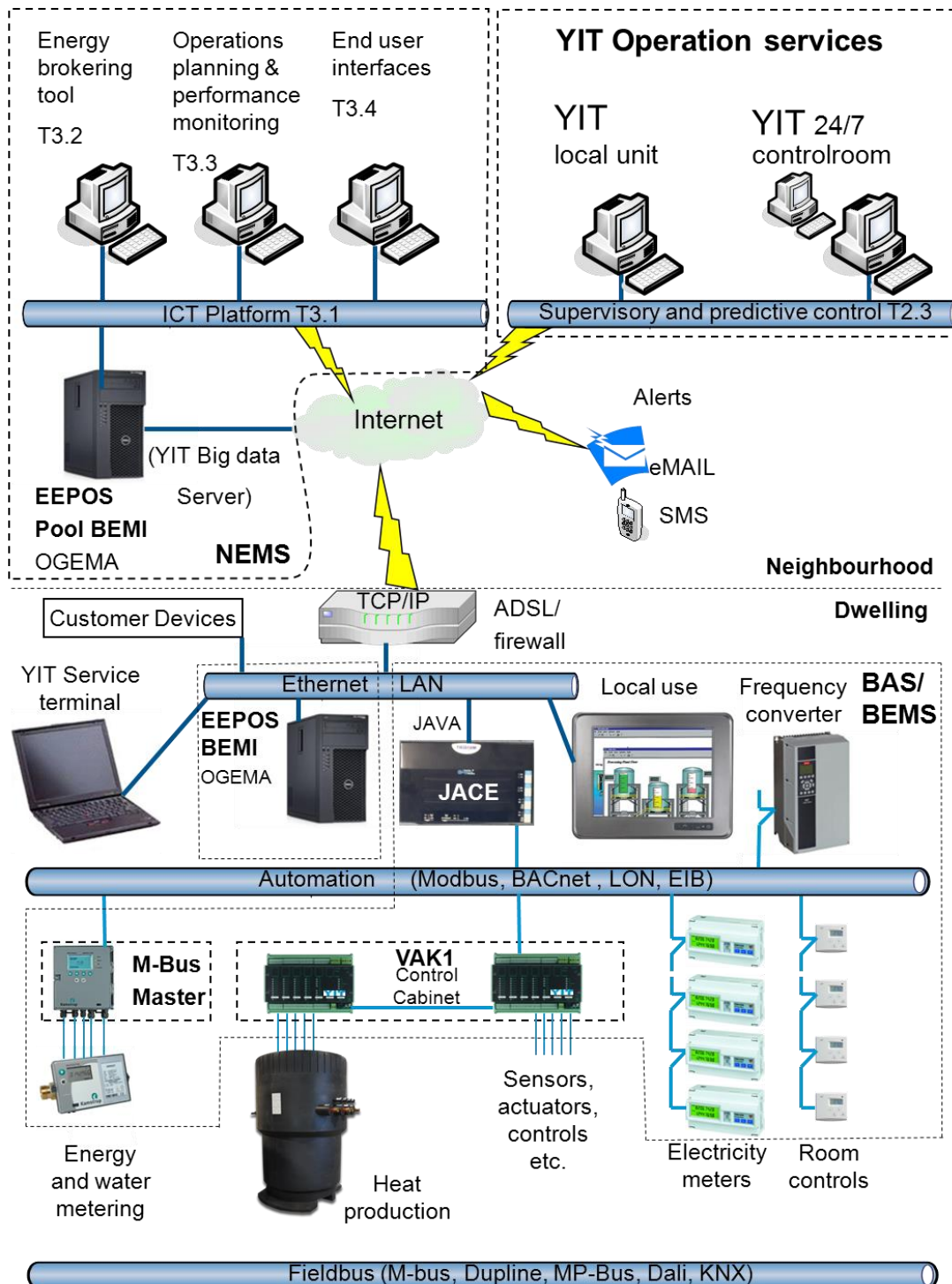


Figure 12. Finnish demonstration system diagram

6.1.2 Used technologies

The energy management system is designed to measure consumption data and temperatures as well as humidity and status signals in the pilot buildings. Therefore the measured data of sensors and meters can be transferred to OGEMA based server for further processing.

At least the following measurements shall be carried out:

Dwellings/buildings:

- x room temperatures per dwelling °C (15 min reading interval) [x depending on the number of rooms in dwelling]
- Relative humidity in the sleeping room or bathroom or exhaust air in %r.H. (15 min reading interval)
- Electrical consumption in kWh (15 min reading interval)
- Maximum power load in kW (15 min reading interval)
- Hot water in m³ (daily reading interval)
- Cold water in m³ (daily reading interval)
- Heat units with electrical heat cost allocators (daily reading interval)
- Calculated heat consumption (approx.) on the basis of measured heat consumption and heat units of every EHCA in kWh (2-3 days interval)

Centralized heat plant

- Heat production kWh (15 min reading interval)
- Electrical consumption in kWh (15 min reading interval)
- System Temperatures in °C (15 min reading interval)

System structure

Control room functions

Control room functions, that serve the housing company needs, are operating from touchscreen integrated to BAS substation or remotely via internet. BAS substation is placed in the technical facility. Bus-controller and firewall/switch is placed in the BAS substation casing.

