SLOVENSKI STANDARD
SIST ES 201 803-7 V1.1.1:2005

01-januar-2005

Dinamiļ ni sinhroni prenosni naļ in (DTM) ï 7. del: Preslikava Etherneta preko preslikave naļ ina DTM

Dynamic synchronous Transfer Mode (DTM); Part 7: Ethernet over DTM Mapping

Ta slovenski standard je istoveten z: **ES 201 803-7 Version 1.1.1**

ICS:

33.040.40	Podatkovna komunikacijska omrežja	Data communication networks

SIST ES 201 803-7 V1.1.1:2005 **en**

ETSI ES 201 803-7 V1.1.1 (2002-05)

ETSI Standard

Dynamic synchronous Transfer Mode (DTM); Part 7: Ethernet over DTM Mapping

Reference
DES/SPAN-130007

Keywords
DTM, Ethernet, LAN, transmission

ETSI

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Services and Protocols for Advanced Networks (SPAN).

The present document is part 7 of a multi-part deliverable covering the Dynamic synchronous Transfer Mode (DTM), as identified below:

Part 1: "System description";

Part 2: "System characteristics";

Part 3: "Physical Protocol";

Part 4: "Mapping of DTM frames into SDH containers";

Part 5: "Mapping of PDH over DTM";

Part 6: "Mapping of SDH over DTM";

Part 7: "Ethernet over DTM Mapping";

Part 8: "Mapping of Frame relay over DTM";

Part 9: "Mapping of ATM over DTM";

Part 10: "Routeing and switching of IP flows over DTM";

Part 11: "Mapping of video streams over DTM";

Part 12: "Mapping of MPLS over DTM";

Part 13: "System description of sub-rate DTM".

Introduction

Dynamic synchronous Transfer Mode (DTM) is a time division multiplex and a circuit-switched network technique that combines switching and transport. The present document specifying the DTM system and protocols is divided into 13 parts.

The present document (part 7) describes the method by which Ethernet [1] packets are carried over DTM.

The topics of the other parts are as follows:

- Part 1 introduces DTM and describes the service over a unidirectional data channel;
- Part 2 includes system aspects that are mandatory or optional for nodes from different vendors to interoperate. These system aspects are addressing, routing, synchronization and channel management. The interworking granularity should be at node level, such that nodes from different vendors can interoperate with regard to well-defined functions;
- Part 3 specifies the physical layer protocol for 8b/10b encoding based physical links;
- Part 4 specifies the physical layer protocol for SDH/SONET VC4 container based physical links;
- The transport of various tributary signals is specified for PDH (part 5), SDH (part 6), Ethernet (part 7), Frame Relay (part 8), ATM (part 9), IP (part 10), Mapping of MPLS over DTM (part 11), and video streaming (part 12). Note that DTM can either run over SDH or carry it as a tributary.
- Finally, management aspects are standardized in part 13.

1 Scope

The present document specifies how Ethernet protocol is transported over DTM. The specification encapsulation of PDUs includes address resolution (mapping the Ethernet source and destination address to the correct DTM destination), DTM channel set-up, channel capacity modification, and Ethernet VLAN handling.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] IEEE 802.3 (1996): "IEEE Standard for Information technology; Telecommunications and information exchange between systems; Local and metropolitan area networks; Specific requirement; Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications".

[2] IEEE 802 (1990): "IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture".

[3] IEEE 802.1D (1998): "IEEE Standard for information technology; Telecommunications and information exchange between systems; IEEE standard for local and metropolitan area networks; Common specifications; Media access control (MAC) Bridges".

[4] IEEE 802.1Q (1998): "IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

access node: node that supports an external network interface, contains an interworking function for an external network and uses the DTM service

channel: set of slots allocated from one source access node to one or more destination access nodes in a network

NOTE: The source and destination nodes can be the same, where the channel is internal to the node.

control channel: channel used for channel signalling and management

data channel: channel used for transport of user data

domain: DTM network or part of a network that is managed by a particular commercial or administrative entity (carrier/operator)

DTM network: set of connected DTM nodes

NOTE: A DTM network may be single-domain, or multi-domain.

frame: set of slots forming an entity that is transmitted on a physical medium repeatedly every 125 µs (nominally), i.e. 8 000 frames/second

node: network element that contains DTM functions

node address: DTM network layer address of a node

slot: time slot within the frame being able to transport 64 bit of data or a number of special codes

switching: process of moving the data of a slot in both time and space, i.e. switching between different ports and changing slot numbers while maintaining the bandwidth and avoiding slot reordering within each channel

switch node: node that contains a switching function

3.2 Abbreviations

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

ATM	Asynchronous Transfer Mode
ARR	Address Resolution Request
CCC	Client-to-Client Channel
CMI	Channel Multiplexing Identifier
CSC	Client-to-Server Channel
DCAI	DTM Channel Adaptation Interface
DCCI	DTM Channel Control Interface
DCAP-1	DTM Channel Adaptation Protocol 1
DCMI	DTM Channel Management Interface
DCP	DTM Channel Protocol
DLE	DTM LAN Emulation
DLEC	DLE Client
DLES	DLE Server
DLT	DTM Ethernet LAN Transport
DST	DTM Service Type
DSTI	DTM Service Type Instance
DTM	Dynamic synchronous Transfer Mode
IP	Internet Protocol
MAC	Medium Access Control
MIB	Management Information Base
PDU	Protocol Data Unit
RFC	Request For Comment (IETF document)
SCC	Server-to-Client Channel
SDH	Synchronous Digital Hierarchy
SSC	Server-to-Server Channel
TDM	Time Division Multiplexing
VLAN	Virtual Local Area Network

4 Service overview

There are two different ways of transporting Ethernet traffic across a DTM network specified in the present document:

- DTM LAN Transport (DLT) is a very simple service where the DTM network is used to set up a tunnel between two DLT clients. Each DLT client is in its turn connected to a logical Ethernet switch. The logical Ethernet switch forwards packets between the DLT client and one or several Ethernet ports and/or other DLT clients.

