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ETSI Secretariat

Postal address
F-06921 Sophia Antipolis Cedex - FRANCE

Office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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c= fr; a=atlas; p=etsi; s=secretariat

Internet
secretariat@etsi.fr
http://www.etsi.fr

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Foreword

This ETSI Guide (EG) has been produced by ETSI Technical Committee Human Factors (HF). TC HF has prepared the present document on Human Factors Issues in Multimedia Information Retrieval Services (MIRS).

The intended users of the present document include:

Table 1: Intended users and potential benefits

	User	EG used for	Potential Benefit
1	Manufacturers, Network Operators, and other developers and providers of MIRS.	Development and qualification of user control procedures for MIRS	Increased usability through harmonized and supportive procedures; facilitate the evaluation of existing products
2	Service and User Interface designers and user groups concerned with MIRS	Provide guidelines for the development process of multimedia user interfaces for retrieval services	Increased usability by user groups, by means of user requirements comprehension for MIRS; help potential buyers in selecting the appropriate products.
3	ETSI Technical Committees	Development of standards concerning MIRS	Improved usability of services by ensuring consideration of user needs

Introduction

Technological advances in terminal and network capabilities offer an increasing number of Multimedia Information Retrieval Services (MIRS). This is one of the fastest growing areas in the telecommunications market, and new users without previous experience are expected to be able to use such services, while the amount of accessible information grows exponentially. There are even implications for daily life of many persons, since, e.g., consulting weather forecasts, news bulletins, legal information, etc., may be more easy and economically made by using MIRS instead of by other more traditional means (e.g., printed materials, distributed services). All these facts make it necessary to provide appropriate navigation tools to allow users to cope with the complexity of manipulating and retrieving the desired information, and to get acceptance of the introduction of these services, as stated in ETR 296 [35] (Standardization areas to be covered by the Multimedia project).

The purpose of preparing this EG has been to gather relevant guidelines on these important issues from different sources into one document to facilitate their common application to this type of services. The present document draws on available material about multimedia services from ETSI TC-HF, as ETR 160 [5], on design guidelines from European projects in the RACE programs [7] and [17], and on ISO documents dealing with Human-Computer Interaction issues [8], [24], [25]. It is intended that these guidelines are generic in nature, for application to general aspects of MIRS. In this way service providers are free to use the different means available to them, so that the service is characteristic in terms of content and navigation, but keeping the minimum features for a service to be usable.

Contents of this EG are the following:

- Clause 4 tries to answer the question "What is a MIRS?", and to differentiate it from other related services. Special attention is paid to the main features of these services from the user point of view.
- Clause 5 describes user tasks in some detail and the different generic user interfaces currently available for accomplishing them. This clause also describes the most common ways of organising the information, and provides guidelines about the generic interface components for helping the user navigate through the information contained therein.
- Clause 6 presents general aspects of service usability and generic user interface aspects.
- Clause 7 deals with multimedia issues, including requirements for media control, presentation and navigation in multimedia systems. It also presents a review of guidelines of media selection and combination, depending on task and information characteristics, together with the current achievable quality for different coding formats.
- Finally, some of the guidelines provided in the document are illustrated by means of real screens from an existing service, which is presented in annex A.
- Annex B presents a review of applications from ETSI documents, and
- Annex C presents some concepts on Quality of Service.

1 Scope

The present document focuses on the principles that are important for navigation in Multimedia Information Retrieval Services (MIRS) from both a functional and implementation point of view. The scope is limited to those services which can be accessed through a telecommunications network, as opposed to those locally accessed (e.g., from the local computer disk unit). The different types of services that fall into this category will be those identified in ETR 181 [36] (the Multimedia Portfolio), whose attributes are:

- normal bandwidth less than 2 Mbit/s;
- on demand;
- any time;
- any duration.

All possible applications will be considered, identifying whenever possible the special navigation requirements for them, with the only exception of Video on Demand, which, for its particular features, is in the scope of other ETSI TC-HF work items. The requirements of different types of users of these services may be different (see ETR 175 [1], and clause 4). We will concentrate on the information consumer (the end user) requirements. This report proposes general Human Factors guidelines with the explicit aim of being applicable to a wide range of different services, and not specific to particular telecommunications networks. Specific topics include:

- The study of important issues in MIRS to ensure the achievement of an adequate level of usability;
- Provision of a thorough and consistent analysis affecting navigation in MIRS with special emphasis in the review of existing techniques and methods for navigation and information search and the identification of critical usability issues;
- Specification of navigation requirements for a limited number of services;
- Provision of interface design guidelines and examples for the implementation of navigation functions within and between services.

2 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETR 175 (1995): "Terminal Equipment (TE); Interworking and interoperabiltiy of retrieval services and audiovisual services on narrow band networks".

[2] ETR 084 (1993): "Terminal Equipment (TE); Multimedia & Hypermedia Information Retrieval Services (M&HIRS) Investigation of candidate architectures for M&HIRS".

[3] CCITT Recommendation B.13 (1988): "Terms and definitions".

[4] ETR 272 (1996): "Terminal Equipment (TE); Audio-visual retrieval services on narrow-band networks; Priority setting and description".

[5] ETR 160 (1995): "Human Factors (HF); Human Factors Aspects of Multimedia Telecommunications".

[6] ETR 228 (1995): "Terminal Equipment (TE); Broadband Multimedia Information Retrieval Service".

[7] RACE ISSUE Project (R1065): "Human Factors Guidelines for Multimedia".

[8] ISO TC159/SC4/WG5 working draft version 1.0 for 14915: "Multimedia User Interface Design - Ergonomic requirements for interactive human computer multimedia interfaces".

[9] ETR 173 (1995): "Terminal Equipment (TE); Functional model for multimedia applications".

[10] ISO 9241 (1992). Part 11: "Guidance on Usability Specification and Measures". International Standards Organization.

[11] ETSI EG 201 013 (1997): "Human Factors (HF): Definitions, abbreviations and symbols".

[12] RACE P173 (1994): "Usability Aspects of Retrieval Services". In *RACE Common Functional Specifications and Common Practice Recommendations. Doc. 14: Usability and Generic Applications*.

[13] ISO 13407: "Human centred design process for interactive systems". International Standards Organization.

[14] ETR 095 (1997): "Human Factors; Guide for Usability Evaluations of Telecommunications Systems and Services".

[15] ETS 300 382 (1995): "Terminal Equipment (TE); Videotex Enhanced Man Machine Interface service (VEMMI) ".

[16] Paap, K. R., and Roske-Hofstrand, R. J. (1988): "Design of Menus". In Helander, M., (ed.), "*Handbook of Human-Computer Interaction*". Amsterdam: Elsevier Science Publishers B.V.

[17] RACE LUSI Project R2092 (1996): Human Factors Guidelines for Designers of Telecommunication Services for Non-expert Users.

[18] Monk, A.F., P. Walsh and A.J. Dix (1988): "A Comparison of Hypertext, Scrolling and Folding as Mechanisms for Program Browsing". In *People and Computers IV: Proceedings of the Fourth Conference of the British Computer Society*. Univ. of Manchester, 5-9 Sept. 1988.

[19] Mohageg, M. F. (1992): "The influence of hypertext linking structures on the efficiency of information retrieval". *Human Factors*, 34, 351-367.

[20] Schneiderman, B. (1978): "*Databases: Improving Usability and Responsiveness*". Academic Press, New York.

[21] Thompson, R. H., and Croft, W. B. (1989): "Support for browsing in an intelligent text retrieval system". *International Journal of Man-Machine Studies*, 30, 639-668.

[22] Joseph, B., Steinberg, E., R., & Jones, A., R., (1989): "User perceptions and expectations of an information retrieval system". *Behaviour and Information Technology*, 8, 77-88.

[23] ETR 116 (1993): "ETSI Handbook: Human Factors Guidelines for ISDN Terminal Equipment Design".

[24] ISO 9241, : "Ergonomic requirements for office work with visual display terminals (VDTs)- Part 10: Dialogue principles".

[25] ISO 9241: "Ergonomic requirements for office work with visual display terminals (VDTs): Part 16: Direct manipulation dialogues".

[26] Ziegler, J. E. and K.P. Fähnrich (1988): "Direct Manipulation". In M. Helander (ed.): *Handbook of Human-Computer Interaction*. Amsterdam: North-Holland.

[27] Gilmore, W. E. et al. (1989): "*The User-Computer Interface in Process Control. A Human Factors Engineering Handbook*". Academic Press. New York.

[28] Cavero, L., Concejero, P. & Gili, J. (1995): "Help and Prompting in Broadband Multimedia Services". *15th. Symposium on Human Factors in Telecommunications (HFT '95)*. Melbourne, Australia.

[29] Barfield, W., C. Rosenberg and G. Levasseur (1991): "The Use of Icons, Earcons and Commands in the Design of an Online Hierarchical Menu". *IEEE Transactions on Professional Communication, vol. 34*, 2, pp. 101-107.

[30] ETS 300 375 (1994): "Pictograms for point-to-point videotelephony".

[31] J. Gili, J. Caballero, I. Rodríguez, C. Reillo (1989): "Human Factors and codec evolution: Still image codification (JPEG). Subjective quality evaluation". RACE FUNCODE (R1041) WPY3 Deliverable.

[32] Gili, J., L. Cavero, M. Roser and P. Concejero (1995): "Subjective Image Quality Assessment of Video Sequences Coded with MPEG1 at 1.15 Mbit/s and MPEG2 at 4 Mbit/s". *15th. Symposium on Human Factors in Telecommunications (HFT '95)*. Melbourne, Australia.

[33] ETR 197 (1995): "Network Aspects (NA); Base document on multimedia services".

[34] ETR 176 (1995): "Terminal Equipment (TE); Multimedia portfolio; A compilation of multimedia applications and services provided by ETSI members".

[35] ETR 296 (1996): "Terminal Equipment (TE); Multimedia; Standardization areas to be covered by the Multimedia project".

[36] ETR 181 (1995): "Terminal Equipment (TE); Multimedia portfolio; A compilation of multimedia applications and services provided by ETSI members".

[37] ETR 166 (1995): "Human Factors (HF);Evaluation of telephones for people with special needs; An evaluation method".

[38] ISO 9335: "Optics and optical instruments - Optical transfer functions".

[39] ISO 8859: "Information processing - 8-bit single-byte coded graphic character sets".

[40] ISO/IEC 10646-1: "Information technology - Universal Multiple-Octet Coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane".

[41] ETR 003 (1994): "Network Aspects (NA); General aspects of Quality of Service (QoS) and Network Performance (NP)".

[42] ITU-T Recommendation E.800 (1994): "Quality of service and dependability vocabulary".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

browsing: It involves, first, the examination of the contents of a particular MIRS, and then, creating a mental model of the information that is available in it. It refers to the examination tasks carried out by the user when he or she is looking for information whose specific location is not exactly known.

combined media: Different media which exist independently and are used in a synchronized way. An example is animation and video running in parallel [8].

compound media: Different media which are synchronized and interlaced very tied so they can be treated as one medium. An example is video which consists of moving images interlaced with audio [8].

cue: A cue gives an indication of opportunity for further information. E.g., a visual cue might provide a small animation on top of a link indicating the kind of information to be expected on following the link [8].

dynamic media: Are those in which the intended presentation to the user changes according to time or other parameters. Examples are video, music, animation, speech [8].

effectiveness: Is the accuracy and completeness with which specified users can achieve specified goals in particular environments.

efficiency: The resources expended in relation to the accuracy and completeness of goals achieved.

hypermedia and hypertext: A hypertext is an assemblage of nodes connected by electronic links so as to form a system which existence is contingent upon the computer. The user/reader moves from node to node either by following established links or by creating new ones. Therefore, hypertext can be defined as the technology of nonessential reading and writing. Whereas hypertext refers to text documents, the term hypermedia implies a mix of text, video, audio and/or graphics. Hyper text/media allows more than one sequence of presentation of information, like turning to pages in a book [5], [8].

interactive graphic user interface: The user interface is based on graphical elements (buttons, list boxes, etc.) that can be manipulated in an interactive way [6].

link: This term means that a data structure contains the direction to another structure. For the user of retrieval services, two objects are linked when, after some action on the object A makes the object B to be retrieved and presented.

Medium (plural Media): A means by which information is perceived, expressed, stored or transmitted.

metaphors: The use of concepts already familiar to the user and from which the user can predict the system's applications use and behaviour. Metaphors can be useful to help explain the concepts of a new domain in terms of the mental model the user has of an existing domain.

The following definitions apply specifically to the different user tasks in a MIRS [5]:

Multimedia: is the property of a system or service being able to handle simultaneous combinations of media having fundamentally different properties [5]. The term multimedia is an adjective and shall be used with a noun which provides the context. The definition is based upon a qualitative distinction, not a quantitative distinction: it does not mean presenting more material, but different media, both time dependent (sound, music, voice, video) and time independent (graphics, text), in a system or service [7].

Multimedia Information Retrieval Services (MIRS): A generic set of interactive services which provide users with the capability to access multimedia and hypermedia information stored in databases. The information will be sent to the user on demand only. The information can be retrieved on an individual basis, i.e., the time at which an information sequence is to start is under the control of the user [1], [2], [3] and [4].

Any particular **Information Retrieval Service** in a network environment is a point (information server; databases) to point (end user) service. Point-to-point refers in this context to user-to-host systems. Users, equipped with suitable terminals, provide commands to an application at the service centre or database computer. The service centre responds by sending information to the user either for further information, selection (menus), or for consumption (requested information) the communication is required in both directions, and the initiator is the user. There is not simultaneity in the communication [1] [12]. From a Human Factors perspective, a multimedia service integrates more than one perception medium accessed using the same terminal equipment [5]. The multimedia aspect will be also found in the interaction between the end-users and the system in the input and output devices.

MIRS provide the users with the capability to request information from a server through a network and retrieve the information (whatever the form it may take, e.g., texts, graphics, document images, moving pictures, photographs, video, voice, music and sounds), and take advantage of interactive facilities [6].

multimedia object: A composite object composed of various different types of related temporal and logical content intended for presentation to the user [9].

