# ETSI

**E**TSI
**T**ECHNICAL
**R**EPORT

# ETR 261-3

**October 1996**

Source: ETSI TC-HF

Reference: DTR/HF-01028-3

ICS: 33.020

**Key words:** Keypad, MMI, supplementary service

# Human Factors (HF);

# Assessment and definition of a harmonized minimum man-machine interface (MMI) for accessing and controlling public network based supplementary services;

# Part 3: Experimental comparison of two MMIs - Simulated UPT access and prototype ISDN supplementary services

# ETSI

European Telecommunications Standards Institute

**ETSI Secretariat**

**Postal address:** F-06921 Sophia Antipolis CEDEX - FRANCE
**Office address:** 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
**X.400:** c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 4 92 94 42 00 - Fax: +33 4 93 65 47 16

# Contents

## Foreword

This ETSI Technical Report (ETR) has been produced by the Human Factors (HF) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

## Introduction

The Technical Committee for Human Factors has prepared this ETSI Technical Report to report publicly its work on the assessment and definition of a harmonized minimum man-machine interface for the access and control of public network based supplementary services. It is intended to complement ETS 300 738 [3].

This ETR constitutes part 3 of a multi-part ETR ("Assessment and definition of a harmonized minimum man-machine interface (MMI) for accessing and controlling public network based supplementary services"), whose parts have the following titles:

Part 1:     "General approach and summary of findings";

Part 2:     "Literature review - Memory and related issues for dialling supplementary services using number codes";

**Part 3:     "Experimental comparison of two MMIs - Simulated UPT access and prototype ISDN supplementary services";**

Part 4:     "Experimental comparison of the effect of categorized and non-categorized formats within user instructions";

Part 5:     "Experimental comparison of the CEPT and GSM codes schemes";

Part 6:     "Survey of existing PSTN, ISDN and mobile networks, and a user survey of supplementary service use within Centrex and PBX environments";

Part 7:     "Experimental evaluation of draft ETS 300 738".

Blank page

# 1 Scope

This multi-part ETSI Technical Report (ETR) presents the results of the research work conducted to develop a European Telecommunication Standard (ETS) defining a harmonized minimum man-machine interface (MMI) for the access and control of public network based telecommunications services, and in particular supplementary services.

This part 3 of the ETR describes the experimental comparison of two MMIs, a phase 1 UPT simulation and an ISDN supplementary service prototype. The experiment compared user performance and preferences within the basic user procedures provided to access both services. The experiment allowed a tentative comparison between an example of a PBI+ (12 keys, tones and voice announcements) and an example of a PBI++ (12 keys, tones, voice announcements and visual messages) interface.

# 2 References

For the purposes of this ETR, the following references apply:

[1]     CEPT T/CAC 02: "Subscriber control procedures for supplementary services in modern telecommunication system".

[2]     ETS 300 511: "European digital cellular telecommunications system (Phase 2); Man Machine interface (MMI) of the mobile station (MS) (GSM 02.30)".

[3]     ETS 300 738: "Human Factors (HF); Minimum Man Machine Interface (MMI) to public network based supplementary services".

[4]     ETR 261-2: "Human Factors (HF); Assessment and definition of a harmonized minimum man-machine interface (MMI) for accessing and controlling public network based supplementary services; Part 2: Literature review - Memory and related issues for dialling supplementary services using number codes ".

[5]     Fay D (1993): "Interfaces to automated telephone services: Do users prefer TouchTone or Automatic Speech Recognition?", 14th International Symposium on Human Factors in Telecommunications, Darmstadt,  p 339.

[6]     Israelski E (1988): "An experimental comparison of user performance with alternative access codes for PBX features." 12th Symposium on Human Factors in Telecommunications, The Hague.

[7]     ITU-T Recommendation E.131:     "Subscriber     control     procedures     for supplementary telephone services".

[8]     ITU-T Recommendation E.161: "Arrangement of figures, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network".

[9]     Jones MLR (1990): "Making numeric command languages more usable." 13th Symposium on Human Factors in Telecommunications, Turin, pp 99-106.

[10]    ETR 261-1: "Human Factors (HF); Assessment and definition of a harmonized minimum man-machine interface (MMI) for accessing and controlling public network based supplementary services; Part 1: General approach and summary of findings".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of this part of the ETR, the definitions, symbols and abbreviations given in part 1 [10] of the ETR apply.

# 4 General Introduction

## 4.1 The Problem

New services are being or will soon be offered on the existing and new networks. The user interface used to access the old plain telephone service was for many decades the telephone set equipped with a rotary dial or a keypad.

Whilst the number and complexity of the new services increases (in fact some services are interactive and require post-dialling data entry), the user interface available to the general public has not substantially changed. Consequently, the access to the services entails entering information in coded form, which creates problems to the users in terms of time spent, errors made and reduced satisfaction. Anyway, beside the traditional Phone Based Interfaces (or PBIs), new ones are being developed and start to be offered to the users.

In this ETR the attention will be focused on the minimum PBIs, which use a numeric keypad as an input device.

The output, i.e. the feedback indications, can consist of telephone tones or a combination of tones, announcements and visual messages as explained in the following:

- PBI: 12-button numeric keypad and tones.
- PBI+: 12-button numeric keypad, tones and announcements.
- PBI++: 12-button numeric keypad, tones, announcements and text (on visual display).

Beside the user interface, other variables are likely to affect the user performance when accessing the services through the PBIs: the presentation of the services to the user, the user procedures, the prompting and feedback messages, the output mode (auditory, visual, both) and so forth.

## 4.2 The Approach

To gain a better knowledge on these aspects, identify possible problems and suggest solutions, it was decided to perform an objective experiment.

