Interfaces in Broadband ISDN*

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1 Introduction

Two sets of interfaces are defined in B-ISDN standards; one referring to *user-network interface (UNI)* at reference points T_B and the other at internodal junction points. This latter interface is referred to as *network-node interface (NNI).*

UNI at reference point T_B defines the boundary between public network and customer premises network (CPN), whereas the interface at S_B is generally known as the terminal interface. The interface at S_B is expected to have a high degree of commonality with the interface at T_B. However, the interface standards at S_B are not yet much advanced. In this paper UNI refers to the interface at T_B. For UNI two hierarchical levels are recommended: the basic rate interface with a gross bit rate of 155.52 Mbit/s and the primary rate interface with a gross bit rate of 622.08 Mbit/s to support a varying mixture of services for broadband users. For each of these interfaces, two options are chosen: a cell-based physical layer and a physical layer based on synchronous digital hierarchy (SDH). UNI specifications are described in the I.413 and I.432 recommendations of CCITT [21]. The NNI is considered as a part of the transmission system in the core network. For NNI three hierarchical levels based on SDH are defined to support various levels of transmission capacities of nodes in the main network. The NNI aspects are covered in the accompanying paper.

The standard interfaces are very important for subsystem development, so that multivendors and multimanufacturers can choose and develop the equipments that are more appropriate to their technical expertise. The service support and the functional support are definable at interface levels, and various configurations can be realized through proper adapters between different interfaces. Such a flexibility will provide the user with a large spectrum of choice for physical implementations to suit his needs for cost-performance advantages. In this perspective, CCITT and ETSI standards organizations have defined the user network interface at T_B reference point for user service support and the network node interface (NNI) at nodal junctions, for an optimized and flexible transmission system.

* Abbreviations, glossary and references see page 238.

2 Reference Configuration

Figure 1 shows the reference configuration with various reference points and interfaces identified for standardization. Though the reference configuration of B-ISDN is identical to that of 64-kbit/s ISDN, physical configurations of CPN may vary in B-ISDN considerably to accommodate various networking topologies like Bus or Ring corresponding to shared media and star, etc. The internal interfaces of such topologies are not standardized, so that vendors can configure the customer's CPN in different ways, but guarantee the standard interfaces through appropriate media adapters (MA). The reference point T_B defines the boundary with the public network. The user terminal and the network are separated by the broadband network termination (NT), divided into NT2 and NT1, the transmission medium (optical fibre or coaxial cable) and the line termination (LT), which is located within the local exchange (LEX). The NT2 has multiplexing, concentrating or switching function, supporting multiple terminals or users. The connection to NT2 will be through standard interface at S_B reference point. NT1 terminates the physical medium and incorporates operations, administration and maintenance (OAM) of the public network up to reference point T_B. The NT2 can have a null function, if only one broadband terminal is connected. In this case interfaces at S_B and T_B should be the same for terminal compatibility. However, the interface at S_B is not yet well-defined.

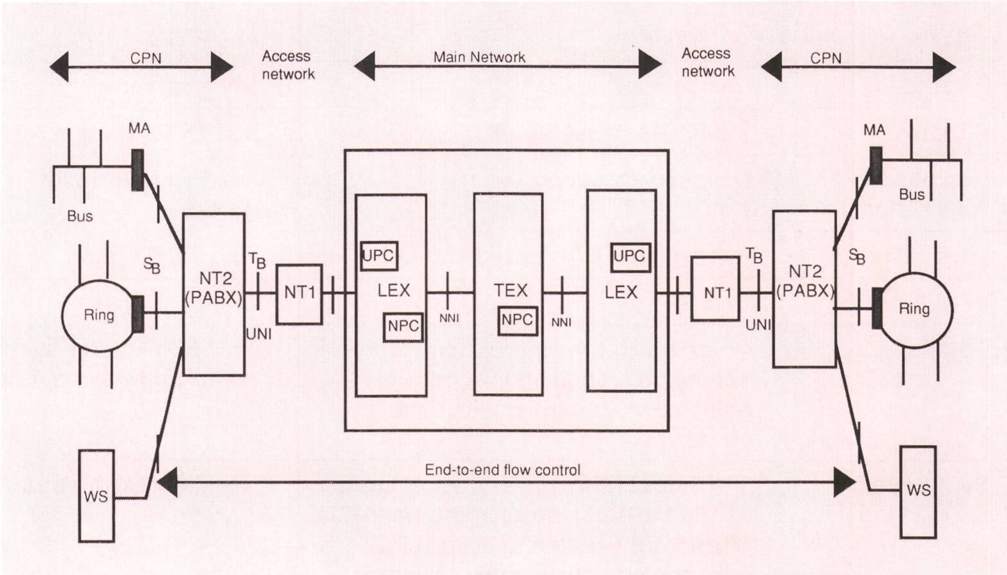
The transmission links between two nodes are achieved through standard network node interfaces (NNI). Whenever the compatibility differs between the network node interfaces, the interworking unit between the two interfaces is introduced.