Ethernet LAN

The bus controller and touch screen (= computer) controller is connected to the substation switch. Switch is connected to the service and maintenance plug of technical facility. Maintenance plug is connected to buildings main switch, which is in turn connected to operators LAN-modem.

Modbus, BACnet, MBus-bus, etc.

The controllers and I/O-units, that are located in the technical facility substation, are connected to bus controller via Modbus-bus. All devices equipped with bus interface (such as energy and water meters) are connected to bus controller. Room controllers in the separate apartments are connected to bus controller via Modbus or similar.

System components of Nupurinkartano BAS

The control room

User terminal is a computer equipped with a touch panel.

Ethernet LAN, bus-controller:

Tridium JACE (Java Application Control Engine)

A variety of network protocols used on-site are integrated into one web-browser manageable entity with bus-controller. In Nupurinkartano project the adequate solutions are Modbus and M-Bus. Other possible solutions are to integrate BACnet, LON, EIB or other.

Modbus

With substation controllers or I/O-controllers:

The control, adjustment and monitoring functions in the substation of technical room is realised with YIT UIO032 controllers or YIT MIO052 I/O-controllers. LuxCool-modules' temperature adjustments are realised with Produl HLS34 regulators.

Field devices:

Sensors and transmitters:	Produal	Produal Oy
Valves and actuators:	Belimo	Oy Suomen Belimo Ab
Damper actuators:	Belimo	Oy Suomen Belimo Ab
Duct thermometers:	Wika	Wika Finland Oy

The operation of the system

1. Field bus – connects sensors and actuators
2. Automation bus – connects room controllers and control-substations
3. Control room level – system integration

6.2 Demonstration in Germany

6.2.1 Used technologies

The energy management system is designed to measure consumption data and temperatures as well as humidity and status signals in the pilot buildings. Therefore sensors and meters with a possibility to connect to a data logging system have to be installed.

The following measurements shall be carried out:

Dwellings:

- 2 room temperatures per dwelling °C (15 min reading interval)
- Relative humidity in the sleeping room or bathroom in %r.H. (15 min reading interval)
- Electrical consumption in kWh (15 min reading interval)
- Maximum power load in kW (15 min reading interval)
- Hot water, if centralized DHW production in m³ (daily reading interval)
- Cold water in m³ (daily reading interval)
- Heat units with electrical heat cost allocators (daily reading interval)
- Calculated heat consumption (approx.) on the basis of measured heat consumption and heat units of every EHCA in kWh (2-3 days interval)

Central Heating unit/building:

- Heat consumption kWh (15 min reading interval)
- Electrical consumption in kWh (15 min reading interval)
- System Temperatures in °C (15 min reading interval)

Combined heat and power plant

- Heat consumption kWh (15 min reading interval)
- Electrical consumption in kWh (15 min reading interval)
- System Temperatures in °C (15 min reading interval)

○ Data logger

The ennovatisSmartbox collects all energy data of a building and transmits it for further processing.

It enables a completely new, high-efficient energy management of buildings. All data concerning energy consumption of buildings are collected fully automatic and round-the-clock and transmitted for further detailed processing. The EnnovatisSmartbox is supplied in a control cabinet which fulfills the IP 65 standard. A lockable control cabinet is available as an option, but not with IP 65 protection. The EnnovatisSmartbox consists of a single PCB system, a power pack, a circuit breaker and various attachable components. In addition to this, options (e.g. M-Bus) can be secured to the integrated mounting rails or inserted into available slots on the PCB (e.g. socket modules or memory expansions). The housing is furnished with Pg connectors at the bottom (1 ea. M25, 4 ea. M16).

Not suitable for explosive or corrosive atmospheres. Conductive contamination, loose small parts and moisture may not be allowed to penetrate the control cabinet.

○ Energy management software

The data-management system uses netCDF (optimized binary format) to save the collected time series and a relational database system (RDBMS) for the management of the meta data. The usage of this technologies allows a data access speed, which is at least 2 times faster than the storage inconventional RDBMS.

