Critical analysis of the state of the art

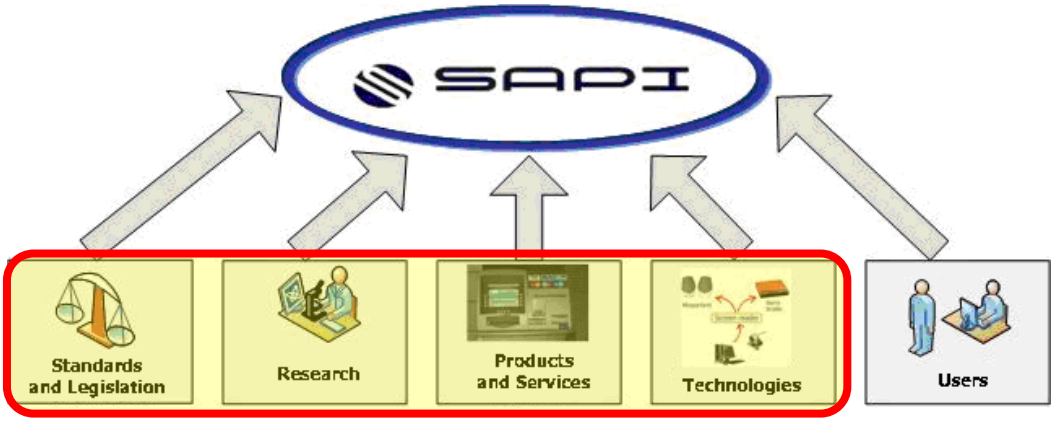
Survey

This document summarises the content of the deliverable "**D1.1_1 Critical analysis of the state of the art** in relation to *RI 1.1 Analysis of the state of the art*, within the scope of the first Development Objective (DO 1) "Study and analysis of state of the art".

Said activity, which is all-important for the SAPI project, both from the point of view of research and prototypal development of the platform, takes a more in-depth look at the following, as can be seen from the figure:

- the most important research at a national and international level
- assistive technologies and instruments for differently-abled users
- commercial products and services currently available
- reference standards and legislation

Given the key role of users and their characteristics, the detail of the study and the need to identify project target users, the study of users is performed through specific activities dedicated to said objective ("D1.2_1 Study of visual pathologies and target identification").



In short, activity 1.1. makes it possible to obtain an overall vision of what are the research activities, technologies, products and services that come together in SAPI in order to:

- develop a software framework to support advanced solutions for the provision of content and services able to offer better services than the solutions currently available in terms of adaptivity, accessibility, flexibility, multimodality and device independence;
- a prototypal platform based on the above framework and able to provide two specific services for Poste Italiane users: "payment of bills" and "online financial consulting services"

The software framework will explicitly allow for re-use of results obtained from research projects looking at similar questions, and innovative application of technologies, products and services that have been suitably adapted for SAPI's target users. The prototypal platform will tend to find a compromise between innovation and compliance with existing standards and specifications.

Research projects conducted in Italy and worldwide for the provision of services to disabled users

Scouting of research projects brought to light various services and products targeted at disabled users. At the present moment, some of these, conducted in a simplified manner, are specialising in specific sectors of non-ability and specific types of assistance. This is the case of the Trinetra project developed to help blind users in their choice of supermarket products, and the White project designed to allow colour blind users to visualise web pages correctly. Other projects looked at involved the adaptation of existing services, for example, Movipolis, initially created to provide tourists visiting Spain with information on how to get around, was extended by Rigel in order to cater for differently-abled users.

While we can see from the more advanced research projects carried out (for example, the MAIS project, which aims to create advanced services based on an SOA, within a multichannel environment, with adaptation of content for various user profiles, the Ask-it project which aims to create a multi agent platform to provide useful information regarding travel for people with mobility-related problems allowing access to the platform from various types of devices, the Mapped project, which, once the device has been localised on the basis of various technologies, associates a set of useful information to the position in order to reconstruct a route taking into account the user's ability in order to help him/her with his/her travel, the AceMedia project which aims to study how to manage intelligent content, able to adapt itself according to the device and service it has to use) that the complexity of architectures and functions makes the presence of a large number of users necessary in order to transform said projects into functioning services. The table below lists the projects looked at, highlighting the characteristics which make them of great interest for the research areas looked at in SAPI.