3 User Network Interface at T_B Reference Point

The gross bit rates of 155.52 Mbit/s and 622.080 Mbit/s have been adopted at basic and primary levels to transport ATM cells in the access network at the physical layer, which corresponds to the transmission capacities of the SDH. Two options have been recommended for these interfaces: SDH-based and cell-based physical layers. Both options may also exist at S_B reference point.

Use of plesiochronous digital hierarchy (PDH) physical layer at UNI for ATM cells transport has also been considered for low bit rates ($<$140 Mbit/s) but has not been elaborated in the approved recommendations.

Fig. 1 B-ISDN reference configuration



The transfer capacity available to the ATM layer is 149.760 Mbit/s in the 155-Mbit/s interface. This includes the capacity for ATM and AAL header fields, signalling, and OAM requirements. The total capacity available for user information is of the order of 132 Mbit/s. The corresponding capacity for 622.080-Mbit/s interface is four times the 155.520-Mbit/s interface.

The basic UNI at 155.52 Mbit/s is a symmetric interface having the same bit rates in both directions, either on electrical or optical fibre medium. The wiring configuration is of a point-to-point configuration. The range of interface varies between 0 and 200 m in case of an electrical interface and between 0 and 2000 m for optical fibres.

In case of electrical interface, two cables with 75 Ω impedance, one for each direction, are recommended. The line coding used is the code mark inversion (CMI) as defined in G.703 recommendation [24].

In the case of optical fibre interface, two single-mode fibres, one for each direction, are preferred. The line coding would be non-return-to-zero (NRZ) code. The operating wavelength window around 1310 nm is used.

Transmission performance across UNI is dependent on the error detection and correction as well as the correct cell delineation. Both these functions are achieved through header error control (HEC) functions. Furthermore, to minimize the error multiplication, a self-synchronizing scrambler with a $1+x^{43}$ polynomial has been identified for the SDH-based physical layer. For cell-based systems, distributed sample scrambler of 31st order (polynomial: $x^{31}+x^{28}+1$) has been identified. The details of transmission convergence functions across UNI may be found in [8]. The UNI at 622.08 Mbit/s is being developed on the similar lines of the 155.52-Mbit/s interface, with an optical fibre medium.

4 Network Node Interface (NNI)

The NNI corresponds to the transmission system interface between the digital sections in the core network. The NNI standards follow synchronous digital hierarchy (SDH) defined in G.707–G.709 [26–28] recommendations. There is a large commonality between UNI and NNI to provide universal service support. However, it should be noted that NNI is not specific to B-ISDN, but defined to fulfill B-ISDN requirements in transport networks. The hierarchical bit rates of NNI defined are $n \times$ 155.520 Mbit/s, with n taking values 1, 4 and 16. The NNI is defined for maximum flexibility for network configuration, common for transmission, multiplexing and cross-connecting of various signals, with enhanced OAM capabilities.

5 Principle Characteristics of UNI and NNI

Though both UNI and NNI have much in common, there are some important differences between these two types of interfaces. They are summarized in *table I.*

6 Structure of Physical Layer

The physical layer of UNI is divided into two sublayers: physical medium (PM) sublayer and transmission convergence (TC) sublayer, as shown in *figure 2.* The PM sublayer has functions of line coding, optoelectronic conversion, etc., that are specific to the type of physical media used and the standards adopted for the reliable transmission of a binary bit stream. The transmission convergence sublayer is responsible for functions that transform a flow of ATM layer cells into a flow of data units on the PM. As illustrated in figure 2, the three options (cell-based, SDH and PDH options) differ only on lower sublayers of PM.

61 Physical Configurations

Figure 3 illustrates some examples of physical configurations [I.413] showing combinations of physical interfaces at various reference points. It shows different ways of implementing NT2 functions, with media adaptors (MA) to support proprietary interfaces, but guaranteeing the standard interfaces at S_B and T_B for B-ISDN

Table I. UNI and NNI characteristics

Parameter	UNI characteristics	NNI characteristics
Bit rates	155.52 Mb/s and 622.08 Mb/s	$n \times 155.52$ Mb/s; $n = 1, 4$, and 16
Broadband Application	User service support	maximum flexibility in transport network
physical layer	two options: SDH based and Cell based	Only SDH option
VPI/VCI	24 bits	28 bits
GFC	4 bits: for traffic control from user to network direction and for possible point-to-multipoint applications (still open)	No GFC field: No traffic flow control and no point-multipoint configurations.
Symmetry	UNI 155.52 Mb/s is symmetric, but the 622.08 Mb/s can be asymmetric (622.08 Mb/s from network to user, 155.52 Mb/s from the user to network: still open)	Normally asymmetric
UPC/NPC	UPC monitors and controls the traffic in terms of traffic offered and validity of the ATM connections	NPC monitors and controls the traffic in terms of traffic offered and validity of the ATM connections
Meta-signalling	Meta-signalling is used to establish, check and release the point-to-point and selective broadcast signalling channel connections.	No Meta-signalling is used
Signalling	Both point-to-point and point-to-multipoint signalling configurations may be used	Only point-to-point signalling configuration is used

compatibility. The media adaptors are used to accomodate the specific topology for the distributed B-NT2. The interface at W may include topology-dependent elements, and it may be a nonstandardized proprietary interface.

