A PROPOSAL FOR A CONNECTION-MODE NETWORK SERVICE RELAY PROFILE

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SUMMARY

Functional standardization activities in ISO and in regional workshops are currently addressing end-system profiles and network layer relay profiles for the interconnection of several types of subnetworks. In order to achieve end-system interconnectivity, connection-mode network layer relays appear as one of the key pieces of the Open Systems Interconnection puzzle. In this paper the authors present a proposal for a connection-mode relay profile that is being input to the European Workshop for Open Systems, discuss the relevant profile options, and identify some issues - concerning the proposed as well as other relay profiles - that will require future attention and discussion.

KEY WORDS: Service relay, protocol relay, network-layer relays, internetworking, international standardized profiles.

1. Introduction

The generalized use of local area networks (LANs), and the need for information interchange between users connected to different types of LANs, possibly located in geographically distant places, has lead in the last few years to the development of LAN interconnection solutions based on wide area packet switching data networks (PSDN WANs) [Schepers 1992].

To prevent incompatibilities between different interconnection solutions, there is an ongoing functional standardization activity in ISO aiming at the development of International Standardized Profiles (ISP), that benefits from the harmonized input of regional workshops (EWOS[1], NIST OIW[2], and AOW[3]). This will, hopefully, lead to standardized and compatible implementations of relays for the interconnection of those types of networks.

This paper presents a proposal for a connection-mode network service (CONS) relay functional standard, or profile, for the interconnection of CSMA/CD LANs and Packet Switched Data Networks. The presented work is being input to the EWOS Expert Group on Lower Layers where it is a current work item, and from where it will be fed into the other regional workshops for harmonization and, eventually, to ISO Special Group on Functional Standardization (SGFS).

Section 2 introduces some basic concepts regarding the network layer and network layer relays, and presents the current status of functional standardization activities in the area. Section 3 presents a general view of network layer relay profiles and discusses some of their protocol issues and supported functionality. A detailed profile presentation is given in section 4, where all the relevant profile options are discussed. Section 5 presents some conclusions and future work directions.

2. Network layer relaying

2.1 The OSI Network Layer

According to the principles of the OSI Basic Reference Model [ISO 7498], the network layer provides the transparent transfer of data between transport entities, in such a way that the characteristics of different transmission and subnetwork technologies are masked and a

[1] European Workshop for Open Systems

[2] National Institute for Standards and Technology - OSI Implementors Workshop

[3] Asian and Oceanic Workshop

consistent network service is offered.

In order to do so, the Network Layer is organized in three sublayers that may or may not be present in a system [ISO 8648], depending on the interconnected subnetworks:

- the Subnetwork Access Protocol (SNAcP) Sublayer, a subnetwork specific sublayer;
- the Subnetwork Independent Convergence Protocol (SNICP) sublayer, that presents an uniform service to the Transport Layer;
- the Subnetwork Dependent Convergence Protocol (SNDCP) sublayer, that is responsible for the necessary adaptations between the SNAcP and the SNICP sublayers.

In spite of this organization, the OSI environment supports two incompatible types of network services: the connection-mode network service, supported by the X.25 Packet Level Protocol [ISO 8208], and the connectionless-mode network service (CLNS), supported by the connectionless-mode network protocol (CLNP) [ISO 8473]. In the OSI environment, the interconnection of end-systems attached to the same or different subnetworks is only possible if the end-systems use the same type of network service and there are no incompatibilities at the transport protocol classes. When CONS/CLNS interworking is necessary or incompatible transport protocol classes are used, one of several possible solutions may be used [EWOS 006] [Schepers 1992], all of them outside the context of OSI.

2.2 Relay functional standardization

ISO/IEC Technical Report 10000-2 [ISO 10000-2] defines a taxonomy for relay system classification. From TR 10000-2, relays are classified according to the form:

RXp.q where

R = stands for Relay

X = relay type identifier, covering the layer at which the relay operates, the service mode being supported and the type of relay; some possible values for X are:

A - CLNS relaying

B - CONS relaying

C - X.25 Packet Level Protocol (PLP) relaying

p, q = subnetwork type numerical identifiers. Table 1 shows some possible subnetwork type identifiers.

