eDIANA
Embedded Systems for Energy Efficient Buildings

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# Certification Standards Analysis

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## Disclaimer

# Summary

*The Certification Standards Analysis is a public document delivered in the context of WP6, task 6.3 with regard to the definition of certification process modelling notations.*

*This document is about the analysis of standards, regulations and existing internal guidelines to be applied in the case study to get a common terminological foundation for a certification meta-model.*

# Contents

# Abbreviations

| | |
|---|---|
| eDIANA | Embedded Systems for Energy Efficient Buildings |
| CASS | Conformity Assessment of Safety-related Systems |
| CEN | Comité Européen de Normalis |
| CENELEC | Comité Européen de Normalisation Électrotechnique |
| CMMI | Capability Maturity Model Integration |
| E/E/PE | Electrical/electronic/programmable electronic |
| E/E/PES | Electrical/electronic/programmable electronic system |
| EPBD | Energy Performance of Building Directive |
| ETSI | European Telecommunications Standards Institute |
| EUC | Equipment under control |
| DG | Distributed Generation |
| HBES | Home and Building Electronic Systems |
| HV | High Voltage |
| IEC | International Electrotechnical Commision |
| ISO | International Organization for Standardization |
| ITU | International Telecommunication Union |
| LV | Low Voltage |
| MV | Medium Voltage |
| PV | Photovoltaic |
| RD | Royal Decree |
| RES | Renovable Energy Sources |
| SEI | Software Engineering Institute |
| SIL | Safety integrity level |

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|---|---|
| SPICE | Software Process Improvement and Capability Determination |

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# 1. Introduction

The task in which this document is placed, Task 6.3 Specification of a Certification Metamodel for Energy Management Deployments covers the aspect of certification of the Work Package 6 Compositional Verification, Validation and Certification. The main objective of this task is to identify the common aspects in the eDIANA required certifications and significant related certification processes in order to define a generic certification process model notation.

This document is the first one defined in the task, the work done inside this document consists of analyzing several standards, code of practices in order to identify the commonalities, differences and to try to map and select the "standards" issues into a certification Metamodel.

A standard in this deliverable has to be understood as the compliance with some horizontal standards, like the safety standards IEC 61508 and the software process improvement models CMMI, and a vertical standards or codes of practice related to energy efficiency or home automation, like CWA 50487 SmartHouse Code of Practice or 2002/91/EC EPBD (Energy Performance of Building Directive) which requires all EU countries to enhance their building regulations and to introduce energy certification schemes for buildings.

The mentioned analysis will provide us the basis to define the elements which will make up the metamodel for the evolutionary certification. The analysis has been performed from the highest level (i.e.: group of processes) to the work products required in each process. The mapping has the intention to, saving the many issues and the different understandings, establish the commonalities and differences between the covered standards. In principle, the analysis has the objective of identifying all the needs for applying and justifying a certification. This means the identification of the tasks/activities and techniques/methods to be performed by a role in order to achieve a required and defined work product.

The metamodel should provide at least the elements required to be reflected in the different models to be able to apply for an evolutionary certification. The typical certification process referred to software developments implies the software processes and the artifacts generated by performing each of the processes to complete the overall life cycle assessment. Therefore, in principle an analysis of the different models to be used is also required.

This deliverable D6.3a Certification Standard Analysis has the objective to analyze the selected standards to allow later deliverables to identify the different elements contained by the metamodel in order to represent the required models to apply for an unambiguous certification process. Once the metamodel will be in place the next deliverables of the task will be the analysis in order to search the best way to represent the metamodel with an standard language supported by a tool to be defined in the deliverable 6.3E Executable process framework for certification.

Based on the industrial partners' experiences applying certification, a typical case is to certify the same product regarding different standards which requires the certification models comparison. Therefore, the main objective of Task 6.3 is to facilitate the certification process applying to different certifications without changing the internal software lifecycle and with a clear view during the lifecycle of the completeness of the needs and producing the work needed to apply for a certification

# 2. Certification

This section shows the most common certification types by the industry and the standards selected after considering the domains of the eDIANA Project (building, embedded devices, energy efficiency, …) and the expertise of involved partners. The objective here is to make a brief summary of the Software and products certification consist of a wide range of formal, semi-formal, and informal assurance techniques, including formal verification of compliance with explicit safety policies, system simulation, testing, code reviews, different measurements etc. As a result, the certification can have different types, and the process himself could require different methods.

Another objective is finding the problems identified by the industry that justifies and therefore leads to define the evolutionary certification basis. The following different types of certification are possible according to the object searching certification.

- Product certification (according to particular technical standards)
- Process certification (according to ISO 9000 or similar)
- Personnel certification has to be understood as the compliance with some standardized rules established by a company in an in house
- Accreditation of certification (i.e.: any of the industrial partners in this project - methodology)

In the eDIANA project certification has to be understood as the compliance with some standardized rules established by a company in a house certification (i.e.: any of the industrial partners in this project - methodology), by an organism in a proprietary standard/model (i.e.: SEI – CMMI), by a local government in a safety standard (i.e.: ISO IEC 61508), by the European Commission in a energy directive (i.e.: 2002/91/EC EPBD or by a non-profit technical organization (i.e.: CENELEC-CWA 50487).

eDIANA Task 6.3 just covers the product and process certification. There are many other types of certification, mainly the ones who certify people in a specific IT knowledge, which also includes the standard knowledge (i.e.: American Society for Quality, PMI, BSI INTACS, ISQI, ISTQB, Microsoft certifications, etc.). There are also specific certifications which guarantee the compliance with a specific product (i.e.: Microsoft, Vodafone, etc.certifiers).

Based on the consortium experiences and needs nowadays the safety certification (mandatory for the application in a specific domain a required by a local government) and the software quality model (mainly CMMI, Spice, AutomotiveSpice required by many customers and governments) are the most common ones.

Industrial firms often adopt some variation of the classic model as the basis for standardizing their software development practices (Royce 1970, Boehm 1976, Distaso 1980, [Humphrey 1985], Scacchi 1984, Somerville 1999). Such standardization is often motivated by needs to simplify or eliminate complications that emerge during large software development or project management.

It is also important to refer the motivation to research for an object certification. This one can be imposed safely or to increase the object reliability.

When instantiating a certification type for a specific object (e.g. software), a certification scheme is defined (e.g. software certification scheme). Considering software as an object of certification, only products and process certification schemes are considered in this document.

Based on the analysis presented in this document, the following groups of software certification schemes have been identified:

- The **first group** includes the certification of safety related systems using specific standards or guidelines, e.g. IEC 61508. In this group, detailed requirements and guidelines are provided relative to the audit trail necessary to achieve the certification objectives;
- In the **second group**, instead of detailed requirements and guidelines, a certification model or framework is provided to be instantiated in terms of quality models and evaluation methods. The framework is focused on quality characteristics (e.g. ISO 9126, IEC 14598, and IEC 12119) which can include safety as well;
- A **third group** consisting of certification schemes that are process-oriented (e.g. ISO 9000). In this case instead of focusing on the final product, the certification scheme focuses the development process itself.

In general, achieving a certification involves the following steps:

- Evaluate certification requirements and establish a liaison with the certification body;
- Create necessary certification artefacts and support their examination by certification body;
- Take action according to results of examination and issue of certificate when results are accepted by certification body.

The steps may differ in complexity and effort depending mainly on the group of software certification scheme.

Certification requirements are managed by the respective certification body and are normally issued in the form of an internationally recognized standard document. During the liaison process the entity searching certification establishes a plan of how to achieve all certification requirements (e.g. what artefacts are to be developed and what examination are expected from the certification body).

Having evaluated and established the certification requirements and respective plan and established a liaison with the certification body, the plan starts its execution which can be simplified to the creation of artefacts that cover all certification requirements. The generation of certification artefacts has to be carried out according to a plan covering all aspects of the certification. Certification artefacts can consist of dynamic tests as well as of static analysis. Certification artefacts can be generated by an entity different from the one requesting the certification.

Parallel to the creation of artefacts, support must be given to the examination of the certification artefacts by the certification body. The created artefacts are checked against the certification requirements and if successful, the certification body issues a certificate.

## 2.1 Certification Actors

This section will identify the different actors that mediate in a most abstract certification process.

- Certification Entities: they are the companies, organizations, associations that have the function of certifying other companies, products or process of companies, etc. They audit the company that wants to obtain the certification. These entities must be independent from the company they audit, so they can not have made any other work for the same company.

- National Accreditation Entities: these entities are in charge of evaluating the Certification Entities. Actually, each country usually has their own National Accreditation Entity, in some cases, there are some agreements to acknowledge certificates between them (IAF – International Accreditation Forum). It is recommendable that the certifications that these entities issue will be supported by an Accreditation of this entity. There are some Accreditation Organizations well known internationally like: ANAB (EEUU), RvA (Netherlands), UKAS (UK), SCC (Canada), IRAM (Argentina), ICONTEC (Colombia)

- Certificated Product or Process. It can be an equipment, a component of an equipment, a system, a company process, a process in a project, …

- Certificated Product or Process Manufacturer or Builder. The company, organization who wants to certificate a product, process, component,…

- Applied Standard, Regulation or Practices. The standard, normative, regulation the certification wants to
- Entity-organization that supplies and support the standard, regulation,…

## 2.2 Certification Use Cases

This section will consider different possibilities about certification inside eDIANA Project.

Taking into account that many eDIANA Consortium members are industry companies that develop their own equipment, each of them inside their respective market field, the first certification use case that can be presented is:

**The certification of existing equipment**. This certification can be necessary in order to have the possibility of selling that equipment inside a community.

An example of that use case can be any appliance inside eDIANA Platform that must be labelled to provide information of the consumption of energy, under the European Commission Directive 92/75/EEC.

Another example can be the certification of an existing product under any standard in order to provide a reference of the quality of the product. It could be the certification of a level of safety (IEC 61508 safety level) for a critical equipment or component of eDIANA platform. In this case, the certification is not mandatory but gives an indication of the quality of the component or equipment.

Next possible use case of certification in eDIANA Project could be:

**Re-Certification**: when a product, process is already certificated for one established standard, but it needs to be compliant with another standard, the whole product or components. This can easily happen when a multipurpose component of a product is intended to be use in different sectors, with different regulations, or if the company intends to sell it in another country with other regulation.

The energy efficiency labels for appliance is similar in US (Energy Star) and EC (92/75/EEC), both establish categories of energy efficiency, but the regulations are not the same, so the same product should be compliant with both regulations and get both certifications if it is desired to be sold in both places.

Another visible use case that can happen is:

**Certification because of a change in the regulation or the adoption of a new regulation**. It is not unusual that European Commission defines and standard or a directive after several countries have adopted their own regulation, that a standard "de facto" is adopted as a mandatory standard, or that a defined standard is improved or extended, mostly when it affects to new technologies. In this case, it is necessary the adaptation to the extended or new standard should be required.

# 3. Standards Identification

This section aims to identify the existing standards that are relevant in eDIANA Project, as well as the entities that produce, control and accredit those standards.

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

| Logo | Entity | Standards | Description | Country members |
|---|---|---|---|---|
| CENELEC | CENELEC (Comité Européen de Normalisation Électrotechnique)- European Committee for Electrotechnical Standardization. | EN-European Standards<br><br>HD-Harmonization Document<br><br>TS-Technical Specification<br><br>TR-Technical report<br><br>G-Guides<br><br>CWA-CENELEC Workshop Agreement | CENELEC is responsible for European Standardization in the area of electrical engineering.<br><br>Standards harmonised by this agency are regularly adopted in many countries outside Europe which follow European technical standards.<br><br>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.<br><br>Albania, Bosnia/Herzegovina, Bulgaria, Croatia, Macedonia, Serbia and Montenegro, Turkey and Ukraine are currently 'affiliate members' with a view to becoming full |

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| | | | | members.<br><br>Although CENELEC works closely with the European Union, it is not an EU institution. |
| | CEN (The European Committee for Standardization or Comité Européen de Normalis) | EN-European Standards<br><br>prEN-Draft European Standard<br><br>CWA-CEN Workshop Agreement<br><br>TS-Technical Specification<br><br>TR/Technical Report | The CEN is a private non-profit organisation 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.<br><br>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 recognised | 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.<br><br>The current affiliates are Albania, Croatia, Macedonia and Turkey. |

| | | | | |
|---|---|---|---|---|
| | | | as a European standards body by the European Union. | The current partner standardisation bodies are Australia, Bosnia and Herzegovina, Egypt, Moldova, Russia, Serbia, Tunisia and Ukraine |
| | ETSI (European Telecommunications Standards Institute) | TS-ETSI Technical Specification<br><br>TR-ETSI Technical Report<br><br>ES-ETSI Standard<br><br>EG-ETSI Guide<br><br>EN-European Standard<br><br>SR-ETSI Special Report | 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.<br><br>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 | 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 arena. |

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

*Table 3-1 European Standardization Entities*

Next table will show the most significative international entities related to standardization

| Logo | Entity | Standards | Description | Country members |
|---|---|---|---|---|
| ISO | ISO (International Organization for Standardization) | ISO[/IEC][/ASTM] [IS] nnnnn[:yyyy] Title-International Standard<br><br>ISO[/IEC][/ASTM] [TR] nnnnn[:yyyy] Title-Technical Report<br><br>ISO[/IEC][/ASTM] [TS] nnnnn[:yyyy] Title-Technical | 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 | ISO has 158 national members, out of the 195 total countries in the world, distributed in member bodies, correspondent members and subscriber members |

| | | | | |
|---|---|---|---|---|
| | | Specification<br><br>ISO[/IEC] Guide N:yyyy: Title-Guide | through treaties or national standards, makes it more powerful than most non-governmental organizations | |
| | IEC (International Electrotechnical Commision) | IEC 60xxxx- IEC Standards | 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.<br><br>This includes:<br><br>o manufacturers, providers, distributors and vendors<br>o consumers and users<br>o all levels of governmental agencies<br>o professional societies and trade associations |

| | | | | |
|---|---|---|---|---|
| | | | | o standards developers |
| | ITU (International Telecommunication Union) | XZ.nnnn[:yyyy]-ITU-T Recommendation | 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 | 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 |

*Tabla 3-1 International Standardization Entities*

The numbering of European standards follows a well structured and organized sequence:

- EN 50225:1996 (the year of availability of the EN is separated from the number by a colon)
- EN 50157-2-1:1996 (the part number is indicated by a hyphen)

The first two numerals indicate the origin of the standard:

- 40000 to 44999 cover domains of common CEN/CENELEC activities in the IT field
- 45000 to 49999 cover domains of common CEN/CENELEC activities outside the IT field
- 50000 to 59999 cover CENELEC activities
- 60000 to 69999 refer to the CENELEC implementation of IEC documents with or without changes

The IEC and the ISO have allocated themselves blocks of publication numbers: from 1 to 59999 for ISO and from 60000 to 79999 for the IEC.