NOTE: Object-oriented interfaces are the user interfaces which use this technology as the man-machine interface principle. In this way, the user does not need to know the internal structure or description of the data being manipulated, and can handle it, whatever its nature (e.g., text, image, video), in a similar way as in real life.

navigation: In a metaphoric sense, all activities carried out by a user of retrieval services when dealing with complex structures when moving towards a goal. It is an essential part of any information retrieval task and an important part of the interactive design. The provided facilities for exploring (browsing, searching, visual cues and aids) and structuring of the application helps the users to develop a coherent mental model of the application structure [8].

navigation procedures: Controls and features offered by a system or service so that the user can achieve his or her goals in the easiest and quickest ways.

object: A finite, independent self-defining piece of information container for content and structure that can be manipulated as a whole by applications and interchanged as one unit [9].

perception medium: The nature of the information as perceived or expressed by the user (e.g. speech, noise, music, text, drawings, moving scenes). The different perception media can involve different sensory media, i.e., the channels used to process the information by the user. They can also involve different processing demands on the user.

pointing: A function in Graphical User Interface (GUI) or direct manipulation interfaces, to indicate the location of an object by means of a pointing device. The interface may require the user some action to select the object so that some other action can be carried out on it.

presentation medium: The type of physical means which is used to reproduce information to the user (output devices) or to acquire information from the user (input devices).

query: Transactions on a system or service to extract specific information. This term usually refers to structured searches implemented in a particular language (query language), which provides the semantics (terms which may be indexed) and syntax (operators) for accomplishing these tasks.

representation medium: The type of interchanged data, which defines the nature of the information itself as described by its coded form.

satisfaction: The comfort and acceptability of the work system to its users and other people affected by its use.

scrolling: To move up and down, line by line and in larger steps, the information on a display, or in a window in a GUI. The information disappears in one extreme, in the other new information is displayed. The manipulation of the information can be usually made in a continuous way, and is perceived as a soft movement on the window or the display. Although this task usually refers to text manipulation, it can be used for other media, as figures, audio or video.

searching: To look for a particular object or information in a retrieval service. This could be considered to be a goal-directed form of the browsing task.

static media: Static Media are those in which the intended presentation to the user does not change over time. Examples of static media are text and picture [8].

transmission medium: The type of physical means to transmit data (e.g., twisted pairs, coaxial cable, optical fibre, radio link) [8].

usability: Is defined [10] as the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals (tasks) in a particular environment. In telecommunications, usability should also include the concepts of learnability and flexibility; and in the context of MIRS, to the interaction of any particular user with the terminals, the telecommunications system and the particular applications [11].

3.2 Abbreviations

The following abbreviations shall apply to this document:

CCIR	International Radio Consultative Committee
CCITT	International Consultative Committee for Telegraph and Telephone
CD-I	Compact Disk Interactive
CD-ROM	Compact Disk - Read Only Memory

CRT	Cathode Ray Tube
ECMA	European Computers Manufacturers Association
EG	ETSI Guide
ETR	ETSI Technical Report
ETS	European Telecommunications Standard
ETSI	European Telecommunications Standards Institute
FTP	File Transfer Protocol
GUI	Graphical User Interface
IEC	International Electrotechnical Commission
ISDN	Integrated Services Digital Network
ISO	International Organisation for Standardisation
ITU-T	International Telecommunications Union-Telecommunications Standardization Sector
JPEG	Joint Photographic Experts Group
LCD	Liquid Crystal Display
MHI	Multimedia and Hypermedia Information
MMI	Man-Machine Interface
MIRS	Multimedia Information Retrieval Service
MPEG	Moving Photographic Experts Group
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone Network
RACE	Research on Advanced Communications in Europe
VEMMI	VErsatile MultiMedia Interface
VOD	Video on Demand
VCR	Video Cassette Recorder
VTX	VideoTeX
WIMP	Windows, Icons, Mouse and Pointing

4 MIRS essential features

Information Retrieval Services fall into the more general classification of Interactive Services. These are defined in [1] as those services which provide the means for bi-directional exchange of information between users, or between users and hosts. Interactive services are subdivided into three classes of services: conversational services, messaging services and retrieval services [1], [3].

Any particular Information Retrieval Service, in a network environment, is a point (information server; databases) to point (end user) service. Point-to-point refers in this context to user-to-host systems. Users, equipped with suitable terminals, provide commands to an application at the service centre or database computer. The service centre responds by sending information to the user either for further information, selection (menus), or for consumption (requested information).The communication is required in both directions, and the user is the initiator. There is not simultaneity in the communication [1], [12]. This configuration is depicted in figure 1.

Differences between MIRS and other types of services can be summarized as follows:

- **Conversational services** provide the required means for bi-directional dialogue in real time. This means that these services are symmetrical. Typical services are telephony and videotelephony services, but also playing multimedia games falls within this definition.

- **Messaging services** provide the means for bi-directional dialogue using store-forward mechanisms, but not the possibility of real-time dialogue.

- **Distribution services** are those in which the source of the information has the control, and sends the information without negotiation with the user. Distribution services provide a continuous flow of information, which the user can view from time to time, without user individual presentation control. From the user point of view, the main difference between retrieval services and distribution services is that the communication in distribution services is unidirectional (from the server), while in retrieval services, the user has the control on the sends from the server [12].

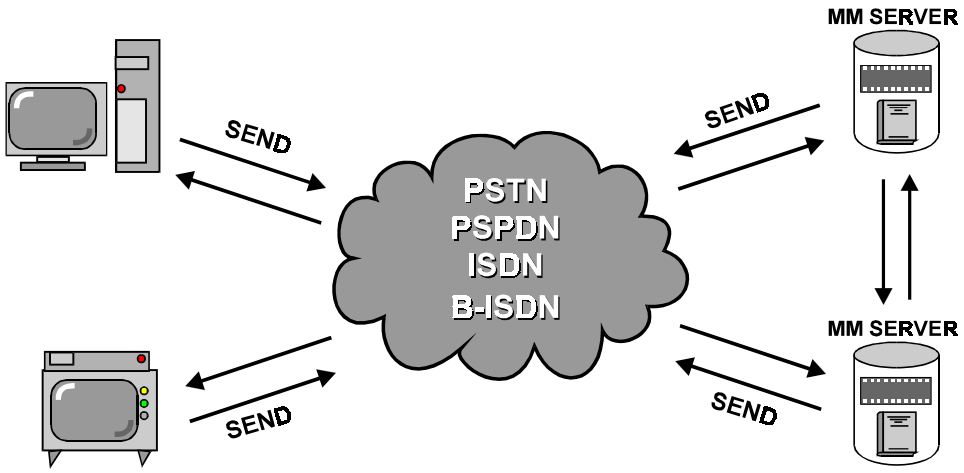

Figure 1: General configuration of a MIRS

Main features of MIRS are, therefore [1], [12]:

1. **Interactivity:** a particular retrieval process is interactive and individualized**.** It will be performed by the end user who, after the initial query, will browse through the returned material to select information of interest. Subject is active with respect to the information, to query, select and retrieve the information. Passive services, as television, or radio, are outside this definition. Interactivity provides many more possibilities to the user, but issues like usability and media quality, for instance, will be very important, since users are very used to those provided by traditional distribution services. Interactivity in the service produces more complexity in the service, and for this reason, issues such as usability and media quality become very important for the effective use of the services.

2. **Real-time interchange of information:** the information shall be represented in a way adequate for its downloading and presentation/execution in real-time. The distinction between real-time interchange and non real-time interchange is clarified by looking at the two interchange techniques from a presentation point of view. Real-time interchange refers to interchanged information that is presented to the user progressively, while it continues to be transmitted. In this way, the information may be used before the transfer is completed. In the non real-time interchange mode, the terminal system shall wait for complete units to be transferred (e.g. files, database records) before exploiting them. In this case real-time presentation cannot be guaranteed. Non real-time interchange through interactive digital networks is referred as file transfer (as defined in ETS 300 075 [30]; file transfer protocol (ftp)). Although these functions may be part of the whole MIRS, this document does not deal with them.

Although not essential, important features in modern MIRS are [12]:

3. **Transparency:**

   - User should not be concerned about the representation media for obtaining the desired information.
   - Issues such as information coding and storage from a data processing point of view are only of indirect concern for end users.
   - Special training should not be required for using the services.
   - MIRS services should be built on existing and known services, or appropriate metaphors of normal user tasks.
   - The goal is to achieve the same level of transparency for information retrieval tasks as for user known tasks, as making a phone call or switching on the TV and 'zapping'.
   - Everything needed to make and to setup/configure the connection should be as easy as possible and built upon existing knowledge.
   - Though the information involves multiple media, multiple databases, and even multiple service providers, the user will not be concerned by these differences.

4. **Flexibility**: this means the ability to perform a wide range of tasks for searching and retrieving the information, and for using it, i.e., different presentation ways.

Three generic **roles, or user categories**, may be identified in MIRS [1]:

- **the information producer** is the source of the multimedia and hypermedia information accessed and interchanged within the service;
- **the information manager** is the service operator, responsible for enabling access to the information base as well as administering information interchange between users;
- **the information consumer** is the end user of the service, who retrieves and consults the information for its own purposes.

The requirements of these users may be different (see [1]). We will concentrate on the information consumer (the end user) requirements. The basic role of the information consumer is to use the multimedia and hypermedia information provided by the information producer and administered by the information manager.

The specific requirements of the information consumer are:

- consulting the multimedia and hypermedia information directory, browsing through the available information;
- selecting information within the directory of available multimedia and hypermedia information;
- downloading multimedia and hypermedia information and their updates;
- remote consultation (real-time downloading) of multimedia and hypermedia.

5 Navigation in MIRS

A Human Factors approach to the navigation in MIRS should be based on the tasks that users want to carry out, and with the ultimate aim of ensuring that people can **effectively retrieve and use** the desired information. It is essential that navigation procedures and information structure are flexible, to adapt to the different users needs, expectations and background. A detailed understanding of who the users are and what they need from the system will enhance the likelihood of the product being successful.

The design and development process should be based on the user-centred design process recommended by ISO 13407 [13] and elsewhere. Any design process should begin with the user requirements definition, obtained from real users. First prototypes should be evaluated using usability assessment procedures [14], and modified as appropriate after these results. Therefore, the design and development process should be iterative, with actual users participating in it, to ensure the close adaptation to the user needs.

User tasks when accessing and using a MIRS are comparable to those made when consulting an encyclopaedia, the printed Yellow Pages book, or the telephone directory. First, the desired information, if known exactly, is searched for in an index or glossary. If the result matches the initial term, it is then located; if it doesn't, related terms are searched for, thus complicating the procedure. The results of this search may be located and consulted, and, again, the new information is compared with the initial desired information. Also, cross-references found in the information could also be searched for.

MIRS should be based on an appropriate metaphor of known user tasks, as those summarized above, However, the main difference between the traditional printed materials, which have a rigid linear structure, and MIRS, is that in these the information can be organized in multiple ways, thus adapting to different user requirements for search, and navigation aids can help the user to achieve his or her goals (accessing the desired information) much more effectively and quickly. In addition, MIRS can contain information in different media, thus enriching the available information and the navigation. The degree of interaction (and therefore the provision of navigation aids) will depend on the precision of recall (of the more or less exact matching of the elements found with those desired in the search). It is important to take into account that users search for meaning rather than exact sequences. This fact is important for designing navigation tools or aids.

Up until the 1980's, retrieval services had the same limitations as books for organizing the information: they were limited to a linear or hierarchical organization, with limited functionality (e.g., simple query language tools, no full-content search tools; occasionally items could only be accessed via the reference number appearing on an index). These old retrieval services were also mainly text-based and required learning command language procedures for using them.

Nowadays modern MIRS provide very flexible ways to retrieve and use the information, to accommodate to the different user requirements and expectations. These are the main features of modern MIRS:

- Provide multimedia information, incorporating, as a minimum, text in different formats and high-quality graphics, both for presenting information, and as navigation aids. It may offer sound, voice and video, thus enriching the information available to the user.
- User interaction is made by means of a Graphical User Interface (GUI), such that there is no need to learn commands, and, in some cases, provides direct manipulation support, so that required user actions are more similar to those made in real life.
- The increasingly growing quantity of available information is organized in different ways, and presented more flexibly, for accommodating different user requirements.
- Provide search and navigation aids not available previously, as full-content search, hypermedia links, etc.

The contents of this part of the document will be focused on user tasks and needs for retrieving the information, not on the technical questions for making it possible. It is organized around the following points:

- **User tasks in MIRS**: this point will specify the most important user tasks in a MIRS, thus defining the user requirements which will be the basis for the following specifications. **Searching**, as one of the most important user tasks, will be reviewed, with special attention to the ways presently available to perform it: keyword/index search or full-text search. Different user interfaces will be also studied, including query language, incremental search and filling forms.
- **Information organization and internal structure**: the different basic structures to be reviewed will not be considered as alternatives, but as part of the whole service, which should offer various possibilities to accommodate different user tasks. Appropriateness of each possibility for different types of information will be presented but emphasis will be made on how to design the MIRS user interface involving all possibilities.
- **Navigation aids and procedures**: this point will review the implications for the design of the MIRS user interface from the different information organization possibilities defined above. Minimum navigation requirements for each basic structure, and for the total integration in the service, will be specified.
- **Alternative views**: this point will refer to the possibility of providing alternative views on the same information, corresponding to different user models and tasks.

In combination with this clause, an extensive example of a complex application, using most of the features of this service, can be found in annex A.

5.1 User tasks in MIRS

Effective human-service interaction relies on the user being able to develop an accurate mental model of the way that the system or service functions [22]. Models are constructed by the continual assimilation and organization of relevant information. If the information presented is familiar and comprehensible the model is constructed more easily. A system which uses the power of analogy and metaphor makes use of the user's existing knowledge in a particular area and the user can bring to the computer system a body of knowledge which has been obtained in other environments.

From a general point of view, within an information retrieval service, user interaction essentially consists of the connection to the distant service, the search process, browsing the search results, and the final presentation of the retrieved information. Each of these points may require several stages, depending on the complexity of the search.

5.1.1 Connection to a distant service

Computer-based terminal may access a MIRS from an icon in one of the GUI windows - in a microcomputer system [15], or by simply switching-on a dedicated terminal, as for example, a TV set with set-top box. In any case, connection is expected to be simple and as similar to other user activities as possible.

In some cases this would open a specific dialogue box to enable a number of set-up choices to be accessed. For example a list box showing the services available from the terminal.

Irrespective of the type of terminal or GUI initiating the call set-up, it may be expected that the server/host - the service provider - responds with a welcome screen, preferably with attractive graphical material, or a multimedia demonstration. It is important that this screen changes from time to time, to avoid the user to get tired of seeing the same thing when accessing the service.