TABLE 1 - Some examples of subnetwork-type identifiers

Identifier	Subnetwork
1	PACKET SWITCHED DATA NETWORK (PSDN)
11	Permanent Access to a PSDN
111	PSTN leased line
1111	Virtual call (VC)
1112	Permanent Virtual Circuit (PVC)
112	Digital data circuit / CSDN leased line
1121	Virtual call (VC)
1122	Permanent Virtual Circuit (PVC)
2	DIGITAL DATA CIRCUIT
21	Leased (Permanent) Service
22	Dial-Up (CSDN)
3	ANALOGUE TELEPHONE CIRCUIT
31	Leased (Permanent) Service
32	Dial-Up (PSTN)
4	INTEGRATED SERVICES DIGITAL NETWORK (ISDN)
41	Semi-permanent service
42	Circuit mode service
43	Packet mode service
5	LOCAL AREA NETWORKS
51	CSMA/CD
52	Token Bus
53	Token Ring
54	FDDI

At the present moment, several functional standardization activities address network layer relaying, covering CLNS relaying (RAp.q profiles), CONS relaying (RBp.q profiles) and X.25 Packet Level Protocol relaying (RCp.q profiles). These functional specifications are being developed by regional workshops and are at different development stages (e.g., development in progress within organization, harmonization between regional workshops in progress, submitted to JTC1/SGFS for ISP processing). Current profile work addresses the interconnection of different types of subnetworks (e.g., CSMA/CD, Token Ring, PSDN and FDDI) in various combinations. In addition, several end-system profiles are approved, or near approval, in ISO, that use the connectionless-mode or the connection-mode approach at the network layer. ISO maintains a directory of ISPs that contains updated profile status information [SGFS SD-4].

3. General view of relay profiles

3.1 Relay protocol stacks

Figure 3.1 presents the protocol stacks of different network layer relays for the interconnection of CSMA/CD and PSDN subnetworks.

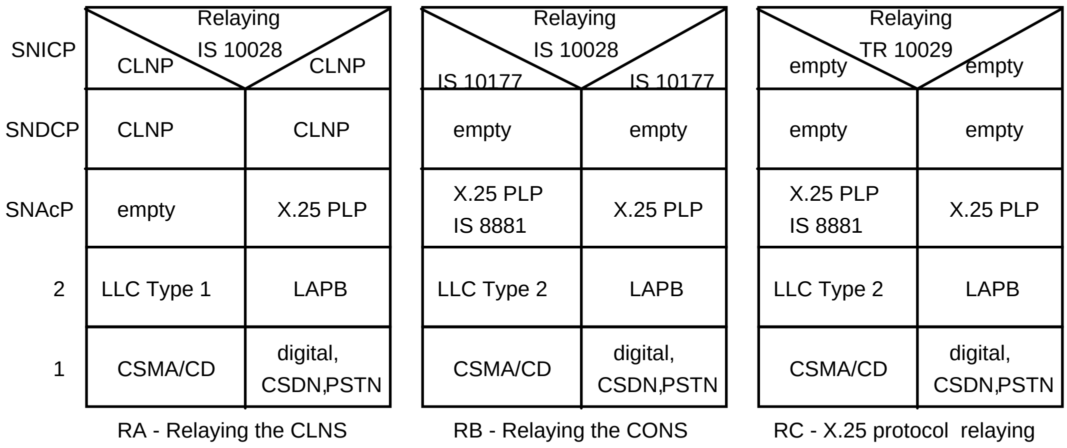

Figure 3.1 - Network layer relays protocol stacks

Particularly, the RB part of figure 3.1 identifies the base standards for which requirements are made in the proposed profiles, with the exception of [ISO 10028] which defines a Network Internal Layer Service (NILS) and the associated relaying function for the CONS.

Some issues and problems concerning the three kinds of network relays, with general subnetworks, will be discussed below.

3.2 Relay supported functionality

The functionality provided by RA and RB relays is the relaying of the CLNS and the relaying of the CONS, respectively. It is outside the scope of this work to make considerations on which is the better mode of service [Bauerfeld 1990]. In fact both, are needed and so there must exist solutions to support them.

In principle, RC relays could provide the relaying of the CONS, of the CLNS and of non-OSI traffic like PAD traffic [EWOS 006]. By comparing the RA and RC protocol stacks we can conclude that establishing a path that uses the two relays for the provision of the CLNS is only possible if at least one of the two following conditions is hold:

- the end systems support the CLNP over X.25 PLP[4];
- the end systems are connected to subnetworks accessible by RA relays.