A standard is a technical specification, they are not compulsory unless legal directives establish formal references to them. They are elaborated through an agreement between the concerned parts inside a well-known organization. They must be base on the experience and the technologically development.

Next table shows the agents that are involved in the definition of a standard.

| | **Requirements of companies** | **UNE Standard** | **Regulation** |
|---|---|---|---|
| Elaboration | Company | All related parts | Public Administration |
| Adoption | Company | Agreement in a well-known organization | Public Administration |
| Application | Company | Economic Agents | Economic Agents |
| | | Voluntary (Administration can obligate to fulfil them by reference) | Mandatory |

*Table 3-2 Agents in the definition of a standard*

Next there is a description of the most suitable standards, workshop agreements, technical specifications and reports related to eDIANA Project. They can be related to processes of eDIANA companies or eDIANA Project, to equipment of eDIANA Platform, or to services and applications of eDIANA Platform.

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| Capability Maturity Model Integration (CMMI) | A process improvement maturity model for the development of products and services. It consists of best practices that address development and maintenance activities that cover the product lifecycle from conception through delivery and maintenance. | An organization can be appraised, not certified. Depending on the appraisal the organization can be awarded a maturity level (1-5) or a capability level achievement profile.<br><br>Standard CMMI Appraisal Method for Process Improvement (SCAMPI) is the official SEI method to provide benchmark-quality ratings relative to CMMI models | SEI-authorized Lead Appraiser | SEI (Software Engineering Institute) | A Process across a project, division or an entire organization |
| ISO/IEC 15504 SPICE (Software Process Improvement and Capability Determination) | the reference model for the maturity models (consisting of capability levels which in turn consist of the process attributes and further consist of generic practices) against which the assessors can place the evidence that they collect during their assessment, so that the assessors can give an overall determination of the organisation's capabilities for delivering products (software, systems, IT services). | Proccess and capacity models appraisals that determine the capability level (0-5) | National Accreditation Entities *ISO Members | ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission). | A Process across a project, division or an entire organization |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| 92/75/EEC (labelling and standard product information of the consumption of energy and other resources by household appliances) | Directive is to enable the harmonization of national measures on the publication, particularly by means of labelling and of product information, of information on the consumption of energy and of other essential resources, and additional information concerning certain types of household appliances, thereby allowing consumers to choose more energy-efficient appliances | Energy efficiency label from G to A | Homologated Laboratories by National Accreditation Entities | European Commision | refrigerators, freezers and their combinations<br><br>washing machines, driers and their combinations<br><br>dishwashers<br><br>ovens<br><br>water heaters and hot-water storage appliances<br><br>lighting sources<br><br>air-conditioning appliances. |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| KNX (KNX is approved as<br><br>CENELEC EN 50090 and CEN EN 13321-1, ISO/IEC 14543-3).<br><br>Chinese Standard (GB/Z 20965).<br><br>US Standard (ANSI/ASHRAE 135)) | The KNX Device Network results from the formal merger of the 3 leading systems for Home and Building Automation (EIB, EHS, BatiBus) into the specification of the new KNX Association. The common specification of the "KNX" system provides, besides powerful runtime characteristics, an enhanced "toolkit" of services and mechanisms for network management. | KNX trademark | KNX Association's Certification Department and KNX accredited test labs | KNX Association | Devices (controllers, display, HVAC, illumination, infrared, load management, sensors, …) |
| EN-50090 (Home and Building Electronic Systems (HBES)) | A standard containing technical rules for Home and Building Electronic Systems (HBES). | | National Accreditation Entities | CENELEC | Home and Building Electronic Systems (HBES). |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| CWA 50487 SmartHouse Code of Practice | A document that provides a system designer working to implement a SmartHouse with a source of information on sensible and pragmatic guidelines for the design, instalation and maintenance of SmartHouse system and the services and applications provided. | | National Accreditation Entities CENELEC Members | CENELEC Workshop Agreement | Services, applications, equipments, networks andd systems that interact inside the SmartHouse |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| IEC 61508 | The standard covers the complete safety life cycle, and may need interpretation to develop sector specific standards. It has its origins in the process control industry sector | The IEC 61508 standard requires evidence of competence of those who perform assessments but does not require they be formally authorized or accredited.The only accreditation program in the world specifically oriented toward IEC 61508 is done by the U.K. government via the United Kingdom Accreditation Service (UKAS), www.ukas.com. This accreditation also requires that the EN45011 product certification quality program be met.A Certified Functional Safety Expert (CFSE) is someone who has met the criteria and passed an exam administered by the CFSE Governance Board. These required competencies are derived from the various phases of the IEC 61508 standard's lifecycle and the activities involved in each of those phases | United Kingdom Accreditation Service<br><br>CFSE Governance Board<br><br>TÜV | IEC | Functional safety of electrical/electronic/programmable electronic safety-related systems. |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| prEN 15900:2009 | Energy efficiency services - Definitions and essential requirements | | | CENELEC | |
| EN 16001:2009 | Energy management systems - Requirements with guidance for use | | National Accreditation Entities CENELEC Members | CENELEC | Organizations |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| EN 50285:1999 | Energy efficiency of electric lamps for household use - Measurement methods. This European Standard has been produced under Standardisation Mandate M/202 in response to the European Commission Directive implementing Council Directive 92/75/EEC with regard to energy labeling of household lamps. A method of classification of lamps according to energy efficiency is given in the directive and is not a part of this standard. This standard specifies the test conditions and method of measurement of luminous flux, lamp wattage and lamp life as given on a label on the lamp packaging, together with a procedure for verification of the declared values. Only those parameters that are specific to the above mentioned Directive are included in this standard. All other parameters are included in the relevant lamp performance standards. Lamps covered by this standard are: mains voltage tungsten filament lamps; mains voltage tungsten halogen lamps; self-ballasted lamps; double-capped fluorescent lamps; single-capped fluorescent lamps | | | | Electric lamps for household use |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| TS 105 174-5-4 | Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators; Part 5: Customer network infrastructures; Sub-part 4: Data centres (customer) | Dependant on National Regulations (ETSI does not certify equipment) | | ETSI | Customer network infrastructures |
| TS 102 706 (Draft) | Environmental Engineering (EE) Energy Efficiency of Wireless Access Network Equipment | Dependant on National Regulations (ETSI does not certify equipment) | | ETSI | Wireless Access Network Equipment |
| ORDER 5/9/1985 | Administrative technical rules for the operation and interconnection to the grid of hydroelectric power plans up to 5MVA and "autogeneration plants". Utilities are bound to buy with a higher price the surplus of electricity generated by these installations. | It is a law issued by the Ministry of Industry and Energy of Spain | | | Interconnection of RES and cogeneration plants to the grid. |
| RD 1955/2000 | Gives rules for transmission, distribution, commercialisation, supply and permission procedures of electric energy plants. | It is a Royal Decree issued by the Ministry of Economy of Spain | | | Legal system applicable to the activities of transmission, distribution, marketing, and |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| | | | | | electricity supply. |
| RD842/2002., part: ICT-BT 40, "Low voltage generating installations" | Complementary instruction (ICT) applicable to generating installations, namely installations aimed at the transformation of any kind of non-electric energy into electric energy. | It is a Royal Decree about Spanish Low Voltage Code, issued by the Ministry of Science and Technology | | | Generating installations |
| RD 1663/2000.<br><br>Resolution 31/5/2001 - Annex | Interconnection of PV installations to the low voltage grid: application, technical conditions, contract, connection and first verification. | It is a Royal Decree issued by the Ministry of Economy of Spain | | | PV installations |
| UNE-EN 50438:2008 | Requirements for microgenerators connected to the main. | It is a resolution | AENOR | | Microgeneration |
| RD 661/2007 | Electric Energy production is Special Regime. | It is a Royal Decree issued by the Ministry of Industry, Turism and Commerce of Spain | | | Electric Energy production |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| RD 1578/2008 | Retribution for PV energy production | It is a Royal Decree issued by the Ministry of Economy of Spain | | | PV energy production |
| 2002/91/EC EPBD (Energy Performance of Building Directive) | The objective of this Directive is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness | Energy performance certificate (depends on each country directive implementation). In Spain | EPBD Platform- Each country and regions Accreditation Entities | European Commission- Concerted Action (CA) EPBD<br><br>CEN (European Committee for Standardization) | A building |

| Standard/Regulation/Practices/Guidelines | Standard Description | Certification Type | National/International Accreditation Entity | Standard Supported by | Certificated Product or Process |
|---|---|---|---|---|---|
| **3.1 DIRECTIVE 2006/32/EC: On energy end-use efficiency and energy services** | Directive for energy use in buildings. TBC | Is an EU Directive | TBC | TBC | TBC |
| **3.2 ETSI ES 202 076:User Interfaces, Generic spoken command for ICT devices and services** | Design and implementation of standardises Human Machine Interfaces | ETSI Certification | ETSI | ETSI | TBC |

*Table 3-3 eDIANA related standards, techical specifications, guidelines, codes of practices…*

# 4. Certification Standards Analysis

This section will analyze different standards significant to eDIANA Project from different facets. Considering that eDIANA Platform is composed of embedded systems and equipments provided by companies that manage defined processes in their product development.

The selected standards face the eDIANA issues through the safety lifecycle developing equipment (IEC 61508), the process maturity model developing a software project (CMMI-Dev), the energy performance of the buildings, the main objective of eDIANA platform (2002/91/EC EPBD) , norms and standards regarding to power line connection or human machine interface development will also covered in this document.

## 4.1 IEC 61508 Introduction

One of the main application areas of embedded systems is the one that is related to the critical systems. This kind of systems is closely attached to applications in which a fail or a malfunction can be the cause of:

- Dead of serious effects to the final user
- Serious damage of the equipment
- Environmental damage

The evolution of programmable electronic units promoted exponential growth in the number of technological applications that can be implemented in any modern engineered system. Previously mentioned critical systems can be found in a high number of different domains. In those critical systems, software is now the primary determinant of functionality, from mass-market products (such as cars) to civil aircraft or nuclear power plants, this kind of systems must work for an extremely long periods of time, managing human errors or hardware and software failures and providing an acceptable level of performance. In those cases, the software is considered safety critical, i.e. failure or malfunction could give rise, or contribute to a fatal accident. In general, where software is a key element of a safety critical system, it is developed in accordance with a set of guidelines or standards produced by the industry, or imposed by a regulation authority.

It is not uncommon to find different certification standards for different industries. IEC 61508 describes a general-purpose hierarchy of safety-critical development methodologies that is applied to a variety of domains ranging from medical instrumentation to electronic switching of passenger railways, including drive-by-wire consumer vehicle subsystems, medical monitoring and diagnostic equipment.

The general approach found in these standards stipulates or constrains the processes to be used in the development, verification and validation of software, intending to reduce the number of faults introduced by these processes (e.g. through increased rigour in specification), and to increase the number of faults revealed by the process (e.g. through increased rigour in verification) in order that such faults can subsequently be removed.

IEC 61508 is publication of the International Electrotechnical Commission (IEC). It is like an "umbrella" document covering multiple industries and applications. His first goal is to help individual industries to develop supplemental standards. The second goal is to permit the development of E/E/PE safety-related systems where specific application sector standards do not already exist.

| | **IEC 61508 standard** |
|---|---|
| **System Aspects** | IEC 61508 Part 1<br><br>General requirements |
| **Hardware Aspects** | IEC 61508 Part 2<br><br>(Requirements for electrical / electronic / programmable electronic systems) |
| **Software Aspects** | IEC 61508 Part 3<br><br>(Software requirements) |
| **Others** | IEC 61508 Part 4<br><br>(Definitions and abbreviations) |
| | IEC 61508 Part 5<br><br>(Examples of methods for the determination of safety integrity levels) |
| | IEC 61508 Part 6<br><br>(Guidelines on the application of IEC 61508-2 and IEC 61508-3) |
| | IEC 61508 Part 7<br><br>(Overview of techniques and measures) |

*Table 4-1 IEC 61508 Standard Parts*

### 4.1.1 IEC 61508 Overview

The main objective of IEC 61508 is to provide guidance for developing devices that are **functionally safe**. In the context of IEC 61508, functional safety is defined as: "part of the overall safety that depends on a system or equipment operating correctly in response to its inputs. It is achieved when every specified safety function is carried out and the level of performance required of each safety function is met”. The Functional Safety that IEC 61508 refers to is the one that can be derived from the functions of the devices or the system, it does not apply to hazards and risk derived from the external environment of the system.

