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Contents

Intellectual Property Rights 6
Foreword 6
Executive summary 6
Introduction 7
1 Scope 10
2 References 10
3 Definitions, symbols and abbreviations 14
3.1 Definitions 14
3.2 Symbols 16
3.3 Abbreviations 17
4 Mandated reviews 18
4.1 Review of mandate references 18
4.1.1 Council directive on implementation of ONP 18
4.1.2 Directive on ONP 18
4.1.3 The Gagliardi report 19
4.2 ETSI tone standardization activities 20
4.2.1 Locally generated tones 20
4.2.2 Network tones 20
4.3 ITU-T activities 20
4.3.1 Study groups 20
4.3.1.1 SG 1 - service definition 21
4.3.1.2 SG 12 - transmission performance of telephone networks and terminals 21
4.3.2 CCITT/ITU-T Recommendations 22
4.3.2.1 E series Recommendations 22
4.3.2.2 F series Recommendations 22
4.3.2.3 P series Recommendations 23
4.4 Existing tones 23
4.4.1 Europe 23
4.4.1.1 The data sources 23
4.4.1.2 The key findings 24
4.4.2 World-wide 27
4.4.3 Standards 28
4.5 Human factors research and reports 29
5 Technology issues 29
5.1 Network aspects 29
5.1.1 Public networks 29
5.1.2 Corporate networks 30
5.2 Terminal aspects 30
5.2.1 Terminal requirements 30
5.2.2 Terminal technology 31
6 Regulatory aspects 32
6.1 Terminals - the present 32
6.1.1 Call progress monitoring 32
6.1.2 Automatic initiation of dialling 32
6.1.3 Automatic control of call progress 33
6.1.4 Repeat call attempts 33
6.2 Terminals - the future 33
6.3 Networks 34
7 User aspects 34
7.1 Human factors research 35
7.1.1 Human perception of sounds 35

7.1.2 Coding and capacity ... 35
7.1.3 Tone discrimination ... 36
7.1.4 Confusion between tones ... 37
7.1.5 Recognition time and errors ... 37
7.1.6 Warning tones and urgency ... 37
7.1.7 Preference and attitude ... 37
7.1.8 Alternatives to tones ... 38
7.2 User requirements ... 38
7.3 Additional HF considerations ... 39
7.3.1 Tones and network usability ... 39
7.3.2 User/network interaction ... 40
7.4 Development of a model to facilitate categorization and description of tones ... 41
7.4.1 Analysis of tasks ... 41
7.4.2 A first model ... 43
7.4.3 Categorization of tones ... 44
7.4.4 Use of model for description of tones ... 44
7.4.5 A new model ... 46
7.4.6 Summary of model features ... 48
7.5 Assessment of tone signals for usability ... 48

8 Potential for harmonization of network tones ... 49
8.1 An audit of European network information tones ... 49
8.2 Results of tones audit ... 51
8.2.1 Audit of tone "Dial" ... 51
8.2.1.1 Dial tone - functional definition ... 51
8.2.1.2 Position in HF model for Dial tone ... 51
8.2.1.3 HF model characteristics for Dial tone ... 51
8.2.1.4 Current European practice for Dial tone ... 51
8.2.1.5 European mode for Dial tone - characteristics ... 52
8.2.1.6 International standards for Dial tone ... 52
8.2.1.7 Human factors issues for Dial tone ... 52
8.2.1.8 Review of options for Dial tone ... 53
8.2.1.9 Implications of options for Dial tone ... 53
8.2.1.10 Recommendations for Dial tone ... 54
8.2.2 Audit of tone "Ringing" ... 55
8.2.2.1 Ringing tone (also known as Ring tone) - functional definition ... 55
8.2.2.2 Position in HF model for Ringing tone ... 55
8.2.2.3 HF model characteristics for Ringing tone ... 55
8.2.2.4 Current European practice for Ringing tone ... 56
8.2.2.5 European mode for Ringing tone - characteristics ... 56
8.2.2.6 Existing international standards for Ringing tone ... 57
8.2.2.7 Human factors issues for Ringing tone ... 57
8.2.2.8 Review of options for Ringing tone ... 58
8.2.2.9 Implications of options for Ringing tone ... 59
8.2.2.10 Recommendations for Ringing tone ... 60
8.2.3 Audit of tone "Busy" ... 61
8.2.3.1 Busy tone - functional definition ... 61
8.2.3.2 Position in HF model for Busy tone ... 61
8.2.3.3 HF model characteristics for Busy tone ... 61
8.2.3.4 Current European practice for Busy tone ... 62
8.2.3.5 European mode for Busy tone - characteristics ... 62
8.2.3.6 Existing international standards for Busy tone ... 62
8.2.3.7 Human factors issues for Busy tone ... 63
8.2.3.8 Review of options for Busy tone ... 63
8.2.3.9 Implications of options for Busy tone ... 64
8.2.3.10 Recommendations for Busy tone ... 66
8.2.4 Audit of tone "Special Information" ... 66
8.2.4.1 SIT - functional definition ... 66
8.2.4.2 Position in HF model for SIT ... 66
8.2.4.3 HF model characteristics for SIT ... 66
8.2.4.4 Current European practice/functions ... 67

8.2.4.4.1 Current European practice for SIT 67
8.2.4.4.2 Current European practice reported for number unobtainable tone 67
8.2.4.4.3 Current European functions reported for tones with similar characteristics to the ITU-T definition 67
8.2.4.5 European mode for SIT - characteristics 67
8.2.4.6 Existing international standards for SIT 68
8.2.4.7 Human factors issues for SIT 68
8.2.4.8 Review of options for SIT 69
8.2.4.9 Implications of options for SIT 69
8.2.4.10 Recommendations for SIT 70
8.2.5 Audit of tone "Call Waiting" 70
8.2.5.1 Call Waiting tone - functional definition 70
8.2.5.2 Position in HF model for Call Waiting tone 70
8.2.5.3 HF model characteristics for Call Waiting tone 70
8.2.5.4 Current European practice for Call Waiting tone 71
8.2.5.5 European mode for Call Waiting tone - characteristics 71
8.2.5.6 Existing international standards for Call Waiting tone 71
8.2.5.7 Human factors issues for Call Waiting tone 72
8.2.5.8 Review of options for Call Waiting tone 72
8.2.5.9 Implications of options for Call Waiting tone 73
8.2.5.10 Recommendations for Call Waiting tone 73
8.2.6 Audit of tone "Pay" 73
8.2.6.1 Pay tone - functional definition 73
8.2.6.2 Position in HF model for Pay tone 74
8.2.6.3 HF model characteristics for Pay tone 74
8.2.6.4 Current European practice for Pay tone 74
8.2.6.5 European mode for Pay tone - characteristics 74
8.2.6.6 Existing international standards for Pay tone 75
8.2.6.7 Human factors issues for Pay tone 75
8.2.6.8 Review of options for Pay tone 75
8.2.6.9 Implications of options for Pay tone 76
8.2.6.10 Recommendations for Pay tone 77

9 Costs and benefits of change 77
9.1 Costs 77
9.2 Benefits 77
9.3 Negative aspects of change 78

10 Conclusions and recommendations 78

History 83

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Foreword

This Technical Report (TR) has been produced by the ETSI Technical Committee Human Factors (HF).

The present document is part 1 of a multipart TR covering the European harmonization of network generated information tones as identified below:

Part 1: A review and recommendations;

Part 2: Listing and analysis of European, World and Standardized tones.

The intended users of the present document include:

Table 1: Intended users and potential benefits

	User	TR used for	Potential benefit
1	Manufacturers, network operators, and other developers and providers of telecommunications networks and services.	Allocation and specification of network generated tones and their technical characteristics.	Improved usability through harmonized application of tones in networks.
2	Designers and users of networks and telecommunications services.	Ensuring conformance with meaning and characteristics for individual tones for existing and new services.	Improved usability through easier identification and verification of tones and their meaning.
3	ETSI Technical Committees and end-users.	Development and upgrading of network services.	Improved usability of national and international services by ensuring consistency with user needs.

Executive summary

In accordance with a commission mandate following a study carried out by Professor D. Gagliardi, a further study has been made within ETSI on the set of ten specified tones, and a report has been prepared that gives a number of recommendations on those tones described by Professor Gagliardi as the priority set.

The study has included an extensive review of the standards originating from the ITU-T, CEPT and ETSI, and a very detailed review of the existing tones used in the European Union, in the countries of the ETSI members and in other countries world-wide.

This review of existing tones has been reproduced in a second part of the report and represents the most detailed listing of European and world wide tones that is currently available.

The report of the study deals with the technological factors in the network and in terminals which affect the generation and detection of tones.

It also describes in detail the present regulatory requirements with respect to tones as they affect telecommunications terminals and foresees the potential for simplification arising from future standardization.

The report makes wide ranging survey of the research on the human perception of sounds and of the human capacity to discriminate, recognize and correctly identify coded meanings present in information tones. It treats the ability to discriminate between tones, possible confusion between tones, recognition time and errors.

It discusses possible alternatives to tones, and also deals with human preferences, usability and user network interaction.

The study has revealed surprising gaps in the corpus of knowledge on telecommunications service tones and of their perception by users. It has identified that the tone most highly standardized in characteristics (Special Information Tone (SIT)) is so little harmonized in its usage as to create significant usability problems, both to human users and terminal equipment. It notes that Pay tone is not a network tone, being generated in the terminal where payment is made and that one ETSI specified tone (Call Waiting tone) is not in accordance with ITU-T Recommendations.

The study has found that in a number of countries, tones with characteristics similar to standard tones are used for non standard purposes. This can create great confusion to travellers in the EU and proposals are made to correct this situation.

The study has also identified the need to regulate the provision of tones by the increasing number of new network operators so as to prevent the unnecessary and confusing proliferation of new tones. It does note, however, the possible demand from some of these new operators to provide a "Corporate Identity" which might possibly be expressed in some of their tones.

Arising from the study, a model has been created which can be used to correct some of the problems noted. The model will require further experimental testing, but it is hoped that it will prove useful in the future for the creation of new tones in such a way that the characteristics of a tone denote the action required by the user so that he may carry out his task without needing to recognize an individual tone, only its characteristics.

Recommendations are made that further research is carried out on aspects of the model in order to quantify the benefits of some of the indicated changes so as to determine whether they are worthwhile.

The study concludes with an audit of the prime candidates for harmonization identified by Gagliardi and makes specific recommendations for each of these. It also identifies a small number of new candidate tones, not previously identified by Gagliardi, that could provide benefit from harmonization.

Introduction

Since public telephone networks were introduced at the turn of the century, end-users, or "subscribers" have been familiar with feedback to convey information from the network to the user regarding the status of a call. In the early days, most of this information was conveyed to the user in plain language by the telephone operator, who was able to interpret network status. Information from the user to the network was also verbal, with the (no longer familiar) dialogue "number please" from the operator, and a user response "ABC123", or even "Mrs Jones at No 24", etc. Paradoxically, some networks are now reverting to plain language recorded voice announcements for information to the user about many functions.

Coding such feedback information using audible tones of various kinds commenced when automatic exchanges were introduced in the early 1920s, when, under normal conditions, a user no longer had any need for operator intervention, except for "trunk calls". As services were more automated and proliferated for direct access by a subscriber utilizing a telephone dial, so more information was, of necessity, provided in the network for presentation to the user as tones.

This usage has continued to develop, partly technology-led, and particularly since the advent of "subscriber trunk dialling", both for domestic and international calls (introducing "foreign" tones), to arrive at today's position, when in some 15 countries in the European Union (EU), and 174 world-wide, some 228 tones are defined as in use in Europe alone.

Besides being used as feedback and as a means of communicating from the network to the user, audible tones may also be used by connected terminals for automatic recognition. In both cases the tones have specific meanings and must be recognized unambiguously. Whilst machine recognition may be able accurately and reliably to detect and differentiate on an absolute basis between differences in frequency of a few hertz, the human user has a much more limited recognition capability, especially in terms of long term retention of the meanings of tones.

The CCITT, now ITU-T, was from early on aware of the potential problem that differences between national network tones would cause for users, and by Recommendations, standardized the parameters for audible tones for use in public networks, both by describing the function represented by the tone code, such as "dial", "ring", or "busy", and also aspects such as audio frequency and cadence and other signal parameters to ensure compatibility between networks. This awareness may have also have been technology-led by the necessity to detect such tones also by automatic means in exchanges and other connected terminals, such as answer machines.

However, consideration was also given to the user, and an example of this early concern from nearly 30 years ago is given by Karlin [1], when the CCITT discussed a contribution based on experimental evidence from five different countries, which showed the degree of confusion that then existed between identification of "ringing" and "busy" telephone signals. Although reasonably well defined for any one nationality of telephone users, tones for these functions differed appreciably among different nationalities, to the point that variation between different national networks led to confusion among user in one country regarding the meaning of some foreign telephone tones. Some principles derived from that work led to a predictive model that it was proposed could be used to devise standards for an international ringing and busy tone. No action followed, however. It should be noted that ITU-T still has a work item on world tones, (see subclause 4.3.1.1).

Notwithstanding ITU-T recommendations and their supplements, expansion of telephone networks and services world-wide, has led to a proliferation of tones. The number of different tones now exceeds one hundred, and leads to confusion and potential error by the users. This has been recognized in a review carried out for the CEC in 1993 by Gagliardi [2], who proposed that standardization and harmonization of network tones between European countries should take place, and certainly within those countries of the EU. The European Commission has endorsed the importance of this proposal, and its relevance to Council Directive 90/387/EEC [3] on the establishment of an open market. Accordingly, Directorate General III issued a CEC Mandate, BC-T-308 [4], to ETSI to investigate in detail the possibilities for specification of the technical characteristics of a limited number of network-generated tones and their eventual harmonization within the EU, Europe and globally.

The present document reports on the work proposed by DGIII, cited in a technical annex to the CEC Mandate [4]. The main aim of the project was to develop proposals on the most appropriate technical characteristics and human factors aspects of telephone service tones generated by public networks, in order to prepare for any future harmonization. This would be achieved by performing the following specific tasks:

- review and follow-up of standardization activities in ITU-T;
- review the different existing tones in Europe and world-wide;
- review relevant research and reports regarding human factors with service tones;
- review references made in the CEC Mandate [4] and the existing ETSI work on the subject of the characteristics of telephone tones when locally generated in terminals and connected private networks.

The Technical Annex to the CEC Mandate [4] defined six tones and specifically suggested them as priority candidates for standardization, including:

- dial tone;
- ringing tone;
- busy tone;
- special information tone;
- call waiting tone;
- pay tone.

A further set of four tones were suggested as possible candidates, including:

- special dial tone;
- positive indication tone;
- intrusion tone;
- congestion tone.

Additional tones for other functions were also to be considered for standardization if they were regarded as necessary, or others may be excluded. A review of World tones has also been included in this report for completeness, and in consideration of current ITU-T activity in this area. Technical and economic factors were also to be taken into account and some guidance given on the testing and assessment of (old and new) tones.

The present document contains summaries of the reviews listed above and discussions of the findings, together with conclusions and recommendations, including some other possible candidate functions for which tones may be appropriate (see subclause 4.2 and part 2).

The starting position for the work is documented and an examination carried out of the human factors and technical background and future possibilities for fixed and mobile radio network tones as they exist today within Europe and globally. Connections to private or corporate networks were included as part of the Mandate. Although mobile networks are outside the scope of Directive 95/62/EC [5] on the application of Open Network Provision (ONP) to voice telephony, they have been included in this study because of the requirement for interworking with public telephony services. A number of options for harmonization have been explored and evaluated, within the study's limited resources, for cost and the feasibility and time scale for technical implementation. An attempt has also been made to predict user attitudes to changing tones if harmonization demands it, and the resources and methodology to manage and evaluate such changes.

Because network tones are a matter for regulation at the national level, this aspect has been explored and is reported on. The second part of the ETR lists and analyses details of tones as used by European and some world network.

1 Scope

The present document is the first part of a Technical Report (TR) that reports the results of a project carried out under the CEC Mandate [4] to study and investigate the potential harmonization of telephone information tones generated by public networks.

The present document reviews:

- standardization activities in the area of tones in ITU-T and ETSI;
- the different existing tones currently in use in Europe and world-wide;
- relevant human factors research relating to service tones;
- technology of tone production;
- references made in BC-T-308 [4] and existing ETSI work on the characteristics of telephone tones when locally generated in terminals and connected private networks.

Based on the reviews, the potential harmonization of tones has been studied in depth. The implications of a number of options are included in the present document, which includes consideration of the following topics:

- human factors such as recognition and differentiation of tones by the user;
- technological factors;
- implications for terminals;
- national regulatory aspects;
- cost/benefit estimates;
- possible implementation strategies and difficulties.

Recommendations are made for the tones most appropriate for harmonization and for their technical characteristics. Guidance is given for a common approach to user testing for discriminability of tones and their interpretation by the user.

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.

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[71] ITU-T Recommendation E.163 (08/92): "Numbering plan for the international telephone service".

[72] 92/264/EEC: Council Decision of 11 May 1992 on the introduction of a standard international telephone access code in the Community.

[73] ETR 329 (1996): "Guidelines for procedures and announcements in Stored Voice Services (SVS) and Universal Personal Telecommunication (UPT)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply (in the case of tones, they are defined as in CCITT Recommendation E.182 [6], or source referenced):

alerting signal: A signal (commonly acoustic) produced by a terminal equipment to advise the called party of an incoming call.

announcement (also referred to as voice announcement): An audible indication in the form of speech, utilized for information, instructions and guidance in the telephone service (see also ETR 131 [7]).

audible indication: An audible indication is understood to be a sound composed of frequencies within the range 300 - 3 400 Hz which is used to inform the user about the state of a telephone call or supplementary service (from CCITT Recommendation E.182 [6]).

busy tone: A tone advising the caller that the telephone is busy (from CCITT Recommendation E.182 [6]).

cadence: The pattern of sound/silence in a tone which gives it a characteristic rhythm.

call waiting tone: A tone advising the user of the call waiting supplementary service who is engaged on a call that someone is attempting to call his number (from CCITT Recommendation E.182 [6]).

caller waiting tone: A tone advising a caller that a called station, though busy, has a call waiting service active (from CCITT Recommendation E.182 [6]).

comfort tone: A tone advising that the call is being processed and that the caller should wait (from CCITT Recommendation E.182 [6]).

confirmation tone: A tone used in some exchanges in place of an announcement to indicate that an interrogated service is active (from BS 6305 [8]).

congestion tone: A tone advising the caller that the groups of lines or switching equipment necessary for the setting-up of the required call or for the use of a specific service are temporarily engaged (from CCITT Recommendation E.182 [6]).

dial tone: A tone advising that the exchange is ready to receive call information and inviting the user to start sending call information (from CCITT Recommendation E.182 [6]).

discriminability: The characteristics of a tone which allows a human user to recognize one tone from another, by for example, frequency or cadence.

earcon: Small meaningful musical phrase, used to provide information on operation.

feedback: Information with respect to the state of the system (terminal, network, or service) that is provided to a user in response to their previous control action. Feedback includes confirmation indications, error indications and status information, as well as implicit or explicit guidance information that further control action may, or may not, be required (see also prompts and ITU-T Recommendation F.902 [9].)

frequency: The characteristic of a telephone tone which determines its pitch, expressed in hertz.

holding tone: A tone assumed to have the same meaning as "tone on hold".

intercept tone: (Also known as intercept treatment tone). A tone indicating that the call cannot be completed by the switching system (cf. as number unobtainable tone).

intrusion tone: A tone during a call advising participants in the call that the privacy of the conversation has been breached, e.g. by intervention of an operator (from CCITT Recommendation E.182 [6]).

Man Machine Interface (MMI): The interface through which a user communicates with a telecommunications terminal or via a telecommunications terminal to a telecommunications service provider.

negative indication tone: A tone telling a subscriber that the request for service cannot be accepted (from CCITT Recommendation E.182 [6]).

nominal value: The stated target figure for a given parameter, may be expanded by a tolerance to include an envelope of values equally spread around the nominal value. The distribution of values should reflect a normal curve with high kurtosis.

number unobtainable tone: (Also known as connection not admitted indication). A tone indicating that the number dialled has not been recognized by the network as valid (ITU-T do not define a tone with this title, but their definition of "special information tone" includes the condition to be indicated, CCITT Recommendation E.182 [6]).

on/off ratio: The quotient of the total time a tone is on during one cadence pattern, divided by the total time of the intervening silences. A tone with a cadence of 0,5 s on and 0,5 s off (usually shown as **0,5** - 0,5) has an on/off ratio of 1. A tone with a cadence of **0,05** - 0,5 has an on/off ratio of 0,1. Therefore on/off ratios <1 are mostly silence with short bursts of tone, and on/off ratios >1 are mostly tone with short bursts of silence (in duty cycle terms - low vs. high duty cycle, as opposed to short vs. long which is equivalent to period).

operator intervening tone: See warning tone - operator intervening and intrusion tone.

pay tone: A tone advising users of a payphone that a payment is required (from CCITT Recommendation E.182 [6]).

payphone recognition tone: A tone advising a public exchange operator that the termination to or from which connection is sought is identified as a payphone (from CCITT Recommendation E.182 [6]).

period: The total length of time required to complete one cadence pattern.

positive indication tone: A tone telling a subscriber controlling a supplementary service that a control procedure has been successfully completed and accepted (from CCITT Recommendation E.182 [6]).

pre-emption tone: This is a new tone that should be required by any multilevel precedence and pre-emption service. The purpose of tone is to tell the user their call is being disconnected.

prompts: Information presented to the user that a particular service state is current and a control action is expected in order for the service state to be changed.

recall dial tone: (Also known as stutter dial tone and transfer dial tone). A modified dial tone indicating that an operating feature is activated that requires presentation of a second dial tone (one having the same meaning as "special dial tone").

record tone: A tone generated by a voice messaging system or by automatic answering equipment to inform the calling user when to start talking in order to record a message (see also CCITT Recommendation E.182 [6] and ISO/IEC 13714 [10]).

ringing tone: A tone advising the caller that a connection has been made and that a calling signal is being applied to a telephone number or service point (from CCITT Recommendation E.182 [6]).

route tone: A tone assumed to have the same meaning as "comfort tone".

rhythm: The subjective effect, or perception, of cadence.

second dial tone: A tone advising the caller that the network has accepted the call information already sent and asking the caller to provide more information (from CCITT Recommendation E.182 [6]).

special dial tone: A tone advising that the exchange is ready to receive call information and inviting the user to start sending call information, at the same time reminding the user that special conditions apply to the termination from which the call is being made (from CCITT Recommendation E.182 [6]).

special information tone: A tone advising the caller that the called number cannot be reached for reasons other than "subscriber busy" or "congestion". The tone may also be used in conjunction with recorded announcements to signify that what the caller is about to hear is a recording. It should always be used to precede all call failure announcements (from CCITT Recommendation E.182 [6]).

stored voice service: A telecommunications service that involves the use of stored (pre-recorded) announcements and (recorded) messages.

subscriber: The person or organizational body who has made arrangements with a network operator to have connection with a telecommunications network and who may make arrangements with a service provider for the provision of services via that network.

terminal: A device connected to a network providing the man machine interface to that network, through which a user makes use of telecommunications services.

tolerance: The acceptable variation or margin of error around a nominal value for a given parameter.

tone on hold: A tone used to reassure a calling user who has been placed on "hold" by a subscriber with the Hold supplementary service, PABX or other facilities (see CCITT Recommendation E.182 [6]).

tone: A tone is an audible indication comprising a small number of discrete frequencies, but excluding speech (from CCITT Recommendation E.182 [6]). Examples are dial tone or special announcement tone (see separate definition for each tone).

user: The person who uses a telecommunications terminal to gain access and control of a telecommunications service. The user may, or may not be the person who subscribes to the provision of the service. Also, the person may, or may not be a person with an impairment, e.g. elderly or disabled.

valid tone: Used in Greece on their radio paging network, it has the same characteristics as their positive indication tone.

warning tone - operator intervening: Wording used in ITU-T Recommendation E.180 Supplement 2 (Series E) [11], assumed to have the same meaning as "intrusion tone".

warning tone: A tone warning participants in a call that the privacy of a conversation cannot be ensured where a recording machine is being used (from CCITT Recommendation E.182 [6]).

