

TECHNICAL REPORT

ISO/IEC
TR 11017

First edition
1998-03-01

Information technology — Framework for internationalization

Technologies de l'information — Cadre pour l'internationalisation



Reference number
ISO/IEC TR 11017:1998(E)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Committee) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC TR 11017, which is a Technical Report of type 3, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 22, *Programming languages, their environments and system software interfaces*.

Introduction

Background

ISO/IEC JTC 1 created SC 22/WG 20 with a specific task to address internationalization in programming languages and applications. The development of a Technical Report for a framework for internationalization of programming languages and applications was selected as the first project of the working group. The update of ISO/IEC TR 10176:1991 "Information technology — Guidelines for the preparation of programming language standards", was added to the projects of the WG 20 to ensure that the other working groups in the SC 22 profit from WG 20's work by including the services described in the framework document, into the development and update of programming language standards.

After surveying the various requirements, ISO/IEC JTC 1 SC 22 defined a set of services that might be provided in a truly internationalized application, and thus also in programming languages. These services are described in this Technical Report, together with short explanations of the requirements and a list of standards on which they are based. This Technical Report forms the base document for the consideration of internationalization features in applications.

The revision of ISO/IEC TR 10176, introduces the services defined in this Technical Report into the development of programming language standards. The recommendations in the guide will enable programming languages to deal with the issues of internationalization and to create programs that can run in culturally different environments without changes to the program code.

While preparing this Technical Report, it became obvious that the culturally correct ordering (sorting) of data is an essential part of most commercial processing. This is particularly difficult when the underlying character set is capable of representing all of today's written languages. SC 22 therefore proposed, and was assigned, an additional work item to develop a standard for "Information technology — International String Ordering — Method for Comparing Character Strings and Description of Default Tailorable Ordering", ISO/IEC 14651.

"The specification of cultural conventions in language independent form" is another work item assigned to SC 22. Programming language specific specifications for such repositories exist in ISO/IEC 9945-2 and in publicly available specifications from various consortia. It is a requirement that output from this work (ISO/IEC 14652) must be compatible with the work already done by ISO/IEC JTC 1 SC 22/WG 15 (POSIX working group) in this field. A working draft exists for this Technical Report.

This Technical Report

The role of information technology in daily life is rapidly growing, and its prevalence now approaches that of social infrastructures such as water or power supplies, public communications links and road or public transportation systems. To ensure the future success of this technology, all communication between systems and users of the systems must be in the natural language of the user in the user's script, and must fit the natural behaviour of the user.

Traditionally, the process of the adaptation to a user culture has been called the internationalization (or localization, or customization in an intermixed way) of information technology.

Historically, the internationalization of information technology has been provided on a demand/requirement basis, and thus solutions have been based on the "best available technology" approach. As a result, the solutions to internationalization for different systems do not necessarily share any common directions or goals. In many cases, different technology solutions have different goals altogether.

This Technical Report is intended to present an organised overview of, and relationship between, the various requirements, approaches and solutions to the internationalization of information technology systems. In addition, this Technical Report recommends services for internationalization of software.

This Technical Report refers to the ISO/IEC JTC 1 TSG-1 final report as a base document (see Annex A).

The purpose of the ISO/IEC JTC 1 internationalization activity is to establish the goals and directions for its production of applications adapted for use in the international environment which can be customised to local cultural conventions, and then to produce the necessary standards. The common internationalization standards will benefit a number of parties in the information technology field:

- users will have a much greater chance of having applications which are compliant with their local cultural conventions, and will also be able to experience a much greater commonality between the handling of cultural conventions in different applications.
- application developers will be relieved from specifying a number of internationalization parameters, which can simply be taken from ISO/IEC member bodies specifications.
- procurers can specify cultural convention sets and obtain well-defined uniform behaviour across hardware and software platforms.
- ISO/IEC member bodies can produce specifications for their national cultural conventions, which then can be applied uniformly across application platforms.
- ISO/IEC JTC 1 working groups can produce bindings to ISO/IEC JTC 1 standards that use the specifications of cultural conventions from ISO/IEC JTC 1 member bodies, and thus reuse internationalization data and specifications without further work.