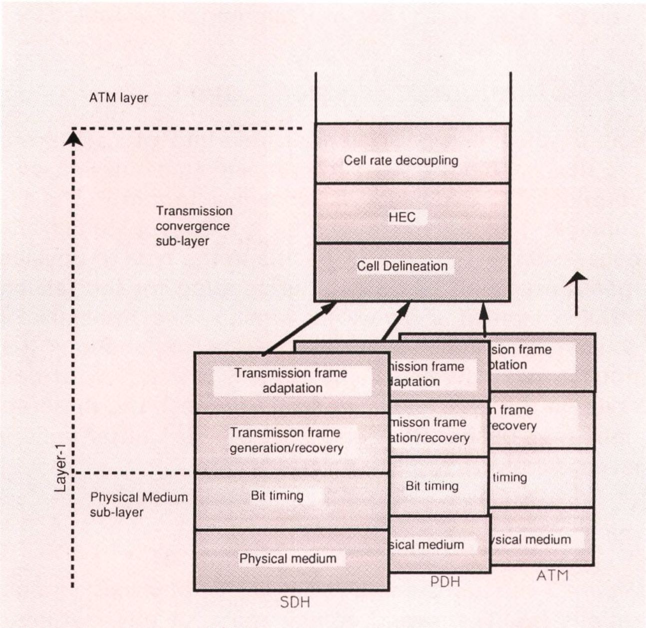


Fig. 2 Protocol reference model of UNI – physical structure

In all configurations, there would be only one UNI at T_B reference point per NT1, whereas there can be more than one interface at S_B reference point per NT2.

The high degree of commonality between interfaces at S_B and T_B is desired, so that a terminal can be directly connected to NT1 at T_B reference point. In this case the B-NT2 may have a null function. However, the interface at S_B is not fully developed. In the standards so far, only point-to-point configurations at the physical layer have been defined. The point-to-multipoint configurations may be there at higher layers. When a shared medium is used, B-TE includes shared-medium access functions (fig. 3c: SSB interface). However, the connection of B-TE to NT2 will be across standard S_B interfaces.

7 Conclusions

The interfaces for B-ISDN have been conceived with a view of commonality between UNI and NNI. The UNI standards are defined with a view of the user service support needs, whereas the NNI is defined in terms of maximum flexibility for network configuration enabling transmission, multiplexing and cross-connecting of various signals. The acceptance of worldwide universal interfaces for UNI and NNI standards provides an easy evolution path, flexibility in network configuration, sim-