3.2 Symbols

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

/	Used within the frequency descriptions in the tone tables to signify a sequence of frequencies e.g. 950/1 400/1 800 equates to a burst of 950 Hz followed by a burst of 1 400 Hz followed by a burst of 1 800 Hz.
//	Sometimes used within the frequency descriptions in the tone tables to signify an alternative frequency may be used on some exchanges, e.g. 400//450 equates to a tone of 400 Hz is used in some exchanges and of 450 Hz in other exchanges.
+	Used within the frequency descriptions in the tone tables to signify a combination of frequencies e.g. 375 + 450 equates to a dual frequency tone with both frequencies given simultaneously.
±	Used within the frequency descriptions in the standards tone tables to signify a tolerance in relation to a nominal frequency, e.g. 425 ± 15 Hz, (see tolerance in subclause 3.1).
×	Used within the frequency descriptions in the tone tables to signify that the first frequency is modulated by the second.
?	Used within the tables to signify that the information is given as recorded in ITU-T Recommendation E.180 Supplement 2 (Series E) [11] but is thought possibly to be erroneous.

3.3 Abbreviations

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

2nd Dial	Second Dial tone
ac	alternating current
ADSI	Analogue Display Services Interface
BS	British Standard
C-Wait	Call Waiting tone
CCBS	Completion of Call to Busy Subscriber
CCIR	Centre for Communications Interface Research (University of Edinburgh)
CCITT	Consultative Committee on International Telegraphy and Telephony
CCNR	Completion of Call on No Reply
CEC	Commission of the European Communities
CEPT	Conférence des administrations Européennes des Postes et Télécommunications
CLIP	Calling Line Identification Presentation
dc	direct current
DG	Directorate General (or Director General)
DSP	Digital Signal Processors
DTMF	Dual Tone Multiple Frequency
EC	European Community
EEA	European Economic Area
EPROM	Electrically Programmable Read Only Memory
ETR	ETSI Technical Report
ETS	ETSI Technical Standard
EU	European Union
GSM	Global System for Mobile communications
HF	Human Factors
I-C-I	Indicate - Control - Indicate
ID	IDentity
IEC	International Electrotechnical Commission
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ITU-T	International Telecommunications Union - Telecommunications Standardization Sector (formerly CCITT)
MMI	Man Machine Interface
N/A	Not Applicable
NET	Norme Européenne de Télécommunications
NRA	National Regulatory Authority
NU	Number Unobtainable
OK	Okay
ONP	Open Network Provision
PABX	Private Automatic Branch eXchange
Pay-Rec	Payphone Recognition tone
PIN	Personal Identity Number
PLMN	Public Land Mobile Network
Posit	Positive Indication Tone
PSN	People with Special Needs
PSTN	Public Switched Telephone Network
PUI	Personal User Identity
Qu.	Question (within an ITU-T Study period)
RLR	Received Loudness Ratings
SG	Study Group (within ITU-T)
SIM	Subscriber Identification Module
SIT	Special Information Tone
SS	Supplementary Service
STC	Sub-Technical Committee (within ETSI)
SVS	Stored Voice Service
SWAT	Signal, Wait, Abort, Talk
SWG HF	Special Working Group Human Factors (within ITU-T)

TBR	Technical Basis for Regulation
TC-HF	Technical Committee Human Factors
TE	Terminal Equipment
TETRA	TErrestrial Trunked RAdio
TRAC	Technical Regulations Application Committee
UK	United Kingdom
UPT	Universal Personal Telecommunications
USA	United States of America
UUS	User to User Signalling
WP	Working Party (within ITU-T)

4 Mandated reviews

The CEC Mandate [4] proposed a number of reviews, which are listed in the Introduction. The results of the reviews follow in the ensuing subclauses, and are summarized and their implications discussed further in clause 8.

4.1 Review of mandate references

The CEC Mandate [4] makes reference to the following three documents:

- 90/387/EEC a Council Directive of 28 June 1990 on the establishment of telecommunications services through the implementation of open network provision [3];

- Common position adopted by the Council on 30 June 1993 with a view to adopting a Directive on the application of Open Network Provision (ONP) to voice telephony [12];

- Report on the audible tones in the telephone service in the EC countries [2].

4.1.1 Council directive on implementation of ONP

The Directive is quoted as the principle justification for a study of any possible harmonization of tones, in that different information tones in the telephone services of different member states could be interpreted as restrictions to access to public networks. Annex II to the Directive, when discussing harmonization principles, however, allows for the adoption of existing interfaces. From the human factors viewpoint, tones are part of the interface between the network and the user, so this issue will be addressed as part of the human factors review in clause 7.

4.1.2 Directive on ONP

The common position paper referred to in the mandate has now been accepted by the European Parliament and adopted by the Council as Directive 95/62/EC [5]. A number of Articles in the Directive have relevance to the issue of harmonization, not only for network tones:

- Article 4 requires the publication of the technical characteristics of interfaces at commonly provided network termination points. Any such publication would require the description of the network tones available at that interface.

- Article 17 requires the adequate provision of public pay phones, and it should be noted that the pay tone is proposed in the mandate as a candidate for harmonization.

- Article 18 permits regulatory authorities to draw up specific conditions to aid disabled users. Any specification of tones must take into account the needs of such users.

- Article 20 refers to the drawing up of standards for new types of harmonized access. Any such standard would require the specification of tones.

- Article 25 demonstrates the expectation that publication of technical characteristics and reports would lead to the provision of harmonized facilities to users, and provides for Commission intervention if this does not occur.

In general, the Directive implies that the application of open network provision to voice telephony services should lead to harmonized elements at all levels of user interaction. This view will be taken into account when discussing the options later in this report.

4.1.3 The Gagliardi report

The purpose of this report was to document evidence of possible difficulties caused to human users by the lack of harmonization of network information tones in the European Community, presumably interpreting this as presenting a barrier to access to another country's services, as discussed above.

The author recognizes that audible tones in the network may be recognized both by human users and by machines. He then excludes consideration of PABX, and also connected terminals such as answering machines and particularly fax machines, because the former are not under the control of public network operators and the latter presumably because they are not part of voice telephony. He distinguishes ISDN terminals, which identify and react to network signals but still need to interpret and replicate specified audible tones for the user. A special note is made, however, that what is called the portability of terminals, e.g. fax, answer machines, which may be connected to the public network, would be affected by significant differences in the characteristics of tones, which in ONP terms could be construed as a barrier to trade. For a discussion of the technical parameters involved in automatic tone recognition, see subclause 5.2.2.

The analysis in the report is based on tones received during call set-up of a normal call, tones received after dialling, of an informative nature, and tones received during a call after a connection is made (this categorization of tones is also reflected in the model discussed in subclause 7.4). A "normal" call is not defined, and the term is used somewhat inconsistently.

As the basis for the analysis of difficulties likely to be encountered by users, the report considers calls made by two groups of users only. These are users temporarily in a foreign country (Category A), and those living in one country who wish to call into another (Category B). However, the reference to these groups is not always consistent, as sometimes potential problems for one group or the other are mentioned, at other times they are not. Furthermore, other user groups who may have problems are not identified, and no general recommendations are made about the potential treatment of users abroad, other than by harmonization.

This analysis leads the author to his priorities, that users temporarily in another country must be able to identify and interpret dial, ringing and busy tones, and especially tones used in payphones. The (larger) group of users requiring to call abroad have a similar need, to be able to recognize and distinguish where necessary between tones used in another country (within the EU), and their own, with particular reference to the rather similar "busy" and "number unobtainable" or "congestion" tones.

The summary of ETSI and CCITT (now ITU-T) position is comprehensive, except that it does not take account of the failure of support for the adoption of an ETSI proposed standardization of network tones. The report also documents at some length the results from a questionnaire on the audible tones in the telephone service sent out to public operators in the EC countries (in 1992/3). Ten countries supplied information. The data in Annex II has been used partly to supplement that used to prepare the Annexes to the present document, which have been updated for the Mandated study as far as possible.

Of particular interest is the summary of the answers to questions included in the questionnaire relating to future intentions and attitudes to any future harmonization. It seems that most network operators may be prepared to harmonize at some time in the future, and especially in connection with the phasing out of older equipment. A rationale for change must be essential as an adjunct to any future harmonization activity. This aspect of harmonization was considered in the current study and is discussed under subclause 5.1.1 and clause 8.

The conclusions and proposals seem logically prepared, based on the survey and analysis. It is clear that some users are confused by some tones, especially when heard out of context, and some tones are not easy to discriminate between. Of particular interest is the discussion of what tone the user expects at a certain point in the dialogue, when some tones (including interference from terminals, e.g. fax signals), may be encountered, or are themselves infrequent, and thus "unexpected". No consideration seems to have been given to two other outstanding issues. Firstly, that no re-examination was made of the underlying evolution of tones with respect to human recognition capabilities, except to repeat and accept Miller's "seven plus or minus one" argument [13], and that cadence recognition was invoked in most cases. This means that there is no basis in the report of Gagliardi [2] for the rational design of new tones, should they ever be required. Secondly, that other ways of coding functions and meanings are available, but were not explored, such as the creation of a radically different set of audible sounds, including combinations of musical notes, scales, chords, etc. Finally, little mention was made of the possible part that could be played by announcements.

4.2 ETSI tone standardization activities

This subclause reviews standards and other related activity within ETSI related to tones. An early attempt at standardization of network tones, referred to in the CEC Mandate [4], in fact failed at public voting. It did so because the arguments for standardization put forward were not compelling. It did not address the human factors arguments in sufficient depth, especially those based on published evidence. Insufficient analysis was carried out on existing tones, so that no logical structure for tones was derived, and no basis created for new tones to be employed if necessary. Other problems related to costs and benefits and the resistance to change were also neglected. The work subsequently became incorporated into ETR 187 [14].

4.2.1 Locally generated tones

ETS 300 085 [15] applies to ISDN telephony terminals and permits as an option, the local generation of information tones on the basis of messages received on the D-channel. An annex gave details of what were described as national characteristics for information tones, but which were in fact, idealized descriptions of such tones without the normally occurring range of frequencies and timings.

prETS 300 295 [16] which was rejected at vote was intended to apply to "Locally Generated" tones (i.e. generated by the terminal). No specific telecommunications technology was defined, the tones definition was intended to cover all PSTN, ISDN and Mobile terminals which generated their own tone sets, in response to network signals.

ETR 187 [14], which replaced prETS 300 295 [16], recommends the same set of tones with one minor change to call waiting tone.

prETS 300 245-7 [17] describes tones generated by ISDN terminals in response to network signals. It includes the tones presented in ETR 187 but permits, as an option, the use of national tones.

TBR 8 [18], the regulatory standard for ISDN telephones, on the other hand contains no approval requirements for locally generated information tones.

ETS 300 512 (GSM 02.40) [19] applies specifically to phase 1 and 2 GSM terminals.

ETR 294 [20] describes the man machine interface for a mobile station on the TErrestrial Trunked RAdio system (TETRA).

4.2.2 Network tones

ETS 300 001 [21] gives details of many tones used for testing the response of PSTN terminal equipment to national network tones. ETR 063 [22] describes some network tones met by and to be replicated by PABXs.

In as much as ETS 300 085 [15] gives details of what were described as characteristics for national information tones, it can be used as a source of information on such tones.

4.3 ITU-T activities

4.3.1 Study groups

Within the ITU-T (previously CCITT), there are two study groups dealing with subjects that may be considered relevant to the harmonization of network tones.

4.3.1.1 SG 1 - service definition

This Committee has a Special Working Group on Human Factors. SWG HF in the 1992 -1996 study period was dealing with three Questions, the titles of which are somewhat obscure. These "Questions" are used as broad titles to embrace a range of work items, those of which refer to network tones being noted:

Qu.17/1 Human factors issues arising in more than one service. This Question dealt with:

- Revision of CCITT Recommendation E.180 [23] - "Target world tone plan for the provision of customer signalling tones";
- Revision of CCITT Recommendation E.182 [6] - "Application of tones and announcements in telephone services".

A reference to "special ringing tone" has been drafted for addition to CCITT Recommendation E.180 [23] and a definition has been added to CCITT Recommendation E.182 [6]. SG 1 has been asked to continue work on the target world tone plan but is currently waiting on the outcome of this report before deciding on further work.

Qu.18/1 Human factors, aspects of voice and non-voice services using public terminals and other terminals using card technologies. This question dealt with:

- CCITT Recommendation E.133 [24] - "Operating procedures for cardphones".

Qu.19/1 Human factors in telecommunications not specifically related to new services.

In the next session of this Study Group it is intended to merge Qu.17 and Qu.19 and to continue with an amended Qu.18.

NOTE: The work of SG1 has been reallocated to SG2 for the current study period 1997 - 2000.

4.3.1.2 SG 12 - transmission performance of telephone networks and terminals

Study Group 12 is responsible for the end-to-end transmission performance of networks and terminals in relation with the speech quality and the acceptance of text, speech and image signals by the users and for related transmission implications. In the period 1992 - 1996 the Group was organized with four working parties.

WP 12/1 dealt particularly with electroacoustic measurement methods. This includes the development and application of objective measuring instrumentation such as artificial mouths and ears and appropriate test signals that reflect subjective performance. Questions affecting perception of tones were:

Qu.7/12 - Test signals and analysis techniques for evaluating the speech transmission characteristics of terminals;

Qu.10/12 - Speech transmission characteristics and measurement methods for digital handset telephones;

Qu.12/12 - Artificial mouths and ears;

Qu.23/12 - Coupling of hearing aids to telephones.

WP 12/2 made recommendations for terminal performance requirements that affect the perceived quality of speech, text and image applications. Questions affecting perception of tones and announcements were:

Qu.2/12 - Hands-free telephony;

Qu.5/12 - Speech synthesis/recognition systems;

Qu.20/12 - Wideband telephony.

WP 12/3 made recommendations for transmission performance requirements for the network and studies methods for measuring and modelling the effect of various degradations. Questions affecting perception of tones and announcements were:

Qu.13/12 - Methods for measuring and modelling the effects of non-linear processes on the speech quality of transmission systems;

Qu.16/12 - Transmission performance of wireless personal communications systems;

Qu.18/12 - Evaluation tools for the assessment of digital transmission systems.

WP 12/4 made recommendations that provide network transmission planning guidance so that speech, text and image signals can be transmitted and received by users with acceptable quality. Questions affecting perception of tones and announcements were:

Qu.11/12 - Noise aspects in the evolving network;

Qu.25/12 - Transmission impairments in the evolving mixed analogue/digital and ISDN networks.

4.3.2 CCITT/ITU-T Recommendations

A number of CCITT/ITU-T Recommendations which might be considered relevant to the provision of harmonized network tones are listed below.

4.3.2.1 E series Recommendations

ITU-T Recommendation E.121 (02/95) [25] gives a number of pictograms for use in telephone services and refers to the graphical representation of tones.

CCITT Recommendation E.126 [26] recommends the harmonization of the information pages in telephone directories and refers to the graphical representation of tones.

CCITT Recommendation E.127 [27] recommends standardization of pages in telephone directories intended for use by foreign visitors and refers to the graphical representation of tones.

CCITT Recommendation E.128 [28] gives advice on the preparation of leaflets for foreign visitors and suggests that descriptions of main tones should be given with graphical representations.

CCITT Recommendation E.131 [29] gives some examples of supplementary service procedures and refers to the use of second dial tone during supplementary service procedures.

CCITT Recommendation E.180 [23] gives preferred limits of cadence, frequency and level for many tones.

CCITT Recommendation E.181 [30] gives advice on information to be given to subscribers on the characteristics of tones.

CCITT Recommendation E.182 [6] gives the responses that networks should provide to subscribers in the operation of both basic and supplementary services. It lists a number of definitions of tones.

CCITT Recommendation E.183 [31] gives advice on the various characteristics of announcements given in telephone services and refers to the use of tones in relation to some announcements.

CCITT Recommendation E.184 [32] covers the requirements of the ISDN equivalent to CCITT Recommendation E.180 [23] to CCITT Recommendation E.183 [31].

CCITT Recommendation E.330 [33] describes the general aspects of user control of ISDN supported services. It recommends that tones and verbal announcements that are used in existing services should not be changed in the ISDN.

CCITT Recommendation E.333 [34] calls up the words of Z.323 which describes how an effective Man Machine Interface (MMI) should appear to a user with a visual display terminal. It refers to the use of an audio signal to stimulate action.

Supplement 2 (Series E) [11] lists the tones currently used in national networks throughout the world.

4.3.2.2 F series Recommendations

ITU-T Recommendation F.901 (03/93) [35] gives advice on experimental procedures for evaluating usability components of telecommunications services.

ITU-T Recommendation F.902 (02/95) [9] provides guidance for the design of basic procedures for the use of interactive telecommunications services including prompts in the form of tones and spoken messages.

4.3.2.3 P series Recommendations

ITU-T Recommendation P.31 [36] gives values for the Receiving Loudness Ratings for digital telephones which determine the perceived loudness of tones received over the network.

ITU-T Recommendation P.34 [37] gives values for the Receiving Loudness Ratings for hands-free telephones which determine the perceived loudness of tones received over the network.

ITU-T Recommendation P.37 [38] sets limits for the performance of the inductive coupling between telephones and hearing aids and determines the perceived loudness of tones received over the network.

4.4 Existing tones

The existing tones used in Europe and the rest of the world are presented in the part 2 of this report. The data is principally extrapolated from ITU-T Recommendation E.180 Supplement 2 (Series E) [11] - dated January 94. The original data was collected by ITU-T in July 1991 and again in March 1992 in response to the CCITT Circular Letter No. 98.

4.4.1 Europe

4.4.1.1 The data sources

Part 2 of this report presents the tones reported to be in use in Europe. Where there was an omission or error detected in the ITU-T material, additional information has been added direct from specific network sources e.g. Norway, Sweden, UK, or direct from Gagliardi's report, or from ETS 300 085 [15] (re locally generated tones). This additional material is shown in italics. Where no alternative source is quoted the source used was the ITU document. An attempt was made to cross check the data with the information recorded in ETS 300 001 [21]. This proved unsatisfactory as these data quoted maximum and minimum frequencies used and gave insufficient information about cadences. Sometimes the reported maximum and minimum frequencies related to the proposed tolerances (e.g. 425 ± 25 = 400 min, 450 max), sometimes they related to two combined frequencies (e.g. 350 + 440 = 350 min, 440 max) and sometimes they seemed to hide possible alternatives (e.g. 425 or 450 ≅ 420 min, 455 max), etc.

Unfortunately, each of the individual sources used was shown to have some degree of error. Therefore where practical these data have been confirmed by direct reference to the National Regulatory Authority or the principal network operator. It is hoped that by cross checking with individual network operators and between the source documents the errors in the tables in part 2 have been minimized.

The list of European countries used for the analysis is based on the ETSI list of National Standardization Bodies. Whilst it is known that there are several operators in some countries providing basic teleservices within the same network type (PSTN, PLMN, etc.) no data was found which identified any differences in the function or characteristics of tones used by the different operators. Anecdotal evidence suggests this maybe true for some areas of the UK at least, i.e. between a cable operator and a national operator. The only reported differences between different networks use of tones was between tones provided in GSM mobile terminals and the tones provided on the local PSTN network.

The analysis divides the tones into three sets. Set 1 and 2 reflect the relative "preference for standardization" weighting given in the CEC Mandate [4] to ETSI. Set 3 lists the other reported tones used in the various countries. These sets are:

1. Dial, Ring, Busy, Special Information, Call Waiting, Pay tones.
2. Special Dial, Positive Indication, Congestion, Intrusion tones.
3. Number Unobtainable, Warning - Operator Intervening, Second Dial, Payphone Recognition, Negative Indication, Route, Offering, Recall Dial, Holding, Valid, Queue, Record, Confirmation, Intercept, Connection, Conference tones.

The analysis of the tones reported to be used in each country is dependent on the interpretation given to the definition which applies to any tone's name. For the core set of tones (Dial, Ring, and Busy) most European countries appear to adhere to the ITU-T (formerly CCITT) Recommendations both in terms of the functional definition and the preferred characteristics. For any named tone there may be three sources of error:

- the "official" definition does not match the actual telecommunication "function/s" the tone is used for, e.g. "warning tone" is officially used to indicate the possibility of the call being recorded, but was frequently reported for "operator intervening" which could officially be known as "intrusion tone";
- one tone may be used to inform the user of differing telecommunications "functions", e.g. Busy tone used to mean subscriber busy, network congestion and negative indication of supplementary service;
- the basic characteristics of the tone, its frequency/ies and/or cadence, may be reported in error.

4.4.1.2 The key findings

The key finding from the data is the strong dependence on using different cadences to differentiate between tones. Different frequencies are not used extensively to differentiate between tones. To explore this reliance on cadence, the raw data was used to compile two additional parameters for each tone. These are the period or total length of one complete cadence, and the on/off ratio (sound versus silence) for each period. These parameters were used in the assessment of the model proposed in clause 7.

In addition to the comparisons by country for each tone shown in the annex, the European tones were also analysed for potential conflicts and existing similarities. A conflict might be defined where the same or very similar tone is used within or between countries to have different meanings. A similarity might be defined as a broad range of countries having a very similar tone for the same function. Tables 2 to 6 highlight some of these potential conflicts and similarities.

Table 2 apparently shows five different meanings for seven very similar tones. The odd tone out is the high frequency tone from Slovakia. Three of the tones are specified as the Route tone (ITU-T defined Comfort tone) and it is possible that the meaning in Turkey and Slovakia is similar to this. But the most interesting conflict is between the use of this tone for Positive Indication in Belgium and for Negative Indication in the Netherlands.

Table 2: Route vs. Positive vs. Negative Indication (from European data)

Tone	Cadence (s)	Period (s)	On/off	Frequency (Hz)	Country/ies
Confirm	**0,04** - 0,04	0,08	1	450	Turkey
Positive	**0,04** - 0,04	0,08	1	425 or 450	Belgium
Route	**0,05** - 0,05	0,1	1	425	Poland
Route	**0,05** - 0,05	0,1	1	440	France
Connect	**0,05** - 0,05	0,1	1	1 400	Slovakia
Route	**0,06** - 0,06	0,12	1	425	Ireland
Negative	**0,0625** - 0,0625	0,125	1	425 or 450	Netherlands

Table 3 shows a simple conflict, a difference in frequency of 25 Hz is all that separates a pay tone in Malta from a Congestion tone in Albania and Greece. So when Maltese visitors go to Greece and get Congestion tone, do they think they have to pay? Conversely when Greeks use payphones in Malta does the pay tone get interpreted as "put money in now" or "network congestion/number unobtainable", i.e. connection success versus connection failure.

