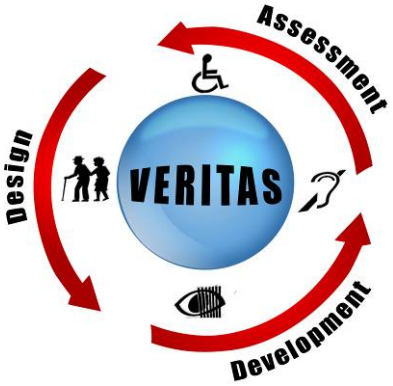
Accessible and Assistive ICT



VERITAS

Virtual and Augmented **E**nvironments and **R**ealistic User **I**nteractions **T**o achieve Embedded **A**ccessibility Design**S**

247765

D4.5.2 VERITAS Roadmap

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Abbreviations list

Abbreviation	Explanation
AAL	Ambient Assisted Living
AALOA	Ambient Assisted Living Open Association
AHA	Active and Healthy Ageing
AmI	Ambient Intelligence
CAD	Computer Aided Design
CEN	Comité Européen de Normalisation (European Committee for Standardisation)
CENELEC	European Committee for Electrotechnical Standardisation
DIN	Deutsches Institut für Normung (German Institute for Standardisation)
DIPLECS	Dynamic Interactive Perception-action LEarning in Cognitive Systems
DSM	Diagnostic and Statistical Manual
E&D	Elderly and Disabled
EFTA	European Family Therapy Association
EIP	Enterpreneurship and Innovation Framework
ETSI	European Telecommunications Standards Institute
EY	European Year
FMA	Field Measurement Approach
GPII	Global Public Inclusive Infrastructure
ICD	International Classification of Diseases
ICF	International Classification of Functionality, Disability and Health
ICT	Information Communication Technologies
IDE	Integrated Development Environmnet
IMS	IP Multimedia Subsystem
ITU	International Telecommunications Union
JTC	Joint Technical Committee
MBUI	Model-Based User Interfaces
OAF	Open Accessibilty Framework
R&D	Research and Development
RDWG	Research and Development Working Group
SDL	Specification and Description Language
SME	Small-Medium Enterprise
SWG	Special Working Group
UCD	User Centered Design
UML	Unified Modeling Language
UN	United Nations
URC	Universal Remote Console
VUM	Virtual User Model
VUMS	Virtual User Model and Simulation Standardisation
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines
WG	Working Group
XPDL	XML Process Definition Language

Executive Summary

The targets of the project roadmap are twofold: on the one hand, through an intensive involvement of the participating research institutions and industrial partners, *to keep track of the state of the art, as well as policies and trends in accessibility as well as independent living and autonomous mobility in the domains related to the project*. On the other hand, taking into account the VERITAS results, to *prepare a roadmap reflecting the future RTD needs, in order to be prepared for and direct our work towards meeting the challenges of 2020 and beyond.*

In this perspective the present Deliverable has been structured in 7 chapters. Chapter 1 is the introduction, referring to the background of the work presented in this Deliverable and the methodology that has been followed.

In Chapter 2, some indicative and significant past and ongoing research initiative, whose work is highly linked to the work performed in VERITAS, are shortly presented and links are provided for extensive information on their activities to be retrieved.

Chapter 3 includes an outline of the EU policy and standards framework. The main legal instruments, ongoing and upcoming EU policy developments and general challenges are presented, along with a set of issues that are of specific interest for the VERITAS project. In this chapter also standardisation issues are discussed. The baseline standardisation activities of VERITAS are presented, along with a list of existing standards that have been taken into account in terms of the VERITAS standardisation policy.

In Chapter 4 the standardisation activities that have taken place throughout the duration of the VERITAS project are highlighted. These have mainly been undertaken within the context of the VUMS cluster, resulting to the VUMS cluster White paper for standardisation.

Chapter 5 includes the mid to long term research priorities, as emerged through the activities of VERITAS. A set of 14 research priorities is presented, with brief description and relevant details (relevant VERITAS domain, applicability to other domains, priority level and background information).

The work presented in the above chapters results in the definition – in Chapter 6 – of the final VERITAS Roadmap with relevant timeline for the identified priorities. Finally in Chapter 7 general conclusions are drawn.

1 Introduction

VERITAS aims to develop, validate and assess tools for built-in accessibility support at all stages of ICT and non-ICT product development, including specification, design, development and testing. The goal is to introduce simulation-based and virtual reality testing at all stages of assistive technologies product design and development into the automotive, smart living spaces, (buildings & construction, domotics), workplace and infotainment applications areas. The goal is to ensure that future products and services are being systematically designed for all people including those with disabilities and functional limitations as well as older people. Furthermore, VERITAS plans to promote its results to the appropriate standards organisations for consideration and potential adoption and also to make them available through an open framework.

In this concept, in WP4.5 a series of actions are undertaken in terms of standardisation concertation actions, input to standardisation bodies and policy promotion, issue of application guidelines etc. All these, incorporating and feeding back to the project results, are ultimately preparing the field for the future of research in the area of user modelling and virtual environments in the service of accessibility design of all kinds of products for all kinds of users. A first step into the “day-after” is to investigate and propose the research priorities, i.e. the next stone in the path, towards the goal of achieving ICT and non-ICT product development in an all-inclusive manner.

1.1 Methodology

The targets of the VERITAS roadmap (A4.5.4) are twofold: on the one hand, through an intensive involvement of the participating research institutions and industrial partners, *to keep track of the state of the art, as well as policies and trends in accessibility as well as independent living and autonomous mobility in the domains related to the project*. On the other hand, taking into account the VERITAS results, to *prepare a roadmap reflecting the future RTD needs, in order to be prepared for and direct our work towards meeting the challenges of 2020 and beyond.*

For the first, literature review as well as synergies and cooperation with other research initiatives, standardisation and policy stakeholders were the main instruments that have been applied. To what concerns the Roadmap and Standardisation plan of VERITAS, this has been structured across a short, mid and long term horizon, as follows:

- **Short-term:** Standardisation actions during the project lifecycle (until the end of the project, 48 months).

- **Mid-term** (up to 2015) and **long term** (2015-2020 and beyond): Standardisation and Research actions proposed and prioritised for the period after the end of the project.

Reaching the end of the project and after the development of the main VERITAS services and modules, but mainly according to the Pilots’ results, new standards and research needs seems to arise and need to be proposed by the Consortium. New standards may be a combination with the existing guidelines and standards, or may be proposed to standardisation bodies as new ones, while further research needs derive from the research activities of VERITAS as a further development or a continuation to the work performed. The task of identifying these needs has been conducted from the VERITAS Consortium members, concerning the VERITAS project results, but, also, in conjunction with the assistance of the

VERITAS User Forum members (especially E&D organisation representatives and experts in it), as well as the VUMS partners, who have contributed towards the identification of relevant needs and priorities for emerging standards, or standard amendments, as well as needs for further research.

This work has been achieved and maintained on the basis of the following template, that specifically for the context of the VERITAS project, was completed (towards the end of the project) by the pilots' responsible Partners and the developers.

Table 1: Further research priority template

Research action/Standard name	
Description	
Relevant VERITAS domain	☐ Automotive ☐ Smart living places ☐ Workspaces ☐ Infotainment ☐Healthcare
Applicability to other domains	☐ Yes Please define: ... ….....…..... ☐ No
Input organisation Country	
Organisation type	☐ Developer, Industry ☐ Developer, SME's ☐ Developer, individual ☐ Expert ☐ E&D (specify disability type :.....) ☐ Authority ☐ Other: ….....
Type of Researcher	☐ Industrial ☐ National ☐ European ☐ International ☐ Other: ….....
Priority level	☐ Essential ☐ Important ☐ Good to have
Background information	(Why you think this research has to be done)
References	(if any, suggesting this has to be performed)
Comments	

2 Past and ongoing research

The core concept of VERITAS project is to research and develop an open framework for providing built-in accessibility support at all the stages of realisation of mainstream ICT and non- ICT technologies. The project aims at delivering to product/software developers 'generic' instructions - embedded in an empowering virtual reality platform, for exploring new concepts, designing new interfaces and testing interactive prototypes that will inherit universal accessibility features, including compatibility with established assistive technologies. By achieving these goals VERITAS is expected to operationalise and potentially revolutionise the accessibility testing at all stages of design and development of new products in five very important industrial domains (automotive, smart living spaces, (buildings & construction, domotics), workplace and infotainment applications areas). The main VERITAS innovation lies in the fact that, even if there have been some limited and isolated attempts to support accessibility testing of novel products and applications, there is a clear lack of a holistic framework that supports comprehensively virtual user modelling, simulation and testing at all development stages and realistic/immersive experience of the simulation.

Relevant and/or connected work has been undertaken in several EU projects that run before or during the VERITAS project. Synergies and exchange of knowledge has been ongoing throughout the duration of VERITAS project, benefitting of the findings and know-how of related research, while also working together in standardisation issues with some of them (mainly within the concept of the VUMS (Virtual User Models Simulation Standardisation) Cluster, which is extensively described in consequent chapters). Some of the most indicative projects and their scopes are described below.

2.1 AEGIS IP [1]

AEGIS (Open Accessibility Everywhere: Groundwork, Infrastructure, Standards) was a Collaborative Project, funded by the 7th Framework Programme of the European Commission. The AEGIS project aimed to determine whether 3rd generation access techniques will provide a more accessible, more exploitable and deeply embeddable approach in mainstream ICT (desktop, rich Internet and mobile applications). This approach has been developed and explored with the Open Accessibility Framework (OAF) through which aspects of the design, development and deployment of accessible mainstream ICT are addressed. The OAF provides embedded and built-in accessibility solutions, as well as toolkits for developers, for "engraving" accessibility in existing and emerging mass-market ICT-based products, thus making accessibility open, plug and play, personalised and configurable, realistic and applicable in various contexts; AEGIS is placing users and their needs at the centre of all ICT developments. Based on a holistic UCD, AEGIS identified user needs and interaction models for several user groups, (users with visual, hearing, motion, speech and cognitive impairments as well as application developers) and developed open source-based generalised accessibility support into mainstream ICT devices/applications:

- desktop,
- rich web applications, and
- Java-based mobile devices.

VERITAS has benefitted from the findings of AEGIS and specifically from OAF for the design of accessible ICT applications, as well as the interaction models (personas) developed within

AEGIS, which have been used as the basis for the consecutive development of VERITAS Virtual User Models.

2.2 ACCESSIBLE [2]

The **ACCESSIBLE (Accessibility Assessment Simulation Environment for New Applications Design and Development)** was a collaborative project, funded under the 7th Framework Programme of the European Commission. The triggering idea behind ACCESSIBLE has been to contribute for better accessibility for all citizens, to increase the use of standards, and to develop an assessment simulation environment (including a suite of accessibility analysing tools as well as developer-aid tools) to assess efficiently, easily and rapidly the accessibility and viability of software applications for all user groups. Accessibility is an urgent issue nowadays. Authorities and experts are putting a lot of effort on pushing forward accessibility of software applications but, despite this fact, ICT applications and systems are not fully accessible yet.

ACCESSIBLE exploited the technologies behind the recent expansion of accessibility tools and standardisation methodologies, in order to provide an integrated simulation assessment environment for supporting the production of accessible software applications mobile or not.

This enabled large organisations, SMEs or individuals (developers, designers, etc.) to produce software products of superior accessibility and quality, accompanied with appropriate measures and proposals for best practice. The proposed system was demonstrated in the four pilots of ACCESSIBLE for the assessment of: a) Mobile applications (including JavaFX Scripts), b) Web applications, c) Web services (mainly focusing on infomobility services), and d) description languages (e.g. UML, SDL, etc.).

ACCESSIBLE project established the basis for the accessibility of various interface components for different types of disabilities. The research work about the needs of UI components for each disability profile specifically and the mapping of these needs and barriers of each disability profile to specific established accessibility guidelines (WCAG1.0, WCAG2.0, etc) has provided a great basis for the continuation of work in disability of ICT and UIs in general, as also employed within VERITAS.

2.3 Cloud4All [3]

Cloud4All (Cloud platforms lead to open and universal access for people with disabilities and for all) is an international project funded by the 7th Framework Programme of the European Union that will advance the concept of the Global Public Inclusive Infrastructure (GPII) . The GPII is a project of Raising the Floor Consortium of academic, industry and non-governmental organizations and individuals. Cloud4all is a European Commission FP7 grant (2011 – 2014) that will develop key parts of the GPII, building the knowledge base and algorithms needed and evaluating the ability of the concept to work across platforms, technologies and applications. Cloud4all/GPII aim at the following objectives:

- Simple Instant accessibility for ALL.
- Anywhere Any Device Access.
- Supply and Demand better connected.

- Affordable method to offer diversity needed.

Cloud4all aims to develop a new paradigm in accessibility, by replacing adaptation of individual products and services for a person (2nd generation concept) with automatic-personalisation of any mainstream product or service a user encounters, using cloud technologies to activate and augment any natural (built-in) accessibility the product or service has (3rd generation concept), based on a profile of the user's needs. Thus, the research of VERITAS in user modeling can and has already been very assistive in Cloud4all, since the user and task models created in VERITAS, can be used for the population and training of the matchmakers in Cloud4all. VERITAS has participated in all collaboration events that have been organized by Cloud4all and has also signed a collaboration agreement. Thus the 2 projects have committed to exchange visions and ideas for a common cause.

2.4 COST 219 on "Accessibility for All to Services and Terminals for Next Generation Networks" [4]

The main objective of **COST 219ter** was to increase the accessibility of next generation telecommunication network services and equipment to elderly people and people with disabilities by design or by adaptation when required. Alternatively, the project has promoted the establishment of appropriate supplementary assistive services and equipment. Taking always into account inclusive design in telecommunications, especially in the mobile field, the project objectives have been to:

- Extend the existing COST 219 website for designers to better understand consumers and their requirements, so that many more people with disabilities and elderly people can be catered for in mainstream design,
- Support the exchange of information on inclusion and accessibility issues so that these can be freely explored with developers, researchers and representatives of the telecommunications industries and service providers, so that
- Disabled and elderly people can share in the benefits of new mobile communication systems.