Key

MM=Multimodal/Multichannel

Ac = Accessibility

It = Italy

Eur = Europe

W = Rest of the world

✓ = Element present

✘ = Element not present

▪ = Element not specified

Table 1 – Taxonomy of research projects looked at

Name	Description	Promoters and main partners	End date	SCOPE			M/M	Ac	Adaptation	Target users		
				It	Eur	W				Visually disabled	Motor disabled	Able bodied
MWA	Mobile Wireless Accessibility	IBM Italia, ASPHI, NOKIA and Talks	2007	●			✓	✓	-	✓	-	✓
SWIMM	Interactive multimodal mobility web services	Bologna University, Integrated Environment Consulting and Development, Famula On Line, Lab G.Marconi, Novell Italia	December 2006	●			✓	✓	✓	✓	-	-
WHITE	Web for Handicap Integrated Training Environment	ISISLab, Salerno University, Modena University, Association for the Blind-Romania	2005	●			✓	✓	✘	✓	✓	✓
Habilio	Computer access system	Bassnet, Florence University	2007	●			✘	✓	✘	✘	✓	✘

MAIS	Multi-channel Adaptive Information Systems	Milan Polytechnic, Brescia University, Lecce University, CEFRIEL, ST Microelectronics	July 2006	●			✓	✓	✓	-	-	-
Ask-it	IT information services for the disabled	SIEMENS, NOKIA, e-ISOTIS, RNIB	2008		●		✓	✓	✓	-	✓	✓
Enabled	Enhanced Network Accessibility for the Blind and Visually Impaired	British Telecommunications, Queen's University of Belfast, Siemens	2007		●		✓	✓	✓	✓	-	-
AceMedia	Creation of content able to describe itself in an independent manner and able to independently adapt to user requirements	Motorola Research Lab, Fraunhofer Institute for Applied Information Technology, Universidad Autonóma de Madrid, Philips	2007		●		✓	✘	✓	-	-	✓
GRISINO	Semantic Web, Web Services, Intelligent Content Object and Grid are integrated in a single infrastructure	UMA, Innsbruck University, Salzburg Research	2008		●		✓	✓	✓	-	-	✓
Mapped	Mobilisation and Accessibility Planning for People with Disabilities	BMT Research and Development Directorate	August 2007		●		✓	✓	-	✓	✓	✓

Movipolis	Provision of information to tourists in the form of virtual guides using cellular mobile devices	Rigel	2007		●		-	-	✓	✓	✓	✓
Speech Technology	Study and development of technologies which allow users to interact with computers using their voice	Microsoft Research Lab	Under way			●	✓	✓	✗	✓	✓	✓
Trinetra	System to help the disabled with their choice of supermarket products	Carnegie Mellon University, Pittsburgh University	2006			●	✓	✓	✗	✓	✗	✗
Dasher	System for the entry of information-based text, piloted by eye movements	Cambridge University, Inference group of the Cavendish Laboratory, IBM Zurich	2007			●	✓	✓	✗	-	✓	-
Home Media Center	Research and development of voice navigation-based system for home media center platforms	NCAM, AFB, Panasonic Speech Technology Laboratories	Under way			●	✓	✓	✗	✓	✓	✓

Assistive technologies and instruments

Another delicate aspect of the study was the analysis of the assistive technologies used by differently-abled users in order to access information and which allow individuals with disabilities to perform the most important everyday tasks. In accordance with the content of a study commissioned by Microsoft and conducted by Forrester Research (*"Accessible Technology in Computing, Examining Awareness, Use, and Future Potential*"), these technologies are suitable for counterbalancing functional limitations, facilitating autonomy and placing the elderly and the disabled in the conditions to express their own potential independently.

Table 2 lists the main assistive technologies, classified on the basis of type and target users.