Table 3: Pay tone or Congestion? (from European data)

Tone	Cadence (s)	Period (s)	On/off	Frequency (Hz)	Country/ies
Pay	**0,15** - 0,15	0,3	1	400	Malta
Congest	**0,15** - 0,15	0,3	1	425	Albania, Greece

Table 4: Busy, Congestion, Number Unobtainable or what? (from European data)

Tone	Cadence (s)	Period (s)	On/off	Frequency (Hz)	Country/ies
Busy	**0,167** - 0,167	0,334	1	425	Czech Republic 2
Congest	**0,167** - 0,167	0,334	1	425 or 450	Belgium
Busy	**0,15** - 0,20	0,35	0,75	133 or 425	Romania
Congest	**0,2** - 0,2	0,4	1	400	Portugal 1
Congest	**0,2** - 0,2	0,4	1	420	Austria 1
Busy	**0,2** - 0,2	0,4	1	425	Italy 2, Spain
Congest	**0,2** - 0,2	0,4	1	425	Finland, Italy, Norway 2, Portugal 2, Slovenia, Switzerland
NU	**0,2** - 0,2	0,4	1	450	Turkey
Negative	**0,2** - 0,2 (+ announcement)	0,4	1	300 + 420	Hungary
NU	**0,2** - 0,2	0,4	1	400 or 425	Portugal
Congest	**0,24** - 0,24	0,48	1	425	Luxembourg 1, Germany 1
Busy	**0,25** - 0,25	0,5	1	425	Bulgaria 1, Denmark 2 (ITU), Faroe Islands, Iceland, Sweden, Switzerland 2
Congest	**0,25** - 0,25	0,5	1	425	Bulgaria 1, Croatia, Cyprus, Denmark, Faroe Islands, Iceland, Norway 1
Negative	**0,25** - 0,25	0,5	1	425	Croatia
Busy	**0,25** - 0,25	0,5	1	425 or 450	Netherlands 2
Congest	**0,25** - 0,25	0,5	1	425 or 450	Luxembourg 2, Netherlands
Busy	**0,3** - 0,3	0,6	1	425	Albania, Finland, Hungary
Busy	**0,3** - 0,3	0,6	1	450	Austria 2
Congest	**0,3** - 0,3	0,6	1	450	Austria 2
Busy	**0,3** - 0,3	0,6	1	425 or 450	Greece
C-Wait	**0,3** - 0,3	0,6	1	425 + 450	Hungary
Busy	**0,375** - 0,375	0,75	1	400	United Kingdom

Table 4 shows the potential set of conflicts resulting from the use of very similar tones which may mean Busy, Congestion, Number Unobtainable, or even Negative Indication or Call Waiting. Of course this may not be a problem if the only strategy the user should be prompted towards is try again later, but this is not the case. The difference between Congestion and Number Unobtainable is important to the user as the prompted user action should be different (for Congestion you can only try later, for NU you should check the number and then try again). It is even more important with the introduction of Call Completion services (e.g. Completion of Call to Busy Subscriber (CCBC)) that the user can distinguish a genuinely Busy subscriber.

The most explicit example of similarity within cadences, periods and on/off ratios for a single function is with the Payphone Recognition tone. The majority of European countries that report using such a tone have a clear consistency in their choice of cadence but perhaps unfortunately use a variety of different frequency combinations.

Table 5: Payphone Recognition (from European data)

Tone	Cadence (s)	Period (s)	On/off	Frequency (Hz)	Country/ies
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	1 100 + 1 750/ 750 + 1 450	Ireland, Luxembourg, Switzerland 2
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	1 100/750	Hungary
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	1 200/800	United Kingdom
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0 (4 cycles)	2,6	0,182	1 206/850	Croatia
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	1 336/1 633	Austria
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	1 477 + 941/ 1 400 + 950	Denmark
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	1 477/941	Norway (4 cycles), Portugal, Sweden (11 cycles)
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	1 633/1 209	Iceland
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0 (5 cycles)	2,6	0,182	1 633/1 336	Germany 1
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0 (5 cycles)	2,6	0,182	1 645 + 857/ 1 215 + 935	Germany 4
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,0	2,6	0,182	800/1 200	Switzerland 1
Pay-Rec	**0,25** - 0,25 - **0,25** - 2,0	2,75	0,22	1 000/1 200 or 1 000/1 330	Turkey
Pay-Rec	**2,2** - 0,2 - **0,2** - 0,2 (6 cycles)	2,8	6	1 336/1 024	Germany 3
Pay-Rec	**0,2** - 0,2 - **0,2** - 2,2 (5 cycles)	2,8	0,167	1 366/1 024	Germany 2

Perhaps the next most obvious similarity is in the characteristics used to define a Special Information Tone (SIT). There is clear consistency in reporting that this tone uses a sequence of three frequencies (950/1 400/1 800), each being presented for a third of a second, followed by one second of silence. What is not so consistent, is the use of the tone. The official ITU-T definition states that Special Information is a tone used to indicate that the called number cannot be reached for reasons other than "subscriber busy" or "congestion", in other words "number unobtainable". Many countries report using SIT in this way and many more report using it a "Special Information" without defining the scenario when it might be invoked. However, one or two countries report some interesting uses, e.g. Norway report using SIT for Positive indication (totally opposite from the official definition), Lithuania report using it for Call Waiting, Denmark for Pay tone, and Belgium has something quite similar for Second dial tone. Yet another group of countries tend to use it to introduce announcements, where these could be of a negative, positive or neutral perspective. Clearly consistency of tone does not imply consistency of function, far from it.

Table 6: SIT and some of its different functions (from European data)

Tone	Cadence (s)	Period (s)	On/off	Frequency (Hz)	Country/ies
SIT	3 × **0,333** - 1,0	1,999	0,999	950/1 400/1 600	Slovenia
SIT	3 × **0,33** - 1,0	1,99	0,99	950/1 380/1 860	Belgium
SIT	3 × **0,33** - 1,0	1,99	0,99	900/1 350/1 800	Portugal
SIT	3 × (**0,33** - 2 × 0,03) - 0,0	0,996	16,5	950/1 400/1 800	United Kingdom 1
Pay	3 × **0,22** - 1,0	1,66	0,66	950/1 400/1 800	Denmark 1
NU	3 × **0,33** - 1,0	1,99	0,99	950/1 400/1 800	Austria, Bulgaria, Croatia, Denmark, Faroe Islands
SIT	3 × (**0,33** - 2 × 0,03) - 1,0	1,996	0,93	950/1 400/1 800	Czech Republic, France, Slovakia, Spain
SIT	3 × **0,333** - 1,0	1,999	0,999	950/1 400/1 800	Austria, Bulgaria, Croatia, Denmark, Finland, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Switzerland, Turkey United Kingdom 2, Yugoslavia
SIT	3 × **0,33** 3 - 1,0 - 1,0 (+ announcement)	1,99	0,999	950/1 400/1 800	Sweden 1
Posit	3 × **0,333** - 1,0?	1,999	0,999	950/1 400/1 800 ?	Norway
C-Wait	3 × **0,333** - 1,0	2	0,999	950/1 400/1 800	Lithuania
Queue	3 × **0,333** - 1,0	1,999	0,999	950/950/1 400	Finland
2nd Dial	3 × **0,333**	0,999		900/1 020/1 140	Belgium

4.4.2 World-wide

Part 2 also presents an analysis of the tones used in the rest of the world. It is again based on the ITU-T Recommendation E.180 Supplement 2 (Series E) [11]. However, it has not been possible to verify these data against any other records (see part 2 clause 6).

As with the European tones tables, the analysis is divided into three sets. Sets 1 and 2 reflect the relative "preference for standardization" weighting given in the CEC Mandate [4] to ETSI. Set 3 presents the other tones listed. These are:

1 Dial, Ring, Busy, Special Information, Call Waiting, Pay tones.

2 Special Dial, Positive Indication, Congestion, Intrusion tones.

3 Acceptance tone, Comfort tone, Confirmation tone, End of Three Party Service tone, Executive Override tone, Facilities tone, Function Acknowledge tone, Holding tone, Identification tone, Intercept tone, Line Lockout tone, Negative Indication tone, Notify tone, Number Unobtainable tone, Offering tone, Payphone Recognition tone, Permanent Signal tone, Pre-emption tone, Re-order tone, Recall Dial tone, Record tone, Refusal tone, Route tone, Search tone, Second Dial tone, Service Activated tone (Positive Indication?), Test Number tone, Warning tone (End of Period), Warning tone (Operator Intervening).

If anything the analysis just confirmed the world-wide scale of the harmonization problem. It is suffice to show one example in table 7. If one hears a tone which is around 400 - 450 Hz, with a fairly rapid cadence, say **0,2 - 0,25 on** and perhaps 0,2 - 0,25 off, what could it mean? Is it Dial or Special Dial; or is it Ringing, Busy, Call Waiting, or Congestion?

Table 7: Confused functional meanings in world tones with periods between (0,4 and 0,5 s)

Function	Cadence (s)	Period (s)	Frequency (Hz)	Country/ies
Dial	**0,2** - 0,2	0,400	400	Philippines 2
Ring	**0,2** - 0,2	0,400	440 + 480 (reported as 440/480)	Burkina Faso 2
Busy	**0,2** - 0,2	0,400	425	San Marino
Busy	**0,2** - 0,2	0,400	450	Guinea
Call Wait	**0,2** - 0,2	0,400	425	S. Lucia
Congest	**0,2** - 0,2	0,400	400	Chile
Congest	**0,2** - 0,2	0,400	425	Sierra Leone
Dial	**0,4** - 0,04	0,440	425	Tunisia 2
SIT	**0,4** - 0,04	0,440	425	Panama
SIT	**0,4** - 0,04	0,440	450	China 1
Special Dial	**0,4** - 0,04	0,440	425	Kuwait, Lao P.D.R., Mali, Papau New Guinea, Vanuatu
Pay	**0,1** - 0,1 - **0,1** - 0,1 - **0,1** (only once)	0,500	900	Malaysia
Dial	**0,25** - 0,25	0,500	400	Japan 2 (Pabx)
Busy	**0,25** - 0,25	0,500	400	Ghana, Namibia 3
Busy	**0,25** - 0,25	0,500	400	
Busy	**0,25** - 0,25	0,500	425	Brazil, Mexico, Nepal, Tunisia 1
Busy	**0,25** - 0,25	0,500	445 or 425	Greenland
Busy	**0,25** - 0,25	0,500	450	Burundi
Pay	**0,25** - 0,25	0,500	900	Brunei Darussalam 1 (pip tone?)
Pay	**0,25** - 0,25	0,500	900	Swaziland
Busy	**0,3** - 0,2	0,500	425	Argentina
Call Wait	**0,5**	0,500	400 × 25	Brunei Darussalam
Call Wait	**0,5**	0,500	400 + 450	New Zealand 1
Pay	**0,5**	0,500	250	Japan 2
Congest	**0,2** - 0,3	0,500	480 + 620	Jamaica 2
Congest	**0,25** - 0,25	0,500	400	Maldives
Congest	**0,25** - 0,25	0,500	400	Namibia, Nigeria, South Africa, New Zealand 2
Congest	**0,25** - 0,25	0,500	400 + 440	Jordan
Congest	**0,25** - 0,25	0,500	425	Aruba, Botswana, Cayman Islands, Indonesia, Iran, Macau, Malaysia, Mexico, S. Lucia, Singapore, Sri Lanka, Suriname, Uruguay, Zambia
Congest	**0,25** - 0,25	0,500	440	Honduras
Congest	**0,25** - 0,25	0,500	445 or 425	Greenland
Congest	**0,25** - 0,25	0,500	480 + 620	Anguilla, Barbados, Bermuda, British Virgin Islands, Canada, Dominica (Commonwealth of), Hong Kong, Montserrat, S.-Kitts-and-Nevis, Turks and Caicos Islands, United States of America 1
Congest	**0,25** - 0,25	0,500	480/620	Antigua and Barbuda

4.4.3 Standards

Part 2 further presents a comparison between the characteristics of telecommunications service tones defined in International and European Standards (see part 2 clause 6) for both network and terminal generated tones. These include ITU-T (formerly CCITT) Recommendations, ETSI Standards and Technical Reports, GSM Standards, the proposed TETRA Standards and CEPT Recommendations.

Specifically these were, for network generated tones:

CCITT Recommendation E.180 [23];

CEPT Recommendation T/SF 23 [69];

CEPT Recommendation T/CS 20-15 [70];

and for terminally generated tones:

ETS 300 245-7 [17];

ETR 187 [14];

GSM 02.40 [19];

ETR 294 [20].

The comparison shows that there has been a very distinct tendency to harmonize the frequency spectrum used within the majority of network information tones towards a single tone within the band 425 ± 15 Hz. Differentiation of individual tones is then based on variance in cadence.

These data have also been used in the assessment of the implications of any harmonization option within the audit of set 1 tones given in clause 8.

4.5 Human factors research and reports

The CEC Mandate [4], as an input to this study, proposed a review of "relevant research and reports regarding human factors with service tones". This review concentrated on aspects likely to improve the efficiency with which network information tones can be employed for this implied purpose. Available data is considered as it may apply both to the existing tones and any future tones or recommendations for change. The aim is the application of human factors research to improving speed and accuracy of recognition and response to tones and hence the improvement of network usability.

There is considerable literature in psychology, ergonomics, human factors, human engineering and human factors engineering or engineering psychology concerning the human ability to detect, react to, discriminate between or recognize sounds. There also exists a body of specialized work under the heading "human factors in telecommunications. This latter body of knowledge is mostly contained in an international symposium series "Human Factors in Telecommunications" proceedings of which are available since 1962 at two or three-yearly intervals, and may often be applied directly to telecommunications questions.

The review has been concentrated on selected papers, recommendations and guidelines dealing with human sensory perception - hearing and cognitive processing, and those attributes relating more specifically to the recognition and identification of tones in telephone services. A collection of papers was assembled and relevant extracts are referenced and quoted in clause 7.

5 Technology issues

This clause is intended to highlight those features of the technology currently employed in supporting public networks and telephone terminals which have some impact on telephone information tones. In particular, the methods used to generate tones are identified.

5.1 Network aspects

5.1.1 Public networks

The manner in which tones are generated in a public network is largely dependent on the current state of development of that network.

Originally tones in public networks were generated by large rotating machines at each exchange which also provided the ringing supply, the tone cadence being determined by cams and contacts mounted on the generator. This method of tone generation restricted the range of tones and cadences to multiples of the rotary speed. The frequency of the tones that could be generated was limited by the cost of additional windings and poles on the machines. It was common to provide more than one set of tones from such a machine by interleaving the cadences. These machines are still in use in many older exchanges within the European economic area.

Smaller exchanges and PABXs used dc to ac converters driven by vibrators that produced outputs that were largely square wave in form and that were rich in harmonics. A separate vibrator was provided for each tone, with cadencing determined by relay timers.

Later developments in public and private exchanges replaced the rotary and vibrating machines by solid state transistorized generators. Many such generators are currently in use.

As digital switching became common, so tone generation became digital in form. Tones stored and switched in digital form are decoded as necessary in the line circuit provided for each customer. Tones are stored in digital memory, commonly Electrically Programmable Read Only Memory (EPROM), which may be situated at major processing sites or distributed throughout the network at a number of smaller line concentrators.

The most modern systems store the tones in a software form that is reprogrammable from a central point in the network.

All of the above tone generation methods are likely to exist in some European public networks. Most public networks will have two or three generation methods in use at the same time in various parts of the network.

Each of the above tone generation methods has differing limitations when considering the possibilities of changing the characteristics of tones. There is no real scope for changing the output of rotary tone generators, and any changes would involve their replacement by new electronic generation methods at considerable expense if they were not already part of a modernization programme.

The same applies to vibratory generators except that any that exist would be relatively small and not so expensive to change out.

There is a limit to the number of different tones that can be stored on an EPROM (typically 16) and the difficulty and cost of changing them is dependent on whether they are plug in, or are permanently soldered to their circuit boards.

The changing of tones stored in software form has few problems except those inherent in any tone change such as the necessity to avoid possible interaction with other tones used for signalling on the network caused either by their basic characteristics or by their harmonics.

Any changes, even those just involving software changes, could take a long time, as most network operators are committed for some years ahead to a rolling programme of rebuilds of their equipment.

5.1.2 Corporate networks

Tones applied to corporate networks are generated in the same manner as tones in public networks, although the techniques used are likely to be more modern than is typical in public networks. This is because private network equipment is usually changed more frequently.

When considering the possible effect of harmonics in tones and their interaction with network signalling, the different signalling systems used in private networks must be taken into account.

5.2 Terminal aspects

5.2.1 Terminal requirements

When a user makes a telephone call tones are a necessary part of the interaction between the network and the user in the process of setting up the call.

The user of a simple telephone terminal only requires that the tones are presented at a suitable time and at a suitable level. This generally implies that when going off hook, a normal transmission path should be established between the telephone line and the receive output transducer, whether it is an earphone or a loudspeaker. The network designer shall ensure that the tones are applied at a level compatible with the terminal Receive Loudness Rating (RLR) suitable for speech transmission.

One additional factor to be considered is the presence of any receive volume control or mute switch. It is a common requirement of telephone specifications that at the minimum setting of the volume control it should still be possible to hear the network tones. This has been specified in ETS 300 085 [15] by requiring that "with the volume control set to the minimum position, the RLR shall not be greater than (quieter than) 18 dB" (it may be noted that, due to the history of their derivation, high positive values of loudness rating are indicative of low sensitivity or quietness, and low or negative values indicative of high sensitivity).

It has also been specified in BS 6317 [39] that any receive mute condition that has a latching arrangement should be arranged such that the mute is removed after hanging up so that normal transmission is available when going off hook again, in case a user in an emergency situation is misled into the belief that the telephone or its associated line is defective or out of use.

Terminals that offer automatic dialling have additional special requirements. The user of such a terminal, whether it is a telephone, PABX, fax or modem requires the call to be set up as rapidly as possible. Similarly, the network designer requires the minimum possible unpaid network occupancy.

To achieve the shortest possible call set up time a terminal needs to detect dial tone before initiating dialling. If dial tone detection is not implemented, either incomplete or incorrect numbers may be generated by dialling too soon, or excessive delays may be caused by waiting for a sufficient period (typically 4 seconds) to give a reasonable assurance that dial tone is present before dialling. Such a wait is not compatible with the recommendation by Gallaway [40] that system activation or requests for a complex service should achieve response times of 3 to 5 seconds.

Where dial tone is presented to the user in the normal manner so that the decision to commence automatic dialling can be taken by the user, such a dial tone detector is not necessary.

In order to ensure the minimum possible unpaid network occupancy, a fully automatic terminal is often required to detect call progress tones and clear down on receipt of tones indicating an ineffective call. It is usual for modems to be able to detect and discriminate between dial tone, busy tone, ring tone, answer tone, carrier and speech. Whether the detection facility is used or not, and the timings for which tones are awaited are usually software controllable.

It is common for modems and fax machines not to detect any progress tones or other signals, but to clear down if the normal connection protocols that follow call answer are not received from the called terminal within a predetermined time period.

Tones that occur during the Talk phase create problems for modems or fax machines in that that they interfere with the received signal. It is thus necessary to make arrangements for such tones to be able to be suppressed, preferably on a per call basis.

5.2.2 Terminal technology

Tone detection is a necessary function in many kinds of equipment. It is used in PABXs, automatic answering machines, fax machines and in screen 'phones using the Analogue Display Services Interface (ADSI).

There are a number of differing techniques used for detecting the various tones used during call set up. Commonly, to simplify the problems, much use is made of the context in which the tones are to be expected.

Simple discrete filters are not now commonly used in modern terminal equipment but sometimes simple counters are used e.g. for the detection of dial tone, which is likely to be the only more or less continuous signal likely to be present immediately after line seizure.

Modern modems are commonly based on proprietary Digital Signal Processors (DSPs) and often use DSP implemented filters for tone detection. This technique can produce very effective filters, but there is a necessity to compromise, as too sharp filtering can lead to errors where network tone frequencies are not sufficiently closely controlled.

Any change in tone characteristics will have an impact on terminal equipment required to detect tones. The severity of such impact will be dependent on the detection technique used (modern DSPs can be software controlled), the value of the equipment affected and the period over which it is normally depreciated.

CCITT Recommendation E.180 [23] recommends that network tones should be provided with an accuracy of ±1 %, and a separation of 10 % has been said to provide an effective spacing for tone discrimination.

Because there is a restricted range of frequencies used for call progress tones it is necessary to time the cadences to distinguish between tones. This is not an efficient method of discrimination as slow cadences with long periods require a long detection time. Cadence periods are often long compared to the period (100 ms) within which tones can readily be identified.

6 Regulatory aspects

6.1 Terminals - the present

The automatic detection of tones by PSTN terminals at the various stages of a call is currently the subject of regulation in most countries in the European Economic Area (EEA) and a memorandum of understanding between the members of the Technical Recommendations Applications Committee (TRAC) agrees national regulations for most PSTN connected equipment to be those technical requirements currently set out in ETS 300 001 [21] (which was originally intended to become a Norme Européenne de Télécommunications as NET 4, and is now treated as such through a TRAC memorandum of agreement).

Some types of PABX access are not covered by this ETS and in some countries ETS 300 001 [21] does not apply to PABXs. The resultant lack of access requirements for these special accesses and terminal equipments is dealt with in ETR 063 [22], "A survey of analogue access to the PSTN not covered by ETS 300 001 [21]".

The recognition of network tones by Terminal Equipment (TE) is complicated by the differences between national tones. It is common to require the automatic detection of network tones by TEs at various stages during a telephone call.

Most such requirements apply to call set up procedures but some apply at other stages in a call. ETS 300 001 [21] details the requirements for dialling initiation, transmission initiation, transmission duration control and automatic repeat calls.

The regulation of terminals is thus fairly stringent, but the burden of requirements varies from country to country.

The requirements of ETS 300 001 [21] which treat aspects of tone detection are detailed in the following subclauses.

6.1.1 Call progress monitoring

It is commonly a requirement that TE with on-hook dialling facilities "which can pass a call attempt to an associated handset or similar device" shall include a call progress monitor in order to enable audible and/or visible monitoring of the progress of the call attempt.

This function is mandatory, in Austria, Belgium, Cyprus, Denmark, France, Greece Iceland, Luxembourg and Portugal.

6.1.2 Automatic initiation of dialling

Automatic initiation of dialling within a terminal equipment can be controlled either by a dial tone detector or by a timer function or by a combination of both. The inclusion of a dial tone detector is mandatory in Austria, Belgium, Bulgaria, Cyprus, Denmark, France, Hungary, Iceland, Italy, Luxembourg, Netherlands, Norway, Sweden and Switzerland.

Austria, Belgium, Denmark, Finland, France, Greece, Iceland, Italy, Netherlands, Norway, Portugal, Spain, Sweden and Switzerland have a further requirements for the dial tone detector not to detect "outband" signals, "weak" signals, or "improperly cadence" signals.

France and Switzerland also require the detection of special dial tone.

Austria, Belgium, Italy and Portugal require second dial tone to be detected if the TE has the capability.

6.1.3 Automatic control of call progress

Prior to the initiation of transmission, the TE may monitor the line to check if PSTN tones are present. There are no mandatory requirements that such tones must be detected, although rather oddly, many countries have requirements that if apparatus is capable of automatic tone detection, it then becomes subject to regulation.

