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Information technology — Local area networks —

Part 7:
Slotted ring access method and physical layer specification

Technologies de l'information — Réseaux locaux —
Partie 7: Spécifications pour la méthode d'accès et la couche physique relatives à l'anneau à découpage temporel

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Contents

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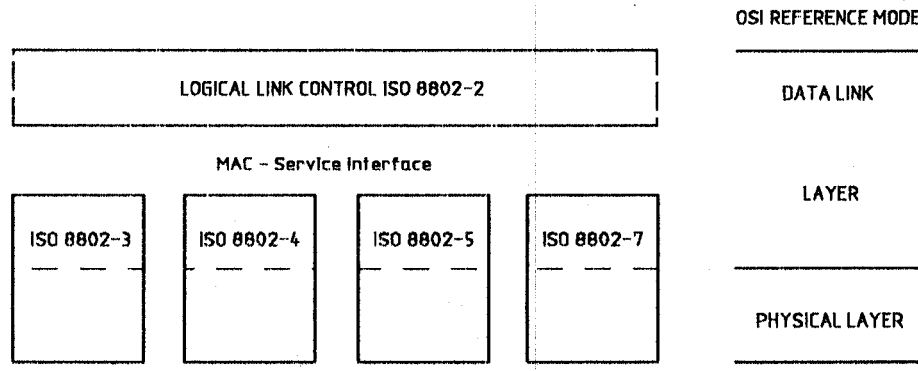
Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8802-7 was prepared by Technical Committee ISO/TC 97, *Information processing systems*.

This part of ISO 8802 is part of a series of documents that form a single standard for Local Area Networks. The standard embraces four alternative media access technologies and a common logical link control (LLC) protocol (ISO 8802-2).



The combination of the Logical Link Control (ISO 8802-2) and any one of the four media access documents form the Data-Link and Physical layers of the ISO 7498 (Open System Interconnection Basic Reference Model). The four media access technologies are

— ISO 8802-3, a bus utilizing CSMA/CD as the access method;

— ISO 8802-4, a bus utilizing token passing as the access method;

— ISO 8802-5, a ring utilizing token passing as the access method;

— ISO 8802-7, a ring utilizing slotted ring as the access method.

All four media access technologies provide the Media Access Control (MAC) Sublayer Interface Service, as specified in ISO 8802-2. It is through this service interface that the LLC sublayer and higher layer entities communicate across the physical media.

It should be noted that the exact relationship of layers described in this standard to the layers defined in the OSI Reference Model is for further study.

ISO 8802 consists of the following parts, under the general title *Information technology — Local area networks*:

— *Part 1: General introduction*

— *Part 2: Logical link control*

— *Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

— *Part 4: Token-passing bus access method and physical layer specifications*

— *Part 5: Token ring access method and physical layer specifications*

— *Part 7: Slotted ring access method and physical layer specification*

Annexes A, B and C form an integral part of this part of ISO 8802. Annexes D, E and F are for information only.

Introduction

0.1 A slotted ring local area network

This section gives a general description of the implementation of a slotted ring local area network.

0.2 Principles

At the lowest level the communication link comprises a closed ring of cable and active repeaters. The delay in signal propagation through the cable and repeaters means that the system may be considered as a continuously circulating shift register. Each 100 m of cable causes a delay of 450 ns and so may be thought of as storage of 4,5 bits for a 10 MHz signalling frequency.

The circulating storage contains a fixed number of bits for any particular configuration of the network; in order to provide communication a regular structure is imposed on these bits by a Monitor. This consists of a small number of concatenated slots, all the same length, with a single gap of a few bits to mark a complete cycle. The start of each slot is indicated by a leader bit which is always one. The gap contains only zero bits. Very simple algorithms may be used to synchronize with this structure.

The signalling frequency is nominally 10 MHz but may vary slightly to produce an integral number of bits in circulation. To allow for adjustment of the amount of circulating storage a variable size shift register is used to provide additional "padding". The variable padding is set to permit an integral number of slots and a small gap.

The repeaters regenerate the signals on to each section of the ring, allowing rings up to several kilometres to be constructed, and providing for different cable types to suit the environment of each part of the network. The repeaters are also the points of attachment to the network for communicating devices. They demodulate signals from the ring and present them to a station which may alter them before they are modulated on to the ring again.