IEC 61508 presents a generic approach for all safety lifecycle activities for systems comprised of electrical, electronic and programmable electronic components (E/E/PE). This standard was originally designed based on the principle that a safety-related protection system controls another system, which is called EUC (Equipment Under Control). The system that is used to monitor inputs from the EUC and used to generate outputs, causing the EUC to operate in the correct mode, is called the EUC Control System. Basically, the protection system must ensure that the EUC perform as specified, and if it fails, it can be stopped in a safe way

Essentially the IEC 61508 standard provides functionally safe support to:

- Analyze and measure the initial risk level that exists in the machinery, process plant and equipment and determine if the risk is adequate.
- Implement a safety function that will provide a level of protection such that the risk is reduced to an acceptable level, in case the initial risk level is considered too high.
- Provide a means to verify if the equipment selected to implement the safety function can provide the required protection.

### 4.1.2 IEC 61508 Structure

The standard IEC 61508 is not focused in any specific industry, it applies to any system composed of at least one E/E/PE where the addition of a safety function may decrease the risk level of the system. IEC 61508 is primarily a process standard generally dedicated to describe the necessary processes involved in the lifecycle of a safety management system, including all the phases present in the implementation of the system, from concept, definition, development phases, etc. to maintaining, modification phases. It is not targeted to “qualify” or “certify” or get approval for a product, although there are companies that historically do IEC 61508 product certifications, like German companies TÜV or CASS Scheme Ltd.

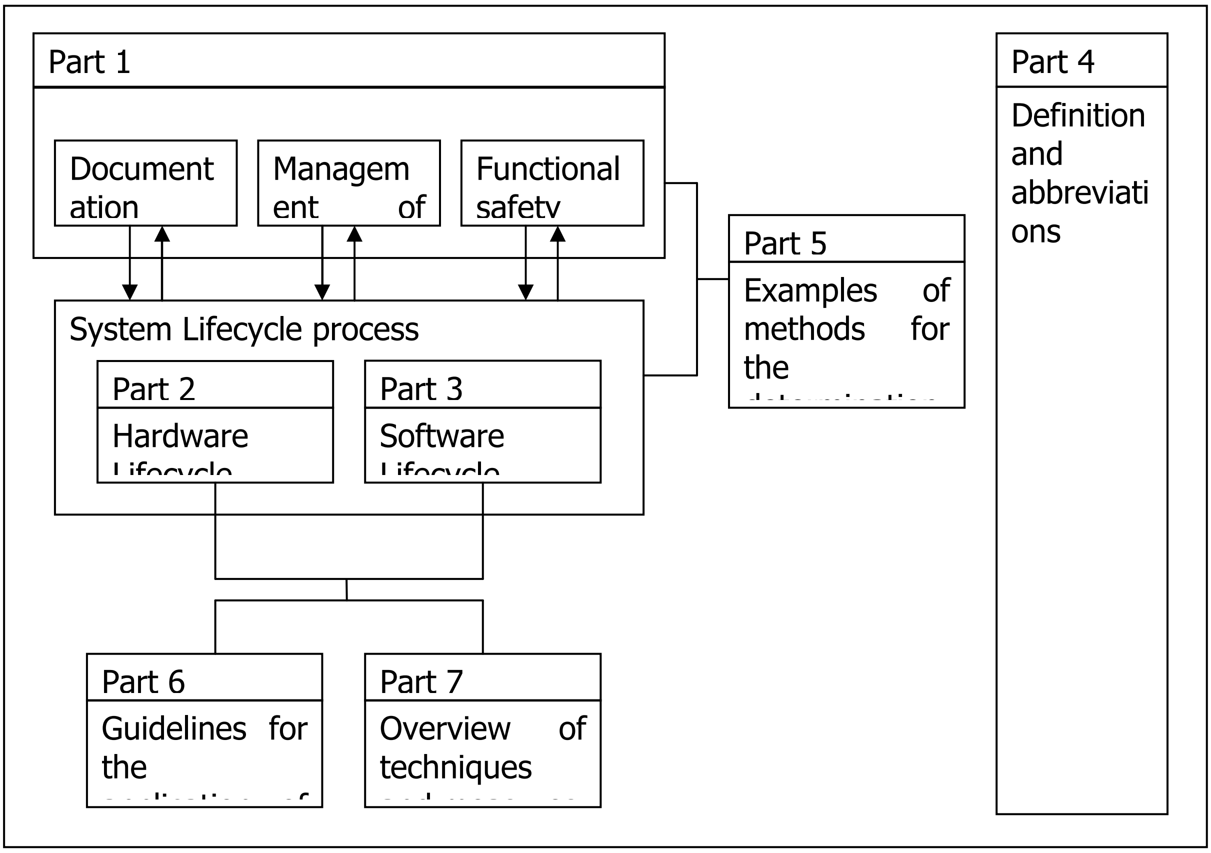


*Figure 4-1 Structure of IEC 61508 standard and software related parts*

The standard adopts a broad range of principles, techniques and measures to achieve functional safety that consists of eight parts:

- Part 0: Functional safety and IEC 61508;
- Part 1: General requirements;
- Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems;
- Part 3: Software requirements;
- Part 4: Definitions and abbreviations;
- Part 5: Examples of methods for the determination of safety integrity levels;
- Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3;
- Part 7: Overview of techniques and measures.

Part 0 introduces the standard. The relationships between Part 1 to Part 7 are shown in Figure 4-1. Part 3 describes the realization phase of safety-related software (i.e. software lifecycle activities).

IEC 61508 concentrates on protection using electrical, electronic or programmable electronic systems. These are referred to as E/E/PE systems. Since they are used to reduce the EUC risk they are said to be "safety-related".

Other methods (i.e. alternatives technologies) can be used to provide protection, e.g. hydraulic systems (which are alternatives to E/E/PE systems) or "external" protection (such as bunds, firewalls or drainage systems). Neither alternative technologies nor external protection are specifically covered by IEC 61508, but their use is recognized as an integral part of reducing the EUC risk to a tolerable level.

The combination of E/E/PE, alternative technology and external protection employed to reduce the EUC risk is described as "**Functional Safety**" – in the sense that the correct operation (or function) of the protective systems provides the required reduction in risk (i.e. the required level of safety).

### 4.1.3 Risk Analysis and Reduction: Safety Integrity Levels

The starting point of this standard leads to the analysis of the risk that exists in the EUC and its Control System (i.e. EUC risk), this is the first point to consider in order to guide the actions to a risk reduction. Better than adding external protections, it is desirable to eliminate or reduce the EUC risk itself.

The terms of risk reduction varies according to the risk that must be reduced and the tolerable risk that the system can afford. The techniques described in IEC 61508 guides to a formal determination of the reduction required for each risk under consideration. To make available a kind of risk measurement, first, the standard leads to allocate the defined safety requirements in the E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities. Once the allocation is made, the IEC 61508 defines two modes of operation that will provide a target failure measures located in one of four **Safety Integrity Level** or **SIL**. The level in which a system is located indicates its safety property of the safety-related system. These levels provide a risk measurement method that will enable a planned risk reduction.

For the safety-related system, IEC 61508 defines four levels of Safety Integrity Levels (SIL) and two fundamental modes of operation: **Low Demand** and **High Demand or continuous,** which depend on the frequency that the system might be required to perform its safety function in a given application (the terms are formally defined in IEC 61508-4 section 3.5.12).

SIL1 is the lowest level of safety integrity and SIL4 is the highest level (the complete mapping between SIL levels and failure rates can be found in IEC 61508-1 section 7.6.2.9). The majority of safety systems are SIL3 or SIL2; SIL4 is rarely used. Note that a SIL is a property of a safety function rather than of a system or any part of a system.

Having determined the overall SIL required, the standard defines the recommended techniques and processes for software development and assurance for each lifecycle phase. For example, for the development of SIL 4 system, it is highly recommended that requirements and design specifications are realised recurring to formal (mathematically based) specification techniques.

| SIL | Average probability of failure to perform its desgn function on demand<br><br>Low Demand Mode of Operation |
|---|---|
| 1 | $\geq 10^{-2}$ to $< 10^{-1}$ |
| 2 | $\geq 10^{-3}$ to $< 10^{-2}$ |
| 3 | $\geq 10^{-4}$ to $< 10^{-3}$ |
| 4 | $\geq 10^{-5}$ to $< 10^{-4}$ |

*Table 4-2 Safety integrity level for a safety function operating in low demand mode of operation*

| SIL | Failure rate per hour<br><br>High Demand-Continuous Mode of Operation) |
|---|---|
| 1 | $\geq 10^{-6}$ to $< 10^{-5}$ |
| 2 | $\geq 10^{-7}$ to $< 10^{-6}$ |
| 3 | $\geq 10^{-8}$ to $< 10^{-7}$ |
| 4 | $\geq 10^{-9}$ to $< 10^{-8}$ |

*Table 4-3 Safety integrity level for a safety function operating in high demand or continuous mode of operation*

The safety integrity level of a safety function is defined according to:

- The average probability of failure to perform its design function on demand (in the case of low demand mode – see Table 4-2), or

- The probability of a dangerous failure per hour (in the case of high demand or continuous mode – see

| SIL | Failure rate per hour<br><br>High Demand-Continuous Mode of Operation) |
|---|---|
| 1 | $\geq 10^{-6}$ to $< 10^{-5}$ |
| 2 | $\geq 10^{-7}$ to $< 10^{-6}$ |
| 3 | $\geq 10^{-8}$ to $< 10^{-7}$ |
| 4 | $\geq 10^{-9}$ to $< 10^{-8}$ |

- Table 4-3). The probability of a dangerous failure per hour is sometimes referred to as the dangerous failure rate (i.e. dangerous failures per hour).

Modes are important when describing the target failure measure of a safety function to be implemented by an E/E/PE safety-related system to the SIL.

A typical application requiring a safety-related system operating in SIL4 is corresponding to one with an equivalent failure rate range of 1 x 10-8 to 1 x 10-9 failures per hour of continuous operation.

A typical application requiring a safety-related system operating in a **high demand or continuous** mode would be for example, a guard for a machine press, where the guard prevents the operator from being at risk from personal injury. The safety system could be expected to operate significantly more than once per year. A safety-related system that operates in high demand mode is therefore required.

A typical application requiring a safety-related system operating in **low demand** mode would be for example, a fire and gas system that acts only in the case of a fire or gas leak. This system would be expected to operate less than once per year and a safety related system operating in low demand mode would be appropriate.

### 4.1.4 Certified products

IEC 61508 puts a quantity of requirements on people and organisations that are involved in the design, implementation and maintenance of safety-related systems. It does not say how this management is done, but it requires a formal development processes to be specified, followed and audited (see IEC 61508-1 section 6).

Organisations may have their functional safety management capability assessed and certified (for example under the CASS scheme), to demonstrate their competence. This can be useful to end users and system integrators in demonstrating compliance to regulatory authorities.

Note that the CASS scheme enables accredited third party certification bodies to offer conformity assessment certification for safety related products that meet the requirements of IEC 61508. The scope of the scheme includes both off-the shelf products and application-specific products and systems, as well as the operation and maintenance of installed products and systems. The scheme offers certification for all organisations involved in the design, development, manufacture, implementation, support and application of software components and complete systems, across many sectors.

One of the advantages of using products certified according to IEC 61508 by a recognised body is that the certificate validates much more than just the actual product itself. The certification also confirms the correctness of:

- The design processes used by the manufacturer of the product to avoid failures
- The design techniques and measures used to control failures (or limit the effects of failures) during operation
- The methods used to define the hardware fault tolerance
- The methods used to measure the safe failure fraction
- The methods used to measure the probabilities of failure

IEC 61508 does not require that certified safety products are used in safety-related systems, but if an end user or system designers decides to use non-certified products then they must take responsibility themselves for validating that all these elements have been carried out according to the standard.

### 4.1.5 Lifecycle process: Software lifecycle process

IEC 61508 covers the overall safety lifecycle of the system; most of them do not differ from a generic product lifecycle phases, but in the list it is possible to find some phases exclusively linked to risk issues.

| | Safety Lifecycle Phase | Description |
|---|---|---|
| 1 | Concept | To develop a level of understanding of the EUC and its environment |
| 2 | Overal Scope Definition | To determine the boundary of the EUC and the EUC control system. To specify the scope of the hazard and risk analysis |

| | | |
|---|---|---|
| 3 | Hazard and Risk Analysis | To determine the hazards and hazardous events of the EUC and the EUC control system, the even sequences leading to the hazardous events and their associated EUC risks |
| 4 | Overal Safety Requirements | To develop the specification for the overall safety requirements |
| 5 | Safety Requirements Allocation | To allocate the safety functions, contained in the specification for the overall safety requirements and allocate a safety integrity level to each safety function |
| 6 | Overall Operation and Maintenance Planning | To develop a plan for operatin and maintaining the E/E/PE safety-related systems |
| 7 | Overall Safety Validation Planning | To develop a plan to facilitate the overall safety validation |
| 8 | Overall Installation and commissioning Planning | To develop a plan for the installation of the E/E/PE safety-related systems in a controlled manner, to ensure the required functional safety is achieved |
| 9 | E/E/PE Safety-Related Systems Realisation | To create E/E/PE safety-related system |
| 10 | Other Technology Safety-Related Systems Realisation | To create other technology safety-related systems to meet the safety fucntions |
| 11 | External Risk Reduction Facilities Realisation | To create external risk reduction facilities to meet the safety functions |
| 12 | Overal Installation and Commissioning | To install the E/E/PE safety-related systems |
| 13 | Overall Safety Validation | To validate that the E/E/PE safety-related systems meet the specification |
| 14 | Overall Operation Maintenance and Repair | To operate, maintain and repair the E/E/PE safety-related systems in order that the required functional safety is maintained |

| | | |
|---|---|---|
| 15 | Overall modification and retrofit | To ensure that the functional safety for the E/E/PE safety-related systems is appropiate, both dureing and after the modificationand retrofit phase has taken place |
| 16 | Decommisioning or Disposal | To ensure that the functional safety for the E/E/PE safety-related systems is appropiate in the circumstances during and after the activities of decommissioning or disposing of the EUC |

*Table 4-4 Lifecycle process*

IEC 61508-3 also covers the requirements for safety-related software. As in other parts of the standard, a safety lifecycle is to be used as the basis of requirement compliance (see Figure 4-2). The software safety lifecycle is an expanded plan of the system lifecycle process from Part 1 and is closely linked with the hardware lifecycle. As for the overall safety lifecycle, there are requirements for a functional safety management plan and safety requirements specification, including all verification and assessment activities.

