



D9.1-A: Inventory and analysis of relevant norms and standards

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Summary

This document presents the deliverable D9.1-A of Task 9.1 of eDIANA.

It presents different standards and technologies that are relevant to the different activities of eDIANA.

Contents

1. INTRODUCTION	7
2. STANDARDIZATION BODIES	9
3. STANDARDS PROCESS MODELS.....	15
4. REGULATORY RESTRICTIONS ON DEVICES	18
4.1 FUNCTIONAL SAFETY: IEC 61508	18
5. COMMUNICATION TECHNOLOGIES	20
5.1 ZIGBEE	20
5.2 GSM	22
5.3 WHITESPACES	24
5.3.1 <i>Whitespace</i>	24
5.3.2 <i>Digital Digital dividend</i>	25
6. (SMART) GRID RELATED TECHNOLOGIES	26
6.1 SMART GRID INTEROPERABILITY.....	27
6.2 BACNET	29
6.2.1 <i>Technical Overview</i>	29
6.2.2 <i>BACnet and Smart Grids</i>	30
6.2.3 <i>Relevance to eDIANA</i>	31
6.3 KNX.....	31
6.3.1 <i>Technical overview</i>	31
6.3.2 <i>KNX and smart grids</i>	32
6.3.3 <i>Relevance to eDIANA</i>	32
6.4 ANSI C12.22.....	32
6.4.1 <i>Technical overview</i>	33
6.4.2 <i>ANSI C12.22 and Smart Grids</i>	33
6.4.3 <i>Relevance to eDIANA</i>	33
7. TOOLING	34
7.1 QT.....	34
7.2 ECLIPSE.....	34
8. WEB SERVICE TECHNOLOGIES	36
8.1 RELEVANT STANDARDS ON WEB SERVICES FOR EDIANA PLATFORM	36
8.2 XML (EXTENSIVE MARKUP LANGUAGE)	36
8.2.1 <i>XML content modelling</i>	37
8.2.1.1 Namespaces	37
8.2.1.2 Parsing.....	38
8.2.1.3 Querying and Transformation	38
8.2.1.3.a <i>XPath</i>	38
8.2.1.3.b <i>XSLT</i>	38
8.2.1.3.c <i>XML document structure and mapping</i>	38
8.3 WSDL (WEB SERVICE DESCRIPTION LANGUAGE)	39

7.1.1.1.a WSDL Elements	39
8.3.1 Types	40
8.3.2 Message	40
8.3.3 Port Types	41
8.3.4 Bindings.....	42
8.3.5 Ports.....	43
8.3.6 Services.....	43
8.4 SOAP (SIMPLE OBJECT ACCESS PROTOCOL)	43
8.4.1 SOAP message framework.....	43
8.4.2 SOAP Message Exchange.....	45
8.4.3 Remote Procedure Call (RPC).....	45
8.4.4 SOAP Fault Message	46
8.4.5 SOAP Processing Model.....	47
8.4.6 The "role" Attribute.....	47
8.4.7 The "mustUndersand" Attribute.....	47
8.4.8 The "relay" Attribute	48
8.5 CE-HTML.....	48
8.5.1 Introduction	48
8.5.2 Features [12]	49
8.5.3 Example.....	50
9. CONCLUSION	51
9.1 eDIANA ENVIRONMENT	51
9.2 eDIANA IN RELATION WITH EXISTING STANDARDS	52
9.3 RECOMMENDATIONS.....	53

Abbreviations

eDIANA	Embedded Systems for Energy Efficient Buildings
AMI	Advanced Metering Infrastructure

1. Introduction

This document presents the first deliverable (D9.1A) of work package 9.1 of eDIANA.

To realize the vision of an eDIANA platform as a smart node of the future smart grids, and make sure that this technology will actually result in a significant step on the road to net zero energy buildings, we need to take targeted measures in the standardization and regulation areas.

Building management systems are classically islands of automation, communicating, internally and externally, only with proprietary terminals. The cost and time required for integration is a barrier both to better communication, and to system upgrades. In the view of the future smart grids, buildings must be able to accept the complexity of new systems and new technologies without bearing the additional cost of complex integrations. This is also true for the embedded system technologies. Before systems can communicate, there is a lot of work to build and integrate the platform they communicate from. So much of the work that will be needed for smart grids is based upon constrained communications between resource-constrained devices.

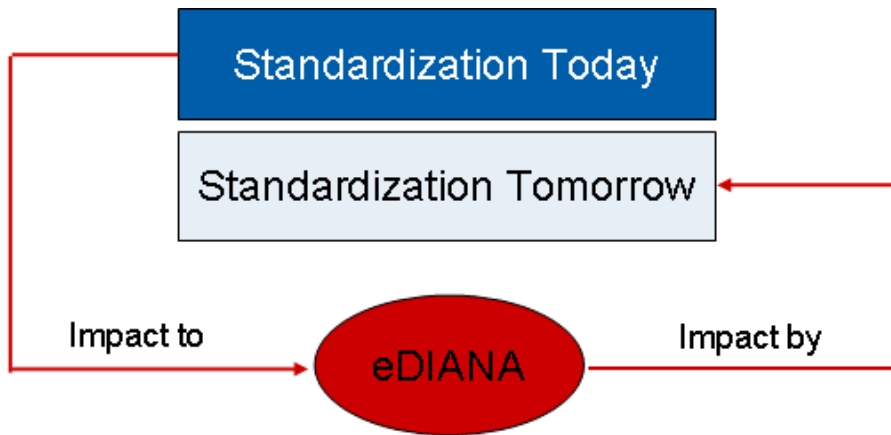
This deliverable presents an inventory of existing tests, norms and standards, that can be cross-checked with the technologies that are developed in eDIANA or that are relevant for the success of the eDIANA concept (impact to/by eDIANA). The technologies include:

- Open source software domain, ICT and metering and prosumer management systems, interfacing with external, mobile displays (control centre level) and with building automation/home control systems.
- Regulations and standards on international and national level.
- Technology areas covered by norms, standards, certification or regulations (incl. a short description of the relevant rules).

The inventory activities will be:

1. literature and online research
2. interviews with experts and standardization bodies
3. consolidation and drafting the overview
4. review discussion with experts
5. finalizing the overview

The different Standards and technologies will be input to further work being done in work package 9.



2. Standardization Bodies

This section will describe the entities that produce, control and accredit almost all the standards this task will work on. This description has been extracted as a relevant part from deliverable D6.3-A, in which a more detailed study of some standards with focus on "certification" is provided.

Inside European Community, there are some entities in charge of the standardization in various application fields.

CENELEC

(Comité Européen de Normalisation Électrotechnique)



European Committee for Electrotechnical Standardization

CENELEC is responsible for European Standardization in the area of electrical engineering.

Standards harmonised by this agency are regularly adopted in many countries outside Europe which follow European technical standards.

CENELEC was founded in 1973. Before that two organizations were responsible for electrotechnical standardization: CENELCOM and CENEL. CENELEC is a non-profit organization under Belgian law, based in Brussels. The members are the national electrotechnical standardization bodies of most European countries.

The current members of CENELEC are: Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, F.T.R of Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Slovakia, Slovenia, Sweden, Switzerland and the United Kingdom.

Albania, Bosnia/Herzegovina, Bulgaria, Croatia, Macedonia, Serbia and Montenegro, Turkey and Ukraine are currently 'affiliate members' with a view to becoming full members.

Although CENELEC works closely with the European Union, it is not an EU institution.

The nomenclature used by CENELEC in its standards is described next:

- EN → European Standards
- HD → Harmonization Document
- TS → Technical Specification
- TR → Technical report
- G → Guides
- CWA → CENELEC Workshop Agreement

CEN

Comité Européen de Normalis

The European Committee for Standardization



The CEN is a private non-profit organization whose mission is to foster the European economy in global trading, the welfare of European citizens and the environment by providing an efficient infrastructure to interested parties for the development, maintenance and distribution of coherent sets of standards and specifications.

The CEN was founded in 1961. Its thirty national members work together to develop European Standards (ENs) in various sectors. Some of these standards are voluntary, whereas other standards such as harmonized standards have been made effectively mandatory under EU law. CEN is officially recognized as a European standards body by the European Union.

The current CEN Members are Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

The current affiliates are Albania, Croatia, Macedonia and Turkey.

The current partner standardization bodies are Australia, Bosnia and Herzegovina, Egypt, Moldova, Russia, Serbia, Tunisia and Ukraine

The nomenclature used by CEN in its standards is described next:

- EN → European Standards
- prEN → Draft European Standard
- CWA → CEN Workshop Agreement
- TS → Technical Specification
- TR → Technical Report

ETSI

European Telecommunications Standards Institute



The European Telecommunications Standards Institute (ETSI) is an independent, non-profit, standardization organization in the telecommunications industry (equipment makers and network operators) in Europe, with worldwide projection. ETSI has been successful in standardizing the GSM cell phone system and the TETRA professional mobile radio system.

ETSI was created by CEPT in 1988 and is officially recognized by the European Commission and the EFTA secretariat. Based in Sophia Antipolis (France), ETSI is

officially responsible for standardization of Information and Communication Technologies (ICT) within Europe. These technologies include telecommunications, broadcasting and related areas such as intelligent transportation and medical electronics.

ETSI has 740 members from 62 countries/provinces inside and outside Europe, including manufacturers, network operators, administrations, service providers, research bodies and users — in fact, all the key players in the ICT domain.