Since it was impractical to take into account all the aforementioned variables, the approach was to rely on the literature, when available [4][6][9], and to integrate this information with first hand experimental data by comparing two different networks, i.e. UPT and ISDN.

The first phase of UPT was considered because it was the only one consolidated by ETSI STC NA7 at the time of testing.

However, the access codes, lack of available standards, were decided on a national basis.

As to ISDN, the Italian Pilot was considered. This is not the standard European ISDN, but was the only ISDN available to the user.

Given the status of the implementation of these two networks, it was not possible to create similar testing conditions to ease the comparison task. For example, code schemes, user interfaces and user procedures are defined already for ISDN and are in a preliminary definition phase for UPT.

An attempt was made to provide the user instructions in a similar (i.e. minimal) way in both networks, taking into account the principle that PBIs should be as far as possible self-explanatory, since they are spread all over the world and users are reluctant to read manuals.

## 4.3 The Target

The experimental results were, where possible, extrapolated to derive general guidelines and achieve better usability through:

- improvement of the user interface and user-to-service interaction;
- harmonization of the minimum PBI across the networks and the services.

In the following, the description of the test bed, test design, methodology, results and conclusions for the two experiments carried out on the UPT and the ISDN services are reported separately.

# 5 Experiment on UPT

## 5.1 UPT Services

At the time of writing (mid-1993) the UPT services in Italy are in a preliminary definition phase and available only on emulators. In the experiment the phase 1 services have been used. The operations that users can perform are:

- In-call Registration;
- In-call Deregistration;
- Single Out-call.

The relevant codes have been defined provisionally and unilaterally by the Italian network operator. They are listed below (table 2):

**Table 2: UPT codes**

| Service | Code |
|---------|------|
| Registration | 1484    XXXXX YYYYY 1 |
| Deregistration | 1484    XXXXX YYYYY 0 |
| OutCall | 1484    XXXXX YYYYY 8 |
| Where: | |
| 1484 is the service access code<br>XXXXX indicates the UPT number<br>YYYYY indicates the PIN<br>the last digit indicates the procedure. | |

The messages (prompts, feedback, status information, etc.) for these services are not decided yet. The version used in the experiment has been defined for this particular circumstance as to wording, number of repetitions, interruptability, error recovery strategy, etc.

## 5.2 The UPT user interface

In the emulation test bed, the aforementioned UPT services are accessed through a telephone set (PBI+) connected to a Sun Sparcstation® computer with speech output emulating the service.

The telephone set consists of a 12-pushbutton keypad (the 0 to 9 digits and *, #).

## 5.3 User-to-system interaction in the UPT services

The user-to-system interaction (user actions and system reactions) for Registration, Deregistration and OutCall is described in annex A.

## 5.4 Task analysis for the UPT services

The following tasks and subtasks have been identified:

### 5.4.1 Tasks

- To register;
- To de-register.

### 5.4.2 Subtasks for the UPT services

- To retrieve the codes of the service;
- To go off-hook;
- To enter the codes of the service;
- To perceive the acoustic indications;
- To understand the acoustic indications (prompts, feedback);
- To go on-hook.

## 5.5 Scenarios for UPT

The following three scenarios were made up:

- To register for InCalls;
- To de-register for InCalls;
- To register for OutCalls.

Each scenario was presented to the users together with name and description of the service and the relevant instructions (annex B).

## 5.6 Test design for UPT

To evaluate the user performance and satisfaction when using the UPT services listed above, the following experiment was designed.

The test subjects were assigned three tasks covering the available services. The order of presentation of the tasks was balanced across subjects to compensate for the learning effect.

One hour was allocated for each subject to read the instructions, carry out the tasks and answer the questionnaire and the interview.

## 5.7 Test bed for UPT

The UPT services were tested on the emulator, consisting of a Sun Sparcstation® computer with 32 Mbyte memory and 400 Mbyte hard disc. The computer was equipped with speech I/O and could both record acoustic signals via microphone, and play them back via loudspeaker or headset.

The software was written in C language in UNIX™ environment. The emulation required to fully exploit the resources offered by the C-UNIX™ interface to implement the input / output mechanisms in raw mode from telephone keypad via RS232 interface, the mechanisms of concurrence between processes (message play, input processing) and the mechanisms of signalling between processes to interrupt them.

The emulator allows to vary all the Network Control Point parameters, namely: length of the PINs or of the numbers requested by the call prompter, type of error management, message interruptability, voiceback provision, length of time-outs.

The audio signal coding accepted by the AM79C30A chip installed on the emulator was performed as follows: the signal was 12 bit sampled at 8 kHz and then compressed to 8 bit using μ-law.

A telephone set was used as the user interface of the emulator. This allow the test to be performed under the same conditions as those of the real service. The solution added reliability to the emulator flexibility.

The telephone set was modified to enable the interaction with the computer: the telephone sent its output to the emulator via an RS232 interface and received the speech input through the emulator's speech output.

The telephone workstation communication protocol via RS232 interface foresaw data coded with 8 bit per character, 1 start bit, 2 stop bits, no parity and 1200 bit/s speed.

The coding of the keys and the hook signals was very simple: for every user action, a byte was sent without autorepeat.

The vocal messages stored in digital form in the emulator's database were sent to the telephone receiver via the emulator's analogue speech output.

### 5.8 Data capture for UPT

Performance data was captured by the emulator computer itself through automatic logging.

User opinions were collected by means of a questionnaire (annex C) and an unstructured interview. The questionnaire was administered after completion of each scenario.

### 5.9 Subjects

Twenty-four paid subjects ranging from 15 to 70 years and spanning all education levels participated in the UPT experiment.

### 5.10 Results

Given the limited number of subjects involved in the experiment, the results should be considered more qualitatively than in a strictly quantitative way.