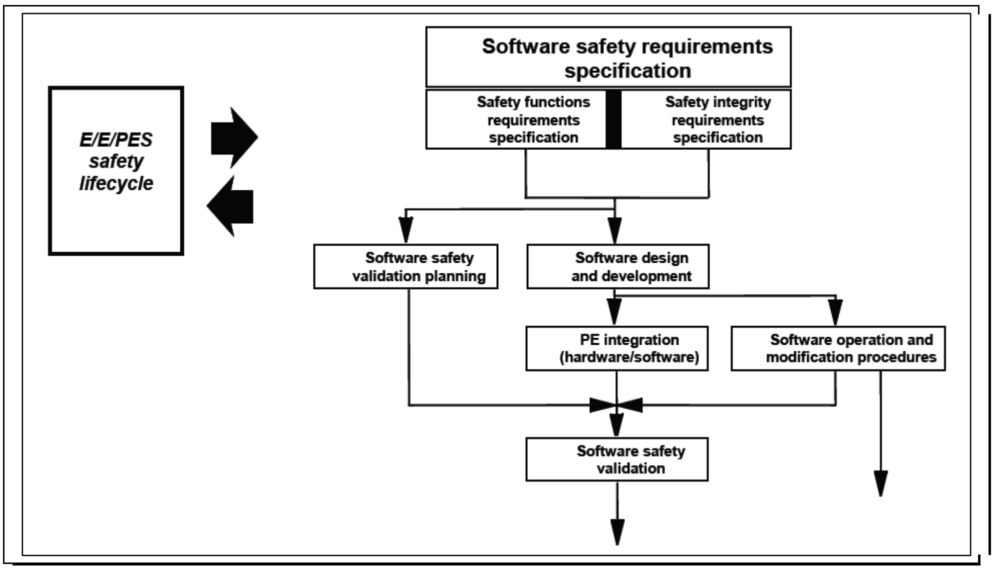


*Figure 4-2 Software safety lifecycle*

Essentially, IEC 61508P-3 describes the software requirements that apply to any software used in a safety-related system. This software is specifically referred as safety-related software. The Annex A (required for compliance) provides a listing of “techniques and measures” used for software development where different development techniques are chosen depending on the SIL level of the software. Annex B (required for compliance) has nine detailed tables of design, coding standards, analysis and testing techniques that can be used in the safety-related software development, depending on the software SIL level and in some cases in choices made by the development team. For a better understanding of part 3, a brief description of the Software lifecycle activity process is shown in Table 4-5 IEC 61508-3 Software lifecycle activities

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| IEC 61508-3 SW lifecycle activities | | Objectives | Section |
|---|---|---|---|
| Documentation | | Specify the necessary information to be documented in order that all phases of the overall, E/E/PES and software safety lifecycles can be effectively performed | 5 |
| Software quality management system | | Specify the management and technical activities during the overall, E/E/PES and software safety lifecycle phases which are necessary for the achievement of the required functional safety of the E/E/PE safety-related systems | 6 |
| Software safety life cycle requirements | General | Structure the development of the software into defined phases and activities | 7.1 |
| | Software safety requirements specification | Specify the requirements for software safety in terms of the requirements for software safety functions and the requirements for software safety integrity and the requirements necessary to achieve the SIL specified for each safety function allocated to that E/E/PE safety-related system | 7.2 |
| | Software safety validation planning | Develop a plan for validating the software safety | 7.3 |

| | | | |
|---|---|---|---|
| | Software design and development | Create a software architecture, review and evaluate the requirements, select a suitable set of tools (including languages and compilers) for the required SIL, design and implement software and verify that the requirements for software safety have been achieved | 7.4 |
| | Programmable electronics integration (hardware and software) | Integrate the software onto the target programmable electronic hardware and combine the software and hardware in the safety-related programmable electronics to ensure their compatibility and to meet the requirements of the intended SIL | 7.5 |
| | Software operation and modification procedures | Provide information and procedures concerning software necessary to ensure that the functional safety of the E/E/PE safety-related system is maintained during operation and modification | 7.6 |
| | Software safety validation | Ensure that the integrated system complies with the specified requirements for software safety at the intended SIL | 7.7 |
| | Software modification | Make corrections, enhancements or adaptations to the validated software, ensuring that the required software SIL is sustained | 7.8 |
| | Software verification | Extent required by the SIL, to test and evaluate the outputs from a given software safety lifecycle phase to ensure correctness and consistency with respect to the | 7.9 |

| | | | |
|---|---|---|---|
| | | outputs and standards provided as input to the phase | |
| Functional safety assessment | | Apply to the assessment of safety-related software | 8 |
| Guide to the selection of techniques and measures | | Some of the section of this standard have an associated table | Annex A |
| Detailed tables | | More detailed tables expand upon some of the entries in the tables of annex A | Annex B |

*Table 4-5 IEC 61508-3 Software lifecycle activities*

Next table shows the main terminology this standard uses by topic:

| Topic | IEC 61508 |
| --- | --- |
| **System Aspects** | EUC (equipment under control)+ EUC control system |
| | Safety-related software (contains EUC control system) |
| | Safety function |
| | Software safety integrity level (SIL) |
| **Life Cycle** | Overall safety lifecycle |
| | Software lifecycle |
| | Phase (only for software Development) |
| | Activity |
| **Planning** | Management of functional safety |
| | Safety planning |
| | Validation planning |
| **Development** | Safety requirements (safety functions requirements, safety integrity requirements) |
| | Design requirements |
| | Software integration |
| | System integration |
| **Quality Assurance** | Functional safety assessment |
| **Maintenance** | Previously developed software, |
| **Certification** | (not covered) |
| **Tool qualification** | Tool qualification (for system validation only) |

*Table 4-6 IEC 61508 Terminilogy*

The next table describes the artefacts the standard specifies by Lifecycle Activity:

| Lifecycle Activities | IEC 61508 artefacts |
| --- | --- |
| Planning | Planning records<br><br>Development tools |

| | |
|---|---|
| | Coding Standards<br><br>Safety Validation Plan |
| Requirements specification | Safety Requirements Specification |
| Design | Architecture Design Description<br><br>System Design Specification<br><br>Module Design Specification |
| Coding | Source code listing, Code Review Report |
| Integration | |
| Testing | Architecture Integration Test Specification<br><br>Software/Hardware Integration Test Specification<br><br>System Integration Test Specification<br><br>Module Test Specification<br><br>Module Test Results<br><br>Verified and Tested Modules<br><br>System Integration Test Results<br><br>Verified and Tested Software System<br><br>Safety Validation Results<br><br>Validated Software |
| Test coverage analysis | (no requirement on produced artefacts) |
| Reviews and analysis | Verification Report |
| Operation and maintenance procedures | Operation and Maintenance Procedures |
| Certification | (not covered) |
| Configuration management | Baselines |

| | |
|---|---|
| | Software Release Documentation<br><br>Configuration Status |
| Modification | Modification Impact<br><br>Analysis Results<br><br>Modification Log |
| Corrective action | Modification Request and Authorisation Documentation |
| Safety Assurance | Safety Audits Records<br><br>Software Functional Safety<br><br>Assessment Report |

*Table 4-7 IEC 61508 Artefacts by lifecycle activities*

## 4.2 ORDER 5/9/85

### 4.2.1 Background for the Order and Objective

As eDiana platform will handle generation devices under its domain, is understood that some power line grid connection regulations may to be taken into account. This law, which was issued by the Ministry of Industry and Energy of Spain, describes the interconnection of RES to the grid. It is reasonable extrapolate that in other countries in the EU will exist similar regulation schemas.

It sets the administrative and technical rules for the performance and connection of cogeneration plants to the grid.

According to the Spanish legislation, LV is voltage under 1000 V, and the words High Voltage are used to express all the voltage levels over 1000V. So, there is not distinction between MV and HV. The grids are normally of 380/220 V.

### 4.2.2 Structure

The order is structured in articles, and their content is shown in the following table.

| Article | Content |
|---|---|
| **Article 01** | General administrative rules |
| **Article 02** | General technical rules |
| **Article 03** | Connection to LV grids |
| **Article 04** | Specific rules for the interconnection of cogeneration plants with asynchronous generator |
| **Article 05** | Specific rules for the interconnection of cogeneration plants with synchronous generator |
| **Article 06** | Grounding of interconnected plants |
| **Article 07** | Measurement of produced and consumed electrical energy |
| **Article 08** | Harmonics |
| **Article 09** | Protection issues |

*Table 4-8 Structure of Order 5/9/85*

In the following subsections, the articles have been grouped in main topics related to the interconnection of eDiana Platform to the grid.

### 4.2.3 General requirements of the network

**Maximum DG Power**

**Section 3.2**. At low voltage, generators can be connected to a three-phase grid (380/220 V) until the sum of rated powers does not exceed 100 kVA (60 kVA for 220/127 V grids) or 50% the capacity of the output of the substation for that line to which the generator will be connected (also in Low Voltage Code (ITC-BT-40 section 4.3.1)).

**Section 3.3**. At high and medium voltage, plants with asynchronous generators can be connected up to 5000 kVA and plants with synchronous generators up to 10 MVA, if the total connected power does not exceed 50% the capacity of the transmission line. For higher powers the electric company will specify the technical requirements for the interconnection. In case of disagreement the administration will decide.

**Short circuit capacity**

**Section 5.2**. The increase of short-circuit power of the grid due to the interconnection of a synchronous generator must be compatible with the conditions of the grid

### 4.2.4 Electrical Interconnection Requirements

**Installation**

**Section 3.2.2**. Three-phase synchronous generators will be connected to the LV grid only through three-phase line commuted inverters (maximum capacity requirements must be fulfilled).

**Section 3.3.1**. At high and medium voltage, the connection of DG plants to the grid will be always carried out by means of transformers with one of its windings connected in delta.

**Grounding**

**Section 6.1.** Grounding of interconnected plants will always be performed without modifying the conditions of the grounding of the electric company, guaranteeing that there is no fault transfer to the distribution grid.

**Section 6.3.** In plants equipped with connection transformers, the grounding will be carried out in an only point, using the neutral of just one generator in case that more than one is installed. The grounding can also be done using the neutral of one of the transformers but only if it is not in the side of the electric company. If the machine or transformer used for the grounding is disconnected, automatic systems must be foreseen in order to transfer the grounding point to another place

**Section 6.4.** Wind generators: grounding of the tower and of the equipment in it for protection against atmospheric discharges will be independent from the rest of the installation grounding circuits.

**Section 6.5**. The protection against indirect contacts can be carried out by other means (not affecting the installations of the electric company grid), if for security reasons the generation installation uses a neutral isolated grid or a grid connected to ground through high impedance.

**Protection issues**

**Section 9.11.** Protections must assure that internal faults in the DG plant do not disturb the correct operation of the grid.

**Section 9.3.** Some specific protections for different types of plants with power under 10 MVA and in radial distribution networks are given. For meshed networks the solutions are studied case by case.

**Measurements**

**Section 7**. To measure the consumed and supplied electric energy, two different metering devices and maximeters are necessary. However, other devices as measurement transformers and switch clocks can be common.

The metering devices for the consumed energy will be set as for the other non-generating consumers.

Metering devices for the supplied energy will have the following characteristics. If the power factor is lower than 0,55 a reactive power metering device is obligatory. All producers with P>40 kW will need a metering device to measure reactive power regardless of the power factor.

The metering device will consist of:

- Active energy meter
- Maximeter: it integrates partial values of the active energy every 15 minutes.
- Reactive energy meter
- Switch clocks: for the different tariffs of the energy meters and the maximeter. Maximum error for time measure 7 minutes/year.
- Current transformer if necessary: according to UNE 21088. Minimum precision class 0,5 for HV, 1 for LV
- Voltage transformer if necessary: according to UNE 21088. Minimum precision class 0,5
- Terminal blocks for verification.

In plants of less than 500 kVA connected to *HV* lines, the metering device can be connected in the low voltage side of the power transformers.

**<u>Synchronisation</u>**

**Sections 5.3 and 5.4**. The plant (with synchronous generators) will have an automatic or manual synchronisation device and an interlocking relay of synchronism. This is not obligatory if the generator is connected to the grid as an asynchronous generator or when using an inverter. Synchronisation must be carried out when the differences in electrical magnitudes between the generator and the grid are lower or equal to the following:

| | | |
|---|---|---|
| Voltage: | ± 10 % | When generator P>1000 kVA |
| | ± 8 % | When generator P<=1000 kVA |

Frequency: ± 0.2 Hz When generator P>1000 kVA

± 0.1 Hz When generator P<=1000 kVA

Phase:± 20º When generator P>1000 kVA

± 10º When generator P<=1000 kVA

**Section 4.5** The connection of an *asynchronous* generator to the grid will not be carried out until its speed is the following percentage of synchronism speed in order to limit the resulting voltage change:

For powers under or equal to 1000 kVA: 90-100%

For powers over 1000 kVA: 95 – 100 %

**Accessible disconnection switch**

**Section 9.1.1.** All interconnected plants must have a disconnection switch accessible to the electric company, both automatic and manual.