Once having accessed this welcome screen (also called home-page), different tasks carried out by users of MIRS in this initial phase can be:

- Go directly to a previously accessed service: For this task it is useful to store the most usually accessed services in an address book (also called bookmarks), but always providing user control for it.
- Accessing the desired service by consulting an alphabetic list. This is the most simple way of organizing the information and is very appropriate when searching for a very particular element in the MIRS. This task is known by most users, thus not requiring special help or training. It requires that the user knows the full name of the service, and the interface should provide some ways to quickly search into the long alphabetic list (e.g., putting the list of initials to go more quickly to the desired information).
- Accessing the desired service as an element of a meaningful hierarchical classification (e.g., a subject guide or menu). This task is carried out when the user does not know the full name, but knows the category to which the service being searched for belongs to.
- Searching for information which is not exactly known, or for information related to previously known information.
- Other more specialized tasks, such as downloading upgrades for the software, providing suggestions to the service provider, or accessing new elements or services recently incorporated.

The top level structure should be clear for any user, and this should be tested with a representative sample of the user population.

Also required functions in the connection setup to MIRS are:

- User access control and access rights. Authentication and security issues are reviewed in subclause 6.3.
- Charging information to the user. User must be aware of the basis for charging (e.g., quantity of information downloaded, or time of connection), and, in any case it is very useful to provide a clock for measuring time of connection.

5.1.2 Search

In this phase, also known as **query stage**, the user queries or searches for the desired information using the available tools (such as a Boolean query, incremental dialogue or form filling), which defines the target and limits the scope of the search.

According to [16] users have three possible intentions when searching: identity matching, class-inclusion matching or equivalence matching.

- **Identity matching** occurs when the user has a specific target. The user knows how it is described in the service database and the target is literally stated as one of the options. Identity matching is only likely to occur when the options have very conventional names (e.g., the names of the months, or the name of a known company). In all other cases it should not be assumed that users will generate the same names as the options stored in the service. For instance, the user may be searching for a particular restaurant whose name he or she knows exactly (e.g.,"Pizzeria Venecia"). In that case, a direct connection interface, as the one shown in figure A.2, or an alphabetic menu, as the one shown in figure A.3, may be more useful than other options.

- **Class-inclusion matching** occurs when users do not exactly know to which class the target of their search belongs to. The decision, which the users have to make, is in which of the classes the target is included. The user engages in a semantic comparison between target and classes in order to decide in which class the target may be found. For instance, the user does not know the exact name of the restaurant, or wants to browse around a list of similar restaurants (following the example, "pizzerias"). The user may have different strategies, e.g., he or she may use an alphabetic list (all entries beginning with "pizzeria"), an example of which can be found in figure A.3, or may use a subject menu (Services-Restaurants) as that shown in figure A.4. In general, the service should provide an interface for all the possible strategies of the user.

- **Equivalence matching** occurs when a user knows the characteristics of the target but does not know the exact description in the service database. This is most likely to occur at the bottom of the search-tree of a menu-driven database, as the subject menu shown in figure A.4. In this case the user is in need of a categorized menu instead of an alphabetical menu. Another very useful option is a well-designed full-text search. For instance, if the user is searching for a pizzeria owned by Mr. Smith, he or she could search in the database using that name, and then browsing in the output of the database. An interface for this kind of tasks can be found in figure A.5.

The following guidelines apply [7]:

- the user must be able to use the same tactics and search strategies to access all information, regardless of the database in which the information is stored;

- if a specialized language is required for interacting with the database, consistency is the first principle to be taken into account;

- where more than one database can be accessed by the user via one application, a consistent interface for all accessible databases must be provided. Ideally, a single interface should be used to access all the databases without the user being aware of this;

- indexing strategy that allows a large number of alternate names or aliases for an object makes it easier to locate a particular item rather than having to search the entire context;

- navigation through databases can be done in the form of an overview, or map. Information about the subjects covered by the database should be provided, and a list of information and frequency with which the information is updated.

5.1.2.1 Content related vs. Index related searching

Searching and retrieving multimedia can be effected in two ways [8]:

- index related searching, in which the search is carried out on an index table describing the available information (e.g., images or videos are indexed with keywords). Indexing may either be related to the whole resource or components within it, e.g., either only a whole picture may be retrieved or objects within a picture may be directly referenced;

- content related searching, in which the search terms are matched directly to the contents, e.g., keywords are matched to words within a text document, or a bitmap pattern to similar bitmaps within an image or video.

The designer's ability to implement searching and sorting functions may be constrained by the level of detail of indexing and the sophistication of content related searching.

5.1.2.2 Search interfaces

The type of request formats required for this interaction vary from simple, and based solely on a single level search required by the user (e.g., looking for a location in a ticket booking system), to more complex services aimed at frequent and expert users to search for more complex information. In this case, the service should provide more complex request dialogues (e.g., allow the user to formulate requests based on previous queries, on combinations of Boolean operators, and on flexible research strategies, e.g., searching for information in a library system). An approach is asking the user to select from a set of parameters, and this selection produces more parameters to select until the transaction is complete. The iteration process is intended to guide the user step by step, and help the search. An alternative approach to this is form-filling, where the user is presented with a form containing the search parameters, on which the user will input the information [17]. Several interfaces for databases exist:

- simple query command languages, which require from the user the knowledge of a syntax and the structure of the database (e.g., the name of fields). A query is a specification of terms which may be index terms or part of a description. A specific instance of a query is a Boolean query. In this case a user can access information by specifying a Boolean combination of terms. A Boolean query consists of two or more keywords which are combined by one or more of the Boolean operators "and", "or" and "but not". The matching items are extracted and returned to the user [19]. Using queries is an information-driven search because the information contained in the database in combination with the query determines the outcome of the search [20];

- form-filling: a menu-driven interface useful when the fields are limited, or only a subset of them are interesting for most users.

5.1.3 Navigation and browsing

The browsing stage occurs when the user accesses several information items. Typically a large quantity of information will be identified as a result of an initial search, depending on the complexity of the search. The user then filters out the uninteresting information by quickly browsing through summary representations, examines in greater detail those items which look interesting, and connects with those which meet his or her needs.

Browsing is the only solution for users in the following cases:

- when they want to find out where specific information is;

- when they are not sure about how the data are indexed;

- when they do not know in which category of a menu the searched information can be found;

- when they have no specific target.

The 1980’s, linear browsing of the presented information was the only method available when designing a service. This type of method allows the user to scan linearly through the text or to access parts of it by searching through an index, contents list, glossary or reference list.

Nowadays, hypermedia is the most frequently used way to browse material in MIRS. Hypermedia is the combination of multimedia objects which have explicit links between them, such that it is possible to access one object using a link from another object [5]. In practice, a typical hypermedia system is made up of screens or windows containing "hot spots" that can be any type of media (text, stills, graphics). Selecting one of these hot spots causes some associated material (again, in any medium) to be displayed.

This technology has the advantage that, in addition to implement traditional browsing strategies (linear, hierarchical), it is also possible to navigate through links in a non-linear fashion, allowing the user to browse through the information search in many different ways, and to go forwards and backwards in the structure from any point. The salient feature of these applications is that they present the user with a physical realization of the conceptual links which can only be symbolized in conventional text. Hypertext permits the use of hierarchies or any other form of the connected network to access related material within the system. Furthermore, if the links between screens can be of different types then it is possible to impose alternative structures on an object [18].

Hypermedia links as a navigation tool are very recent, and new users can get confused by the apparent lack of structure [18]. A training advice, explicit help procedures, or guidance information may be required for these users to achieve satisfactory performance with the system. However, its growing application for different purposes assists many users in having some knowledge of its use.

The following guidelines apply:

- A most important issue is **consistency** in the hypermedia links: the indications to the user that an object contains a link shall be the same for a service, and, if possible, across services of the same type. For instance, if a red and underlined text means that it provides a link, this same indications shall be applied for any other text containing links.

- It is important to change colour of the link when it has already been used.

5.1.4 Presentation of the information

The following guidelines apply:

- In case of full text search, the context in which the information is searched for should be clearly displayed to the user, so that he or she is aware of all the information contained therein.
- It is important to keep the last term searched for, in case that the user wants to repeat the search. To make this option more useful, not only the last, but also previous ones could be stored.
- Items found in the search should be accessible by simply clicking on them. User should not need any special action apart from the standard ones required in the general operation of the service.
- A trade-off between the quantity of information searched and found, and the capabilities of the terminal and the network transmission should be made. For example, for a long list of elements found, the terminal should not be blocked for the only reason of the time required for displaying or downloading them. It is generally better for the user to have a subset of the whole list presented quickly to find out if this is the desired information.
- If possible, items found should be presented in order of relevance or importance.

5.2 Organization of the information

Top level is usually a hierarchical structure, so that the different options are visible for the user, together with search tools in case that the desired information is very specific or not found at this level. This default structure is presented in figure 2, and detailed images from an existing service which follows this approach are presented in Annex A.

User actions are then either browsing down the structure, or searching using a query language or a query form. Below that top level, the organization may vary, depending on the complexity of the service or the information contained therein. As a result of the search, or the browsing, the information is usually a linear structure (text, together with figures or any other multimedia information). Navigation through the service may be made using hypermedia links, and user tasks being simply clicking on the name of the desired information or on an appropriate iconic representation.

This kind of organization, together with the query tools provided in the service (not depicted in figure 2), allows the user to accomplish the different search tasks identified in subclause 5.1.2. using different strategies. The figure represents the example briefly outlined in that subclause.

Basic data structures can be classified in several ways: linear, hierarchical structures and databases. This classification will serve as the basis for the specification of the minimum navigation procedures for each elementary structure, for which they should be kept. Assuming the standard model we have proposed (hierarchical structure with hypermedia links to access the different contents) linear structures become, for the user, a presentation issue. The different elementary structures involved should be adapted to the requirements of that particular type of information and the necessary navigation aids and procedures should be provided for each part.

Also, the differences between fixed structures (e.g., a basic hierarchical structure) and dynamic structures (those which change as a result of the search, e.g., a database) for the user will be reviewed. With a database there is no fixed structure and information can be presented in many different ways, e.g., in response to selections made by the user.

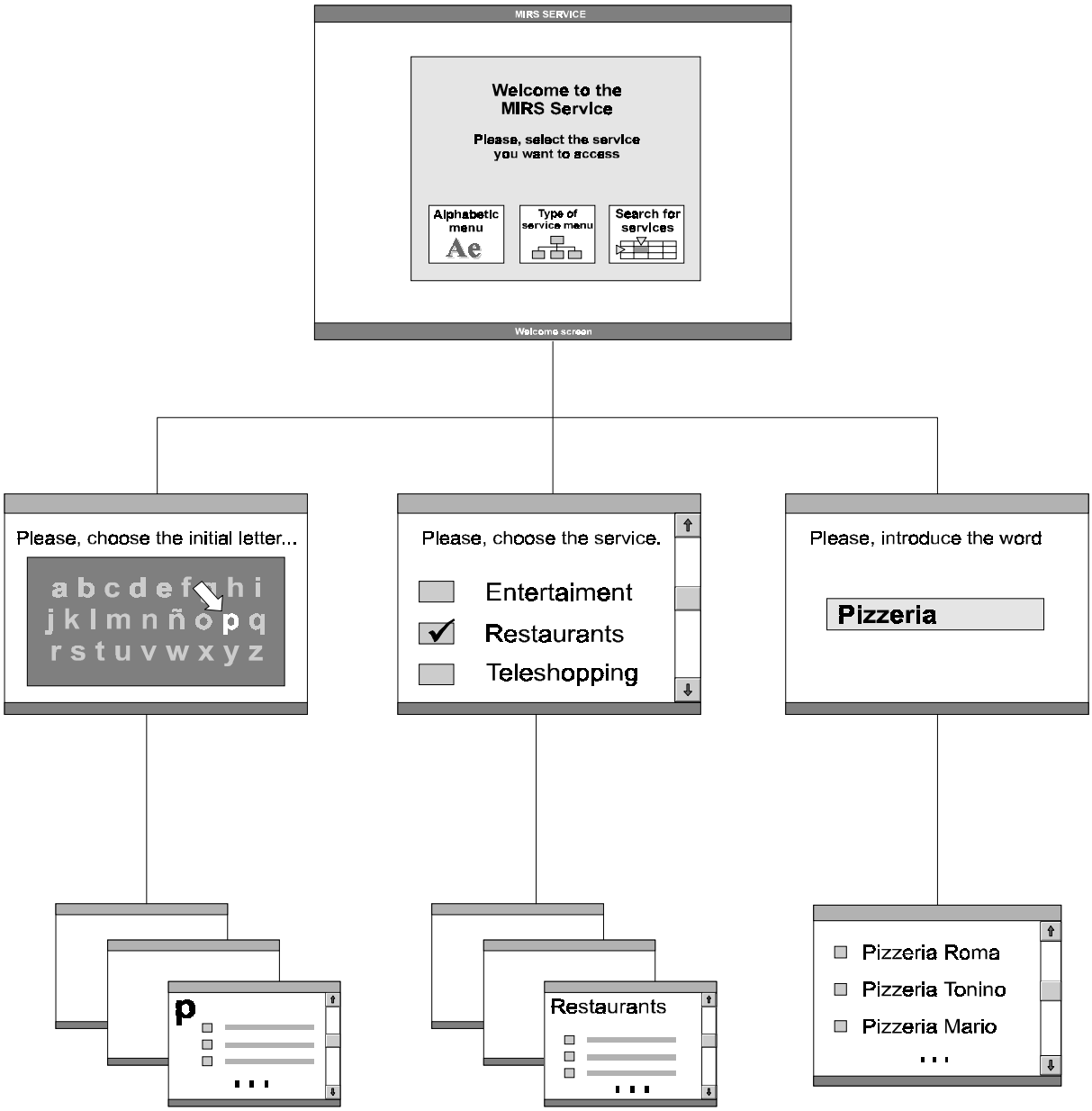

Figure 2: General structure of a MIRS

5.2.1 Linear Structures

Linear structures are often found as the final presentation of the retrieved information. For the user, this is a presentation issue rather than a logical organization of information. For example, see the lowest screens in figure 2.

The main feature is that these structures have a strict order or sequence of presentation. This can be due to the specific requirements of the information (e.g., card indexes or an authors' list have an alphabetical order), or on the assumption of a specific order (e.g., books are structured in chapters, technical reports can be organized chronologically). The organization of the information should be, in any case, made on common assumptions (e.g., alphabetical or chronological order), and an important principle is that they are meaningful for any user. In case of the information being organized in a way that could be new for the user, the system shall provide the necessary help to the user (e.g., the information in order of importance).