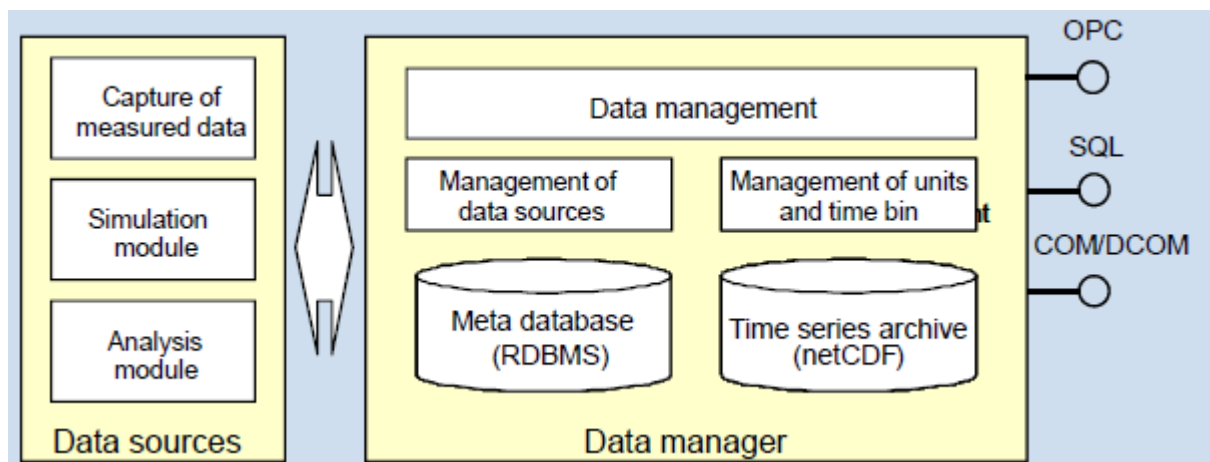


Figure 13. Functionality of ennovatis Controlling

6.3 Laboratory prototypes

6.3.1 System diagram

In T4.2, DERlab will set up and implement a laboratory test bed comprising the EEPOS neighbourhood automation and energy management system prototype as defined and developed in WP2, supporting new device profiles and data communication interfaces. The planned architecture of the EEPOS automation and energy management system is described in Section 7.2.1.

6.3.2 Used technologies

For testing the EEPOS neighbourhood automation and energy management system, DERlab will use the laboratory testing facilities of Fraunhofer IWES. The EEPOS system will be tested and validated according to the testing procedures and use cases developed and described in WP2. The tests will focus on the smart neighbourhood level applications for automation, operation, (predictive) control, brokering and monitoring developed in T2.3.

The tested use cases will be related to the development of energy positive technologies. Thus, the laboratory tests will also evaluate the energy efficiency gains and load/generation shifting potentials obtained by the neighbourhood level management. For this, in T4.2, a reference scenario (energy consumption/load profiles/generation profiles without management) will be defined for the situation represented by the laboratory environment. Furthermore, the performance criteria developed in T2. (e.g. energy efficiency, energy management/integration capabilities, usability, IT-system integration) will be evaluated in line with the field tests.

7. OVERALL ARCHITECTURE

7.1 Requirements

7.1.1 DERlab

For the successful development of the EEPOS neighbourhood automation and management system, following interfaces, data models and services and applications have to be developed or enhanced

Internal and external interfaces (T2.1)

- Interfaces to connect The building automation and energy management systems deployed in the field tests (Ennovatis Smartbox and YIT Niagara).
- Interfaces to the ICT platform (→ WP3) on both the building and the neighbourhood levels.
- Application and service interfaces between the heating and energy grids and the EEPOS system on both the building and neighbourhood levels.
- Interfaces to external and customer devices that are connected to the EEPOS gateway via standardized data models / device service models .
- Interfaces for data external from the OGEMA gateway relevant to various applications (such as the price of electricity) based on standardized data models.

Data models for neighbourhood energy grids and – if necessary – also in house communication (T2.2)

Standard services of the EEPOS framework for using data models and devices (T2.1)

- Extension of Resource Administration: Implement the support for automated registration/discovery of new devices based on standardized data models and device services (already existing or developed in T2.2).
- Logging and Evaluation of text log messages as well as of measurement data series.
- Persistent Storage: persistent storage of e.g. preferences, application data or structures that are commonly needed by applications in the field of energy management and efficiency.
- User Administration, data security: support of the definition of priorities and specific access rights and permissions for different applications according to agreements between different actors in the distribution grids.
- Web services for platform internal communication between the EEPOS pool-BEMI and the EEPOS BEMIs on the building level.

Applications (T2.3)

- Applications to access costumer devices, user displays, smart meters, measuring data, pricing data, renewable energy generation data and other smart grid information on both the neighbourhood and the building levels.
- Smart neighbourhood level applications for automation, operation, (predictive) control, brokering and monitoring that support new device profiles and data communication interfaces.

Furthermore, performance criteria regarding e.g. energy efficiency, energy management / integration capabilities, usability or IT-system integration, optimized during the further design process and evaluated in the laboratory test will have to be defined, optimized and evaluated.

7.1.2 Enovatis

The overall subject of the energy management solution in the EEPOS system is the monitoring, energy management and control of the existing energy consuming systems of the buildings.

The ICT system shall include mainly the following functions:

- Provide measurement data of heating, water and electric energy to the tenants and the energy manager of the building and for the input to an energy trading marketplace, brokering system etc. and to calculate energy savings with the measured data.
- Monitoring and observation of the energy consumption data and the regulation of temperatures and humidity in the dwellings.
- Automatic monitoring of specific parameters to send alarm messages in case of any malfunction of the controlled building automation systems.