**4.2.5 Power Quality**

**Power factor**

**Section 4.1.** For *asynchronous* generators the power factor of the supplied energy will not be lower than 0.86 at rated power. To achieve this, capacitor banks will be installed when necessary. To avoid over-excitation in the case of fault in the line, protection devices will be installed to disconnect the battery bank.

**Section 5.1.** *Synchronous* generators must maintain the power factor between 0.8 and 1 leading or lagging, measured at the connection point.

**Section 5.7** In order to control the reactive energy supplied by the generator, an excitation control will be available with the scope of regulating the reactive energy supplied to the grid.

**Harmonics**

**Section 8.1.** Plants must inject no harmonics that cause the harmonic level in the grid surpasses the allowable caps.

**Section 8.2.** The injection of disturbances to the grid in levels higher than the permitted, allows the electric company to disconnect the DG installation under certain conditions and complying with certain procedures

**Flicker**

**Section 4.4.** The power of *wind* generators (*asynchronous and synchronous*) will not be higher than 1/20 of the short-circuit power of the grid at the interconnection point, in order to avoid voltage fluctuations due to fast wind speed variations.

**Voltage variations**

**Section 4.2** When interconnecting an *asynchronous* generator, the maximum allowed voltage drop is 5% of the rated voltage. In case of *wind* generators, the frequency of connections will be of three per minute at the most, and the limit of voltage drop 2%.

**Section 4.3.** In order to limit interconnection currents and voltage drops with *asynchronous generators*, adequate devices will be used. For over-currents the following solutions are proposed:

Limitation reactances between generator and grid (they are short-circuited after the transient time)

Auto-excitation with no load by means of condensers and grid connection through an appropriate synchronisation device

**Section 4.5.** Its speed must be the following percentage of synchronism speed in order to limit the resulting voltage change:

| | |
|---|---|
| For powers under or equal to 1000 kVA: | 90 – 100% |
| For powers over 1000 kVA: | 95 – 100 % |

**Section 4.6.** The start as a motor for thermal groups is only permitted when, in the interconnection, variations of voltage are lower than 5% and in less than 1 second. In this case generators don't have to comply with the requirement on speed of interconnection for asynchronous generators.

**Section 5.5.** Connection of *synchronous* generators of power equal to or under 1000 kVA can be connected to the grid as asynchronous generators, if maximum voltage drop in the interconnection is at the most 5% of rated voltage and if duration is no longer than 0.5 seconds.

### 4.2.6 Behaviour during Fault Condition in the Grid

**Unintentional islanding**

**Section 2.1.4**. In the case of circuit breaker opening in the line, the plant connected to that line will not maintain the voltage in the grid (also in RD 1663/2000, art. 8 section 2)). If it were possible for the plant to maintain voltage (synchronous generator or self-excited asynchronous generator), a remote tripping system will be installed so that the plant can be disconnected from its substation. Overhead lines with automatic reclosing will be equipped with the necessary devices to prevent the plant to reconnect until reclosing is firm.

**Autoreclosures**

**Section 9.2.1.** Reclosing to the grid will not be performed until voltage is higher than 85% of rated voltage and before three minutes have passed. Should the plant have more than one generator, the re-connection will be carried out step by step with at least 10-second intervals.

## 4.3 Low Voltage Code (ITC-BT-40)

### 4.3.1 Background for the Order and Objective

This is a complementary instruction (ICT) about Spanish Low Voltage Code.

It is applicable to installations which transform any kind of non-electric energy into electric energy.

According to the Spanish legislation, LV is voltage under 1000 V, and the grids are normally of 380/220 V.

### 4.3.2 Structure

This law is structured in articles, which are shown in the following table.

| Article | Content |
|---|---|
| **Article 01** | Scope and field of application |
| **Article 02** | Classification |
| **Article 03** | General conditions |
| **Article 04** | Interconnection conditions |
| **Article 05** | Connection wires |
| **Article 06** | Waveform |
| **Article 07** | Protection issues |
| **Article 08** | Grounding |
| **Article 09** | Commissioning |

| | |
|---|---|
| **Article 10** | Other legal provisions |

*Table 4-9 Structure of ITC-BT-40*

In the following subsections, the articles have been grouped in main topics related to the interconnection of eDiana Platform to the grid.

### 4.3.3 General requirementes of the network

**Maximum DG Power**

**Section 4.3.1.** For wind generators in low voltage, power can not exceed the 5% of short-circuit power at the PCC in order to avoid network fluctuations

### 4.3.4 Electrical Interconnection Requirements

**Installation**

**Section 4.3.2.2**. At low voltage networks, the use of synchronous generators must be agreed with the Distribution Company.

**Grounding**

**Section 8.** Generation installations must be provided with grounding systems that assure that metallic parts of the installations do not to cause people to be exposed to the following values of voltage: for times between 3 and 5 seconds, the applied contact voltage to the human body shall not exceed 64 V; above 5 seconds the applied contact voltage will not be over 50 V.

**Section 8.2.1**. Islanded installations: The grounding systems connected to the generation will be independent from any other grounding system. The neutral of the generator and the frames (exposed conductive parts) will be connected to ground.

**Section 8.2.3**. Interconnected installations: When the DG installation is connected to a Public Distribution Grid with the neutral to ground, grounding scheme will be TT and installation and consumer equipment frames will be connected to a ground independent from that of the grid neutral. When the installation is working in islanded mode, an interconnection switch, by means of an auxiliary pole, must disconnect the neutral of the Public Distribution Grid and connect the generator neutral to groun.

**Protection issues**

**Section 7.** Generators will have specific protections, advised by the manufacturer, in order to reduce the damages as a result of internal or external faults.

In the generation plants that can be interconnected with the Public Distribution Network, a set of protections, acting on the interconnection switch, will be placed in the origin of the installation. These will correspond to an accredited model and must be properly verified and sealed by a recognised laboratory: The protection system must include, at least:

- Over-current protection, by means of direct magnetothermic relays or any equivalent solution.
- Instantaneous minimum voltage protection connected between the three phases and the neutral. I must operate before 0.5 seconds, from the moment that the voltage reaches 85% of its rated value.
- Over-voltage protection, connected between one phase and the neutral, it must operate before 0.5 seconds, from the moment that the voltage reaches 110% of its rated value.
- Maximum and minimum frequency protection connected between phases. It must operate when frequency is under 49 Hz or above 51 Hz during more than 5 periods.

For current flow detection through the generators neutral connection to the Distribution Public Grid neutral, a device will be installed with the scope of disconnecting the installation if the 50% of the rated current is surpassed

**Measurements**

**Section 4.3.3.** At *low voltage, asynchronous* generators need a metering device to register the consumed reactive energy.

**Synchronisation**

**Sections 4.3.2.2.** Points of coupling without synchronisation equipment must have an interlocking device in order to prevent parallel operation with the grid.

### 4.3.5 Power Quality

**Harmonics**

**Section 6**. In low voltage, the generated power will be as close as possible to the sine wave form, with a maximum harmonics rate of:

- Even-order harmonics: 4/n
- Third-order harmonics: 5
- Odd-order harmonics (≥ 5): 25/n

The harmonic rate is the relationship, in percentage, between the rms value of the n-order harmonic and the rms value of the fundamental harmonic.

**Flicker**

**Section 4.3.1.** In order to avoid voltage fluctuation, the power of generators will not be higher than 1/20 of the short-circuit power of the grid at the interconnection point.

**Voltage variations**

**Section 4.3.2.1**. At low voltage, the maximum allowable voltage drop in the connections of an asynchronous generator is 3% of grid rated current. For Wind generators connection frequency will be of 3 per minute at the most and the voltage drop limit 2% of rated voltage during 1 second.

#### 4.3.6 Behaviour during Fault Condition in the Grid

**Unintentional islanding**

**Section 4.3.4**. In low voltage, installations with asynchronous generators will have protection devices assuring disconnection time lower than one second when a fault in Public Distribution Network occurs.

## 4.4 2002/91/EC EPBD (Energy Performance Building Directive)

## 4.5 Background for the Directive

The EU is promoting a set of directives orientated to establish the building energy consumption basic standards; the EPBD has been developed in this context.

As most of the EU directives' background is stated in the Treaty establishing the European Community and in this particular case, in Articles 175 and 271 whereas;

Treaty requires environmental protection requirements to be integrated into the definition and implementation of Community policies and actions.

The natural resources, to the prudent and rational utilisation of which Article 174 of the Treaty refers, include oil products, natural gas and solid fuels, which are essential sources of energy but also the leading sources of carbon dioxide emissions.

Increased energy efficiency constitutes an important part of the package of policies and measures needed to comply with the Kyoto Protocol and should appear in any policy package to meet further commitments.

Demand management of energy is an important tool enabling the Community to influence the global energy market and hence the security of energy supply in the medium and long term.

In its conclusions of 30 May 2000 and of 5 December 2000, the Council endorsed the Commission's action plan on energy efficiency and requested specific measures in the building sector.

The residential and tertiary sector, the major part of which is buildings, accounts for more than 40 % of final energy consumption in the Community and is expanding, a trend which is bound to increase its energy consumption and hence also its carbon dioxide emissions Council Directive 93/76/EEC of 13 September 1993 to limit carbon dioxide emissions by improving energy efficiency (SAVE) (5), which requires Member States to develop, implement and report on programmes in the field of energy efficiency in the building sector, is now starting to show some important benefits. However, a complementary legal instrument is needed to lay down more concrete actions with a view to achieving the great unrealised potential for energy savings and reducing the large differences between Member States' results in this sector.

The energy performance of buildings should be calculated on the basis of a methodology, which may be differentiated at regional level that includes, in addition to thermal insulation, other factors that play an increasingly important role such as heating and air-conditioning installations, application of renewable energy sources and design of the building. A common approach to this process, carried out by qualified and/or accredited experts, whose independence is to be guaranteed on the basis of objective criteria, will contribute to a level playing field as regards efforts made in Member States to energy saving in the buildings sector and will introduce transparency for prospective owners or users with regard to the energy performance in the Community property market.

As stated in the directive, the certification process may be supported by programmes to facilitate equal access to improved energy performance; based upon agreements between organisations of stakeholders and a body appointed by the Member States; carried out by energy service companies which agree to commit themselves to undertake the identified investments. To the extent possible, the certificate should describe the actual energy-performance situation of the building and may be revised accordingly.

## 4.6 Objective

The objective of this Directive is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness.

This Directive lays down requirements as regards:

(a) The general framework for a methodology of calculation of the integrated energy performance of buildings.

(b) The application of minimum requirements on the energy performance of new buildings.

(c) The application of minimum requirements on the energy performance of large existing buildings that are subject to major renovation.

(d) Energy certification of buildings; and

(e) Regular inspection of boilers and of air-conditioning systems in buildings and in addition, an assessment of the heating installation in which the boilers are more than 15 years old.

### 4.6.1 Directive Structure

The directive is structured in articles that cover from objectives of the directive to the its review program in order to adapt it to new technical progress.

Being an European Union level directive, each country has to develop its own law framework to accomplish the stated commitments.

Next table show the articles relation and their content:

| Article | Content |
|---|---|
| Article 01 | Objectives |
| Article 02 | Definitions |
| Article 03 | Adoption of Methodology |
| Article 04 | Setting of energy performance requirements |
| Article 05 | New Buildings |
| Article 06 | Existing Buildings |
| Article 07 | Energy Performance Certificate |
| Article 08 | Inspection of Boilers |
| Article 09 | Inspection of Air Conditioning systems |
| Article 10 | Independent Experts |

| | |
|---|---|
| Article 11 | Review |
| Article 12 | Information |
| Article 13 | Adaptation of the framework |
| Article 14 | Committee |
| Article 15 | Transposition |
| Article 16 | Entry into force |
| Article 17 | Addressees |

*Table 4-10 2002/91/EC EPBD Directirve articles*

The most relevant Articles in the context of the eDiana Platform are summarized in next section. Its content has been mostly literally transposed trying to stick as much as possible to its original aim.

**Article 03: Adoption of Methodology**

Member States shall apply a methodology, at national or regional level, of calculation of the energy performance of buildings on the basis of the general framework set out in the Annex. […]

This methodology shall be set at national or regional level. The energy performance of a building shall be expressed in a transparent manner and may include a CO2 emission indicator.

**Article 04: Setting of energy performance requirements**

1. Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings[….]. When setting requirements, Member States may differentiate between new and existing buildings and different categories of buildings. These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building. These requirements shall be reviewed at regular intervals which should not be longer than five years and, if necessary, updated in order to reflect technical progress in the building sector.

2. […]

3. Member States may decide not to set or apply the requirements referred to the following categories of buildings:

- buildings and monuments officially protected as part of a designated environment or because of their special architectural or historic merit, where compliance with the requirements would unacceptably alter their character or appearance
- buildings used as places of worship and for religious activities
- temporary buildings with a planned time of use of two years or less industrial sites, workshops and non-residential agricultural buildings with low energy demand and non-residential agricultural buildings which are in use by a sector covered by a national sectorial agreement on energy performance
- residential buildings which are intended to be used less than four months of the year
- stand-alone buildings with a total useful floor area of less than 50 m2.

**Article 05: New Buildings**

Member States shall take the necessary measures to ensure that new buildings meet the minimum energy performance requirements […].

For new buildings with a total useful floor area over 1 000 m2 Member States shall ensure that the technical, environmental and economic feasibility of alternative systems such as:

- decentralised energy supply systems based on renewable energy,
- CHP
- district or block heating or cooling, if available
- heat pumps, under certain conditions is considered and is taken into account before construction starts.

