



OGEMA Technology in Brief

How OGEMA works and what it can do for you

The Open Gateway Energy Management Alliance (OGEMA) provides an open software platform for energy management which links the customer's loads and generators to the control stations of the power supply system and includes a customer display for user-interaction. The main technology goal of OGEMA is to allow software applications from various sources to be executed on an embedded computer (the "gateway"). The gateway connects to building automation systems and to communication systems outside the customers' premises in order to enable energy management and energy efficiency. This paper describes the most important concepts and features of OGEMA developed in order to fulfil this goal.

OGEMA uses well-known widely-accepted software standards for its execution environment that are available as open source and as commercial products

To be able to execute software applications from various sources on a single embedded computer a common execution environment has to be defined to which all these applications are deployed. OGEMA uses Java and OSGi as widely accepted software standards that provide a cross-platform execution environment. OSGi enables different applications to be executed in parallel. Like OGEMA also these technologies are available as public standards with open source implementations available for download on the internet, but also several commercial products are on the market.

References:

<http://www.sun.com/java/>

<http://jamvm.sourceforge.net/> and <http://www.gnu.org/software/classpath/> (open source java implementation)

<http://www.osgi.org/Main/HomePage>

<http://www.eclipse.org/> (open source development platform)

OGEMA allows connecting to an arbitrary number of different home automation systems in parallel

Each communication system and protocol can be connected to an OGEMA gateway by installing the appropriate software driver. Also the required hardware interfaces have to be installed at the gateway, of course.

OGEMA links the "Smart Grid" and the customer sphere by providing data models for both domains and connecting to different communication technologies relevant for these areas

OGEMA offers data models for "smart grid data" such as variable energy prices, metering data and control signals. But it includes also data models for control and supervision of devices inside the customer's premises. OGEMA connects to home and building automation systems as well as to Wide Area Networks (WAN).

OGEMA allows applications to be developed independently from the communication connection of devices and communication drivers can be developed independently from the application that uses the driver

This feature is why we call OGEMA an “operating system for energy management at the customer side”. Both applications and drivers connect to data models that are defined by the OGEMA specification. These data models act as a Hardware Abstraction Layer allowing both applications and drivers to be developed against this common interface definition (see figure 1).

New device types can be added to the framework dynamically by providing appropriate Java classes (see next Section).

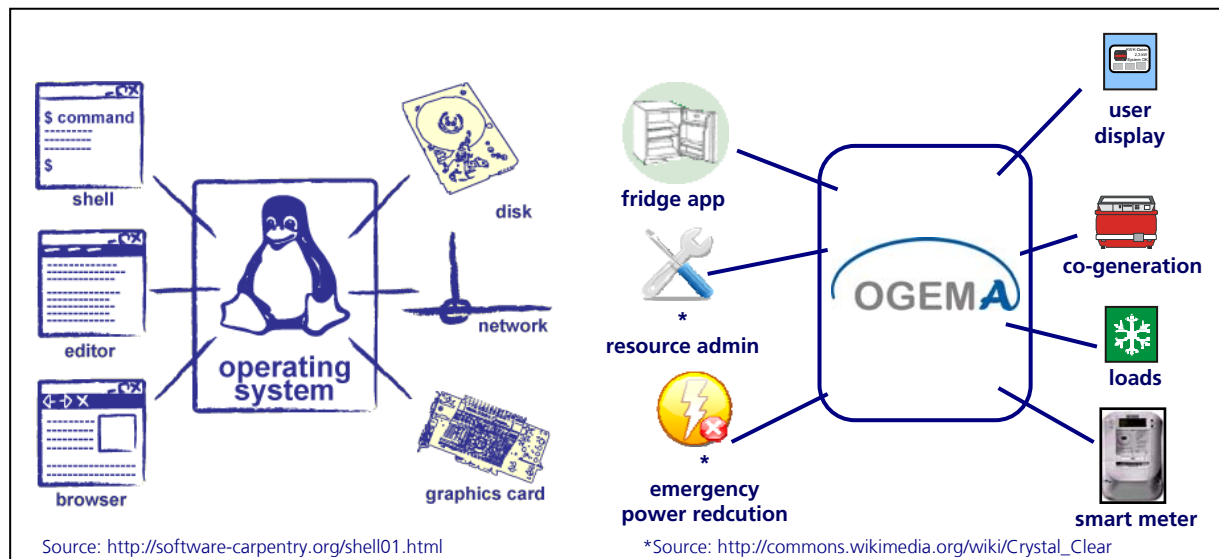


Figure 1: OGEMA links applications on the gateway computer to devices inside the house like an operating system on a PC links applications to the hardware resources of the PC.

Representation of devices and common services by data models

The OGEMA framework provides a fixed number of services needed to register/unregister device types, representations of the devices installed, applications and communication drivers. Also services for the Plug&Play-functionality, for application runtime control, for logging and for getting information on components registered are included into this API. Finally methods for reading and writing device data are part of this API. The framework does NOT provide any methods specific to any device type, though. This has the advantage that new device types can be installed just 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. Any additional code required for using / managing a device must be provided as part of an OGEMA application or a communication driver.

Open interface for software applications and hardware/communication drivers

The entire API of the OGEMA framework including interfaces for software applications and communication drivers is made public on the OGEMA web site. Also sample source code for applications and communication drivers is provided as projects for the Eclipse development environment, which is also available as Open Source software. So starting the development of your own applications and software drivers for OGEMA is made as simple and free of cost for you as possible.