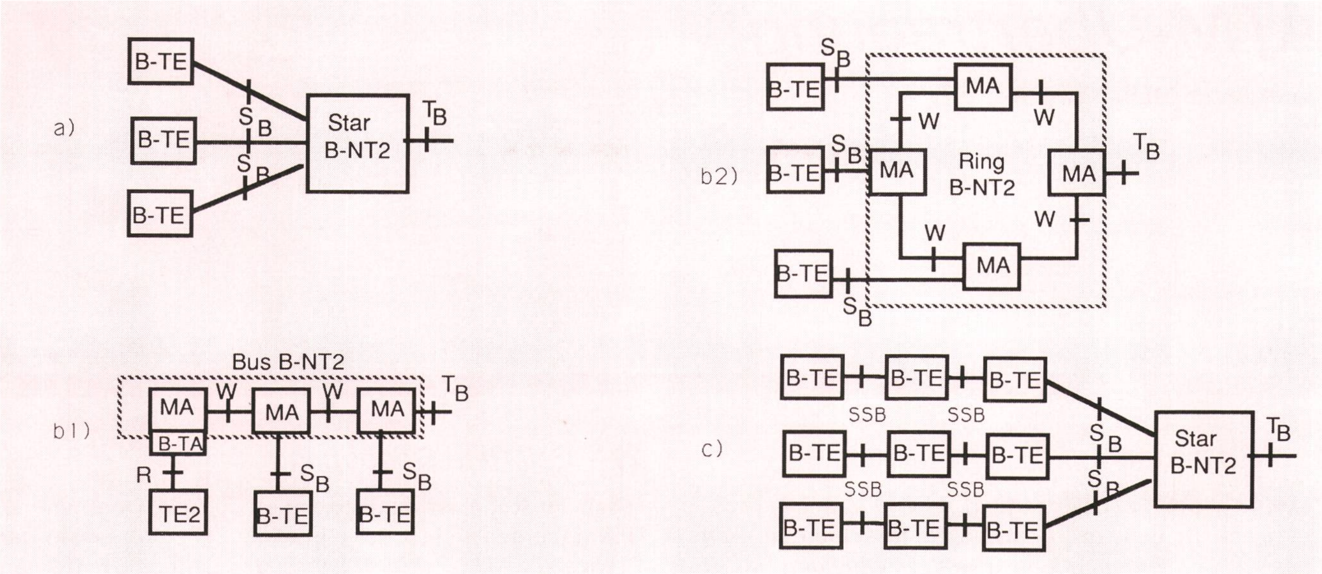


Fig. 3 Examples of physical configurations

ple interworking with existing interfaces and early realization of B-ISDN. The commonality achieved between UNI and NNI as well as the independence of the physical layer from higher layers result in multiple types of transmission systems that are optimally designed for the user needs without much penalty on the network design.

Zusammenfassung

Schnittstellen im Breitband-ISDN

In diesem Beitrag werden die Schnittstellen im Breitband-ISDN, wie sie in den CCITT- und ETSI-Normen definiert sind, vorgestellt. Anhand der Referenzkonfiguration wird die Bedeutung der funktionellen Gruppeneinteilung und der Schnittstellendefinitionen erklärt. Die Eigenschaften zweier Typen von Benützer-Netz-Schnittstellen (UNI) – eine auf Rahmen der synchronen digitalen Hierarchie SDH und die andere auf einer reinen Zellenfolge beruhend – werden erläutert. Auch die Anwendung der plesiochronen digitalen Hierarchie PDH an der Benützer-Netz-Schnittstelle wird erwähnt. Die wichtigen Unterschiede der an der UNI-Schnittstelle und an der Netzknoten-Schnittstelle (NNI) beteiligten Funktionen werden gezeigt. Struktur und Funktionen der physischen Schicht werden ebenfalls kurz behandelt. Als ausführbare Szenarien werden einige physische Konfigurationen mit verschiedenen internen Schnittstellen-Referenzpunkten dargestellt.

Résumé

Interfaces dans le RNIS à large bande

L'auteur décrit les interfaces propres au RNIS à large bande définies dans les normes du CCITT et de l'ETSI. En se fondant sur la configuration de référence, il explique la signification de la répartition fonctionnelle des groupes et des définitions des interfaces. Il aborde les caractéristiques de deux types d'interface utilisateur-réseau (UNI), l'une se fondant sur des trames de la hiérarchie numérique synchrone SDH et l'autre sur une pure succession de cellules. On évoque l'application de la hiérarchie numérique plésiochrone (PDH) à l'interface usager-réseau. Les principales différences entre les fonctions apparaissant à l'interface UNI et celles qui sont rattachées à l'interface des nœuds de réseau (NNI) sont démontrées. La structure et les fonctions de la couche physique sont esquissées. On montre quelques configurations physiques présentant divers points de référence d'interface internes.

Riassunto

Interfacce nella rete ISDN a larga banda

In questo articolo l'autore presenta le interfacce nella rete ISDN a larga banda come sono definite nelle norme CCITT e ETSI. In base alla configurazione di riferimento egli spiega l'importanza della suddivisione funzionale in gruppi e delle definizioni delle interfacce. Illustra quindi le caratteristiche di due tipi di interfacce rete/utente (UNI): una basata su trame della gerarchia sincrona digitale SDH e l'altra su una pura successione di celle. L'autore menziona poi l'applicazione della gerarchia digitale plesiocrona PDH all'interfaccia rete/utente. Indica quindi le differenze importanti delle funzioni interessate dell'interfaccia UNI e dell'interfaccia dei nodi della rete (NNI) e parla brevemente della struttura e delle funzioni dello strato fisico. Presenta infine, come scenari realizzabili, alcune configurazioni fisiche con diversi punti di riferimento interni delle interfacce.

Summary

Interfaces in Broadband-ISDN

This paper identifies the Broadband ISDN (B-ISDN) interfaces as defined in CCITT and ETSI standards. The reference configuration is used to explain the significance of functional groupings and interface definitions. The characteristics of two types of User-Network Interfaces (UNI), one based on Synchronous Digital Hierarchy (SDH) frame and the other on the pure cell stream are outlined. Use of the plesiochronous digital hierarchy (PDH) at UNI is also considered. The important differences in the functions involved at UNI and at the Network Node Interface (NNI) are given. The physical layer structure and functionalities involved are also briefly discussed. Some physical configurations as implementable scenarios with different internal interface reference points are also cited.