The EEPOS solution shall be designed to provide the following data via web interface to the tenants:

- Consumption data of heat (in every room of the dwelling), water (hot and cold) and electric energy of every dwelling.
- Costs of the above stated types of consumptions.
- CO₂ emissions for electric energy and heating energy consumption.
- Energy cost information (tariff prices).
- Room temperatures of specific (measured) rooms in the dwellings.
- Relative humidity.
- Outside temperature.
- Energy savings tips.
- Attractive apps to keep and rise awareness of the end user.
- Messenger functions.

The energy management solution is designed to provide the following data via web interface for the energy manager of the ESCO:

- Consumption data of heat, water (hot and cold) and electric energy of every dwelling and the building.
- System temperatures (flow, return, hot water etc.) of the central heating system.
- Error messages from the regulation system of the central heating.
- Costs of the above stated types of consumptions.
- CO₂ emissions for electric energy and heating energy consumption.
- Room temperatures of specific (measured) rooms in the dwellings.
- Relative humidity and outside temperature.

7.1.3 Fatman

ICT platform will be in key role for all tasks in Work Package 3. Platform will provide interfaces for IT systems and for the automation platform (WP2).

Biztalk server will be key part of the ICT platform providing many integration possibilities for upper level software (ERP, FM software and IT systems).

It is important to recognise interfaces what we already have in different solutions partners are using and use them if possible. Also some guidelines for data models and information should be considered. Of course detailed specification and implementation is done on future tasks.

7.1.4 YIT

Communication protocols:

- JACE to BEMS server: TCP/IP (cable internet)
- BEMS server to NEMS server: TCP/IP (cable internet)
- JACE to operation services: TCP/IP (cable internet)

Basically NIAGARA JACE controller is built to operate on JAVA application language and is compatible with oBIX standard. More detailed connectivity issues will be explained in respected tasks T2.1, T2.3, T3.3 and T3.4.

7.1.5 VTT

The EEPOS platform needs be designed to provide the following NEMS, BEMS, BAS and SG related real-time (and historical) data via web interface (WS) to the EEPOS energy performance monitoring and planning tools (T3.3) and/or to the EEPOS end user collaboration tool (T3.4):

Building level (including apartment level):

- Heat and electric transient powers as detailed as possible.
- Load shifting related information including costs.
- Heat, electric and water (hot, cold) consumption (as detailed as possible) and related cost information (tariff prices).
- Renewable energy generation and storage (energy and transient power if possible).
- Temperatures and volume flows of RES and HVAC systems (air handling units, central heating system, etc.) if possible.
- BAS related other measurements (outside and inside temperatures, relative humidity, CO₂, etc.) as detailed as possible.
- BAS and BEMS related events and alarms.

Neighbourhood level:

- Neighbourhood level heat and electric transient powers, energy consumptions and related CO₂ emissions and energy cost information (tariff prices).
- Load shifting related information including costs.
- Neighbourhood level renewable energy generation and storage (energy and transient power) and related energy cost and CO₂ emissions information.
- Purchased and sold energy (from/to urban energy network) and related transient power, energy cost information (tariff prices) and if available CO₂ emissions.
- Temperatures and volume flows of neighbourhood level energy systems.
- NEMS related other measurements as detailed as possible.
- NEMS related events and alarms.
- Energy grid capacity and tariffs.
- Energy power quality related data.

Requirements for EEPOS platform services:

- Information (measurement point etc.) related ID based services.
- Location related services: GPS coordinates QR code or some other location related access to EEPOS services.
- End user role related access to EEPOS data / services.

Access/integration requirements to third-party platforms:

EEPOS clients should be able to use the following complementary platform components, if they are not directly supported by the core EEPOS platform.

- Standard based BAS and BEMS systems if not supported by EEPOS.
- Proprietary WS based BAS, BEMS and FM systems if not supported by EEPOS.
- Partner specific external databases.
- External weather and weather forecasts services.

Other optional requirements:

- Some level support of IFC and LandXML/CityGML data models.

7.1.6 AIT

To be able to fully integrate the controls envisioned in Task 2.3, the ICT systems need proper bi-directional interfaces to the individual components, local building management systems, controllers and databases. Collecting data covers the following sources

- Energy consumption, both current and historical.
- Physical states of the system: temperatures, flows, set-points etc.
- Control variables: state, run time etc.

Relaying control variables is needed to the relevant components through the central platform.

From the viewpoint of Task 3.3, the platform needed for performance monitoring and operations planning tools has to be able to both integrate the hierarchical information model from T2.2 and the algorithms being devised in T4.4.