5.2.2 Tree Structures

The most characteristic feature is the fact that the information is organized hierarchically, from the most general aspect to the most particular. For example, see the highest two levels of screens in figure 2. At each level of the hierarchy a choice has to be made regarding which path to take. Very often, there are many possible ways to organize the information. A careful study of user needs is then required to allow them to achieve their goals in the most effective way.

The system should provide first a limited general classification with the most general aspects. The users will expect to find a meaningful option in the main layer, which will guide them to find the desired element down the tree. The structure should be organized on user previous knowledge, or after an extensive requirements research. In any case, the structure should be made explicit to the user at any moment, and feedback shall be provided about which particular node and layer the user is. When new users are expected, or the structure has suffered any change an explicit map should be provided.

Branches and new nodes hang down in this classification. The two most important issues are depth and breadth of the hierarchy. Depth is defined as the number of levels in the hierarchy, and breadth is the number of options per menu panel.

The most important recommendation is that the system has to provide clear feedback on which point of the tree the user is in a particular moment.

Since the structure of the menu determines which paths are possible, it is called a structure-driven search [19]. A menu- or structure-driven search can also be characterized as a computer-directed search since the computer determines the options available to the user [20].

5.2.3 Databases

A database can be divided into three technically distinct parts: the contents, the data manager and the user-system interface. The contents of the database is raw data. The data manager stores, finds, organizes and if necessary replaces the raw data. The user-system interface translates the input and output between the system and the user.

They represent the most complex form of information organization, since it is categorized in multiple ways, and the data manager provides multiple ways to access the information. They are best suited for tasks in which the quantity of information is large, or when it is necessary to classify the information in multiple and different ways.

Databases are organized in records and fields. Records are the individual items composed by related information. This is grouped in categories, which are the fields. It is then possible to search for any record or subset of records containing specific information, or for any combination of record and field. This is made by the data manager, and a most important issue is its user interface, which provides a useful metaphor for usually complex tasks.

Two problems users may have in expressing their information needs in databases have been identified in [21]. The Boolean notation many systems require may pose a problem for users. Often the interface is responsible for this problem. A second and very important problem is that many users can not precisely express what they are looking for. In [21] it is stated that browsing is an information retrieval method that has the advantage of enabling users to recognize wanted information when they are not able to express what they want. To facilitate this process, the interface should optimize the presentation of the information according to the needs of the users (see subclause 5.1.2.2 about search interfaces).

5.3 Navigation aids and procedures

The purpose of navigation aids is to show which piece of information can be reached with a certain navigation step and how this information will be presented, e.g., in the form of a video, music, a text or a graph. It is necessary to show the user which possibilities for navigation are available [8]. The following guidelines apply:

- provide multimedia cues concerning the target of the link;
- give an indication on links already visited;
- additional information should be provided for possible links, e.g., which information will be presented;

- in addition, an equivalent cursor feedback should be provided in order to show if additional information is available and in what form.

As defined above, default structure can be considered a hierarchical structure. Minimum navigation requirements are to go up and down the tree, going backwards and forwards in the same level, and go to the first / main layer. The top level of the hierarchy is usually known as "home page". A function to go directly to this level should always be implemented.

In general, the primary problems encountered by users of a hypermedia service are:

- users get "lost in hyperspace";
- users find it difficult to gain an overview of the material - they don't know what's there;
- users have difficulty in finding specific information. Users know what they want but cannot find it, or even when they've found it they cannot find it again.

In any system which provides hypermedia links, a history function should always be provided. In this way, the user will be able to save the address of the elements of the structure he or she is interested in, and access them just by selecting from the history, without having to recall the explicit path to reach it. Also, a user-configurable directory, or "bookmark", is very useful, since it allows to reach directly the most interesting components in different structures.

There are alternative ways to provide the control to the user, e.g., pop-up and pull-down menus. Since menus and these particular ways of controlling a hierarchical structure are characteristics of a GUI, recommendations and examples will be found in subclause 6.2.1.

As the final presentation of information, a linear structure is usually presented to the user (e.g., a list of the found elements). The user should be able to go backwards and forwards in the list, or advance and go back in larger steps (e.g., page by page). A "go to the beginning" or "go to the end" should also be possible. If a GUI is used, the scroll bar usually found in word processors offers all these possibilities (see subclause 7.2.1).

Very often, the user may need to find a particular element from a long list. This requirement means that some form of search procedure should be implemented, or, if the item can be accessed directly the standard action for accessing that element should be enough for retrieving it. An incremental search procedure may be used, so that the user obtains feedback of the possible elements at the same time as he or she introduces characters.

5.4 Alternative methods of navigation

Ideally, the service should closely adapt to the particular user model for exploring the information [7]. A successful design for a MIRS depends both on the inherent structure of the material and the tasks that users will wish to carry out. This points to the importance of providing alternative methods of navigation. The main distinction comes from the answer to the following three questions:

1. Target orientation: Does the user have a definite target in mind?

   This distinguishes browsing (no target) from querying (targeted), but both activities should be seen as the extremes on a continuum of user behaviours that are characterized by the level of specificity of the user informational goals.

The following guidelines apply [22]:

- if user is querying (that is, knows what he or she is looking for), then hypermedia (following links) is not an effective way of finding the information, and another model is needed. Structuring by means of a tree or menu, or a query language for a structured database will help the user to quickly reach the topics of interest;
- if the user does not know what he or she is looking for (that is, he or she is browsing), then hypermedia is a good option;
- following linear sequences can be efficient when limited information is available;
- designers should make a flexibility trade-off for the structure to "channel" the search and restrict the breadth of exploration. If the user has at least a rough idea of the topic of interest, guided retrieval may help narrow down the area of exploration;

- any practical method will likely be a mixture of the different structures, e.g., browsing and querying can be harmoniously combined, so that users can browse and then query, and viceversa. Both activities are best regarded as points of a continuum rather than strictly different entities.

2. Structural responsibility: is the user or the system responsible for carrying out the search?

   "Navigation is unstructured from the system perspective, but structured from the user perspective. In traditional information retrieval it is the system that is responsible for searching and that consequently must be concerned with structure".

3. Interaction method: does the user select/refer to what is wanted or does s/he describe it?

   "Generally descriptive interfaces have been associated with querying behaviour in traditional information retrieval style, whereas referential interfaces have been associated with browsing during navigation".

Experienced users may have some preferred search procedures that are used regularly, whereas for novice users metaphors from other contexts can help when interacting with a complex system.

The following table provides a summary of the most important guidelines about each approach as a function of the tasks the user wants to perform in the MIRS.

Table 2: Summary of guidelines for different user tasks

User task	Guidelines
The term being searched for is exactly known	Provide alphabetical menu, or direct search for that element
User does not know the exact term for locating the desired information	Provide full-text search
User wants to have a rough idea of the information contents in the system	Provide a clear tree of contents, with hypermedia links so that user can browse with freedom through them

6 Human Factors Issues supporting navigation in MIRS

Designing a service does not only consist of providing the physical means to make the communication possible, but also supplying the means for the service to be usable by as many people as possible. The concept of usability is fully described, and different procedures for its assessment explained in detail, in ETR 095 [14] "Guide for usability evaluations of telecommunications systems and services". General user requirements applying to all telecommunications services are discussed in some detail in ETR 116 "Human factors guidelines for ISDN Terminal equipment design", while ETR 166 [37] "Evaluation of telephones for people with special needs; An evaluation method", proposes checklists for groups of disabled people which could serve as the basis for the development of a similar tool for MIRS.

In the following subclauses is a list of principles which should be followed in every MIRS design (see subclause 6.1), together with interface components guidelines.

6.1 Generic interface design issues

Interface design principles are generic rules and concepts that are required for an effective use of any interface. The interface must consider the system's requirements, as well as an effective user model. The following guidelines apply:

- user control procedures should comply with the simple rule "indicate-control-indicate". This rule summarizes the human factors principle that users require information on the state of a service or system and its control (e.g., instructions, prompts, etc.) to be available before they execute a control action; and for further information (e.g., feedback, additional prompts, error cues, etc.) to be given after a control action about the changed state of the service or system;

- users require to be able to correct errors, especially self-detected errors, without detriment to the service being used or causing any loss of previously entered data. Users should never feel it necessary to leave the system and start again;

- users require as little load on their memory as possible. They should not be expected to learn lengthy, unstructured command strings. However, services should be designed to be flexible enough to allow users to utilise previous knowledge;
- an important feature of telecommunications services is their availability for all users, including those who are elderly or disabled. This may entail attention to the attributes of a number of impairments - for the hearing impaired by provision of loudness control; for the memory impaired with respect to the memory load, e.g. control sequences, menu design, response times and, where a visual display is provided, for the needs of the visually impaired. Physically disabled users may need special input devices and procedures. Response times must be consistent with the needs of the whole range of users;
- information presented to the user, whether in menu form or as announcements, should be comprehensible to the target user group, jargon free, concise and consistent with user expectations and stereotypes;
- ease of learning: to encourage rapid learning the system should not violate user expectations, but build on his past experience with similar services, in terms of the procedures used to access the service, the terminology and announcements used and the dialogue structure;
- consistency and reliability: The interface structures should be designed to be externally consistent with similar services at least from the same provider, and internally, within itself, including the use of terms for functions, text style, and key assignments. The system should be reliable, so that each time it is used system reactions do not change, and robust, so that no amount of abusive input will change the system;
- feedback redundancy: In general, it is better for the user to have too much feedback rather than too little. In most cases it is better to give feedback on one action as well as a prompt for the next. These may be integrated into one announcement. Giving the feedback to the previous action may be sufficient to confirm to a user they need to return to the previous service state. Giving only the prompts to the next actions may simply lead the user on into parts of the dialogue that do not address their current task. Where the opportunity arises, redundant feedback should be provided by employing more than one medium e.g. audio and visual. If additional feedback is provided, ensure consistency is maintained between media, in terminology, commands and procedures;
- usability testing: It is important that any MIRS should be tested for usability, in near final or prototype form, using a sample of users representative of the target group, and preferably using different terminals. The testing should cover the terminology, the commands, the announcements, the time-outs, the response times and the user guidance materials.

The usability of a service will have a great influence on its usage and efficiency in terms of the utilization of network and service time. Measures of usability are commonly of two kinds:

- performance measures, which are "objective" measures or observations of user behaviour and are focused on task performance, i.e. how well the user can achieve a specific task;
- attitude measures, which are "subjective" measures or observations of the users opinion of working with the system, i.e. how well they like to use the system.

6.2 User interfaces

Multimedia and hypermedia systems interact with their users by audio and visual means. This is called the user interface. Today, commercial user interfaces are based in complementary approaches: Graphical User Interface, or GUI, and direct manipulation. The most important Human Factors Principles of these interfaces are outlined below.

6.2.1 Graphical interfaces

Graphical User Interfaces (GUIs) are nowadays the most usual way to control a system or application. They are based on metaphors or analogies with normal user tasks, and a main feature is the continuous presentation of the alternative actions which are possible in a given moment. The particular implementation can be very variable, ranging from simple windowing interfaces, to real direct manipulation ones. In the following parts, a review of the most characteristic features will be offered.

A metaphor, as the usual desktop concept, can be thought of as a real world situation or object that can be used as a basis for software design (upon which the user interface to a software system is based), e.g., an electronic desktop. Interaction is facilitated because even naïve users will know what to expect from the system, and will have previous knowledge of what to do in specific situations. Having encountered those situations before in the non-electronic world, they can generalize to their electronic counterparts. Metaphors are also particularly useful for training naïve users in the use of complex system. In addition, analogy and metaphor are powerful ways of presenting information simply and intelligibly. For instance, controlling digital video in a multimedia terminal will be easier for an inexperienced user if tasks are performed in the same way as in his or her domestic Video Cassette Recorder (VCR), this is, with buttons resembling those of the VCR in the GUI display.

However, many telecommunication services offer functions which are totally new, so that there is no realistic context to reflect such new functions and their relationships. Common metaphors are the sheet of paper, the book, the dictionary, the map, the form, the library. For MIRS, suitable examples are electronic newspapers, electronic yellow pages, electronic telephone directories, teleshopping applications.

The following guidelines apply [25], [28]:

- When choosing a metaphor, the following aspects should be considered:
  - Relevance: the metaphor should appear relevant to the application, e.g., for an electronic encyclopaedia, a suitable metaphor may be a set of linked information objects;
  - Complexity: a metaphor should not try to represent the real world equivalent too realistically, e.g., the real complexity of an office environment… the metaphor should simply convey the concept it represents;
  - Audience suitability: make sure that the metaphor represents the situation that the user population will understand.
- within an overall graphical interface, there should be a clear distinction between fields that just represent the current status of the service (output fields) and input fields;
- the basic metaphor should never disappear from the screen, whatever actions the user takes. Switching-off the main interface should be an option which requires the user's acknowledgement to decrease the chances of doing it by mistake;
- the use of colour within a metaphor is extremely important, as users often associate certain objects with certain colours. For example, yellow pages;
- the colour grey should be avoided as it is the colour widely associated with clickable buttons. However, clickable surfaces within a metaphor may be represented in grey to differentiate them from other non-clickable surfaces;
- the design should provide visual cues to support the metaphor, but sparingly so as to avoid distracting the user.

6.2.2 WIMP (Windows, Icons, Mouse and Pointing)

Multitasking system environments are nowadays implemented via windows metaphors. This way, multiple processes can be kept simultaneously on screen. Minimum requirements for this are high-resolution bitmapped displays and a pointing device.

A window may be defined as an area on a computer display, usually rectangular and delimited by a border, that contains a particular view of some data in the computer [7].

A full description of the interface components for a particular application VErsatile MultiMedia Interface (VEMMI) can be found in [15].

The following guidelines apply [7]:

- do not display more than 9 windows simultaneously;
- for text, preferred aspect ratio is 1:1. For Bar charts, it is 4:3. For pie charts, 1:1. For landscape stills, it is 16:9. For video (head and shoulders), it is 1:1;

- data should be grouped in the display, with consistent placement of items, so that user more easily detects similarities, differences, trends and relationships. Grouping can be made by colour coding, graphic borders around different groups of information, or by highlighting using reverse video or brightness;
- if there is an importance or frequency order, use it to locate different windows on the display. Begin by the top rightmost position for the most important/frequently used information, following a clockwise logic for the next ones, until the least important which should be located in the bottom leftmost screen location;
- when there is not appropriate logic for grouping data, alphabetical or chronological grouping should be adopted.