The main issues of priority as emerged from the project were:

- Co-ordination of moves to introduce the concept of accessibility into ICT standards
- Identification and promotion of Best Practice in accessible electronic communications
- Extension of Universal Service obligations to match evolving user expectations
- Introduction of horizontal legislation for equality in access to services
- Dialogue with national regulators to push forward 'subsidiarity' measures
- Urging national regulators to take up access issues with terminals suppliers
- Close liaison with service providers to sustain awareness of disability
- Fostering mainstream provision through Inclusive Design at every opportunity

Following the concept of COST 219, VERITAS provides a tool to realise most of the above COST 219 priorities, as it includes accessibility into mainstream products, designs and developments.

2.5 VUMS Cluster projects

All VUMS cluster projects were co-founded by the European Commission under the 7th Framework Programme for RTD.

2.5.1 ViCON [5]

The VICON Vision has been to support the development of accessible consumer products through the use of virtual models in the early product development phases (Sketch, CAD, Evaluation).

The needs of people with physical or sensory impairments are generally not well considered when designing user interfaces to consumer products. Controls and displays often fail to meet the requirements of users with visual, hearing, mobility or dexterity impairments. It is difficult for mainstream manufacturers to have a detailed understanding of these needs and how to design for them. Manufacturers would benefit from the support of a third party solution to input the necessary knowledge.

VICON provided this support through the development of an advanced Virtual User Model which enables virtual testing and feedback throughout the development lifecycle.

2.5.2 MyUI [6]

The MyUI European research project aimed at increasing and mainstreaming the accessibility of every-day ICT products. The MyUI infrastructure generated individualized user interfaces and performed adaptations to diverse user needs, devices and environmental conditions during run time.

The MyUI Development Toolkit supports industrial developers and designers to easily create self-adaptive applications. MyUI also contributed to the further development and mainstreaming of accessible ICTby a number of innovative concepts and approaches towards self-adaptive user interfaces which go beyond the current state-of-the art.

MyUI approach to adaptive user interfaces for accessibility was based on the following central pillars:

- User Interface Generation and Adaptation - procedures for generating and dynamically adapting individualized user interfaces during runtime
- Design patterns – building blocks for individualized user interfaces
- Abstract Application Interaction Model – a statechart-based notation to specify the interaction between the user and the application

2.5.3 GUIDE [7]

The European project GUIDE ("Gentle user interfaces for elderly people") created a software framework and design tools which allows developers to efficiently integrate accessibility and personalisation features into their applications, minimizing intervention with existing development process and tools.

GUIDE provided automatic integration and adaptation of various legacy and next-generation user interface technologies, such as gesture interaction, voice control, avatars, second screen multi-touch devices and gyroscopic remote controls. The GUIDE-enabled applications and services can automatically adapt their user interface to the specific impairments and preferences of elderly users.

GUIDE also putted a dedicated focus on the emerging Web & TV platforms and services (Connected TVs, Set-Top Boxes, etc.). These platforms have the potential to become the main media terminals in the users' homes, due to their convenience and wide acceptance.

It also developed a set of references applications (home automation, video conferencing, tele-learning, media access) that can help elderly citizens to simplify their daily life, stay connected in their social network and enhance their understanding of the world.

The research project was partly funded by the European Commission under the Seventh (FP7 - 2007-2013) Framework Programme for Research and Technological Development.

2.5.4 VAALID [8]

VAALID project aimed at creating new tools and methods that facilitate and streamline the process of creation, design, construction and deployment of technological solutions in the context of Ambient Assisted Living (AAL) assuring that they are accessible and usable for senior citizens.

This goal has been achieved through the development of an integrated development environment (VAALID IDE) for computer aided design and validation of User-Interaction subsystems that improve and optimize the accessibility features of Ambient Assisted Living services, for the social inclusion and independent living of Senior Citizens.

The results of the project support the design of an AAL solution in all the stages of a user centred design methodology, putting in practice the guidelines for the verification and validation of the accessibility and usability facets. The simulation environment is composed by software and hardware components, and allows the Information and Communication Technology (ICT) designer to test and define future scenarios of AAL in a virtual environment, getting involved the final users with the design process.

The new VAALID tools help the European industrial players, ICT companies specialized in Human Factors and User Interaction design, Research and Academia in streamlining their respective business with regard to products and services for the Independent Living and Inclusion, creating new market opportunities.

The common ground between the VUMS cluster projects is illustrated in the table below:

Table 2: VUMS Cluster projects – main objectives, product focus, end users, beneficiaries, design phase

VUMS cluster project	Main objective	Product Focus	End Users	Beneficiaries	Design Phase
VICON	Support designers by offering qualitative and quantitative design recommendations for user interfaces of consumer products in the early product developments phases; Developing a virtual simulation environment for evaluation of virtual prototypes with virtual user models.	Hardware UIs (User Interfaces of Consumer Products)	Designers	Users with mild to moderate physical impairments.	Sketch phase, CAD, phase, and evaluation phase
GUIDE	Development of a software framework for designers to create adaptive TV interfaces for elderly people.	Adaptive Software UIs	Designers	Elderly	Software development
MyUI	Creation of software adaptive user interface with respect to end user impairments.	Adaptive Software UIs	Beneficiaries with physical impairments	Elderly	Software development
VERITAS	Support designers in product development by a complex simulation framework including end user impairments	Software UIs	Designers	Physical, cognitive and behavioral/psychological impaired users	Evaluation Phase
VAALID	Creation of new tools and methods that facilitate and streamline the process of creation, design, construction and deployment of technological solutions in the context of Ambient Assisted Living (AAL).	Software UIs	Designers	Senior Citizens	Evaluation Phase

3 EU policy and standards framework

3.1 Policy issues

The main policy issues that are related to the work performed in VERITAS have been identified [9] and followed throughout the duration of the project. Here some brief information is presented regarding the main legal instruments, the ongoing and upcoming EU policy developments, the general challenges and the issues that are of particular interest for VERITAS.

3.1.1 Main legal instruments

1. The **Charter of Fundamental Rights** which ensures both protection in decision making and its implementation at the national level

2. The **Employment Directive** prohibits discrimination as well as harassment and instruction to discriminate. All employers must provide 'reasonable accommodation' for people with disabilities, which means that disabled people have a right to get adaptations to the workplace in order to be able to fulfil their job. Many Member States have had to substantially amend their national law to comply with employment regulations.

3. The **UN Convention on the Rights of People with Disabilities** also ratified by the European Union, makes it compulsory for all EU actions to mainstream the needs of persons with disabilities including older people. The Convention places obligations on member states and European institutions to apply it in practice. The rights recognised by the Convention cover almost all policy fields from justice to transport, from employment to information technology, from social to health policy. Accordingly implementation of the Convention needs to be part of a strategic approach to disability.

3.1.2 European policy developments

1. The **European Innovation Partnership on Active and Healthy Ageing** (EIP AHA) will seek to create the supportive environment needed to promote healthy and active ageing and to develop innovative solutions for the ageing population. It will set an excellent framework to engage a wider range of stakeholders across the EU to work together on the promotion of active and healthy ageing, a key objective of the Europe 2020 Strategy and the theme of the recently announced European Year 2012.

2. The **European Year 2012 on Active Ageing** (EY 2012) shares the same objective as the EIP AHA: it will seek to engage a wide range of stakeholders (public authorities, the business sector, social actors, civil society organisations) to commit to supporting active ageing. The EY 2012 and the EIP AHA will play very complementary roles: while the objectives of the EY 2012 are to get all relevant stakeholders to take a political commitment to act, the EIP AHA should provide the means and resources to translate these commitments into reality in a coherent and sustainable way. These two EU processes should be mutually reinforcing to avoid a waste of energies and resources.

3. The **European Disability Strategy** (2010-2020) is meant to eliminate barriers in everyday life (accessibility, participation, equality, employment, education and training, social protection, health, external relations) and encourage member

governments to work together in removing obstacles to inclusion. It will also fulfil the EU's commitment to the UN Convention on the Rights of Persons with Disabilities. The strategy's targets for the first five years include:

- devising policies for inclusive, high-quality education;
- ensuring the European Platform Against Poverty includes a special focus on people with disabilities. The forum brings together experts who share best practices and experience;
- working towards the recognition of disability cards throughout the EU to ensure equal treatment when working, living or travelling in the EU;
- developing accessibility standards for voting premises and campaign material;
- taking the rights of people with disabilities into account in external development programmes and for EU candidate countries.

4. The **European Digital Agenda** acknowledges accessibility as a major challenge for European citizens and proposes among others to review current legislatives initiatives under this spectrum.

5. The **Urban mobility Action Plan** can be used to improve accessibility of the urban built environment and transport.

3.1.3 Upcoming policy developments

- The commission intends to establish a "European Accessibility Act", which would set EU ılegislative measures for goods and services. In 2012 a consultation was closed.

  The European Accessibility Act is expected according to the background document of the consultation [10] “a proposal for a Directive to improve the market of goods and services that are accessible for persons with disabilities and elderly persons, based on a ’design for al’ approach. This business friendly initiative will include binding measures to promote procurement and harmonisation of accessibility standards.”

- Negotiations and work on Mandate 376 related to accessibility standards for ICT goods and services are almost finished.

- Ongoing effort of the European Standardisation Bodies (CEN-CENELEC and ETSI) to implement Standardisation Mandate 420 on accessibility to the built environment

- The work on Mandate 473 has begun. This mandate aims at including accessibility following "Design for all" (or Universal Design) in relevant mainstream standards and to develop process standards for manufactures and services providers on how to include accessibility in their product development cycle and service provision. This Mandate addresses accessibility in the sense of article 4 (f) of the UNCRPD. The work is just at the beginning.

- Technical Specification on Interoperability - Persons with reduced mobility (TSI PRM)
  From beginning 2011, the European Railway Agency is running a working group to review the TSI PRM. The group is composed of representatives national safety agency for railway, railway companies, industries providing coaches and other rolling stock material and societal stakeholders. A first draft was issued in December 2012 and submitted to a public consultation.

- The ICT Standardisation Platform: The decision to set up this platform was taken by the European Commission on November 28h, 2011. The tasks of the platform are to advise the Commission on all matters related to European ICT standardisation policy, on ICT standardisation work programme, on possible standardisation mandates, on technical specifications in the field of ICT, on cooperation between standards development organisations and European standardisation bodies to improve the integration of their work in European ICT standardisation and ensure availability of ICT standards supporting interoperability, on other initiatives that may be taken at European level to address barriers to ICT interoperability, including the need for interoperability testing. The Platform is composed of Member States and EFTA countries representatives, standards setting organizations representatives and Industry and Societal stakeholders representatives.
- The Commission proposed rules to make public sector websites accessible for all.

3.1.4 Challenges in general

- From a more general perspective the EU should propose legislation to address the technical content of accessibility ensuring an inclusive society for older people and people with disabilities. This piece of legislation could address standards, problems of interoperability and affordability of developed solutions. Standardisation must cover ICT, built environment and Design for All.

- A mandatory implementation of the concept of Design for All could improve the development and deployment of products that are fully accessible for older people, people with disabilities and the broader population as a whole. All EU programmes could make the promotion of the concept of Design for All a prerequisite for funding. Users are the best information resource for adapting products and services to their needs and expectations and they should be included in the product design and development.

- Potential users lack knowledge about the extent and detail of products that are on the market and know even less which products could help them best and would provide value for money. Member States should be encouraged to provide comparative information about good and affordable products that are suitable to meet specific needs (including niche market products). This would improve awareness of the existing solutions and increase competition which will bring costs down.

- Different national and regional regulations for certification of accessible solutions are a barrier to an EU-wide market for products and services for all. Common certification schemes, accessibility labels, in close cooperation with suppliers and users organisations can provide an added value for users, designers and manufacturers. This will also guarantee that accessible solutions are available all over the EU and current discrepancies will be tackled.

- Today innovative products for older people and people with disabilities are too often developed for a niche market and thus either target a very specific group and/or are available only at an expensive price. A cost/benefit analysis is essential as well as to convince public authorities to invest in innovative products.

- Public policies can provide financial support to help reduce purchase and connection costs and the industry can apply flexible and creative pricing strategies and mainstream the Design for All principle. This is particularly important for the growing number of older people, who have low incomes and are at risk of poverty.

- To overcome the legal and market fragmentation of accessible solutions introducing or reinforcing accessibility and inclusion requirements in legislation, design and implementation of other policies (i.e. on housing and construction, ICT, social affairs, consumer protection, employment, education as well as public funding at national and European level) is essential. Public procurement can stimulate the diffusion of accessible products and services. Accessibility can also be promoted through Corporate Social Responsibility.

3.1.5 Issues for VERITAS

VERITAS provides methods and tools to design accessible or inclusive products. The resources are open and freely available. How can industry be motivated to use those resources? Shall and can their application be politically enforced?

It does not fit into current legal and standardisation frameworks to prescribe the development tools for industry. Since the provision with software tools is a business of the software industries such an approach would also lead to conflicts with competition regulations. Moreover Europe strives for business friendly accessibility regulations.

In consequence more incentive- or added-value-oriented ways need to be found. Certification or self-certification could be a solution. This would help the actors on the market to communicate more efficiently. However this will only have an effect if a common standard is introduced which gains an appropriate awareness. Fragmentation has to be avoided.