The ability to acquire the relevant data for the methods to be defined in T4.4 will most likely be as follows:

- Energy consumption data.
- Neighbourhood energy grid status.
- Data about supervisory control signals sent for the purpose of load management, e.g. from the energy broker to the individual components.
- Pricing and pricing options.
- Weather data: historic, current and forecasts.

Most high level decisions will be based on these parameters, but additionally, for operations planning the following information will be needed

- Maintenance information (planned and fault related).
- Forecast about pricing, if applicable.
- Physical data related to energy storages.

Finally, for T3.4, the End-user collaboration tool has to have access to the user data collected from at the demo sites as well as parameters also needed for T4.4.

7.2 Overall system architecture

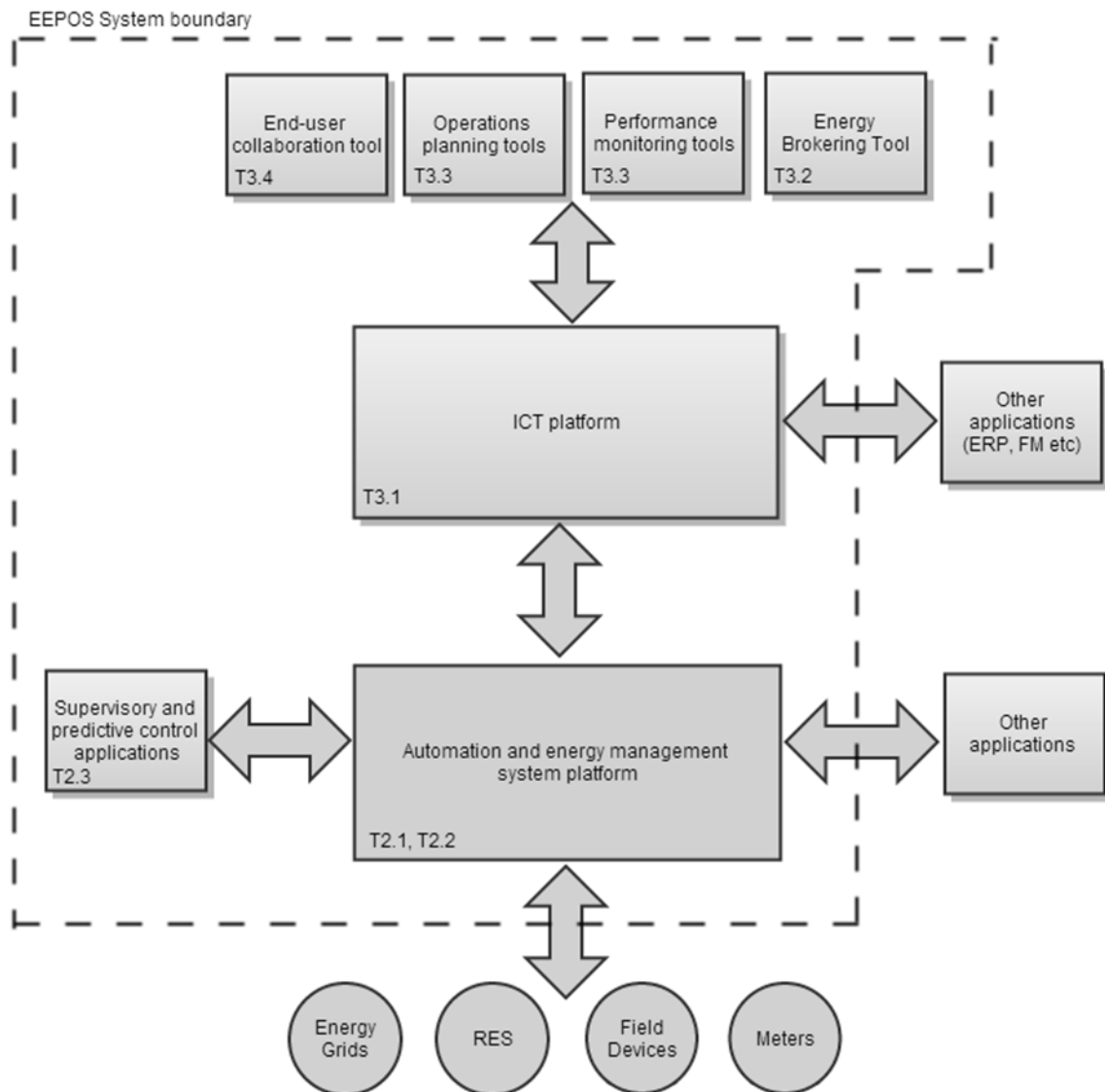


Figure 14. Draft of the system diagram (task aspect)

EEPOS project will produce 2 main subsystems:

- Automation and energy management system platform (T2.1)
- Information and decision support system (T3.1)

Automation platform will provide means to access different devices and meters. It will also provide interface for control applications. Related issues are described in more detail in section 4.

ICT platform connects to Automation platform to get meter/sensor readings for example. It also provides interfaces for higher level applications to access this data (ERP, FM etc). Related issue is described in more detail in chapter 5.