### 5.10.1 Performance data

A negligible number of errors was recorded. The only errors were due to time-out expiry.

The performance time is reported in the next table.

**Table 3: Performance time in UPT**

| Service | Code |
|---|---|
| Registration | 66,4 s |
| Deregistration | 49,0 s |
| OutCall | 67,3 s |

The average time per keystroke was about 4 seconds.

### 5.10.2 Subjective reactions

The scores given on the Likert scales are shown in table 4.

**Table 4: Subjective reactions in UPT**

| Attributes | Registration | Deregistration | OutCall |
|---|---|---|---|
| Overall satisfaction | 4,5 | 4,5 | 4,6 |
| Length of the procedures | 4,1 | 4,4 | 4,2 |
| Ease of use of the procedures | 4,7 | 4,8 | 4,8 |
| Understandability of the messages | 4,7 | 4,8 | 4,8 |

The subjective data indicates very favourable attitudes, which in at least one case (Length of the procedures) seem to be overoptimistic.

As to the results of the interview the following points were made:

1) The procedures are too lengthy (too many digits to dial).

2) The codes are difficult to remember.

3) The procedures are very easy because the user is guided step-by-step through them.

4) The courtesy words ("Please", "Thank you") are redundant, especially if repeated in several phases of the same interaction session.

5) No feedback at all is provided on which service has been activated (Registration or OutCall).

6) The prompting message "Please dial the desired number. Thank you" is not clear enough. It would be preferable to word it as follows: "Please dial the number of the subscriber desired. Thank you".

7) After the activation of the Registration and OutCall services, no feedback is provided about the number actually dialled.

8) The piece of music is useless. Instead, the message should be delivered immediately.

# 6 Experiment on ISDN

## 6.1 ISDN Supplementary Services

The ISDN supplementary services tested in the experiment are those of the Italian ISDN Pilot. The ISDN Pilot differs from and will be replaced by the Euro-ISDN, but at the time of testing only the Pilot was available in Turin.

Some of the ISDN supplementary services require the user to interact with the system in the enabling phase (e.g. 3-Party Conference) and others do not (e.g. Call Barring).

For the ISDN experiment the following three services were considered, because they seem to be representative of the ISDN situation:

- Call Barring (CB);
- Call Forwarding Unconditional (CFU);
- 3-Party Conference (3PTY).

For these services three features are taken into account:

- activation;
- deactivation;
- interrogation of the status of the service.

The relevant access codes are reported in table 5.

**Table 5: ISDN services and relevant codes**

| Service | Activation | Deactivation | Interrogation |
|---------|-----------|--------------|---------------|
| CB | *33# | #33*PIN# | *#33# |
| CFU | *21*TN# | #21# | *#21# |
| 3 PTY | TN1<br>RIC<br>1<br>TN2<br>1 | | |
| Where: | PIN = Personal Identity No.(to enable calls)<br>TN = Telephone Number (new destination)<br>RIC = "Service access" function key | | |

## 6.2 The ISDN User Interface

To access the ISDN services a standard FACE-ALCATEL telephone set (PBI++) is used which consists of:

- a 12-pushbutton keypad (the 0 to 9 digits and *, #);
- 3 editing keys (<--, Cancel, -->);
- 4 function keys labelled with abbreviations or acronyms to access the following functions: Setup (ASS), Suspend/Resume (S/R), Redial (RIS), Access by menu to specific ISDN supplementary services (e.g. 3-Party Conference);
- a 2-line * 20-character LCD display;
- 2 small lamps associated with the ASS and RIC keys.

Prompting and feedback messages are presented on the display, the only auditory indications being the tones (dial, ringing, busy tones) and the announcement "The 3 party conference service has been activated" repeated twice.

## 6.3 The User-to-system interaction in the ISDN services

The user-to-system interaction (user actions and system reactions) for the 3 services considered and their features are reported in annex D.

## 6.4 Task Analysis for the ISDN Services

The following tasks and subtasks were identified:

### 6.4.1 Tasks

- To setup a call;
- To activate a service;
- To deactivate a service;
- To interrogate the status of a service;
- To terminate a call.

### 6.4.2 Subtasks for the ISDN services

- To go off-hook;
- To enter the code of the service;
- To use a function key;
- To perceive the acoustic indications;
- To perceive the visual indications;
- To understand the meaning of the acoustic indications (prompt, feedback);
- To understand the meaning of the visual indications (prompts, feedback);
- To go on-hook.

## 6.5 Scenarios for ISDN

The following scenarios were made up:

- To activate the Call Barring service;
- To deactivate the Call Barring service;
- To interrogate the Call barring service;
- To activate the Call Forwarding service;
- To deactivate the Call Forwarding service;
- To activate the 3-Party Conference service.

The interrogation of the Call Forwarding service, originally considered, was later discarded. In fact, the activation of this service entails a modification of the dial tone to remind the user of the new status. Therefore there is no point in interrogating the service, since the same information is provided without any specific action every time the handset is picked up.

Each scenario was presented to the users together with name and description of the service and the relevant instructions (annex E).

All ISDN subscribers receive from the public network operator a leaflet (A5 format) containing a description of the user interface (6 pages) and the user manual to access the basic (8 pages) and the supplementary services (10 pages).

These instructions were not used as such in the ISDN experiment for these reasons:

- the three services selected for the test are a subgroup of those described in the leaflet;
- the language used in the leaflet is often technical and not always clear;
- users dislike reading manuals and prefer the trial-and-error approach;
- a telephone set should be as far as possible a self-explanatory device guiding the user through the dialogue by means of prompting and feedback;
- similar test conditions were looked for as in the UPT experiment, for which no leaflet was available.