As the internationalization activity involves many parties, it is planned to have a staged approach to producing the relevant standards. First a framework document will be produced (this document); then the "Guidelines for the preparation of programming language standards" will be revised with respect to internationalization (a revised ISO/IEC TR 10176); and finally the various internationalization standards will be produced.

This Technical Report is structured as follows:

Clause 1 describes the scope of this Technical Report, clause 2 lists the documents referenced, and clause 3 defines the key terminology (Only those items necessary for the understanding of this Technical Report are referenced in clause 2 and clause 3).

Clause 4 presents many different categories of internationalization, all of which are useful in internationalized information systems.

Clause 5 recommends the INTERNATIONALIZATION/LOCALIZATION model as a comprehensive solution to accommodate the different types of internationalization described in clause 4.

Clause 6 itemises the major conventions which differ between cultures, also emphasizing that number of these conventions are open ended.

Clause 7 presents the basic model for internationalized systems and recommends a set of services which are necessary to support the major cultural differences (described in clause 6) based on the model.

Annexes provide supporting information to the main text.

Information technology — Framework for internationalization

1 Scope

This Technical Report presents the framework and recommended model for internationalization and identifies the services required for the internationalization of information technology.

This Technical Report:

- discusses the requirements of internationalized systems and their users,
- suggests a concerted, unified approach to internationalization,
- recommends services to fulfil the requirements, and lists the standards related to the services.

This Technical Report is intended to be a reference for future standards on the internationalization of information technology, to act as a communication vehicle between those who provide standards and those who request them, and also to function as a basis for all future ISO/IEC JTC 1/SC 22/WG 20 activities.

NOTE 1 This Technical Report does not propose any specific solutions for internationalization. Future standards are expected to provide the solutions, reflecting the directions in this Technical Report.

NOTE 2 Internationalization services consist of internationally generic services and nationally specific information (data). This Technical Report covers only the internationally generic portion of software, so it does not discuss:

- preparation of internationalized information technology systems for localization by a local user.
- hardware-related issues or requirements.
- requirements related to system ergonomics.

NOTE 3 The internationalization solutions and services available in the mid-late 1980s are the technical basis for this Technical Report.

2 References

See annex A.

3 Definitions

For the purposes of this Technical Report, the following definitions apply.

3.1 application platform:

A set of resources on which an application will run.

3.2 application program interface (API):

The interface between the application software and the application platform, across which all services are provided.

3.3 byte:

A bit string that is operated as a unit.

3.4 character repertoire:

A specific set of characters that are represented in a coded character set.

3.5 coded character set:

A set of unambiguous rules that establishes a character set and the relationship between the characters of the set and their coded representation.

3.6 cultural convention:

A convention of an information system which is functionally equivalent between cultures, but may differ in presentation, operational behaviour or degree of importance.

3.7 cultural convention set:

A set of cultural conventions for which support services are defined to be ideally located within the application platform. (Services are normally available through Application Program Interfaces [APIs])

3.8 INTERNATIONALIZATION (I18N):

A process of producing an application platform or application which is easily capable of being localized for (almost) any cultural environment. (Note, therefore, that an INTERNATIONALIZED information system does not have a dependency on any specific culture unless it is LOCALIZED to that selected culture.)

3.9 LOCALIZATION (L10N):

A process of adapting an INTERNATIONALIZED application platform or application to a specific cultural

environment. In LOCALIZATION, the same semantics are preserved while the syntax may be changed (Refer to clause 5).

3.10 octet:

An ordered sequence of eight bits considered as a unit.

3.11 ordering:

An operation by which two different objects (for example two character strings) are assigned a context free deterministic order.