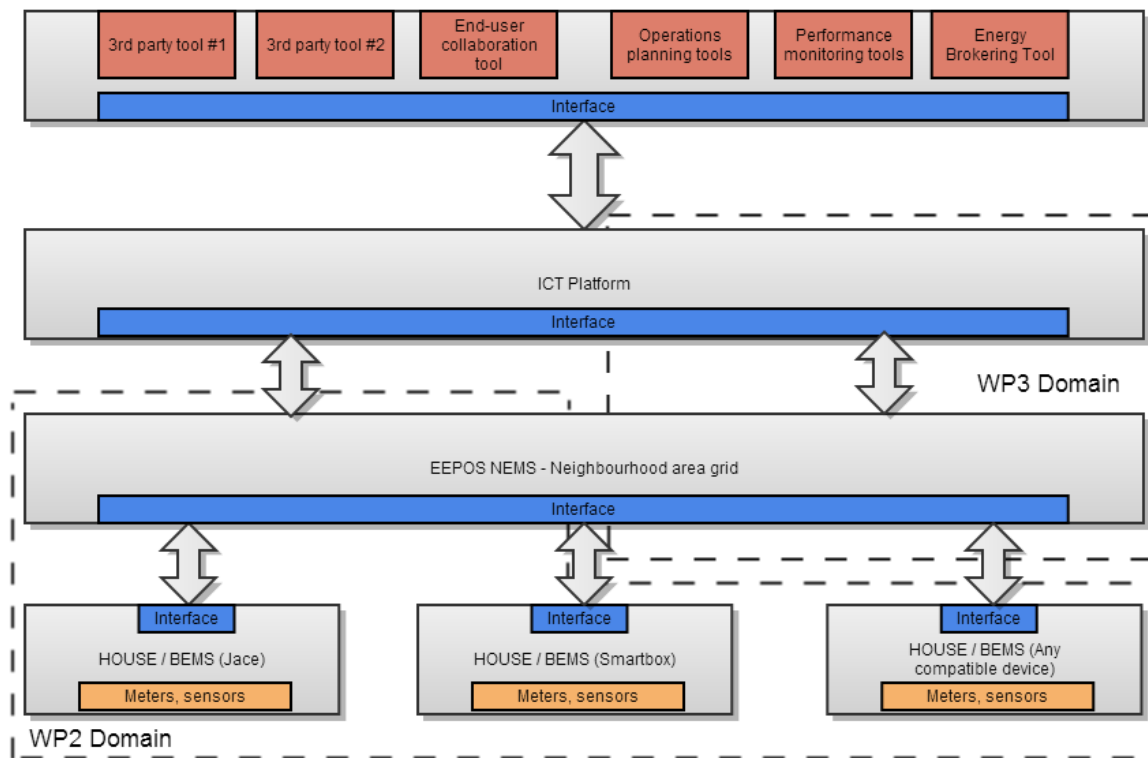


Figure 15 , System diagram

7.2.1 Automation system

The EEPOS automation and energy management system, which aims to adapt the energy consumption on the neighbourhood level to the energy generation, will be developed in WP2. The EEPOS framework will introduce the possibility that control applications for both grid operator and customer can run within the same hardware and software framework.

The EEPOS neighbourhood automation and energy management platform, the EEPOS pool BEMI, will be developed in T2.1 (cf. figure 16) and will represent a single gateway between the customer and the grid. The EEPOS pool BEMI will base on OGEMA, whereas on the building levels, different energy management systems, e.g. Jace, Smartbox, or OGEMA will be used. For the building automation and energy management systems, which are present at the demonstration sites, interfaces to the EEPOS neighbourhood automation and energy management platform will be developed (cf. section 7.1.1).

The EEPOS platform will provide clearly defined internal and external interfaces and will integrate two levels of information models: data models for neighbourhood energy grids (T2.2) and data models for in house communication. External application and service interfaces between the heating and energy grids and the EEPOS system on both the building and neighbourhood levels (T2.1) will use the information models developed in T2.2. The same applies to the interfaces required to access external and customer devices, the ICT platform on both the neighbourhood and building level (→ WP3), as well as the building automation and energy management systems deployed in the field tests.

On top of the platform, a variety of applications will be executable to access customer devices, user displays, smart meters, measuring data, pricing data, renewable energy generation data and other smart grid information on both the neighbourhood and the building

levels. Smart neighbourhood level applications for automation, operation, (predictive) control, brokering and monitoring that support new device profiles and data communication interfaces will be developed in T2.3. The EEPOS platform will support the definition of priorities and specific access rights for different applications according to agreements between different actors in the distribution grids.