## 6.6 Test design for ISDN

To evaluate the user performance and satisfaction when using the aforementioned ISDN services, an experiment was designed as similar as possible to the UPT experiment, so as to allow for easy data comparison.

In the ISDN experiment the test subjects were assigned 6 scenarios covering the selected services and their features.

To compensate for any learning effect, two sets of scenarios (i.e. services and relevant features) with different orders of presentation were used, in which deactivation always follows activation:

- 3-Party Conference;
- Call Barring activation;
- Call Barring interrogation;
- Call Barring deactivation;
- Call Forwarding activation;
- Call Forwarding deactivation;

and

- Call Forwarding activation;
- Call Forwarding deactivation;
- Call Barring interrogation;
- Call Barring activation;
- Call Barring deactivation;
- 3-Party Conference.

Half to one hour was taken by each subject to read the instructions, carry out the tasks and answer the questionnaire and the interview.

### 6.7 Test bed for ISDN

The ISDN services were tested directly on the network, accessed through an ISDN telephone set (FACE-ALCATEL).

### 6.8 Data capture for ISDN

Performance data was captured by means of automatic log. A PC equipped with an ISDN board was connected on one of the eight basic accesses on the same bus as the ISDN telephone set. The board recorded in coded form all the keystrokes made by the test subjects, the relevant time and the answers provided by the network.

In addition, user opinions were collected by means of a questionnaire (annex F) and an unstructured interview. The questionnaire was divided into 2 parts and administered after completion of the scenario on the 3-Party Conference and after the completion of the scenarios on the other services.

### 6.9 Subjects

Twenty-seven paid subjects ranging from 18 to 60 years took part in the ISDN experiment. Most of them were students, some were CSELT employees. Only two had participated in the UPT experiment.

### 6.10 Performance data

The performance data collected in the experiment were:

- the failure rate;

- the number of attempts made before performing correctly the tasks concerning the Call Barring and Call Forwarding services;

- the number of unnecessary steps made to complete successfully the task on the 3-Party Conference service;

- the time spent to perform correctly a given task (time of the last attempt, in case of more trials).

The performance data averaged across the subjects is reported in table 6.

**Table 6: Performance data in ISDN**

| ISDN services | Functions | Failures (%) | Unnecessary trials/steps | Performance time (sec) |
|---|---|---|---|---|
| Call Barring | Activation | 0 % | 1,07 | 28,6 s |
| | Deactivation | 0 % | 0,19 | 43,4 s |
| | Interrogation | 0 % | 0,18 | 28,8 s |
| Call Forwarding | Activation | 0 % | 0,52 | 56,2 s |
| | Deactivation | 0 % | 0,15 | 34,1 s |
| 3 Pty Conference | Set-up | 37 % | 3,2 | 506,9 s |

The 3-Party Conference service will be discussed separately from and after Call Barring and Call Forwarding (and relevant functions) because these share a great deal of commonalities.

The first column shows that the tasks relevant to the Call Barring and Call Forwarding were completed by all the subjects successfully.

The inspection of the second column indicates that, though similar in complexity, the five tasks concerning Call Barring and Call Forwarding are characterized by very different numbers of unnecessary trials (= call attempts). In particular, activation of Call Barring and Call Forwarding entailed many more trials than the other three tasks.

This is explained by the fact that in the 2 sets of scenarios, deactivation of either Call Barring or Call Forwarding always followed activation.

Considering the detailed data "Services vs Presentation Order" (table 6a), it can be observed that the learning phase took no more than 2 steps and the asymptotic value is about 0,2 extra trials per subject.

The two data relevant to each service refer to the two sets of scenarios presented to the subjects.

**Table 6a: Error data (services vs order)**

| Services | | Presentation order | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Call Barring | Activation | 0,9 | - | - | 0,1 | - |
| | Deactivation | - | 0,2 | 0,1 | - | - |
| | Interrogation | - | - | 0,1 | - | 0,1 |
| Call Forwarding | Activation | 2,1 | - | - | 0,1 | - |
| | Deactivation | - | 0,2 | - | - | 0,1 |

As to the performance times in the third column of table 6, they refer to the correct task performance (i.e. last trial) and are not cumulative of all the trials made for a given task.

**Table 6b: Time data (services vs order)**

| Services | | Presentation order | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Call Barring | Activation | 28,7 | - | - | 28,5 | - |
| | Deactivation | - | 25,1 | 32,8 | - | - |
| | Interrogation | - | - | 45,1 | - | 41,6 |
| Call Forwarding | Activation | 70,0 | - | - | 43,4 | - |
| | Deactivation | - | 33,1 | - | - | 35,0 |

From the inspection of table 6b reporting the performance times for "services vs presentation order", the learning phase seems to be even shorter than for the error data because the asymptote is reached after one step only. The asymptotic value varies with the service as a function of the length of the relevant procedure: some services require just the service code to be entered, others required more keystrokes (telephone numbers, electronic keys).

The inverted trend of Call Barring activation and Call Forwarding deactivation is only apparent: both the Neuman-Keuls and Tukey's post-hoc tests proved that the differences are not significant.

The average time per keystroke (5 to 7 seconds) is pretty long for this type of services: it reflects the uncertainties about understanding the feedback.

The situation depicted in table 6 as regards the 3-Party Conference service is a dramatic one:

- 37 % of the subjects failed to use the service;

- the extra steps (= logical operations) made in addition to the minimum number (2 steps) required by the optimal user procedure was 3,2, i.e. 150 %. The "logical" steps do not account for all the keystrokes, i.e. pressing numeric keys or inactive function keys;

- the performance time is better representative of this situation. Its exorbitant value (more than 8 minutes) is a clear indicator of the poor usability of the service.

## 6.11    Answers to the questionnaire

The answers are summarized in tables 7 and 8.