The nomenclature used by CEN in its standards is described next:

- TS → ETSI Technical Specification
- TR → ETSI Technical Report
- ES → ETSI Standard
- EG → ETSI Guide
- EN → European Standard
- SR → ETSI Special Report

Related to international standardization bodies, next entities are the most relevant in eDIANA project scenario.

ISO



International Organization for Standardization

ISO is an international-standard-setting body composed of representatives from various national standards organizations. Founded on 23 February 1947, the organization promulgates worldwide proprietary industrial and commercial standards. While ISO defines itself as a non-governmental organization, its ability to set standards that often become law, either through treaties or national standards, makes it more powerful than most non-governmental organizations.

ISO has 158 national members, out of the 195 total countries in the world, distributed in member bodies, correspondent members and subscriber members.

ISO use the next nomenclature to define its standards, reports, etc.

- ISO[/IEC]/[ASTM] [IS] nnnnn[:yyyy] Title
- ISO[/IEC]/[ASTM] [TR] nnnnn[:yyyy] Title-Technical Report
- ISO[/IEC]/[ASTM] [TS] nnnnn[:yyyy] Title-Technical Specification
- ISO[/IEC] Guide N:yyyy: Title-Guide

Where:

- nnnnn: number of the standard

- yyyy: year when the standard is published
- Title: title or short description of the standard

IEC



International Electrotechnical Commission

IEC is a not-for-profit, non-governmental international standards organization that prepares and publishes International Standards for all electrical, electronic and related technologies – collectively known as "electrotechnology". IEC standards cover a vast range of technologies from power generation, transmission and distribution to home appliances and office equipment, semiconductors, fibre optics, batteries, solar energy, nanotechnology and marine energy as well as many others.

The IEC also manages three global conformity assessment systems that certify whether equipment, system or components conform to its International Standards

An IEC member is called a National Committee and each NC represents its nation's electrotechnical interests in IEC management and standardization work.

This includes:

- manufacturers, providers, distributors and vendors
- consumers and users
- all levels of governmental agencies
- professional societies and trade associations
- standards developers

IEC numbers its standards between 60000 and 79999. There are some old standards (numbered below this range) that have been adapted to this nomenclature by adding 60000.

ITU

International Telecommunication Union



The International Telecommunication Union is the second-oldest international organization still in existence, established to standardize and regulate international radio and telecommunications. It was founded as the International Telegraph Union in Paris on 17 May 1865. Its main tasks include standardization, allocation of the radio spectrum, and organizing interconnection arrangements between different countries to allow international phone calls. The section that is in charge of standardization is **ITU-T** (Telecom Standardization). Other sections focus their activity on managing the international radio-frequency spectrum and satellite orbit resources (ITU-R, Radio communication), helping spread equitable, sustainable and affordable access to information and communication technologies (ITU-D, Telecom Development) and events organization (ITU TELECOM, Telecom Exhibitions and Forum).

As part of the United Nations structure, a country can be a member, in which case it is referred to as a Member State. Companies and other such organizations can hold other classes of membership referred to as Sector Member or Associate status. As of September 2007 there were 191 Member States and more than 700 Sector Members and Associates.

ITU-T produced documents are known as ITU-T Recommendations and are numbered by a capital letter which indicates the serie, followed by an identifying number.

Next list shows the series which ITU-T works on:

- A: Organization of the work of ITU-T
- B: Means of expression: definitions, symbols, classification
- C: General telecommunication statistics
- D: General tariff principles
- E: Overall network operation, telephone service, service operation and human factors
- F: Non-telephone telecommunication services
- G: Transmission systems and media, digital systems and networks
- H: Audiovisual and multimedia systems
- I: Integrated services digital network
- J: Cable networks and transmission of television, sound programme and other multimedia signals
- K: Protection against interference
- L: Construction, installation and protection of cables and other elements of outside plant
- M: Telecommunication management, including TMN and network maintenance
- N: Maintenance: international sound programme and television transmission circuits
- O: Specifications of measuring equipment
- P: Telephone transmission quality, telephone installations, local line networks
- Q: Switching and signalling
- R: Telegraph transmission
- S: Telegraph services terminal equipment
- T: Terminals for telematic services
- U: Telegraph switching
- V: Data communication over the telephone network

- X: Data networks, open system communications and security
- Y: Global information infrastructure, Internet protocol aspects and next-generation networks
- Z: Languages and general software aspects for telecommunication systems

3. Standards Process Models

This section will describe the entities involved in the definition of standards bodies for modelling Processes and their respective standards. Modelling notations and Meta-models are covered by these standards and could be the basis for the application in some phases to reach a standard Certification Metamodel for eDIANA.

Object Management Group (OMG)

OMG is a consortium, originally aimed at setting standards for distributed object-oriented systems, and is now focused on modeling (programs, systems and business processes) and model-based standards. This consortium provides only specifications and does not provide implementations.

<http://www.omg.org>

Standards

- *SPEM 2.0*

SPEM 2.0 (Software Process Engineering Meta-model) is the OMG's standard for software process modelling. The main objective is to provide a formal framework for the definition of development processes of Software and for the definition of the description on all the elements that make up.

SPEM defines the elements used in describing a process as well as elements used for structuring and managing this information. The basic elements used to structure and manage the information are: Method Library, Method Plug-in, Method Package, Process Package, Method Configuration. With this structure of elements SPEM 2.0 is to be able to maintain and support a wide range of fragments of method and processes of different styles, backgrounds, levels of formality, life cycle models, and communities to develop projects. SPEM describes structures needed to formally express and maintain method content and processes, i.e. it defines a language and representation schema for method contents and processes. A key feature is that it defines the ability to choose the behavior modeling approach that fits the implementer's needs and uses the UML 2.0 infrastructure and diagram interchange standards.

www.omg.org/spec/SPEM/2.0/

- *BPMN 2.0*

The Business Process Definition Metamodel (BPDM) is a standard XML-based proposal for business processes. The BPDM is a framework which supports the representation of business processes independent from notation or methodology and provides an explicit MOF based metamodel and a robust serialization mechanism based in XMI, which is going to allow exchange

business process specifications between modeling tools, and between tools and execution environments.

www.omg.org/spec/BPMN/2.0/

Workflow Management Coalition (WfMC)

WfMC is a consortium, formed to define standards for the interoperability of workflow management systems founded in May 1993 by an offshoot of the Black Forest Group with original members including IBM, Hewlett-Packard, Fujitsu, ICL, Staffware and approximately 300 software and services firms in the business software sector. Today is focused principally around process definition file interchange, using the standard XPDL.

www.wfmc.org

Standards

- *XPDL 2.1*

XML Process Definition Language (XPDL) is the language proposed by the WfMC to interchange process definitions between different workflow products. The goal of XPDL is to provide a standard language for the workflow domain allowing for the import and export process definitions between a variety of tools ranging from workflow management systems to modeling and simulation tools. The main elements of the language are: Package, Workflow-Process, Activity and Transition.

A remarkable feature is that XPDL provides a file format that supports every aspect of the BPMN process definition notation including graphical descriptions of the diagram, as well as executable properties used at run time. This allows interchanging diagrams between different tools and reproducing the diagram with totally fidelity, basically XPDL is the Serialization Format for BPMN and currently can be considered the best file format for exchange of BPMN diagrams.

www.wfmc.org/xpdl.html

OASIS

OASIS (Organization for the Advancement of Structured Information Standards) is a not-for-profit consortium that drives the development, convergence and adoption of open standards for the global information society. It was Founded in 1993 and currently has more than 5,000 participants representing over 600 organizations and individual members in 100 countries.

www.oasis-open.org

Standards

- BPEL

The Business Process Execution Language (BPEL) is an XML-based language for describing business processes and is based on web services orchestration allowing the composition of the web services with a process oriented approach to SOA (Service oriented architecture) which practically implies that role of BPEL is primarily for execution of web services in right order such that the technology implementation of the business processes is flexible, scalable and in alignment with the business goals.

docs.oasis-open.org/wsbpel/2.0/wsbpel-specification-draft.html

For more information related to these standards, please have a look at deliverable D6.3-C Analysis of Standards Process Models.

4. Regulatory restrictions on devices

4.1 Functional Safety: IEC 61508

Description

The Norm IEC 61508 "Functional safety of electrical, electronic and programmable electronic safety related systems", is proposed as a reference to be taken into account in eDIANA because in certain cases safety functions can be under the embedded systems control and monitoring domain.

In this context Safety is the freedom from unacceptable risk of physical injury or of damage to the health of people, either directly as a result of damage to property or to the environment

Functional safety is part of the overall safety that depends on a system or equipment operating correctly in response to its inputs

URL

<http://www.iec.ch/functionalsafety/>

Applies to geographic area:

EU, NL, US, Asia, World, ...

Current status

1st release 1998?

2nd release 2010-04

EN version will be available later in 2010

Relevance to eDIANA

Related to safety critical related equipment as in cases where continuity of electrical power service is a strong requirement (special industrial or residential buildings, hospitals, ...).

Where does it have influence

Being the worldwide reference standard for Functional Safety, compliance with it is required for the design and development of safety related embedded systems and devices based on them.

It has been the basis for the elaboration of other embedded systems related standards in several important application areas (Medical, Automotive, Aerospace, Nuclear,...)

Important rules

Centered on methodology to calculate and obtain determined Safety Integrity Levels for both Hardware and Software aspects along the life cycle of the safety related embedded systems.