VERITAS allows for optimising products for a wide variety of special needs and disabilities. Design for user groups with special needs might however not be economically reasonable. This is in particular the case, if development expenses and costs per piece will reduce the profit or increase the price to an extent not accepted by the (mass) market. How can these economic needs be considered in “Design for All” policy? Shall this be left to the manufacturer or be regulated? How can a manufacturer be assisted by standards and guidelines or other means to act appropriately? Which could be potential and effective incentives?

The “Design for All” approach looks helpful for all. Manufacturers increase their potential markets and more users will find appropriate products on the market. However, it is only a general principle, which will not lead to covering everybody’s needs with every product. Designing for all is not designing for everybody. Design conflicts will occur and products which adapt to really everybody will result in extremely high costs and prices. VERITAS tools will allow telling precisely who will be excluded from using a product under development. But what is acceptable and what is necessary? A kind of ethically acceptable cost-benefit analysis is needed for the manufacturer.

But from the political point of view there exists a legitimate interest also of small minorities to find appropriate products on the markets. On the other hand industry is interested only in profitable business. As long as additional costs do not occur for the manufacturers or these additional costs can be expected to be balanced by the margin of the additional turnover generated from those minorities, investment in “design for special needs” is economically justified.

In this case the burden on a European enterprise can be accepted without reducing competitiveness compared to other global actors. But this is only true if not other economic key factors such as longer time-to-market are influenced negatively.

An approach from the enterprises' point of view is proposed in Dangelmaier 2013 [11]. Four strategies for implementing inclusive products or product features (Figure 1) are discussed, while the Positive / Balancing approach is proposed to be followed.

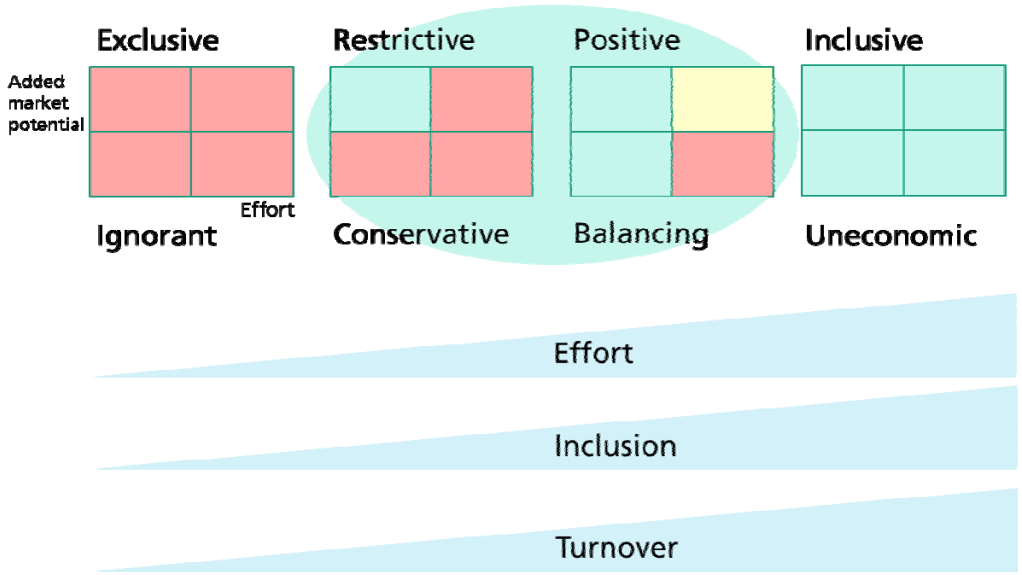

Figure 1: Four inclusion strategies for products/product features (green: implement, yellow: verify, red: do not implement)

Politically there is an interest to exploit all self-financing measures, even if they do not seem attractive, because they do not generate additional profit. Therefore an appropriate incentive system with monetary or additional benefits is needed. The latter could include a better public image of the company or a contribution to ethical claims such as corporate social responsibility.

As other complex R&D projects VERITAS raises many research questions to be solved in the area of inclusive design. How can the identified additional research needs be implemented in future? Which are the priorities?

In particular more applied research is needed to provide the manufacturers with tools to decide, which special needs can be taken into account by their future products during the design process. Both the benefits for users with special needs and economic characteristics have to be taken into account and to be balanced. And this preferably in real-time, and if possible in the background of the typically design and verification software.

Furthermore, VERITAS revealed a crucial lack of data for design and for design and verification purposes on users with special needs, both for elderly and otherwise impaired user groups (e.g. range of motion, forces, reaction times, degradation curves over age etc.). A European – and in the times of global markets – even an intercontinental data acquisition project is needed. This should include all main market.

Is there a need to educate/train designers/developers or accessibility specialists for the use VERITAS tools?

On the one hand one can observe an increase in awareness issues and ability in European markets. This holds in particular true for the IT sector and the World Wide Web. However, on the other hand we also observe a decrease in ergonomics knowledge in many sectors. There

is still a deficit in applying even mainstream usability engineering. Now we provide tools, which aim at “inclusive ergonomics”, which needs a sound background knowledge in application. But this topic has never been taught at universities and engineering schools. It is also an education policy task to correct that.

3.2 Standardisation issues

Standardisation has been a major concern throughout VERITAS. Since the early stages of the project [11], existing standards have been studied and related activities planned.

3.2.1 Objectives

Industrial standards cover the following **objectives**:

- Safety (Saf),
- Usability (Use),
- Quality (Qua),
- Measurements and dimensions (Dim),
- Testing (Tes).

The most relevant objective for VERITAS is ”Usability” with focus on “design for all” and “accessibility” for the targeted population (elderly, disabled) with special needs.

3.2.2 Level of stipulation

Standards may include **stipulations** at quite different **levels**. One can distinguish between:

- Definitions,.taxonomies, ontologies (Def);
- Procedures and processes (Proc);
- Characteristics and properties (Prop).

The first group of stipulations tries to establish a common language and a common understanding. It supports communication in a specific field. It demarcates a “world” by including and excluding and explains it. All standards include such elements, for instance the Scope of the standard. This is the lowest level as far as restrictions to a product itself are concerned. Work within VERITAS and the VUMS cluster showed the need of such standards i. e. in the fields of human models.

The second group defines how things have to be done. Procedural standards have gained particular importance during the introduction of a total quality management in several areas ranging from industry to healthcare. They do not define the product itself, but they can describe the way how to create and test it. This type of standards best fits the approach of VERITAS. The project supports the way of designing and developing products and does not define the products themselves.

The third group is the most restrictive one. It fixes the product’s properties and characteristics, e. g. by specifying dimensions, colours, material. As far as an end-user product is concerned, this type of stipulations is not always favourable, because they restrict

the individuality of the product, thus potentially hindering the creation of unique selling propositions. They are however necessary if it comes to technical interfaces. Those require precise specifications in order to work properly.

3.2.3 Areas and potential scopes

In this context different **scopes** of standardisation are related to VERITAS, which are characterized by the following list:

- General characteristics / properties of products in the application domains;
- Accessibility of products in the application domains (Access);
- Development and engineering processes in the application domains (Process);
- Development/engineering tools in the application domains (Tools);
- User characteristics of ageing and disabled users (User);
- Simulation in usability and accessibility engineering (Simu);
- User modelling (Model).

The order of topics is not random. The sequence follows increasing importance and specificity for the core activities of the project's tasks and objectives.

Existing standards on general characteristics and properties of products are of low interest for VERITAS. They are application domain specific and normally do not take into account, what VERITAS is aiming at: the needs of special user groups. They will not be listed in case they do not belong to one of the following groups as well.

Accessibility standards in certain application domains do exist. In particular the accessibility in the World Wide Web has been an issue in standardisation and shows quite good progress. Most of their stipulations are not the main focus of VERITAS. They are frequently guidelines, determining the characteristics of an interface rather than the development process.

Procedural standards in the application domains are relevant for VERITAS as long as they are related to the accessibility engineering process in the individual application domains. VERITAS does not intend to establish new development and engineering processes per se. It rather tries to fit into existing processes as long as they allow for the integration of simulation and VR based accessibility engineering. Therefore this type of standards establishes a kind of interface to existing processes, which VERITAS has to take into account. The same holds true for the tools used in the application domains.

User characteristics of ageing and disabled users are as well an input of VERITAS as an output. VERITAS intends to rely on existing taxonomies and data from literature. In case data for specific disabilities do not exist, the Multi-Sensorial Platform will be used to measure the user characteristics. Therefore VERITAS tries to use existing standards and will investigate, whether and how to be involved in standardisation in this scope. Moreover, VERITAS tries to perform statistical analysis on data found in the literature in conjunction with data coming from the multisensorial platform, in order to identify how the value of each disability parameter varies over the disabled population and, thus, make as realistic as possible assumptions at the development of virtual user models.

Simulation in usability and accessibility engineering is the core task of VERITAS. The area is under research. In particular the simulation of special needs is a challenge here. Standards in that field would be highly relevant but are not expected to exist. VERITAS has to develop during the runtime of the project a position whether the elaborated results are suited for standardisation and where such initiatives have to be placed.

User modelling is of high relevance for the project, because user modelling has been the main topic of the first year's work of VERITAS. The project has gained experience in the required processes and VERITAS user models are already available. So User Modelling is a promising candidate to incorporate VERITAS results into standardisation initiatives. Standardisation of user modelling should not be addressed by VERITAS alone but within the VUMS cluster.

3.2.4 Glossary of Terms on User Modelling

Collaboration in the VUMS cluster revealed that there is even among the experts a confusion concerning the wording about user modelling and user profiles. The understanding and use of technical terms differ considerably. This hinders efficient communication and aggravates interoperability problems.

As already mentioned in above, the definition of terms is also relevant for standardisation. A unified vocabulary would not only support the research community but also facilitate the dialogue between research and industry as well as within industry.

A self-evident breakdown of this issue is given in the following:

- Provision of a common glossary of terms of the project within the VUMS cluster;
- Dissemination of the glossary to standardisation bodies and groups;
- Collaboration with a standardisation group to implement the glossary or a modified glossary in a standard addressing user models/user profiles;
- Publication of the glossary in related publications.

The glossary of terms was created in workshops of the VUMS cluster. Following the suggestions form the 2nd year's VERITAS and VUMS cluster review the glossary was improved and updated. The glossary is disseminated through the VERITAS/VUMS cluster website, is used in the deliverables and promoted in the VUMS cluster projects for common use.

The glossary still reflects the view of the VUMS cluster projects. Incorporating it in standardisation activities might require merging with other glossaries and in losing essence. The VUMS cluster should look for other platforms to publish the glossary.

3.2.5 VUMS cluster synchronization

An important issue within the VUMS cluster is the synchronisation of the cluster project activities. This is needed to optimise synergies between projects, to achieve interoperability of the results and to get the available input into standardisation activities.

Pace and duration among the cluster projects differ according to their initial workplans. Some will finish earlier and others later. The projects have to consider measures to ensure best

value from their activities by synchronising their activities respectively. Established measures include:

- Synchronisation of the schedules in terms of having deliverable exchange on time for their respective activities.
- Common deliverables as »synchronisation gates«.
- Focus in synchronisation on the relevant common standardisation topics (currently user models and related terms).
- Regular phone conferences to exchange and discuss standardisation activities.

3.2.6 Boundary conditions in European standardisation

The boundary conditions are favourable in Europe, because the European Commission gave accessibility-related mandates to CEN, CENELEC and ETSI.

- Mandate 376 focuses on accessibility standards for ICT goods and services, and the standards are intended to be used in public procurement proceedings.
- Mandate 420 aims at developing accessibility standards for the built environment.
- Mandate 473 aims at including accessibility following "Design for all" in relevant mainstream standards and to develop process standards for manufactures and services providers on how to include accessibility in their product development cycle and service provision.

Furthermore the European “Acessibility Act” is intended to stipulate accessibility standardisation. The main issue is that the effects of measures and the intended additional degree of detail brought by the Accessibility Act will come too late for VUMS cluster projects.

3.2.7 Teaming up with existing activities

It is not a declared objective of VERITAS to initiate standardisation activities. The objective is to contribute with the VERITAS project results within standardisation activities. It does not make sense to start an own initiative in case appropriate standardisation groups and projects already exist.

Thus, VERITAS has preferably to team up with existing initiatives. The project therefore

- identified appropriate activities related to relevant topics (user models and profiles);
- collaborated in this task with the VUMS cluster projects;
- provided relevant results to standardisation groups in order to make them become part of a standards;
- collaborated with the VUMS cluster.

The VERITAS results on user modelling, including also a significant part of VUMS cluster results, have been already presented in the Model-Based UI Working Group Charter [12] of W3C and through this Working Group VERITAS aims to standarise the parts of the VERITAS user model, which are more relevant to the UI design.

The VUMS cluster worked successfully on harmonising activities for three years and published a white paper on standardisation of user models including a revision. It prepared a repository of user models and converter tools to convert user models from a normative format to user model formats used within the cluster projects and proved usability of the common normative format. A joint publication has been already presented in the UMAP 2012 international conference and currently a joint journal publication is being prepared.

The main issue remains to get a commitment from standardisation groups that fit into the time frame of the VERITAS and the VUMS cluster projects. VERITAS and the VUMS cluster disseminated the white paper to various standardisation groups. It is under consideration but there is no commitment on implementation reached so far.

3.2.8 Existing standards

A compendium of existing standards has been identified early in the project to be used as guidance for the research and consecutive standardization activities to be undertaken. These are summarized in the table below, highlighting also their relevance and with VERITAS activities.