3.12 script:

A set of graphic characters used for the written form of one or more languages.

4 Categories of user culture for internationalization

Internationalization is the adaptation of a user-interface to a user culture. However, it is a fact that there are many different views on user culture. Each user culture may define its own requirements for internationalization which are different from each other. This clause gives an overview of those user culture differences which are needed to understand the requirements for internationalization.

4.1 User interfaces

Applications must be user-friendly. A user interface containing familiar terms is of paramount importance to user-friendliness.

The user interface needs to ensure meaningful input and output for the user. Messages and representation of cultural conventions such as dates and times should be provided in a language and format which is natural to the user. Incorporating these capabilities into a system increases user acceptance and decreases error rates in human-machine interactions.

The requirement for this user-friendliness to support a wide range of cultures in the world is called the "need for the internationalization of information technology" in a general sense.

4.2 Scope of user culture

The scope of user interface applicability varies from person to person. An application which is to be implemented in several different countries or cultures will clearly need to be implemented in such a way that it can provide suitable output for, and accept suitable input from, its different users. Even applications produced for a single country or a single location may

still need to accommodate users with different cultural backgrounds within that environment; for example Canada, Belgium, European Union Secretariat or airports.

The requirements for user-friendliness can vary widely depending on the combinations of cultural adaptation, languages, scripts etc.

This subclause presents a basic classification of the variations. Note that all of the requirements described in 4.2.1 to 4.2.7 are just one aspect of the overall internationalization requirement.

4.2.1 Mono-culture/script/language

This is the most simple case of user-friendliness, and the most primitive and basic requirement for internationalization.

The requirement is for:

- Users to be able to read and write one language using one script.
- All users to have a single cultural background.

4.2.2 Mono-culture/script/language, including ISO/IEC 646

A user interface that offers a mono-culture/script/language is regarded as normal, and the basic requirement for user-friendliness. However, the history of information technology shows that ISO/IEC 646-IRV, a national version, or a similar character set, is also necessary in most cases in addition to the basic native script. In practice, therefore, the coded character set which supports the native script of the user might be expected to include the repertoire of the ISO/IEC 646-IRV coded character set, if it does not already include it.

The requirement is for:

- Users to be able to read and write one language using their own native script, which may include the base Latin alphabet of ISO/IEC 646.
- All users to have a single cultural view.
- Some (or most) system-level user interfaces and programming languages to use a "computer language" written in a "computer repertoire" based on the Latin alphabet (ISO/IEC 646).

This is the basic requirement, and the most widely accepted user interface applicability of the user interface.

ization. This is often called a bi-lingual system, but in reality, it is a system with dual coded character sets.

4.2.3 Mono-culture/language, Multi-script

The extension of the mono-culture/script/language requirement, including ISO/IEC 646, to allow additional scripts is a possible user requirement. In this Technical Report, this is called a Multi-Script system. Note that this refers to a single language and culture; embedded French or Spanish text in a Korean document for Korean user in Korean language and culture might be an example of this type of application.

4.2.4 Mono-culture, Multi-script/language

The extension of the mono-culture/language, multi-script requirement to multiple languages is a natural extension to the above.

Some countries or regions share almost similar cultural requirements with an acceptable degree of compromise, even if the languages and scripts are different. Sometimes unification of these cultural aspects will satisfy the user needs for this type of internationalization requirement. Some of the pan-European systems which support "Western culture" and several European language might be a sample of this type of multi-lingual system.

There are two types of multi-lingual/script mono-culture systems. One is the sequential and the other is the concurrent type. (see 4.2.5.1 and 4.2.5.2 for a description of these two types in the multi-cultural case.)

4.2.5 Multi-culture/script/language

Finally, multiple solutions for each components may be required. In this Technical Report this is termed a multi-lingual system. In practice, multi-lingual systems can be classified into two groups:

4.2.5.1 Sequential multi-lingual

A sequential multi-lingual system is able to service several kinds of users, but only one kind of user at a time.