**Article 06: Existing Building**

Member States shall take the necessary measures to ensure that when buildings with a total useful floor area over 1000 m2 undergo major renovation, their energy performance is upgraded in order to meet minimum requirements in so far as this is technically, functionally and economically feasible.

Member States shall derive these minimum energy performance requirements on the basis of the energy performance requirements set for buildings […]. The requirements may be set either for the renovated building as a whole or for the renovated systems or components when these are part of a renovation to be carried out within a limited time period, with the abovementioned objective of improving the overall energy performance of the building.

**Article 07: Energy Performance Certificate**

1. Member States shall ensure that, when buildings are constructed, sold or rented out, an energy performance certificate is made available to the owner or by the owner to the prospective buyer or tenant, as the case might be.

Certification for apartments or units designed for separate use in blocks may be based:

- on a common certification of the whole building for blocks with a common heating system
- on the assessment of another representative apartment in the same block.

2. The energy performance certificate for buildings shall include reference values such as current legal standards and benchmarks in order to make it possible for consumers to compare and assess the energy performance of the building.

The certificate shall be accompanied by recommendations for the cost-effective improvement of the energy performance.

The objective of the certificates shall be limited to the provision of information and any effects of these certificates in terms of legal proceedings or otherwise shall be decided in accordance with national rules.

3. The range of recommended and current indoor temperatures and, when appropriate, other relevant climatic factors may also be clearly displayed.

**Article 10: Independent Experts**

Member States shall ensure that the certification of buildings, the drafting of the accompanying recommendations and the inspection of boilers and air-conditioning systems are carried out in an independent manner […]

The annex of the directive makes reference to other aspects that the directive may have influence or impact:

1. The positive influence of the following aspects shall, where relevant in this calculation, be taken into account:

(a) active solar systems and other heating and electricity systems based on renewable energy sources

(b) electricity produced by CHP

(c) district or block heating and cooling systems

(d) natural lighting.

2. For the purpose of this calculation buildings should be adequately classified into categories such as:

(a) single-family houses of different types

(b) apartment blocks

(c) offices

(d) education buildings

(e) hospitals

(f) hotels and restaurants

(g) sports facilities

(h) wholesale and retail trade services buildings

(i) other types of energy-consuming buildings

### 4.6.2 Extents to the Directive

In November 2008, the Commission adopted the proposal for a recast of the Energy Performance of Buildings Directive.

There are several new elements to the proposed directive that eceee welcomes. These include:

- dropping of the 1,000m2 threshold for “major refurbishment”;
- clarification of "buildings frequently visited by the public" for a display of an Energy Performance Certificate (EPC);
- a requirement for effective control systems and penalties for non-compliance
- a requirement to draw up national plans and targets for increasing the number of low/zero energy and carbon buildings.

- monitor and verify energy and carbon savings arising (in accordance with the Energy Services Directive (ESD) methodology);

## 4.7 DIRECTIVE 2006/32/EC: On energy end-use efficiency and energy services

### 4.7.1 Background for the Directive

Similarly to the previously explained EPBD directive, this one's background is stated in the Treaty establishing the European Community and in this particular case, in Articles 175 and 251 whereas, among others;

In the Community there is a need for improved energy end-use efficiency, managed demand for energy and promotion of the production of renewable energy, as there is relatively limited scope for any other influence on energy supply and distribution conditions in the short to medium term, either through the building of new capacity or through the improvement of transmission and distribution. This Directive thus contributes to improved security of supply.

Improved energy end-use efficiency will also contribute to the reduction of primary energy consumption, to the mitigation of CO2 and other greenhouse gas emissions and thereby to the prevention of dangerous climate change. These emissions continue to increase, making it more and more difficult to meet the Kyoto commitments. Human activities attributed to the energy sector cause as much as 78 % of the Community greenhouse gas emissions. The Sixth Community Environment Action Programme, laid down by Decision No 1600/2002/EC of the European Parliament and of the Council (4), envisages that further reductions are required to achieve the United Nations Framework Convention on Climate Change long-term objective of stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Therefore, concrete policies and measures are foreseen necessary.

The liberalisation of the retail markets for final customers for electricity, natural gas, coal and lignite, heating, and in some cases even district heating and cooling, has almost exclusively led to improved efficiency and lower costs on the energy generation, transformation and distribute on side. This liberalisation has not led to significant competition in products and services which could have resulted in improved energy efficiency on the demand side.

In order to enable final consumers to make better informed decisions as regards their individual energy consumption, they should be provided with a reasonable amount of information thereon and with other relevant information, such as information on available energy efficiency improvement measures, comparative final consumer profiles or objective technical specifications for energy-using equipment, which may include 'Factor Four' or similar equipment.

### 4.7.2 Objective & Scope

The purpose of this Directive is to enhance the cost-effective improvement of energy end-use efficiency by:

Providing the necessary indicative targets as well as mechanisms, incentives and institutional, financial and legal frameworks to remove existing market barriers and imperfections that impede the efficient end use of energy;

Creating the conditions for the development and promotion of a market for energy services and for the delivery of other energy efficiency improvement measures to final consumers.

On the other hand the scope or domain for the current EU directive is in first term applicable to:

- Providers of energy efficiency improvement measures, energy distributors, distribution system operators and retail energy sales companies.
- Final customers.

### 4.7.3 Directive Structure

The directive on energy end-use efficiency and energy services has its articles grouped in chapters regarding their content or application domain.

Next table show the articles relation and their content, grouped by chapters:

| Chapter | Article | Content |
|---|---|---|
| **Chapter 01:** **Subject Matter & Scope** | **Article 01** | Purpose |
| | **Article 02** | Scope |
| | **Article 03** | Definitions |
| **Chapter 02:** **Energy Saving Targets** | **Article 04** | General Target |
| | **Article 05** | Energy end-use efficiency in public sector |
| **Chapter 03:** Promotion Of Energy End-Use Efficiency And **Energy Services** | **Article 06** | Energy distributors, distribution system operators and retail energy sales |
| | **Article 07** | Availability of information |
| | **Article 08** | Availability of qualification, accreditation and certification schemes |

| | | |
|---|---|---|
| | **Article 09** | Financial instruments for energy savings |
| | **Article 10** | Energy efficient tariffs and other regulations for netbound |
| | **Article 11** | Funds and funding mechanisms |
| | **Article 12** | Energy audits |
| | **Article 13** | Metering and informative billing of energy consumption |
| **Chapter 04: Final Provisions** | **Article 14** | Reports |
| | **Article 15** | Review and adaptation of the framework |
| | **Article 16** | Committee |
| | **Article 17** | Repeal |
| | **Article 18** | Transposition |
| | **Article 19** | Entry into force |
| | **Article 20** | Addressees |

*Table 4-11 2006/32/EC Directive Structure*

The most relevant Articles in the context of the eDiana Platform are summarized in next the section, its content has been mostly literally transposed trying to stick as much as possible to its original aim.

**Article 05: Energy end-use efficiency in public sector**

1. Member States shall ensure that the public sector fulfils an exemplary role in the context of this Directive. […]

Member States shall ensure that energy efficiency improvement measures are taken by the public sector, focussing on cost-effective measures which generate the largest energy savings in the shortest span of time. […]

2. Member States shall assign to a new or existing organisation or organisations the administrative, management and implementing responsibility for the integration of energy efficiency improvement requirements […]

**Article 06: Energy distributors, distribution system operators and retail energy sales companies**

1. Member States shall ensure that energy distributors, distribution system operators and/or retail energy sales companies:

(a) provide on request, but not more than once a year, aggregated statistical information on their final customers to the authorities or agencies […]

This information must be sufficient to properly design and implement energy efficiency improvement programmes, and to promote and monitor energy services and other energy efficiency improvement measures. It may include historical information and must include current information on end-user consumption, including, where applicable, load profiles, customer segmentation and geographical location of customers, while preserving the integrity and confidentiality of information that is either of private character or commercially sensitive, in compliance with applicable Community legislation;

(b) refrain from any activities that might impede the demand for and delivery of energy services and other energy efficiency improvement measures, or hinder the development of markets for energy services and other energy efficiency improvement measures. The Member State concerned shall take the necessary measures to bring such activities to an end where they occur

2. Member States shall:

(a) choose one or more of the following requirements to be complied with by energy distributors, distribution system operators and/or retail energy sales companies, directly and/or indirectly through other providers of energy services or energy efficiency improvement measures:

(i) ensure the offer to their final customers, and the promotion, of competitively priced energy services;

(ii) ensure the availability to their final customers, and the promotion, of competitively-priced energy audits conducted in an independent manner and/or energy efficiency improvement measures […]

(b) ensure that voluntary agreements and/or other market oriented schemes, such as white certificates, with an effect equivalent to one or more of the requirements referred to in point (a) exist or are set up […].

To that end, the voluntary agreements shall have clear and unambiguous objectives, and monitoring and reporting requirements linked to procedures that can lead to revised and/or additional measures when the objectives are not achieved or are not likely to be achieved […].

3. Member States shall ensure that there are sufficient incentives, equal competition and level playing fields for market actors other than energy distributors, distribution

system operators and retail energy sales companies, such as ESCOs, installers, energy advisors and energy consultants, to independently offer and implement the energy services, energy audits and energy efficiency improvement measures […]

**Article 08: Availability of qualification, accreditation and certification schemes**

With a view to achieving a high level of technical competence, objectivity and reliability, Member States shall ensure, where they deem it necessary, the availability of appropriate qualification, and accreditation and/or certification schemes for providers of energy services, energy audits and energy efficiency improvement measures […].

**Article 10: Energy efficient tariffs and other regulations for net bound Energy**

1. Member States shall ensure the removal of those incentives in transmission and distribution tariffs that unnecessarily increase the volume of distributed or transmitted energy. […] Member States may impose public service obligations relating to energy efficiency on undertakings operating in the electricity and gas sectors respectively.

2. Member States may permit components of schemes and tariff structures with a social aim, provided that any disruptive effects on the transmission and distribution system are kept to the minimum necessary and are not disproportionate to the social aim.

**Article 12: Energy audits**

1. Member States shall ensure the availability of efficient, high-quality energy audit schemes which are designed to identify potential energy efficiency improvement measures and which are carried out in an independent manner, to all final consumers, including smaller domestic, commercial and small and medium-sized industrial customers.

2. Market segments that have higher transaction costs and non-complex facilities may be reached by other measures such as questionnaires and computer programmes made available on the Internet and/or sent to customers by mail. […]

**Article 13: Metering and informative billing of energy consumption**

1. Member States shall ensure that, in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters that accurately

reflect the final customer's actual energy consumption and that provide information on actual time of use.

When an existing meter is replaced, such competitively priced individual meters shall always be provided, unless this is technically impossible or not cost-effective in relation to the estimated potential savings in the long term. When a new connection is made in a new building or a building undergoes major renovations, […] individual meters shall always be provided.

2. Member States shall ensure that, where appropriate, billing performed by energy distributors, distribution system operators and retail energy sales companies is based on actual energy consumption, and is presented in clear and understandable terms. […]

3. Member States shall ensure that, where appropriate, the following information is made available to final customers in clear and understandable terms by energy distributors, distribution system operators or retail energy sales companies in or with their bills, contracts, transactions, and/or receipts at distribution stations:

(a) current actual prices and actual consumption of energy;

(b) comparisons of the final customer's current energy consumption wit consumption for the same period in the previous year, preferably in graphic form;

(c) wherever possible and useful, comparisons with an average normalised or benchmarked user of energy in the same user category;

(d) contact information for consumers’ organisations, energy agencies or similar bodies, including website addresses, from which information may be obtained on available energy efficiency improvement measures, comparative end-user profiles and/or objective technical specifications for energy-using equipment.

### 4.7.4 Extents to the Directive

National Implementations.

## 4.8 ETSI ES 202 076: User Interfaces, Generic spoken command vocabulary for ICT devices and services

### 4.8.1 Objective & Scope

The present standard is applicable to the functions required for user interface navigation, call handling, the control of and navigation in media, and management of device and service settings.

The eDiana platform doesn't consider spoke driven systems, but the rules applicable to these kind of systems could be taken into account for further enhacements. Anyway the commands identified by the standard could be used in traditional HMI systems, the study, that the standard makes for the most appropriate commands applicable to different languages, is fully applicable for the eDiana platform.

The methodology and outputs described in latter paragraphs are fully compliant with the eDiana platforms' Multilanguage human machine interface definition and development.

### 4.8.2 Standard Structure

The standard is structured in chapters in which cover from the reference documents to the list of commands taken into account as output for the normalized standard.

The most relevant chapters are the ones that describe the methodology followed to identify the subset of commands that will be part of the standard.

### 4.8.3 Standard Methodology

#### *4.8.3.1 General*

In order to meet the requirements designed for a wide range of end users, an empirical method has been employed for the elicitation and validation of potential voice commands. The previous standard used an online method of data collection where respondents were asked to complete a questionnaire. This worked well for the five most frequently spoken languages of the EU. However, the extension of the standard covers countries where internet penetration is relatively low and online questionnaires for these countries would not yield a representative sample of users for the purposes of inclusion.

The employed method consists of three phases:

- Phase 1: Elicitation of command candidates.
- Phase 2: Validation of command candidates..

- Phase 3: Phonetic discriminability.

These phases are outlined here. More detailed descriptions of each phase can be found in Standard's annex A.