Belgium, Cyprus, Finland, France, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway and Portugal all have requirements for busy tone detection for "TE capable of detecting busy tone" although only Belgium, France and the Netherlands have a requirement not to falsely detect "outband", "weak", "improperly cadenced" or "short" signals in these circumstances.

Belgium, Cyprus, France, Italy, Luxembourg, Netherlands, Norway and Portugal all have requirements for congestion tone detection for "TE capable of detecting congestion tone" although only Belgium, France and the Netherlands have a requirement not to falsely detect "outband", "weak", "improperly cadenced" or "short" signals in these circumstances.

Belgium, France, Hungary, Italy, Luxembourg have requirements for ringing tone detection "for TE, capable of detecting a ringing tone". Belgium and France have a requirement not to falsely detect "outband", "weak", "improperly cadenced" or "short" signals in these circumstances.

Only Belgium has requirements for SIT detection for "TE capable of detecting SIT" and only Belgium has a requirement not to falsely detect "outband", "weak", "improperly cadenced" or "short" signals in these circumstances.

Belgium and France also have requirements for the detection of answering tone sent by remote apparatus "for TE capable of detecting answering tone". Belgium and France also have a requirement not to falsely detect "outband", "weak" or "short" signals in these circumstances.

6.1.4 Repeat call attempts

TE with automatic calling functions may be capable of performing repeat call attempts to the same or different numbers in an arbitrary order. In general, requirements for repeat call attempts apply separately to each number. It is normal to permit one quick re-attempt and then require a longer period between subsequent attempts. Norway requires the ability to make repeat attempts to be dependent on the ability to recognize the network tones indicative of call failure.

Austria, Belgium, Bulgaria, Cyprus, Finland, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Spain, Switzerland and the United Kingdom permit a second attempt 5 seconds after clearing down following the first attempt. Denmark and France permit a second attempt after 2 seconds, Sweden 3 seconds, whilst Portugal requires a one minute wait.

Belgium, Bulgaria, Cyprus, Finland, France, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Portugal and Spain require a pause of 1 minute between subsequent call attempts. Denmark only requires a pause of 2 seconds between attempts, whilst Austria and Switzerland require a pause of 30 seconds. Germany permits 5 seconds for up to 12 attempts. The UK permits a number of options ranging from 1 minute to 10 minutes dependent on the total number of call attempts.

Belgium, Cyprus, Finland, France, Greece, Ireland, Italy, Luxembourg, the Netherlands and Spain limit the number of repeat attempts in any hour, in most countries to four. France permits six calls/hour and The Netherlands 15/hour. The UK number is related to the period between attempts and ranges from five in total to seven in every two hours.

Austria, Denmark, Iceland, and Sweden limit the total number of attempts. Denmark, Iceland, Norway and Sweden permit ten attempts, Austria permits 3 or sometimes 6 attempts. Germany permits 12 attempts for calls repeated within less than 30 seconds but unlimited repeat attempts if the pause is greater than 30 seconds.

Most countries have more relaxed requirements for emergency calls.

6.2 Terminals - the future

It can be expected that non-voice PSTN terminals which a supplier wishes to submit for pan-European approval will in future be subject to the requirements of a Technical Basis for Regulation (currently prTBR 21) [41], which differs from the national requirements described in ETS 300 001 [21].

As a TBR, this standard contains only those requirements deemed to be essential under Articles 4(d) and 4(f) of Directive 91/263/EEC [42], which (as far as tone detection is concerned) in the case of prTBR 21 [41] are considered to be requirements:

a) to protect the network from harm caused by unrestricted repeat call attempts; and

b) ensure correct interworking with the network by preventing a TE with automatic dialling from sending address information before the network is ready to receive it.

Requirement a) is controlled by a simple timing requirement which sets limits to the repetition rate and number of call attempts to the same network address.

Requirement b) permits equipment without a dial tone detector to send dialling information no sooner than 2,7 seconds after seizing the line. Equipment with a dial tone detector is permitted to start dialling within 0,4 second after seizing the line, but shall commence dialling before 8 seconds has elapsed.

Thus, in practice, there will be no regulatory need for tone detection as any terminal can meet the requirements by commencing dialling between 2,7 and 8 seconds after seizing the line.

This TBR will not apply to TEs intended solely for national approval, but it can be expected that national regulatory requirements for tone detection will be reduced to similar "essential" requirements in a relatively short space of time.

A TBR for voice terminal access is in the early stages of drafting but, for its requirements with respect to tone detection is expected closely to replicate the requirements of prTBR 21 [41].

6.3 Networks

Tones on networks have not in the past been subject to significant regulation. In some countries there has been a requirement to consult with users and/or manufacturers before making changes, in others a simple period of notice is all that is required.

In general, there appears to be no regulatory control of any tones offered by new telephone network operators to the users of their networks. Tones within any network are completely at the choice of the network operator and often depend on the source of any exchange in that network. Where two networks are connected together, any tones transmitted across the interface are determined by agreement between the two network operators.

Thus a subscriber to two different network operators with a line from each can easily receive different tones on each line. The growth in the number of available network operators in Europe can readily lead to problems for users unless some steps are taken to limit the proliferation of tones and/or their meanings.

Directive 95/62/EC [5] on the application of Open Network Provision (ONP) to voice telephony should bring about some change in this situation, as Article 4 requires that national regulatory authorities ensure that up-to-date information on access to and use of the voice telephony service is published. The information required to be published includes the technical characteristics of the interfaces at commonly provided network termination points. To be complete, such a description should include a description of the various tones that are provided to facilitate proper interworking with analogue networks as well as the signalling protocols for the ISDN.

Such publication could be expected to lead to commercial pressures to reduce the range of network tones as well as to public pressure to achieve the same end.

7 User aspects

Tones, as auditory displays, are an essential part of the interface between the telephone user and the telephone system or network. The other component is the telephone set itself, with its handset (auditory input/output) and controls (keypad).

This clause focuses on user-centred aspects of tones. This is central to the human factors approach, which seeks to apply knowledge about users mental and physical attributes, including capacity allowing for learning and limitations, to an analysis of the user tasks. This analysis is normally aimed at deriving a set of user requirements in relation to that task, so that the task may be performed most efficiently by the user. In this case the task is telephony, where a user is engaged in making or receiving telephone calls over the public network from a variety of telephone terminals, and responding to the information tones supplied from the network.

It should be noted that tones encountered by users may also originate from terminals or PABXs in corporate networks, and these may not be the same as those in the public network. The tones generated in Corporate networks or PABXs are not included in this study, neither are tones which may be heard either intentionally or accidentally when attempting to make connections for data transmission, including facsimile. The ensuing clauses cover the review of relevant human factors literature, usability of the network and a specific form of task analysis aimed at a descriptive and predictive model of the telephony process as seen by the user.

7.1 Human factors research

The findings from the review have been grouped into a number of areas as they relate to different aspects of the perception, discrimination and recognition of information tones. The review has included some work on music and auditory icons, for instance, which allows a broader view to be taken of harmonization possibilities and options for change.

7.1.1 Human perception of sounds

The human auditory process allows perception of sounds in the frequency band from 20 - 20 000 Hz, but there are wide variations between individuals and the sexes (Woodson [43]). Women tend to hear sound better at "higher" frequencies, while men tend to hear better at "lower" frequencies (no precise definition has been found for higher or lower, but it is implied in (Woodson [43]) that 1 760 Hz is "low". On the other hand, Pollack [44] quoted frequencies as "low" up to 44 Hz, as "medium between 400 and 2 000 Hz and as "high frequencies from 2 000 - 8 000 Hz; in addition, see below for ageing effect). The very young have increased sensitivity, while the ageing process in most cases gives measurable hearing loss across the band but more in some frequencies than others - the typical so called presbycusis curve, an example of which was derived by Glorig [45].

The effective "auditory communication window" is sometimes quoted at 50 - 50 000 Hz [46]. Analogue telephone systems (PSTN) have bandwidth restricted to 300 - 3 400 Hz, but the limitations of the hearing impaired mean that their effective upper limit rolls off at 1 500 Hz. ISDN bandwidth may be greater (100 - 7 100 Hz), but the same limitation for hearing losses apply. Early work in the British Post Office (Archbold et. al. [47]) proposed that the frequency spectrum for an alerting signal (tone caller) should be within the range 400 - 4 000 Hz with at least one component below 1 kHz. Telephones for all [48] recommended that ringing should contain at least 2 fundamental tones below 700 Hz and harmonics of these. If the sensitivity of the ear to middle range frequencies is taken into account, then the range should be further restricted to 200 Hz - 1 500 Hz (Van Cott [49]).

Effectively, on the basis of these references, tones for use as auditory indications in telephone networks should be restricted to the range 200 - 1 500 Hz.

The duration of a sound also has an effect on its detection, since the ear's response is not instantaneous. In the case of pure tones, it takes 200 - 300 ms to reach full loudness perception. Sounds lasting less than 200 - 300 ms do not sound so loud and are not so audible in noise as sounds of longer duration (Munson 1947 [50]).

7.1.2 Coding and capacity

The user has a restricted capacity to discriminate, recognize and correctly identify coded meanings present in information tones. In the case of telephone networks, the network places constraints on bandwidth and intensity. Intensity as a coding dimension is not to be recommended, because of the needs of the hearing impaired and the elderly (Telephones for all [47]), so that coding has to be restricted to tones limited to a single dimension of frequency, or multiple dimensions of one or more frequencies, plus duration, interrupt rate and cadence [rhythm]. In addition, any loudness control or amplification fitted to a telephone may interact with intensity in a differential way. All these may be generated and presented in a network under processor control comparatively simply (see subclause 5.1.1). User performance in terms in interpreting telephone tones is likely to depend more on memory for the meaning of tones than the memory of the tones themselves (Doll and Folds [51]).

The use of musical tones or other sounds would be special case. As with the use of the visual sense to recognize, discriminate between and identify correctly numerous printed words, faces or objects, so a user can use the auditory sense to memorize all the notes from a piano, and tens or even hundreds of pieces of music or tunes, because of the many dimensions of stimulus and the patterns they present (Van Cott [49]). However, the choice of musical or other, naturally occurring, sounds, whilst possible in the context of telephone networks, would place greater demands on the technology in terms of memory and generation or control than at present, and although outside the scope of the study, is discussed in subclause 7.1.8.

7.1.3 Tone discrimination

Discrimination of one tone from another implies there is some difference that can be perceived between their characteristics. With pure tones, a difference in frequency, pitch or intensity (loudness) above a certain threshold will allow it to be seen as different. Pitch is a subjective attribute of sound, determined primarily by frequency, but also affected by loudness, spectrum, etc. (Van Cott [49]). Because of the affect of intensity, and the implications for the hearing impaired, pitch as such cannot be considered as a coding dimension in the case of telephone networks.

As stated in subclause 7.1.2, telephone networks have restricted bandwidth, further reduced by the needs of the hearing impaired which limits the remaining frequencies. Absolute discrimination of frequency can be as little as two or three hertz, below 1 000 Hz, but above this figure is about 0,3 % of frequency Van Cott [49]. On this basis some 600 discrete frequencies could be recognized as different.

In the case of telephone networks, however, each tone has a specific meaning, which must be learned, so that a user has not only to discriminate one tone from another, but recognize it and understand its associated meaning, and his correct response. In this context there is good evidence that five to seven such tones and their meanings are reliably recognized, in a general case provided by Miller [13], based on a number of studies and different sense modalities. Pollack [52] investigated auditory tones, and arrived at perfect identification for only five, with only the best experimental subjects achieving six or seven.

For complex tones, the discrimination process will be assisted by frequency, or combination of frequencies, intensity, rate of interruption, on-off fraction, or cadence. Such multi-dimensional coding increases the possible number of recognisable tones to nine or more (Pollack and Ficks [44]). Modulated tones also have greater attention-getting value, as do tones having increasing or decreasing frequency characteristics, either discrete or continuous (Van Cott [49]). This type of coding for tones involves a degree of pattern recognition, and the following conditions should be taken into account (Garner [53]):

- recognition becomes poorer as the number of stimuli increase;
- as patterns increase in redundancy, they are discriminated one from another more accurately, but more slowly;
- symmetrical patterns are more accurately identified than asymmetrical ones;
- patterns easily associated with other, familiar, patterns are more readily identified than novel ones;
- the use of more than one coding characteristic, e.g. frequency plus cadence, known as redundancy coding increases the chances of a tone being recognized.

The characteristics of a sound to produce recognisable patterns may be changed in ways other than outlined above. For example, frequency may be changed over time to give rising or falling tones; or intensity (loudness) may be changed over time to give a fading or increasingly loud tone. Indeed, by subtle manipulation of the decay characteristics of a tone it may be possible to produce bell-like sounds. However, changing only the intensity of a single frequency tone is not recommended as an appropriate coding dimension.

The effect of learning is not clear from much of the published work and, in particular, the effect on recognition capability of tones heard frequently (many times a day or week), or rarely (once a day, week, month, etc.). Studies of aircraft pilots ability to retain the meanings of warning sounds in memory was found to decline by 10 % to 20 % within one week (Patterson and Milroy [54]). A review of the use of non-speech auditory signals used for warnings in aircraft (Doll and Folds [51]) confirmed the problem of attaching a meaning to a specific tone differentiated by sound from another. Experiments designed to explore such effects within the telephony environment, as well as the effects of learning, including positive or negative transfer, would greatly simplify the task of tones designers.

7.1.4 Confusion between tones

Previous attempts at standardization of network tones have often cited confusion as a reason for undertaking the activity, especially between domestic and foreign tones, and a number of published papers examine this aspect. In laboratory studies of international trunk dialling (Schoeffler and Sheridan [55]), US subscribers listened to previously unheard tones, such as UK, Netherlands and German ring tones as well as their own familiar busy and (precise) ringing tones. The results showed that nearly half those taking part mistook the UK ring tone as a busy tone, and that the same number did not even think it was a "real" tone at all. Tones having a long period (six seconds) were judged more like ring tone than those with shorter period (cf. busy tone). Similarly, a short ratio (on-off) sounded less like ring tone than longer ratios, and that the 16 Hz modulation in the US ring tone also made a tone sound like ringing.

Another study carried out with support from the CCITT (Karlin [1]) repeated this experiment in Germany, Japan, Netherland, UK and USA. In all countries except UK the UK ring tone was consistently judged as ring tone on fewer occasions than the others. From this data the authors postulated that some rules which would allow creation of a new standard for international busy and ring signals. However, as far as is known, no action took place as a result.

Two studies were reported which showed that confusion in interpreting international tones could be significantly reduced by prior experience of tones by users, either in written descriptive form (Leopold [56]), or by listening to pre-recorded tapes (Cohen and Schoeffler [57]).

7.1.5 Recognition time and errors

Long user response time will have a negative effect on network performance, so that tones designed to give a rapid response from the user will be preferable to those that take a long time to recognize. Errors in recognition of a tone, which result in incorrect or inappropriate response from a user will load the network unnecessarily, and so should also be avoided. In general, reaction time is shortest to simple conspicuous signals, and increases as the number of choices increases.

A study of continuous and intermittent tones (März [58]) confirmed that a continuous tone used as a public network dial tone (in Germany) was responded to faster than the intermittent tone (Morse S) used in a PABX. Another study, of "good" and "bad" tones (Heberle [59]) showed that tones previously assigned and learned as "good" and "bad" were recognized more quickly and with fewer errors.

7.1.6 Warning tones and urgency

A general recommendation to make some tones more demanding of attention is to modulate the signal to give intermittent bleeps, or to modulate frequency to give rising or falling tones (Van Cott [49]). Another series of experiments on auditory warnings found that higher frequency tones (600 Hz), having a regular, fast cadence, was ranked highest for warning ability, a finding also supported by Pollack [52].

7.1.7 Preference and attitude

Work at the CCIR - Centre for Communication Interface Research [60] has established that for a specific set of meanings concerned with stored voice services (in this case home shopping service), preferences were shown for certain types of tone. Some of these meanings are similar with already known meanings for network tones, "prompt" and "acknowledgement" for feedback tones, "attention" or "topic change" for action required.

Table 8: Most preferred choices for dialogue function

	Simple tone	Level chime	Rising chime	Falling chime	Sequence	Total
Prompt	6	2			3	11
Acknowledgement			7	2	2	11
Error signal	2	1		5	3	11
Attention	2	2			7	11
Topic change		1	1		9	11
Total	**10**	**6**	**8**	**7**	**24**	**55**

From table 7 it can be seen that a simple tone is preferred for "prompt", a rising chime (three notes) for "acknowledgement", a falling chime for "error signal", a sequence (up to five tones) for "attention" and "topic change".

Furthermore, when allowed to choose the parameters for their own tones, the range of values for the simple tone above, was from 440 - 1 000 Hz, with duration ranging from 200 - 500 ms.

7.1.8 Alternatives to tones

The choice of the present tone type for network tones, depending for coding on single or complex frequency (limited range) or cadence, was dictated partly by technology at the time of introduction, but any possible change since has been constrained not so much by the most modern technology, as by existing specification and the perceived high costs of technical change and the higher costs to the user in terms of re-learning and confusion.

A feasible way forward is to take advantage of current technology to produce complete new families of sound to represent the functions or facilities in the network, designed from the outset to be capable of a very wide range of coding possibilities. One such way would be to design so-called "auditory icons", using musical or naturally occurring sounds, as described by Gaver [61].

In conventional telephone tones, dimensions of sound, such as frequency, duration, on-off ratio, have been used to convey dimensions of meaning, and as such are largely abstract (but see later). An alternative is to convey information about the world to the listener, so that an auditory icon is a sound that provides information about an event that represents the desired meaning. Instead of using dimensions of the sound to convey meaning, dimensions of the sound's source are used. Such a strategy uses the source of the sound, or apparent sound, e.g. a bell, to stand for meaning. Auditory icons are caricatures of naturally occurring sound such as bumps, scrapes or thuds.

Another way of differentiating the meaning of tones would be to design a set of corresponding "earcons", based on musical theory (Sumikawa [62]). An earcon is defined as being an audio cue that is used to provide information to the user about operations (procedures and interactions). The design of earcons uses simple pitches and motifs as building blocks. A motif is simply a brief succession of two or more pitches to produce a tonal identity. Two to four pitches may be used in motif construction.

The systematic approach used allows the power of being able to build larger sets of objects from the elements, and well-defined blocks provide the benefits of modularity, giving easy modification for future expansion and tailoring. Earcons may be made up from single or multi-element structures. The single element structure is based on a single pitch or single motif, while the multi-element may be based on two or more elements or motifs having common features or characteristics that impose a hierarchy or family. At first sight this appears to correspond with identifiable families of tones in telephony, as identified later in the model.

The use of voice announcements should not be excluded, for their ability to convey precise meanings, either on their own, or as a compliment to a standard alerting tone. Two things militate against their use, their language dependency, and a longer reaction time. The first can be overcome with use of services like Calling Line Identity Presentation (CLIP), and the second objection may not be serious when the improved accuracy of comprehension and response is taken into account.

In addition to voice announcements to convey network information messages to the subscriber, another technology has emerged that could be used visually to display text or graphics versions of network information tones and feedback. Bellcore has named this the Analogue Display Services Interface (ADSI) [64], and has created its own standard. ADSI was developed to provide an improved interface for user control of so-called "*CLASS*™" services, such as call waiting, three party conference and calling line identification presentation. Operating on analogue lines, it employs tone recognition techniques and allows text messages and graphics to appear on a small screen to inform and give user guidance on procedures and call status. Specifically, it replaces conventional tones with supplemented visual information. To enable such technology to be employed to overcome some of Gagliardi's original concerns about users not in their own country, it would, in addition have to provide language options.

7.2 User requirements

User requirements are identified as arising out of the various analyses and reviews that have been carried out prior to or during this study. They are based on specific human user characteristic, such as the auditory sense, or memory ability for procedures and meanings of information tones, or general requirements for the usability of the network at a national or international level. Some requirements have been identified in the first place by Gagliardi, others during the derivation of the model (see subclause 7.4.2), and others from good human factors practice or from the literature.

Table 9: Summary of user requirements

No	Requirement	Source reference
1	Users in a foreign country should be able to distinguish the local tone for the same function correctly.	Gagliardi [2]
2	Any users calling a foreign country should be able to interpret the distant tones correctly.	Gagliardi [2]
3	A user should know the procedures and dialogue for each call or service function he needs to use.	
4	A user needs to know the controls (actions) available to him. In particular the correct use of the star (*) and square (#) keys on the phone he is using.	
5	A user needs to know and memorize tone meanings for: - ordinary calls; - calls for other services, e.g. supplementary services, PUI.	
6	A user needs to know the displays, i.e. tones as feedback: - for action; - simply for feedback - no action.	
7	Each tone should be distinguishable from every other tone by the auditory sense.	See subclause 7.1.3
8	Each tone should have a unique meaning, (but families may exist see also above).	
9	Tones in a family should be recognisable as such, but no confusion should be possible between families.	
10	User should be in no doubt about what control action to take e.g. dial, hang up, do nothing.	See subclause 7.4.2
11	Tones should be in range of frequency 200 - 1 500 Hz.	See subclause 7.1.1
12	Users may perceive low tones with slow cadence as comforting and that the network is responding satisfactorily.	
13	Users may perceive fast or high tones with fast cadence as urgent and needing attention.	See subclause 7.1.6
14	Cadences should be in range 0,1 - 5,0 s.	
15	Any announcements should be in language of choice.	
16	Tones should be presented within recommended response times or a "please wait" message sent. Undue silence should be avoided.	
17	Time-outs after presentation of tones should be in range 2,0 - 8,0 s.	ETR 329 [73]
18	Tones should take into account the needs of users with hearing disabilities.	Archbold, Ithell, Johnson [47]

7.3 Additional HF considerations

7.3.1 Tones and network usability

The central mission for TC-HF is concerned with usability (see for example ETR 095: "Human Factors guidelines for usability evaluation of telecommunications systems and services" [65]). Much of the work completed, as well as the on-going work in STCs HF1 and HF2 is directed at this issue.

Usability is defined in ETR 095 [65] as "the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments". A similar definition is given in ISO 9241-11 [66] as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use".

ETR 095 [65] furthermore states that measures of usability are assumed to be of two kinds:

a) 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. Performance is often measured as time to task completion (efficiency) and goal achievement, e.g. as error rate (effectiveness);

b) attitude measures, which are subjective measures or observations of the user's opinion of working with the system. Such measures may be the degree of satisfaction or acceptability.

There is little doubt that, with reference to such usability criteria, the telephone service generally is highly effective. Also, the users within a country will have learnt and understood the meaning of information tones and are likely to be satisfied with this part of the telephone service. However, when making international calls or when travelling in a foreign country, i.e. in a different context of use, the users can meet unfamiliar tones which may not be correctly recognized. At worst the user may hang up and try a different approach, which means loss of time and possibly not achieving the intended task. At best, the confusion effect only leads to reduced satisfaction.

When users have learnt the differences between tones that they meet in other countries, these differences may have little overall impact on performance but may still cause annoyance, which means that users are not completely satisfied.

Therefore, even if international harmonization of tones may not, in itself, have much affect on effectiveness, it might improve efficiency by faster recognition and discrimination between tones. Ultimately, harmonization will also result in a higher percentage of satisfied users. Because future (potential high revenue) services or calls may come to depend more on tones (and/or voice announcements) it is in the interests of the network providers not only to maintain network efficiency but to increase the usage of their services in a competitive world by maximizing the usability of their services.