Applications and drivers can be any type of open or closed source. The license used by OGEMA allows you to offer commercial applications and drivers without restrictions. If you want to put the OGEMA logo on your product certification is required, though. The cost of the certification will have to be covered by the party requesting the certification, of course.

Plug&Play#1: Interface for hardware/communication drivers allows for various levels of auto-detection and installation of new devices depending on communication system capabilities

Two main steps have to be performed in order to make use of any device newly connected to the gateway: Firstly the device has to be discovered via the communication system by which it is connected to the gateway with its capabilities. Secondly the device discovered has to be assigned to one or several applications making use of the devices capabilities.

The OGEMA interface for communication drivers allows for various communication concepts and levels of auto-detection of devices. Ideally a device is discovered completely automatically. This is not always possible, though. Many communication systems for home automation have data models for various sensors and actors, but not for entire devices like freezers, washing machines etc. So either the user has to tell the system to what kind of device the sensors and actors found belong to (because the user should know, what type of devices has been connected to the gateway) or it is also possible to use applications automatically trying to find out e.g. from sensor values which type of device probably has been connected. OGEMA also allows "semi-autodetection" provided by vendor-specific applications that detect devices from specific manufacturers by proprietary information.

Some communication systems do not have any auto-discovery functionality at all. In this case the installation of devices has to be performed manually. OGEMA also supports such kind of communication drivers and allows for simple configuration via the OGEMA web interface if the driver provides a suitable configuration web page.

Plug&Play#2: The management agent brings together applications and devices available

The OGEMA framework API allows applications to register the types of devices they are able to connect to. As soon as a suitable device is available (either by auto-discovery or by manual installation, see Plug&Play#1) the application is notified and connected to the device. Sensors can be read by several applications in parallel. In contrast each actor and device parameter can only be controlled/written by a single application at a time in order to avoid interfering control actions on a device. In case more than one application registers for write access for the same device connection is granted based on a priority system. So emergency applications can gain control on relevant devices quickly in case they are activated - independently from the applications that perform the control in normal operation.

Plug&Play#3: OGEMA device models use flexible components allowing for communication drivers and applications to address only relevant parts of devices

As described in Plug&Play#1 many communication systems only provide the information which sensors and actors are connected, but not entire device information. In this case such a communication driver can register a suitable sensor or actor data model in order to provide as much information by auto-detection as possible. These component models can then be mapped to the device model they belong to via the OGEMA framework API.

Most applications are not limited to a specific device type but can be used for a number of similar device types. For example an application shifting operation of a device based on a variable electricity price by using a thermal storage can be applied to a fridge, a freezer and (in some cases) even to a heat pump with thermal storage. In the OGEMA framework such applications would not register

demand for each such device type separately, but for the OGEMA component “thermal storage”, which is part of the relevant device models. Even if a new device with thermal storage is installed in the system that was not known at the time of the development of the application, it can be controlled by the application via the known data model components.

“Firewall” between public grid and customer grid: access control, data privacy

OGEMA communication drivers are used to connect to devices inside the house as well as for connections going out of the customers’ premises, e.g. connecting to the dispatching and grid control stations of the energy supply system. The interaction of these communication systems (meaning also the interaction between the grid control station and the devices) is determined by the configuration of the gateway computer and by the applications installed. The gateway computer may be limited to a protocol converter with a user web interface or it may perform most of the energy management algorithms. But in both cases the gateway acts as a firewall between the public and the private communication systems allowing only the interaction between the systems as defined by the gateway configuration.

Additionally user confidence and data privacy shall be supported by the possibility to display data usage explanation and data privacy statements for each data connection delivering data outside the customer’s premises and to display these statements in the web interface.

Resource control based on user-specific access rights and permissions

The OGEMA gateway shall allow executing software from various sources. In order to allow for a maximum protection of the system against usage not intended by the user only applications signed by a trusted authority should be installed. Evaluation of applications is simplified by a declaration of Java-permissions needed by the application. Experienced users can even assess applications that are not signed based on the required permission declaration.

The different parties deploying software shall each have an OGEMA user account on the gateway granting specific device access permissions. So the administrator of the gateway can control which devices can be accessed by applications installed by each user.

Applications bring their own web page(s)

The user interface is a decisive element of most applications in the area of energy management and energy efficiency. Also for the gateway functionality user information and interaction is important so that the user is able to see how his private space is connected to a smart grid system.

OGEMA uses standard web technology to implement the user interface. So the user can access the interface by any web-enabled device with an internet browser. Applications bring their own web pages using HTML, Servlets and JSP (Java Server Pages) for dynamic page content. The reference applications also contain samples for building such web pages and for their connection to the application data. The application web page is integrated into a general framework navigation via a separate frame. This allows for a flexible extension of the user interface via standard software/programming technologies.

Applications register their web pages and a desktop icon in their OSGi manifest file. Icon and access to the application pages are integrated into the user web interface navigation by the framework automatically.

OGEMA supports development, deployment and service by logging functionalities

The specification extends the standard OSGi logging functionality and the reference implementation offers persistent storage and filtered view of log messages. The specification also contains interfaces for storing and accessing data logging series and for the configuration of the data logging for any sensor or other data value in the resource models.

OGEMA is designed to run also on embedded devices

It shall be possible to implement the OGEMA specification on an embedded platform with less than 64 MB RAM and power consumption considerably below 5 W. Work to demonstrate this goal is ongoing. OGEMA can also be executed on any larger architecture for which Java is available including PCs running windows or Linux. In order to limit energy consumption for the energy management system this is not recommended for productive systems in private households and small businesses, though.

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