#### 4.8.3.2 Elicitation of command candidates

In this phase, native speakers representing three age groups, aiming for an equal distribution of men and women, were invited to take part in an interview. At this stage, they were given some general background to the aims of the study in order to inform them of the aims of the study prior to gaining their consent to participating in the research. In most cases the interview was conducted by telephone. The interviewer, or Native Language Assistant (NLA), was also always a native or near-native speaker who also carried out translations and transcriptions from documents in the original English and conducted analyses. They read out, for each command, a phrase describing the function of the device or service, known as the Carefully Worded Description (CWD), without mentioning any of the most likely resulting terms. The interviewees were then asked to name the term or terms they would find most suitable as a command in the context of a spoken command supported device or service.

#### 4.8.3.3 Validation of command candidates

In identifying the appropriate commands it is not sufficient to conduct elicitation alone. It was also necessary to rank the proposed terms in order to provide a degree of validation. Therefore, validation interviews were set up and carried out in a similar way to elicitation interviews.

The top-ranked commands were then put forward to the phonetic discriminability phase.

The experts comprised a combination of: the NLAs, industry experts, linguistic and cultural representatives from the countries involved, and Human Factors experts.

#### 4.8.3.4 Phonetic discriminability

Whilst the previous two steps have provided a user-centric approach to the selection of command words, it is still important to address technology issues.

A selection of words may be chosen as a result of the previous two phases that have a high level of agreement across the user group.

However, if this selection gives rise to a high degree of confusability in the speech recognizer, between words which are available for use in the same context, then the overall goal of usability is nullified. Therefore, discriminability analysis was carried out to ensure that command words that are likely to be active simultaneously in a dialogue context can be recognized correctly by the speech recognition system.

The approach consisted of the following steps:

a) Commands were clustered according to those which would be simultaneously available, e.g. all commands for functions related to the handling of phone calls.

b) For each context, the top three commands from validation were assessed by native-language experts with respect to their sounds and not to their orthographic forms. Commands were listed as potentially phonetically confusable if:

- they share the same initial consonant or consonant cluster;
- they share similar stressed vowels;
- they are of equal length.

c) Commands that give rise to possible phonetic confusion were collated.

d) An alternative for one of the command words was chosen, with minimum repercussion with respect to the ranking of candidates.

### 4.8.4 Standard Command List

#### *4.8.4.1 Principles of use*

The spoken commands specified by the standard are divided into the following categories:

1) basic commands;

2) digits;

3) communication commands;

4) commands for the control of and navigation in media;

5) commands for device settings.

The following principles of use in implementations apply, assuming a speech recognition or traditional user interface is provided:

1) The ICT device or service shall support all the commands specified in the present document if the corresponding functionality is implemented.

2) If a function as defined in the present document is not supported by the ICT device or service, the corresponding command should still be accepted as user input and guidance information should be provided to the user.

3) In addition to the commands specified in the present document, alternative and additional commands may be offered by the device and service provider. However, additional commands should be tested for phonetic discriminability with other commands available in the same context.

4) One word which was suggested for inclusion in the standard is "Select". This allows users to choose an item from a menu. However, the suggestion came too late for the data collection exercise. This word may be the subject of an extension to the present document but, in the mean time, command 1.1 in table 1.a ("confirm operation") may provide a suitable command.

6) In some languages functions are covered by one command, in other languages alternative commands exist for those same functions. This is a direct result of the empirical data collection and subsequent analysis.

For clarity where there is more than one command for a function, these commands will be separated by commas and the first word of a command starts with an upper case letter.

7) For commands for emergency services (3.7) only the relevant words in each language are given. The spoken commands for the digits 112 are already specified in clause 6.3. In addition, if a user wanted to say "Call 112" or "Dial 112", the relevant word for "Call" or "Dial" is also specified in clause 6.4. ETSI

12 ETSI ES 202 076 V2.1.1 (2009-08)

8) Two of the official languages of EFTA member countries Norway and Switzerland are represented by more than one variant, namely Bokmål and Nynorsk for Norwegian (Riksmål and Høgnorsk have not been considered), and Ladin, Surmiran, Sursilvan, and Rumantsch Grischun for Raeto-Romance (Sutsilvan, Putér, and Vallader have not been considered). Which of these variants is represented in a given command is indicated by indices and footnotes in the respective tables.

Standard annex II covers the commands which could provide full functionality for human machine interfaces adapted to all EU countries.

## 4.9 CMMI

As part of the maturity of the market many clients are demanding more quality to their IT providers. Also IT companies have realized that the institutionalization of the software process provide maturity to the company and they can reduce costs by non repeating tasks or delivering products according to the requirements needs, feasible in the practice and without bugs. Software is becoming a fundamental part of any company's processes and therefore those companies want to be sure that the IT provider has certain guarantee to provide a quality product.

In addition, many bad experiences from the governments buying software have become into a new trend where the public organism ask for these kinds of guarantees to work from them. This is the reason because CMMI is becoming almost a de facto standard.

Something similar is happening in the automotive domain where OEM needs to be sure that the different pieces of software integrated and provided by different users work perfectly. Even more the OEM itself used to appraise the provider's software processes during the project and also gets involved in some phases of the development provider to ensure the processes are being fulfilled and the product artefacts have being done correctly. For example, in some innovative projects the project starts with many doubts that are resolved during the project, which means that the OEM has to get involved to learn from the taken decisions and this also means the review of process and artefacts.

Because of those reasons the different software improvement model like (SPICE, Spice for Space, AutomotiveSpice, CMMI) are becoming very popular between the IT companies.

eDIANA Task 6.3 has analysed one of this standards which covers a generic quality maturity model, CMMI for development. With this model the most common software process improvement method will be analysed.

### 4.9.1 Software Process Improvement Models

This section tries to describe some of the most well known process improvement practices models. It will focuses on Capability Maturity Model Integration (CMMI).

It is a model for the improvement of the processes that provide to the organizations the necessary elements for efficient processes. Nowadays, there are two areas where CMMI focuses its interests:

- CMMI for Development: it considers services and products development processes
- CMMI for Acquisition: it considers supply chain management, acquisition and outsourcing processes in government and industry.

Next releases will include CMMI for Services a guide for delivering services within organization and to external customers.

Capability Maturity Model Integration (CMMI) for Development consists of best practices that address development and maintenance activities applied to products and services. Its practices cover the product's lifecycle from conception through delivery and maintenance. CMMI works over every aspect that is necessary to build and maintain the total product.

Considering the organizations as entities that are necessary to dissect in order to analyze their structure and behavior, there can be three dimensions which the study can be focused on:

- People
- Procedures and Methods
- Tools and equipments

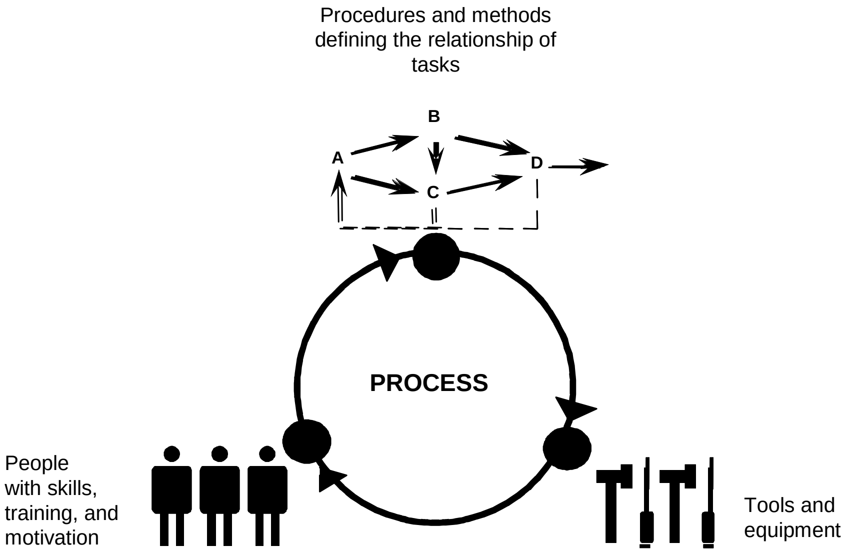


*Figure 4-3 The Three Critical Dimensions*

It is the processes used in most organizations. Processes allow aligning the way to do business. Through processes it is possible to address scalability and provide a way to incorporate knowledge of how to do things better [CMMI 2006].

The beginning of CMMI is located in the 1930s; Walter Shewhart began work in process improvement with his principles of statistical quality control [Shewhart 1931]. These principles were refined by W. Edwards Deming [Deming 1986], Phillip Crosby [Crosby 1979], and Joseph Juran [Juran 1988]. Watts Humphrey, Ron Radice, and others extended these principles even further and began applying them to software in their work at IBM and the SEI [Humphrey 1989]. Humphrey's book, Managing the Software Process, provides a description of the basic principles and concepts on which many of the capability maturity models (CMMs®) are based.

The CMM IntegrationSM project came up because there were some CMMs that should be combined [CMMI 2006]:

- The Capability Maturity Model for Software (SW-CMM) v2.0 draft C [SEI 1997b]
- The Systems Engineering Capability Model (SECM) [EIA 1998]
- The Integrated Product Development Capability Maturity Model (IPD-CMM) v0.98 [SEI 1997a]

CMMI for Development covers now these three source models.

CMMI for Development is a reference model that covers the development and maintenance activities applied to both products and services. Organizations from many industries, including aerospace, banking, computer hardware, software, defense, automobile manufacturing, and telecommunications, use CMMI for Development.

### 4.9.2 CMMI Representation

CMMI allows approaching process improvement and appraisals establishing two different representations: continuous and staged.

- The continuous representation enables an organization to select a process area (or group of process areas) and improve processes related to it. This representation uses capability levels to characterize improvement relative to an individual process area.
- The staged representation uses predefined sets of process areas to define an improvement path for an organization. This improvement path is characterized by maturity levels. Each maturity level provides a set of process areas that characterize different organizational behaviors.

The continuous representation offers the ability to improve the performance of a concrete process that is considered high critical for the organization or it can work on several areas to the organization assigns a high degree of risk.

CMMI recommends the continuous representation when the processes that need to be improved and the dependencies among the process areas described in CMMI are well understood.

The staged representation allows providing a definite sequence of improvements, each element of the sequence is referred to a specific stage or time. If a stage is achieved, it certificates that the process infrastructure is enough stable at that point, so the basis is established for the next stage. This stages sequence defines a method to allow the comparison between the maturity level of different projects or organizations.

Process areas are organized by maturity levels that take some of the guess work out of process improvement. The staged representation prescribes an order for implementing process areas according to maturity levels, which define the improvement path for an organization from the initial level to the optimizing level. Achieving each maturity level ensures that an adequate improvement foundation has been laid for the next maturity level and allows for lasting, incremental improvement.

CMMI recommends this representation when the start point or the processes to improve are not well known because it gives a specific set of processes to improve at each stage that has been determined through more than a decade of research and experience with process improvement [CMMI 2006].

| Continuous Representation | Staged Representation |
|---|---|
| Grants explicit freedom to select the order of improvement that best meets the organization's business objectives and mitigates the organization's areas of risk | Enables organizations to have a predefined and proven improvement path |
| Enables increased visibility of the capability achieved in each individual process area | Focuses on a set of processes that provide an organization with a specific capability that is characterized by each maturity level |
| Allows improvements of different processes to be performed at different rates | Summarizes process improvement results in a simple form—a single maturity level number |
| Reflects a newer approach that does not yet have the | Builds on a relatively long history of use that includes |

| | |
|---|---|
| data to demonstrate its ties to return on investment | case studies and data that demonstrate return on investment |

*Table 4-12 Comparative Advantages of Continuous and Staged Representations*

### 4.9.3 CMMI Components

CMMI model components can be divided into three categories. These categories make easier their interpretation:

| Component Category | Description |
|---|---|
| Required Components | o These components describe what organizations must keep to fulfil a process area. They have to be completely visible inside the organization processes.<br>o Specific and Generic Goals are required components in CMMI<br>o Goal satisfaction is used to evaluate if a process area has been achieved |
| Expected Components | o These components describe what organizations may implement to achieve a required component<br>o Specific and Generic Practices are expected components in CMMI<br>o Practices are to be described in processes before to consider if goals are satisfied |
| Informative Components | o These components help organizations to discover how to establish the required and expected components.<br>o Suppractices, typical work products, amplifications, generic practice elaborations, goal and practice titles, goal and practice notes, and references are informative components |

*Table 4-13 Component Category*

Next Table will describe the CMMI model components:

| Component | Description |
|---|---|
| Process Areas | A process area is a cluster of related practices in an area that, when implemented collectively, satisfy a set of goals considered important for making improvement in that area.<br><br>There are 22 process areas |
| Purpose Statements | The purpose statement describes the purpose of the process area and is an informative component. |
| Introductory Notes | The introductory notes section of the process area describes the major concepts covered in the process area and is an informative component. |
| Related Process Areas | The related process areas section lists references to related process areas and reflects the high-level relationships among the process areas. The related process area section is an informative component. |
| Specific Goals | A specific goal describes the unique characteristics that must be present to satisfy the process area. |
| Generic Goals | A generic goal describes the characteristics that must be present to institutionalize the processes that implement a process area |
| Specific Goal and Practice Summaries | The specific goal and practice summary provides a high-level summary of the specific goals, which are required components, and the specific practices, which are expected components. |

| | |
|---|---|
| Specific Practices | The specific practices describe the activities that are expected to result in achievement of the specific goals of a process area. |
| Typical Work Products | The typical work products section lists sample output from a specific practice. These examples are called typical work products because there are often other work products that are just as effective but are not listed. |
| Subpractices | A subpractice is a detailed description that provides guidance for interpreting and implementing a specific or generic practice. |
| Generic Practices | A generic practice is the description of an activity that is considered important in achieving the associated generic goal. |
| Generic Practice Elaborations | A generic practice elaboration appears after a generic practice in a process area to provide guidance on how the generic practice should be applied uniquely to the process area. |
| Notes | A note is text that can accompany nearly any other model component. It may provide detail, background, or rationale. |
| Examples | An example is a component comprising text and often a list of items, usually in a box, that can accompany nearly any other component and provides one or more examples to clarify a concept or described activity. |
| Amplifications | Amplification is a note or example that is relevant to a particular discipline. The disciplines covered in this model are hardware engineering, systems engineering, and software engineering. |
| References | A reference is a pointer to additional or more detailed information in related process areas and can accompany nearly |

| | |
|---|---|
| | any other model component |

*Table 4-14 CMMI Model Components*

Next, it will be described the list of process areas that exist with their acronyms:

| Process Area | Acronym |
|---|---|
| Causal Analysis and Resolution | CAR |
| Configuration Management | CM |
| Decision Analysis and Resolution | DAR |
| Integrated Project Management +IPPD | IPM+IPPD |
| Measurement and Analysis | MA |
| Organizational Innovation and Deployment | OID |
| Organizational Process Definition +IPPD | OPD+IPPD |
| Organizational Process Focus | OPF |
| Organizational Process Performance | OPP |
| Organizational Training | OT |
| Product Integration | PI |
| Project Monitoring and Control | PMC |
| Project Planning | PP |
| Process and Product Quality Assurance | PPQA |
| Quantitative Project Management | QPM |
| Requirements Development | RD |
| Requirements Management | REQM |
| Risk Management | RSKM |

| | |
|---|---|
| Supplier Agreement Management | SAM |
| Technical Solution | TS |
| Validation | VAL |
| Verification | VER |

*Table 4-15 Process Areas*

Next sections will describe how all those components are use to achieve the process improvement needs. The concept of levels is introduced to show how the process areas are organized and how all the components interact between them.