An active system of this kind lends itself to the implementation of a number of low level error detection and correction techniques that can be used to quickly localize faulty devices.

Since the operation of the repeaters is essential to ring integrity they are powered along the ring cable and are thus independent of the station and attached device.

0.3 Access

Communication takes place between stations which synchronize to the slot structure. The unit of transmitted data between stations is known as a mini-packet and occupies exactly one slot. Each mini-packet is in-

dividually addressed, carrying eight bit destination and source addresses, 2, 4, 6, or 8 bytes of user data are carried, and in addition two "type" bits that provide for flexible user identification or framing of the data. The first bit following the slot leader bit is a full/empty marker, used to control access to the slots. Following the user data and type bits are two response bits.

A station wishing to transmit waits until an empty slot arrives; it then marks it as full, inserts the addresses and data, and initializes the response bits. The transmitter is only allowed one mini-packet in flight at the time and it counts passing slots to determine when the mini-packet it transmitted returns. The transmitter marks the returning slot empty and copies the response bits. By requiring that the returning slot be emptied, round-robin scheduling is introduced in which, however heavily loaded the ring, each slot passes around the stations giving them an opportunity to transmit within a determined time.

The response bits are used to carry back low level flow control information to the transmitter. The receiver may be physically or logically absent from the ring and in this case the transmitter will see that the mini-packet has been ignored. The receiver may also indicate that although he is present he is not listening; a "source selector" may be set to "anyone", "no-one" or "*n*". When it is set to no-one or a value of *n* different to that of the transmitter address, the response bits indicate "not selected" to the transmitter. Thus the receiver is able to listen to all transmitters (anyone) and multiplex the incoming mini-packet individually or may concentrate on one transmitter (*n* = transmitter address), allowing very simple implementation of block protocols. The receiver can also generate a "busy" response when unable to process the mini-packets as fast as the transmitter tries to send them. A transmitter seeing the busy response sends the data again in a new slot. A mini-packet that has been successfully received is marked as "accepted".

Some refinements to this basic mechanism enhance its performance and reliability.

Whenever a transmitter receives a response other than accepted it is not permitted to transmit immediately but must wait for the ring structure to cycle around. Subsequent unsuccessful transmission attempts cause the transmitter to be backed off by a number of slots. This prevents the ring being swamped with useless traffic. Further, the delay is made traffic dependent by requiring that only empty slots are counted for backoff purposes. The round-robin scheduling puts an upper limit on the delay while the variable backoff produces a system in which efficiency improves under load.

When a mini-packet returns, a transmitter is able to check for consistency with the mini-packet that was sent out. If a discrepancy is found, then the response seen by the attached DTE is "transmit error", overriding the response within the mini-packet.

A repeater and station together make up a Node that is common to all DTE's communicating on the network. Logic is required to interface the Node to any particular DTE and this logic is called an Interface Unit.

0.4 Maintenance

In addition to the error detection used by the transmitter, facilities are included to continually monitor the entire system.

Every slot includes a parity bit that is checked and maintained by all nodes. A node that detects a slot with faulty parity corrects it and also sends a fault message in the next empty slot to destination zero. The

fault message contains the address of the sending node and so indicates the section of the ring where the fault occurred.

The mini-packet structure includes a bit, the Monitor Pass bit that is set by a transmitter when it fills a slot. This bit is always cleared by the Monitor on passing slots. If the Monitor detects a slot that has this bit cleared but is still marked full then it marks the slot empty. It is, therefore, impossible for a fault to cause a slot to become permanently full.

The Monitor is able to detect errors that interfere with the permanent structure and rapidly reinstates the correct structure in a non-destructive way. A burst of errors, perhaps caused by a power dip, cause the Monitor to reinitialize the network, resetting its basic frequency.

A Monitor can also fill empty slots with random address and data as they pass and check them as they return if they are still marked empty. In this way the Monitor keeps the performance of the ring under continuous surveillance and can give warning of incipient faults.