The EEPOS platform framework will offer several functionalities to applications and communication systems. The API-Service will be the entity of all modules that can be expected on any EEPOS framework implementation and will thus serve as a base set for interoperability. Standard services of the EEPOS framework for using data models and device services can be grouped into the following categories (T2.1):

- Resource Administration: automated registration/discovery of new devices based on standardized data models and device services.
- Application Administration and Time Control: Administration of applications, the system time they are using and the way they are executed.
- Standardized Services for OGEMA Functionality: Services that will be needed for many applications, e.g. the user and (pool) BEMI web interfaces.
- Persistent Storage: persistent storage of e.g. preferences, application data or structures that are commonly needed by applications in the field of energy management and efficiency.
- Logging and Evaluation of text log messages as well as of measurement data series.

Further services available to applications and communication systems in specific EEPOS systems will be provided by applications.

7.2.2 ICT system

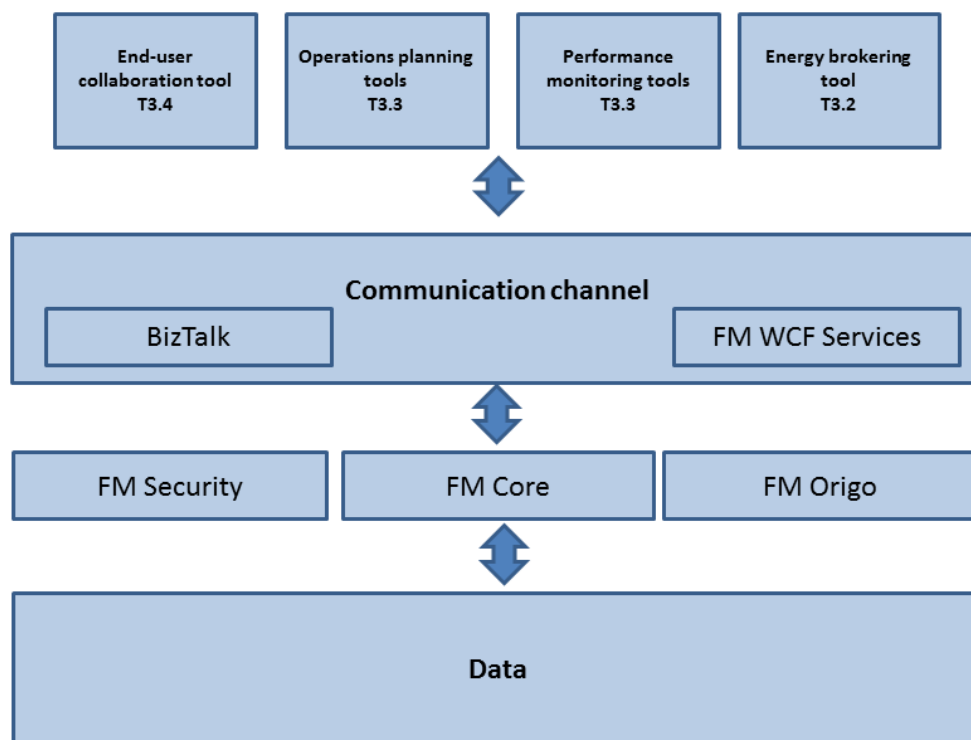


Figure 16. WP3 System diagram

ICT platform provides easy access for tools created in work package 3 to access different measurement systems as internal data communication interface. Also external interfaces for other ICT platforms will be possible, one example being OrigoXRP.

Actual services will be described in the T3.1 work starting in the January 2013. Platform will be based on interoperable standards like web services and biztalk adapters.

7.3 External and internal interfaces

Main focus on the interface side is to get all the different subsystems communicating with each other in the way it supports the whole EEPOS project. There is a lot of different components used by different partners that will be part of the bigger picture.

With the work done in the work packages 2 and 3 we are trying to achieve just that. This documents purpose is to identify all the components we are using and try to figure out which kind of new components must be created to achieve that goal.

Using open standards and interfaces when possible will help us to create needed new components.

7.3.1 Requirements

EEPOS project will be demonstration driven and two main demonstrations (Finland and Germany) will define most of the requirements. Also the laboratory prototypes task 4.2 will provide some requirements.

7.3.2 Interfaces already existing usable in EEPOS

Most of the systems and software used in the demonstrations uses standard interfaces or can be configured to support them. YIT's Niagara and Fatman Oy's OrigoXRP can use oBIX for example. And OGEMA can support numerous different protocols. In the WP2 automation work package this aspect can be further studied and common interfaces will be identified and tested.

7.3.3 Interfaces created during project

Biztalk connection for OrigoXRP will be created in T3.2 (Energy Brokering Tool). Also interface communicating with Automation Platform (WP2) will be created. Used methods not yet described, will be done later as work starts in WP2 and WP3.

Also WP2 will connect devices used in demonstrations (mainly YIT's Jace and Enovatis Smartbox) to OGEMA platform.

8. CONCLUSIONS

8.1 Summary of achievements

This task's purpose was to identify each partner's existing solutions and to identify how these are going to be used in the planned demonstrations. Also the underlying system architecture was designed, taking into account different applicable technologies.