Table 3: Overview of existing standards and their relevance for VERITAS [13]

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
ISO 9241-20:2008	2008	Ergonomics of human-system interaction Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services	Use/ Access	Proc	ISO 9241-20:2008 is intended for use by those responsible for planning, designing, developing, acquiring, and evaluating information/communication technology (ICT) equipment and services. It provides guidelines for improving the accessibility of ICT equipment and services such that they will have wider accessibility for use at work, in the home, and in mobile and public environments. It covers issues associated with the design of equipment and services for people with a wide range of sensory, physical and cognitive abilities, including those who are temporarily disabled, and the elderly. [1]	The standard is guideline-oriented, while VERITAS is simulation-oriented. Guidelines can be used in addition to VERITAS simulation methods during use cases
ISO/IECTR 15440:2005	2005	Information technology Future keyboards and other associated input devices and related entry methods	Use/ Process	Def	ISO/IEC TR 15440:2005 is aimed at both the users and manufacturers, and intends to present the user requirements regarding keyboards and associated devices and methods, at time of its publication. ISO/IEC TR 15440:2005 covers ■the different input requirements catering for national and international practices and support of cultural and linguistic diversity; ■the recognition of requirements regarding comfort of use (for any user, including children, elderly and disabled people), and improved user productivity related to inputting data; ■enhancements of keyboards and related input devices and methods required for new emerging phenomena such as Internet, multimedia, virtual reality; ■virtual input requirements; ■labelling issues (soft [LCD] and hard, permanent and temporary labels), function symbols and icons. [2]	VERITAS is not working on keyboard design. But applications will work with keyboards. The standard can support the selection of required devices. VERITAS could come up with additional findings on user needs that can be fed back to the standard.
ISO/IEC TR 19766:2007	2007	Information technology Guidelines for the design of icons and symbols accessible to all	Use/ Access	Def	ISO/IEC TR 19766:2007 provides recommendations relating to the design of icons to support accessibility by the elderly and people with disabilities. These recommendations assist accessible implementation of all icons for users. While these recommendations were developed to meet the needs of the elderly and people with disabilities, they can also provide greater accessibility to a wider range of users in a variety of	Icons might be used in VERITAS applications. The automotive, domotic and healthcare domain within VERITAS can benefit from the guidelines. Findings during the VERITAS

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
		users, including the elderly and persons with disabilities			different contexts. ISO/IEC TR 19766:2007 introduces a set of attributes and operations that can be implemented as features of graphic icons to make the functionality of these icons accessible to the widest possible range of users. Textual attributes are emphasized because they can be rendered in various alternate modalities. ISO/IEC 11581-1 provides guidance on the graphic aspects of icons. Specific renderings of these attributes (or of icons in general) are not dealt with as part of ISO/IEC TR 19766:2007. [3]	pilots might lead to input for improving the guidelines.
ISO 9241-171:2008	2008	Ergonomics of human-system interaction -- Part 171: Guidance on software accessibility	Use/ Access	Def	ISO 9241-171:2008 provides ergonomics guidance and specifications for the design of accessible software for use at work, in the home, in education and in public places. It covers issues associated with designing accessible software for people with the widest range of physical, sensory and cognitive abilities, including those who are temporarily disabled, and the elderly. It addresses software considerations for accessibility that complement general design for usability as addressed by ISO 9241-110, ISO 9241-11 to ISO 9241-17, ISO 14915 and ISO 13407. ISO 9241-171:2008 is applicable to the accessibility of interactive systems. It addresses a wide range of software (e.g. office, Web, learning support and library systems). It promotes the increased usability of systems for a wider range of users. While it does not cover the behaviour of, or requirements for, assistive technologies (including assistive software), it does address the use of assistive technologies as an integrated component of interactive systems. It is intended for use by those responsible for the specification, design, development, evaluation and procurement of software platforms and software applications.[4]	The standard is applicable for the software development in VERITAS. Interaction between designers/developers and VERITAS tools should partly comply with this standard. However, in providing an experience of disabilities to the designer, e. g. with the interaction tools developed in VERITAS, this standard has to be violated on purpose: The interaction is impeded to simulate restrictions and special needs.
ISO/IEC 24751-1:2008	2008	Information technology Individualized adaptability and accessibility in e-learning,	Use/ Access	Def	ISO/IEC 24751 is intended to meet the needs of learners with disabilities and anyone in a disabling context. ISO/IEC 24751-1:2008 provides a common framework to describe and specify learner needs and preferences on the one hand and the corresponding description of the digital learning resources on the other hand, so that individual learner preferences and	This standard is not too relevant with the goals of VERITAS. However, it proposes a process for matching digital resources to user's needs and preferences.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
		education and training Part 1: Framework and reference model			needs can be matched with the appropriate user interface tools and digital learning resources [5]	Some of the steps of the proposed process could provide guidance to VERITAS on how the Virtual User Models could be used by a simulation platform.
ISO/IEC 24751-2:2008	2008	Information technology Individualized adaptability and accessibility in e-learning, education and training - Part 2: "Access for all" personal needs and preferences for digital delivery	Use/ Access	Prop	ISO/IEC 24751-2:2008 provides a common information model for describing the learner or user needs and preferences when accessing digitally delivered resources or services. This description is one side of a pair of descriptions used in matching user needs and preferences with education delivery (as described in ISO/IEC 24751-1). ISO/IEC 24751-2:2008 discusses the basic principles adhered to in developing this model for describing personal needs and preferences. It explains: the rationale for using a functional approach to describing needs, possible methods of creating a personal needs and preference statement, the major groupings of needs and preferences within the standard, the use of different needs and preferences statements in different contexts, how needs and preferences can be ranked with respect to priority, and the use of generic and application-specific needs and preference specifications. It contains the information model for ISO/IEC 24751-2:2008, including the attribute, allowed occurrence and datatype of each element. It defines and describes how the terms in the information model should be used. Conformance to ISO/IEC 24751-2:2008 is discussed. Conformance is dependent on the role played by the conformant technology. Conformance requirements for both education delivery applications and alternative access systems are explained. ISO/IEC 24751-2:2008 provides ■a consolidated list of all the terms defined in ISO/IEC 24751-2:2008, sorted in French alphabetical order, ■the ISO French language equivalent terms and definitions, and	VERITAS may include a subset of the stated in the standard user needs and preferences related to disabilities to the structure of the Virtual User Models.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
					■the codes representing the gender of the French terms. The vocabulary codes, values and associated rules of application are defined. An informative list of recommended default values for the learner preferences and needs is provided. It lists existing bindings of the IMS Learner Information Package Accessibility for LIP - Version 1 [ACCLIP] that serves as the reference specification for ISO/IEC 24751-2:2008. It describes information scenarios for applying ISO/IEC 24751-2:2008 and gives informative implementation examples. Use of ISO/IEC 24751-2:2008 will assist in matching individual learner needs in a computer mediated learning environment with the necessary user interface and resources needed to meet those needs.[6]	
Web Content Accessibility Guidelines (WCAG) 2.0	1999	The Web Content Accessibility Guidelines (WCAG) documents explain how to make Web content accessible to people with disabilities. Web "content" generally refers to the information in a Web page or Web application, including text,	Use/ Access	Prop	Web Content Accessibility Guidelines (WCAG) 2.0 covers a wide range of recommendations for making Web content more accessible. Following these guidelines will make content accessible to a wider range of people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity and combinations of these. Following these guidelines will also often make your Web content more usable to users in general. WCAG 2.0 success criteria are written as testable statements that are not technology-specific. Guidance about satisfying the success criteria in specific technologies, as well as general information about interpreting the success criteria, is provided in separate documents. See Web Content Accessibility Guidelines (WCAG) Overview for an introduction and links to WCAG technical and educational material. WCAG 2.0 succeeds Web Content Accessibility Guidelines 1.0 [WCAG10], which was published as a W3C Recommendation May 1999. Although it is possible to conform either to WCAG 1.0 or to WCAG 2.0 (or both), the	The Delivery Context Ontology itself constitutes a vocabulary of terms describing different types of devices. This vocabulary can be used in the Abstract User Models as well as in the Virtual User Models wherever special requirements have to be defined for a user concerning the interaction with various devices.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
		images, forms, sounds, and such. WCAG is part of a series of accessibility guidelines, including the Authoring Tool Accessibility Guidelines (ATAG) and the User Agent Accessibility Guidelines (UAAG). Essential Components of Web Accessibility explains the relationship between the different guidelines.			W3C recommends that new and updated content use WCAG 2.0. The W3C also recommends that Web accessibility policies reference WCAG 2.0.[7]	
http://www.w3.org/TR/2004/REC-CCPP-struct-vocab-20040115	2004	Composite Capability/Preference Profiles (CC/PP): Structure and Vocabularies 1.0	Use/ Process	Proc	This document describes CC/PP (Composite Capabilities/Preference Profiles) structure and vocabularies. A CC/PP profile is a description of device capabilities and user preferences. This is often referred to as a device's delivery context and can be used to guide the adaptation of content presented to that device. The Resource Description Framework (RDF) is used to create profiles that describe user agent capabilities and preferences. The structure of a profile is discussed. Topics include: •structure of client capability and preference descriptions, AND •use of RDF classes to distinguish different elements of a profile, so that a schema-aware RDF processor can handle	VERITAS may use the user preferences specified by the standard, especially those related to disabilities, for the development of the Abstract and Virtual User Models.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
					CC/PP profiles embedded in other XML document types. CC/PP vocabulary is identifiers (URIs) used to refer to specific capabilities and preferences, and covers: •the types of values to which CC/PP attributes may refer, •an appendix describing how to introduce new vocabularies, •an appendix giving an example small client vocabulary covering print and display capabilities, and •an appendix providing a survey of existing work from which new vocabularies may be derived. [8]	
IMS Access For All Personal Needs and Preferences Description for Digital Delivery Information Model	2004	Composite Capability/Preference Profiles (CC/PP) is a specification for defining capabilities and preferences (also known as 'delivery context') of user agents. CC/PP is a vocabulary extension of the Resource Description Framework (RDF). Delivery context can be used to guide the process of tailoring content for a user agent. The CC/PP specification is maintained by the W3C's Ubiquitous Web	Use/ Access	Prop	This part of the Access For All Specification provides a common information model for describing the learner or user needs and preferences when accessing digitally delivered resources or services. This description is one side of a pair of descriptions used in matching user needs and preferences with digital delivery. This model divides the personal needs and preferences of the learner or user into three categories: a) Display: how resources are to be presented and structured; b) Control: how resources are to be controlled and operated; and, c) Content: what supplementary or alternative resources are to be supplied? This part of the Access For All Specification is intended to meet the needs of learners with disabilities and of anyone in a disabling context. The purpose of this part of Access For All Specification is to provide a machine-readable method of stating user needs and preferences with respect to digitally based education or learning. This part of Access For All Specification can be used independently, for example to deliver the required or desired user interface to the learner/user, or in combination with Access For All Specification Digital Resource Description to deliver digital resources that meet a user's needs and preferences. This document is based upon the original ISO/IEC 24751-1:2008 Information technology Individualized adaptability and accessibility in e-learning, education and training Part 2: "Access For All Personal Needs and Preferences for Digital Delivery". The ISO/IEC 24751-1:2008 document was a	This standard provides a machine-readable method of stating user needs and preferences with respect to digitally based education or learning. Some of the stated user needs may also be used out of the scope of e-learning, describing the limitations in interaction of the user with the environment (ex. there are attributes like "speech-rate", "pitch" and "volume" concerning screen readers). The description of such user needs, as it is proposed by the standard, may be used in the development of VERITAS Abstract and Virtual User Models.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
		Applications Working Group (UWAWG) Working Group			further development of the original IMS GLC Access For All Learner Information Package Specification, July 2003. The key changes from the ISO/IEC equivalent document are (note that these changes are documentation in nature and the technical solution is faithfully reproduced): a) The ISO/IEC Annex A has been removed and the subsequent appendices renumbered. This annex consisted of the French equivalents; b) The ISO/IEC Section 6 and 7 have been combined into a new Section 6 to contain all of the formal description of the information model. Also, this model is described using the Unified Modelling Language representation as defined in the IMS GLC Specification Note 07: UML Profile for Platform Independent Model Descriptions of Specifications for Data Models.[9]	
ETSI EG 202 116	2009	Major revision of ETR 116, Human Factors guidelines for ISDN terminal equipment design to include provision for elderly and disabled users. The content of ETR 029 and ETR 166 will be revised and merged into the final document.	Use/ Access	Proc	The present document gives guidance to Information and Communication Technology (ICT) product and service designers on Human Factors issues, good Human Factors design practice, and relevant international and national standards. In particular, it aims to help designers to maximize the level of usability of products and services by providing a comprehensive set of Human Factors design guidelines. The guidelines are intended to encourage a "Design for All" approach so as to make products and services accessible to as many people as possible, including elderly people and persons with disabilities, without the need for adaptation or specialized design. The present document is applicable to ICT products with a user interface that are connectable to all kinds of fixed and mobile telecommunications networks. This includes products such as telephones, Multimedia terminals, Personal digital Assistants (PDAs) and services such as e-mail, Short Message Services (SMS) and voice messaging. It is applicable to public and private access devices and services. ETSI HF produced three very significant deliverables that provided guidance to the designers of communications products and services: • ETR 029: "Human Factors (HF); Access to	ETSI EG 202 116 contains definitions of user characteristics, including sensory, physical and cognitive abilities. These definitions may be used in the development of the VERITAS Abstract User Models, in order to express how the disabilities are connected with the sensory, physical and cognitive abilities of the user. Additionally, ETSI EG 202 116 describes how user abilities are changing over years. This information could be used in the development of VERITAS Generic Virtual User Models representing users of different age groups.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
					telecommunications for people with special needs; Recommendations for improving and adapting telecommunication terminals and services for people with impairments" [10]; • ETR 116: "Human Factors (HF); Human factors guidelines for ISDN Terminal equipment design" [14]; • ETR 166: "Human Factors (HF); Evaluation of telephones for people with special needs; An evaluation method" [15].	
ETSI EG 202 132	2004	Human Factors (HF); User Interfaces; Guidelines for generic user interface elements for mobile terminals and services MMI in Mobile telecoms	Use/ Access	Prop	The aim of this work is to widen and simplify end user access to mobile information and communication devices and services. The document will be based on consensus and best practice, addressing key issues from the end user's perspective. It will provide guidance to ETSI, manufacturers and service providers on possible and beneficiary options to harmonize generic UI elements for mobile ICT terminal devices and services, on the basic level, without limiting their options to use the user experience of brand-specific user interface implementations as a competitive edge. In order to support the trend toward mobile access to ICT for all, basic needs and goals of users of mobile telecommunication terminals and services will be examined in detail, taking into account all users (e.g. novice users, professional users, the mobile worker, young, elderly and disabled people).	The guidelines are taken into the healthcare and wellbeing as well as in the domotic application domain, where mobile devices play a role in VERITAS.
ETSI EG 202 325	2005	Human Factors (HF); User Profile Management	Use/ Process	Prop	Effective user profile management will be critical to the uptake and success of new and advanced communication services and it is therefore important to focus on the users' requirements in this area. The objective of the work item is to produce an ETSI Guide (EG), establishing a set of guidelines relevant to users and their need to manage their user profiles for personalisation of services and terminals to provide efficient communications. The ETSI Guide will describe a conceptual framework in which user profiles can be considered. The following key areas are addressed: The user profile concept. Administering sub-profiles that reflect users' lifestyles and different situations. The benefits of user profiles to different parties. Scenarios in which user profiles may bring benefits. Administering automatic activation of sub-profiles.	EG 202 325 provides guidelines relevant to users' needs to manage their profiles for personalisation of services and terminals. VERITAS may follow some of these guidelines for the better management of the Virtual User Models.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
					[12]	
BS EN 1332-4:2007	2007	Identification card systems. Man-machine interface. Coding of user requirements for people with special needs	Use/ Tools	Proc	Identity cards, Cards, Interfaces, Ergonomics, Identification methods, Data elements, Integrated circuit cards, Objects (programming language), Tags (data processing), Length, Coding (data conversion), Colour codes, Position, Amplification, Frequencies, Programming languages, Conformity, Disabled people, Aids for the disabled [13]	BS EN 1332-4:2007 provides a set of detailed definitions of user needs (such as preferred speech output rate, requirement for specific type of fonts, etc.), including people with special needs, for example the aged, minors, people with disabilities, those with learning difficulties, first time users, those not conversant with the local language. These user needs may be used in the VERITAS Abstract User Models, presenting this way how user needs are connected with the disabilities.
ISO 11228-2:2007	2007	Ergonomics - Manual handling - Part 2: Pushing and pulling	Use/Tool	Proc	ISO 11228-2:2007 gives the recommended limits for whole-body pushing and pulling. It provides guidance on the assessment of risk factors considered important to manual pushing and pulling, allowing the health risks for the working population to be evaluated. The recommendations apply to the healthy adult working population and provide reasonable protection to the majority of this population. These guidelines are based on experimental studies of push-pull tasks and associated levels of musculoskeletal loading, discomfort/pain, and endurance/fatigue. Pushing and pulling, as defined in ISO 11228-2:2007, is restricted to the following: whole-body force exertions (i.e. while standing/walking); actions performed by one person; forces applied by two hands; forces used to move or restrain an object; forces applied in a smooth and controlled way; forces applied without the use of external support(s); forces applied on objects located in front of the operator; forces applied in an upright position (not sitting). ISO 11228-2:2007 is intended to provide information for	ISO 11228-2:2007 provides structured information illustrating the maximum acceptable forces concerning pushing/pulling for the 90% of the healthy adult working population, according to different parameters (gender, pushing/pulling distance, frequency, etc.). Additionally, many other comparative tables are provided (ex. population subgroup profiles varying in age and gender and reflecting elderly working population (50-64 years)). This information could be taken into account during the development of the VERITAS Generic Virtual