Table 2 – Existing technologies and aids for differently-abled users

Name	Description	Type		Target users		
		HW	SW	Visually impaired	Blind	Other disabled users
Braille Display	Line formed of some piezoelectric cells, each of which is a character expressed in Braille notation	✓	✗	✗	✓	✗
Braille printers	Embossers	✓	✗	✗	✓	✗
Braille Top	Portable sensor which converts printed pages into Braille	✓	✗	✗	✓	✗
Optacon	Video camera + matrix of embossed points	✓	✗	✗	✓	✗
OCR	Optical Character Recognition	✓	✗	✓	✓	✗
Trackball	Finger operated pointing device	✓	✗	✗	✗	✓
Head House	Pointing device based on head movements	✓	✗	✓	✗	✓
Pressure, pedal and breath-operated sensors	Devices which transform mechanical or pneumatic impulses into the closing or opening of an electrical contact	✓	✗	✗	✗	✓
Video enlargers	Closed circuit video camera system Captures the image of a text and projects an enlarged version on a video	✓	✗	✓	✗	✗
Alternative keyboards	Simplified, enlarged and ergonomic keyboards	✓	✗	✓	✗	✗
Enlarger	Applications which increase character size on monitors	✗	✓	✓	✗	✗

Screen reader	Application which identifies and interprets the text shown on a screen	✘	✓	✓	✓	✘
Voice browser	Applications created explicitly for website navigation	✘	✓	✓	✓	✘
Voice synthesis	System comprising sound card, amplifier, acoustic diffusers and software with the task of defining word pronunciation rules	✓	✓	✓	✓	✘
Voice recognition	Techniques which allow a computer fitted with an input sound source to interpret the human voice	✘	✓	✓	✓	✓
Voice system	System which processes images through sounds	✓	✓	✘	✓	✘
Sonic Torch and KASPA	Ultrasonic sensor to detect obstacles	✓	✘	✘	✓	✘
NAVI	Navigation Assistance Visually Impaired	✓	✓	✓	✓	✘
QualiEye	Computer cursor control via analysis of user movements	✓	✓	✓	✘	✓
Aurora	PC interaction management system	✘	✓	✓	✓	✓

Products and services for differently-abled users

As regards the various technologies looked at, a study was made of the main products still in use at a national and international level, produced by the leading developers of assistive technologies and products for disabled users (Alva, Tieman, Phoenix Interactive, Freedom Scientific, Dolphin Computer Access, GW-Micro, IBM, Microsoft, Qualilife, Adobe, Siemens)

Specific attention was given to mobile telephones. In this area, new products designed for special needs have appeared on the market in recent years. Indeed, some programmes which allow the display to be read via voice synthesis are available for the Nokia Communicator (9110, 9210, 9210I, 9300 and 9500), as well as "60 series" phones. The models in question are Nokia 7650, 3650, 3660, 6600, 6710, 6260, 6670, 6630 6680, 6681, N70 and N-Gage, Siemens SX1 and Samsung SGH-D730 which use the Symbian operating system.

Just like screen readers such as JAWS, Window-Eye, HAL and many more, there are also screen readers in the mobile telephone area such as TALKS, Mobile Speak, Audio-phone and Voice Suite. Said programmes vocalise all the functions of a mobile phone allowing the user to use it in a simple, complete manner. They are designed for the visually disabled, but they can also be of assistance to the elderly and all those who need a mobile device with voice support.

These programmes provide a vocal response for all the operations that can be performed using said mobile telephones: sending and receiving text messages, emails as well as the traditional contacts, organiser and notes functions.

Not only can the visually impaired and blind benefit from these products in terms of usability of the services offered, but also the elderly and users with poor IT skills and all those who need a device with voice support for their work, free time, and also to improve their autonomy and mobility.

Among the products looked at, specific attention was given to ATMs (Automatic Teller Machine). Said instruments, even if very common worldwide, have only undergone technological development, which takes into account the needs of differently-abled users, in recent years.

Table 3 – ATMs looked at and their main features

Product Name	Manufacturer	Main features
Diebold Opteva	Diebold	Ergonomic solutions Embedded TTS Technology
Iris ATM	NCR	Customer identification through iris scan
Biometric ATM	NCR	Customer identification through fingerprint
ProCash 2150 HDM	WINCOR NIXDORF	Hardware solutions to ensure the physical accessibility of ATMs

Regulations and standards

An overview was performed of the existing standards and regulations at a national and international level in relation to accessibility as well as the most common recommendations for website usability. Such regulations and standards set the objective of making web content easier to use for all users, regardless of the specific browser in use or any limitations users may be subject to.

The WAI (Web Accessibility Initiative), concerned with making the web effectively accessible to everyone, was started up within the W3C framework.

The WAI has produced a series of technical recommendations aimed at providing developers with the tools to make web content accessible. Said recommendations are known collectively as the Web Content Accessibility Guidelines, or the WCAG for short, the current version of which is 1.0.