0.5 Performance

The access control rules require that a transmitter has only one mini-packet in flight at a time, and also that a slot is emptied after it is used. This specification also requires that the slot after the one emptied be allowed to pass. Thus the maximum slot utilization that a transmitter can achieve is one in every $(n + 2)$ slots. Therefore, the maximum point to point data transmission rate is

$$B_{pp} = B_s/(n + 2)$$

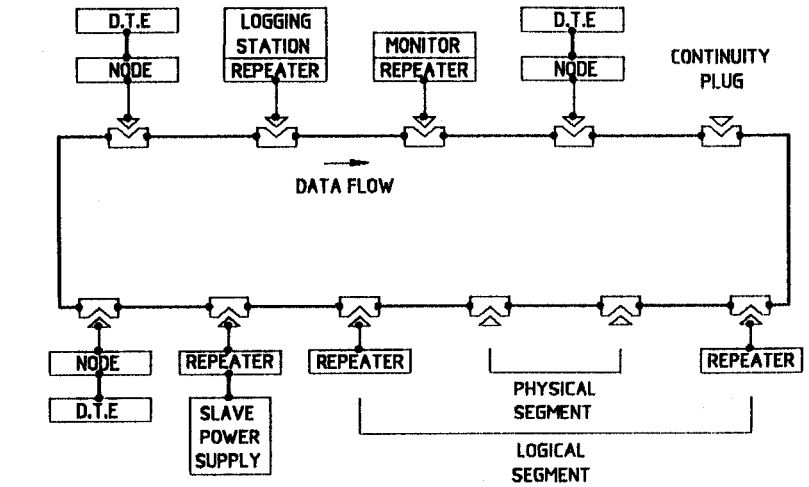
B_s is the total system data bandwidth, and is a function of the bit rate (clocking frequency) "f", the number of slots on the ring "n", the number of data bits in each slot "l" and the number of bit periods in the gap "g":

$$B_s = \frac{f \cdot l \cdot n}{n\,(1 + 24) + g}\ [\text{Mbps}]$$

If $m > 1$ nodes all wish to transmit simultaneously then each Node is still guaranteed access to one in every $(m + n)$ slots (provided of course it is not backed off by a slow receiver). The bandwidth is effectively shared out with each Node achieving at least $B_s/(m + n)$ unless limited by the maximum point to point bandwidth B_{pp}. If $m > n + 2$ then this maximum B_{pp} is reduced to B_t the traffic limited bandwidth.

$$B_t = \frac{B_s}{m\,(n + 2)}$$

Notice that $n + 2$ communicating pairs can achieve B_{pp} without traffic limiting of the bandwidth. Figure 0.1 shows a typical Slotted Ring network configuration, and the relationship between OSI Architecture, Functional blocks and the Implementation of the Slotted Ring LAN.



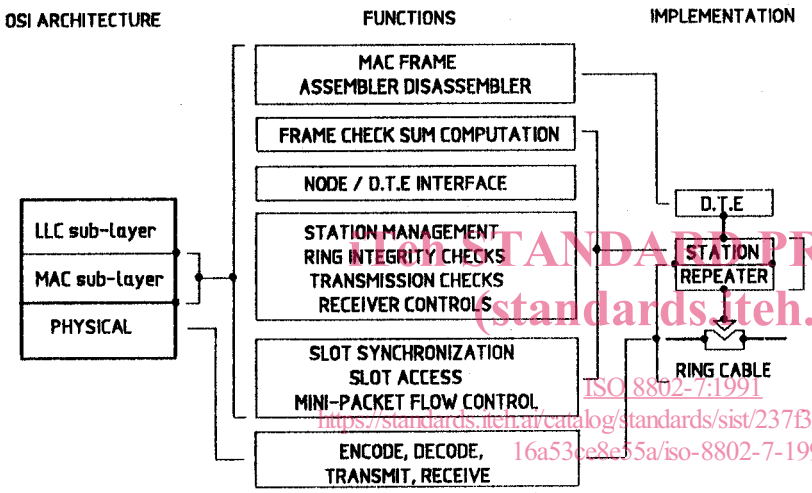


Figure 0.1 — Typical SR-LAN configuration and relationship between OSI architecture — Functions — Implementation

Information technology — Local area networks —

Part 7:
Slotted ring access method and physical layer specification

1 Scope

This part of ISO 8802 specifies the requirements for a local area network that utilizes the slotted ring access method, and that operates at 10 Mbits/second data rate.