By comparison of the RB and RC stacks, one possible conclusion could be that RC relays do

[4] Internetworking between TA5x and RC5x.y in the same subnetwork is impossible because TA5x does not use X.25 PLP.

everything that RB relays do and more. This conclusion is superficial and is not correct at all. The next table identifies some differences between these relays:

TABLE 2 - Some differences between RB and RC approaches to relaying

RB	**RC**
Does not depend on the type of the subnetwork.	Only the following subnetworks: 11n, 21, 31, 41n, 431n, 43211, 4322n, 5n [ISO 10000-2].[5]
Based in a stable international standard [ISO 10028] for the definition of the relaying function.	Based in a technical report [ISO 10029] of type 2, which means: "the subject is still under technical development requiring wider exposure".
By using [ISO 10177] it uses only the [ISO 8208] functions needed for the provision of the CONS. The rest is not required to be implemented (things like Q-bit, for example).	It requires a complete implementation of [ISO 8208].
The method of defining the relaying function consists in mapping the X.25 PLP [ISO 8208] PDUs on one side to a well defined NILS [ISO 10028], propagating the NILS to the other side and then reverse mapping[6].	[ISO 10029] only gives a general overview of the PDU mappings, and does not have Protocol Implementation Conformance Statements (PICS).

3.3 Protocol stack issues

Let us now see some important issues concerning the stacks in figure 3.1 .

In RA profiles, the use of CLNP over X.25 PLP has the problem of lowering the quality of service offered by the network layer. So, for the provision of the connection-mode transport service (COTS), transport protocol class 4 (TP4) should be used over CLNP[7]. This combination is expensive in terms of computer resources as well as network resources. On the other hand, LLC Type 1 is a good choice because the error rate in LANs is low and TP4 can provide the

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[5] Of course in the specific case of RC51.11x1 and RB51.11x1 they are interchangeable for the provision of CONS.

[6] Although the method of mapping a PDU for a NILS, and again to a PDU seems to be more expensive than directly mapping PDUs, in [Bernardes 1992] we see that for this kind of subnetworks and for traffic loads less than 70% there is no resource overloading. Also in this case we have the X.25 PLP [ISO 8208] in both sides of the relay so we can use protocol mapping [EWOS 006].

[7] There is no need for TP4 if UA profiles are used, but the fact is that there has been little interest in UA profiles, when compared to TA profiles. So, in general, that is a problem.

necessary reliability.

In RB and RC profiles, the use of LLC Type 2 seems a waste of resources, due to the low error rate normally found in LANs. Nevertheless, conformance to [ISO 8881] mandates the usage of LLC Type 2, and so the solution recommended in [NIST 1992] violates the standard. Use of LLC Type 1 would have the advantages of using a set of procedures which is mandatory for all classes of LLC [ISO 8802-2]. In addition, according to [NIST 1992] the only possible relaying function is that defined in [ISO 10029] (X.25 protocol relaying [EWOS 006]) which has the limitations expressed in Table 2 and ignores the RB solution presented in [ISO 10028]. Also, as stated before, in some cases RC relays can support the CLNS. When some network layer addressing problems are solved[8] RB relays shall also be able to support the CLNS.

3.4 RB51.11x1 applicability scenario

Figure 3.2 illustrates the scenario in which RB51.11x1 profiles are applicable. The figure shows two reference points, but an implementation of this profile may include more attachments to either of the subnetworks.