6.2.3 Direct manipulation

Object oriented interfaces are a main feature of systems characterized by a high degree of interactivity. Interface is based upon metaphors, which are defined as "a fixed conceptual and visual model of the task domain, based on concepts, operations and images which are taken from known situations and environments" [26]. ISO defines Direct Manipulation as a dialogue technique by which the user directly acts on objects on the screen, e.g., by pointing at them, moving them and/or changing their physical characteristics via the use of an input device [25].

There are a number of features of these systems which are characteristic. Spatial relationships among objects reflect real life; objects can be over, under, or partially obscured by others. They move from one position to another smoothly without jerky movements, feeling of continuity, of real existence.

Main interface features are:

- continuous presentation of the object of interest;
- physical actions (moving the mouse and the pointer on the screen) or clicking with mouse button instead of complex syntax and commands;
- rapid incremental reversible operations whose impacts on the object of interest are immediately visible.

The use of graphical components constitutes an important aspect of this approach because it allows abstract entities and technical artifacts to be displayed as "real objects" and can therefore be more easily manipulated by the user. Actually, the user does not need to know "what is going on" inside the application or system, but only that he or she is carrying out certain operations with that element, which resemble, as much as possible, actions performed with similar objects in real life.

Following this approach, for example, selection tasks in an alphabetical menu can be implemented in a similar way as in an agenda: clicking on the desired initial, a list of the matching items is shown for the subject to choose one of them; or, for a selection task based on the geographical location of the elements, a map can be presented, and the user can select one point directly on it. More abstract functions can be implemented by means of standard icons.

Essential Human Factors Principles for these interfaces are:

- always provide feedback, as soon as possible, so that the user can always notice the effect of his or her actions. Interactivity principle means that the system immediately interprets every input action, and any change in internal system state is indicated with appropriate feedback to the user;
- consistency of actions: the meaning of a particular element is constant along all the interface. It also means consistency regardless of the particular object of interest;
- clarity: objects should represent the function or state without ambiguity;
- univalency: they must represent only one object or action;
- objects must have perceptual similarity with what they represent: e.g., the map in the geographical selection procedure, or button-shaped screen components for functions.

Direct manipulation interfaces provide the following advantages:

- the system is easy to learn and easy to retain as it uses knowledge from the real world. Hence it is suitable for novice users;
- it reduces task complexity by visualization and manipulation of concrete objects;
- it encourages exploration.

Direct manipulation is time consuming for repetitive tasks, e.g., deleting files; it depends heavily on the pointing device for accuracy, and visual representations, although they may look obvious, may not always be obvious to use.

The following guidelines apply:

- provide as much immediate feedback as possible. Interactivity requires that the system immediately interprets any user action, and any change in the system is reflected at the interface;
- design the interface consistently within the same service, and if possible, beyond, to help provide a feeling of permanence, continuity and reality;
- define the set of interface objects to have a consistent behaviour and appearance. Each object should represent only one function or action;
- objects must have perceptual similarities: design the objects so that users can distinguish between what is selectable and what is not, e.g., all selectable objects could share the same colour, or appear greyed when the cursor is clicked on them;
- in certain situations, when extra support is needed, each selectable item could be highlighted as soon as the cursor moves over it.

6.3 Authentication, security and access control to remote MIRS

There are three security issues:

- Security of access (confidentiality). This issue relates to who has access to particular pieces of information. This is typically controlled through the use of passwords. The following guidelines should apply for password introduction:
  - allow passwords to contain both alphabetic and numeric characters;
  - allow passwords to be as long as is practical;
  - never display the password on the screen, not even while the user is typing it. A common method of providing feedback to the user is to display a bullet character for each character that the user types. (This recommendation is seldom followed by many mainframe or multi-user systems, which do not provide a feedback to the user of the number of characters introduced. Other systems provide a space for each character, thus making difficult to know exactly how many characters have been introduced);

Figure 3: Example password introduction for a MIRS

- when the user edits a password, the Delete key erases one character in a system that displays a character for each character typed;
- provide a way for the user to verify the password when it is entered or changed. Requiring the user to enter the password twice minimizes the possibility of a typing error. If a person makes a mistake in entering the password but does not have to verify it, he or she will then be denied access to the data.

Other guidelines regarding security which are available in [27] are:

- the user should be warned of potential threats to security by appropriate messages and/or alarm signals;
- computer security procedures should be understood by authorized users;
- user interface design should provide consistent procedures for error correction and deletion in data input;
- inputs to the computer, including data entries and control entries should require explicit user actions (not shortcuts);
- security during transmission. It is of particular relevance for users when transmitting confidential information that it cannot be accessed during transmission by people who do not have access to it. This may be overcome by coding or encrypting information prior to transmission and then decoding it on reception;
- security of reception (integrity). This requires that information may not accidentally become corrupted during transmission. This is primarily a question for technical experts to devise a robust enough transmission network.

Several scenarios can be imagined where security and confidentiality is important: e.g., in a medical database keeping confidentiality on patients' records, or for industrial organizations, maintaining security over transmission on the network.

These issues will require careful structuring of the system, in the first instance based on the potential requirements of the different categories of users and, in parallel, careful negotiation and discussion over the implementation of the system. Furthermore, the need for access codes to be kept secret must be instilled in all users.

Lastly, integrity in transmission is clearly of vital importance for MIRS, especially when transmitting encrypted data. A network which regularly corrupts the information that it is supposed to be transmitting will be both unusable and unacceptable.

6.4 System response time

Usability of any particular retrieval service will be compromised if long response times are the rule rather than the exception. Keeping the frequency and length of long response times to absolute minimum and offering some degree of storage to support anticipation, are requisites for a successful service, and one of the main features of a modern MIRS. The following guidelines apply for long retrieval times:

- when a lengthy response time is unavoidable, keep the user informed concerning the actual state of the system and about the expected waiting time e.g., with a progress indicator.(with a box or window on the display showing meaningful information, e.g., a "thermometer" or percentage of completed task). The feedback message should be consistent no matter the particular representation media being retrieved or the user task being accomplished (e.g., it should be the same for audio or for video data, or for the percentage of a database being searched), and only meaningful indications to the user should be given; e.g., time to finish the process, and percentage carried out until the moment;

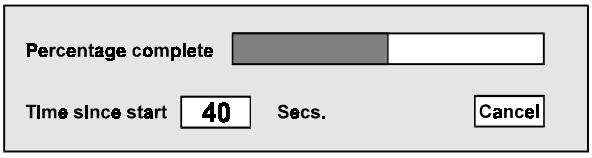

Figure 4: Proposed feedback of a retrieval process

- where available, provide ways to spend the waiting time on other tasks (multitasking). Do not lock input device;
- terminal control should remain under the user.

Acceptable delays depends on the different media retrieved and tasks performed by the user. Several guidelines can be found about the acceptable retrieval times as a function of user tasks. One of them is taken from [15]:

Table 3: acceptable retrieval times as a function of user tasks

User task	Time (maximum)	Examples in MIRS
Reaction to key actuation.	0,1 s	Displaying the movement of input device, or an entered character in a text input area or field.
Display of short and simple guidance information that can be taken at a glance.	0,5 s	User prompts, error messages, validation of a simple component, displaying document headings.
Display of large amount of complex information that needs to be read.	1,0 s	Displaying the next page in VideoTeX (VTX). Displaying a text data block section selected by means of scroll bars.
Simple inquiries.	2,0 s	Activating service or program with a function key, from menu or icon.
Complex inquiries.	5,0 s	Querying a database, responding to specific search request.

Some form of prediction should be available when waiting time is likely to be more than 10 s. In these cases, special feedback must be provided to the user [15], and a special function to stop the retrieval process provided.

Provide at least immediate feedback and progress control to any activity of the user so the user is always aware that the system has taken up its input. This avoids multiple input of the same command (e.g., pressing the play button of a video several times). Also some form of prediction should be available when waiting time is likely to be more than the above mentioned time spans. In these cases, special feedback should be provided to the user.

6.5 User guidance and support

Irrespective of user experience, specific and task-oriented support about how to use the service has to be provided, so that user knows how to use the most important service's functionalities.

6.5.1 Help and prompting

Help and prompts are essential for inexperienced users or in the initial moments of interaction for a new user. Help should be context-sensitive, and be always available for the user to access it.

There is a trade-off between effectiveness of the type of help and its requirements. On-line help is only appropriate when human contact is required, either for confidentiality or for other very specific reasons (for instance, when opening an account with your bank). Multimedia help and demonstrations are excellent for general users, but its development may

be costly. Textual help is good and inexpensive for general purposes. Only-audio help is hardly adequate for modern graphical interfaces.

Prompts indicate to the user the action expected by the system. They are very important for naïve users in complex, graphical systems. In a series of experiments in [28], it was found that people preferred prompts by both visual and auditory ways.

6.5.2 Control and indication issues

Control refers to any system component (i.e. switch, key, mouse, voice input control) used to produce a change in the system state.

Indication refers to any system component (LED, LCD text, pictogram, audible signal) used to indicate a control state or system state.

6.5.2.1 Labels and icons

Pictographic symbols in interface design are widely used in modern graphical interfaces, since they have great advantages over command languages. However, they present disadvantages, which are also reviewed in this part.

Advantages of iconic representations for objects or actions in a user interfaces are [29]:

- people have extraordinary memory for remembering pictures, and research suggests that this ability is very stable over long periods of time. In many circumstances, the recall of images is superior to that of text;
- icons or pictograms require relatively little space on a display or device compared to text;
- they are language independent, such that they are valid for people from different countries.

Disadvantages are also found:

- many objects or actions simply do not have familiar pictorial representations;
- dense visual displays can lead to screen clutter and increased mental workload;
- although they are independent from language, they are not independent from culture. Cross-cultural (international) evaluation studies should be performed before accepting any pictorial representation.

The best way (if there is space enough) is providing both the icon and a text label. Use of sound as an alternative channel can be explored. The advantage of pairing sound with icon is to provide additional or redundant information about the process or operation being represented via the audio channel.

These "non-verbal audio messages used in the user-computer interface to provide information about some computer object, operation or interaction" are also known as earcons [29].

6.5.2.2 Feedback

Feedback is the response from the system indicating that an action has been selected and is taking place, or has failed. It helps user to avoid errors and reduces learning time [23]. Feedback must be positive, immediate, and be redundant, if possible. This means that it is more likely that the user detects the feedback (or the state of an element) if it is provided by dual-channels (i.e. image and auditory signals).

Feedback is the response from a system to a user acknowledging that an action is currently taking place, has taken place, or has failed [17]. Feedback is a very important issue for usability, and a general recommendation is that it is provided as immediate as possible after user action. Good feedback procedures have many advantages [17]: they help users to recall appropriate procedures, particularly when recovering for errors, to learn the interface, and raise confidence in using the equipment and reduce learning time.

There are two possibilities for feedback messages:

- when the system has received the input and can execute it, the system must provide some form of feedback to the user that the action is taking place or has taken place;
- when the system has received the input but can not execute it, the system must clearly inform the user of this fact, and propose alternatives. For instance, in case that there is a network overload, the system should inform the user and propose alternative actions (e.g., try to connect later).

It is mandatory that for destructive actions, the system informs of the consequences of them and requests confirmation from the user. For instance, for deleting a file, the feedback message could be: You will not be able to use this file again. Do you want to continue with the action? (yes/no).

Feedback messages should always refer to user actions and concepts, not to system's ones, e.g., messages of the kind "Error number 5968" don't have any meaning for normal users.

In GUI or Direct Manipulation Interfaces there are several ways to provide feedback apart from text messages. Specially important for retrieval tasks is the feedback of the time to complete an operation. A different cursor (e.g., watch) can be used for tasks which will take little time, and a status bar (as illustrated in figure 4) for those actions requiring more time. Using the different cursor for time-consuming tasks is not informative for the user, and, besides, may not be noticed by him or her. Feedback in these cases should be provided with the expected time to finish the action. Also, provide the possibility of cancelling the operation in case that it takes too long.

Cost information should be given, and the user should be informed of the basis for charging, e.g., quantity of information being retrieved or connection time. If possible, the cost information should be provided with the actual quantity of money being spent in the process.

Duplication of media presenting feedback messages increases the probability of the user detecting and reacting to them, e.g., visual and auditory feedback.

6.6 Terminal equipment

Terminals for a MIRS can either be general purpose computers (personal computers or workstations) with multimedia capabilities or special purpose (dedicated) devices (Minitel, X-terminals, Compact Disc Interactive (CD-I), ISDN-phones), and TV set with set-top box [1]. A general description of the required terminal functionality for the targeted services is given by the following definition [4]:

"The terminal will give the user the possibility to navigate through information interacting by keyboard and/or pointing device able to retrieve simultaneously: audio, video and textual information".

Multimedia presentation can be distinguished in terminal equipment hardware that handles the output to the user, from that which handles the input from the user. A general recommendation is that, wherever possible, different media should be controlled using multipurpose input and output devices following consistent interaction models and procedures. For example both video and audio output levels could be controlled by moving similar sliders on the screen with a pointing device.

6.6.1 Input devices

Input hardware refers to all the elements of a terminal which allow the user to carry out the procedures associated with particular operations or functions. Criteria for design of these devices are adequacy for the task (i.e., mouse or pointing devices for graphical displays, or keyboards for discrete data items) and human error rates in using that technology within the range of tasks expected.

Nowadays, there is a considerable amount of input devices, and only the most widely used will be briefly reviewed below. For a more complete list, see the ETSI Handbook: Human Factors Guidelines for ISDN Terminal Equipment Design [23], page 135.

The following guidelines apply [23]:

- alphanumeric devices are useful to input discrete data, containing letters, numbers, and other special characters;

- analogue controls are used for selecting the level of a continuous variable, i.e., audio volume. They can be linear (slider) or circular (rotary). These controls must be properly labelled, and consistent with user stereotypes (top maximum, and bottom minimum for slider; clockwise for rotary);
- for signalling the relative position of an element in a display, several devices are available. Cursor keys are the simplest pointing devices. The preferred layout for these keys are the cruciform or the inverted T layouts. Joysticks are devices consisting of a small stick which can be moved in any direction. They are suited to continuous tracking and pointing tracks that do not require great precision. The mouse has become the most widely used point-and-select device. The greatest advantage is that it allows a great precision in the task. Disadvantages are that it requires some space and a smooth surface. Roll or tracker balls require minimum space and effort. However, they may be less precise than mouse;
- a keyboard and mouse combination makes it easier to enter text and graphics, and is the standard configuration for the majority of computer systems;
- other devices which are not so widely used are light pens or data gloves. Touch screens can be used for specific designs, like selection of alternatives directly on the screen in a public service;
- where more than one input device is required, the input devices should be selected and positioned as an integrated system, taking care to minimize physical or functional conflicts between the devices, see ISO 9335 [38].