**Table 7: Subjective reactions in ISDN**

| Attributes | Conference | Other services |
|---|---|---|
| Overall satisfaction | 3,0 | 4,1 |
| Ease of use of the procedures | 2,9 | 4,3 |
| Understandability of the messages | 2,3 | 3,9 |

Table 7 reports the scores (Likert scales) about the satisfaction on how the service is provided, the ease of use of the procedures and the understandability of the messages presented on the display.

These scores indicate a favourable (but not a very favourable) attitude as to the Call Barring and Call Forwarding services, the lowest score being the one on the messages. Negative assessments have been given to the 3-Party Conference service, especially as regards the understandability of the messages.

Table 8 reports the answers to two questions. The former concerns the agreement on the auditory presentation of the messages; the latter regards the agreement on the provision of the messages both auditorily and visually.

**Table 8: Further questions on ISDN**

| Questions | Mean response |
|---|---|
| Agreement on auditory vs. visual presentation | 3,0 |
| Agreement on auditory and visual presentation | 3,6 |

The results indicate no preference for either mode, probably because the pros and cons compensate each other. A slight agreement has been expressed on the presentation in both auditory and visual mode.

The comments made by the subjects during the task performance and the interview help understand these results.

1) Verbal announcements allow more freedom in the use of the telephone, for example in poorly lighted premises or when the terminal orientation / distance is not optimal. In fact the verbal information can reach the user even if his attention is not focused on the display. The verbal announcements are necessary for blind users. The present Italian ISDN Pilot is a clear step back for this category of users.

   On the other hand, the displayed messages are less ephemeral and can be caught more quickly at a glance;

2) The LCD was readable only with difficulty. Its insufficient tilt made this task even more difficult: the user had to lean over the display or grasp the whole terminal and tilt it as appropriate;

3) There is no point in presenting the verbal announcements also in visual form if display legibility is poor.

Further insight was allowed by the results of the interview.

**6.12    Other subjective results**

Further subjective reactions were collected during the performance of the tasks ("thinking aloud" method) and the interview.

### 6.12.1 Call Barring and Call Forwarding

A significant minority of subjects commented that * and # are symbols, not numbers. Anyway, after the first attempts, they got accustomed to the novelty.

Most complaints concerned the type and content of the feedback which was felt to violate the user model under many respects. In fact, immediately after dialling the service code, a busy tone was issued accompanied by the visual message:

> DISCONNECTED
> LINE ENABLED (or DISABLED)

> or

> DISCONNECTED
> TRANSFER ACTIVATED (or DISACTIVATED).

In the case of successful calls the traditional user procedure was as follows:

- the ringing tone was sent after dialling;
- the remote user answered;
- the busy tone was issued after call termination.

Therefore, according to 50 % of the subjects, hearing a busy tone after dialling had a negative meaning, i.e. the call failed to be answered. This negative feeling was confirmed by the first part of the displayed message

> (DISCONNECTED).

The second part of the message may have been consistent or not with the first one, depending on the message. For example, the feedback message for the activation of the Call Barring service

> DISCONNECTED
> LINE DISABLED

is considered to be consistent, whereas the feedback message relevant to the deactivation of the same service

> DISCONNECTED
> LINE ENABLED

was perceived as inconsistent.

In fact, in the latter case, the second part of the message indicated that it was possible to call, which was denied by the first part.

The situation is complicated by the fact that to some subjects "DISCONNECTED" referred to the service, whereas to other subjects it referred to the line.

In these conditions the subjects' behaviour was twofold:

- some subjects focused only on the meaningful part of the message (e.g. LINE ENABLED) and ignored the remainder;

- most subjects, uncertain about the effect of their action, decided to try again.

Further comments made by the subjects are reported in the following:

1)  Verbal announcements belong to the telephone tradition. Therefore, when the receiver is picked up to make a call (to a person or to a service), a verbal announcement is expected, accompanied or not by a visual message;

2)  At the beginning, it is unnatural to look at the display;

3)  Once a call is completed, a "good-bye" message is usually exchanged before going on-hook. This should apply also to conversations with the system, in which case a prompt message ("Please hang-up") is more appropriate than a feedback message ("Disconnected");

4)  In the Call Barring service, to enable the line it is necessary to deactivate the service (a negative action determines a positive effect);

5)  The service codes are (a) difficult to remember and (b) rather similar, which is potentially confusing;

6)  If the user has activated from a telephone set the Call Forwarding service, upon picking up the receiver he is reminded of the status of the service by a modified dial tone. The tone used is a continuous one, which is confusing, being similar to the Italian congestion tone.

### 6.12.2    3-Party Conference

The comments made by the subjects are summarized below:

1)  The user procedures are easy but guided in incomprehensible way;

2)  The language used in most messages is unclear (e.g. "Intermediate conversation") and technical (e.g. "Release" for "Disconnect" and "3-party Conference" for "3-party Conversation");

3)  The abbreviations of the command names (RIC) and of the messages are ambiguous. Examples:

    -   does CONF. mean CONFIRMATION (37 % of subjects) or CONFERENCE?

    -   does CONVERS. mean CONVERSION or CONVERSATION?

    -   does CHANGE mean to replace one party with another, or to replace a wrongly dialled number with the correct one, or to change from 2-party to 3-party conversation?

    -   why is a 3-party conversation called conference?

4)  The most misleading message was "1: Intermediate convers.", which is displayed immediately after the RIC key has been pressed to invoke the 3-Party Conference service. This obscure message is interpreted as a feedback rather than as a prompt ("Dial 1 to obtain the intermediate conversation"). Therefore the subjects proceed to dial the number of the second user without pressing 1.
    In fact, the user model to set up a 3-Party Conference is the following:

    -   dial the number of the first user;
    -   press RIC to put the first user on hold;
    -   dial the number of the second user;
    -   connect the 3 users together.