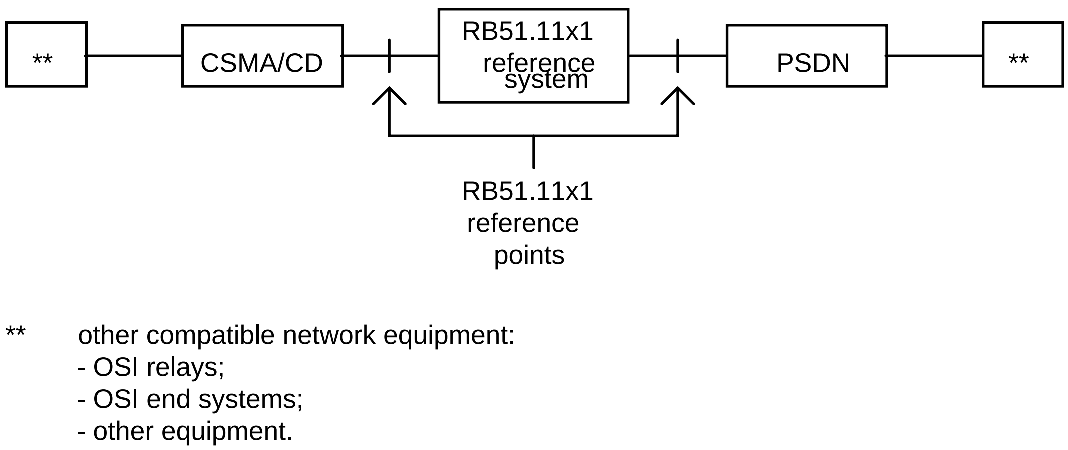

Figure 3.2 - Scenario of applicability of the RB51.11x1 profile.

As those profiles are members of the RB group, it is intended that conforming implementations are capable of interworking with other profiles of the RB group and with end systems implementing profiles from the TB, TC, TD and TE groups or the UB group, provided that suitable relays are in place in the case of those members of these groups which relate to different

[8] The problem is that in [ISO 10177] the subnetwork address is an NSAP address which must appear in the called and calling address extension facilities of the appropriate X.25 PLP packets, and the CLNP SNDCP for X.25 PLP places the X.121 DTE address into the called and calling address fields. ISO recognized the problem and, as far as the authors know, is working in a solution.

elements of the subnetwork taxonomy.

4. RB51.11x1 profile options description

4.1 General overview

The specification of these profiles is contained in a document written according to the multi-part ISP rules [ISO 10000-1].

According to [ISO 10000-1] the first reason to use the multi-part ISP format is to reuse material from different profiles but with close relationships; this is essential to ensure consistency and internetworking, to avoid unnecessary duplication of text, and to aid writers and reviewers of ISPs. In this specification only the parts that define the specific profiles, by referencing material from the other parts, are separate to permit each profile to be subject of a separate ISP ballot [ISO 10000-1].

For now, the presented work only specifies two profiles: RB51.1111 and RB51.1121 (referred in the text as RB51.11x1). The next logical step would be to specify the RB53.11x1 profiles, for which there is a recognized interest and the main work is already done in the presented RB specification and in [ISO 10608-13].

In part 4, "requirements for the PSDN subnetwork", there are references to material from [ISO 10609-9]. The idea is to reuse the IPRLs[9] for the Data Link and Physical layers.

A general description of the profile parts is presented in Table 3.

[9] The purpose and meaning of IPRLs and the related ISPICS is clearly explained in [Stallings 1993] and [ISO 10000-1].

TABLE 3 - General description of the profile parts

Part	Title	Standards constrained
1	Subnetwork-type independent requirements	[ISO 10177], [ISO 8208]
2	LAN Subnetwork-type dependent media independent requirements	[ISO 8208], [ISO 8802-2]
3	CSMA/CD LAN Subnetwork-type dependent media dependent requirements	[ISO 8802-3]
4	PSDN Subnetwork dependent media dependent requirements for virtual calls over a permanent access	[ISO 8208], [ISO 7776]
5	Profile RB51.1111	parts 1-4 and standards for the X.25 dedicated access by a PSTN
6	Profile RB51.1121	parts 1-4 and standards for the X.25 dedicated access by a digital data circuit /CSDN

The scope of this paper is only to present and discuss the options taken in the specification of profiles RB51.11x1. In accordance to this, in the rest of the paper there are no further references to the structure of the work neither to where in the parts appear the constraints or the requirements made.

The rest of the chapter is a description of the requirements on the base standards and the justification for those requirements. A distinction is made between static and dynamic requirements. The former are requirements for implementation, and the later are requirements for use. It should be noted that, according to [ISO 9646-7], these two types of requirements only exist because base standards PICS are incomplete.

4.2 Requirements for ISO/IEC 10177

This standard defines the mappings between the X.25 PLP[10] PDUs and the NILS for the provision of the CONS.