References:

General definitions for functional safety. IEC 61508.
<http://www.iec.ch/functionalsafety/>

5. Communication technologies

5.1 Zigbee

Description

ZigBee was created to address the market need for a cost-effective, standards-based wireless networking solution that supports low data-rates, low-power consumption, security, and reliability.

The initial markets for the ZigBee Alliance include [Consumer Electronics](#), [Energy Management and Efficiency](#), [Health Care](#), [Home Automation](#), [Telecommunication Services](#), [Building Automation](#) and [Industrial Automation](#). Among all of them, [Energy Management and Efficiency](#), i.e. Smart Energy, and [Home Automation](#) are the most relevant for eDIANA.

ZigBee Smart Energy offers utilities and energy service providers secure, easy-to-use wireless home area networks (HAN) for managing energy and helps to implement new advanced metering and demand response programs.

The ZigBee Smart Energy specification provides standard interfaces and device definitions to allow interoperability among ZigBee devices produced by various manufacturers of electrical equipment, meters, and Smart Energy enabling products.

Devices Specified in the Smart Energy Profile:

- Energy Service Portal
- Metering Device
- In-Premise Display
- Programmable Communicating Thermostat (PCT)
- Load Control Device
- Smart Appliance
- Prepayment Terminal

ZigBee Home Automation is the global standard for the control of appliances, lighting, environment, energy management, safety and security. For consumers, ZigBee Home Automation offers an affordable, reliable, expandable and easy way to control their energy consumption, environment, lighting, safety, and security in their homes or small offices.

One of its main features and the most relevant for eDiana is the power control. This standard allows the user to monitor the power use and to Turn on/off devices remotely

There are a growing number of interoperable products certified by the Alliance for ZigBee Home Automation. Devices Specified in the HA Profile:

- Generic: On/Off Switch, Level Control Switch, On/Off Output, Level Controllable Output, Scene Selector, Configuration Tool, Remote Control, Combined Interface, Range Extender, Mains Power Outlet
- Lighting: On/Off Light, Dimmable Light, Color Dimmable Light, On/Off Light Switch, Dimmer Switch, Color Dimmer Switch, Light Sensor, Occupancy Sensor
- Closures: Shade, Shade Controller
- HVAC: Heating/Cooling Unit, Thermostat, Temperature Sensor, Pump, Pump Controller, Pressure Sensor, Flow Sensor
- Intruder Alarm Systems: IAS Control and Indicating Equipment, IAS Ancillary Control Equipment, IAS Zone IAS Warning Device Reserved

As not all the devices nor the functionalities are covered by the ZigBee Alliance, both standards allow the use of manufacturer specific solutions.

URL

<http://www.zigbee.org>

Applies to geographic area

Worldwide

Current status

ZigBee Home Automation Public Application profile

1st release: October 25, 2007

2nd release: February 8, 2010

ZigBee Smart Energy Profile Specification

1st release: December 1, 2008

Relevance to eDIANA

The IEEE 802.15.4/Zigbee has been selected for the intra-Cell network as the most suitable technology for reasons mainly related to the plethora of products already available on the market, the good results in simulations and experimentation and because of the fulfillment of the system requirements set by the applications.

Most Devices in eDIANA can be mapped to a ZigBee Smart Energy (SE) or Home Automation (HA) profile although some devices require the implementation of more than one device profiles on different endpoint to function correctly.

To provide white goods with the features required by the eDIANA application, the use of a Manufacturer-specific Cluster for white goods has been proposed. The new cluster will use commands made available by the Zigbee Cluster Library.

To guarantee interoperability within the Cell, the ZigBee Coordinator (at the CDC) will implement the following profiles: HA, SE and the manufacturer-specific cluster. Whereas the different Cell level devices will implement: the HA profile, or both HA and SE profiles, or HA and SE profiles extended with the manufacturer-specific cluster (white goods).

Where does it have influence

Important rules

Smart Energy networks will not interact with a consumer ZigBee Home Area Network unless a device is used to perform an “application level bridge” between the two profiles or the HA devices satisfy the Smart Energy profile security requirements. This is due to the higher security requirements on the Smart Energy network that are not required on a Home network.

HA devices may also be extended with Smart Energy clusters providing they support the use of Link Keys and the Smart Energy security models. If so, they can be certified as HA and Smart Energy capable allowing those devices to operate either in an HA network or a Smart Energy network.

5.2 GSM

Description

GSM is the most popular standard for mobile telephony systems in the world. It is used for mobile telephony as well as data. Currently there are 3 standards in use 2g, 2.5g and 3 G in the market and new standards are under development. All these standards are backwards compatible.

GSM uses licensed spectrum, this means that a contract with a GSM service provider is required in order to use GSM communication in your devices. Due to the popularity of GSM the coverage is very good; GSM systems can be used in most populated areas. Due to this popularity, it is also more and more used as a communication means between devices and back-end services.

2G GSM/GPRS

Frequencies used: 1800/900 Mhz

Data rate:

Class 2 8-12kbps up

Class 2 16-25kbps download

Class 12 32-48 UL/DL

2.5G GSM/EDGE

Frequency: 1800/900 Mhz

Data rate:

8 Timeslots 236Kbps UL 384Kbps DL

3G HSPA/UMTS

Frequency

2100/1900/850

Data rate:

HSUPA 5.76Mbps

HSDPA 7.2Mbps

UMTS 384Kbps

4G LTE (Long term evolution)

Frequencies:

700-2600Mhz (all cellular bands, including digital dividend (700Mhz))

Data rate:

Different channel bandwidth sizes from 1.4 to 20 mhz

10mhz channels 27.8 / 52.9

20mhz channels 55.5 / 105.2

URL:

<http://www.gsm.org/>

Applies to geographic area:

Europe, US, China

Current status :

2 , 2.5, 3 G is readily available and standardized. 4G LTE is currently being developed and 4G LTE Advanced is being researched and is promising speeds up to 1 gbps.

Relevance to eDIANA

GPRS (2G) is currently used by many Smart Grid meters in Europe. It is expected that also the newer GSM standards will be used as way to communicate between an device and a backend service with no dependencies on local (user/building owner controlled) infrastructure.

5.3 Whitespaces

Whitespace technologies relates to the reuse frequencies in the television spectrum that are, at a specified location and time, not used by the party holding rights to that spectrum.

Two different approaches to Whitespace are considered: Whitespace and Digital Dividend.

5.3.1 Whitespace

Whitespace relates to the reuse frequencies in the television spectrum that are at a specified location at this time not used by the party holding rights to that spectrum.

As the rights to the spectrum are owned by a different party, they may only be used when they are not used. There are two approached to determine whether a part of the TV spectrum may be used:

1. Spectrum sensing, measure if the spectrum is being used, if so, use an other frequency
2. Geolocation, determine where the device is located (within 50m) and look up in an online database what frequencies are available.

In the spectrum sensing and for some devices geolocation is required.

The range is expected to be similar to DECT. The available in-home bandwidth is expected to be sufficient for HD videostreaming (50-100Mb/s).

Spectrum and geographic area

USA: 50- 698 Mhz

EU: 470 – 790 Mhz (under discussion)

Current status

Whitespaces is still a topic of discussion; in the US it is on hold due to the administration change. In Europe each member state has to address it, at the moment there are no regulations yet. Time to market is at least 2-3 years after all the rules are finalized. The timing is yet unsure.

Relevance to eDIANA.

HD videostreaming.

5.3.2 Digital Digital dividend

Digital TV causes a part of the spectrum to be unused and available for other purposes, the spectrum is re-assigned.

Europe each member state has to address it, at the moment there are no regulations. Time to market is estimated at least 2-3 years after all the rules are finalized. The timing is yet unsure. It is expected the bandwidth will be used for GSM like protocols are DVB-H broadcasts.

Relevance to eDIANA.

Voide, text and IP connection.

6. (Smart) grid related technologies

The Smart Grid “market” has many moving parts. There are hundreds of vendors, large and small, providing software, hardware and solutions at every layer of the market, from the physical power infrastructure layer to the communications layer, up to the applications and services layer. Countless technologies are being developed, evaluated and deployed. Competing and complimentary system- and network-level standards are being defined. Power providers are planning and implementing varying systems architectures. Government policies are shaping the landscape at state and EU levels. Investments, private and public, are driving innovation at a scale large enough to match that of the problem itself.

There is currently on-going debate surrounding what will emerge as the AMI communications standard of choice in the next few years. In order to realize the true vision of a Smart Grid, utilities will want to run as many applications as possible over their field area networks. Issues of reliability, scalability and cost will continue to dominate the conversation, but expect much more attention paid to bandwidth and latency in the coming years, as utilities gear up to attempt advanced applications such as real time demand response. Just as with the internet, the more these applications take hold with the general public, the more data is likely to be generated – and will need to be transported. Utilities will need to prepare themselves not just for today’s applications, but what can be expected in 10 to 20 years.

The speed of development and widespread adoption of smart networks across Europe will depend heavily on national and European level standards being applicable in a number of key areas.

- End-to-end cyber-security for smart networks

The technology choices deployed for smart networks will heavily depend on the setting of cyber-security policies. Depending on the level of risks identified and preventive measures, these security decisions will then determine the types of communication infrastructure and devices that an operator will choose for an application.

- Interconnection and interoperability standards for energy connection

The connection of widespread energy storage and micro-generation solutions is anticipated to increase significantly with the adoption of smart networks. These new energy sources are predominantly focused on renewable technologies and low carbon emitting alternative fuel sources. There is currently widespread research into possible hybrid and electric powered vehicles for the automotive sector.