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
					designers, employers, employees and others involved in the design or redesign of work, tasks, products and work organization.[14]	User Models.
EN ISO 24502:2010	2010	Ergonomics - Accessible design - Specification of age-related luminance contrast for coloured light	Use/ Tools	Prop	This international standard specifies age-related luminance contrast of any two lights of different colour seen by a person at any age by taking into account the age-related change of relative luminous efficiency of the eye.This basic international standard provides a method that can be applied to the design of visual signs and displays. It applies to visual environments in which the spectral radiance is known or measurable and viewed under the moderately bright light level called photopic vision. It does not apply to those which are seen under a dark environment called mesopic and/or scotopic vision.	ISO/DIS 24502 provides a comparative analysis concerning the age-related spectral luminous efficiency (age is defined in decade). This information is pretty useful when there is need for the development of User Models representing a population group of specific age and could be taken into account during the development of the VERITAS Generic User Models.
WHO ICF	2002	International Classification of Functioning, Disability and Health (ICF)	Dim/ User	Def	The International Classification of Functioning, Disability and Health, known more commonly as ICF, is a classification of health and health-related domains. These domains are classified from body, individual and societal perspectives by means of two lists: a list of body functions and structure, and a list of domains of activity and participation. Since an individual's functioning and disability occurs in a context, the ICF also includes a list of environmental factors.[16]	WHO ICF provides classifications related to body functions and structure, and a list of domains of activity which may be used during the development of the VERITAS Abstract User Models.
UsiXML	2007	USer Interface eXtensible Markup Language) is an XML-based markup language for defining user interfaces on computers	Use/ Tools	Proc	The UsiXML language was submitted for a standardisation action plan in the context of the Similar network of excellence and of the Open Interface European project. For this purpose, the Université catholique de Louvain has been accepted by W3 Consortium for entering its academic initiative Recently, in the context of the HUMAN project, UCL is responsible to enrich the UsiXML language by modeling aspects into abstractions that are general (e.g., more detailed modeling aspects of graphical UIs in general) but also in order to address aspects that are specific to Advanced Human Machine Interfaces (AHMIs). Therefore, the main goal was to enrich UsiXML in order to become able to describe, specify any AHMI involved in the	One of the requirements of VERITAS is the formal and detailed description of multimodal interfaces as well as user tasks. On the other hand, UsiXML provides meta-models that describe in detail the design of multimodal user interfaces, while it also supports task modeling. Consequently, UsiXML could be used in VERITAS for the development of multimodal

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
					HUMAN project in a way that will become standard at various organisations. Of course, it is likely that some parts of UsiXML will be transferred to standardisation and not the entire language since the goal of the standardisation consists of extracting the best aspects of existing UIDLs.	user interfaces and task models.
ETSI TS 102 747	2009	Human Factors (HF);Personalization and User Profile Management;Architectural Framework	Use/Tools	Prop	The work will build on results from STF265 on User Profile Management. With the goal of obtaining maximum benefits for users, profiles would not be limited to cover today's ICT market, but would also embrace ubiquitous services and applications, and be able to communicate with a wide range of devices in digital homes/buildings. The deliverable will be a Technical Specification (TS) on issues related to networks, terminals and SmartCards. The intended readers of this deliverable are profile providers, telecom companies and device manufacturers who will implement and provide the underlying infrastructure and architecture of network and devices necessary to achieve the user profile management concept described in EG 202 325 Human Factors (HF); User Profile Management. [18]	VERITAS may follow some of the recommendations provided by this standard (ex. those concerning privacy) for the management of the Virtual User Models.
ETSI TR 102 068	2002	Human Factors (HF); Requirements for assistive technology devices in ICT	Use/ Access	Proc	A technical report giving guidance on the needs of older and disabled people for assistive technology devices and the requirements for the interconnection of such devices to ICT systems. The report considers devices for user interface input (eg key presses) and output (eg display content) as well as speech and video transmission. It reviews available transmission technologies (eg bluetooth and DECT) and requirement on the transmission protocols. [19]	ETSI TR 102 068 describes user sensory, physical and cognitive disabilities and correlates them with assistive devices. VERITAS may use this information in the development of the Abstract User Models, which describe the disabilities, in order to correlate the disabilities with assistive devices.
ETSI ES 202 746	2010	Human Factors (HF);Personalization and User Profile Management;User Profile Preferences and	Use/ Tools	Def	This STF will standardize a rule definition language for defining automatic activation of profiles, a set of components (including attributes, operations and relations) and a common terminology related to user profile management. The work will build on results from STF265 on User Profile Management. With the goal of obtaining maximum benefits for users, profiles would not be limited to cover today's ICT	VERITAS may include the user preferences specified by the standard, especially those related to disabilities to the structure of the Virtual User Models.

Standard	Year	Title	Objective/ Scope	Level of stipulation	Short description	Relevance for VERITAS
		Information			market, but would also embrace ubiquitous services and applications, and be able to communicate with a wide range of devices in digital homes/buildings. The deliverable will be an ETSI Standard that will standardize: - objects (including settings, values, operations and relations) related to user profile management; - rule definition language for defining automatic activation of profiles; - common terminology. [20]	
BPMN	2008	Business Process Modeling Notation (BPMN) is a graphical representation for specifying business processes in a business process model.	Use/ Tools	Def	A standard Business Process Modeling Notation (BPMN) will provide businesses with the capability of understanding their internal business procedures in a graphical notation and will give organizations the ability to communicate these procedures in a standard manner. Furthermore, the graphical notation will facilitate the understanding of the performance collaborations and business transactions between the organizations. This will ensure that businesses will understand themselves and participants in their business and will enable organizations to adjust to new internal and B2B business circumstances quickly.[21]	BPMN may be used for the graphical notation of the VERITAS Task Models.

4 Short term Roadmap – Standardisation actions during the project lifetime

The VUMS cluster (Cluster on Virtual User Modeling and Simulation) including the projects VERITAS, VICON, MyUI, GUIDE and VAALID cooperates on common standardisation activities. The project common view on standardisation of user models is documented in the document “A proposed standard for interoperable user models (White Paper)” [14]. This proposal includes the VERITAS approach to user models for simulation. Compliance to this approach is implicitly given because the processes and tools used in VERITAS either constitute the basis for the White Paper or were adjusted according to VUMS cluster consensus.

The VUMS cluster has been initiated by the European Commission in beginning of 2010 to synchronize efforts among several on-going research projects. The projects VERITAS, VICON, MyUI, GUIDE and VAALID agreed to co-operate on issues of common interest in order to synergise among them and to disseminate their results to the scientific community and standardisation bodies. All projects in VUMS follow activities in the area of user modelling/simulation and involve human users in their developments and evaluation processes.

VERITAS has, thus, organized its standardization activities through the VUMS cluster, as this would be a more effective channel for promoting its standardization needs, than acting as a stand-alone Consortium. Joining the efforts of so many exceptional specialists in the area participating in the VUMS projects, constitutes a rare opportunity for cooperation and optimization of efforts that the European Commission recognized and encouraged and the VUMS projects welcomed and were eager to benefit from.

Therefore the main objective of the VUMS cluster is to align activities in the areas of:

- User modelling
- Standardisation
- Dissemination
- Ethics

Contributions to international standards are considered a major target of the cluster. This requires communication and cooperation with many external institutions, especially standardisation bodies and other research projects and experts. Therefore, dissemination and networking activities are an important part of the VUMS standardisation activities. Application and nature of user models are very heterogeneous among the different projects and different contexts of use. This heterogeneity has been reflected in the standardisation activities. Our goal was not to create a new common standardized user model, but to make user models interoperable through standardisation of common aspects. This interoperability shall support the exchange and sharing of user profiles among different services and contexts in the future.

4.1 VUMS White Paper as input for international standardisation

The most important results of the VUMS cluster work have been summarized in a VUMS White Paper. This white paper aims at disseminating the major concepts and approaches of the VUMS cluster. It serves as a starting point and important input for discussions with relevant international standardization bodies. The content of the White Paper [14] can be summarized as follows:

- It motivates the need for and benefits of a common standard for user models in the field of usable and accessible ICT products and services. Such a standard can help designers and developers to maximize the usability and accessibility of products and services by providing appropriate interoperable representations of user properties. It would ease the development of applications, shorten the development time and reduce project costs. Moreover, user models are intended to be used for the generation and adaptation of accessible user interfaces during runtime.

- The white paper presents definitions of general terms and a concept of a generic interoperable user model that describes the relevant characteristics of users interacting with products and user interfaces. User characteristics include physical, cognitive, and sensory attributes, habits, and preferences and in particular cover the issues of accessibility of user interfaces. It provides a table explaining a wide range of user characteristics to help other research groups and standardization bodies to advance the discussions in this area.

- The white paper proposes a specification for standardisation of user models. It defines the structure of the VUMS user model. This structure includes a taxonomy of user model variables and a structure of the descriptors for each user model variable. Moreover, syntactic requirements for user models are summarized and an XML definition of abstract user models is give. Finally, the VUMS Exchange Format is introduced to foster interoperability between the user models of the different VUMS projects.

4.2 VUMS standardisation activities and achievements

4.2.1 Overview and introduction

International standardisation is a complex and difficult undertaking. Much of the VUMS cluster work is targeted towards the active contribution to international standardisation. In order to better understand the remarkable achievements of the VUMS standardisation activities, it is necessary to understand the major challenges and pitfalls of standardisation within research projects:

- **Time consuming**

International standardisation is time-consuming. Most relevant working groups work on the basis of two official meeting per year. All standardisation activities rely on a process of sometimes hard-earned consensus. Starting and finalizing a new standardisation project often takes about five years. The VUMS cluster, however, started with an expected lifetime of less than three years. For this reason, it was clear that starting and finalizing a new own initiative is not feasible and that contributing to an already running standardisation activity will be much more efficient.