4.2.5.2 Concurrent multi-lingual

A concurrent multi-lingual system is able to service several kinds of users as if the services are provided simultaneously from the human user's point of view.

4.2.6 Global Uniformity

Global Uniformity aims to minimize the information ambiguity due to the culturally dependent multiple solutions for the same items of information. It also

aims to maximize the scope of user interfaces and the acceptance of international standards. Simultaneously, the number of necessary interfaces decreases, and conventional ambiguities, such as date format, disappear. (For example, a date format of 01-02-03 means February 3, 2001, January 2, 2003, or February 1, 2003 depending on cultural conventions. For Global Uniformity, one standard format would be chosen, thus eliminating ambiguity.)

NOTE 4 Historically, ISO and IEC have pursued this Global Uniformity strategy with respect to other technologies. In the field of information technology, however, multiple views of internationalization and international standards are also necessary.

4.2.7 Cross-Cultural Friendliness

Like Global Uniformity, Cross-Cultural Friendliness aims to maximize user interface applicability and user-friendliness. In this context, "friendliness" denotes the ease with which unfamiliar culturally-dependent information can be understood by persons who are not familiar with this culture. This is accomplished through strategic adaptation of cultural conventions within one culture which appear familiar to new users. As the popularity of information technology increases, the frequency of confrontations with unfamiliar data increases, thus justifying the need for Cross-Cultural Friendliness.

Cross-Cultural Friendliness supports users who are unfamiliar with the culture by widening the overall applicability of cultural conventions. For example, Spanish dictionaries order CH after CZ, which contrasts with the collation sequence of most of other Latin script based languages. Users unfamiliar with the Spanish alphabet might assume an order consistent with the system already known from other languages; users familiar with the Spanish alphabet would not, however, feel comfortable with the ordering system provided for users who are unfamiliar with Spanish (CH after CG, before CI). Another example of this kind of situation occurs in Denmark, where AA is ordered as one single letter at the end of the alphabet.

Another example of Cross-Cultural Friendliness is the input method for unfamiliar characters. The CJK (Chinese, Japanese, Korean) ideographic input method for users who are not familiar with the CJK ideographs may not be acceptable to Chinese, Japanese or Korean natives, but it might be easy to use for those who are infrequent users of CJK ideographs.

Cross-Cultural Friendliness is, therefore, one of the aspects of internationalization considered in this Technical Report.

4.2.8 User-Culture Summary

In summary, a "friendly" system could mean one of the following:

- a system which supports one of many different cultures (that is, "friendly" to one culture);
- a system which supports one of many different cultures (that is, "friendly" to one culture) as well as supporting ISO/IEC 646-IRV coded character set;
- a system which supports several scripts simultaneously within one culture and one prime language;
- a system which supports multi-script/language sequentially in one culture;
- a system which supports multi-script/language concurrently in one culture;
- a system which supports multi-culture/script/language sequentially;
- a system which supports multi-culture/script/language concurrently;
- a system which supports Global Uniformity;
- a system which supports Cross-Cultural Friendliness;

4.3 A Future Vision

The needs of internationalization expressed in 4.2.1 to 4.2.7 are necessitated by current information technology. Inter-personal communication via information technology has traditionally been confined to text and keyboard applications within machines in a single culture. The requirements and standards for internationalization are highly volatile. Communication media are broadening to include multi-media data, and information technology is growing toward an age of general machine-facilitated communication between humans from diverse backgrounds.

The required technology components for message passing between cultures must first be present at both ends of a communication link. The people communicating must also have knowledge about the conversation topic, and must also have an adequate understanding of all the cultures involved in the discussion. Only then can the true inter-cultural communication take place directly through the machine. Each user can interact with the machine in a different natural language, and the machine will

convert the information into the appropriate form for the recipient. This is the future vision of the internationalization of information technology.