The guidelines are the technical references transferred, more or less fully, into Italian law. This is also the case since the European Parliament put forward the WAI-W3C recommendations as the accessibility rules to be applied to EU sites. Thus, the implementation of proprietary accessibility rules, not homogenous with regard to the international standard represented by the WAI-W3C WCAG has been avoided, avoiding the path taken by the United States, which, with the sixteen rules of Section 508, has rewritten accessibility for the exclusive use of the US public sector.

There are 14 W3C guidelines based on two general principles: ensuring elegant transformation, making content understandable and navigable. Moreover, the tools for checking correct application of guidelines are provided in the form of a series of checkpoints for each guideline. A priority level was assigned to each checkpoint. By appropriately combining the priority levels complied with by developers, the parties responsible for performing checks can associate a specific level of accessibility to the web pages developed, which corresponds to the assignment of a "W3C stamp of approval".

To ensure that web sites are functional, can be easily accessed and leave visitors with a positive experience, some rules —recommended by researchers to make the information available over the web "usable"—are illustrated.

Innovative aspects of SAPI

With regard to the state of the art in SAPI, the innovative aspects can be summarised as follows:

- Unlike the other projects looked at (AceMedia, MAIS, GRISINO), which were focused on intelligent content and adaptivity features, the concept of **intelligent service** will be studied and tested which, in addition to adaptivity features, will be able to customise interaction with users, managing both the business logic it was designed with and the status of data directly or indirectly linked to said business logic. Said intelligent service will also deal with storing all the types of behaviour resulting from the application logic, indicating whether or not they are acceptable. The stored history of types of behaviour is subsequently used to fine tune the behaviour of the service when used successively.
- In order to achieve multimodality, the various projects looked at (e.g. MAIS) had to incorporate into the created platform the design of an entity assigned to coordinate various applications, each of which able to respond on a different perceptive channel. Moreover the study of existing technologies (e.g. screen readers) brought to light the current shortage of instruments able to group textual content according to meaning prior before being able to synthesise and reproduce said content in audio format. In this way, the textual information contained in a webpage is read in the order in which written, demeaning the usability of information content. As regards SAPI, a software demo (**semantic screen reader**) will be designed and tested that allows users to navigate among web content in a semantic manner, pursuing the goal of allowing users to communicate with the computer not just via keyboard or mouse but also via audio, offering the possibility of interacting with the same application through different perceptive channels.
- Innovative techniques for optimising user interfaces and the service provided on the basis of user preferences/abilities and context of use will be studied.
- Techniques for the deployment and provision of the same service through **a number of operating logics and user interfaces** will be studied. The mode of use of the same service can be influenced by various factors such as user preferences and abilities, context of use, access device, etc. For example, an online telephone top-up which involves three actions: selection of a telephone operator, specification of the top-up cost and method of payment, can be performed by the user using a single display on a PC with a 15" monitor or, the same service adapted and customised for a visually impaired user using a palmtop may require the three actions to be presented in sequential order on the device display with adaptation of both the presentation and business logics.
- In agreement with the research activities performed at the Minnesota Laboratory for Low-Vision Research located inside Minnesota University, the possibility of implementing **eye-tracking techniques** will be investigated. Said techniques are used to interpret the physical attitudes of users and collect implicit information able to help the adaptation process and customisation of web services designed for visually impaired users. Eye-tracking is already used in the design of web environments within which user experience can be tracked with millimetric precision, recording in a totally reliable manner the areas (words, graphics, spaces, geometries, etc.), timeframe and succession of movements of what is "looked at" by users interacting with a webpage. At an

international level, there are research projects such as the Dasher project that are able to monitor the eye movements used to insert information-based text and piloted through natural pointing movements. Qualilife, a Swiss partner of Microsoft, produces innovative technologies for interaction with the computer through head or hand movements; innovative technologies such as the Voice system created by the Phillips research laboratory are able to scan digital images acquired from a video camera and convert them into sound. SAPI will try to use the available technology to collect information to be transformed into knowledge, which will go to enrich the knowledge contained in User, Domain and Context models. For example, an eye-tracking application which makes it possible to measure the length of time that a user stares at the same area of the screen, if interpreted within a context where the service and content shown are suitably enriched with semantic information (a precise meaning is associated to the area of the screen), could lead to the deduction that the user cannot manage to read well and therefore suitable corrective action could be performed (increase in character size or change in brightness).