4.2.1 Static conformance requirements

Table 4 summarizes the proposed profiles static conformance requirements, with respect to [ISO 10177].

[10] Only for the CCITT X.25 1984 and later versions, because [ISO 10177] does not define the SNDCP for the support of the CONS, needed by the 1980 version.

TABLE 4

1)	meet the static conformance requirements specified in clause 6.1 of [ISO 10177].
2)	implement the following capabilities identified in table 1 of [ISO 10177]: a. use of VC service; b. NC establishment, outgoing;c. NC establishment, incoming; d. expedited data transfer; e. receipt confirmation; f. NC release on mapping-protocol violation; g. NC reset on mapping-protocol violation.
3)	conform to the following PICS items in clauses A.5, A.6 and A.7 of [ISO 10177]: a. NC establishment incoming on VC - m[11]; b. NC establishment outgoing on VC - m; c. expedited data transfer - m; d. receipt confirmation - m; e. INTERRUPT when non-use of Expedited Data negotiated NC release - o.1; f. INTERRUPT when non-use of Expedited Data negotiated NC reset - o.1; g. D-bit when non-use of Receipt Confirmation negotiated NC release - o.2; h. D-bit when non-use of Receipt Confirmation negotiated NC reset - o.2; i. Q-bit set to 1 NC release - o.3; j. Q-bit set to 1 NC reset - o.3; k. Zero-length M-bit sequence NC release - o.4; l. Zero-length M-bit sequence NC reset - o.4; m. Zero-length M-bit sequence ignore - o.4.

The use of the VC service is a characteristic of RB51.11x1 profiles and, of course, a profile implementation needs to establish outgoing connections when it decides to accept incoming connections. The expedited data transfer service is part of the CONS [ISO 8348] as well as the receipt confirmation service.

The mapping protocol violations are events that although correct from the viewpoint of the [ISO 8208] are errors according to [ISO 8878] and [ISO 10177]. So, in item 2 the two methods of acting when one of these violations occurs are supported. The situation of ignoring the errors would lead to internetworking problems. In item 3 the restriction is to support at least one of the methods of action for each of the identified violations.

4.2.2 Dynamic conformance requirements

A conforming implementation shall conform to the dynamic conformance requirements specified in clause 6.3 of [ISO 10177].

[11] m stands for mandatory item. o.n stands for support of at least one of the items identified with the same "n" [Stallings 1993] [ISO 10000-1].

4.3 Requirements for ISO/IEC 8208

4.3.1 Subnetwork-type independent static conformance requirements

Table 5 summarizes the proposed profiles static conformance requirements, with respect to [ISO 8208].

TABLE 5

1)	meet the requirements for the X.25 Packet Layer Protocol of [ISO 8208], as modified by [ISO 10177] in clause 6.2.1.
2)	meet the static conformance requirements specified in clause 21 of [ISO 8208/Amd.3].
3)	implement the following option from clause 21.1.2 of [ISO 8208/Amd.3]: a. transmit RR packets.
4)	conform to the following PICS items in clauses C.6.4.1 and C.6.8.1 of [ISO 8208/Amd.3]. a. Call clearing to reject an incoming VC - m b. Sending Q=1 in data packets - x

The "transmit RR packets" requirement is due to the fact that this requirement is not clearly stated in [ISO 10177]. The same type of problem applies to the option "Call clearing to reject an incoming VC". Finally, for coherence with the [ISO 10177] requirement to send data packets with the Q bit set to zero, sending data packets with the Q-bit set to 1 is excluded.

4.3.2 Subnetwork-type independent dynamic conformance requirements

A conforming implementation shall conform to the dynamic conformance requirements specified in clause 21 of [ISO 8208/Amd.3].

4.3.3 LAN dependent media independent static conformance requirements

Table 6 summarizes the proposed profiles LAN dependent media independent static conformance requirements, with respect to [ISO 8208].