Clause 3 defines the terms used in this part of ISO 8802.

Clause 4 specifies the coding of bits and structure of slots and mini-packets.

Clause 5 specifies, in general terms, the components of a configured slotted ring local area network (SR-LAN); in detail, the functional requirements for ring cable, ring connector sockets and ring continuity plugs; and the constraints on the size of, and the combination of components in, a configured SR-LAN.

Clauses 6, 7, 8, 9 and 10 specify in detail the functional requirements for the following components:

free standing repeaters;
nodes;
monitors;
logging stations;
slave power supplies.

Each component is specified in terms of its functionality and measurable characteristics at the ring connector plug; and in the case of nodes (clause 7) the functions at the node/DTE interface connector and the processing of mini-packets.

Clause 11 specifies the procedures to be used by the DTE at the time of communications:

a) when transmitting

1) in the construction of a frame in response to a request from the user of the media access control service;

2) in the transfer of the frame to the local area network node for transmission as a series of mini-packets;

3) in determining whether the mini-packets have been successfully transmitted to the destination node;

4) in notifying the user of the media access control service whether the frame has been successfully transmitted.

NOTE 1 This event does not necessarily imply receipt by the remote media access control service user.

b) when receiving

1) in collecting from the node the contents of received mini-packets;

2) in assembling the contents into frames;

3) in transferring the contents of the frames to the user of the media access control service.

This clause specifies requirements to be met in each instance of the communication of a frame to and from a single media access control service access point (MAC-SAP), with conditions applying when multiplexing frames to and from one or more MAC-SAPs.

This clause also specifies a range of additional functions from communication with the local node that are not required for the communication of frames, but which may be used for management purposes and to improve efficiency and error detection.

Clause 12 specifies the implementation requirement for the media access procedures specified in clause 11.

The functionality is described in terms of two classes: Basic class being the minimum requirement, and Enhanced Class being a defined extension to the basic functionality. Certain optional features are also specified.

Each clause includes the specification of the information that must be provided by the supplier.

Excluded from this part of ISO 8802 is

a) internal design information used to meet these requirements;

b) requirements relating to safety, for which the regulations and standards relevant to the environment in which the equipment is installed apply.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8802. At the time of publication, the editions indicated were valid, All standards are subject to revision, and parties to agreements based on this part of ISO 8802 are encouraged to investigate the possibility of applying the most recend editions of the standards indicated below. Members of IEC and ISO maintian registers of currently valid International Standards.

ISO 4903:1989, *Information technology — Data communication — 15-pole DTE/DCE interface connector and contact number assignments.*

NOTE 2 This standard uses the mechanical specification if ISO 4903, not its pin assignment specification. Further it is used not for the DTE/DCE interface but for the DCE/MEDIA.

ISO 8802-2:1989, *Information processing systems — Local area networks — Part 2: Logical link control.*

IEC 807-2:1985, *Rectangular connectors for frequencies below 3 MHz.*

3 Definitions

For the purposes of this part of ISO 8802, the following definitions apply.

3.1 slotted ring local area network (SR-LAN): A network for data communication within an area where maximum distances are in the order of 10 km; the network is in the form of a ring connecting all attached data terminal equipment, around which slots for data circulate continuously.

3.2 ring: The physical communication medium comprising ring cable, ring connector sockets and continuity plugs.

3.3 ring cable: Any cable used in the ring, comprising two twisted pairs conveying data, plus one or more conductors used for control voltage return (V_{sig}) and screening.

NOTE 3 This may be either a dedicated cable or a set of conductors from any suitable multi-conductor cable which may carry other traffic.

3.4 Pair A: The twisted pair in a ring cable, carrying the positive d.c. supply and one of the two data signalling channels.

3.5 Pair B: The twisted pair in a ring cable carrying the negative d.c. supply and the other data signalling channel.

3.6 ring connector socket: A socket at which the monitor, repeater, node, logging station or continuity plug is connected to the ring.