While there are existing standards already available in the industry for connecting new loads, it is suggested that these standards need to be reviewed and modified to cater for interconnection of devices onto the network. In particular, the network will need to interact with these devices on a more sophisticated level, for example in the case of electric vehicles different batteries will tolerate different charging patterns to enable optimum life, or the type of plug connection for an electric vehicle.

- Application-level data communications standards

In order to facilitate a smart network, there is also a need to establish standards in areas that will enable interoperability and technology advancement. In the short term, standards development for data communications is required. These standards will be needed to enable a device in the field to converse with back-office systems using a common protocol that is interoperable. It is suggested that these standards are leveraged from existing local and international telecommunications and IT industry standards.

Other areas of standardization may come through utilities developing consistent IT and operational telecommunications architectures. It is suggested that best practice be encouraged but not mandated, as these standards will emerge from other parts of the world and their adoption will be subject to individual business circumstances.

The different technologies developed on the Smart Grid domain will have to face the challenge of supporting the integration of different Smart Grid actors.

In this chapter will analyze the above mentioned standardization requirements applied to the different fields or domains that are behind the Smart Grid concept.

- Smart Network Integration, such as IEC 61850, 61850-7-420 or IEC61970
- Smart Metering Integration, such as ANSI C12.22
- Home and building Integration, such as BACnet or KNX
- Distributed generation and Electrical Vehicle Integration, such as IEC 61235

6.1 Smart Grid Interoperability

As stated above, numerous technologies and standards are available for use in smart grids. Because many players are involved in the smart grid (utilities, transmission and distribution operators, home and building automation vendors, etc.), interoperability is of overwhelming importance.

In **Europe**, CEN, CENELEC and ETSI have recently established a joint Working Group for this purpose [1] with the goal to “advise on European requirements relating to Smart Grid standardization, and assess ways to address them”. The group intends to release “a report that will outline Europe’s standardization views in the area of smart grids” before the end of 2010. The outcome of this group will surely be relevant for eDIANA.

Europe level effort had also been established for Smart Metering with the European Smart Metering Industry Group (ESMIG) [4] trying to harmonize the various national Smart Meter standards/technologies.

The most advanced initiative on smart grid interoperability, however, is the US National Institute of Standards and Technology (NIST) Smart Grid Interoperability Standards Project. On the NIST Smart Grid Collaboration Site [2] related material can

be found. 18 "Priority Action Plans" are defined so far (with the most relevant being highlighted):

0. Meter Upgradeability Standard

1. Role of IP in the Smart Grid

2. Wireless Communications for the Smart Grid

3. Common Price Communication Model

4. Common Scheduling Mechanism

5. Standard Meter Data Profiles

6. Common Semantic Model for Meter Data Tables

7. Electric Storage Interconnection Guidelines

8. CIM for Distribution Grid Management

9. Standard DR and DER Signals

10. Standard Energy Usage Information

11. Common Object Models for Electric Transportation

12. Mapping IEEE 1815 (DNP3) to IEC 61850 Objects

13. Harmonization of IEEE C37.118 with IEC 61850 and Precision Time Synchronization

14. Transmission and Distribution Power Systems Model Mapping

15. Harmonize Power Line Carrier Standards for Appliance Communications in the Home

16. Wind Plant Communications

17. Facility Smart Grid Information Standard

The framework document [3], table 4.1 shows a list of interoperability standards identified by NIST.

Among the NIST selected standards relevant for eDIANA are:

- **BACnet** (ANSI/ASHRAE 135-2008/ISO 16484-5 BACnet - Data Communication Protocol for Building Automation and Control Networks)
- IEC 61970 This IEC standard was initiated by the EPRI with the name of Common Information Model (CIM), to be used to exchange data between applications in Energy management Systems (EMS). The standard started focusing on the transmission network and the main applications of the EMS but now it is evolving to cover the Distribution network, the access to SCADA information and the definition of APIs for information exchange. ESMIG is referencing it.
- ZigBee/HomePlug Smart Energy Profile 2.0 (see 5.1)

- OpenHAN (specification for home area network to connect to the utility advanced metering system including device communication, measurement, and control.) and OpenADR (messages exchanged between utilities and commercial/industrial customers for price-responsive and direct load control)

Further relevant standards:

- KNX is a recognized communication standard for applications in home and building control, ranging from lighting and shutter control to various security systems, heating, ventilation, air conditioning, alarming, water control, energy management, metering and household appliances
- ANSI C12.22. This is a new ANSI standard developed to enable sending and receiving of meter data in a uniform way.
- IEC 61850. This standard (has been defined by the IEC Technical Committee 57 - Architecture for Electrical Power Systems (IEC-TC57). IEC 61850 "Communication networks for power utility automation" is a flexible standard that supports interoperability in substation automation and communication. Interoperability is achieved by defining a coherent information model for electrical components.
- IEC 61850-7-420. This is an extension of the IEC 61850 to support the communication with Distributed Energy Resources (DER) A widespread adoption of this standard would solve interoperability problems related at DER communications with the grid, enabling the grid to accept power injections from all kinds of DG, without additional efforts.

6.2 BACnet

BACnet is a leading communication protocol for **B**uilding **A**utomation and **C**ontrol **net**works. Developed by ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) it became ANSI/ASHRAE Standard 135 in 1995, and ISO standard 16484-5 in 2003. BACnet is under continuous maintenance by ASHRAE, the current release of the standard is 135-2008 [5]. A European BACnet interest group has been established [6].

BACnet has been included into the list of Smart Grid Interoperability Standards by NIST [3].

6.2.1 Technical Overview

The BACnet communication protocol is based on a four-layer collapsed architecture that corresponds to the physical, data link, network, and application layers of the well-known OSI model (OSI Basic Reference Model, ISO-7498), see Figure 1.

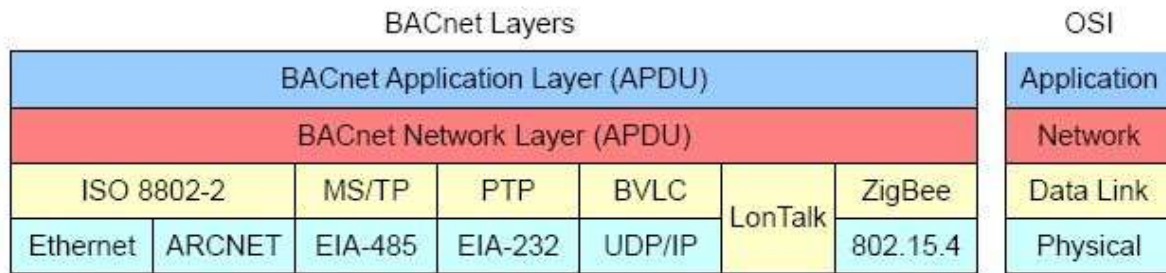


Figure 1 BACnet Architecture (http://kargs.net/BACnet/BACnet_Basics.pdf)¹

- For the low-layer communication in a BACnet segment (i.e. for the physical and link layer), BACnet selects a number of standard technologies and defines how BACnet messages are transported over them. Among them are Ethernet, PTP, and LonTalk.
- BACnet also specifies in a normative annex the transfer of BACnet messages over **UDP/IP**, while the ZigBee alliance in cooperation with the ASHRAE BACnet Standard Project Committee (SPC) specifies the transport (tunnelling) over **ZigBee**. Typically both are included as lower layers in the architecture picture as in Figure 1, which is not precise as IP itself is a network layer and the transport over ZigBee even happens in the ZigBee application layer.

The BACnet standard defines an own **network layer** providing for end-to-end communication over multiple segments with potentially different link technologies. BACnet segments can be connected via bridges to form a BACnet network (with a single local address space). Multiple BACnet networks are connected by BACnet routers to form a BACnet internetwork. BACnet routers are specified in the BACnet standard.

The basic concept of the BACnet **application layer** is that “each network device is modelled as a collection of network-accessible, name entities called ‘**objects**’” [5]. Basic communication is accomplished by reading and writing the properties of particular objects. The application layer consists of an “application entity” that provides application services via an API to the application program (outside the scope of BACnet). The application entity itself is made up of two parts: the BACnet user element (responsible for mapping device activities into BACnet objects) and the BACnet application service element, generating the service primitives (request, indication, response and confirm) that represent the basic information exchanged between two application processes. The service primitives result in the generation of (Application) Protocol Data Units (PDUs) that are passed to the network layer.

6.2.2 BACnet and Smart Grids

The BACnet specification contains a “Load Control” object type. A BACnet device can use such an object to allow external control over the shedding of a load that it

¹ Stephen Karg is a member of the ASHRAE Standard Project Committee 135 (BACnet)

controls. A controller can write the related object properties (Request_Shed_Level, Start_Time, Shed_Duration, and Duty_Window) to initiate a load shedding action. How the device implements the shedding is a local matter. If the device is unable to comply with the shed request it may e.g. provide via the "Expected_Shed_Level" property the amount of power that the device expects to be able to shed in response to the request.

6.2.3 Relevance to eDIANA

Interoperability with/integration into building automation systems will be essential for eDIANA. There are at least 3 "big" building automation standards (or de-facto standards): LonWorks [7], KNX [8], and BACnet. The speciality of BACnet is its inclusion into the NIST Smart Grid Interoperability Standards lists.