- **Consensus with other experts**

The VUMS cluster is clearly a European initiative. Despite the many researchers and working groups in the world who deal with user modelling, the strong emphasis on user models for simulation of accessibility problems during design-time (as addressed by VUMS) is not that big topic in current international research and development. Moreover, the VUMS combination of user models for simulation and UI adaptation is unique world- wide. This can make it difficult for the VUMS cluster to find relevant existing standardisation groups to approve our approaches and results. As a consequence, our standardisation activities can be regarded as subdivided into two subsequent stages of a longer process with changing objectives and priorities:

1. The first stage is marked by intense and focused effort to develop a strong position for VUMS models and approaches as a basis for later discussions with standardisation stakeholders. The result of this first stage was the VUMS White Paper as described in section 2.
2. In the second stage, it is important to broadly spread the results and to make compromises in order to influence on-going standardisation activities. In this stage, publications have been prepared; demonstrations have been implemented at conferences and contacts have been established. We took a broad strategy with more than one target in order to minimize the risk of dead ends.

Figure 1 provides an overview of the most important standardization activities. ISO and W3C have been targeted as they have been identified as the most promising platforms for VUMS standardization. VUMS documents, especially the VUMS White Paper serve as the major input and basis for discussions with relevant standardisation bodies. In order to assure sustainability after the VUMS projects' lifetimes, liaisons with other projects- especially the Cloud4All project – have been established. The details of this figure are described in the following sections.

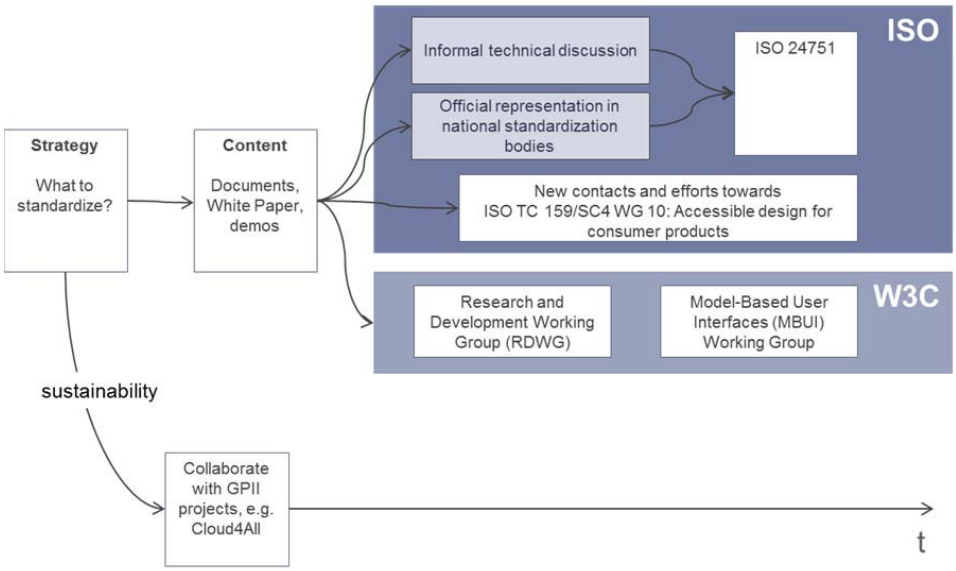

Figure 2: Overview of important VUMS standardization activities

4.2.2 What does VUMS standardize?

The main purpose of VUMS standardization is to foster the vision of interoperability of user models. This means that VUMS does not aim at defining the one and only user model. But VUMS standardisation shall help to establish an infrastructure for interoperable user models. This vision addresses industrial users (developers and designers) who will be able to share virtual human models across different fields of applications and different technical platforms and development and simulation tools. At the same time, end users will also benefit from interoperable user models when using different adaptive user interfaces which rely on different but interoperable user

models. This will make it possible to use one data set about personal preferences for the adaptation of many different products and services to the individual needs. In order to support this vision, VUMS strives to standardize the following issues:

- **Terms and definitions** in the field of user modelling for simulation and user interface adaptation
- **User model structure**
  - Meta-structure for user models with different purposes
  - Meta-model including a superset of variables
  - Descriptors of user model variables
- **User model syntax** VUMS user model exchange format

4.2.3 Analysis of standardisation opportunities for VUMS

As a first step towards international standardisation, a profound state-of-the art review has been carried out. Table 4 below provides an overview of related standards.

Table 4: Standards related to User Modeling – Comparison

Standard/Aspects covered	Focus on accessibility	Tasks support	Workflows support	Description of user needs/ preferences	Description of device characteristics	Description of user (physical, characteristics cognitive, etc)	UI definition support	Guidelines	Implementation details
ETSI TS 102 747								✓	
ETSI ES 202 746	✓			✓					✓
ISO/IEC 24751-1:2008	✓								✓
ISO/IEC 24751-2:2008	✓			✓					✓
MARIA XML		✓	✓				✓ (multimodal)		✓
W3C Delivery Context ontology					✓				✓
W3C CC/PP				✓	✓				✓
URC Standard (ISO/IEC 24752)	✓	✓		✓	✓				✓
IMS Access For All Personal Needs and Preferences Description for Digital Delivery Information Model	✓			✓					✓
ETSI EG 202 116	✓				✓	✓	✓ (multimodal)	✓	
ETSI TR 102 068	✓				✓	✓		✓	
ETSI EG 202 325	✓ (limited)							✓	
BS EN 1332-4:2007				✓					✓
ISO 11228-2:2007						✓		✓	
ISO/DIS 24502						✓		✓	
XPDL			✓						✓
WHO ICF	✓								
WHO ICD	✓								
FMA			✓			✓			✓
H-Anim			✓			✓	✓		✓
ISO/FDIS 9241-129:2010			✓				✓	✓	

4.3 VUMS cluster standardisation at ISO

4.3.1 ISO 24751

In an initial analysis, ISO 24751 ("Individualized adaptability and accessibility in e-learning, education and training") has been identified as the best arena for VUMS standardisation. ISO 24751 is maintained under JTC 1/SC 36 WG 5. Major reasons for focussing on this standard include:

- ISO 24751 is currently under revision. It seemed to be a good opportunity to get involved into the current revision activities.
- The editors are planning to extend the current standard's scope beyond e-learning towards a broader application to interactive systems in general.
- Jutta Treviranus and Erlend Overby (responsible editors and ISO-WG7-convenors) have signalled interest in collaborating with VUMS when continuing their work on ISO 24751. Other active contributors to the new ISO 24751 standard like Gottfried Zimmermann and Gregg Vanderheiden foster a good relationship with VUMS cluster members.

In order to officially contribute to the new ISO 24751 standard, VUMS cluster partners joined respective working groups at ISO and the national levels. Contacts to DIN (Germany) and BSI (UK) have been made. Christian Stracke (Convener ISO/IEC JTC1 SC36/WG5) and Nikolaus Kovacs (DIN secretary) have welcome Matthias Peissner (MyUI) as an active member of DIN NIA 36. Matthias presented the VUMS approach and potential contributions in a DIN NIA 36 meeting in 18th November 2011. Pradipta Biswas (GUIDE) has been inducted to the BSI committee and will attend the ISO/IEC SC36 meeting at Shanghai, China in September. Pradipta has also been appointed as coordinator of a working group in ITU-T Focus group on Audio Visual

Media accessibility and this focus group will work with ISO/IEC JTC 1 Special Working Group on Accessibility (SWG-A).

Besides this official impact on the standard, the VUMS cluster aimed at a very close collaboration with the international experts working on the ISO 24751-revision. Technical discussions and conference calls have been attended and a strong association with the Cloud4All project has been established (see Figure 3).

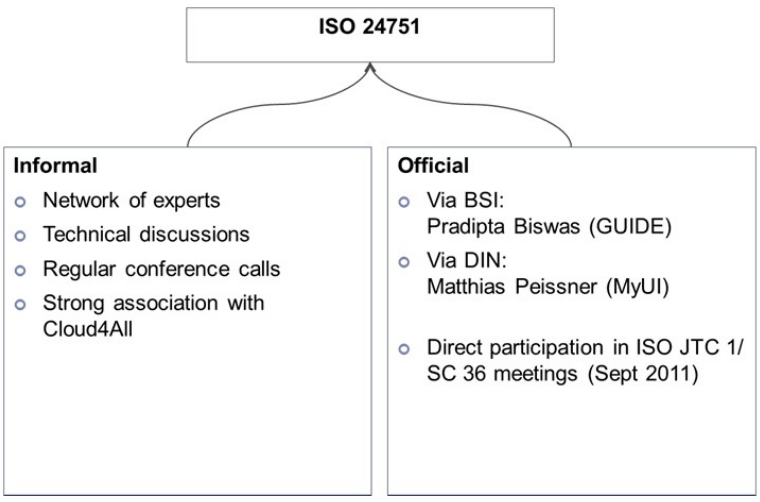

Figure 3: Two-fold impact strategy on ISO 24751

During the collaboration, it became more and more obvious that the approaches of the ISO 24751 experts and the VUMS cluster are hardly compatible. While the VUMS cluster integrates the purposes of user simulation and user interface adaptation by taking a modelling approach which describes the user and relevant capabilities on a quite detailed level, the ISO24751 position (which is very close to the current Cloud4All project) focuses on modelling interaction requirements for specific applications and devices. VUMS on the one hand side models the user, whereas ISO 24751 concentrates on modelling the user interface by specifying adaptable features and value spaces (see Figure 4).

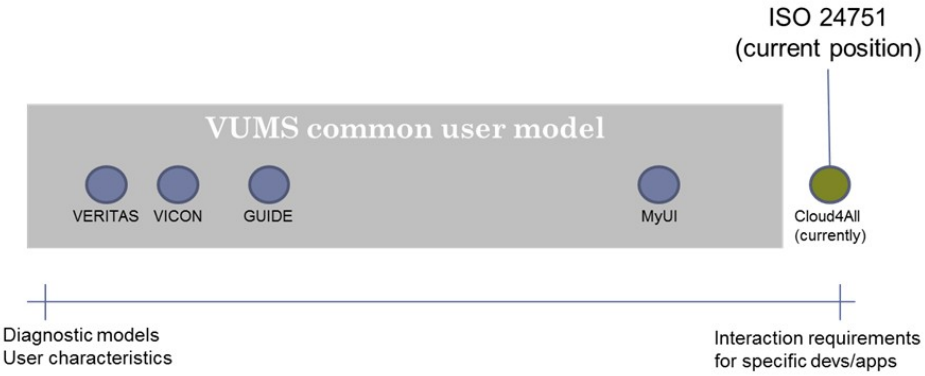

Figure 4: VUMS and ISO 24751 follow different approaches to user modelling

In recent discussions, it became clear that VUMS and ISO 24751 are not compatible. The AccessForAll group as the main contributor to the new standard has provided a declaration that ISO 24751 will explicitly avoid any type of profiling of a user or making assumptions about a user's needs. It will rather define user interface preferences which should empower each individual user to discover, declare and refine their own understanding of what they need functionally (with individualized forms of support and guidance if necessary). A conclusion of how the VUMS results can influence the revision of ISO 24751 has been drawn. AccessForAll will use the VUMS work as a check list of what must be included in ISO 24751. They acknowledge the value of the VUMS knowledge of the range of capabilities and ways that these capabilities can be optimized as a means to inform the choices that should be included in the choices presented to the user (summarized from an email from Jutta Treviranus).

4.3.2 Activities under ISO TC 159/SC4 (Ergonomics of Human-System Interaction)

A second new strand of ISO activities within the framework of TC 159/SC4 (Ergonomics of Human-System Interaction) has been started only recently. *Matthias Peissner* (MyUI) has presented the VUMS White Paper in a recent meeting of DIN NA 023-00-04-05 GAK (06 November 2012, Berlin). The attendees have shown their interest in the topic and recommended to present the approach to DIN NA 023-00-02 GA, the German mirror committee of ISO TC 159/SC4 WG 10 (Accessible design for consumer products). Contact to the German chairman Klaus-Peter Wegge has been established.

4.4 VUMS cluster standardisation at W3C

The VUMS user model approach has been presented to three different W3C working groups:

- Research and Development Working Group (RDWG)
- Model-Based User Interfaces (MBUI)
- Evaluation and Repair Tools Working Group (ERT WG)

Further actions have been taken in the first two working groups:

4.4.1 Research and Development Working Group (RDWG)

The Research and Development Working Group (RDWG) is a working group of the W3C Web Accessibility Initiative (WAI), to increase the incorporation of accessibility considerations into research on web technologies, and to identify projects researching web accessibility and suggest research questions that may contribute to new projects. RDWG maintains an annotated catalogue of research topics related to web accessibility. The catalogue includes a combination of research topics with short-, medium-, and long-term perspectives to help advance accessibility for people with disabilities. This catalogue is collaboratively maintained using the publicly available RDWG wiki (http://www.w3.org/WAI/RD/wiki/Main_Page). The VUMS cluster has submitted an excerpt of the VUMS white paper to RDWG. RDWG have accepted „user modelling“ as a new research topic of the group. The topic "user modelling" (http://www.w3.org/WAI/RD/wiki/User_modelling) was added to the wiki as a contribution of the VUMS cluster. RDWG organizes frequently so called online symposiums with a selected topic, there a call for papers is then issued and a review process is organized. Selected papers are then presented on the online symposium and published in a w3c proceeding. RDWG plans to select "user modelling" as the next topic for an online symposium in February 2013. This online symposium will be based on the work and results of the VUMS cluster which will provide great visibility and an excellent dissemination opportunity for the VUMS cluster work. The VUMS contact person at RDWG is Yehya Mohamad (VICON).

4.4.2 Model-Based User Interfaces (MBUI) Working Group

Nikolaos Kaklanis (VERITAS) is an active member of the Model-Based User Interfaces (MBUI) Working Group of W3C (http://www.w3.org/2011/mbui/). He participated in the 3rd face-to-face meeting of the group that took place on 29-30 October 2012 in Lyon. During this meeting he presented the VERITAS user modelling approach, which is actually almost identical to the VUMS user modelling approach. There was a very positive feedback and interest in discussion, as this was the most detailed user model that the group members had ever seen.