TABLE 6

1)	meet the requirements for the X.25 Packet Layer Protocol of [ISO 8208], as modified for operation over LLC type 2 in a LAN environment by [ISO 8881].
2)	support the following optional user facilities: a. Non-standard Default Packet Sizes; b. Non-standard Default Window Sizes.
3)	support at least the following non-standard default parameter values[12]: a. all Non-standard Default Packet Sizes from 32 octets to 1024 octets; b. all Non-standard Default Window Sizes from 1 to 7.
4)	conform to the following PICS items in clause C.5 of [ISO 8208/Amd.3]: a. DTE/DCE (1988, 1984 and 1980) - x b. DTE/DTE with dynamic role selection - m c. Modulo 8 - m

As stated before, the support of the LLC type 2 is mandatory. Support of the values in 3) contributes to a more efficient LAN operation, by using its large bandwidth and its large packet sizes[13]. The support of the dynamic role selection method has the advantage of being automatic and based in the restart procedure which is mandatory [ISO 8208], and so it adds no extra costs. According to [ISO 8208] it is required to support at least one of the sequencing methods (modulo 8 or modulo 128). To avoid interworking incompatibilities the requirement for modulo 8 sequencing was made mandatory.

4.3.4 LAN dependent media independent dynamic conformance requirements

Table 7 summarizes the proposed profiles LAN dependent media independent dynamic conformance requirements, with respect to [ISO 8208].

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[12] The same requirements apply to the following PICS items from clause C.10.1 of [ISO 8208/Amd.3]: "Default packet sizes, sending ?", "Default packet sizes, receiving ?", "Default window sizes, sending ?" and "Default window sizes, receiving ?".

[13] Following is a justification for not requiring values greater than 1024 octets for X.25 PLP Maximum User Data Field. From all the LAN standardized technologies the one that has the smaller Maximum Packet Size is Ethernet with a value of 1518 octets [ISO 8802-3]. From that value, the following must be subtracted: 14 octets for the MAC header, 4 octets for the MAC trailer, 4 octets for the LLC header and 3 octets for the PLP header (using modulo 8 sequencing), giving a total of 1493 octets. So, if support for values of the Non-standard Default Packet Sizes, as defined in [ISO 8208], is required independently of the LAN technologies, the Maximum User Data Field should be 1024 octets because the next standardized value is 2048.

TABLE 7

1)	carry out the supported [ISO 8208] functions in accordance with the procedures for the X.25 PLP of [ISO 8208], as modified for operation over LLC type 2 in a LAN environment by [ISO 8881].
2)	not make use of the procedures for the operation of [ISO 8208] over LLC type 1, defined in section 3 of [ISO 8881].
3)	support the method of determining the range of logical channels approved in EWOS and already used in [ISO 10614-2].

Requirement 2) is also used in [ISO 10614-2] and [ISO 10609-12]. This is the kind of constraint which can lead to interworking problems with the [NIST 1992] based solutions. LLC type 1 support seems to be unnecessary because all the standardized solutions must support LLC type 2, as required by [ISO 8881].

Method 3) presents a harmonized procedure for a subject that is poorly defined in [ISO 8881] and [ISO 8208]. Basically, this method establishes the following procedure: the logical channel ranges to be used are determined by local knowledge; if local knowledge is not available then, by default, only a single two-way logical channel will be used; if more than one channel is available, a higher value may be negotiated using the On-line Facility Registration Facility.

4.3.5 PSDN dependent media dependent static conformance requirements

Table 8 summarizes the proposed profiles PSDN dependent media dependent static conformance requirements, with respect to [ISO 8208].

TABLE 8

1)	implement operation in a DTE/DCE environment according to [ISO 8208].
2)	conform to the following PICS items in clause C.5 of [ISO 8208/Amd.3]: a. DTE/DTE environments - x b. DTE/DCE (1980) - x c. Modulo 8 - m

[ISO 10117] states that compatibility with the 1980 version of [ISO 8208] is outside its scope, and so this environment is not supported by these profiles.

4.4 Requirements for ISO/IEC 8802-2

4.4.1 LAN subnetwork independent static conformance requirements

Table 9 summarizes the proposed profiles LAN subnetwork independent static conformance requirements, with respect to [ISO 8802-2].

TABLE 9

1)	implement the functions required by [ISO 8802-2] for the support of LLC Class II[14].
2)	in order to achieve intercommunication, agree the values of N1 and of the Ack Timer on a LAN-wide basis[15].
3)	support an Ack Timer value of 5±1 seconds, and it is recommended that this timer be configurable [ISO 10614-2].