7.3.2 User/network interaction

Successful telecommunications depends on the quality of the user/terminal/network interaction that is necessary for the purposes of establishing a call, modifying it by invoking a supplementary service, or clearing it down. The quality of this interaction may be judged from the view of the network (or rather its designer) on the basis of whether the user responds to indications as desired, and from the view of the user on the basis of comprehensibility of such indications and the ease of use. A good system should meet the desires of both parties.

ETR 170 [67] describes the basic principle that should govern the interaction required between the user and the terminal/network. This is defined as the simple sequence, INDICATE - CONTROL - INDICATE (I-C-I). Each indication should then consist of two components, an indication of the underlying system status and an indication of the status of the required control (see figure 1).

INDICATE: System status/prompt
INDICATE: Control status
CONTROL ACTION
INDICATE: Control status change
INDICATE: System status change

Figure 1: The basic I-C-I principle for controls and indications in user interactions

When this principle is integrated into a procedural task involving the system (terminal/network) progressing through a number of intermediary states in response to user control actions, the required indications become chained together.

STATE - Waiting for user's control action
CONTROL ACTION
INDICATE - Feedback on control and system changes
INDICATE - Prompt on next expected inputs
STATE - Waiting for next user's control action

Figure 2: Integrating I-C-I into procedures

This demonstrates that any single indication given after a user's control action can have more than one function. It can be both feedback on the changes to the system/control status and a prompt for the next expected actions. This distinction is important when considering the roles that tones play within a user/terminal/network interaction, because the different roles may suggest differing characteristics. For example, a crude distinction could be developed where feedback tones are slow and reassuring, but prompt tones are fast and alerting.

Within telecommunications, there is another distinction which can be made regarding indications directed to the user. For a variety of reasons it has become a desired practice to inform the user when the privacy of a call is infringed. For example, the Warning tone when the call is being recorded (other than by answering machine/voice mail), the Intrusion tone when an operator or other third party breaks into a call, or the Conference tone when a new party joins a conference and/or for the duration of a Conference. These indications are not intended to give feedback on a user's actions or to prompt a user to make a control input. Rather they are to prompt the user that they may have to change their behaviour to accommodate the changed/unexpected status of the current connection.

Within telecommunications the range of options open to the user for controlling a call are limited. In an ordinary telephone they may be summarized as:

Signal - to the terminal/network or service: includes going off-hook, dialling numbers, pressing function keys, etc.

Wait - until the telephone, network, service or other user/s has done something.

Abort - return the terminal, network and/or service to idle.

Talk - all telecommunication including fax and data.

The indications used to inform and prompt the user need to differentiate between which of these base level options is appropriate, and possibly which of the various signals the user can send is appropriate.

7.4 Development of a model to facilitate categorization and description of tones

7.4.1 Analysis of tasks

Work in the area of audible signals suggests that specific characteristics of sounds impart specific meaning to the listener. For instance Pollack [52] has shown that tones with long cadences infer "goodness" whereas tones with short cadences infer "badness". In defining what attributes should be inherent in a set of telecommunications network tones it is necessary to consider what information the tones need to impart.

To this end a task analysis of common user interactions with the telecommunications network was undertaken, with results that suggested that the feedback given by tones needs to indicate success or failure in achieving the user's desired goal. Another requirement is that the tones either provide a prompt to stimulate an action from the user, or indicate that no further action is required. The information given by the tone needs to be sufficient to elicit the appropriate action from the user. Table 9 gives details for the tones defined in the CEC Mandate [4] plus some others.

Table 10: Task analysis of existing and proposed tones

Tone	Type	When	User Choices
Busy	Prompt	Set-up	Hang up or invoke SS - CCBS, UUS, etc.
Call Waiting	Prompt	Talk	Ignore or Hang up to get new call or Attempt call control
Dial	Prompt	Set-up	Send or Dial address
Intrusion	Information/ Prompt	Talk	Modify your conversation or talk to intruder
Negative Indication	Information/ Prompt	Network MMI	Confirms a service is not active or a data string relating to a service is not correct
Number unobtainable	Prompt	Set-up	Hang-up check number and try again - Same as Intercept
Pay	Prompt	Talk	Make payment soon
Personal User ID	Prompt	Set-up for UPT	Enter PUI, PIN etc.
Positive Indication	Information/ Prompt	Network MMI	Confirms a service is active or a data string relating to a service is correct - same as Confirm
Pre-empt	Information/ Prompt	Talk	Informs user that connection is about to be lost, (may be followed by silence)
Recall Dial	Prompt/ Information	Set-up	Enter address and remember a service is in operation
Record	Prompt	Talk	Leave you message after the tone
Ringing	Information	Set-up	Wait for answer or on personal time-out hang-up or invoke SS - CCNR
Special Dial	Prompt/ information	Set-up	Enter address and remember a service is in operation
Special Information	Information/ prompt	Set-up/Talk	Depends on use - Definition is same as NU In practice also used as Call Waiting, Pay, Positive Information

In general the tones occurring at the end of a successful interaction can be considered to be feedback of the resultant network status, often requiring no action. Tones occurring during a series of multiple interactions are usually prompts for action. In some cases tones have a dual purpose of both feedback and prompt.

A further point to be considered is whether the tones are applied during the setting up of a call or service (when interworking with the network) or are applied later during the conversational phase of the call (telecommunicate). Tones occurring during the conversational phase of a call are generally unexpected and indicate a change in the network status which may or may not be desired by the user.

Considering that only four actions in total are available to the user (Signal, Wait, Abort and Telecommunicate) and only three during the call set-up phase, it is tempting to consider whether more than three tones are required. This idea leads to the possibility of a taxonomy of tones into basic groups or families. Within any group of tones there can be simple tones (reflecting the less informed user's requirement for simple prompts) and sophisticated tones containing additional information permitting the knowledgeable user to adjust his actions to the prompt.

7.4.2 A first model

On the basis of this analysis, the multi-dimensional user goal based model shown in figure 3 was proposed in an attempt to define the complete "set" of network tones in terms of the dimensions discussed above.

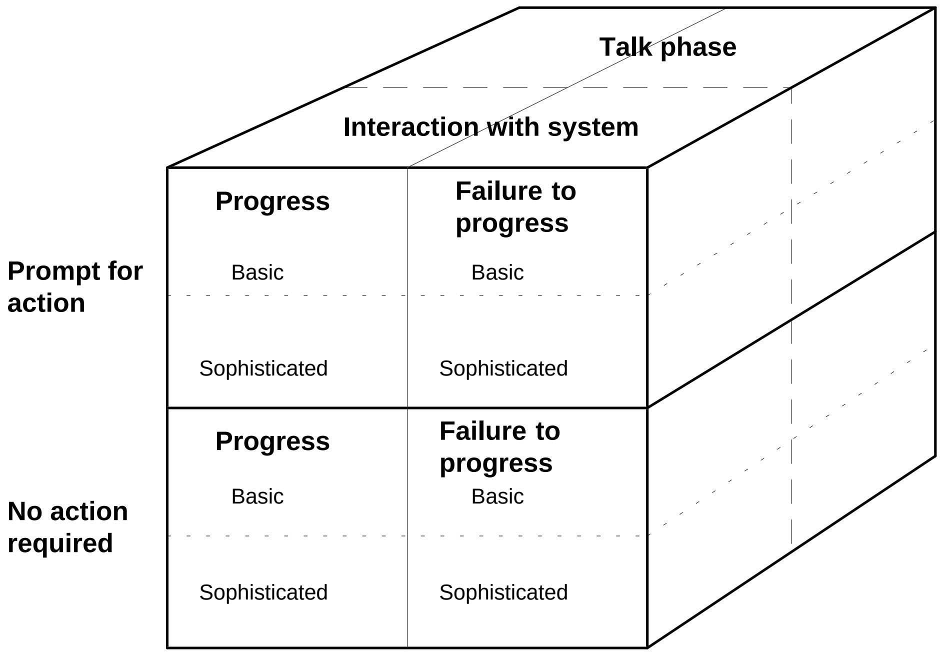

Figure 3: User goal based model

A) User Activity Dimension: Action Required/Not Required

On hearing the tone in question the user is prompted either to carry out a specific action in order to move closer to achieving their goal (which could be setting up a conversation, setting up a network service etc.) or to remain passive, awaiting the next phase in the process.

B) User Awareness Dimension: Progress/Failure to progress

On hearing the tone in question, the user is aware whether or not they have moved closer to achieving their goal.

C) System State Dimension: Interaction with the system/Talk phase

Tones occurring in the interaction phase are normally expected feedback tones. Tones occurring during the Talk phase are generally unexpected.

D) Information Content Dimension: Basic tone/sophisticated tone

Dial tone can be considered to be a basic tone, giving an indication of reaching the desired system status and also prompting for a number input. Special dial tone would be classified as a sophisticated tone giving additional information on the system status to an expert user.

The benefits of such a model/taxonomy are as follows:

1 If it is possible to associate each of the dimensions with a unique tone characteristic, then the specification of a new tone (or tone set) will be facilitated.

2 Categorization as above indicates groupings and/or individual tones which may be considered in more detail for combination with others, or deletion.

3 If the tone **characteristics** define whether action is required and whether progress is being made towards the goal, then in the worst case situation the user may still achieve their goal without recognizing ANY INDIVIDUAL tones, only their characteristics.

7.4.3 Categorization of tones

It was felt that a good indication of whether this model was a realistic first step could be obtained by considering only the first two dimensions of the model and assigning the tones defined in the CEC Mandate [4] (and some others) into dimensions A and B, with the tones shown in **bold** being those defined as priority.

Progress prompt for action	**Failure to progress prompt for action**
Dial **Call waiting** Special Dial Personal User Identity	**Busy** **Pay tone** ***Special information*** Congestion Negative information
Progress action not required	**Failure to progress action not required**
Ring Positive information	***Special information*** Intrusion Pre-empt

Figure 4: Tone assignments for dimensions A and B

Assignments are shown in figure 4 and were reasonably straightforward, giving some confidence in the applicability of the model.

The model gave somewhat indeterminate results for only one tone. SIT as defined by ITU-T is used to indicate call failure. In some cases it stands on its own and requires that the caller acts to release the call. In other cases it is followed by a message and requires the caller to do nothing but wait for the message before deciding on a course of action. It is therefore context dependent and is *italicized* to show that it does not fall firmly into one single classification.

It may also be noted that in fields outside telecommunications (e.g. at airports), tones very similar to SIT are used to draw a listener's attention to the fact that a message follows.

7.4.4 Use of model for description of tones

When attempting to apply the model it was necessary to postulate tone characteristics appropriate to the various dimensions of the model. The following tone characteristics were identified as possibilities for mapping onto the tone model defined above.

Frequency

High/low, single/multiple, simultaneous/sequential, rising/falling, discrete steps/continuous.

Complexity

Harmonic content.

Cadence

Fast/slow, duration, duty cycle, continuing, once/twice.

Intensity

Comparative.

Defining which dimensions to apply to the "progress" axis and which to apply to the "action" axis would have required further study of the literature and possibly the commissioning of some specific research, but as interim postulations, the following dimensions were considered likely.

Considering the axis "progress/failure to progress".

Progress

- An indication of satisfactory progress should be a "good" tone with reassuring characteristics having a calming effect.
- Low frequency, harmonious, slow cadence (Pollack [44, 52], Heberle [59]), rising frequency?

Failure to progress

- An indication of failure or imminent failure to progress should be a "bad" tone with disturbing characteristics having a stimulating effect.
- High frequency, discordant, rapid cadence (Pollack [44, 52], Heberle [59]), falling frequency?

Considering the axis "Action required/action not required".

Action required

- A tone indicating action required should awaken the user, convey urgency and be persistent so as to invite action.
- High frequency (Gale), discordant, rapid cadence (Patterson), continuing (until action performed)?

Action not required

- A tone indicating action not required should lull the user into inaction.
- Low frequency (Gale), harmonious, slow (Patterson) cadence?

Putting these characteristics into the four cells relevant to the first two dimensions of the model (the tones not allocated from experimental evidence being *italicised*) shows that two cells are more or less concordant but two (shown shaded) are also contradictory as shown in table 11.

This could suggest that this level of coding discrimination was too simplistic, that the context in which the published information was derived was not relevant, or it could illustrate a conflict between the need of the system designer and those of the user.

Table 11: Assignment of tone characteristics from the literature

	Progress	**Failure to progress**
Action required	Progress - choose from: Low frequency*, Harmonious,* Slow cadence*, Rising frequency*	Failure to progress - choose from: **High frequency, *Discordant*** **Rapid cadence***, Falling frequency*
	Action required - choose from High Frequency, *Discordant,* Rapid cadence*, Continuing*	Action required - choose from **High Frequency, *Discordan***t, **Rapid cadence**, *Continuing*
Action not required	Progress - choose from: **Low frequency**, ***Harmonious*** **Slow cadence**, *Rising Frequency*	Failure to progress - choose from: *High frequency, Discordant* Rapid cadence*, Falling frequency*
	Action not required - choose from **Low Frequency**, ***Harmonious*** **Slow cadence**	Action not required - choose from Low Frequency*, Harmonious* Slow cadence

7.4.5 A new model

A number of alternative models were subsequently investigated, and a number of unsuccessful attempts were made to select a subset of tone characteristics that would satisfy the model in all aspects, but it was finally concluded that as the network was not itself user goal related, the model in all its variants investigated did not fully allow mapping of all possible goals, or adequately take into account the limitations on the prompts and information to be conveyed to the user.

Finally the version illustrated in figure 5 was designed to allow classification of tones by system state, their characteristics, and their presentation to the user. It contains the original concept of OK/Not OK, gives a general indication to the user of call progress towards an (assumed) goal, indicates the phase of the call with the addition of talk/non talk and makes a distinction between feedback, prompt "Can" and prompt "Must".

Feedback is just the simple provision of information on system status, prompt "Can" suggests some option or choice for the user and prompt "Must" is an imperative that demands action from the user in order to prevent failure of the call.

		System Status **OK**		System Status **NOT OK**	
		Non-Talk	Talk	Non-Talk	Talk
FEEDBACK	Basic	Ring, Comfort, Holding, Caller Waiting	Conference	Busy, Number Unobtainable	Pre-empt
	Sophist	Special Ring, Positive indication		Congestion, Negative Indication	Intrusion, Warning
PROMPT CAN	Basic	Dial, Second Dial	Call Waiting		
	Sophist	Special Dial			
PROMPT MUST	Basic	UPT (PUI/PIN), Record	Pay tone		
	Sophist				

Figure 5: Tone assignments to the cells defined in the final model

NOTE: In figures 5, 6 and 7, the shading indicates the talk phase.

It was found possible to clarify and further develop this model by adjusting the presentation to the form shown in figure 6. The prompt "Must" section has been moved into the system status "Not OK" area on the interpretation that the system status is referring to actual or potential status, and the system would become "Not OK" if the "Must" prompt was ignored.

		System Status **OK**		System Status **NOT OK**	
PROMPT CAN	Basic	Dial, Second Dial	Call Waiting		
	Sophist	Special Dial			
PROMPT MUST	Basic			Pay tone	UPT (PUI/PIN), Record
	Sophist				
FEEDBACK	Basic	Ringing, Comfort, Holding, Caller Waiting	Conference	Pre-empt	Busy, Special Information Number Unobtainable
	Sophist	Special Ring, Positive indication		Intrusion, Warning	Congestion, Negative Indication
			Talk Phase		

Figure 6: Modified tone assignment model

Figure 6 can then be presented in the simplified form of figure 7 which for the sake of clarity omits the dimension Basic/Sophisticated and superimposes the Signal, Wait, Abort, Talk (SWAT) user control options discussed in subclause 7.3.2.

	System Status **OK (good)**		System Status **NOT OK (bad)**	
		SIGNAL		
PROMPT CAN	Dial, Second Dial	Call Waiting		
PROMPT MUST			Pay tone	UPT (PUI/PIN), Record
	WAIT		**ABORT**	
FEEDBACK	Ringing, Comfort, Holding, Caller Waiting Positive Indication	Conference	Pre-empt	Busy, Special Information, Congestion, Number Unobtainable Negative Indication
		TALK		

Figure 7: Simplified tone assignment model

Figure 7 was then rearranged and populated with the tone characteristics derived in subclause 7.4.3 and on this basis the diagram of figure 8 was obtained.

	"Good" Feedback	Prompt		"Bad" Feedback	
		Can	Must		
	WAIT	**SIGNAL**		**ABORT**	
Reassuring Calm Not urgent Smooth Pleasant	Low frequency Slow cadence Long period			High frequency Fast cadence Short period Continuing	Worrying Disturbing Urgent Rough Unpleasant
	TALK Low duty cycle				

Figure 8: Tone characteristics

7.4.6 Summary of model features

The final model in figure 6 encompasses virtually all of the dimensions analysed as characteristics of the user-telephone interaction. Some assumptions relate to user goals in this interaction, and others to system goals, because a single model cannot represent them all. Tones assigned to the model appear to be in their right places. Figure 8 shows the superimposition of technical characteristics (not quantified) derived from the human factors literature, and the subjective descriptions associated with them for each phase according to the SWAT model.

If the characteristics of known tones as assigned to the model in figures 6 and 8 are examined they are found largely to conform with the literature-derived figures in most cases. One exception is Dial tone, whose functional definition does not make it completely clear whether it should be considered as a prompt or a feedback tone. There is a body of opinion that many users merely accept dial tone as feedback indicating that the network (or terminal) is working. It may also be interpreted to suggest that the tone should be within the family "Prompt Can". Nevertheless, there is some confidence in using the model to assess the conformance of each tone to the model, and to use it to identify the characteristics of a new tone for a given function in future, provided its functional description can be matched to a cell in the model. This matching is part of an audit procedure developed and described in clause 8 to examine each of Gagliard's six priority tones, in order to sensibly determine how they might be "harmonized" in the future.

For the purposes of this audit, values need to be assigned for the technical characteristics described in the model. Table 11 gives a preliminary assessment of these values which will require later confirmation by suitable experiment.

Table 12: Possible values for tone characteristics

	Frequency	Rhythm	Period	Other
"Good"	Low < 500 Hz	Slow - 1/s	Long - 3 s	
"Bad"	High > 500 Hz	Fast - 2/s	Short - 1 s	Continuing
	Non-intrusive Duty cycle < 5 %	**Talk Phase**	Intrusive Duty cycle > 15 %	

7.5 Assessment of tone signals for usability

The definition of "usability" contained in ETR 095 [65] is applied in this context where usability is considered a pure ergonomics concept not depending on costs. The balance between the benefit for the user and the financial costs form the concept of "utility".

The measures of usability are of two kinds and will apply to the assessments proposed in this report. The first are performance measures, which are objective measures, and are focused on task performance. The second are attitude measures, which are subjective measures of the users' opinions.

For a product to be regarded as usable, it must achieve a high score in both of these measures. Any new tone signal created, or any one or more tone signals compared, must be assessed in both dimensions.

To assess the two dimensions of usability, the following techniques are proposed.

Performance measurement

The main performance criterion is considered to be how easily distinguishable a tone signal is compared with a set of tone signals already in use in a specific context. This is best measured by classical psychophysical techniques in a controlled environment with known characteristics.

An example of a particularly useful such technique in this context is when the tone signals in question are presented one at a time, each time using a different signal strength. After each presentation the subject must choose an interpretation of the signal amongst a set of predefined interpretations. From the subject's responses, the confusability of the tone signals can be estimated.

Attitude measurements

In the past (e.g. in a "call waiting" tone evaluation), a technique has been used where tone signals are presented in a controlled environment with known characteristics and in a specific context, just as in a performance study.

After each presentation, the subject has been asked to judge the tone signal with reference to a few relevant subjective scales. This combination of questionnaire and laboratory study is usually a cost effective and powerful method.

Both of these methods should be used to evaluate the existing model for generating tone signals and to determine the usability of new signals to be introduced. They should also be used to assess the "confusability" of two or more tones or to discriminate between tones in any given set of tone signals.

Here, the context of use is defined, the expected performance and user assessment goals are specified, and, based on the proposed model, the tone signal characteristics are established.

A test situation will need to be defined in appropriate surroundings (e.g. a usability laboratory) where representative telephone users can evaluate the proposed tone signal. About 25 randomly selected users will need to be selected for each test and from each country depending on the goals and actual design of the test. There may be need to carry out the assessment in two or more European countries if significant effects due to difference in culture and tradition are suspected.

Experience suggests that a minimum of 300 - 400 man hours will be required for each assessment test. This includes all activities ranging from planning, user recruitment, test execution to final report and presentation. The number of hours could increase if help from local network operators were not to be forthcoming.

The calendar time to carry out an assessment test would be about two months.

8 Potential for harmonization of network tones

In accordance with the CEC Mandate [4] this clause describes a procedure that has been developed to allow the HF model to be used in a critical examination of European tones in order to make recommendations about the possible harmonization of network tones in Europe.

8.1 An audit of European network information tones

The detailed analysis of European tones is presented in part 2 and summarized in clause 4. These focus on the two priority sets proposed by Gagliardi [2] and extracts their detailed technical characteristics. The European data is based on both the EU and ETSI member countries and contains some 30 or more national entries.

Each individual tone may then be subjected to an "audit", the aim of which is to develop recommendations relating to its future harmonization, as required by the Mandate. The procedure for the audit contains ten steps:

1 The target tone is first named and defined by its functional description, i.e. what it is intended to convey to the user about a call. At this stage it is possible to identify some tones where it is not clear either what their function is, or that they are using the wrong description or name.

2 The next step is to assign the tone to a position in the HF model, based on its functional description.

3 Step 3, then defines the characteristics of the tone postulated by the HF model.

4 Step 4, identifies the range of characteristics reported for the target tone by the chosen group, i.e. Europe. These data may be inspected for coherence, spread of certain characteristics, and any significant modal value.

5 Step 5, identifies a modal set of characteristics for the tone. By inspection, it may be possible to identify a "mode" group within any one tone - that is, the tone characteristics which the largest number of countries report using. Such a mode may be extracted from any set of tones grouped by economic, regional or geographical boundaries.

6 Step 6, inspects the existing standards for that tone, both for network and terminal generation.

7 The relevant human factors issues on the users expectations, the potential for confusion and any usability issues are reviewed next. The tone characteristics are compared for possible confusability with other tones in the same group or any other group, and usability in relation to the task the user is carrying out. For the purposes of the audit, only an expert estimation can be made of usability in terms of likely confusion with other examples in the tone group for users in Gagliardi's groups A and B (those visitors to a foreign country dialling internally and users dialling into another country). Doubtful cases can only be settled by usability testing.

8 Five options for harmonization or change, labelled a-e, are now examined in some detail:

Option a: Use the HF model. In this case harmonization could be achieved by countries aligning the characteristics of their tone with those proposed by the model. In the case of a gross misfit, the audit would try to determine whether any change could be justified in terms of improvement in usability versus cost.

Option b: Use the existing standards. In this case, harmonization could be achieved by countries changing some aspects of a tone's technical characteristics to align it with a specific international standard.

Option c: Use the European mode. As explained above, harmonization could be achieved by countries changing their tone's characteristics to those most commonly occurring in Europe (or in any other grouping).

Option d: Do something different. In an exceptional or new case, it may be desirable to create a tone with characteristics completely outside an existing range, in order to make it truly distinguishable, or a characteristic "earcon" may be created.