However, it was said that such a detailed user model is not very suitable to be included in the results of this working group. Maybe a briefer version of the proposed user model will be integrated in the meta-models that this W3C working group will propose. Nikolaos has already developed an updated metal-model including only the main containers of the proposed user model and waiting for feedback from the other group members.

4.5 Further standardisation activities

4.5.1 AALOA

AALOA (www.aaloa.org) is a recently founded open organisation that fosters research, collaboration, development impact and uptake in the area of Ambient Assisted Living (AAL). Fraunhofer is one of the main drivers in the AALOA association (also with the AALOA member projects GUIDE and universAAL), and could forward an invitation for collaboration to the Governing Board of AALOA. In a first response AALOA acknowledges the importance of standards in AAL, and also mentions the important role open source publication of reference implementations, as it is currently applied by VUMS with its public user model specification and reference user profiles. AALOA will help creating visibility among its members for the VUMS development, in order to stimulate collabration. VUMS has also offered to have a first online meeting of representatives of both initiatives.

4.5.2 Access4all

The VUMS White paper has been spread to the partners of the access4all group. Via the involvement in the Cloud4All project, VUMS cluster members will represent the VUMS position in ongoing access4all discussions and conference calls related to user model standardization.

4.5.3 ITU-T FG on Audio Visual Media Accessibility

The Working Group F Coordinator, Mr *Pradipta Biswas* (University of Cambridge, GUIDE) introduced the WG F updated report contained in input document AVA I 0106. As being discussed in this Working Group, participation will be increasingly going towards the virtual media Internet connection because it consists of both audio media and also viewing the media and transmission of media. Input AVA-I-0107 “White paper of the VUMS “Virtual User Modelling and Simulation Standardization” cluster of projects” was also presented. This document is from the on-going work of a multi country research project on virtual user modelling and simulation standardization: how do we actually standardize simulators so they actually provide us with appropriate answers to design questions. The first step is to actually have simulators that reflect different groups or clusters of disabilities. Secondly is necessary to have some sort of consensus as to the kinds of things that the simulators have to be able to do before we start applying them. This document is a white paper of the VUMS cluster of projects.

The ITU-T Focus Group on Smart TV (http://www.itu.int/en/ITU-T/focusgroups/smartcable Pages/default.aspx) aims to assist development of globally unique future ITU-T Recommendations on Smart Cable Television. It will carry out a gap analysis and produce deliverables based on the existing activities and expertise. As a Vice-Chairman of this focus group, *Pradipta Biswas* will co-author its reports to different standardization bodies including ITU and use these reports to promote VUMS user modelling concept and its utility to personalize interfaces of smart TV.

5 Mid to long – term roadmap (up to 2020)

The technology trends foreseen for the next 20 years as defined in the 2020 roadmap for the future are outlined in the following Figure 5, which expects an evolution of the current technological advancements in Ambient Intelligence and Smart Environments that will make key technologies available for the adoption of accessible designs and services.

It is widely expected that increased interoperability and smart appliances will become mainstream in the retail industry around 2015. As this scenario will evolve, a vast amount of objects will be addressable, and could be connected to IP-based networks, to constitute the very first wave of the "Internet of Things" [15]. Another very important aspect that needs to be addressed at this early stage is the one related to interaction standards, accessibility and personalised objects.

Extrapolation of technology trends and ongoing research

Vision society People	• Socially acceptable RFID	• Pervasive RFID	• Interacting objects	• Personalised objects
	• Realising benefits (food safety, anti counterfeiting, health care) • Consumer concerns (privacy) • Changing ways to work	• Changing business (processes, models, ways to work) • Smart appliances • Ubiquitous readers • Access rights • New retail and Logistics	• Integrated appliances • Smart transportation • Energy & Resource conservation	• Mastered ambient intelligence • Interaction of physical and virtual worlds • Search the physical world (google of things) • Virtual Worlds
Politics & Governance	• De-facto governance • Privacy legislation • Address cultural barriers • Future Internet governance	• EU governance • Frequency spectrum Governance • Sustainable Energy Consumption guidelines	• Authentication, trust and verification • Security, social well-being	• Authentication, trust and verification • Security, social well-being
Standards	• RFID security and Privacy • Radio frequency use	• Sector specific standards	• Interaction Standards	• Behavioural Standards
	Before 2010	**2010-2015**	**2015-2020**	**Beyond 2020**

	Before 2010	**2010-2015**	**2015-2020**	**Beyond 2020**
Vision technology	• Connecting objects	• Networked objects	• Executable objects /semi-intelligent objects	• Intelligent objects
Use	• RFID adoption in logistics, retail and pharmaceutics.	• Increased interoperability	• Decentralised code execution • Global applications	• Unified network that connects people, things and services • Integrated industries
Devices	• Smaller and cheaper tags, sensors and active systems	• Increasing memory and sensing capacities	• Ultra high speed	• Cheaper materials • New physical effects
Energy	• Low power chipsets • Reduced energy consumption	• Improved energy management • Better batteries	• Renewable energy • Multiple sources	• Elements of energy harvesting

Figure 5: Extrapolation of technology trends and ongoing research

5.1 Research priorities

Following this concept, along with the work undertaken within VERITAS, the main research that should be put as priority for the mid to long term (up to 2020), as identified by VERITAS, is summarized in the following paragraphs. For this reason, a working group of 5 internal and 5 external to the project experts has been established, focused in identifying and prioritizing the research needs. Some preliminary research needs that were identified earlier in the project were also included in D4.5.3 [15], and later on enriched with new ones. Of course this list of further research topics is not exhaustive; many other aspects can be seen as important research items to be investigated in the years to come. Here, we tried to set the general framework in which the research in the field should be focused on.

5.1.1 Generalisation of use and standardisation of dynamic virtual user models

Description: One of the major research challenges is to move from a static approach with respect to user modeling to a dynamic one, where the virtual user models will be continuously updated taking into account user interactions, preferences and real-time accessibility needs.

The dynamic VUM repository will provide the information about specific virtual user models to the application designers, while it will also receive information on the interaction history, user profile update and customization that will be contextualized using the information received by the environment related to physical measurements and interaction context. This iterative procedure can be seen as a “measurement loop”. Moreover, the dynamic VUM platform will continuously perform an off-line optimization procedure that will use the interaction and environmental measurements, of the mobile platform and AmI infrastructure respectively, and map them to the virtual user model specific parameters. Then it will iteratively perform training of the virtual user models according to specific interaction contexts. This procedure, “VUM optimization loop”, will result to dynamic up-to-date virtual user models that will be subsequently used whenever required.

Moreover, through the research conducted under the scope of VERITAS as well as the cooperation among the VUMS cluster project, there has been identified the need to proceed to standardization of the contents, scope, format and interoperability of Virtual User Models so that they can be cross-compatible among different domains, applications and research activities

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any domain that can benefit from simulated accessibility assessment would be applicable for this initiative since it would facilitate the Design 4 All initiative

Priority level: Essential

Background information: This is the culmination of the Design4All initiative, the interoperability of standards in VUMs so that they can be extended to cover more domains, as well as become mainstream in the already targeted domains of VERITAS.

5.1.2 Iterative on-the-go optimisation

Description: One of the major grand challenges identified by the VERITAS partners is the introduction of a mobile simulation platform, which could be potentially a sub-set of the core simulation platform that will automatically and without user intervention perform automatic interface accessibility assessment tests, interface optimization and iterative adaptation, based on the dynamic virtual user models, the environmental measurements and contextual information.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit as it linked to virtual user models

Priority level: Essential

Background information: Originally a multivariate accessibility metric should be defined. The local and global metrics will be estimated for a specific interface, a specific virtual user and the relevant environmental set-up, by the “context-aware personalized assessment” module. Then, “template-based adaptation recommendation” will be performed by estimating the accessibility metric in the local neighbourhood of the parameter metric space that will result in the estimation of the gradient (i.e. tendency) of the multivariate accessibility metric with respect to small variations of several parameters

5.1.3 Smart adaptive interfaces

Description: Smart adaptive user interfaces should support high-level accessibility of ICT products and services in daily life. On the basis of a specific user profile from the virtual user model (VUM), the Adaptive Interfaces Platform should put together proven user interface components to an individualised user interface which will fit the specific user requirements and constraints. Smart adaptive User Interfaces (UI) that will be provided in different portable devices will be able to adapt themselves to the changing habits, preferences and requirements of the user in terms of the presentation and interaction modes, and based on the past choices made by the user within changing daily environments. Besides automatic user interface adaptation, the foreseen smart adaptive user interfaces should provide the possibility for manual individualization. This helps users and their relatives, carers or alike to keep control over the user interface appearance

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Essential

Background information: The user interfaces should adapt to the gradual development of an individual user profile that reflects long-term changes in the physical, perceptual and mental state of the end user and the increasing completeness and reliability of the user profile which is refined during the time of use. Moreover, it should also react to short-term variations in the current context of use including the presence of other users or objects of personal interest. Multimodal as well as implicit interaction modes should be also covered in order to account for individual user needs and changing environmental context conditions (ambient intelligence / ambient interaction/adaptation)

5.1.4 Seamlessly operating products

Description: Of significant importance for the emerging accessible designs and technologies is to provide seamless roaming of the individuals between different domains of daily life, by retaining dynamic time-varying needs, temporal habits and accessibility constraints.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Essential

Background information: Such prototypes should be interoperable and should be transparently connected to the AmI, while they should also provide sufficient mechanisms to allow for adaptive device control and information presentation/rendering. During run-time, the prototypes, the AmI should communicate so as to dynamically provide optimal interaction and interfacing solutions to the users.

5.1.5 Holistic cognitive-behavioural-motor modeling

Description: A key research technology that should be mentioned is the making of user models a step beyond VERITAS, in the sense that they fully integrate cognition and physics. In other words further research and efforts should be addressed to produce some kind of «copy» of human beings that reproduces cognition, decision, motion planning, motor control and physical movement. Such kind of model would be able, for example, to produce itself the task tree to

achieve a goal, to plan primitive movements, to execute and adjust them, and to ultimately interact in a realistic humanlike way with objects and interfaces.

Such kind of virtual user (call it a digital human) will produce motion primitives and solution strategies that are influenced by its own capabilities. Therefore user behaviour and tasks will emerge from user capabilities and goals (just like for real human beings). As an example, consider the goal of grasping an object. A holistic cognitive-motor virtual user that has some limitation in the mobility and control of hands resulting from, say, from Hereditary Motor Sensor Neuropathy (Charcot Marie Tooth disease) will produce workaround strategies for grasping and grasping patterns that (if the model is accurate enough) resembles the ones people with that disability use [1]. Another example is the emergence of gait patterns: a holistic cognitive-motor virtual user will walk according to its own capabilities, for example include spasticity.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Important

Background information: Attempts to replicate human behaviour in such way have been carried out with some success with Cognitive System in limited domains. For example, the project DIPLECS [17] developed an Artificial Cognitive System that “learns by watching humans, how they act and react while driving, building models of their behaviour and predicting what a driver would do when presented with a specific driving scenario”. This learning process can be seen as the process of making a «copy» of the human driver (in this case limited to driving task). The technology used in the above project is a subsumptive [18] Perception-Action architecture [19], [20].

5.1.6 Incorporate psychological aspects to address other categories

Description: The virtual user models should include other aspects of the users and not only physical characteristics, but also psychological ones e.g. expand the spectrum to include other DSM-V categories, such as Neurodevelopmental disorders, Depressive disorders, Anxiety disorders, Trauma- and stressor-related disorders, Sleep–wake disorders, etc.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Essential

Background information: Consideration for personality types, personality predispositions (e.g. mood, aggression) and personalisation factors. Personalizing user models increases their sensitivity, effectiveness and applicability. This research action is closely related to the action about expanding the application areas.

5.1.7 Inclusion of other application areas

Description: Apart from the application areas that have already been identified and researched within VERITAS, more application areas should be included in the design – for – all concept of the VERITAS tools. Such areas could be: travelling, e-commerce, leisure (not only infotainment and games), social networks, etc.

Relevant VERITAS domain: N/R

Applicability to other domains: This is exactly the point of this priority. Many different areas can be included, indicatively mentioning travelling, e-commerce, leisure (not only infotainment and games), social networks,etc.

Priority level: Important

Background information: Inclusion of other research areas would increase the generalizability and validity of the virtual user models. Such an attempt would also increase the marketability of VERITAS products.

5.1.8 Establish a flexible, reliable and valid evaluation framework (Virtual-User Centered Design)

Description: The aim is to develop an evaluation framework that could transfer findings from virtual users to real users with no loss in reliability and validity; because these two aspects are important in generalizing findings. In the end of the day, we want to do in the virtual environments what we do in real life.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Essential

Background information: Certain guidelines, clusters, taxonomies, and structured methodologies should be developed based on existing theoretical approaches. Mixture of professional (experts) and end-users (beneficiaries' experience) is necessary to be involved, at least for the first

5.1.9 Methodology for the assessment of accessibility of healthcare applications using VERITAS tools: application and validation for p-health applications and tools

Description: The methodology defined in VERITAS, which has been tested and validated with 3 applications in the healthcare domain during the project, will be applied and validated with more applications and tools. Specifically, several p-health applications for the management of chronic diseases will be assessed (including Parkinson disease, cardiovascular diseases and diabetes).

Relevant VERITAS domain: Healthcare

Applicability to other domains: No

Priority level: Important

Background information: The application will be performed by Life Supporting Technologies (LifeSTech), a research, development and innovation group, belonging to the Universidad Politécnica de Madrid (UPM) and dedicated to design, development and evaluation of services and applications based on ICT (Information and Communication Technologies), in order to create and promote new ideas, methods and technological solutions in every aspect of the value chain of organizations. It will come as a continuation of their work in VERITAS through the validation and assessment of more applications and tools in the healthcare domain.

5.1.10 Further development and applications of virtual user models for cognitive disabilities

Description: Continuation of the work on the definition of virtual user models with cognitive disabilities and explore usefulness for the field of cognitive rehabilitation.