    The user expectations are violated because, on the contrary, the RIC key gives access to a number of services selectable by menu. Of these services, only one (the 3-Party Conference) is at present implemented, and therefore the menu consists only of one item. Dialling the number of the second user is only possible after this unique menu item has been selected;

5)  Another common source of complaints was the last step in the user procedure. After dialling the number of the second user, the subject was presented with the following menu:

- 1: Conf.;
- 2: Change;
- 3: Release.

Thirty-seven per cent of the subjects, being unfamiliar with menus or getting confused by the obscure terminology, associated "3" with "3-Party Conference".

6) There is no point in repeating the verbal announcement provided upon activation of the service: "The 3-Party Conference service is activated".

## 6.13 Proposed solutions

The results of the experiment showed that:

### 6.13.1 User procedures

The user procedures for all the services considered are easy-to-use.

### 6.13.2 Service codes

The service codes are difficult to remember. The perplexity caused by the presence of unusual symbols (*, #) is very quickly overcome.

This problem of the codes can only be solved by using an advanced user interface allowing for a more user-friendly style of interaction.

### 6.13.3 User model

Violating the user model causes errors and dissatisfaction. Knowing and taking into account the user expectations is of paramount importance for the success of the services. These expectations concern the respect of:

- the traditional telephone procedures (dialling, communicating, terminating);
- the natural way of conveying information (i.e. the verbal one);
- the traditional meaning of the indications (e.g. busy tone is equivalent to rejection).

### 6.13.4 Feedback and prompts

Good quality of feedback and prompt messages helps improve the user to system interaction. In particular these messages should be meaningful and provided in non technical language.

Consistency between auditory and visual indications is to be ensured. Error handling should also be provided.

The following two examples refer to the activation and interrogation of the Call Forwarding service, respectively.

**Activation**

After dial completion of the service code, the ringing tone should be provided, followed by the message "All incoming calls WILL BE forwarded to the NNN number. Please hang up". Busy tone.
The "Disconnected" message should be replaced by "Please hang up".

**Interrogation**

"All incoming calls ARE forwarded to the NNN number.
Please hang up". Busy tone.

The next examples refer to the 3-Party Conference service:

- The visual prompt message "1: Intermediate conv." should be replaced by: "To call 2nd user: 1" and provided also verbally: "To call the second user press 1".

### 6.13.5 Terminology

Common words are better understood than technical ones or jargon. The same function should be indicated by the same word throughout the service (e.g. "Disconnection" instead of "Disconnection" and "Release").

### 6.13.6 Labels

Full names should be used. If not possible, meaningless and ambiguous abbreviations must be avoided.

### 6.13.7 Tones

The introduction of new auditory indications is to be avoided because of the limited human ability of discrimination. If new tones are to be introduced, these should not be confusable with existing ones.

### 6.13.8 Display

Multimodal provision of the information is advantageous in terms of flexibility and redundancy. Anyway, the potential benefits provided by the addition of a display can be partially nullified by its limited size and poor legibility.

## 7 Conclusions

The two experiments carried out on Phase 1 UPT services and some supplementary services of the Italian ISDN Pilot allowed the collection of data on the usability aspects and the comparison of the performance of different Phone Based user Interfaces.

**Table 9: Comparison between UPT and ISDN**

| Data Measured | UPT Registration Deregistration | ISDN Activation Deactivation Interrogation | ISDN 3-Party Conference |
|---|---|---|---|
| Failures | - | - | 37 % |
| Errors | - | 0,42 | 3,2 |
| Time per keystroke | 4 s | 6 s | 508 s |
| Satisfaction | 4,5 | 4,1 | 3,0 |
| Length of procedures | 4,2 | - | - |
| Ease of procedures | 4,8 | 4,3 | 2,9 |
| Understandability of messages | 4,8 | 3,9 | 2,3 |

The results (table 9) show that:

1)  Users dislike entering long strings of digits;

2)  Mixed codes (symbols and digits) in comparison with numeric only codes are perceived as less easy to use (4,3 in ISDN versus 4,8 in UPT) and are accompanied by longer dialling times (6 s versus 4 s respectively) and higher error rates (0,42 versus 0). This difference will probably soon disappear with practice;

3)  Most service codes, regardless of whether numeric or mixed, are arbitrary and hence difficult to remember;

4)  The user procedures are very easy, with the exception of 3-Party Conference;

5)  Prompting and feedback messages, included error handling, play a fundamental role in the user interaction: easy but poorly guided procedures are responsible for high error rates and

low satisfaction. Meaningfulness and unambiguity of the messages are the most important characteristics to ensure their understandability. The abbreviated, technically worded and too concise ISDN visual messages are less understandable than the UPT verbal announcements (their Mean Opinion Score was 3,9 instead of 4,8).

To conclude, the following considerations can be made. The PBIs are very simple to use and meet the minimum user requirements, but are inadequate for making the access to the services user-friendly.

The main problems are represented by the arbitrary and long service codes, which are difficult to remember and tedious to dial. A satisfactory solution does not exist, as far as PBIs are used: resorting to service directories is unavoidable. It is however possible to reduce the user memory load by harmonizing the service codes and user procedures across the different networks. Also the controls and indications should be standardized.

All the services tested in the experiment can be accessed by means of a PBI, even the 3-Party Conference service which has the most complicated user procedure. Anyway, the user interaction can be significantly improved by complying with the user expectations and by making the user interface a self-explanatory one. This can be achieved by guiding the user in the service navigation, i.e. by carefully designing the prompting and feedback announcements. Good user guidance is essential if manuals are to be eliminated.