Option e: Do nothing. This would imply that the tone was usable, would not confuse users in Gagliardi's Categories A or B, and was conformant with known definitions and standards. In other words the tone was in effect already harmonized.

No other options are considered, although there are many other options for change which could be examined, for example:

- different calculations of the European mode - e.g. by weighting countries by reference to their number of subscribers, or their volume of traffic, or by their ETSI voting rights;

- the consideration of a World Mode, however calculated;

- the specific use of new tones or earcons.

However, these five (a-e above) represent the key choices that may be made.

9 The penultimate step reviews the implications for each option (a-e), including crude estimates of cost and benefits and the ease with which a possible migration path may be established as part of an implementation plan.

10 The final step derives a set of recommendations in priority order with respect to the harmonization of each tone.

This auditing process, which may well be iterative, provides a suitable logical basis for the recommendations for harmonization in fulfilment of the aim of the Mandate. The same method may also be adapted and used for critical evaluation of any proposal for a new tone In particular in this case, the requirement for usability assessment would ensure that new tones not only fit the model, but are acceptable and useful to representative users.

This audit has been performed on each of the six priority tones identified by Gagliardi [2] and the results are reported in the subclauses that follow. Recommendations appear for each tone and are generally summarized in clause 10 of the report "Conclusions and recommendations".

8.2 Results of tones audit

Each of the six priority tones listed in the CEC Mandate (Dial, Ring, Busy, SIT, Call Waiting, Pay) have been audited according to the process described in subclause 8.1. Each audit includes its own set of recommendations.

8.2.1 Audit of tone "Dial"

8.2.1.1 Dial tone - functional definition

The auditory indication to be presented to a user to indicate that a network connection is available and ready to receive call information and inviting the user to start sending call or service related information (this definition is consistent with CCITT Recommendation E.182 [6]).

8.2.1.2 Position in HF model for Dial tone

This functional definition places the dial tone in the HF model within the family of Feedback + System State OK and at the "Good" end of our characteristics continuum. It may also be interpreted to suggest that the tone should be within the family Prompt Can.

8.2.1.3 HF model characteristics for Dial tone

Low frequency <500 Hz

Slow rhythm <1/s

Long period >3 s

8.2.1.4 Current European practice for Dial tone

Table 13: Dial tones used in Europe

Cadence (s)	Frequency (Hz)	Number of Countries
Continuous	350 + 400	1
Continuous	350 + 440	1
Continuous	350 + 450	2
Continuous	400 or 425	1
Continuous	400 or 425 or 450	1
Continuous	400 or 450	1
Continuous	420 or 450	1
Continuous	425	14
Continuous	425 or 450	4
Continuous	440	1
Continuous	450	1
0,165 - 0,165 - **0,66** - 0,66	425	a
0,3 - 0,33 - **0,66** - 0,66	425	1+a
0,2 - 0,2 - **0,6** - 1,0	*425*	1
0,7 - 0,8 - **0,2** - 0,3	425	2
0,2 - 0,3 - **0,7** - 0,8	425	1
0,2 - 0,3 - **0,7** - 0,8	425 or 450	b
0,2 - 0,8 - **0,7** - 0,3	425 or 450	b
0,25 - 0,3 - **0,7** - 0,8	425	c
0,25 - 0,75 - **0,75** - 1,0	425	c
NOTE: Letters are used for countries which report two or more different tone characteristics for the same function. See part 2 for the fuller details.		

8.2.1.5 European mode for Dial tone - characteristics

Continuous cadence, 425 Hz single frequency.

8.2.1.6 International standards for Dial tone

Table 14: International standards for network generated Dial tones

Network generated tones			
Source	**Cadence (s)**	**Frequency (Hz)**	**Preference for any update of equipment**
CCITT Recommendation E.180 [23]	Continuous	Single f, range 400 - 450 Combined, up to 3f (1f range 340 - 425, 2f range 400 - 450)	Continuous cadence at single frequency of 425 ± 15 Hz
CEPT Recommendation T/SF 23 [69]	Continuous	400 - 450	
CEPT Recommendation T/CS 20-15 [70]	Continuous	425 ± 15	

Table 15: International standards for terminal generated Dial tones

Terminal generated tones		
Source	**Cadence (s)**	**Frequency (Hz)**
ETS 300 245-7 [17] (ISDN Terminals)	Continuous or National tones	425 or National tones
ETR 187 (General) [14]	Continuous	425
GSM 02.40 [19] (Dial tone is not normally required, but if it is provided)	N/A Continuous	N/A 425 ± 15
ETR 294 [20] (TETRA - no characteristics defined)	N/A	N/A

8.2.1.7 Human factors issues for Dial tone

Expectations

A continuous low frequency tone of single or dual frequencies.

Confusability

HF expertise would suggest that in the absence of the facility to compare two frequencies:

- few users (may be as low as 10 %) would report a difference between two continuous single frequency tones, when the variation of tones used is within ±25 Hz;
- more users (may be as many as 50 %) would report a difference between continuous multi-frequency tones and continuous single frequency tones;
- most users (may be as high as 95 %) would report a difference between discontinuous single or multi-frequency tones and continuous single or multi-frequency tones.

Usability

In practice most users of unfamiliar networks may assume that any auditory signal presented on requesting connection to a network can be taken to be the invitation to send call or service related information.

The alternative - Silence - would be taken to indicate no connection is available.

8.2.1.8 Review of options for Dial tone

a) Use the HF Model

If the dial tone is correctly located in the "Feedback/System OK" family, the characteristics should be located towards the lower frequency slower end of the range. If it should be located in the "Prompt Can" family, it should lie more towards the higher frequency fast end of the same characteristics.

In this context, if continuous is taken as the extreme of slow cadence, the HF model requirements are similar to the requirements of the standards and also the existing European mode.

b) Use the standards

The characteristics defined in the current ITU-T, CEPT Recommendations and ETSI standards are all coherent with each other. They all define a Continuous tone with differing tolerances on the acceptable frequencies. There are two EU and a number of other European counties that do not comply with the loosest standard ITU-T, these are identified in subclause 8.2.1.9. The key change required for compliance with ITU-T is for countries with discontinuous tones to migrate to a continuous tone. The changes required for compliance with the tightest standard are the same as for converting to the European mode.

c) Use the European mode

The characteristics of the modal dial tone provide a good fit to the HF model, but there are a number of EU and other European countries with Dial tones that do not precisely match these characteristics, these are identified in subclause 8.2.1.9. The key changes required are for some countries to migrate from a Discontinuous to a Continuous tone, some to migrate from a dual to a single frequency and for others to change the frequency.

However, the HF evidence suggests that:

- the differences within the range of single frequencies used is unlikely to cause any confusion;
- the differences between the dual frequency and single frequency tones is unlikely to cause much confusion;
- the use of a discontinuous tone with a short period is the most likely source of confusion to Category A users.

d) Do Something different

There is no human factors or technical reason for such a change to the public network service. Where there may be a requirement to express a "corporate identity" through a "unique" dial tone, any proposed tone or earcon would need to be tested for usability.

e) Do nothing

The spread of characteristics of existing European dial tones is not large, and there are few confusion or usability issues. Where these may be expected i.e. in the case of discontinuous tones and perhaps also in the case of dual frequency tones, the impact will be felt most by Category A users (travellers temporarily using another network).

8.2.1.9 Implications of options for Dial tone

Option a - Use the HF model

No changes required.

Option b - Use the Standards

Change to a continuous cadence.

EU

Greece (change cadence to continuous, and maybe change NU tone for Paging).

Italy (change cadence to continuous, and change Special Dial tone).

ETSI area

Bulgaria, Croatia, Czech Rep. Slovakia, Slovenia and Yugoslavia (change cadence to continuous).

Option c - Use the mode

Change to a continuous cadence and a single frequency (based on continuous at 425 Hz).

EU

Greece (change cadence to continuous and maybe change frequency on some exchanges 450 to 425 and maybe change NU tone for Paging).

Italy (change cadence to continuous; and change Special Dial tone).

United Kingdom (change frequency from 350 + 440 to 425).

Insignificant changes would be required in Austria, Belgium, Germany, Luxembourg, Netherlands, France, Ireland, Portugal.

ETSI area

Bulgaria, Croatia, Slovakia, Slovenia, and Yugoslavia (change cadence to continuous).

CI Jersey and Cyprus (change frequency from 350 + 450 to 425).

Czech Rep. (change the cadence on some exchanges to continuous).

Gibraltar (change frequency from 350 + 400 to 425).

Insignificant changes would be required in Romania and Turkey.

Option d - Do something different

The implications of this course of action are dependent on just how different the "different" is. At least it would imply extensive testing of the proposed tone or earcon.

Option e - Do nothing

There are no additional costs in this course of action but benefits will be foregone, particularly to terminal equipment manufacturers and users.

8.2.1.10 Recommendations for Dial tone

1	To encourage the rapid harmonization of the functional use for dial tone and to encourage the cessation of the use of a similar tone to indicate other system functions, e.g. positive indication.

2	To encourage the rapid change to the consistent use of a Continuous dial tone of single or dual frequencies.

3	To encourage the gradual change to a single harmonized dial tone based on the Continuous tone of 425 Hz, when planned changes to the public networks make it possible.

4	To encourage National Regulatory Authorities (NRAs) to require new public network operators providing services which require the provision of a dial tone to comply with either their existing national dial tone characteristics or to provide a dial tone with a Continuous tone of 425 Hz.

5	NRAs should ensure that any new dial tones are properly regulated, are usable, are compliant with the HF model and are significantly distinguishable from network tones having other meanings, e.g. new dial tones based on the HF model that may assist the provision of a "Corporate Identity" to Public Network Operators or Corporate Networks.

8.2.2 Audit of tone "Ringing"

8.2.2.1 Ringing tone (also known as Ring tone) - functional definition

The auditory indication to be presented to a user to indicate that a connection has been made and that an alerting signal is being applied to the called terminal or service (this definition is consistent with CCITT Recommendation E.182 [6]).

8.2.2.2 Position in HF model for Ringing tone

This functional definition places the ring tone in the HF model within the family of Feedback + System State OK and at the "Good" end of our characteristics continuum.

8.2.2.3 HF model characteristics for Ringing tone

Low frequency < 500 Hz

Slow rhythm <1/s

Long period > 3 s

8.2.2.4 Current European practice for Ringing tone

Table 16: Ringing tones used in Europe

Cadence (s)	Frequency (Hz)	Number of Countries
0,25 - 4,0 - **1,0** - 4,0	425 or 450	g
0,4 - 0,2 - **0,4** - 2,0	400 or 450 or 425 × 25	a
0,4 - 0,2 - **0,4** - 2,0	400 × 25	b
0,4 - 0,2 - **0,4** - 2,0	400 + 450	2
0,4 - 0,2 - **0,4** - 2,0	400 + 450 or 450 × 25 or 425 × $16^2/3$	2
0,4 - 0,2 - **0,4** - 2,0	425	a
0,5 - 4,0 - **1,0** - 4,0	425 or 450	g
0,8 - 3,2	425	2
1,0 - 3,0	400 or 450	c
1,0 - 3,0	425	b
1,0 - 3,0	425 or 450	1
1,0 - 4,0	425	11, c, d, e, f
1,0 - 4,0	425 or 450	2, g
1,0 - 4,0	425 or 500	1
1,0 - 4,0	450	e
1,0 - 5,0	400 or 425	1
1,0 - 5,0	420 or 450	1
1,0 - 5,0	425	h
1,0 - 5,0	425 or 450	g
1,0 - 9,0	400	h
1,0 - 9,0	425	d
1,0 - 9,0	450	g
1,0 - 9,0	450 × 25	f
1,2 - 3,7	425	1
1,2 - 4,7	425	1
1,5 - 3,0	425	1
1,5 - 3,5	440	1
1,83 - 3,0	425	d
2,0 - 4,0	400 × 16 or 450 × 25	1
2,0 - 4,0	450	1
NOTE: Letters are used for countries which report two or more different tone characteristics for the same function.		

8.2.2.5 European mode for Ringing tone - characteristics

Cadence **1,0 s on** - 4,0 s off; 425 Hz single frequency.

8.2.2.6 Existing international standards for Ringing tone

Table 17: International standards for network generated Ringing tones

Network generated tones			
Source	**Cadence (s)**	**Frequency (Hz)**	**Preference for any update of equipment**
CCITT Recommendation E.180 [23]	Slow period (tone<silence) tone range 0,67 - 1,5 silence range 3,0 - 5,0 1st tone starts a.s.a.p.	prefer 425 rec. range 400 - 450 accept range 340 - 500 avoid 450 - 500	Cadence **1,0** - 4,0 at single frequency of 425 ± 15 Hz
CEPT Recommendation T/SF 23 [69]	**(0,75 - 1,25)** - (4,0 - 5,0)	400 - 450	
CEPT Recommendation T/CS 20-15 [70]	**1,0** - 4,0	425 ± 15	

Table 18: International standards for terminal generated Ringing tones

Terminal generated tones		
Source	**Cadence (s)**	**Frequency (Hz)**
ETS 300 245-7 [17] (ISDN Terminals)	**1,0** - 4,0 or National tones	425 or National tones
ETR 187 (General) [14]	**1,0** - 4,0	425
GSM 02.40 [19] (Ringing tone is not normally required, mobile station presents network tone, but if it is provided)	N/A **1,0** - 4,0	N/A 425 ± 15
ETR 294 [20] (TETRA - name and function defined)	No characteristics defined	

8.2.2.7 Human factors issues for Ringing tone

Expectations

A slow cadence tone of single or dual frequencies, equivalent in cadence to the local Alerting or Ring Signal.

Confusability

HF expertise would suggest that in the absence of the facility directly to compare two ring tones:

- few users (may be as low as 10 %) would report a difference between two single frequency simple cadence tones, when frequency of tones used is within ±25 Hz and the variation of cadence is within 0,75 - 1,25 s on - 3,0 - 5,0 s off;
- most users (may be as high as 99 %) would report a difference between a single frequency tone with a simple cadence (single on/off rhythm - within tone period) and a single or dual frequency tone with a complex cadence (multiple on/off rhythm - within tone period).

There are two cases where confusion may be expected by Category B users (people who are connecting with another network):

- callers used to a ringing tone with a simple cadence may be confused when they receive a complex cadence Ringing tone, especially if they believe they have not crossed national borders;
- conversely, callers used to a Ringing tone with a complex cadence may be confused when they receive a simple cadence Ringing tone, especially if the period is lengthy.

Usability

In practice most users of unfamiliar networks may assume that any slow repetitive auditory signal presented after apparently successfully requesting a connection through a network can be taken to be the Ringing tone.

Anything else, and especially the alternatives listed below, would probably be taken to indicate no such connection is available and the request has failed:

- silence;
- a single burst of noise or tone followed by a lengthy silence;
- a fast repetitive tone;
- an announcement;
- a tone followed be an announcement.

Again in practice, the unfamiliar user would probably wait for a short period to see what else, if anything, may happen.

Consequently:

- the Ringing tone should start as early as possible to avoid silence;
- the length of the "off or silent" part of the tone period should not be too long. Unfortunately, what constitutes "too long" depends on a user's past experience. To those used to a 3 s period, a period of 4 - 5 s may seem a little too long and periods of 6 s or more distinctly too long.

NOTE: As the Ringing tone should match the Alerting (Ringing) Signal, there is good reason to consider also the characteristics of this signal although it is outside the scope of the mandate. For example: the length and tonal characteristics of the "on" part of the tone period should minimize masking (by other noises) and aid localization. Both of these are assisted by a multi component tone. Also the length of the "off or silent" part of the tone period should not be too long to minimize the loss of the localization "trace".

The argument may also be presented that this signal should have an urgency component to try minimize the time the network is tied up unproductively.

8.2.2.8 Review of options for Ringing tone

a) Use the HF model

If the Ringing tone is correctly located in the "Feedback/System OK" family, all of the Ringing tones reported in use in Europe comply with the characteristics of the model - There would be no changes required.

However, the HF evidence suggests that there may be some value in increasing the perceived urgency of the alerting signal, which would imply a similar change in the Ringing tone. This would also reduce the chance of errors made by users used to short period tones, assuming a system failure during an unexpectedly long silence period.

b) Use the standards

The characteristics defined in the current ITU-T, CEPT Recommendations and ETSI standards are all coherent with each other. They all define a simple cadence tone with differing tolerances on the acceptable on/off ratio and frequencies. There are four EU and a number of other European counties that do not comply with the loosest standard, ITU-T, these are identified in subclause 8.2.2.9. The key change required for compliance with ITU-T is for countries with complex cadences to migrate to a simple cadence tone. The changes required for compliance with the tightest standard are the same as for converting to the European mode.

c) Use the European mode

The characteristics of the modal ringing tone provide a good fit to the HF model, but there are a number of EU and other European countries with Ringing tones that do not precisely match these characteristics, these are identified in subclause 8.2.2.9. The key changes required are for some countries to migrate from a complex cadence to a simple cadence, some to migrate from a dual to a single frequency, for others to change the frequency, and for a few to do two of these.

However, the HF evidence suggests that:

- the differences within the range of single frequencies used is unlikely to cause any confusion;
- the differences between the dual frequency and single frequency tones is unlikely to cause much confusion;
- the use of a complex cadence tone with a shorter period is the most likely source of confusion to Category B users;
- there can be some value in differing Ringing tones confirming that the user has crossed national boundaries;
- there may be some value in reducing the length of the "off or silent" part of the tone period to increase the perceived urgency, and reduce the chance of errors made by users used to short period tones, assuming a system failure during an unexpectedly long silence period.

d) Do something different

There is no human factors or technical reason for such a change to the public network service. Where there may be a requirement to do something different, any proposed tone or earcon would need to be tested for usability.

e) Do nothing

Despite the number of different tones shown above, the spread of characteristics of existing European Ringing tones is not large, principally there are two groups: Simple cadence tones with a single on/off rhythm and Complex cadence tones with a multiple on/off rhythm. As stated above there are few significant confusion or usability issues.

8.2.2.9 Implications of options for Ringing tone

a) Use the HF model

The use of the HF model requires no specific changes to the reported Ringing tones. The model does not disclose the increase in usability that would result from harmonization.

b) Use the standards

Change to a simple cadence.

EU

Germany and Sweden (a change of cadence may be required to shorter silence on some exchanges).

Ireland and United Kingdom (change cadence to single tone burst and longer silence).

ETSI area

Bulgaria (maybe change cadence to shorter tone burst and shorter silence on some exchanges).

CI Jersey, Gibraltar and Malta (change cadence to single tone burst and longer silence).

Cyprus (maybe change cadence to single tone burst and longer silence on some exchanges).

Romania and Turkey (change cadence to shorter tone burst).

Switzerland (maybe change frequency on some exchanges from 500 to 400 - 450).

Yugoslavia (maybe change cadence to shorter silence on some exchanges).

c) Use the mode

Change to a simple cadence 1 s on and 4 s off and a single frequency 425 Hz.

EU

Ireland (change two tone burst cadence to single tone burst 1 s on and 4 s off and change frequency from 400 or 450 to 425).

United Kingdom (change two tone burst cadence to single tone burst 1 s on and 4 s off and frequency from 400 + 450 or 450 × 25 or 426 × 176,7 to 425).

Insignificant changes would be required in Austria, Belgium, France, Germany, Greece, Luxembourg, Netherlands, Portugal, Spain, Sweden.

ETSI area

Bulgaria 1 (change cadence from 1 s on and 9 s off to 1 s on and 4 s off).

CI Jersey and Gibraltar (change two tone burst cadence to single tone burst 1 s on and 4 s off and change frequency from 400 + 450 to 425).

Cyprus 2 (change two tone burst cadence to single tone burst 1 s on and 4 s off, and change frequency from 400 × 25 to 425).

Malta (change two tone burst cadence to single tone burst 1 s on and 4 s off and change frequency from 400 + 450 or 450 × 25 or 426 × 176,7 to 425).

Romania (change cadence from 2 s on and 4 s off to 1 s on and 4 s off, and change frequency from 400 × 16 or 450 × 25 to 425).

Turkey (change cadence from 2 s on and 4 s off to 1 s on and 4 s off, and change frequency from 450 to 425).

Yugoslavia 1 (change cadence from 1 s on and 9 s off to 1 s on and 4 s off, and change frequency from 450 × 25 to 425).

Insignificant changes would be required in Bulgaria, Cyprus, Hungary, Iceland, Lithuania, Norway, Russia, Switzerland.

d) Do something different

The implications of this course of action are dependent on just how different the "different" is. At the minimum it would imply extensive testing of the proposed tone or earcon.

e) Do nothing

There are no additional costs in this course of action but benefits will be foregone, particularly to terminal equipment manufacturers and users.

8.2.2.10 Recommendations for Ringing tone

1	To encourage countries with simple cadence ringing tones to harmonize rapidly the on/off period within the range **0,67 - 1,5 on** - 3,0 - 5,0 off.

2	To encourage countries with frequencies outside the range 400 - 450 to harmonize rapidly the frequency/ies used in their ringing tone within the range 400 - 450 Hz.

3	To encourage the gradual change to a single harmonized ringing tone based on the simple cadence of **1 s on** and 4 s off and a frequency of 425 Hz, when planned changes to the public networks make it possible.

4	To encourage National Regulatory Authorities to require new public network operators providing services which require the provision of a ringing tone to comply with either their existing national ringing tone characteristics or to provide a ringing tone with a simple cadence of **1 s on** and 4 s off and a frequency of 425 Hz, or to develop a "Corporate Identity" ringing tone in line with recommendation 5.

5	NRAs should ensure that any new ringing tones are properly regulated, are usable, are compliant with the HF model and are sufficiently distinguishable from network tones having other meanings.

6	To facilitate ETSI and/or other bodies to research the benefit of reducing the total period of the ringing tone to less than 4 s.

7	To facilitate ETSI to research the requirements for and harmonize a number of special ringing tones and the associated alerting signals for special services - e.g. Call Diversion, Videotelephone Call, Voice Mail, UPT Call, etc.

8.2.3 Audit of tone "Busy"

8.2.3.1 Busy tone - functional definition

The auditory indication to be presented to a user to indicate that a connection has been made but that the called party is busy and inviting the user to abort the call or to invoke a supplementary service, e.g. Call Completion on Busy Subscriber (This definition is consistent with CCITT Recommendation E.182 [6]).

8.2.3.2 Position in HF model for Busy tone

This functional definition places the busy tone in the HF model within the family of Feedback + System State Not OK and at the "Bad" end of our characteristics continuum. It may also be interpreted to suggest that the tone could be within the family Prompt Can.

8.2.3.3 HF model characteristics for Busy tone

High frequency >500 Hz

Fast rhythm >2/s

Short period <1 s

8.2.3.4 Current European practice for Busy tone

Table 19: Busy tones used in Europe

Cadence (s)	Frequency (Hz)	Number of Countries
0,15 - 0,20	133 or 425	1
0,15 - 0,475	425 or 450	h
0,2 - 0,2	425	1 + j
0,2 - 0,4	400 or 450	e
0,2 - 0,4	425	f
0,2 - 0,5	425	a
0,25 - 0,25	425	3 + a, b, c
0,25 - 0,25	425 or 450	d
0,3 - 0,3	425	4
0,3 - 0,3	425 or 450	1
0,3 - 0,3	450	g
0,33 - 0,33	425	1
0,333 - 0,333	425	1
0,375 - 0,375	400	4
0,4 - 0,4	420	g
0,4 - 0,4	425	2
0,45 - 0,45	425	b
0,48 - 0,48	425	i
0,48 - 0,48	425 or 450	h
0,5 - 0,5	400 or 425	1
0,5 - 0,5	425	5 + a, c, e, f, j
0,5 - 0,5	425 or 450	1 + d, i
0,5 - 0,5	440	1
0,5 - 0,5	450	1
NOTE: Letters are used for countries which report two or more different tone characteristics for the same function. See part 2 for the fuller details.		