The issue of the requirement for support services for this future vision of internationalization is not addressed in this Technical Report, because the technology to implement this future vision is not yet widely and reliably available.

5 INTERNATIONALIZATION and LOCALIZATION

The requirement for the integration of script, natural language and local practice into information systems is additional to basic system requirements. Such integration is a user requirement and is thus an "fundamental requirement", because it constitutes a basic constraint which the system must satisfy. If the system meets all fundamental requirements and is sufficiently user-friendly, the methodology which ensures this "friendliness" is not a primary concern for its users.

However, this methodology does concern suppliers whose goal is to meet user requirements efficiently and economically. INTERNATIONALIZATION facilitates the provision of similar applications to different cultures with maximum economic gain, efficiency and quality. Although numerous approaches exist for providing local adaptation solutions, each faces similar initial problems and cultural differences.

This clause presents an INTERNATIONALIZATION/LOCALIZATION approach as the recommended methodology of this Technical Report.

5.1 Local adaptation

Providing "User friendliness" to the end user is part of the adaptation of an information system to local needs. There are very many varieties of "locals" and many varieties of "friendliness", as described in 4.2.1 to 4.2.7 and it is possible to respond to any of localization requirement by optimising the technology to suit that specific requirement. However, meeting the requirements of all combinations individually is impractical in terms of resources. There is a need for a basic universal solution to meet the fundamental needs of all cases, such that the total resources required for the local adaptation of information technologies to specific local needs may be minimised.

NOTE 5 The end user should see no difference between the results of specific local adaptations and the results of applying a uniform and universal methodology. What end users are looking for is simply friendliness and familiarity to them.

5.2 Current local adaptation approach

Many system developers incorporate into an application the hard-coding necessary to support one cultural environment. That application then requires substantial rewriting to support other cultural environments. Thus, programs with identical functions are developed repeatedly. Not only does this waste design and programming effort, but it creates the following problems:

- Application development is expensive because code is rewritten for different cultures;
- High cost inhibits many applications from being developed for multiple environments, which automatically limits the potential market of those applications;
- Justification of the cost of the local adaptation for minorities is very difficult. Sometimes, this fact unfairly penalises the requirement of small markets;
- The rewriting of code results in staggered marketplace introductions of an application. This may cause serious problems with some applications, such system software distributed in world-wide networks;
- The possibility of application inconsistencies in different cultures arises even though the external functional interfaces may be identical. This creates problems in world-wide networks and leads to updating/maintenance complications such as inconsistent next-generation system upgrading.
- Ownership of rewritten applications becomes unclear, so maintenance and support responsibilities become lost.

For these reasons, alternative systematic approaches are required to make application development more efficient and consistent.

5.3 The INTERNATIONALIZATION/LOCALIZATION approach

INTERNATIONALIZATION/LOCALIZATION simplifies the development of systems for different cultural environments and substantially reduces the necessary production efforts. It also facilitates the uniform addition of cultural features to all applications.

INTERNATIONALIZATION is intended to permit the design and implementation of an application platform and/or an application which can accommodate users

with a variety of cultural backgrounds. Services are required which insulate the application platform and/or the application from a variety of cultural differences that are not relevant to its functionality.

A system which provides this service is referred to as an INTERNATIONALIZED system in this Technical Report.

5.3.1 INTERNATIONALIZATION

An INTERNATIONALIZED system has a distinct function, but its code contains predetermined slots into which cultural information will be loaded. This cultural information relates to the cultural conventions and messages in the natural language(s) and script of the user of the system, and allows the user to communicate with the system in familiar terms and in familiar forms. Ideally, information from any culture can be fitted into any system framework, thus changing the system user interface but maintaining the functionalities of the system unchanged. In other words, the system is free of any culturally dependent items.

INTERNATIONALIZATION is the process of constructing such a system framework. Once the INTERNATIONALIZED system is associated with a specific cultural information and system platform (a computer or an operating system), the entire system is called a LOCALIZED system. Such an approach can satisfy the needs of users from different cultures without requiring modifications to system functions or application software.