In general, eDIANA needs to reflect on the question how it would interact with a standard building automation system (like BACnet)?

6.3 KNX

KNX [8] (pronounced Konnex) is the first standardized system, to deploy home automation scenarios, without any royalty fees or additional licensing charges. KNX is fully independent of the platform and it is composed by different operation profiles to enable different usage domains.

KNX association is composed mainly by security system manufacturers, home automation systems' manufacturers, white-good manufacturers, and telephone companies.

6.3.1 Technical overview

KNX is an OSI-based network communication protocol for intelligent buildings. KNX covers whole stack from presentation down to physical layer. KNX supports several communication media: twisted pair, powerline, radio frequency and Ethernet. Twisted pair is the most common KNX medium and is generally installed when new buildings are constructed. Powerline and radio frequency are typically used when existing buildings are retrofitted.

KNX specifies three operation modes:

- S.mode (System mode). Configuration philosophy follows the EIB concept. This implies that devices have to be installed and deployed by skilled stakeholders.
- E.mode (Easy mode). The main configuration is done by the manufacturer of the devices, nevertheless specialized configuration has to be done at deployment site. To perform this last term configuration it is not necessary high skill. In this type of deployments the functionality is constrained by the pre-configuration done by the manufacturer

- A.mode (Automatic mode). This mode is based on Plug & Play philosophy. In this case, neither the system deployed nor the end user has to do any configuration. This mode is the most appropriate for white-goods, entertainment devices and so on. The aim of this mode is provide to a wide range of manufacturers the possibility to offer a portfolio of products that could be easily integrated in bigger deployments.

At link level, KNX takes advantage of the mayor part of the EIB interfaces, but also incorporated these coming from Batibus and EHS. The different physical media covered by KNX are:

- Twisted Pair (TP1), applying the EIB norm
- Twisted Pair (TP0), applying the Batibus norm
- Power Line Communications (PL 132) applying the EHS norm
- Power Line Communications (PL 100) applying the EIB norm
- Ethernet communications, applying EIB.net
- Wireless radio communications, applying EIB.RF

6.3.2 KNX and smart grids

KNX is a European initiative launched by three associations, EIBA (European Installation Bus Association), Batibus Club International y EHSA (European Home Systems Association). The main objectives for this initiative are:

- Create a standard for Home automation applications to provide functionality to industrial and residential buildings.
- Improve the performance of the different communication medias mainly on radio interfaces
- Introduce new family of devices that could act with Plug & Play policies

6.3.3 Relevance to eDIANA

As stated in previous chapter, KNX is one of the most important building automation standards..The aim of KNX is create a European Standard based on existing platforms (EIB, EHS & Batibus) which could enter in concurrence with the US systems (Lon & CEBus)

This is another reference to eDIANA building automation system.

6.4 ANSI C12.22

This new standard, which is related to smart metering, it is part of an ANSI protocol Group for Meter Communications. This group includes:

- C12.19: describes meter data formats and structures;
- C12.18: provides an optical point-to-point communications protocol that enable communications between companies and ANSI standard meters;

- C12.21: adapts C12.18 to modem communications.

6.4.1 Technical overview

ANSI C12.22 [10] is thought to carry ANSI C12.19 table data over networked connections.

ANSI C12.22 is more abstract than C12.21, because it omits all the details about the underlying protocols, so that it can be used over any communication network (for example TCP/IP over Ethernet, SMS over GSM and so on).

6.4.2 ANSI C12.22 and Smart Grids

OPEN Meter is a project financed by the European Commission within the Seventh Framework Programme. It aims to specify a comprehensive set of open and public standards for AMI, based wherever possible on already existing and accepted standards.

The OPEN Meter Project intends to contribute to the execution of the smart metering standardization mandate given by the European Commission to CEN, CENELEC and ETSI. In particular it is expected that Open Meter deliverables will be helpful inputs to the work of the Smart Metering Coordination group.

6.4.3 Relevance to eDIANA

AMI technology is another challenge to eDIANA system. The adoption of an open standard to manage energy usage enables interoperability, flexibility and integration.

7. Tooling

7.1 QT

QT is a cross-platform application development framework used for the development of GUI programs, in which case it is known as a widget toolkit, and also for developing non-GUI programs such as console tools and servers.

QT uses standard C++ but makes extensive use of a special pre-processor called the meta object compiler, or moc, to enrich the language. QT can also be used in several other programming language via language bindings. It runs on all major platforms and has extensive internationalization support.

Non-GUI features include SQL database access, XML parsing, thread management, network support and a unified cross-platform API for file handling.

QT is released by Nokia on the following platform:

1. Linux/X11 – QT for X Windows system (Unix Linux)
2. Mac OS X – QT for Apple Mac OS x. Support for applications on top of Cocoa APIs
3. Windows – QT for Microsoft Windows
4. Embedded Linux – QT for embedded platforms
5. Symbian –QT for the symbian platform
6. Windows CE – QT for Windows CE
7. Maemo – QT for Maemo

URL

<http://qt.nokia.com/>

Current status :

Current version is version 4.6.3.

Relevance to eDIANA :

Due to the platform independent GUI and non-GUI libraries it is an interesting system to develop embedded cross-platform applications. The cross-platform aspect allows development and debugging on a PC environment and deploy the system on an embedded device.

7.2 Eclipse

Eclipse is a universal tool that can integrate different applications to build an integrated development environment (IDE). The project is developed as open-source

software, and it is split into three parts: the Eclipse Project, the Eclipse Tools Project, and the Eclipse Technology Project.

The Eclipse Project is subdivided into three sub-projects: the platform, JDT (Java Development Tool) and PDE (Plug-in Development Environment).

With Eclipse you can create multiple applications such as Web sites, programs in Java and C++, and Enterprise Java Beans. In addition, Eclipse can integrate other applications as plug-ins, which are automatically recognized by Eclipse during start-up. This plug-ins, contributed to the IDE, become available for the developer.

The plug-in structure of Eclipse has been constructed on top of OSGi. The OSGi framework allows Eclipse to discover and run new plug-ins contributed to the workbench.

As Eclipse is written in Java, for its operation must be installed JRE (Java Runtime Environment). Eclipse will automatically detect the location of the JRE installed.

URL

<http://www.eclipse.org/>

Current status :

Current version is version 3.6 (Helios).

Relevance to eDIANA :

Eclipse is becoming the de-facto standard IDE for the development of Java based applications. In the case of eDIANA, some parts of the architecture are going to be developed with this technology. Additionally, the Eclipse Modeling Framework project (EMF) enhances the functionality of Eclipse to support model-driven engineering techniques. These techniques are relevant to the work being developed in WP6 and for the model driven methodology defined in T2.1.

8. Web Service Technologies

8.1 Relevant standards on web services for eDIANA platform

Web services are usually seen as application interfaces which enable two systems to interact over a network. In practice, applications developers are provided an API (application programming interface) to ease communication with the external system and get application level data. The abstraction layer web services create does not only include communication as its main purpose is to provide business logic, data and processes over the network.

For its use an interface is described by WSDL (Web Service Description Language) and the underlying communication is basically performed by SOAP messages exchange using HTTP with an XML serialization.

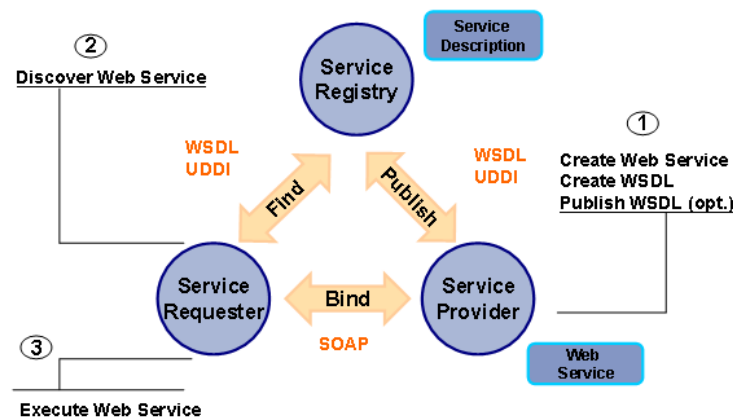


Figure 2 Figure 1Web service architecture²

When programming applications developers can simply add web services to a GUI to offer different functionalities to users. For example, in eDIANA, when retrieving external data sources the weather forecast could be retrieved from any available weather forecast server which usually provide a web service based access.

In the following paragraphs a more detailed explanation of each standard is done in order to understand how these standards' properties enable web service usage.

8.2 XML (eXtensive Markup Language)

Extensible Markup Language (XML) is a text format derived from SGML (ISO 8879). XML plays an important role in the exchange of a wide variety of data on the Web

²

http://help.sap.com/saphelp_mdm550/helpdata/en/45/018c03166a0486e10000000a155369/content.htm

and elsewhere providing the means to describe, store and transmission format of Web services.

XML is similar to HTML, it has elements and attributes but the main difference is XML allows any number of them to be defined being this feature the start for defining data models and structure specifics to a given software domain.

8.2.1 XML content modelling

XML provides an abstraction layer to interoperate across software domains as it can be used as an independent data type and structure mechanism, this means developers only have to map application data into XML and backwards.