8.2.3.5 European mode for Busy tone - characteristics

Cadence **0,5 s on** - 0,5 s off, 425 Hz single frequency.

8.2.3.6 Existing international standards for Busy tone

Table 20: International standards for network generated Busy tones

Network generated tones			
Source	**Cadence (s)**	**Frequency (Hz)**	**Preference for any update of equipment**
CCITT Recommendation E.180 [23]	Quick period (tone=silence) total period 0,3 - 1,1 ratio tone/silence 0,67 - 1,5 tone > 0,1 Slower than congestion	Single f, prefer 425 rec. range 400 - 450 accept range 340 - 500 avoid 450 - 500	Keep to recommended range
CEPT Recommendation T/SF 23 [69]	**(0,4 - 0,5)** - (0,4 - 0,5)	400 - 450	
CEPT Recommendation T/CS 20-15 [70]	**0,5** - 0,5	425 ± 15	

Table 21: International standards for terminal generated Busy tones

Terminal generated tones		
Source	**Cadence (s)**	**Frequency (Hz)**
ETS 300 245-7 [17] (ISDN Terminals)	**0,5** - 0,5 or National tones	425 or National tones
ETR 187 (General) [14]	**0,5** - 0,5	425
GSM 02.40 [19]	**0,5** - 0,5	425 ± 15
ETR 294 [20] (TETRA - Name and function defined "Called Number Busy")	No characteristics defined	

8.2.3.7 Human factors issues for Busy tone

Expectations

A continuing rapid cadence tone of single or dual frequencies indicates a call set-up failure for some reason.

Confusability

HF expertise would suggest that in the absence of the facility to directly compare two busy tones, few users (may be as low as 10 %) would report a difference between two single frequency simple cadence tones when the variation of frequencies used is within ±25 Hz and the variation of cadence is within 0,4 - 0,5 s on; 0,4 - 0,5 s off.

More users (may be around 50 %) may report a difference between two fast cadence tones with the same frequency when the variation in cadence is within 0,15 - 0,5 s on; 0,15 - 0,5 s off.

There are possibly two cases where confusion may be expected by Category B users (People who are connecting with another network):

- Callers used to a slower busy tone (0,4 - 0,5 on; 0,4 - 0,5 off) may perceive a faster busy tone (0,15 - 0,3 on; 0,15 - 0,3 off) as network congestion or number obtainable; they may then fail either to retry after a short period or to invoke an appropriate supplementary service.

- Callers used to a faster busy tone (0,15 - 0,3 on; 0,15 - 0,3 off) may perceive a slower busy tone (0,4 - 0,5 on; 0,4 - 0,5 off) as network congestion or number obtainable; they may then fail either to retry after a short period or to invoke an appropriate supplementary service.

Usability

In practice most users of unfamiliar networks may assume that any fast repetitive auditory signal presented after apparently successfully requesting a connection through a network can be taken to indicate the request has failed. The indication may also be regarded as a prompt to the user to abort the call and perhaps try again later, with or without checking the number.

Where the user may also have the option to use a supplementary or other service to facilitate completion of the call, the auditory indication may also be regarded as a prompt to signal the network to activate the service, e.g. call completion to busy subscriber, priority intrusion, etc.

8.2.3.8 Review of options for Busy tone

a) Use the HF model

If the busy tone is correctly located in the "Feedback/System Not OK" family, the model is recommending a higher frequency and a faster rhythm than existing standards.

Many of the cadences of the busy tones reported in use in Europe meet the rhythm characteristics of the model but no tones meet the recommended frequency.

Therefore for full compliance with the model some countries would need to shorten the on/off times and all countries would need to introduce a higher frequency for busy tone.

Such changes should only be considered if usability tests show them to be justified.

b) Use the standards

The characteristics defined in the current ITU-T, CEPT Recommendations and ETSI standards are all coherent with each other. They all define a fast repetitive tone with differing tolerances on the acceptable frequencies and the speed of the cadence. There is one EU and five other European counties that do not comply with the loosest standard ITU-T, these are identified in subclause 8.2.3.9. The key change required for compliance with ITU-T is for countries to migrate to a simple cadence with an on/off ratio of 0,67 - 1,1. The changes required for compliance with the tightest standard are the same as for converting to the European mode.

c) Use the European mode

The characteristics of the modal busy tone provide a reasonable fit to the HF model, but there are a number of EU and other European Countries with Busy tones that do not precisely match these characteristics, these are identified in subclause 8.2.3.9. The key changes required are for some countries to migrate to a simple cadence with an on/off ratio of 0,67 - 1,1 and for some to change the frequency.

However, the HF evidence suggests that:

- the differences within the range of single frequencies used is unlikely to cause any confusion;
- the predominant use of a rapid cadence with a short period will result in the caller aborting the call, the confusion is only likely to occur within the reasons different users assign to the cause of the failure.

d) Do something different

There is no human factors or technical reason for such a change to the public network service.

e) Do nothing

Despite the number of different tones shown above, the spread of characteristics of existing European busy tones is not large and there are only a few confusion or usability issues.

8.2.3.9 Implications of options for Busy tone

a) Use the HF model

Change to simple cadence tone, with rhythm of approximately 2/s and a period of <1 s with a frequency <500 Hz. All of the current tones are concordant with this requirement, The model does suggest that a faster rhythm may be desirable but some experimental evidence would be required to justify a change to probably half of the current cadences.

b) Use the standards

Change to simple cadence tone, with on/off ratio between 0,67 - 1,5 and total period of 0,3 s - 1,1 s with a frequency of 425 Hz.

EU

Germany 2 (maybe change ratio tone to silence from 0,315 to between 0,67 - 1,5 within some exchanges).

ETSI area

Bulgaria 3 (change ratio tone to silence from 0,4 to between 0,67 - 1,5).

Czech Rep. 3 (change cadence to single silence period).

Norway 2 and Yugoslavia 2 (change ratio tone to silence from 0,5 to between 0,67 - 1,5).

Romania (change frequency from 133 to 400 - 450 in some exchanges).

c) Use the mode

Change to a simple cadence tone 0,5 s on; 0,5 off (on/off ratio 1 and total period of 1 s) with a frequency of 425 Hz.

EU

Austria 2 (change cadence from 0,3 on/off to 0,5 on/off and change frequency from 450 to 425).

Denmark 2 and Sweden (change cadence from 0,25 on/off to 0,5 on/off).

Finland (change cadence from 0,3 on/off to 0,5 on/off).

Germany 2 (change cadence from 0,15 on and 0,475 off to 0,5 on/off and change frequency in some exchanges from 450 to 425).

Greece (change cadence from 0,3 on/off to 0,5 on/off and change frequency in some exchanges from 450 to 425).

Italy 2 (change cadence from 0,2 on/off to 0,5 on/off).

Netherlands 2 (change cadence from 0,25 on/off to 0,5 on/off and change frequency in some exchanges from 450 to 425).

Spain (change cadence from 0,2 on/off to 0,5 on/off).

United Kingdom (change cadence from 0,375 on/off to 0,5 on/off, and change frequency from 400 to 425).

Insignificant changes would be required in Austria Belgium, Luxembourg, Netherlands, Denmark 1, France, Germany, Portugal.

ETSI area

Albania, Estonia, Hungary(change cadence from 0,3 on/off to 0,5 on/off).

Bulgaria 1, Faroe Islands, Iceland, Switzerland 2 (change cadence from 0,25 on/off to 0,5 on/off).

Bulgaria 3 (change cadence from 0,2 on and 0,5 off to 0,5 on/off).

CI Jersey, Gibraltar, Malta (change cadence from 0,375 on/off to 0,5 on/off and change frequency from 400 to 425).

Czech Rep. 1 (change cadence from 0,333 on/off to 0,5 on/off).

Czech Rep. 2 (change cadence from 0,167 on/off to 0,5 on/off).

Czech Rep. 3 (change cadence from 0,165 on and 0,165 or 0,333 off to 0,5 on/off).

Norway 2 (change cadence from 0,2 on and 0,4 off to 0,5 on/off and change frequency from 400 or 450 to 425).

Romania (change cadence from 0,15 on and 0,2 off to 0,5 on/off and change frequency in some exchanges from 133 to 425).

Slovakia (change cadence from 0,33 on/off to 0,5 on/off).

Insignificant changes would be required in Lithuania, Russia, Turkey.

d) Do something different

Not applicable as no proposal is made for change.

e) Do nothing

There are no additional costs in this course of action but benefits will be foregone, particularly to terminal equipment manufacturers and users.

8.2.3.10 Recommendations for Busy tone

1	To encourage the rapid harmonization of the functional use for busy tone and to encourage the cessation of the use of similar tones to indicate other system functions, e.g. negative indication.

2	To facilitate ETSI and/or other bodies to research the benefit of using a high frequency tone in preference to existing usage and standards.

3	To encourage the gradual change to a single harmonized busy tone based on the results of the research referred to in recommendation 2 above, when planned changes to the public networks make it possible.

4	To encourage National Regulatory Authorities (NRAs) to require new public network operators providing services which require the provision of a busy tone to comply with either their existing national busy tone characteristics or to provide a busy tone consistent with the results of the research referred to in recommendation 2 above.

8.2.4 Audit of tone "Special Information"

8.2.4.1 SIT - functional definition

The auditory indication to be presented to a user to indicate that a connection cannot be made for some reason other than subscriber busy or short term network congestion. The calling party is invited to abort the call and to seek further information with respect to the called party before trying again (this definition is consistent with CCITT Recommendation E.182 [6]).

This definition is coherent with the definition which may be applied for a Number Unobtainable tone.

CCITT Recommendation E.182 [6] also states that: "The tone may also be used on conjunction with recorded announcements, to signify that what the caller is about to hear is a recording. It should be used to precede all call failure announcements." This implies that the SIT may also be used to introduce announcements that are presented for reasons other than call failure.

8.2.4.2 Position in HF model for SIT

This functional definition places the SIT in the HF model within the family of Feedback + System State Not OK and at the "Bad" end of the characteristics continuum.

8.2.4.3 HF model characteristics for SIT

High frequency >500 Hz

Fast rhythm >2/s

Short period <1 s

8.2.4.4 Current European practice/functions

8.2.4.4.1 Current European practice for SIT

Table 22: SITs used in Europe

Cadence (s)	Frequency (Hz)	Number of Countries
	None reported	8
3 × **(0,33** - 2 × 0,03) - 0,0	950/1 400/1 800	a
3 × (**0,05** - 0,2) - **0,6** - 0,2	400	b
3 × **0,33** - 1,0	900/1 350/1 800	1
3 × **0,33** - 1,0	950/1 380/1 860	1
3 × **0,333** - 1,0	950/1 400/1 600	1
3 × **(0,33** - 2 × 0,03) - 1,0	950/1 400/1 800	4
3 × **0,333** - 1,0	950/1 400/1 800	18, a
3 × **0,33** - 1,0 (+ announcement)	950/1 400/1 800	b

8.2.4.4.2 Current European practice reported for number unobtainable tone

Table 23: Number unobtainable tones used in Europe

Cadence (s)	Frequency (Hz)	Country or Network
	None reported	17
Continuous	400	4
Continuous	450	1 (radio paging)
	Recorded Announcement	1
0,2 - 0,2	400 or 425	1 (also used as their congestion tone)
0,2 - 0,2	450	1
6 × (**0,033** - 0,03) - **0,1** - 0,03	400 or 450	1
0,2 - 0,2 - **0,2** - 0,6	425	1
3 × **0,33** - 1,0	950/1 400/1 800	6
3 × **0,333** - 1,0 (+ announcement)	950/1 400/1 800	1
2,5 - 0,5	425	1
6,0 - 1,0	400 or 425	1

8.2.4.4.3 Current European functions reported for tones with similar characteristics to the ITU-T definition

Part 2 shows that one country in each case reports using an SIT similar tone for Pay tone, Positive Indication tone, Call Waiting tone, Second Dial tone, and Queue tone. In some case this is may be in addition to using a very similar if not the same tone for Number Unobtainable and other SIT conditions.

8.2.4.5 European mode for SIT - characteristics

Cadence **3** × **0,33 s on** - 1,0 s off, in a rising sequence of three single frequencies 950 Hz then 1 400 Hz then 1 800 Hz.

8.2.4.6 Existing international standards for SIT

Table 24: International standards for network generated SITs

Network generated tones			
Source	**Cadence(s)**	**Frequency (Hz)**	**Preference for any update of equipment**
CCITT Recommendation E.180 [23]	**3 × 0,33 ± 70** - 1,0 ± 0,25	950 ± 50/ 1 400 ± 50/1 800 ± 50	Keep to recommended range
CEPT Recommendation T/SF 23 [69]	**3 × (0,26 - 0,4)** - 1,0	900 - 1 000/ 1 350 - 1 450/1 750 - 1 850	
CEPT Recommendation T/CS 20-15 [70]	**3 × 0,333** - 1	950/1 400/1 800	

Table 25: International standards for terminal generated SITs

Terminal generated tones		
Source	**Cadence (s)**	**Frequency (Hz)**
ETS 300 245-7 [17] (ISDN Terminals)	3 × 0,333 - 1	950/1 400/1 800
ETR 187 (General) [14]	3 × 0,333 - 1	950/1 400/1 800
GSM 02.40 [19] Also used to indicate Error, Number Unobtainable and Authentication Failure	3 × 0,333 - 1	950/1 400/1 800
ETR 294 TETRA [20]		

8.2.4.7 Human factors issues for SIT

Expectations

HF expertise would suggest that users may expect a tone which is presented to indicate call failure should be similar in characteristics to other tones in the call failure group where the user is being invited to abort the call, e.g. busy and congestion.

HF research suggests that a rising frequency tone of similar characteristics to SIT has positive values, which is contrary to the negative values associated with a call failure.

Confusability

HF expertise would suggest that the characteristics of SIT are so different to any other defined network tone that it is unlikely to be confused with any other telecommunications tone.

Tones similar to SIT are used in other contexts to introduce announcements. These announcements may be either positive or negative in content. HF expertise would suggest that users may have more exposure to these other contexts than to telecommunications scenarios where ITU-T's original call failure indication of SIT occurs.

In practice a number of network operators across Europe are using the SIT defined tone characteristics to indicate a number different network states, Therefore both Category A and B users may be expected to confuse the intended interpretation of this tone, as this may depend on the network where it is generated and the telecommunications context.

Usability

HF expertise may suggest that different networks practice with SIT has significantly reduced the usability of this tone.

8.2.4.8 Review of options for SIT

a) Use the HF model

If SIT is used correctly it should, according to its functional description, be located in the "Feedback/System Not OK" family, but in practice SIT is used in a number of different circumstances, e.g. in the UK one operator uses it to introduce the third and final message within their Caller Waiting indication sequence.

Unfortunately the characteristics of SIT suggests a conflict. The high frequencies (> 500 Hz) and fast rhythm (> 2 per second) for the three tone bursts put the tone on the negative side of the model, but the pleasant rising sequence and 2 second period place it on the positive side of the model.

Operator practice again presents a conflict, as the functional use of SIT can vary, from the positive to the negative side.

In conclusion, the HF model would suggest that SIT as defined functionally should have different characteristics, closer to the characteristics of busy or congestion tone.

b) Use the standards

All the existing standards are consistent in their description of the tone characteristics, with only slight variations in the degree of tolerance to be applied. They are also consistent with their description of the functions. However, as described above operator practice is functionally inconsistent with these standards and may have progressed too far to enable harmonization.

c) Use the European mode

The European mode is consistent with the original ITU-T original description of the characteristics. However, their functional use of the tone is not clear and evidence suggests that it is not reserved solely for call failure indications.

d) Do something different

There is perhaps a case for this option. There is clearly a role for a call failure indication which is different to busy and congestion. Many countries already define and use a Number Unobtainable tone. The characteristics of such a tone should be coherent with the requirements of the HF model.

e) Do nothing

The existing inconsistent use of the tone for functions other than call failure will continue, and users (both Category A and B) and terminal equipment using tone detectors will not be able to reliably correctly interpret the tone.

What should the user do, abort the call, wait for an announcement, try to invoke call control services, or something else?

8.2.4.9 Implications of options for SIT

a) Use the HF model

The use of a tone based on the HF model to indicate that the connection cannot be made would require a significant change in all European countries.

b) Use the standards

EU

Belgium (change frequency from 950/1 380/1 860 to 950/1 400/1 800).

Sweden 2 (change cadence from 3 × (0,05 on - 0,2 off) - 0,6 on to 3 × 0,33 s on and 1 s off, and change frequency from 400 to 950/1 400/1 800).

United Kingdom 1 (change from single tone burst unrepeated, to a cadence repeated after 1 s silence).

Portugal (change frequency from 900/1 350/1 800 to 950/1 400/1 800).

ETSI area

Slovenia (change frequency from 950/1 400/1 600 to 950/1 400/1 800).

c) Use the mode

The European mode for SIT is concordant with the standards and thus carries the same implications for change as in option b above.

d) Do something different

Not applicable as no proposal is made for change.

e) Do nothing

There are no additional costs in this course of action but benefits will be foregone, particularly to terminal equipment manufacturers and users.

8.2.4.10 Recommendations for SIT

1	To encourage the harmonization of SIT to better reflect operator practice and arguably user expectation, by changing the functional description and restrict the functional use of SIT to the introduction of announcements. These announcements may indicate a call failure or other system states. When presenting a call failure these announcements may also present user options for call progress. For example, to remind users that a number change has occurred and that in future they should dial a different number, but to be connected press X.

2	To create a new tone within the call failure group and in line with the HF model to indicate Number Unobtainable or Invalid Service. The user behaviour that should be prompted by the tone is first to abort the call and then to check the number they were dialling.

3	To encourage NRAs to require new public operators providing services which require the provision of an additional call failure tone to harmonize with the decisions taken in respect of recommendations 1 and 2 above.

8.2.5 Audit of tone "Call Waiting"

8.2.5.1 Call Waiting tone - functional definition

The auditory indication to be presented to a user during a call to indicate that a new call is arriving and that call control options (e.g. put call 1 on hold and speak to call 2, reject call 2, etc.) should apply. The indication is presented when the supplementary service Call Waiting is active and a new call invokes the service (this definition is consistent with CCITT Recommendation E.182 [6]).

8.2.5.2 Position in HF model for Call Waiting tone

This functional definition places the call waiting tone in the HF model within the family of Prompt Can + System State OK and at the "Good" end of our characteristics continuum.

8.2.5.3 HF model characteristics for Call Waiting tone

Low frequency < 500 Hz

Slow rhythm < 1/s

Long period > 3 s

On/off ratio < 0,05 (or Duty Cycle of <5 %) preferably.

8.2.5.4 Current European practice for Call Waiting tone

Table 26: Call Waiting tones used in Europe

Cadence (s)	Frequency (Hz)	Country/ies
	None reported	10
0,3 - 0,3	425 + 450	1
0,2 - 0,6	425	a
0,4 - 0,1 - **0,25** - 0,1 - **0,15** - 15,0	425	1
0,8 once only	821	1
0,5 - **0,5** - 0,25	350 + 450 or 450	1
0,04 - 1,95	420	1
3 × 0,333 - 1,0	950/1 400/1 800	2
0,1 - 2 to 5 s	400	b
0,1 - 2,5 - **0,1**	400	1
0,1 - 3,0	400	1
0,175 - 0,175 - **0,175** - 3,5	425	a
0,175 - 0,175 - **0,175** - 3,5	1 400	1
0,15 - 0,15 - **0,15** - 4,0	425	1
0,2 - 0,5 - **0,2** (only once)	425	1
0,33 - 5,0	425	1
0,2 - 0,2 - **0,2** - 5,0	425	2
0,2 - 0,6 - **0,2** - 5,0	425	1
0,25 - 0,25 - **0,25** - 0,25 - **0,25** - 5,0	400	b
0,3 - 8,0	425	1
0,15 - 0,15 - **0,15** - 8,0	425	1
0,33 - 9,0	425	2
0,5 - 9,5	425 or 450	1
0,3 - 10,0 - **0,3**	440	1
0,2 - 0,6 **- 0,2** - 10,0	425	1
0,3 - 10,0 - **0,3** - 10,0	425	1

8.2.5.5 European mode for Call Waiting tone - characteristics

There is no European mode for cadence, but the mode for frequency is 425 Hz.

8.2.5.6 Existing international standards for Call Waiting tone

Table 27: International standards for network generated Call Waiting tones

Network generated tones			
Source	**Cadence (s)**	**Frequency (Hz)**	**Preference for any update of equipment**
CCITT Recommendation E.180 [23]	(**0,3 - 0,5**) - (8,0 - 10,0) or **(0,1 - 0,2)** - (0,1 - 0,2) - **(0,1 - 0,2)** - (8,0 - 10,0) repeated, cycles cease at time-out	Range 400 - 450	None given
CEPT Recommendation T/SF 23 [69]	**(0,1 - 0,25)** - (0,1 - 0,25) - **(0,1 - 0,25)** - (2,0 - 5,0)	400 - 450	None given
CEPT Recommendation T/CS 20-15 [70]	None given	None given	None given

Table 28: International standards for terminal generated Call Waiting tones

Terminal generated tones		
Source	**Cadence (s)**	**Frequency (Hz)**
ETS 300 245-7 [17]	**0,2** - 0,6 - **0,2** - 3,0 (repeated once, i.e. 2 cycles only)	425
ETR 187 [14]	**0,2** - 0,6 - **0,2** - 3,0 (may be repeated once only)	425
GSM 02.40 [19]	**0,2** - 0,6 - **0,2** - 3,0 - **0,2** - 0,6 - **0,2** (1 cycle, alternative tones are acceptable but not preferred)	425 ± 15
ETR 294 [20] (TETRA)	None defined	None defined

8.2.5.7 Human factors issues for Call Waiting tone

Expectations

An alerting but not intrusive tone occurring during conversation indicating that a caller is waiting.

Confusability

HF expertise would suggest that there is a strong possibility of confusing this tone with Intrusion tone or Warning tone - Operator Intervening.

Usability

HF expertise may suggest that the lack of consistency in the characteristics of this tone within different networks and its clear potential for confusion with other tones (e.g. Intrusion, Warning, etc.) has significantly reduced the usability of this tone.

8.2.5.8 Review of options for Call Waiting tone

a) Use the HF model

If the call waiting tone is correctly located in the "System OK - Prompt Can - Talk phase" family, the characteristics should be located towards the lower frequency slower end of the range with a low duty cycle. Most of the tones used at present fit the model.

b) Use the standards

The ETSI standards for the terminal generated tones differ in cadence from the International and CEPT Recommendations for Network tones. Also the ETSI standards call for the tone to be presented twice whereas the ITU-T and CEPT tones are repeated until time out. Therefore there is no common standard applicable, and additional research may be required to make a judgement of the required characteristics.

c) Use the European mode

As there is no European mode for cadence, this is not a feasible possibility.

d) Do something different

There is no human factors or technical reason for such a change to Call Waiting tone.

e) Do nothing

Although the spread of basic characteristics of existing European Call Waiting tones is not large, there are differences in the number of applications and there are significant confusion or usability issues. The impact will be felt mostly by Category A users (travellers temporarily using another network). Therefore this should not be an option.