3.7 ring connector plug: A plug to mate with the ring connector socket, attached to a monitor, repeater, node or logging station.

3.8 continuity plug: A plug to mate with the ring connector socket, to provide ring continuity when no device is plugged in to the ring connector socket.

3.9 physical ring segment: The portion of the ring between two ring connector sockets.

3.10 logical ring segment: The portion of the ring, comprising one or more physical ring segments linked by continuity plugs, that lies between two ring connector sockets at which repeaters are attached.

3.11 repeater: A device, powered from the ring, that receives a modulated signal from one ring segment, and either regenerates it and outputs it to the next ring segment, or passes it to the attached station and output data from the attached station to the next ring segment.

NOTE 4 A repeater may be either a free standing repeater or part of a node, monitor or logging station.

3.12 free-standing repeater: A repeater that does not form part of a node, monitor or logging station, and whose function is limited to regeneration of the signal.

3.13 node: Equipment combining the functions of a repeater and a station.

NOTE 5 A node is the equipment specific to the SR-LAN of the general class of data circuit-terminating equipment (DCE).

3.14 station: The part of a node that interfaces to both the repeater section of the node and to the data terminal equipment; it performs serial to parallel and parallel to serial conversion, controls communication over the ring, and detects and reports errors.

3.15 data terminal equipment (DTE): The equipment, attached to a network, that is the source and sink of data communicated over the network; except where otherwise specified, the DTE is always the local DTE.

3.16 node/DTE interface: The interface between the node and the DTE.

3.17 node/DTE interface connector plug: The plug attached to the node for the purposes of the node interface.

3.18 node/DTE interface connector socket: The socket, attached to the DTE for the purposes of the node interface.

3.19 monitor: A device, attached to a ring connector socket, that initializes and supervises ring operation.

3.20 logging station: A device, attached to a ring connector socket, that records ring errors.

3.21 Basic Class

3.21.1 of nodes: The class of nodes supporting only 40-bit slots and having the minimum permitted functionality of the node/DTE interface.

3.21.2 of monitor and logging stations: The class designed primarily for interworking with Basic Class nodes.

3.22 Enhanced Class

3.22.1 of nodes: The class of nodes supporting alternative length slots, and having enhanced functionality at the node/DTE interface.

3.22.2 of monitors and logging stations: The class designed primarily for interworking with Enhanced Class nodes.

NOTE 6 As applied to monitors and logging stations, the terms Basic and Enhanced Class refer only to compatibility at ring level with the equivalent class of nodes; there is no necessary association between the classes and the degree of sophistication of other monitor and logging station functionality.

3.23 slave power supply: A unit supplying power at 28 V d.c. to the ring for powering repeaters.

3.24 slot: A group of 40, 56, 72 or 88 consecutive bit-positions in the bit stream circulating round the ring; each slot contains one mini-packet.

3.25 slot structure: A series of one or more consecutive adjacent slots, each of the same length, circulating round the ring, with a single gap between the end of the last slot and the beginning of the first slot when the ring is closed.

3.26 gap: A series of bits, all set to ZERO, used to close the beginning and end of the series of slots into a cycle of circulating bits, and which acts as a reference point for the identification of slots.

3.27 mini-packet: the information contained in a slot, being the data unit used to convey fragments of frames between nodes, under the control of the DTE.

3.28 leader bit: The first bit in a mini-packet, whose value is always ONE, and which thus distinguishes a slot and the mini-packet that it contains from the gap, which is composed of ZEROs.

3.29 full/empty bit: A bit in a mini-packet that distinguishes between a mini-packet that is conveying data from source to destination and back to source (FULL) and a mini-packet that is not conveying data (EMPTY).

3.30 monitor pass bit: A bit in a mini-packet that is used in conjunction with the full/empty bit by the monitor to ensure that error conditions do not allow a mini-packet to remain permanently full.

3.31 node address: An eight-bit integer used to provide unique logical identification of nodes attached to a ring.

NOTE 7 Ensuring that no duplication of node addresses occurs is the responsibility of the SR-LAN administration.

3.32 destination node address: The node address in a mini-packet that identifies the node to which a full mini-packet has been sent.