6.6.2 Output devices

The presentation of Multimedia objects requires simultaneous and/or sequential presentation of several data formats (representation types): text, graphics, images, audio and video sequences using the same terminal equipment. Separate output devices are usually required for each sensory medium. However, the control of different sensory medium can be carried out using a single multipurpose output device, for example a visual display.

6.6.2.1 Display Features

Display resolution is measured in two different ways for two different types of displays. For discrete element displays the resolution is simply the number of pixels both vertically and horizontally. For analogue displays, the resolution is usually determined by the number of lines displayed on the screen [7]. For the former type of displays (those found in personal computers), a large range of screen capacities is currently available, with 640 pixels on each of 480 lines, just over 300 K pixels in all, being available on most personal computer displays. Higher resolutions are also commonly available [1]. An important recommendation is, therefore, that design of the interface should be made in such a way that it is perfectly usable in a 640 x 480 pixels display. Design flexibility will provide good aspect when the visual material is displayed with higher display resolutions.

Displays can also be of different types: Cathode Ray Tubes (CRTs), Liquid Crystal Displays (LCDs), etc. For the former, and in order to minimize flicker effects, a 70 Hz refresh rate must be used for progressive CRTs. In interlaced CRTs operating at 90 Hz, flicker effects are avoided for over 90 % of the population. Guidelines about the latter can be found in ECMA 136.

Screen orientation is an important factor, related to other environmental ones, such as illumination levels, reflections and body posture. Tiltable screens help to minimize screen reflections and allow that the user adapt the configuration to his/her preferences. A range of adjustability for a tiltable screen from approximately 15 to 20 degrees backwards and 5 degrees forwards is usually adequate for these purposes [7].

6.6.2.2 Loudspeakers (sound output)

Loudspeakers are the terminal equipment components that provide the sound output. A volume control device is mandatory for these components. This can be implemented in the terminal hardware, by means of a linear slider, a rotary knob or a thumb wheel. For a comparison between them as a function of different features, see [23].

In some cases, the control can be made from the user interface, providing a metaphor of the hardware controls in a GUI or direct manipulation interface. For this purpose, it is recommended to use a graphical representation of the linear slider, since with the modern pointing devices (e.g., mouse), it is not easy to control a rotary knob or thumb wheel representation. Besides, the linear slider representation provides a visual feedback of the relative audio volume. There is no standard icon for this control, but a combination of the icon for audio in videotelephony [30] and a linear slider icon can be used.

7 Media selection, quality and manipulation

What makes a service really multimedia is the joint presentation of continuous, time-dependent perception media like sound, video, animation and discrete, time-independent ones, like text, graphics or stills. Specific issues are: adequacy of media for different purposes and inherent features, interactions about different media and synchronization of media.

Presenting a multimedia object means not only displaying some time-invariant representation types such as text or graphics or images, but involves also time-variant representation types such as audio or video. That means that the presentation of a multimedia objects consists of a set of actions temporally related to each other, which have to be executed in a special intended sequence. This scheduling is generally called synchronization of actions.

7.1 Human capabilities in relation with the different media

The output of multimedia presentation should be matched to the user. Before specifying the requirements and appropriateness of the different media the limits of a user to perception of different media are described [1].

The visual resolution of the human eye is better than an angular resolution of 1/120 of a degree, this corresponds to a 380 dpi resolution at normal reading distance. Current and near future display technology can only provide about 1/10 of this resolution on displays that are very small (compared with the field of vision a human possesses).

The eye has a dynamic adjustment to brightness, but within one "brightness environment" it can discern about 240 to 300 shades of grey, but is less sensitive in the blue spectrum and more so in red and green shades. That means that 24 bit colours (256 shades each in red, green and blue) are sufficient to produce all the colours the eye can recognize. In most cases the amount of available colours is more important than the resolution.

To produce a smooth motion, at least 25 to 30 frames/s are needed.

Like the eye, the ear has a dynamic range for loudness: the sensitivity in a given range is about 80 decibel (16 bits can represent a dynamic range of 96 decibel), and the ear can hear frequencies from approximately 20 Hz to 20 kHz. To produce a pure tone at 20 kHz, a device has to provide samples at more than twice that frequency. To produce "realistic" sounds, 44,1 kHz sampling with a 16 bit range is sufficient. To produce stereo sound, double the bandwidth is required for the two channels.

7.2 Inherent features of different media and its appropriateness

How the user handles the different media types in the real life is an important condition to consider when designing the user interface to control them. For time-independent media, as text, graphics or images, the metaphor is the usual printed material (books, magazines, etc.), and the functions provided should accommodate to usual user tasks with them (zoom, go to next / last page, go to the next / last image, etc.). For time-dependent media, user tasks are play, stop, fast forward and rewind, and the metaphor is usually built on the functions provided by domestic video or audio tape players. Of course, multimedia involves displaying different media simultaneously, but these minimum functions should be provided in any case for each medium.

Time-independent media, as text or graphics and still images, can be processed at the user's own pace. It is static information and should remain under total user control. These media have no specific synchronization requirements (still images can be presented within text, or in different windows, without special requirements). When the user controls its presentation, i.e., when scrolling, zooming, etc., maintain the presentation of the media on user terminal.

Time-dependent media, as video, animations, speech or sound have strict requirements for them to be perceived adequately. Presentation of these media is under the system's control. Allow some degree of control (i.e., fast forward or rewind). Visual media, as video or animations, should be continuously presented to the subject, even when he or she is

using the controls. Acoustic media, as speech or sound, are not usually recognizable when played at a different speed, thus not requiring output or synchronization when using these options.

Another classification of perception media is possible as a function of the type of information conveyed: text and speech are verbal media; video, animation or graphics are visual media. The former are suitable for presenting detailed information, the latter for more abstract information.

As a general recommendation, the use of the media should be optimized for the information conveyed, e.g., the best way to display complex verbal information is text, when it is properly displayed. Using more complex media for this, such as images or even video, can be useless in many cases if the important quality requirements of the latter media are not met.

7.2.1 Text specific requirements

Text is most appropriate for conveying large amounts of detailed information. Different fonts or graphical styles for text symbols may be used within an application for aesthetic reasons or for purposes of emphasis. Font specification should generally require only a few characters per font change in a document. The identities of the fonts used and form of references to each font may be agreed in advance by the sender and recipient of the document, or be specified once, at the start of the document [1].

The following recommendation apply about text symbols [1]: ensure that the character set used allows for the display of the different national characters of the countries or communities where the service is going to be used, e.g., ISO 8859 [39] for several variants of the Latin alphabet, or ISO/IEC 10646-1 [40] for the characters and symbols used in almost all current writing systems.

The minimum recommended functions to handle text are: go forwards and backwards, go to the next or last page, and go to the beginning or end of the document. These functions can be implemented via commands or by means of a scrolling bar in a GUI (see figure 5), but the functions should remain essentially the same.

In general, the scrolling bar permits to see the text as it is printed in a continuous vertical scroll of paper. The user issues commands to change what part of the scroll is displayed through the window on the CRT at once. The scrolling can be continuous, one or a few lines at a time, window-full at a time, or to particular points (pages) in the document.

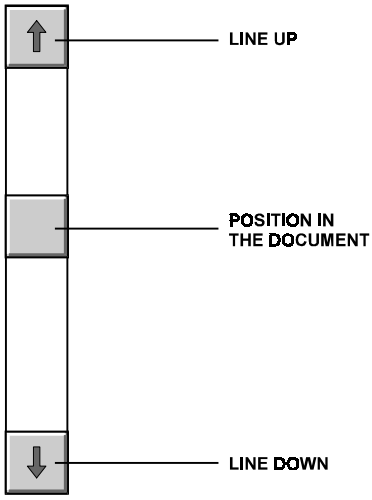

Figure 5: Example of scrolling bar

Another important aspect is the length of line that is displayed. If the line is longer than the screen allows, the best option is that the terminal breaks and formats it in several lines. An alternative is to request the user to scroll horizontally, but this is less desirable.

Avoid the multiple-columns format of printed material (e.g., newspapers or magazines), since they usually require both vertical (to allow reading the full column) and horizontal (to display adjacent columns) scrolling, thus needing many actions performed by the user. In the same way, when including graphics or stills in the document, do not request the user to scroll unnecessarily (that is, not more than would be required if it were text).

For reading text, black text on white background is best as measured by speed and accuracy, since it maximizes contrast. Another possible combination which maximizes contrast is the reverse, white text on black background, but it is less desirable, and usually makes reading more difficult. In general, for reading text, text / background contrast should be maximum, and colour choice should be made very carefully.

Character (font) size should also be considered. Allow a size big enough for characters to be displayed in the lowest resolution possible in a particular type of terminals.

7.2.2 Still images and graphics

Still images give exact or pictorial representations of existing objects. Graphics are best for schematic representations of concepts, expressing ideas, large amounts of data or showing relations in space and time [7].

Stills and graphics have no special requirements to be included within or together with text. The requirements and guidelines are the same for text: do not require the user to scroll unnecessarily to see the complete picture.

Some users may want to control the presentation of graphics or images. This can be implemented in the main user interface or in separate applications, and minimum functions to be provided are: zoom, either in discrete steps (200-400 %, or, alternatively, 2x-4x), or in continuous steps, allowing specific areas to be zoomed in and out. In any case, do not alter the aspect ratio (horizontal / vertical) of the image when being zoomed in or out (see figure 6).

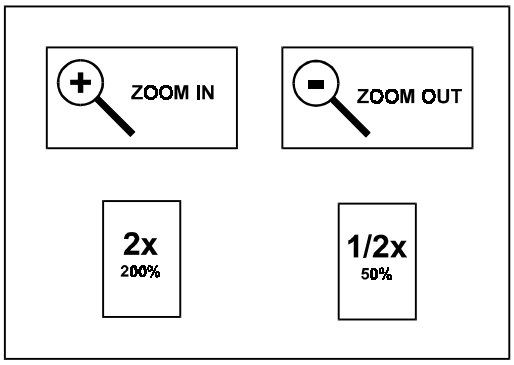

Figure 6: Example of zoom controls for still images

Although text can be presented in graphics or image format, this is in general not recommendable, since the amount of data to be transmitted is more, and the readability can be lower. This is only adequate when very special text format is required, or for special applications.

An important issue dealing with graphics and images is their compression formats and the quality achieved. This latter issue is reviewed separately. Regarding the former, it is required that the user has not to be concerned with the particular way of coding way used to compress the information (it should be performed automatically by the terminal).

7.2.3 Video or animation

Video is used to portray action and dynamic processes, and is very attractive for many persons. Image quality should be evaluated, since people usually compare it with television. (Video sequences must be of high quality, as users have high expectations based on their experience with television) [7].

Minimum user controls are play and stop (pause). Optional, but very useful controls, are fast forward and rewind. Since the video source will more likely be digital, additional controls, such as frame to frame, or go to an specific point in the sequence, can be provided. The most usual metaphor for these controls is based on a domestic VCR. An alternative way of controlling video sequences in multimedia microcomputers exist, and is based on the already known scrolling bar. This is presented horizontally, just below the video window, and allows, apart from being able to play and stop the sequence, access to particular frames by moving the scroll point (see figure 7).

Video sequences are not good for communicating large or amounts of detailed information, but for recreating atmosphere, real-world objects. In particular, video is not recommended for displaying text strings or still images which require great detail, since they do not achieve the same quality level as with still image formats, and also requires additional controls by the user (e.g., stop, pause, or image by image controls).

Video requires in most cases accompanying sound, either in form of music, or with a speech sound-track with explanations about what is being presented on the video sequence. When a person appears in the video sequence, lips and speech synchronization is most important.

Animation is the presentation of abstract, recreated or non-existing objects, in a dynamic fashion. It is used to express imaginary events or exploring viewpoints to determine the relationship between an object and its environment [7].

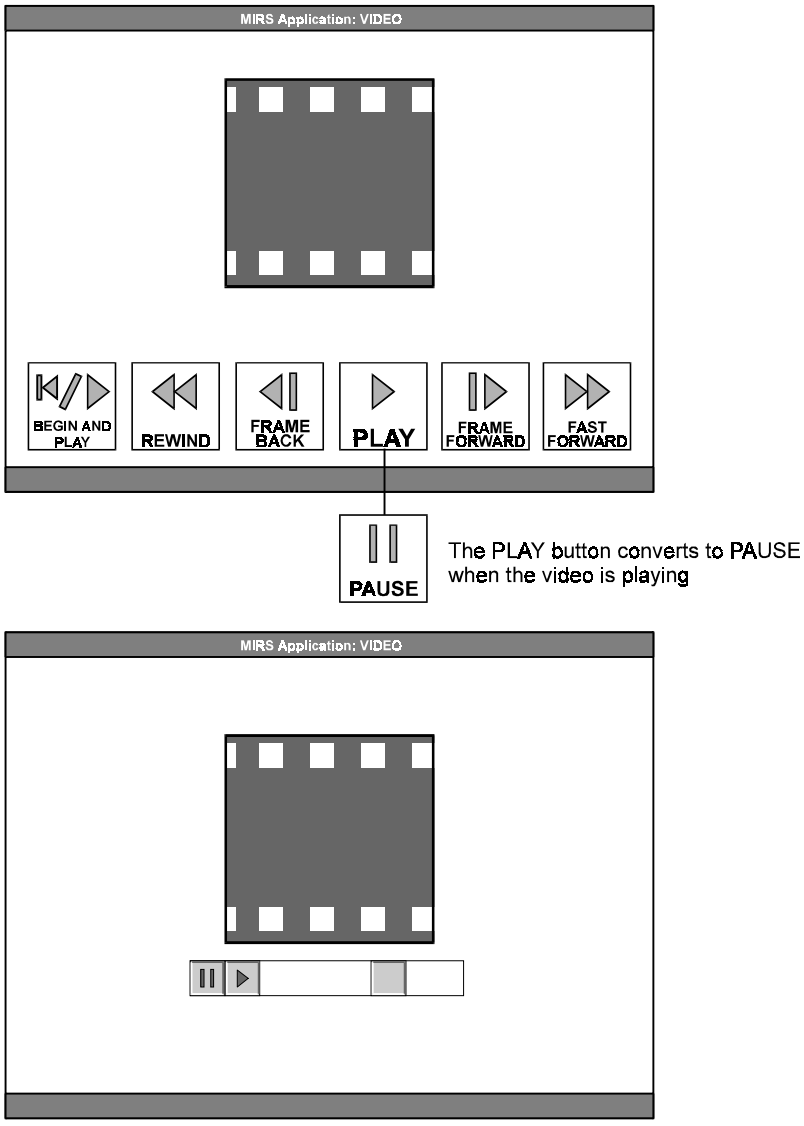

Figure 7: Example of possible user interfaces for video control

Animation techniques can be used successfully as interface components. Also, an effect comparable to animation can be achieved with an adequate timing of displaying still images, which may require a lower bandwidth and, therefore, achieve higher global quality.