5.3.2 LOCALIZATION

LOCALIZATION is the adaptation of INTERNATIONALIZED systems to the specific cultural needs of users. This occurs when cultural information is fitted into the predetermined slots in the system framework. Thus, the cultural data is the only component of an INTERNATIONALIZED system that changes, and this change occurs only to suit the culture of the user. The functions and basic coding of the system always remain same.

LOCALIZATION data may be provided not only for specific single cultures, but also for multiple cultures. In fact, all culture combinations described in 4.2.1 to 4.2.7 may be loaded into an INTERNATIONALIZED system as part of the LOCALIZATION process. Even Global Uniformity and Cross-Cultural Friendliness are only examples of single cultural data sets for LOCALIZATION.

NOTE 6 It is not necessary to start the process of internationalization from the U.S. culture. Once an INTERNATIONALIZED system is in place, it can be LOCALIZED to the U.S. culture.

5.3.3 Summary

In summary, INTERNATIONALIZATION is "super-localizability" which ensures lower cost, higher quality, and faster delivery of LOCALIZED applications. All INTERNATIONALIZED applications must still be subsequently LOCALIZED, but the LOCALIZATION process is cost and time effective.

The pictures in FIGURE 1 symbolise the INTERNATIONALIZATION/LOCALIZATION approach. Once space for any language is provided, the girl can speak any language in any script — even a Global Uniformity solution is possible.

On the other hand, it is very difficult to carry out local adaptation when the message is hard-coded, as in FIGURE 2, without some or even significant degradation. Local adaptation from one culture to another is impossible in practice.



Figure 1 — INTERNATIONALIZED System free space for messages



1) hard coded message (low localizability) (Messages in Japanese characters are part of the picture.)

Figure 2 — Hard-coded localization



Figure 3 — Examples of a LOCALIZED English system

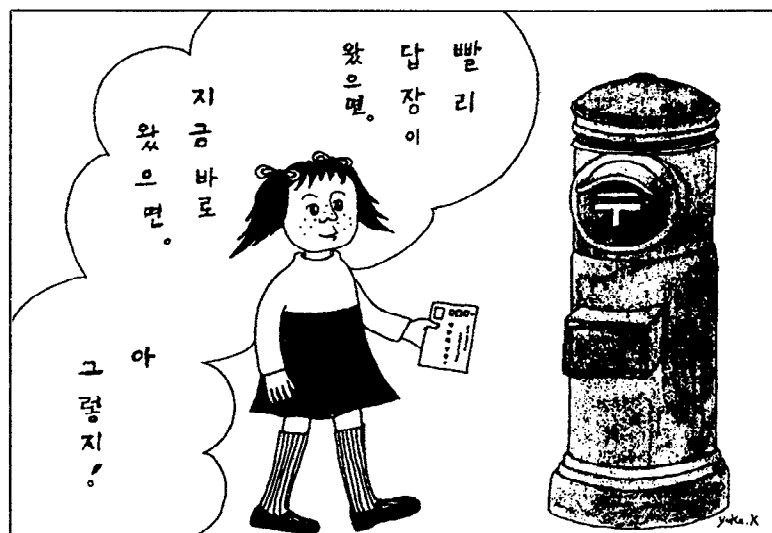


Figure 4 — Examples of a LOCALIZED Korean system



Figure 5 — Examples of a LOCALIZED Japanese system

FIGURE 6 shows a sample of cultural conventions. Without adapting the cultural conventions to the target culture, the true user friendliness of the solution is lost to some degree.