XML instances are text based documents structured under descriptive tags. For example:

```
<UserNumber>13536467</UserNumber>
```

XML elements are enclosed in angle brackets and have a start and end. These elements can have one or more attributes described by using a name/value pair for each attribute.

```
<CompanyName Country="Spain" City="Madrid">
```

```
    SP
```

```
</CompanyName>
```

XML schemas are too instances which define types, structure and semantic meaning to be applied to the instance data. Elements in these instances are identified with the xsd prefix.

```
<xsd:element name="UserName" type="xsd:string"/>
```

For instances validation XML processors match element names between the instance and the correspondent schema.

But schemas have a wider use in Web services applications. They are not only limited to data formatting but they are used to contain instructions for data manipulation and storage.

8.2.1.1 Namespaces

Web services usually employ namespaces which are usually modelled as uniform resource indicators (URIs) and a prefix. For example:

```
xmlns:soap="http://www.w3.org/2001/12/soap-envelope"
```

Namespaces solve the problem of when same element names appear in several related documents or document fragments. This is a significant issue in Web services since they typically make use of multiple documents at the same time. Namespace's

URIs can be used for validating elements since they can contain additional information about them.

Another important use for namespaces in Web services is for referencing locations of methods to be executed.

```
<ns1:getWeather xmlns:ns1="urn:examples:weatherservice">
```

8.2.1.2 Parsing

There are two standard programming APIs for parsing XML:

- SAX (Simple API for XML)
- DOM (Document Object Model)

DOM loads the whole document to memory and creates a nodes tree where nodes are XML data. In order to access the information the program has to follow the path to a specific node. On the other hand, SAX works quite differently as it does not require a big use of memory. It does its job by firing events into the application as the document is parsed.

8.2.1.3 Querying and Transformation

8.2.1.3.a XPath

This language has been created to select parts for transformation. Putting it simple, it is possible over this tool to navigate through elements and attributes and extract the desired information for transformation.

8.2.1.3.b XSLT

XSL stands for eXtensive Stylesheet Language, and is a style sheet for XML documents. The extension of this technology is XSLT which means XSL Transformation. The latest one was developed to transform XML documents into presentation formats for screen, paper, etc.

XSLT is widely used in Web Services because it provides the ability to transform an XML document format to another.

8.2.1.3.c XML document structure and mapping

It is a major requirement for Web services to recognize the structure of XML documents and map existing data into XML structures.

Conversion from native data to XML format is not on XSLT scope so tools to take care of this task are needed.

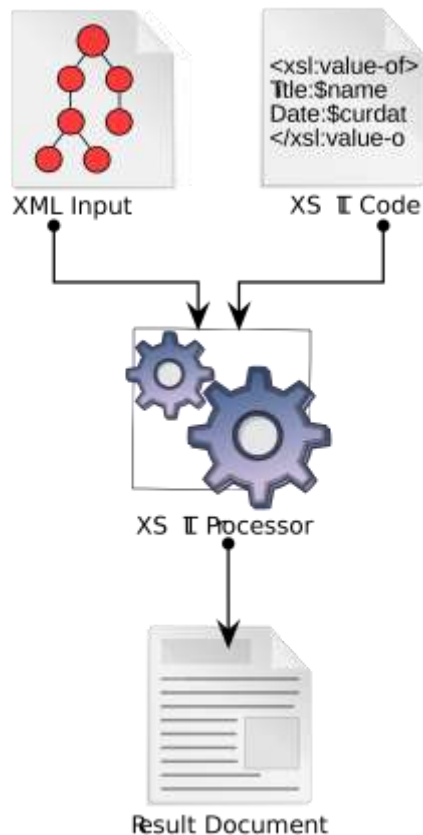


Figure 3 Figure 2 XML transformation

After the XML document is finalized the parser reads through the data and generates a nodes tree in its memory to allow programs to access. Then, it is XSLT's job to include instructions for producing a new document with a new structure.

8.3 WSDL (Web Service Description Language)

WSDL is an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information.

7.1.1.1.a WSDL Elements

WSDL documents use the following elements in the definition of network services:

Types: a container for data type definitions

Message: an abstract description of the data being exchanged

Operation: abstract description of an action supported by the service

Port type: an abstract collection of operations

Binding: a concrete protocol and data format specification for a specific port type

Port: a network address associated with a reusable binding

Service: a collection of ports.

8.3.1 Types

Type element includes data type definitions which are relevant for the exchanged message. It also defines the type system using XSD as default system.

```
<types>
  <xsd:schema .... /*>
</types>
```

It is also allowed to add other type systems via extensibility elements

```
<types>
  <!-- type-system extensibility element --> *
</types>
```

8.3.2 Message

Messages consist of one or more logical parts. Parts are flexible mechanisms to describe the logical abstract content of a message.

```
<message name="PO">
  <part name="po" element="tns:PO"/>
  <part name="invoice" element="tns:Invoice"/>
</message>
```

If the message contents are complex it is allowed to describe parts using the type system directly but only one part may be specified.

...

```
<complexType name="Composite">
  <choice>
    <element name="PO" minOccurs="1" maxOccurs="1"
type="tns:POType"/>
    <element name="Invoice" minOccurs="0"
maxOccurs="unbounded" type="tns:InvoiceType"/>
  </choice>
</complexType>
```

...

```
<message name="PO">
  <part name="composite" type="tns:Composite"/>
</message>
```

8.3.3 Port Types

Port Type is a named set of abstract operations and the abstract messages involved in each operation.

```
<portType name="Hello_PortType">
  <operation name="sayHello">
    <input message="tns:SayHelloRequest"/>
    <output message="tns:SayHelloResponse"/>
  </operation>
</portType>
```

WSDL supports four types of operations:

One way. The operation has one single input element.

```
<wsdl:definitions .... > <wsdl:portType .... > *
  <wsdl:operation name="nmtoken">
    <wsdl:input name="nmtoken"? message="qname"/>
  </wsdl:operation>
</wsdl:portType >
</wsdl:definitions>
```

Request-response. The operation has an input followed by and output element.

```
<wsdl:definitions .... >
  <wsdl:portType .... > *
    <wsdl:operation name="nmtoken" parameterOrder="nmtokens">
      <wsdl:input name="nmtoken"? message="qname"/>
      <wsdl:output name="nmtoken"? message="qname"/>
      <wsdl:fault name="nmtoken" message="qname"/>*
    </wsdl:operation>
  </wsdl:portType >
</wsdl:definitions>
```

Solicit-response. The operation has an output element followed by the input.

```
<wsdl:definitions .... >
  <wsdl:portType .... > *
    <wsdl:operation name="nmtoken" parameterOrder="nmtokens">
      <wsdl:output name="nmtoken"? message="qname"/>
      <wsdl:input name="nmtoken"? message="qname"/>
      <wsdl:fault name="nmtoken" message="qname"/>*
    </wsdl:operation>
  </wsdl:portType >
</wsdl:definitions>
```

Notification. The operation has a single output.

```
<wsdl:definitions .... >
  <wsdl:portType .... > *
    <wsdl:operation name="nmtoken">
      <wsdl:output name="nmtoken"? message="qname"/>
    </wsdl:operation>
  </wsdl:portType >
</wsdl:definitions>
```

Operations are named via the name attribute. If input and output elements are not named, WSDL links those elements to the operation's name since it provides default values according each operation.

8.3.4 Bindings

A Binding defines messages format and protocol details for operations described by a particular portType. It must specify only one protocol and no address information.

```
<wsdl:definitions .... >
  <wsdl:binding name="nmtoken" type="qname">
    <!-- extensibility element -->
    <wsdl:operation name="nmtoken">
      <!-- extensibility element -->
      <wsdl:input name="nmtoken"? >
        <!-- extensibility element -->
      </wsdl:input>
      <wsdl:output name="nmtoken"? >
        <!-- extensibility element -->
      </wsdl:output>
      <wsdl:fault name="nmtoken">
        <!-- extensibility element -->
      </wsdl:fault>
    </wsdl:operation>
  </wsdl:binding>
</wsdl:definitions>
```

The name attribute gives a unique name among all bindings found in the WSDL document. The type attribute references the portType that it binds.

Binding extensibility elements are used to specify the concrete grammar for the input, output, and fault messages. Per-operation binding information as well as per-binding information may also be specified.

8.3.5 Ports

A port specifies a single address for a specific binding.

```
<wsdl:service .... >  
  <wsdl:port name="nmtoken" binding="qname">  
    <-- extensibility element -->  
  </wsdl:port>  
</wsdl:service>
```

Extensibility element specifies port's address information.

8.3.6 Services

As previously mentioned, a service groups a set of related ports together.

How ports are related:

None of them communicate with each other

There can be alternative ports which are the same portType but binded in a different manner

We can determine a service's portTypes just by examining its ports. It is useful for a user to choose an appropriate service to accomplish certain tasks.

8.4 SOAP (Simple Object Access Protocol)

SOAP is an XML-based protocol for exchanging information in the implementations of Web Services in computer networks. It specifies one-way messages using XML Information Sets, which provide an abstract description of their content. These messages are provided for a simple request/response interaction pattern so an underlying protocol or applications can create more complex structures by combining such one-way exchange with extra features.

8.4.1 SOAP message framework

Message structure specification includes three main elements and correspondent sub-elements: the envelope, header and message's body. The following figure illustrates SOAP message's structure.