### 4.9.4 Capability Levels

Capability levels are related to the continuous representation which facilitates an incrementally and continuous improvement in a process inside an individual process area specified by the organization.

There are six capability levels that can be applied to processes:

| Capability Level | Name | Description |
|---|---|---|
| 0 | Incomplete | o One or more of the specific goals of the process area are not completed<br>o There are no generic goals |
| 1 | Performed | o The specific goals of the process area are completely satisfied |
| 2 | Managed | o A performed process plus the basic infrastructure<br>o This level provides the capacity of fixing the existing practices |
| 3 | Defined | o A managed process plus organization's standard processes, contributes work products, measures and other process improvement information |
| 4 | Quantitatively Managed | o A defined process plus statistical and other quantitative techniques |

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| 5 | Optimizing | o A quantitatively managed process plus an understanding of the common causes of variation inherent in the process |

*Table 4-16 Capability Levels*

### 4.9.5 Maturity Levels

A Maturity Level is defined by several generic and specific practices to be applied in a predefined set of process areas that will allow improving the performance of the organization. They are related to the staged representation.

Each Maturity Level focuses on important subsets of the organization's processes; it establishes how to improve them to reach the next level. The measures to evaluate if a Maturity Level is approached are the specific and generic goals associated with the predefine set of process areas.

Once a Maturity Level is reached in an organization, it will be possible to show in advance the performance of that organization.

There are five maturity levels:

| Maturity Level | Name | Description |
|---|---|---|
| 0 | Initial | o There is not a stable environment to support the process |
| 1 | Managed | o Processes are planned and executed through a policy<br>o Existing practices can be used during timing of stress<br>o The work products and services conform to the process descriptions, standards and procedures |
| 2 | Defined | o Processes are completely defined in standards, procedures, tools and methods<br>o There is a completed set of standard processes belonging to the organization used to ensure the consistency across the organization<br>o More rigorous described processes |

| | | |
|---|---|---|
| 3 | Quantitatively Managed | o There are quantitative objectives for quality and process performance → evaluation criteria<br>o Needs of customers, end users, organization, etc. are considered to establish those quantitative objectives<br>o Predictability of process performance |
| 4 | Optimizing | o Incremental and innovative process and technological improvements<br>o Quantitative processes improvement objectives are continually revised |

*Table 4-17 Maturity Levels*

### 4.9.6 Process Areas Interactions

This section will describe how Process Areas interacts between them reflecting a complete view of the processes of the organization.

They will be showed through two different axes or dimensions. The fist one describes the interactions of individual process areas, how the flow is through different process areas. The second axe shows the interactions between groups of process areas. It classifies them into basic or advanced, the basic ones should be implemented before the advanced one.

Process Areas can be grouped into four categories:

| Process Areas Category | Description | Process Areas involved | Dimension |
|---|---|---|---|
| Process Management | This process area is related to defining, planning, deploying, implementing, monitoring, controlling, appraising, measuring and improving processes | Organizational Process | Basic |
| | | Organizational Process Definition + IPPD | Basic |
| | | Organizational Training | Basic |
| | | Organizational Process Performance | Advanced |
| | | Organizational Innovation and Deployment | Advanced |
| Project Management | This process area is related to planning, monitoring and controlling the project | Project Planning | Basic |
| | | Project Monitoring and Control | Basic |
| | | Supplier Agreement Management | Basic |

| | | | |
|---|---|---|---|
| | | Integrated Project Management + IPPD | Advanced |
| | | Risk Management | Advanced |
| | | Quantitative Project Management | Advanced |
| Engineering | This process area is related to the development and maintenance activities that are spread our over different engineering disciplined | Requirements | |
| | | Requirements | |
| | | Technical Solution | |
| | | Product Integration | |
| | | Verification | |
| | | Validation | |
| Support | This process area is related to the activities that support product development and maintenance | Configuration | Basic |
| | | Process and Product Quality Assurance | Basic |
| | | Measurement and | Basic |
| | | Decision Analysis and Resolution | Advanced |
| | | Causal Analysis and Resolution | Advanced |

*Table 4-18 Process Areas categories*

This document will not focus on every Process Area Category, since it would exceed the objective of the project. The chosen parts to study in detail will be those which are referred to the processes involved in the Validation, Verification and Certification, the areas involved in this task.

Next table shows the Specific Practices of CMMI by Process Area:

| **CMMI** | |
|---|---|
| Process Area | Specific Practices |
| RD - Requirements Development | SP1.1 Elicit Needs<br>SP1.2 Develop the customer requirements<br>SP2.1 Establish product and product component requirements<br>SP2.2 Allocate product component requirements |

| | |
|---|---|
| | SP2.3 Identify interface requirements<br>SP3.1 Establish operational concepts and scenarios<br>SP3.2 Establish a definition of required functionality<br>SP3.3 Analyze requirements<br>SP3.4 Analyze requirements to achieve balance<br>SP3.5 Validate requirements |
| REQM - Requirements Management | SP1.1 Obtain an understanding of requirements<br>SP1.2 Obtain commitment to requirements<br>SP1.3 Manage requirements changes<br>SP1.4 Maintain bidirectional traceability of requirements<br>SP1.5 Identify inconsistencies between project work and requirements |
| TS – Technical Solution | SP1.1 Develop Alternative Solutions and Selection Criteria<br><br>S1.2 Select Product Component Solutions<br><br>SP2.1 Design the Product or Product Component<br><br>SP2.2 Establish a Technical Data Package<br><br>SP2.3 Design Interfaces Using Criteria<br><br>SP2.4 Perform Make, Buy or Reuse Analysis<br><br>SP3.1 Implement the Design<br><br>SP3.2 Develop Product Support Documentation |
| PI – Product Integration | SP 1.1 Determine Integration Sequence<br><br>SP 1.2 Establish the Product Integration |

| | |
|---|---|
| | Environment<br><br>SP 1.3 Establish Product Integration Procedures and Criteria<br><br>SP 2.1 Review Interface Descriptions for Completeness<br><br>SP 2.2 Manage Interfaces<br><br>SP 3.1 Confirm Readiness of Product Components for Integration<br><br>SP 3.2 Assemble Product Components<br><br>SP 3.3 Evaluate Assembled Product Components<br><br>SP 3.4 Package and Deliver the Product or Product Component |
| VER- Verification | SP 1.1 Select Work Products for Verification<br><br>SP 1.2 Establish the Verification Environment<br><br>SP 1.3 Establish Verification Procedures and Criteria<br><br>SP 2.1 Prepare for Peer Reviews<br><br>SP 2.2 Conduct Peer Reviews<br><br>SP 2.3 Analyze Peer Review Data<br><br>SP 3.1 Perform Verification<br><br>SP 3.2 Analyze Verification Results |
| VAL - Validation | SP 1.1 Select Products for Validation<br><br>SP 1.2 Establish the Validation Environment<br><br>SP 1.3 Establish Validation Procedures and Criteria |

| | |
|---|---|
| | SP 2.1 Perform Validation<br><br>SP 2.2 Analyze Validation Results |
| CM – Configuration Management | SP 1.1 Identify Configuration Items<br><br>SP 1.2 Establish a Configuration Management System<br><br>SP 1.3 Create or Release Baselines<br><br>SP 2.1 Track Change Requests<br><br>SP 2.2 Control Configuration Items<br><br>SP 3.1 Establish Configuration Management Records<br><br>SP 3.2 Perform Configuration Audits |

*Table 4-19 CMMI Specific Practices*

Finally, the main identified artifacts of this standard by Process Area are:

| CMMI | | |
|---|---|---|
| **Process Area** | | **Work Products** |
| ENGINEERING | RD - Requirements Development | o Customer Requirements<br>o Product Requirements<br>o Component Requirements<br>o Interface Requirements<br>o Scenarios<br>o Functional Requirements<br>o Requirements Defects Reports<br>o Requirements Risks Assessment<br>o Validation Methodology |
| | REQM - Requirements Management | o Requirements<br>o Requirements bidirectional traceability<br>o Requirements changes<br>o Requirements commitment |

| | | |
|---|---|---|
| | TS - Technical Solution | o Alternative solution screening criteria<br>o Evaluation Reports of new technologies<br>o Alternative solutions<br>o Selection criteria for final Selection<br>o Evaluation Reports of COTS products |
| | VER - Verification | o List of work products selected for verification<br>o Verification methods for each selected work product<br>o Verification Environment<br>o Verification procedures<br>o Verification Criteria<br>o Peer review schedule<br>o Peer review checklist<br>o Entry and exit criteria for work products<br>o Criteria for requiring another peer review<br>o Peer review training material<br>o Selected work products to be reviewed<br>o Peer review results<br>o Peer review issues<br>o Peer review data<br>o Peer review action items<br>o Verification results<br>o Verification reports<br>o Demonstrations<br>o As-run procedures log<br>o Analysis report<br>o Trouble reports<br>o Change request for the verification methods, criteria and environment |

| | | |
|---|---|---|
| | PI - Product Integration | o Product Integration sequence<br>o Rationale for selecting or rejecting Integration sequences<br>o Verified environment for Product Integration<br>o Support documentation for the Product integration environment<br>o Product Integration procedures and criteria<br>o Categories of interfaces<br>o List of interfaces per category<br>o Mapping of the interfaces to the Product components and the Product Integration environment<br>o Table of relationships among the different Product components<br>o Relationships among the components and the external environment<br>o List of agreed-to interfaces defined for each pair of components<br>o Reports from the interface control working group meetings<br>o Actions items for updating interfaces<br>o Application program interface (API)<br>o Updated interface description or agreement<br>o Acceptance documents for the received components<br>o Delivery receipts<br>o Checked packing lists<br>o Exception Reports<br>o Waivers<br>o Assembled products or components<br>o Exception Reports<br>o interface evaluation Reports<br>o Product Integration summary |

| | | |
|---|---|---|
| | VAL - Validation | o List of products components selected for validation<br>o Validation methods and validation constraints for each product or component<br>o Validation Environment<br>o Validation procedures<br>o Validation Criteria<br>o Test procedures for maintenance, training and support<br>o Validation reports<br>o Validation results<br>o Validation cross-reference matrix<br>o As-run procedures log<br>o Operational demonstrations<br>o Validation deficiency reports<br>o Validation issues<br>o Procedure change request |
| | CM - Configuration Management | o Identified Configuration items<br>o CMS with controlled work products<br>o CMS access control procedures<br>o Change request database<br>o Baselines<br>o Description of Baselines<br>o Change requests<br>o Configurations items revision history<br>o Archives of the Baselines<br>o Change log<br>o Change request copy<br>o Configuration items status<br>o Differences between Baselines<br>o Configuration audit results<br>o Action items |

*Table 4-20 CMMI Artefacts by Process Area*

# 5. Conclusion

This document is the first step in the common objective of all the deliverables of this task 6.3 Specification of a Certification Metamodel for Energy Management Deployments. The task aims to define a Certification Metamodel placed between the different domains that apply to eDIANA Project.

Once considered the significant environment in which eDIANA Project is placed, embedded systems, energy efficiency, buildings, partners' expertise has provided a brief state of the art of relevant standards, directives, code of practices that can be related completely or partially to the eDIANA objectives and issues.

The document observes the certification processes at high level, since, as previous sections clarify, not all the certifications have the same subject. The definition of a certification process and relevant terms can differ from process certification, product certification or personnel certification. Furthermore, the conjunction of standards, directives, regulations, etc. does not simplify the scenario of a certification Metamodel that embraces all the facets.

The established analysis gives a wide view of the different possibilities in certification that appear when several domains converge in the same objective. The variety of terms, domains, subjects of certification complicates the attempt to coordinate all of them into a unique context. Next deliverables will accomplish the task of identifying the commonalties of the relevant standards, directives, etc. in order to define the common aspects relevant to eDIANA project, as well as the required certification processes. This will be the next step to achieve inside this task, this step will be essential to accomplish the work of compose the Certification Metamodel.

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