The use of PBIs equipped with dedicated keys and a small display may further improve the dialogue. In fact, the user indications can be provided in both auditory and visual mode, thus improving the redundancy of the information and the flexibility of use.

Unfortunately, these benefits are often of marginal importance, due to the limited size and poor legibility of the displays.

Besides, the greater complexity of the terminal might entail reading a manual (at least once), which reduces the user satisfaction.

The best solution is probably represented by more user-friendly telephone interfaces able to transfer the psycho-cognitive load of the tasks from the user to the terminal. This can be achieved by using speech recognition technology (ASR) or screen phones.

ASR is not mature enough and does not allow for a natural interaction because of its constraints on how the user has to speak and of the still relatively high error rate. Besides, recent studies [5] revealed that users are reluctant to use this new technology when alternative input modes exist.

The screen phones seem to be a promising solution. Their real possibilities should be assessed experimentally.

## Annex A:    User-to-system interaction in the UPT services

## A.1    UPT registration

All user inputs are via a 12 key keypad. All system messages are provided as verbal announcements and tones. There is no supporting visual display.

### A.1.1    Procedure

| User | System |
|---|---|
| Goes off hook and (within 9 s) dials the access code 1484. | "Please dial your Personal Number. Thank you". |
| Dials (within 12 s) his/her PN. | "Please dial your identification code. Thank you". |
| Dials (within 12 s) his/her PIN. | "Please dial the function code". |
| Dials (within 12 s) the appropriate function code. | "Please dial the desired number. Thank you". |
| Dials (within 12 s) the desired number. | Forwards the call after 9 seconds, then sends a short piece of music and the message: "Your entry has been recorded. Please hang up" repeated twice. Then the busy tone is issued and the user is disconnected. |

### A.1.2    Remarks

1)    If the user, after going off hook, does not dial the access code within 9 seconds, the system sends the busy tone and disconnects.

2)    If the user, after being prompted by the message to enter the PN or the PIN or the function code or the desired number, does not enter any digit within 12 seconds, the message is repeated. If again no action is taken by the user, the system sends the busy tone and disconnects the user. Example:

| User | System |
|---|---|
| Goes off hook and (within 9 s) dials 1484. | "Please dial your Personal Number. Thank you". [12 s] |
| No action. | "Please dial your Personal Number. Thank you". [12 s] |
| No action. | Busy tone. Disconnection. |

3)    If the user dials a wrong / non-existent access code, PN, PIN or function code, the system adopts the same error recovery strategy as in the previous bullet point.

4)    If the user, at the end of the procedure, does not wish to wait 9 seconds for the call being forwarded, he can press #: the piece of music is issued immediately, followed by the message "Your entry has been recorded. Please hang up" repeated twice and the busy tone.

5)    The user can dial ahead or through any prompting or feedback message.

## A.2    UPT deregistration

### A.2.1    Procedure

| User | System |
|---|---|
| Goes off hook and (within 9 s) dials the access code 1484. | "Please dial your Personal Number. Thank you". |
| Dials (within 12 s) his PN. | "Please dial your identification code. Thank you". |
| Dials (within 12 s) his PIN. | "Please dial the function code". |
| Dials (within 12 s) the appropriate function code. | Sends a short piece of music and the message: "Your entry has been recorded. Please hang up" repeated twice. Then the busy tone is issued and the user is disconnected. |

### A.2.2    Remarks

The same remarks apply as for Registration.

## A.3    UPT outcall

### A.3.1    Procedure

| User | System |
|---|---|
| Goes off hook and (within 9 s) dials the access code 1484. | "Please dial your Personal Number. Thank you". |
| Dials (within 12 s) his PN. | "Please dial your identification code. Thank you". |
| Dials (within 12 s) his PIN. | "Please dial the function code". |
| Dials (within 12 s) the appropriate function code. | "Please dial the desired number. Thank you". |
| Dials (within 12 s) the desired number. | Forwards the call after 9 seconds, then sends the message: "Your call was successful" instead of the ringing tone. |

## Annex B: Instructions and scenarios for UPT services

### B.1 UPT registration

You are waiting for an important call but you have been invited by friends to dinner.

As soon as you arrive at your friends' home you register at their phone for the incoming calls: you use the PERSONAL MOBILITY SERVICE to communicate the telephone number at which you wish to be reached from that moment on.

To do so you dial the Service Access Code, 1484, and follow the instructions given through the telephone.

Please remark that:

- your Personal Number is 56 789;
- your Personal Identification Number is 12 345;
- the function code is 1;
- the Telephone Number of your friends is 011/22 86 166.
- After dialling the last digit press #.

### B.2 UPT deregistration

You have been in Rome on business for a week and have used the telephone of your office in Rome as your personal phone.

Before leaving you de-register for the incoming calls by means of the PERSONAL MOBILITY SERVICE. In this way the calls sent to you will reach again your usual telephone number.

To do so you dial the Service Access Code, 1484, and follow the instructions given through the telephone.

Please remark that:

- your Personal Number is 56 789;
- your Personal Identification Number is 12 345;
- the function code is 0.

### B.3 UPT outcall

You are visiting your mother-in-law and need to make a long distance call. Since you do not like to charge your call on her telephone bill, you register at her telephone number.

This means that you will use the PERSONAL MOBILITY SERVICE which allows you to use any telephone set to make a call the cost of which will be charged on your bill.

To do so you dial the Service Access Code, 1484, and follow the instructions given through the telephone.

Please remark that:

- your Personal Number is 56 789;
- your Personal Identification Number is 12 345;
- the function code is 8;
- the telephone number of the subscriber you like to call is 06/23 45 678.
- After dialling the last digit press #.