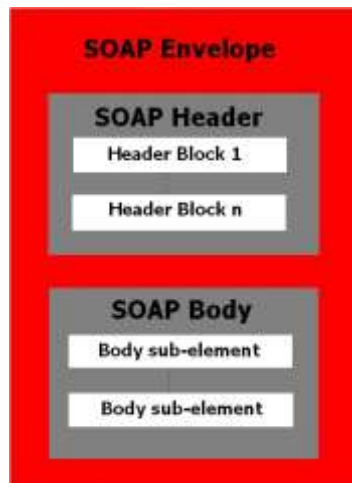


Figure 4 Figure 3 SOAP message's structure

SOAP envelope element defines the start and end of a message. The header is optional and it is useful when "meta-data" needs to be processed by a SOAP node. This additional data could contain, i.e. user data or time-stamp for control operations, etc. Sub-elements Header blocks represent a logical grouping that can be individually be targeted by SOAP nodes (also called SOAP intermediaries).

The last element, the body, is the message's main part and it is intended for information exchange between SOAP ends (sender and receiver). XML format is a better way to appreciate how messages are actually implemented.

```
<?xml version="1.0"?>
<SOAP-ENV:Envelope
xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">

<SOAP-ENV:Header>
...
</SOAP-ENV:Header>

<SOAP-ENV:Body>

...
<SOAP-ENV:Fault>
...
</SOAP-ENV:Fault>
</SOAP-ENV:Body>
</SOAP_ENV:Envelope>
```

Figure 5 Figure 4 SOAP XML message

It is worth mentioning that the Fault sub-element which appears in the figure is optional and it is used for applications to know when there has been a failure in message processing.

8.4.2 SOAP Message Exchange

SOAP makes use of one-way XML-based messages. Therefore, the simplest scenario involves a request response interaction between a SOAP sender and a SOAP receiver, see also figure 5. Some early uses employed this simple pattern to convey remote procedure calls (RPC) but not all request-response exchanges must be modelled as RPCs. More complex patterns can be achieved as “conversational” exchanges leaving the semantics to the application level.

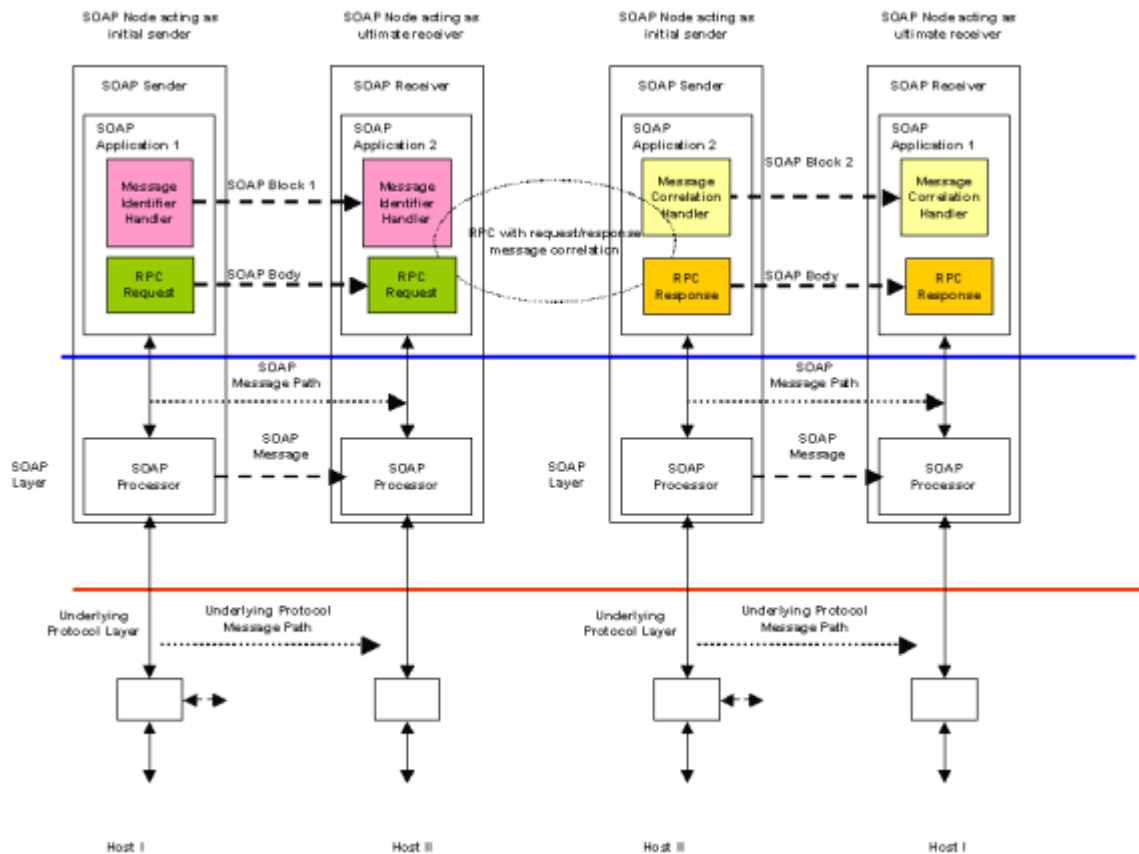


Figure 5 SOAP RPC Exchange

8.4.3 Remote Procedure Call (RPC)

RPC refers to remote invocation of a method or procedure. The application using this functionality does not really have the notion of executing a subroutine in another address space (another network or computer) as it is programmed almost as if it was part of a class' method.

This SOAP feature's goal is to encapsulate RPC functionality. To invoke a SOAP RPC, the following information is needed:

- SOAP node's address
- Procedure or method name
- Arguments and values for the method and the expected output parameters and return value.

- Separation of arguments used to represent the Web resource which is the target for the RPC from control data used for processing the call by the target resource.
- Binding information
- Optional header blocks

From a SOAP perspective, there is an end point which supports the RPC. It is the SOAP node addressed by the first item at the list the one that plays the role of the ultimate receiver. This node can identify the target of methods by looking for its URI.

The RPC itself is carried as a child of the Body element and is modelled as a “struct” which takes the name of the procedure or method.

8.4.4 SOAP Fault Message

Fault messages are used for communicating failures in the processing of a message. The SOAP Fault model requires that the *env:Fault* element is placed within the message’s body. This element must contain two specific sub-elements, *env:Code* and *env:Reason*, and (optionally) application-specific information in the *env:Detail* sub-element.

```
<env:Envelope xmlns:env="http://www.w3.org/2003/05/soap-envelope">
  <env:Header>
    ...
  </env:Header>
  <env:Body>
    <env:Fault>
      <env:Code> (required)
      <env:Value>env:VersionMismatch | env:MustUnderstand | Sender
        | DataEncodingUnknown | Receiver</env:Value> (required)
      <env:Subcode> (optional)
      <env:Value>text</env:Value> (required)
      <env:Subcode> (optional)
      ...
    </env:Subcode>
  </env:Subcode>
</env:Code>
<env:Reason> (required)
  <env:Text xml:lang="languageCode">text</env:Text> (required)
  <env:Text xml:lang="languageCode">text</env:Text> (optional)
  ...
</env:Reason>
<env:Node> (optional)
  http://herong.com/processingNode
</env:Node>
<env:Role> (optional)
  http://herong.com/processingRole
</env:Role>
<env:Detail ...> (optional)
  ... (any XML structure)
</env:Detail>
</env:Fault>
</env:Body>
</env:Envelope>
```

Figure 6 Figure 6 SOAP Fault Message structure

8.4.5 SOAP Processing Model

The SOAP processing model describes the specific actions to take by a node when receiving a message. Obviously, the first step to take is to check SOAP message's syntax. Then, it is required for the node to analyse those parts of a message in the *env* namespace.

8.4.6 The "role" Attribute

The `env:role` attribute - syntactically, `xs:anyURI` - is optional and it may be present in a header block. It is up to the role attribute whether the header is processed or not by the node. In other words, the role specified for the node must match the role attribute of the header block.

There are three standardized roles defined:

"<http://www.w3.org/2003/05/soap-envelope/role/none>" (hereafter simply "none")

"<http://www.w3.org/2003/05/soap-envelope/role/next>" (hereafter simply "next"),
and

"<http://www.w3.org/2003/05/soap-envelope/role/ultimateReceiver>" (hereafter simply "ultimateReceiver").³

The following table summarizes the different roles that may be assumed by different nodes.⁴

Role	Absent	None	Next	ultimateReceiver
Node				
initial sender	not applicable	not applicable	not applicable	not applicable
intermediary	no	no	yes	no
ultimate receiver	yes	no	yes	yes

8.4.7 The "mustUnderstand" Attribute

The `env:mustUnderstand` attribute is found in a header block. It is utilized to ensure a SOAP node do not ignore header blocks which are relevant for the overall purpose of the application. When found, message processing must not continue until the node has identified all mandatory header blocks and understood them.

³ <http://www.w3.org/TR/2007/REC-soap12-part0-20070427/#L1244>

⁴ <http://www.w3.org/TR/2007/REC-soap12-part0-20070427/#L1244>

Values for this attribute can be:

true: It is mandatory to process this block unless the node's role does not match the role attribute. In case it is not possible to process the required header block a SOAP fault must be generated.

false: The header block might be processed or not. It is not mandatory.

8.4.8 The "relay" Attribute

The env:relay of type xs:Boolean is defined in SOAP version 1.2, which indicates whether a header block targeted at a certain SOAP intermediary must be relayed if not processed.

By default, SOAP intermediaries erase non processed headers from the message. In case relay is set to "true" within a header block, the node retains such header in the message.