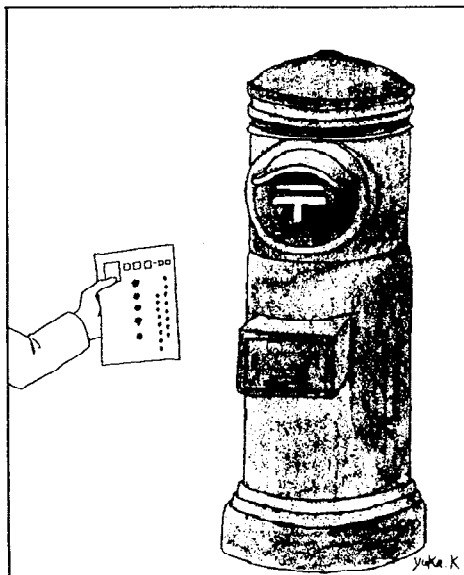
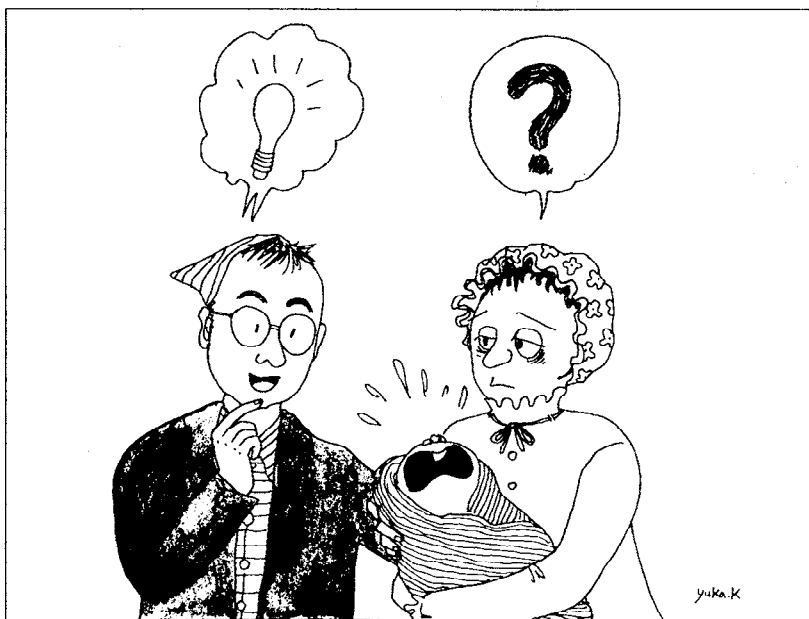


FIGURE 7 is a LOCALIZED example which is achieved by Global Uniformity. The question mark and light-bulb in the message space do not require translation to any culture (see 4.2.6).

2) The address format of mail and the "Post" mark on mailboxes are culture dependent.

Figure 6 — Cultural conventions to be localized



3) The meaning of a question mark is understood in almost all cultures.

Figure 7 — Global Uniformity

5.4 Environments for internationalization

The requirements for "user friendliness" in different cultures are often facilitated by the introduction of new

technologies, and new technologies encourage further requirements for user friendliness. TABLE 1 contrasts the traditional common practice with the needs of international environments for information technology.

Table 1 – Environments for internationalization

	Common Practice	International environment
coded character set	specific to each application platform (mostly ISO/IEC 646-IRV)	any coded character set
character repertoire	tightly linked with character code	code independent
one character	one byte	one or more bytes
one byte	7 or 8 bits	8 bits or more
display width of a character	one column on a character cell display	variable numbers of columns on a character cell display
	fixed width	variable width
character count	=byte count, =display width	not always equal to byte count, not always equal to display width
maximum number of a character	128 or 256 in most cases	unknown
printable character	ISO/IEC 646-IRV	no assumption can be made
collating sequence	ISO/IEC 646-IRV, per code sequence	no assumption can be made
input from keyboard	direct	specially designed device, or indirectly using(interactive) interpreting methods
message	in English	in any language
writing direction	left to right and top to bottom	might vary, even within one execution environment
coded character set of program source code	same as execution coded character set	an execution coded character set might be different from the coded character set of program source code
coded character set of file	coded character set of program	not always the same as coded character set of program