## Annex C:    Questionnaire on UPT Services

Now express your agreement/disagreement on the following statements:

### 1. I am very satisfied with how the service is provided.

Quite                                                           Quite
Disagree                                                        Agree

-------         -------         -------         -------         -------
   1               2               3               4               5


### 2. The operations required by the service are very short.

Quite                                                           Quite
Disagree                                                        Agree

-------         -------         -------         -------         -------
   1               2               3               4               5


### 3. The operations required by the service are very easy.

Quite                                                           Quite
Disagree                                                        Agree

-------         -------         -------         -------         -------
   1               2               3               4               5


### 4. The messages are very understandable.

Quite                                                           Quite
Disagree                                                        Agree

-------         -------         -------         -------         -------
   1               2               3               4               5

## Annex D: User-to-system interaction in the ISDN services

### D.1 ISDN Call Barring (activation)

#### D.1.1 Procedure

| User | System |
|---|---|
| Goes off hook | dial tone + DIAL (on display) |
| Starts dialling (within 9 s): *3... | DIALLING IN PROGRESS (*3...) |
| Completes dialling: *33* | DISCONNECTED. DISABLED LINE (on display) + busy tone. |

#### D.1.2 Remarks

1) If the user, after going off hook, does not start dialling within 9 seconds or interrupts dialling for more than 9 seconds, the system sends the busy tone and disconnects.

2) If the user dials a wrong / non-existent code, the system sends the vocal announcement "SIP. Complimentary information. The number you have dialled does not exist. Please check your number".

### D.2 ISDN Call Forwarding Unconditional (activation)

#### D.2.1 Procedure

| User | System |
|---|---|
| Goes off hook | dial tone + DIAL (on display) |
| Starts dialling (within 9 s): *21... | DIALLING IN PROGRESS (*21...) |
| Completes dialling: *21*555555# | DISCONNECTED. TRANSFER ACTIVATED (on display) + busy tone. |

#### D.2.2 Remarks

The same remarks apply as for Call Barring.

### D.3 ISDN Three-Party Conference

#### D.3.1 Procedure

| User | System |
|---|---|
| Goes off hook | dial tone + DIAL (on display) |
| Starts dialling telephone number of first user: 111... | DIALLING IN PROGRESS (111...) |
| Completes dialling: 111111 | DIALLING COMPLETED (111111) |
| | FREE (111111) + ringing tone |
| | CONNECTED (111111) |
| Presses RIC key | 1:INTERMEDIATE CONVERS. |
| Presses 1 | dial tone + DIAL (on display) |
| Dials telephone number of second user: 222222 | DIALLING COMPLETED (222222) |
| | FREE (222222) + ringing tone |
| | CONNECTED (222222) |
| | (after 5 s) 1:CONFER. 2:CHANGE 3:RELEASE |
| Presses 1 | CONFERENCE. 1: RETURN + verbal announcement "The 3-party conference service has been activated" |
| Goes on-hook | Display clears |

#### D.3.2 Remarks

The same remarks apply as for Call Barring.

## Annex E:    Instructions and Scenarios for the ISDN Services

## E.1    ISDN Call Barring

### E.1.1    ISDN Call Barring - Activation

You are leaving for a few days and like barring the outgoing international calls to prevent your son from calling his friends overseas.

Therefore you dial *33# and then hang up.

### E.1.2    ISDN Call Barring - Deactivation

Back home from your trip you re-enable your phone for the international calls. Therefore you dial #33* followed by your PIN number and #. Then you hang up.

Your PIN is 1307.

### E.1.3    ISDN Call Barring - Interrogation

You do not remember whether the outgoing international calls are barred from your phone. Therefore you dial *#33#.

Then you hang up.

## E.2    ISDN Call Forwarding

### E.2.1    ISDN Call Forwarding - Activation

You are leaving for your country-house where you will be spending the weekend. You want your incoming calls to reach you there. Therefore you dial *21* followed by the telephone number of your country-house and #. Then you hang up.

The telephone number of your country-house is 228 6166.

### E.2.2    ISDN Call Forwarding - Deactivation

Back home from your weekend in the country-side you want your incoming calls to reach you again at your usual telephone address. Therefore you pick up the receiver and, upon hearing a continuous tone (replacing the dial tone to remind you that the service is active), dial #21#. Then hang up.

## E.3    ISDN Three-Party Conference

You want to organize an excursion with a couple of friends, Frank and Paul. To reach an agreement on the departure time you use the 3-Party Conference service.

Therefore, you start by calling Frank, press the RIC key and follow the instructions given on the display to call Paul.

When Paul answers, you follow the instructions given on the display to put all the three of you in communication.

After a short conversation with your friends you hang up.

Your friends' telephone numbers are:

    Frank: 228 6193
    Paul: 228 6119

## Annex F: Questionnaire on ISDN Services

Now express your agreement/disagreement on the following statements:

**1. I am very satisfied with how the service is provided.**

Quite                                                                    Quite
Disagree                                                                 Agree

-------      -------      -------      -------      -------
  1            2            3            4            5

**2. The operations required by the service are very easy.**

Quite                                                                    Quite
Disagree                                                                 Agree

-------      -------      -------      -------      -------
  1            2            3            4            5

**3. The messages are very understandable.**

Quite                                                                    Quite
Disagree                                                                 Agree

-------      -------      -------      -------      -------
  1            2            3            4            5

**4. The messages should be provided verbally instead of visually.**

Quite                                                                    Quite
Disagree                                                                 Agree

-------      -------      -------      -------      -------
  1            2            3            4            5

**5. The messages should be provided both verbally and visually.**

Quite                                                                    Quite
Disagree                                                                 Agree

-------      -------      -------      -------      -------
  1            2            3            4            5

## History

| Document history | |
|---|---|
| October 1996 | First Edition |
| | |
| | |
| | |
| | |