8.2.5.9 Implications of options for Call Waiting tone

a) Use the model

EU

Denmark and Belgium would require changes to the reported frequency used.

Denmark, Spain and Sweden would require change to the cadence used.

ETSI area

Estonia, Hungary, Lithuania and Turkey would require change to the tones reported.

b) Use the standards

As there are no common standards, this option is not applicable.

c) Use the mode

As there is no European mode for cadence, this is not a feasible possibility.

d) Do something different

Not applicable as no proposal is made for change.

e) Do nothing

The research and standardization costs are not incurred, but the user's confusion and usability costs will remain and potential benefits particularly to terminal equipment manufacturers and users will be foregone.

8.2.5.10 Recommendations for Call Waiting tone

1	To facilitate ETSI and/or other bodies to research the benefit of using the ETSI standards in preference to international Recommendations.

2	To encourage the rapid harmonization of the functional use for Call Waiting tone and to encourage the cessation of the use of similar tones to indicate other system functions, e.g. Intrusion or Warning tone - Operator Intervening.

3	To encourage countries with frequencies outside the range 400 - 450 to harmonize rapidly the frequency/ies used in their Call Waiting tone within the range 400 - 450 Hz.

4	To encourage the gradual change to a single harmonized tone based on the cadence resulting from the research of recommendation 1 above and a frequency of 425 Hz, when planned changes to the public networks make it possible.

5	To integrate any research and harmonization activity of Call Waiting tone with similar research and harmonization of the Caller Waiting tone, as the latter is probably much more likely to be encountered by users.

8.2.6 Audit of tone "Pay"

8.2.6.1 Pay tone - functional definition

The auditory indication to be presented to a user of a payphone during a call to indicate that any existing credit is about to expire and that an additional payment is required (this definition is consistent with CCITT Recommendation E.182 [6]).

Pay tone is normally generated in the terminal but as payphones in many countries are considered to be part of the network, and the tone is given in the CEC Mandate [4] as a first preference to be considered for harmonization, it has been subject to an audit.

8.2.6.2 Position in HF model for Pay tone

This functional definition places the Pay tone in the HF model within the family of Prompt Must + System State NOT OK and at the "Bad" end of the characteristics continuum. The cadenced tone should be moderately intrusive into conversation and continue until payment is made.

8.2.6.3 HF model characteristics for Pay tone

High frequency > 500 Hz

Fast rhythm > 2/s

Short period <1 s

On/off ratio ca. 0.18 (or Duty Cycle ca. 15 %)

8.2.6.4 Current European practice for Pay tone

Table 29: Pay tones used in Europe

Cadence (s)	Frequency (Hz)	Number of Countries
	None defined	27
0,125 - 0,125	400	2
0,125 - 0,125	800	1
0,15 - 0,15	400	1
0,2 - 0,2 - **0,2** - 3,6 (2 cycles)	941	1
0,2 - 0,2 - **0,2** - 3,6 (3 cycles)	940	a
1,0 Single burst	425	1
3 × **0,22** - 1,0	950/1 400/1 800	a
A 1 - 2 s burst given 15 - 20 s before paid time expires	770 or 850 or 950	1
NOTE 1: Letters are used for countries which report two or more different tone characteristics for the same function. NOTE 2: Many countries have not reported the tone as it is considered a terminal (rather than a network) tone.		

8.2.6.5 European mode for Pay tone - characteristics

There is no European mode. Those few countries reporting Pay tone characteristics state:

Mean Cadence 0,15 on - 0,15 off; Frequency bi-modal Low (400 - 425 Hz) and High 770 - 950.

However this is contrary to information reported by a supplier of payphones to 78 countries world wide who although quoting similar typical cadences of 0,1 to 0,2 sec. on and off, states that frequencies from approximately 600 Hz to 850 Hz are used with the most common being 622 Hz.

8.2.6.6 Existing international standards for Pay tone

Table 30: International standards for network generated Pay tones

Network generated tones			
Source	**Cadence (s)**	**Frequency (Hz)**	**Preference for any update of equipment**
CCITT Recommendation E.180 [23]	None given	None given	None given
CEPT Recommendation T/SF 23 [69]	**(0,1 - 0,5)** - (0,1 - 0,5) **(0,1 - 0,5)** - (0,1 - 0,5) - **(0,1 - 0,5)** - (3,0 - 4,5)	900 - 1 100 or 900 - 1 100	None given
CEPT Recommendation T/CS 20-15 [70]	None given	None given	None given

Table 31: International standards for terminal generated Pay tones

Terminal generated tones		
Source	**Cadence (s)**	**Frequency (Hz)**
ETS 300 245-7 [17] (ISDN Terminals)	None given	None given
ETR 187 (General) [14]	None given	None given
GSM 02.40 [19]	None given	None given
ETR 294 [20] (TETRA)	N/A	N/A

8.2.6.7 Human factors issues for Pay tone

Expectations

When using a payphone, users expect to get a clear indication that their existing credit is about to expire and to have the opportunity to extend the credit, or complete the call. Therefore any tone used for this purpose should have qualities of alerting and urgency, but not be so intrusive as to prevent the courtesies of call completion.

Confusability

From the limited number of tones reported, there are confusion possibilities with Congestion, Intrusion and Special Information tones, used in other networks. The tone should be discriminable from any tone presented after disconnection.

Usability

In practice most users of pay phones in unfamiliar networks may assume that any auditory signal indicating urgency, presented during the talk phase of a payphone call, can be taken to be the invitation to insert more money/insert another card or complete the call.

8.2.6.8 Review of options for Pay tone

a) Use the HF model

If the Pay tone is correctly located in the "Prompt Must - NOT OK" family, the characteristics should be located towards the higher frequency faster end of the range. The model also implies the tone should be continuing, this may require additional checking because it is in conflict with the users requirement to complete the call courteously. Several of the tones reported broadly fit the model.

b) Use the standards

There is only one standard (CEPT Recommendation T/SF 23 [69]) detailing any characteristics for the Pay tone. This definition is consistent with the model except that it is not continuing. However only Sweden and Denmark report using this standard.

c) Use the European mode

Within the limited number of reported tones there is no European mode. However, the mode reported by a large manufacturer of payphones however does provide a reasonable fit to the model. Further research would be required to identify a true European mode.

d) Do something different

There is no human factors or technical reason for such a change to Pay tone. It may be assumed that any requirement to express a "corporate identity" could be expressed in the appearance of the payphone terminal.

e) Do nothing

Although there is no reported harmonized tone it is believed that most users of terminals in unfamiliar networks would assume that any auditory signal, implying urgency, presented during the talk phase of a payphone call could be taken to be the invitation to insert more money or another card. Any impact would be felt most by Category A users (travellers temporarily using another network), and there will be some confusability factors which will remain.

8.2.6.9 Implications of options for Pay tone

a) Use the model

EU

UK, Malta and Italy could require changes to the reported frequency used.

Italy and the Netherlands could require changes to the cadence used.

Introducing a continuing cadence could require changes in Sweden, Denmark, Italy and the Netherlands.

ETSI area

The use of the model would require change to the reported frequency used CI Jersey.

b) Use the standards

EU

UK, Malta and Italy would require changes to the reported frequency used.

UK, Ireland, Italy and the Netherlands would require changes to the cadence used.

Denmark would require change either to the frequency or to the cadence.

ETSI area

CI Jersey would require changes to the reported frequency and cadence used.

c) Use the mode

There is insufficient evidence of a mode.

d) Do something different

Not applicable as no proposal is made for change.

e) Do nothing

The research and standardization costs are not incurred, but the user's confusion costs will remain and potential benefits particularly to terminal equipment manufacturers and users will be foregone.

8.2.6.10 Recommendations for Pay tone

1	To encourage the rapid development of a Harmonized standard for a Pay tone based on the HF model.

2	To urge that any European standard for payphones recommends the Harmonized standard for Pay tone.

3	To encourage National Regulatory Authorities (NRAs) to require new public payphone terminals to meet the Harmonized standard.

9 Costs and benefits of change

9.1 Costs

Some broad figures have been obtained for some aspects of the cost of some recent major changes introduced by public networks in Europe. Technical changes are discussed in clause 5, and discussions with network operators suggest that the costs for these are relatively modest, provided that proper advance planning is undertaken, and advantage is taken of pre-existing plans for modernization.

Two other components of cost may be far from modest, however. First is the direct cost of publicity and advertising of proposed changes for the users. Such costs include public advertising in newspapers, TV and radio, costs incurred with preparation and mailing similar publicity material direct to users. Additional costs follow from setting up additional help and enquiry systems, whether operator manned or automatic. Finally, there are costs involved with more permanent changes to network publications, which includes telephone directories and other publications intended for external consumption, as well as that intended for internal material for education and training of staff, including change notices, technical instructions and similar.

The UK underwent changes to its numbering plan for the so-called "Phoneday" in 1994, Norway changed its entire numbering plan over several months in 1993, and France is making significant changes affecting users connected to its network in 1996, with a change to the recommended international dialling prefix 00 ITU-T Recommendation E.163 [71], and the abolition of one of its network tones.

The International Dialling Prefix has been adopted in nearly all member states of the EU as a result of a CEC Decision 92/264/EEC [72]. It is significant to note that the CEC was basing its reasons on easier access for business and citizens to telephone services across the EU, and specifically mentions the needs of travellers, that is, Category A users in Gagliardi's report. A six-year time scale was introduced, with full compliance by member states by the end of 1998.

In addition to monetary costs incurred by the network provider, there is cost to the user in terms of possible calls lost or repeat call attempts, due to misinterpretation of network information tones. No estimate can be made of these costs, neither does there appear to be any data anywhere from experimental studies on learning, or more appropriately, forgetting the meaning of tones over time.

It is possible on the basis of approximations of gross costs for each of the three examples cited above to compute an average cost per line for cost of major changes, such as a tone harmonization, to be about 1.25 ECU per line. This is based on the number of lines as quoted in the ITU-T Statistical Yearbook [68].

9.2 Benefits

The main benefits of change, according to Gagliardi, would be the elimination, after an undetermined period of changeover, of misunderstanding and confusion among both Category A and Category B users. By way of comparison, it is unknown what benefits may have flowed from changes to the international dialling prefix, in Europe. Any benefits for the networks in the first months of operation, without dual working, are likely to be negative, as users dial the old code and have to redial, which increases demand on the network without revenue. The users' benefits similarly, will only accrue after some period of learning, especially for Category A users, who thereafter will definitely find such a change useful. Any findings based on an investigation of the changes discussed above would be helpful in the final decision-making process before any possible tone harmonization is undertaken.

9.3 Negative aspects of change

To the extent that automatic tone recognition actually recognizes a unique set of tone characteristics, then problems will be created by automatic recognition in:

- PABXs;
- other connected terminals.

It has not been possible to estimate the number of connected terminals in any one country, let alone EU, but faxes, modems and answering machines will combine to a very large number. It is known, however, that some of these work simply by timing, and assume, for example a dial tone after so many seconds. Such machines obviously will not be affected by any change in tone characteristics, but others may be affected to an unknown degree. On the other hand, the grouping of tone characteristics related to user actions could assist the machine recognition of tones.

Other problems will be caused by confusion for the users over an unknown period, but this is to be offset against reduced confusion later. Much of this negativity may be reduced by adequate detailed advance publicity, but any change is seen by users as negative as they cannot appreciate the stated problem in the first place.

The costs of replacing hardware when necessary, the confusion which results in lost calls and lost revenue, and the cost of re-education generally are not computable.

10 Conclusions and recommendations

In accordance with a commission mandate following a study carried out by Professor D. Gagliardi this report describes a further study that has been made on the specified set of tones and makes recommendations on those tones described as the priority set. The study has included an extensive review of the research performed and of the reports written on the subjects of Human Factors and of telecommunications service tones. A review was also carried out of the standards dealing with tones originating from the ITU-T, CEPT Recommendations and ETSI and a comprehensive review and analysis was made of the existing tones used in the European Union, in the countries of the ETSI members and in other countries world-wide.

This detailed listing and analysis of European and world-wide tones appears in part 2 of this report.

The key findings from the tone data show that there is at present a strong dependence on using different simple cadences to differentiate between tones. The dimension of frequency has not been used extensively. One tone was found to used in differing countries to have five different meanings. In one country the tone was used to give a positive indication, in another a negative one! There was little difference between tones used as busy, congestion and number unobtainable in many countries.

SIT was revealed as the tone most highly standardized in characteristics but it was found to be so little harmonized in its usage as to create significant usability problems both to human users and terminal equipment. Some countries used it (as defined by the ITU) to indicate that the number could not be reached for reasons other than congestion. Others used it or similar tones for positive indication, call waiting, pay tone and second dial tone. Another group of countries used the tone to introduce announcements whether they conveyed positive, negative or neutral information.

The study of tones and standards also revealed that one ETSI specified tone (Call Waiting tone) is not in accordance with International Recommendations. Although it was in the list of network tones to be investigated, the report notes that Pay tone is not in fact a network tone, being generated in the terminal where payment is made.

Although the ability of terminals to detect tones has commonly been subject to regulation throughout the European Economic Area, the same has not applied to the tones generated by the networks. As the number of network operators increases, there will grow a need to regulate the provision of tones by such new operators so as to prevent the unnecessary and confusing proliferation of new tones. It was reported that there is a desire on the part of some of these new operators to provide a "Corporate Identity" which might possibly be expressed in some of their tones.

It is hoped that proper application of Directive 95/62/EC [5] on the application of ONP to voice telephony should bring about some harmonization in this situation, as Article 4 requires that national regulatory authorities ensure that up-to-date information on access to and use of the voice telephony service is published. The information required to be published should include a description of the various tones that are provided to facilitate proper interworking with analogue networks as well as the signalling protocols for the ISDN.

The study of the human factors research and literature has revealed surprising gaps in the corpus of knowledge on telecommunications service tones and of their perception by users. When analysing tones, it was found difficult to describe such characteristics as high frequency and low frequency in the absence of any authoritative previous work to assign such properties and best judgement had to be made. The same applied to concepts of fast and slow cadence, no definition could be found of what tone rhythms a user perceived as slow, and what as fast.

In spite of these difficulties, a model has been created which assigns the requirements of tones into various categories related to network conditions, to user tasks and to the actions available to the user to control the progress of a telephone call. It is thought to be concordant with user expectations and behaviour and it should be able to be used to correct some of the problems noted in some of the existing tones. The model will require further experimental testing, but it is hoped that it will prove useful in the future for the creation of new tones in such a way that the characteristics of a tone denote the action required by the user so that he may carry out his task without needing to recognize an individual tone, only its characteristics.

In order to prove this model, it is recommended that further research be carried out on aspects of the model in order to quantify the benefits of some of the indicated changes required to some tones so as to determine whether the changes are worthwhile.

The model was used as a tool to audit each of the tones classified as priority by Professor Gagliardi. As a result of this audit, recommendations are made for each tone. These recommendations are listed below.

Dial tone recommendations

1 To encourage the rapid harmonization of the functional use for dial tone and to encourage the cessation of the use of a similar tone to indicate other system functions, e.g. positive indication.

2 To encourage the rapid change to the consistent use of a continuous dial tone of single or dual frequencies.

3 To encourage the gradual change to a single harmonized dial tone based on the continuous tone of 425 Hz, when planned changes to the public networks make it possible.

4 To encourage National Regulatory Authorities (NRAs) to require new public network operators providing services which require the provision of a dial tone to comply with either their existing national dial tone characteristics or to provide a dial tone with a Continuous tone of 425 Hz.

5 NRAs should ensure that any new dial tones are properly regulated, are usable, are compliant with the HF model and are significantly distinguishable from network tones having other meanings, e.g. new dial tones based on the HF model that may assist the provision of a "Corporate Identity" to Public Network Operators or Corporate Networks.

Ringing tone recommendations

1 To encourage countries with simple cadence ringing tones to harmonize rapidly the on/off period within the range **0,67 - 1,5 on** - 3,0 - 5,0 off

2 To encourage countries with frequencies outside the range 400 - 450 to harmonize rapidly the frequency/ies used in their ringing tone within the range 400 - 450 Hz.

3 To encourage the gradual change to a single harmonized ringing tone based on the simple cadence of **1 s on** and 4 s off and a frequency of 425 Hz, when planned changes to the public networks make it possible.

4 To encourage National Regulatory Authorities to require new public network operators providing services which require the provision of a ringing tone to comply with either their existing national ringing tone characteristics or to provide a ringing tone with a simple cadence of **1 s on** and 4 s off and a frequency of 425 Hz, or to develop a "Corporate Identity" ringing tone in line with recommendation 5.

5 NRAs should ensure that any new ringing tones are properly regulated, are usable, are compliant with the HF model and are sufficiently distinguishable from network tones having other meanings.

6 To facilitate ETSI and/or other bodies to research the benefit of reducing the total period of the ringing tone to less than 4 s.

7 To facilitate ETSI to research the requirements for and harmonize a number of special ringing tones and the associated alerting signals for special services - e.g. Call Diversion, Videotelephone Call, Voice Mail, UPT Call, etc.

Busy tone recommendations

1 To encourage the rapid harmonization of the functional use for Busy tone and to encourage the cessation of the use of similar tones to indicate other system functions, e.g. negative indication.

2 To facilitate ETSI and/or other bodies to research the benefit of using a high frequency tone in preference to existing usage and standards.

3 To encourage the gradual change to a single harmonized busy tone based on the results of the research referred to in recommendation 2 above, when planned changes to the public networks make it possible.

4 To encourage National Regulatory Authorities (NRAs) to require new public network operators providing services which require the provision of a busy tone to comply with either their existing national busy tone characteristics or to provide a busy tone consistent with the results of the research referred to in recommendation 2 above.

SIT recommendations

1 To encourage the harmonization of SIT to better reflect operator practice and arguably user expectation, by changing the functional description and restrict the functional use of SIT to the introduction of announcements. These announcements may indicate a call failure or other system states. When presenting a call failure these announcements may also present user options for call progress. For example, to remind users that a number change has occurred and that in future they should dial a different number, but to be connected press X.

2 To create a new tone within the call failure group and in line with the HF model to indicate Number Unobtainable or Invalid Service. The user behaviour that should be prompted by the tone is first to abort the call and then to check the number they were dialling.

3 To encourage NRAs to require new public operators providing services which require the provision of an additional call failure tone to harmonize with the decisions taken in respect of recommendations 1 and 2 above.

Call Waiting tone recommendations

1	To facilitate ETSI and/or other bodies to research the benefit of using the ETSI standards in preference to international Recommendations.

2	To encourage the rapid harmonization of the functional use for Call Waiting tone and to encourage the cessation of the use of similar tones to indicate other system functions, e.g. Intrusion or Warning tone - Operator Intervening.

3	To encourage countries with frequencies outside the range 400 - 450 to harmonize rapidly the frequency/ies used in their Call Waiting tone within the range 400 - 450 Hz.

4	To encourage the gradual change to a single harmonized tone based on the cadence resulting from the research of recommendation 1 above and a frequency of 425 Hz, when planned changes to the public networks make it possible.

5	To integrate any research and harmonization activity of Call Waiting tone with similar research and harmonization of the Caller Waiting tone, as the latter is probably much more likely to be encountered by users.

Pay tone recommendations

1	To encourage the rapid development of a Harmonized standard for a Pay tone based on the HF model.

2	To urge that any European standard for payphones recommends the Harmonized standard for Pay tone.

3	To encourage National Regulatory Authorities (NRAs) to require new public payphone terminals to meet the Harmonized standard.

It was found difficult to quantify the costs and benefits of these recommendations in other than general terms and by comparison with the cost of other recent network changes. Discussions with network operators suggest that the costs for these are relatively modest, provided that proper advance planning is undertaken, and advantage is taken of pre-existing plans for modernization.

Two other components of cost may be far from modest, however. First is the direct cost of publicity and advertising of proposed changes for the users. Additional costs follow from setting up additional help and enquiry systems, whether operator manned or automatic. Finally, there are costs involved with more permanent changes to network publications, change notices, technical instructions and similar documents as well as the standards.

It is possible, on the basis of approximations of gross costs for each of the recent changes to numbering in the UK, Norway and France, to compute an average cost to the network operator per line for cost of major changes, such as a tone harmonization, to be about 1.25 ECU per line. This is based on the number of lines as quoted in the ITU-T Statistical Yearbook [68].

To the extent that automatic tone recognition actually recognizes a unique set of tone characteristics, then problems will be created by automatic recognition in PABXs and other connected terminals. It has not been possible to estimate the number of connected terminals in any one country, let alone EU, but faxes, modems and answering machines will combine to a very large number and costs will arise for most of them. In the recent French number change it has been estimated that the cost was between 150 and 400 ECU for a small enterprise with less than 10 telephones. Any apparatus with an autodialler, for example an alarm system, needed to be changed at a cost ranging from 0 to 100 ECU for each item. Similar costs would arise from any tone change.

The main benefits of change, according to Gagliardi, would be the elimination, after an undetermined period of changeover, of misunderstanding and confusion among both when away from home and when dialling overseas. It is unknown what benefits may have flowed from changes to the international dialling prefix in Europe. Any benefits for the networks in the first months of operation, without dual working, are likely to be negative, as users dial the old code and have to redial, which increases demand on the network without revenue. The users' benefits similarly, will only accrue after some period of learning. Any findings based on an investigation of these changes would be helpful in the final decision-making process before any possible tone harmonization is undertaken.

The application of these recommendations, even if international harmonization of tones may not, in itself, have much effect on effectiveness, might be expected to improve efficiency by faster recognition and discrimination between tones both by human and machine users. Ultimately, harmonization will also result in a higher percentage of satisfied users.

Because future (potentially high revenue) services or calls may come to depend more on tones (and/or voice announcements) it is in the interests of the network providers not only to maintain network efficiency but to increase the usage of their services in a competitive world by maximizing the usability of their services.

Finally, it is worth noting several other tones which are strong candidates for any programme of European harmonization. For example: there are four which were identified that could assist users overcome the language problems of recorded announcements. These are:

Caller Waiting tone: The indication given to calling parties who are connected with a called station, which though busy, has a call waiting service active.

Record tone: The indication given to calling parties to start leaving a message within a recorded messaging system, e.g. voice mail.

UPT Access tone: The indication given to any user accessing a UPT service, prior to the start of the UPT welcome announcement. The purpose is to advise the user that they are connected to a valid UPT service and to prompt them to enter their UPT Personal User Identity (PUI) and Personal Identification Number (PIN).

Error tone: An indication given to users of stored voice services to advise them that their last control action or data input was invalid. The tone should be followed by an explanatory announcement.

There was also one, the user's requirement for which was identified during the study. When a call is going to be terminated by the system due to a call with a higher level of priority making a service demand, it is a useful courtesy to inform the users, and a tone will be more informative than sudden silence.

Pre-empt tone: The indication given to both A and B parties involved in a call which is subjected to pre-emption by a higher priority caller. It tells both parties that the call has been terminated for reasons of pre-emption, and informs them that multi level precedence and pre-emption is in operation. This type of service is used by public service organizations to ensure call priority for example in areas of limited mobile telephony resources.

Not to be out done, ITU-T are also considering a Special Ringing tone, to indicate that the called number has some special service in effect (e.g. call forwarding), although some consider this may be an infringement of personal security requirements.

History

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