Both techniques are very time-consuming to produce, they take a large storage space and require very high bandwidth to be transmitted with sufficient quality. Therefore, they must be used with care. In case of long sequences, potentially taking a long time to retrieve and present, the user must be able to interrupt the retrieval process [7].

7.2.4 Audio

Audio sequences can be of two types: speech, conveying verbal information, and music, providing atmosphere and entertainment. Also included in this distinction are short audio sequences, as earcons or verbal auditory prompts/feedback.

When a person's speech is presented in both video and audio forms, synchronization is most important. To preserve lips synchronism, the delay difference between sound and vision channels should not exceed the following limits (CCIR 412-3): 40 ms when the sound arrives after the vision; 20 ms. when the sound arrives before the vision. If the quality of the picture is good but audio is low-quality, there may be an annoying imbalance between both qualities.

Caution must be taken when presenting verbal information by both visual means (text) and audio: if the information is different in each, a person may be unable to process both sets of information. Sound can be potentially useful for providing redundant verbal information, but care must be taken not to present different information (verbal).

Sound is useful for adding atmosphere to information being presented on the screen and attracting users' attention to it. It is not appropriate for portraying large amounts of information, graphical information, or description information, unless used in connection with moving video.

Information presented by sound is difficult to remember. Repetitive audio messages of all types quickly become tiresome, therefore messages should be as varied as possible.

Volume control must be provided in interfaces presenting auditory information. As with video or animation, the user controls are usually based on a tape metaphor. Therefore, allow stop, play, fast forward and rewind functions (see figure 8). A function to allow the user to move to the beginning or intermediate points can also be provided. However, in the case of audio, step to step and related controls are not necessary. Sound output is not required when the presentation rate is different from the normal one, since it cannot be properly perceived by the user.

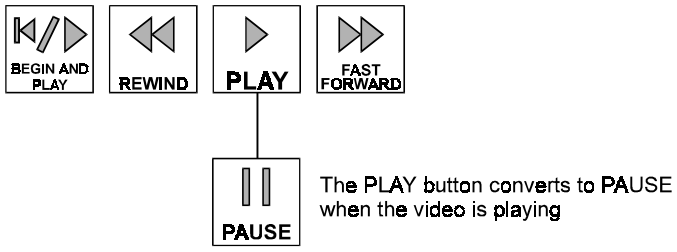

Figure 8: Example of audio controls

7.3 Combining media

Generally, two or more media can be considered combined if their representation is concurrent. Sequential presentation of media may also be considered combined where the content is closely related or where the media are explicitly grouped, for example, presenting a picture followed by a description.

Combining media can provide advantages for the user. Interfaces can be created that present information in a way similar to the real world. Depending on the context of use, this can make users' tasks easier, or more natural, especially where features of the information match the users' experiences of the real world. This means that carefully using more than one medium simultaneously leads to an increase in the understandability of information, as people learn more readily when exposed to information in several modes. However, its success will depend more on the chosen combination of media than on the provision of a rich set of media [7].

Combinations of media can be used to strengthen or reinforce meaning by using [8]:

- redundant presentation: presenting the same information using different media; or
- complimentary presentation: presenting similar information using different media.

Combining media redundantly can also benefit users with special needs who may not be able to perceive information presented in a specific medium. For example, an interface that presents auditory information as well as visual information may not preclude blind users. Combining media can also help accommodate user preference for information in a particular format. For example, presenting text as well as picture can accommodate users with a preference for either.

The following guidelines for combinations of media apply [8]:

- Consider the task:

  Generally, media should only be combined if the combination supports the user's tasks. Where the media presented contain information, the combination should not be such that the overall meaning is incongruent.

  Some tasks benefit more from combination than others. If the task involves learning or drawing attention to specific information, then the users will benefit from media combination that presents information redundantly. If, however, the task is focused predominantly on one medium, for example, visual inspection of diagrams, then there will be considerably less benefit from combination.

- Consider the context:

  The use of combined media should be appropriate in the context in which the interface is used. An example of appropriate combination is the presentation of pictograms to accompany text for international use of an interface. An example of inappropriate combination is the presentation of information that a user may consider private using combined media which could compromise that privacy; e.g., auditory as well as visual display of bank account details.

  Certain environments may impede accurate perception of information presented in a specific medium, for example an auditory warning may not be heard if presented in a noisy environment. Combination of media should not be such that the inability to perceive information in one medium changes the overall meaning of the information presented.

- Use redundancy for critical information:

  Where critical information is presented, the combination of media should provide redundant information only, so as to maximize the likelihood of accurate perception of that information.

- Avoid semantic conflicts:

  Concurrent presentation of conflicting information in any combination of media should be avoided, e.g., the auditory presentation of the word 'incorrect' combined with the visual presentation of the word 'correct'.

- Avoid perceptual channel conflicts:

  Concurrent presentation of media combinations should be avoided where the combination makes it difficult for the users to perceive information from each individual source. For example, combining two or more sources of speech.

- Support different points of view:

  Some users may prefer to interact with systems using a particular medium. Wherever appropriate to the task and in the context redundancy should be used to allow interaction using a preferred medium. It may be appropriate to allow users to select a preferred medium or suppress certain media.

  An example of selecting preferred media is choosing to display text captions on pictures. An example of suppressing media is choosing not to be presented with auditory dialogue.

7.4 Synchronization between different media

Guidelines about the time constraints for successfully achieving synchronization between time dependent media are presented in table 4 [8].

Humans are more tolerant if a sound is delayed (this is interpreted as sound transmission time) if the sound is coming from an action, e.g., sound of hand clapping before the hands touch each other is more critical.

Synchronization between objects is accomplished via the time line. There are basically three forms of absolute synchronization, i.e., where time is set with reference to the starting point of the media object:

- one object or a set of objects will start at a fixed specified time;
- one object or a set of objects will stop at a fixed specified time;
- one object or a set of objects will play within a fixed specified time interval, eventually forcing some of the events to be played faster or slower than originally recorded.

These are the most simple synchronization options. More advanced features will include cascaded synchronization, where a sequence of media objects start one after the other with a fixed time lag in between, and backward synchronization, where the reference point is the endpoint of the clip instead of the starting point.

Special synchronization issues when separate connections for each medium are required are dealt with in reference [33].

Table 4: synchronization parameters in different situations

Kind of synchronization	Example	Sync. Tolerances
Lip sync.	video before speech	-60 ms up to + 80 ms
Subtitle	Picture before text	±80 ms
Music (notes)-sync.	Picture or note before tone	±5 ms
Pointer sync.	Pointer (mouse) before speech	-750 ms up to +500 ms

7.5 Media quality

Compression of audio, video or still images allows them to be transmitted using digital networks with limited bandwidth, such as ISDN. Joint Photographic Experts Group (JPEG) standards for still images and Moving Photographic Experts Group (MPEG) standards for video sequences are good solutions for displaying for images and video sequences, respectively. However, these standards only guarantee the interworking of the coding-decoding process, which are usually performed in specialized equipment for the former, and in the user terminal for the latter, but do not guarantee the achievement of any pre-determined quality. Therefore, different encoding processes can provide different quality levels. As a first approximation, the quality levels that each format can provide for still images and video can be found in table 5.

As a general rule, graphics and still images compression does not depend on the bandwidth provided by the network, since these are time-independent media. However, the delay in retrieving them must be considered, and the compression ratio chosen so that they both meet the user required transfer speed and final quality. Users' requirements may be different (e.g., the quality requirement differs for graphic design, telemedicine or teleshopping applications). The JPEG standard is suitable for continuous tone images, as those found in highly detailed photos. In these, with a compression ratio of 10:1 generally no perceptible differences can be observed between the JPEG compressed image and the original, whilst with a ratio of 20:1 the difference is generally noticeable [31].

With time-dependent media, such as audio (music) and video, the required bandwidth must be maintained to achieve the required quality level. This will be variable, depending on the application. Although this is an aspect still being investigated [32], table 5 indicates the preliminary recommended standards for each bitrate and quality levels for video.

Table 5: Standards for video encoding and their achievable quality and applications

Coding Standard	Required Bitrate	Achievable Quality	Applications
H.261	p x 64 Kbit/s; p=1..30	Variable, depending on p	Multimedia Mail ISDN Videotex ISDN Retrieval
H.263	p x 8 Kbit/s; p=1..8	Variable, depending on p	PSTN Retrieval Multimedia Mail
MPEG-1	1,5 Mbit/s	Similar to that obtained with a domestic VCR	CD-I Video on Demand
MPEG-2 (H.262)	4-15 Mbit/s	Broadcast Quality	Studio
ETS 300 174	34 Mbit/s	Broadcast Quality	Studio

Annex A (informative): Example of interface screens for a MIRS

This annex presents the user interface for Telefónica service Infovía, which provides the top structure for accessing to different services within Telefónica PSPDN. They are presented as illustrations of the concepts and guidelines provided in this document.

Figure A.1 presents the welcome screen or home page for the service. This interface screen provides the following functions:

- information and help about the service;
- new information providers;
- means for sending suggestions or requesting advice about the service;
- means for accessing information providers directly (see figure A.2);
- link to subject menu (see figure A.4);
- link to an alphabetical menu (see figure A.3);
- link to a full text search interface (see figure A.5);
- link to download software interface.