There is no standardized PICS for [ISO 8802-2], and so a PICS based on the most recent draft was used. The requirements and the modified PICS can be found in [Rodrigues 1993]. A recommendation concerning the use of LLC congestion control procedures is specified in [EWOS 006] and is used in the proposed profiles as well as in [ISO 10614-2].

4.4.2 LAN subnetwork independent dynamic conformance requirements

Table 10 summarizes the proposed profiles LAN subnetwork independent dynamic conformance requirements, with respect to [ISO 8802-2].

TABLE 10

1)	carry out the supported [ISO 8802-2] functions in accordance with the procedures specified in [ISO 8802-2].
2)	if a value of k other than 7 it is to be used, negotiate the value by use of XID frames[16].

4.5 Requirements for ISO/IEC 8802-3

The requirements for this standard are the same as in [ISO 10612-2], [ISO 10613-3] and [10614-3]. There are three points for discussion:

- the fact that the requirements for 48 bit addressing and maximum frame size of 1518 octets for 10BASE2 are not in [ISO 8802-3]. Because of that, extra requirements had to be made

[14] Type 2 is mandatory in Class II.

[15] Recommended values for: N1, k, N2, Busy-state, Reject and P-bit [ISO 8802-2] are given in [ISO 10614-2].

[16] The procedure used is the same as in [ISO 10614-2]

in the proposed profiles;

- migration to 48 bit universal addressing, which has the advantage of eliminating the need for duplicated address checking procedures at the LLC sublayer;
- addition of the 10BASET media, because the requirements only specify 10BASE2 and 10BASE5 and the this kind of media is becoming very common.

4.6 Requirements for ISO 7776

4.6.1 Static conformance requirements

Table 11 summarizes the proposed profiles static conformance requirements, with respect to [ISO 7776].

TABLE 11

1)	support the functions required by [ISO 7776] for DTE/DCE operation.
2)	implement basic (Modulo 8) operation.
3)	conforms to the IPRL for the Data Link Layer in [ISO 10609-9]

Modulo 8 operation is the only one available in all the public data networks [ISO 7776]. In order to prevent interworking problems, modulo 8 operation was made mandatory, according to [ISO 10588] [ISO 10732].

4.6.2 Dynamic conformance requirements

Table 12 summarizes the proposed profiles dynamic conformance requirements, with respect to [ISO 7776].

TABLE 12

1)	carry out the supported [ISO 7776] functions in accordance with the procedures specified in [ISO 7776].
2)	use only the single link procedures.
3)	conform to the IPRL for the Data Link Layer in [ISO 10609-9].

[ISO 7776] mandates the support of the single link procedures. In the applicable scenarios of the proposed profiles there are no reasons for the support and use of multiple link procedures.

There are recommendations concerning [ISO 7776] parameters N1, k, T1, DCE T1, T3 and N2, according to [ISO 10613-7], [ISO 10614-4], [ISO 10588] and [ISO 10732]. The recommendations can be found in the proposed profiles [Rodrigues 1993].

4.7 Requirements for the PSDN Physical Layer

These requirements are the same as the those in [ISO 10613-7] and [ISO 10614-4]. Reference is made to the IPRL for the Physical Layer of [ISO 10609-9]. All those constraints are in accordance with [ISO 10588] for the RB51.1121 relay, and [ISO 10732] for the RB51.1111 relay.

5. Conclusion

This paper presented a proposal for connection-mode network service relay profiles RB51.1111 and RB51.1121, that is being input to the European Workshop for Open Systems for further development. RB profiles are key profiles of the OSI architecture, as they are indispensable when end-systems conforming to TB, TC, TD or TE profiles are attached to the interconnected subnetworks.

The work behind the presented proposal also permitted to identify some issues requiring strategic discussion, namely the possibility to support the connection-mode as well as the connectionless-mode network service in the same relay, the possibility to use X.25 over LLC type 1 procedures, the use of universally administered 48-bit MAC addresses (in order to eliminate the need for duplicate address check procedures), and the hidden inefficiency of RA profiles that use the connectionless-mode network protocol over X.25 and interconnect TA end-systems.

In addition to discussing these issues, future work will try to harmonize the proposed profile among the regional workshops and, eventually, to develop the specification of profiles RB53.11x1. Other possible work would be the inclusion of management capabilities, routeing and security, but this will largely depend on the general policy to be taken in relation to other lower layer profiles.

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