Relevant VERITAS domain: Healthcare

Applicability to other domains: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Priority level: Important

Background information: Nowadays there is a continuous ageing process of the European population, and an increasing number older people who are unable to live independently because of age-related cognitive impairments. Modeling of cognitive problems such as cognitive ageing, dementia or Alzheimer's disease can significantly benefit research on the field of cognitive rehabilitation.

5.1.11 Definition of European ergonomic constrains for impaired drivers

Description: To define a methodology (recognized at European level) to be applied for the ergonomic assessment in car interiors

Relevant VERITAS domain: Automotive

Applicability to other domains: No

Priority level: Important

Background information: Lack of present regulations and methodologies: OEMs may have, or not, internal rules-of-thumbs for elderly people or impaired people, but European regulations for automotive do not explicitly ask for additional constrains.

5.1.12 Continuation of standardization efforts through VUMS cluster in ISO & W3C

Description: VUMS cluster representatives will continue their ISO and respective DIN/BSI engagements. Especially, the active contribution to new work proposals in ISO TC 159/SC4 WG 10 are considered to offer good opportunities for disseminating the VUMS cluster results. Moreover, VUMS cluster experts will continue their active membership in the two W3C working groups MBUI, UAD and RDWG. They have agreed to represent the concepts and interests of the VUMS cluster in future standardisation activities, projects and workshops.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Essential

Background information: More information about these ongoing standardization initiatives can be found in Section 4 of the present document.

5.1.13 Further research and promotion of standardization efforts through Cloud4All project

Description: Current and future GPII projects like Cloud4All will be a great platform for VERITAS (and the rest of VUMS members) to disseminate and further develop their research results. Currently, with Fraunhofer IAO and CERTH are also involved in Cloud4All. Cloud4All and future GPII projects will also aim at international standardization in the field of accessibility. These activities will be supported by VUMS players in order to make sure that VUMS results can be reused and exploited.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Essential

Background information: More information on Global Public Inclusive Infrastructure and Cloud4All project can be found in http://gpii.net/ and www.cloud4all.info.

5.1.14 Prosperity4All: A holistic ecosystem infrastructure for the provision of services and applications that are accessible for all

Description: The Prosperity4All project aims at delivering fully functional key elements –as opposed to “research prototypes”–of a holistic infrastructure that will entice, engage, and enable stakeholders and individuals to create or deliver accessible solutions and/or services. It will also deliver numerous real-life implementations of services and applications that are accessible for all, thus proving the feasibility and applicability of the proposed ecosystem infrastructure across technology and user domains. Its work is highly based on the findings of previous research projects (among which VERITAS and Cloud4All) while the participation of VERITAS Consortium members in it, guarantees the further deployment of the VERITAS findings through the work performed in Prosperity4All.

Relevant VERITAS domain: Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare

Applicability to other domains: Any other domain can benefit

Priority level: Essential

Background information: Prosperity4All is an EU funded project (FP7) that starts in 2014 and will run for 4 years.

6 VERITAS Roadmap

The research priorities presented in the previous Section can be summarized in the following table:

Research priority	Description	Relevant VERITAS domain	Applicability to other areas	Priority level
Generalisation of use and standardization of Virtual User Models for Accessibility Assessment in multiple domains	The "VUM optimization loop" procedure, will result to dynamic up-to-date virtual user models that will be subsequently used whenever required. Moreover, , there has been identified the need to proceed to standardization of the contents, scope, format and interoperability of Virtual User Models so that they can be cross-compatible among different domains, applications and research activities	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any domain that can benefit from simulated accessibility assessment would be applicable for this initiative since it would facilitate the Design 4 All initiative	Essential
Iterative on-the-go optimisation	Introduction of a mobile simulation platform, which could be potentially a sub-set of the core simulation platform that will automatically and without user intervention perform automatic interface accessibility assessment tests, interface optimization and iterative adaptation, based on the dynamic virtual user models, the environmental measurements and contextual information	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit as it linked to virtual user models	Essential
Smart adaptive interfaces	Smart adaptive User Interfaces (UI) that will be provided in different portable devices will be able to adapt themselves to the changing habits, preferences and requirements of the user in terms of the presentation and interaction modes, and based on the past choices made by the user within changing daily environments. The foreseen smart adaptive user interfaces should provide the possibility for manual individualization.	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Essential
Seamlessly operating products	Provide seamless roaming of the individuals between different domains of daily life, by retaining dynamic time-varying needs, temporal habits and accessibility constraints.	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Essential
Holistic cognitive-behavioural-motor modeling	Produce some kind of «copy» of human beings that reproduces cognition, decision, motion planning, motor control and physical movement. Such kind of model would be able, for example, to produce itself the task tree to achieve a goal, to plan primitive movements, to execute and adjust them, and to ultimately interact in a realistic humanlike way with objects and interfaces. Such kind of virtual user (call it a digital human) will produce motion primitives and solution strategies that	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Important

Research priority	Description	Relevant VERITAS domain	Applicability to other areas	Priority level
	are influenced by its own capabilities.			
Incorporate psychological aspects to address other categories	The virtual user models should include other aspects of the users and not only physical characteristics, but also psychological ones e.g. expand the spectrum to include other DSM-V categories, such as Neurodevelopmental disorders, Depressive disorders, Anxiety disorders, Trauma- and stressor-related disorders, Sleep–wake disorders, etc.	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Essential
Inclusion of other application areas	Apart from the application areas that have already been identified and researched within VERITAS, more application areas should be included in the design – for – all concept of the VERITAS tools. Such areas could be: travelling, e-commerce, leisure (not only infotainment and games), social networks, etc.	N/R	This is exactly the point of this priority. Many different areas can be included,	Important
Establish a flexible, reliable and valid evaluation framework (Virtual-User Centered Design)	The aim is to develop an evaluation framework that could transfer findings from virtual users to real users with no loss in reliability and validity; because these two aspects are important in generalizing findings. In the end of the day, we want to do in the virtual environments what we do in real life	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Essential
Methodology for the assessment of accessibility of healthcare applications using VERITAS tools: application and validation for p-health applications and tools	The methodology defined in VERITAS, which has been tested and validated with 3 applications in the healthcare domain during the project, will be applied and validated with more applications and tools. Specifically, several p-health applications for the management of chronic diseases will be assessed (including Parkinson disease, cardiovascular diseases and diabetes).	Healthcare	No	Important
Further development and applications of virtual user models for cognitive disabilities	Continuation of the work on the definition of virtual user models with cognitive disabilities and explore usefulness for the field of cognitive rehabilitation	Healthcare	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Important
Definition of European ergonomic constrains for impaired drivers	To define a methodology (recognized at European level) to be applied for the ergonomic assessment in car interiors	Automotive	No	Important
Continuation of standardization efforts through VUMS cluster in ISO & W3C	VUMS cluster representatives will continue their ISO and respective DIN/BSI engagements. Especially, the active contribution to new work proposals in ISO TC 159/SC4 WG 10 are considered to offer good opportunities for disseminating the	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Essential

Research priority	Description	Relevant VERITAS domain	Applicability to other areas	Priority level
	VUMS cluster results. Moreover, VUMS cluster experts will continue their active membership in the two W3C working groups MBUI, UAD and RDWG. They have agreed to represent the concepts and interests of the VUMS cluster in future standardisation activities, projects and workshops.			
Further research and promotion of standardization efforts through Cloud4All project	Current and future GPII projects like Cloud4All will be a great platform for VERITAS (and the rest of VUMS members) to disseminate and further develop their research results. Currently, with Fraunhofer IAO and CERTH are also involved in Cloud4All. Cloud4All and future GPII projects will also aim at international standardization in the field of accessibility.	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Essential
Prosperity4All: A holistic ecosystem infrastructure for the provision of services and applications that are accessible for all	The Prosperity4All project aims at delivering fully functional key elements of a holistic infrastructure that will entice, engage, and enable stakeholders and individuals to create or deliver accessible solutions and/or services. It will also deliver numerous real-life implementations of services and applications that are accessible for all, thus proving the feasibility and applicability of the proposed ecosystem infrastructure across technology and user domains. Its work is highly based on the findings of previous research projects (among which VERITAS and Cloud4All) while the participation of VERITAS Consortium members in it, guarantees the further deployment of the VERITAS findings through the work performed in Prosperity4All.	Automotive, Smart living spaces, Workspaces, Infotainment, Healthcare	Any other domain can benefit	Essential

Taking into account the time horizon foreseen for their implementation, these research priorities can be illustrated in the following graph:

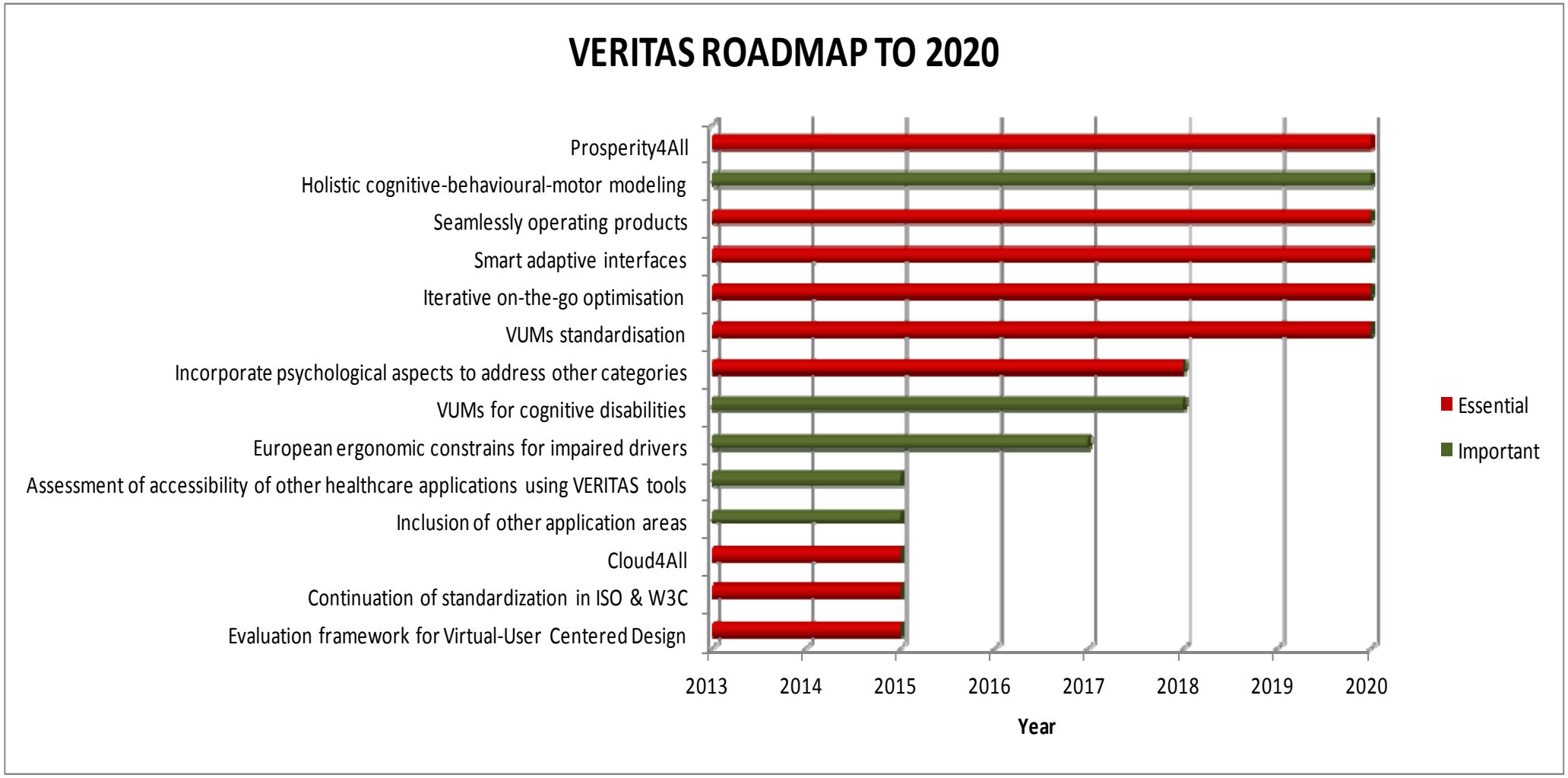

Figure 6: VERITAS Roadmap

7 Conclusions

Within VERITAS' aim to develop, validate and assess tools for built-in accessibility support at all stages of ICT and non-ICT product development, including specification, design, development and testing, a series of research activities have been undertaken. The overall goal to ensure that future products and services are being systematically designed for all people including those with disabilities and functional limitations as well as older people has, thus, been driven one step forward. However, many more steps are required to reach this ultimate goal. In order to promote the continuation of work in the area, VERITAS has been in touch with policy organisations and has also (mainly through the VUMS cluster) promoted its results to the appropriate standards organisations for consideration and potential adoption. Moreover, the VERITAS consortium has been in close cooperation with past and ongoing related research initiatives, through numerous concertation actions.

The finalisation of the project does not however entail the end of these activities. Standardisation activities continue, also within the framework of upcoming research initiatives, which are employing the VERITAS results into their work. Moreover, further research that is needed has been identified and the first actions for implementing it are already been undertaken. More specifically, within VERITAS, 14 research priorities have been identified and are detailed in the present document, to be initiated and implemented with a horizon up to 2020.

The field of research is of course so broad that the priorities presented here can only be considered as indicative examples. Intensive effort is required by different actors in research, policy making and standardisation areas, so as to be able to achieve mainstream design and production of ICT and non-ICT products in an all-inclusive manner within the near future. The prospects are good, the technologies are rapidly developing, but it takes collective and dedicated action to reach the point of turning the page into a more accessible everyday reality.

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