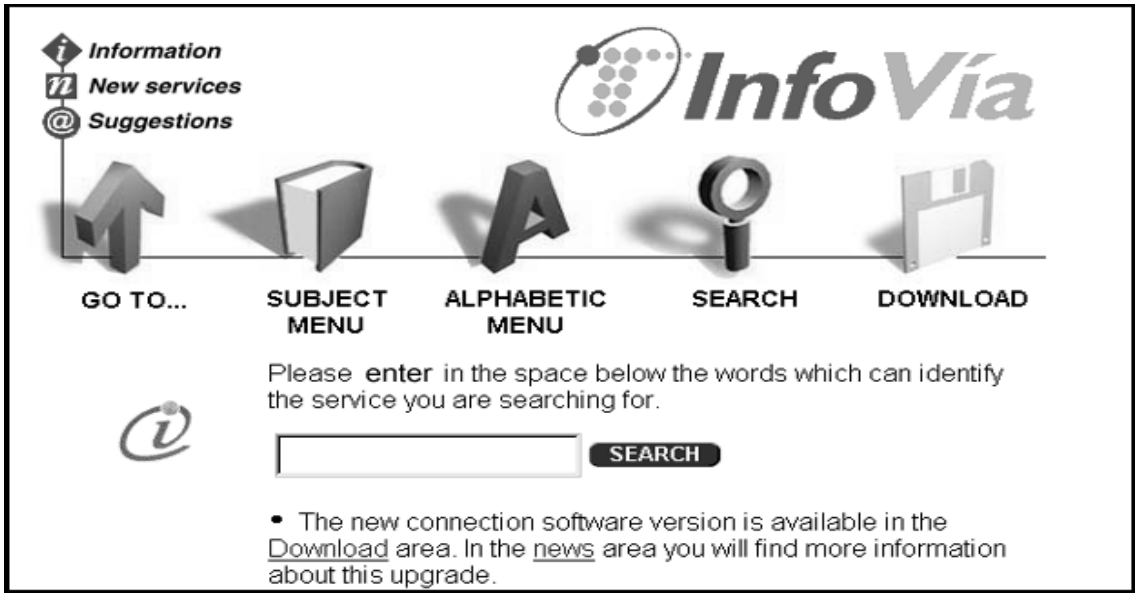

Figure A.1: Welcome screen or home page

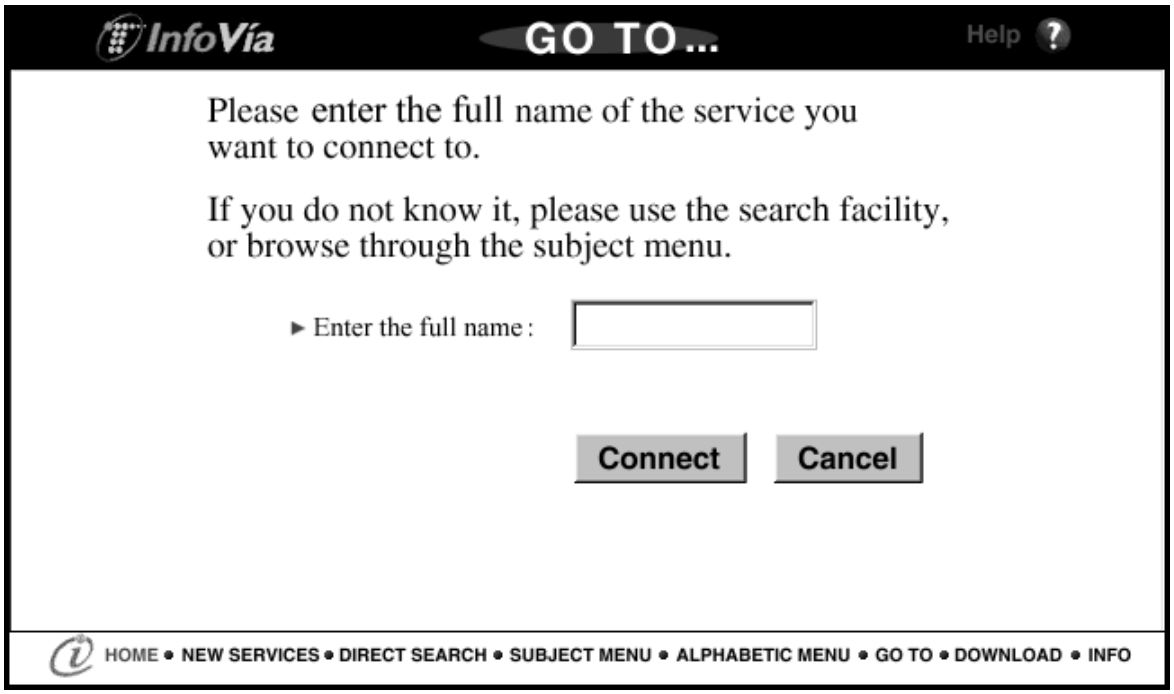

Figure A.2: Screen for directly accessing the information provider

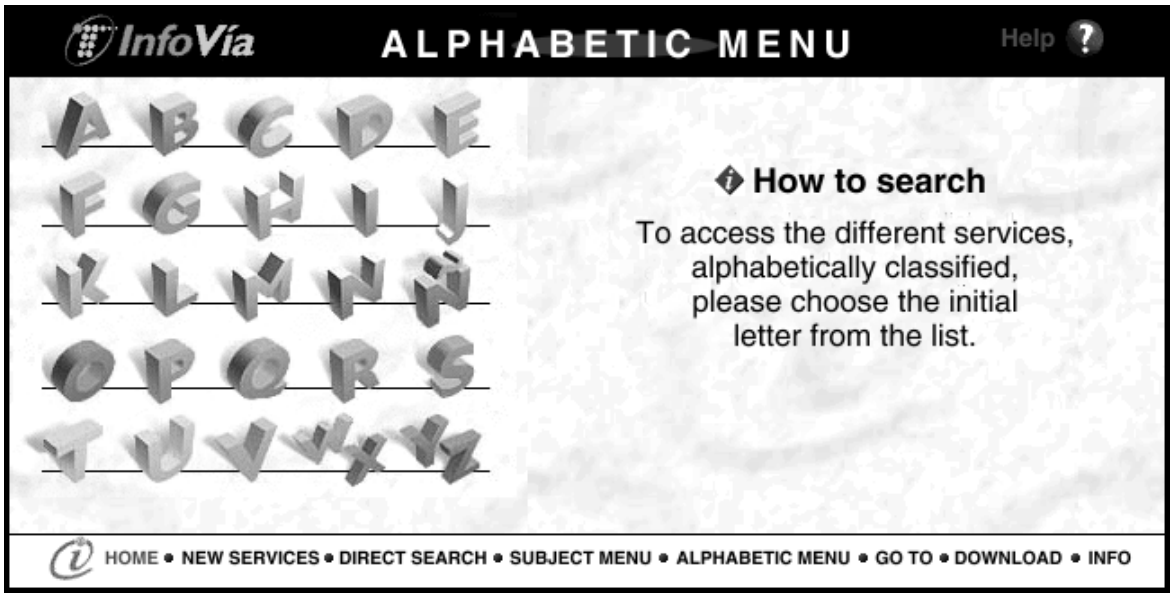

Figure A.3: Alphabetic menu for searching the information provider

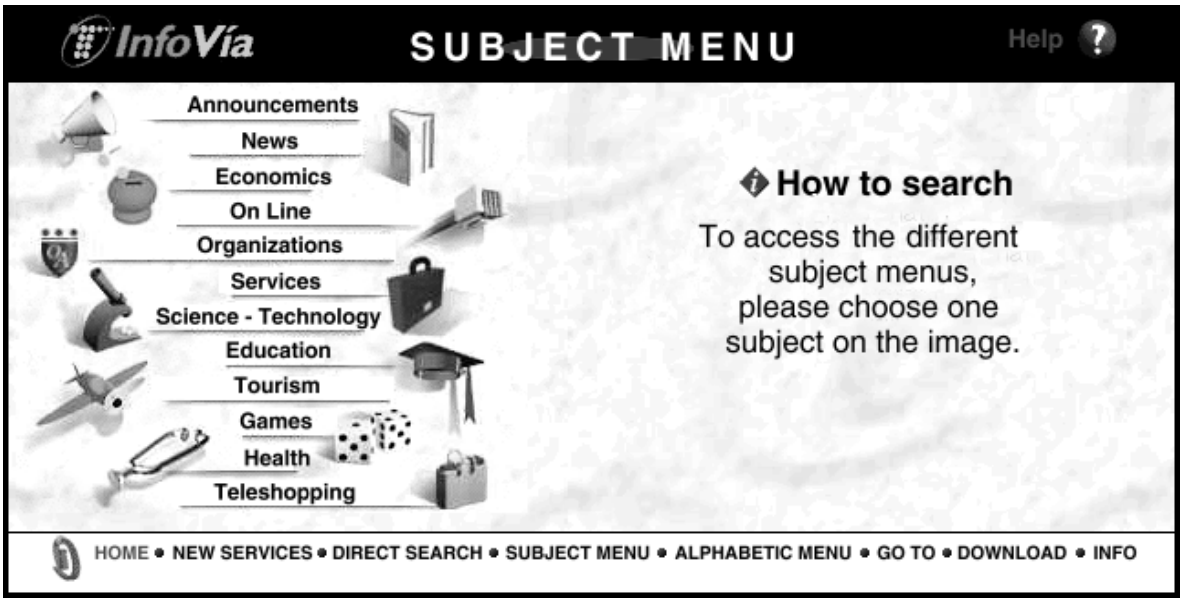

Figure A.4: Subject menu for searching the information provider

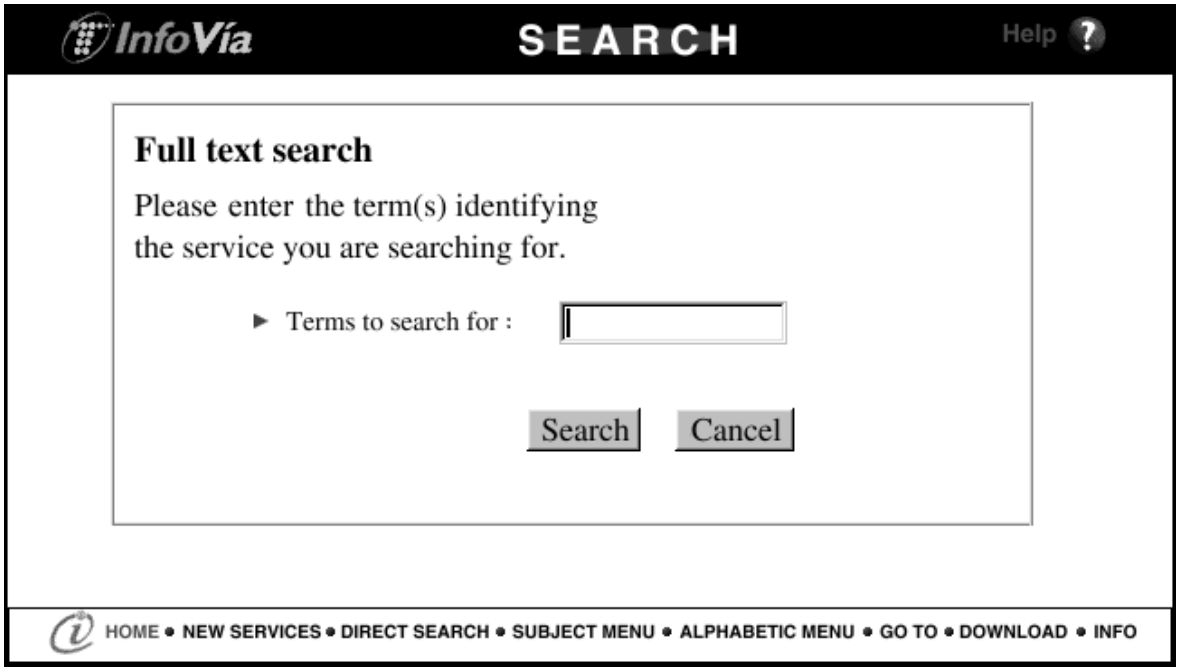

Figure A.5: Full text search interface

Annex B (informative): Examples of applications

Applications of MIRS are present in several ETSI documents, such as ETR 228 [6], "Terminal Equipment (TE); Broadband Multimedia Information Retrieval Service", and ETR 181 [36] "Terminal Equipment (TE); Multimedia portfolio; A compilation of multimedia applications and services provided by ETSI members". These applications are briefly summarized here. For more information on them, please refer to these documents.

Video on Demand (VoD) and Electronic Programme Guide, although examples of MIRS, have very important differences with the rest of MIRS (World Wide Web, Multimedia Videotex) considered throughout the present document, and this is the reason why they are not reviewed here. The main difference is the terminal equipment for these services, which is usually a TV set with some added equipment, which imposes important restrictions in the way of using the services (usually interaction is made with a remote keypad, with a limited number of keys).

Therefore, only more "traditional" applications are reviewed here. These include:

1 Tele-shopping

The user may access, among others, the following functions:

- consult an interactive database;
- navigate through a catalogue (including especially extensive information on the currently advertised product);
- fill in and forward product order forms.

Among possible providers:

- mail order companies (selling general purpose home equipment, e.g. refrigerators, shoes);
- supermarkets;
- travel agencies (e.g. hotel rooms, flights);
- real estate agencies.

2 Home banking

The user can access the following features (existing already in Videotex):

- browse through bank account(s) of the user;
- transfer money from one account to another account of the same user.

More advanced features include:

- transfer money from one bank account of the user to the account of somebody else;
- payment of bills.

3 Tele-Education

The following scenarios characterize interactive telematic training and education applications from a user’s perspective. A user consults prepared Multimedia lessons, interacts with simulations, asks a tutor for an explanation of some demonstrated process and gets it through some additional Hyper links in the lessons, makes personal annotations about lessons, gives remarks about some aspects of lessons to the lesson author, works together with other students to solve a problem, etc.

4 Electronic Publishing (Video books, Multimedia Encyclopaedias)

The following features characterize encyclopaedic applications, electronic libraries and electronic books from a user's point of view. A user:

- consults a core encyclopaedia on CD-ROM, updates (subscription) through regular downloads, hot topics available on-line;
- consults yellow pages, tourist guides using electronic publishing of Multimedia and Hypermedia Information (MHI) material.

5 Point of information

The following features characterize point of information and point of sales applications from a user's perspective. A user:

- consults information booths with a city guide including street maps and orientation help. The information is regularly updated (traffic situation, cinema and restaurant programmes, special events,...) from a remote source and may be combined with advertising.

The user may also do tele-transactions (ticket and other reservations), telebanking or tele-shopping transactions as well.

Other possible applications include:

- medical applications: exchange of diagnostic pictures, videos, sounds and data-based simulations;
- music on demand: user selects a "mood", some preferences (American folk music without vocals) and a duration, service delivers corresponding music to the personal hi-fi centre;
- discussion corners, MHI bulletin boards: similar to current systems (CompuServe, BIX, Usenet) with the inclusion of MHI objects;
- news on demand: personalized electronic newspaper with "tell-me-more" feature, can be similar to current electronic news or current television news.

Annex C (informative): Quality of Service issues

A very important, but very often neglected, issue from the user point of view is the Quality of Service. This is a complex issue for which not much information has been found. This annex contains a brief summary of some material from ETR 003 [41]. However, much more research is required to define the QoS aspects in modern MIRS.

Quality of Service (QoS) is defined in ITU-T Recommendation E.800 [42] as "The collective effect of service performance which determine the degree of satisfaction of a user of the service".

A typical user/customer is not concerned with how a particular service is provided, or with any of the aspects of the network's internal design, but only with the resulting end-to-end service quality. From the user's/customer's point of view, QoS is expressed by parameters that:

- focus on user/customer-perceivable effects, rather than their causes within the network;
- do not depend in their definition on assumptions about the internal design of the network;
- take into account all aspects of the service from the user's/customer's point of view;
- may be assured to a user/customer by the service provider(s);
- are described in network independent terms and create a common language understandable by both the user/customer and the service provider.

Among these parameters, ETR 003 [41] makes several distinctions which are reproduced here. These concepts should be then applied to the particular aspects of the MIRS under consideration.

QoS offered by service provider

QoS offered by the service provider is a statement of the level of quality expected to be offered to the user/customer by the service provider. The level of quality is expressed by values assigned to QoS parameters. These parameters are usually designed to be understandable to the user/customer. Each service would have its own set of QoS parameters.

QoS achieved by service provider

QoS achieved by the service provider is a statement of the level of quality achieved by the service provider. This is expressed by values assigned to parameters, which are, as far as possible, same as those for the QoS offered. These performance figures are summarized for specified periods of time, e.g. for the previous 3 months.

QoS perceived by the user/customer

QoS perceived by the user/customer is a statement expressing the level of quality experienced by them. The QoS perceived is expressed usually in terms of degrees of satisfaction and not in technical terms. Technical terms may be expressed where the user/customer is able to understand and use these. QoS perceived is assessed by customer surveys and from user's/customer's own comments on levels of service.

Network Performance

A general definition of Network Performance is given in ITU-T Recommendation E.800 [42]: "The ability of a network or a network portion to provide the functions related to communications between users".

Network performance is a statement of the performance of a connection element or concatenation of connection elements employed to provide a service. It is defined and measured in terms of parameters which are meaningful to the network and service provider and are used for the purposes of system design, configuration, operation and maintenance. NP is defined independently of terminal performance and user/customer actions. It is also service independent in that it must be able to support all the services the particular network level is required to transport.

Service performance

Service performance is a statement of performance of a telecommunications service expressed in parameters applicable to that service, together with values for those parameters. These parameters will apply to QoS, technical and non-technical features of the service.

Each service would have its own set of performance parameters and values to constitute the service performance.

Service performance is expressed in a more formal language, yet understandable and meaningful to the user/customer. The QoS parameters included in the service performance is the QoS offered. It is up to the service provider to state if any guarantee of the QoS is implied over a period of time.

It is often convenient to translate the user's/customer's QoS requirements into service performance before these are translated into network performance parameters, for instance, the loss of service may be repaired within "x" hours in 90 % of the cases; or the incidence of network interruptions will be less than 1 in 1 000 connections.

The Quality of Service Control Process

The process of Quality Control has several steps, which are very similar to those taken for measuring usability.

First step is Capturing and defining user's/customer's QoS requirements. The method for capturing user's/customer's QoS requirements for any telecommunications service involves two steps. In the first step a service-specific framework is derived by identifying the service specific criteria for the particular service under consideration. In the second step the QoS requirements of the users/customers are ascertained.

In the second step an assessment of QoS perceived and subsequent follow-up are made. This assessment is usually made by customer surveys. Customer surveys have to be designed by those knowledgeable and familiar with telecommunications and the culture of the local market.

The QoS perceived and the QoS achieved are compared for correlation. Due to the subjective element on the part of the user there is likelihood of variation in the correlation between QoS perceived and achieved. The aim will be to reach a level of QoS achieved which correlates satisfactorily with the QoS perceived.

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