We have two big demonstrations and one laboratory prototype defining the needs and requirements for the EEPOS solution. All three use very different solutions and products but the expected results are very close to each other. This gives us very good starting point to go forward with the EEPOS project. Additionally a virtual demonstration will be conducted in. With various demonstrations the feasibility of the EEPOS system will be verified and additional development areas are identified.

This document achieves its goal to explain the starting point of each partner involved in the project and gives directions where to go from here with the development.

8.2 Relation to continued developments

This document will be starting point for WP2 and WP3 work. Within R&D work in WP2 and WP3 the need for additional changes in overall architecture is taken into account and the system is conformed accordingly.

That is also one key point for this document. We keep the D13 overall architecture document up-to-date as we progress with the other work packages and tasks.

9. ACRONYMS AND TERMS

API	Application Programming Interface
BACnet.....	Building Automation and Controls Networks
BAS	Building Automation System
BEMI.....	Bidirectional Energy Management Interface
BEMS	Building Energy Management System
BIM	Building Information Model
BMS	Building Management System
CEN.....	European Committee for Standardization
CityGML.....	City Geography Markup Language
COBie.....	Construction Operations Building Information Exchange
COSEM.....	Companion Specification for Energy Metering
DALI	Digital Addressable Lighting Interface
DER.....	Distributed Energy Resources
DLMS.....	Device Language Message Specification, originally Distribution Line Message Specification
DMX512.....	A communications protocol that is most commonly used to control stage lighting and effects
DSO.....	Distribution System Operator
Eclipse IDE	Java and open source based Integrated Development Environment
EMG.....	Energy Management Gateway
EMS.....	Energy Management System
ERP.....	Enterprise Resource Planning
ESCO.....	Energy Service Contractor/Company
FSGIM.....	Facility Smart Grid Information Model
HAN	Home Area Network
HomePlug.....	Power-Line Networking standard/alliance
HomePlug GreenPhy...	HomePlug version developed specifically to meet utility industry requirements for Smart Grid applications
HVAC.....	Heating, Ventilation and Air Conditioning
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IFC.....	Industry Foundation Classes
IFD	International Framework for Dictionaries
ISO	International Organization for Standardization

JACE	Java Application Control Engine
KNX	Standardized OSI-based network communications protocol for intelligent buildings
LandXML.....	An industry standard for civil/survey data
LonWorks.....	Local Operation NetWORK
M-Bus.....	Meter-Bus
Modbus.....	A serial communication protocol developed by Modicon (now Schneider Electric) in 1979
NEMS.....	Neighbourhood Energy Management System
OASIS	Organization for the Advancement of Structured Information Standards
oBIX	Open Building Information Xchange
OGEMA	Open Gateway Energy Management Alliance
OLE	Object Linking and Embedding
OPC	OLE for Process Control
OPC UA	OPC Unified Architecture
OpenADR.....	Open Automated Demand Response
OSGi.....	OSGi Alliance (formerly Open Services Gateway Initiative)
PDA.....	personal digital assistant
PLC.....	Power line communication
ZigBee	A low-cost, low-power, wireless mesh networking standard

10. REFERENCES

- [1] <http://www.bacnet.org>
- [2] <http://www.echelon.com>
- [3] <http://www.lonmark.org>
- [4] <http://www.knx.org>
- [5] <http://www.obix.org>
- [6] <http://www.opcfoundation.org>
- [7] <http://www.osgi.org>
- [8] <http://www.dali-ag.org>
- [9] <http://www.modbus.org>
- [10] http://www.homeplug.org/tech/homeplug_gp
- [11] <http://www.m-bus.com>
- [12] <http://en.wikipedia.org/wiki/Meter-Bus>
- [13] <http://zigbee.org>
- [14] <http://en.wikipedia.org/wiki/ZigBee>
- [15] <http://www.dlms.com>
- [16] <http://buildingsmart.org>
- [17] <http://www.wbdg.org/resources/cobie.php>
- [18] <http://www.buildingsmartalliance.org/index.php/projects/activeprojects/25>
- [19] <http://www.citygml.org>
- [20] Bushby, S., Information Model Standard for Integrating Facilities with Smart Grid generating, BACnet Today & the Smart Grid - A Supplement to ASHRAE Journal, November 2011.
- [21] Facility Smart Grid Information Model, BSR/ASHRAE/NEMA Standard 201P, Advisory Public Review (July 2012).
- [22] Reference Architecture for Power System Information Exchange (Part 1), IEC 62357: TC57 Architecture, Second Edition Draft, Revision 6, October 1, 2011
- [23] <http://www.openadr.org/>
- [24] OGEMA – Open Energy Management Gateway Alliance. Online resource, <http://www.ogema.org/>, accessed 2012-12-11.
- [25] Ringelstein, Jan. Betrieb eines übergeordneten dezentral entscheidenden Energiemanagements im elektrischen Verteilernetz. Renewable Energies and Energy Efficiency. Vol. 16. Kassel: university press GmbH, 2010.