8.5 CE-HTML

8.5.1 Introduction

CE-HTML is a language, developed for creating Consumer Electronics' user interfaces such as Philips televisions. CE-HTML pages are placed on a server. Originally, they mainly focus on a UI that will be read by the users from a long distance (>3m), so called "10 foot interfaces". These are user interfaces that support an easy navigation from a long distance. Nowadays, CE-HTML has no specific relation anymore with screen sizes or read distances. Today, CE-HTML supports also mobile device displays for example.

CE-HTML is part of the ANSI/CEA-2014 standard (also referred to as Web4CE [11]), defined within the Consumer Electronics Association. Also, the use of CE-HTML is rising within other standards, such as the Open IPTV Forum, the Digital Living Network Alliance (as of version 2) and HbbTV. Philips is very involved in the discussion and realization of these standards.

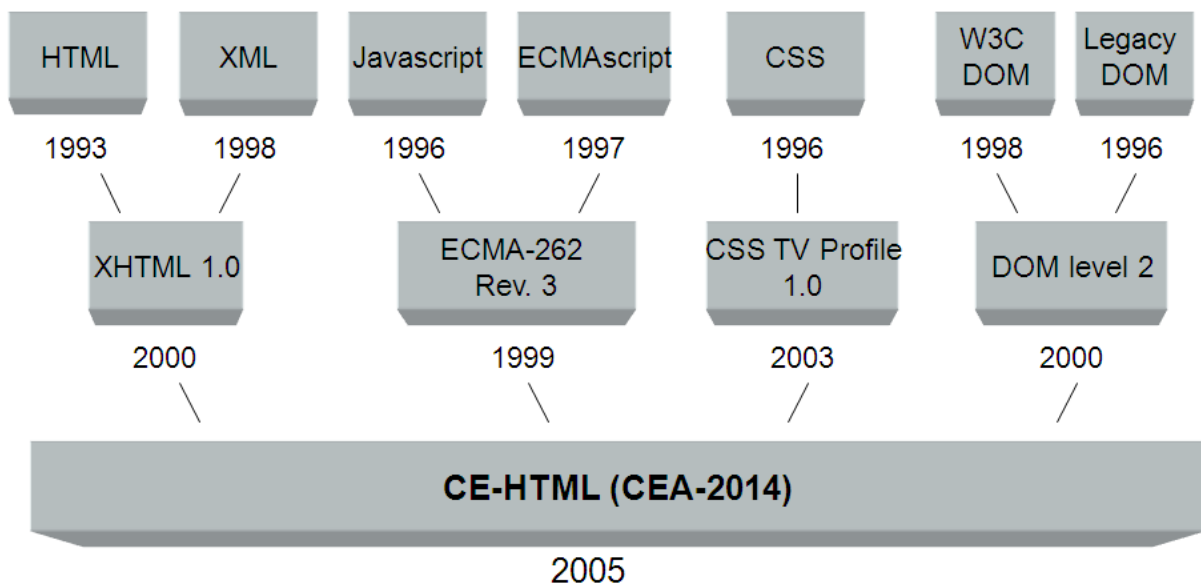


Figure 7 : CE-HTML history

8.5.2 Features [12]

CE-HTML consists of the following internet languages:

- EcmaScript 262, 3rd edition
- XHTML 1.0 transitional/strict
- CSS TV Profile 1.0
- XMLHttpRequest object
- DOM level 2.0 (Core, Style, Events, HTML)
- a number of specific extensions for CE devices.

CE-HTML can both be used in-home through UPnP as via the internet. It allows the content creator to use the common and known languages in the web to define a user interface that can be controlled on a CE device. A CE-HTML client typically consists of a web browser adapted for the CE-HTML standard running on a consumer electronics device. CE-HTML offers specific extensions for these browsers such as :

- Multi-tap or other CE-specific alpha-numeric input support, by making use of the CSS3 input-format tag.
- media (audio/video) playback through the use of an audio/video scripting object.
- operation via remote control (spatial navigation) using the up, down, left, right and OK keys.
- client capability matching - to match the client capabilities to the user interfaces that the server offers. For this purpose, each CE-HTML compliant client is making use of a capability profile. This profile, placed in the user-agent string of the client, lets the server know what part of CE-HTML is supported by the client. The server in turn transmits its capabilities in a so

called "XML UI Listing" so the client can choose between the various CE-HTML user interfaces the server offers.

- user interface profiles for usage on CE devices such as a television. These are predefined capability profiles on which a CE-HTML client can base its capabilities. They define e.g. the fonts supported, screen-size of the device and the media that is supported by the a/v scripting object in the device. All profiles are based on a 10-foot user interface.
- 3rd party notifications which allow a client to poll for messages from an external server, and display these to the user regardless of the currently displayed user interface.
- a specific new MIME-type for CE-HTML content: "application/ce-html+xml".

8.5.3 Example

An example of CE-HTML code:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"ce-html-1.0-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>CE-HTML</title>
</head>
<body onload="document.getElementById('myvid').play(1);">
CE-HTML a/v object:<br/>
<object type="video/mp4" id="myvid" data="myvideo.mp4" width="640"
height="480"></object>
</body>
</html>
```

9. Conclusion

9.1 eDIANA environment

The understanding of the technologies used at the development of the Smart Grids provides to the eDiana project the knowledge about the future Smart Grids deployment. Based on this knowledge, the eDiana platform acquires the required background to take into its design phase the coming concepts about the energy trading and the role of buildings on it.

Numerous technologies and standards are available for use in smart grids. Because many players are involved in the smart grid (utilities, energy traders, transmission and distribution operators, home and building automation vendors, etc.), interoperability is of overwhelming importance. Powerful initiatives are established to achieve interoperability by selecting recommended standards. eDIANA platform will have to be designed in a way that allows conforming to these interoperability requirements when finally established.

Currently, energy management systems are ready to operate with market tariffs and day ahead trading. Nevertheless the concept of the Macrocell as high level contract concentrator that intermediates between the last term user and the utilities is a coming approach to the energy trading business.

The main impact of the Smart Grids technologies is reflected on WP04, this is the developments around the Macrocell level concentrator.

At demonstrator level different trading scenarios will be tested, introducing situations in which overall building consumption, energy tariffs and different contracts may enter in conflict.

9.2 eDIANA in relation with existing standards

In general, eDIANA can exploit and support standardisation initiatives linked with:

- Standards to increase the number of intelligent components, equipment and services that take into account their direct and indirect energy consumption. For instance, smart metering needs standards of energy flows by time slice. To achieve transparent clearing markets, smart meters must report what amount of what kind of power was purchased at what price at what time. These functions will have a big role in the future world of distributed generation and Net Zero Energy embedded systems. European Smart Metering Industry Group (ESMIG) covers all aspects of Smart Metering, i.e. utility metering, installation, consulting, software, meter reading, hosting and all relevant communications' solutions. eDIANA consortium should coordinate and interact with ESMIG (and CENELEC) the topics related to smart metering technologies covered in eDIANA.
- Data interchange standardisation with external entities. The eDIANA platform is being designed to provide a common description of building space and building systems to support energy models. This is supported by the ontologies and model-based approach followed in the eDIANA project. As can be seen in eDIANA WP1 deliverables, there was an initial effort to define the device ontology based on the IFC data models. This is a first effort towards BIM (Building Information Model) datasets, and it should be possible to expose information with little trouble. The final goal is to foster the standardisation of BIM. A standard for the exchange of this information would reduce the costs of information discovering and perhaps stimulate a market for third party discovery tools.
- Energy-aware communication – in this area UPnP architecture offers pervasive peer-to-peer network connectivity of PCs of all form factors, intelligent appliances, and wireless devices by enabling capabilities discovery of the devices in proximity and instantiation. eDIANA should study and check potential contributions to the UPnP Low Power architecture, which allows devices implementing power saving and stand-by modes to report and track their status.
- OSGi alliance group aims at defining a standardized, component oriented computing environment for networked services. OSGi offers the technological means, by which services can be added on residential gateways and administered in a seamless way. OSGi has received significant attention mainly targeting the residential users and the domestic market. Nevertheless, issues related to energy consumption and power consumption patterns are not supported by the currently provided bundles.

- Intelligent Buildings. The eDIANA project consortium is actively using and should also seek extensions of key standards in this area, including LonWorks, ZigBee, Z-Wave, BACnet, etc.

9.3 Recommendations

- eDIANA shall will communicate with ProSE, REEB and ARTEMISIA about possible standardisation promotion actions by ensuring consistency with the ARTEMIS standardisation agenda. This A set of real contributions to standards shall be listed in deliverable D9.3-A. in order to prepare a promotion strategy, aligned with other relevant support activities under FP7 such as REEB (<http://www.ict-reeb.eu/>) or ProSE (<http://www.prose-project.eu/>) as well as ARTEMISIA roadmap. eDIANA has already interacted with REEB by providing inputs to their roadmap (Labein, ACCIONA and ESI-Tecnalia). This will be reflected in deliverable D9.2-A.
- ProSE will provide a vision and recommendations on the way in which embedded systems standards can create synergies between business domains. eDIANA should link with ProSE to leverage their activities in the field of embedded technologies for energy efficiency.
- Dissemination activities are being promoting the eDIANA platform in standardisation bodies and in initiative like ProSE and REEB.
- eDIANA shall identify how eDIANA partners can actually influence in standardisation bodies (monitoring, contribution, harmonisation tasks) and what are the priorities. This will be reflected in deliverable D9.1-B
- Beyond the project (assuming its success), project partners will continue to push the technology.

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