- DTM LAN Emulation (DLE) provides the additional service of a distributed Ethernet switch function, allowing VLAN switching where two or more DLE Clients can be interconnected via the DTM network.

The characteristics of the Ethernet transport utilize the characteristics of the DTM transport service providing traffic isolation and very low delay variation. The DTM network allows the distance limitation of connected Ethernets to be removed.

Ethernet is a connectionless technology, meaning that data is transported in packets that are handled independently of each other. The packets carry sufficient information to identify the Ethernet destination of the packet. DTM, on the other hand, is connection-oriented; meaning that data is transported using an established connection. During the establishment of the connection sufficient state information is stored in the switches along the path from source to destination. In order to forward the data, each data item does not need to carry information specifying the destination.

4.1 DLT service overview

This clause specifies how point-to-point Ethernet transport through a DTM network is done. The system consists of two DLT clients that are connected via a DTM network. This forms a point-to-point Ethernet link between two logical Ethernet nodes or switches. Each logical Ethernet switch connects several logical Ethernet interfaces to each other. A logical Ethernet interface can be either a physical Ethernet interface or a DLT client.

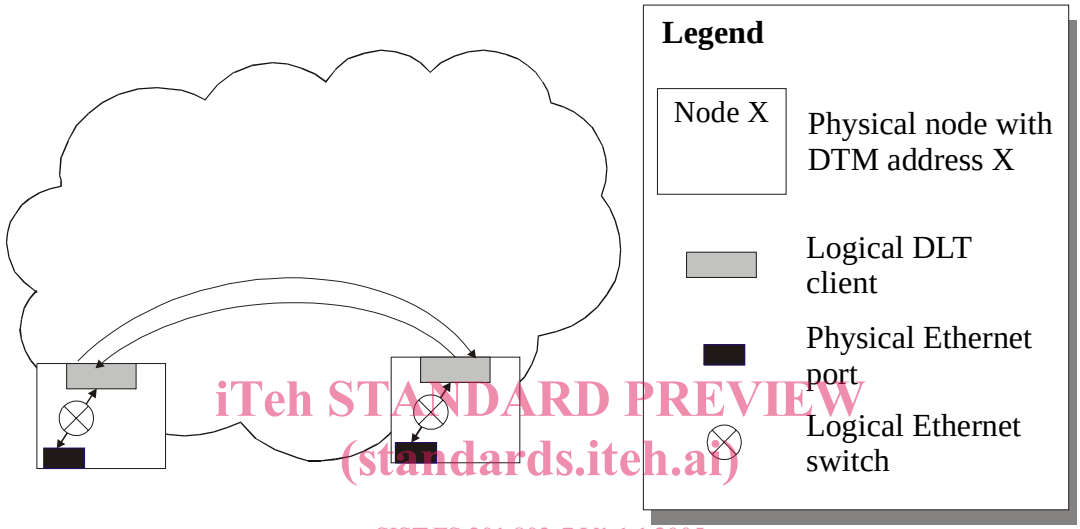

Figure 1: A DLT tunnel between two DLT clients. Each DLT client is connected to one logical Ethernet switch

During normal operation, the logical Ethernet switches forward packets between their Ethernet ports and DLT clients. The logical Ethernet switch can either operate as a bridge or as a learning bridge, in which case it can only interconnect two logical Ethernet interfaces, or as a hub or an Ethernet switch in which case it can interconnect two or more logical Ethernet interfaces to each other.

A DLT client can belong to one or several VLANs. The DLT client should perform ingress filtering and discard all packets with a VLAN tag outside of the set of VLANs that the client belongs to. The DLT client should also be associated with a default VLAN. All packets that arrive to the DLT client on its incoming channel without VLAN information (i.e. VLAN = 0) should be classified as belonging to the default VLAN. This is consistent with the way ingress filtering works in the 802.1Q Ethernet standard [4].

The operation of the logical Ethernet switch is beyond the scope of the present document.

A DLT client can also be connected as an interface to a regular protocol stack, e.g. an IP routing process. The DLT client should then behave as a normal Ethernet interface.

4.2 DLE service overview

DTM LAN Emulation allows DTM to be used as a bridge between different segments of an Ethernet network. PDUs are forwarded through the DTM network based on the destination address of the Ethernet frame. This allows forming emulated LANs where a number of nodes can behave as if they were connected to the same Ethernet LAN. The emulated LANs are independent of the DTM topology and are separated from each other by the DTM channelization. DLE is completely transparent to all connected nodes and the nodes will not know if the node they are sending to or receiving from is connected to the same Ethernet segment or if the Ethernet frames are sent via DTM. This makes it possible to connect standard Ethernet equipment to the Ethernet segments.

Each DLE segment consists of one (or more, when using redundant DLE Servers) DLE Server (DLES) and several DLE Clients (DLECs).

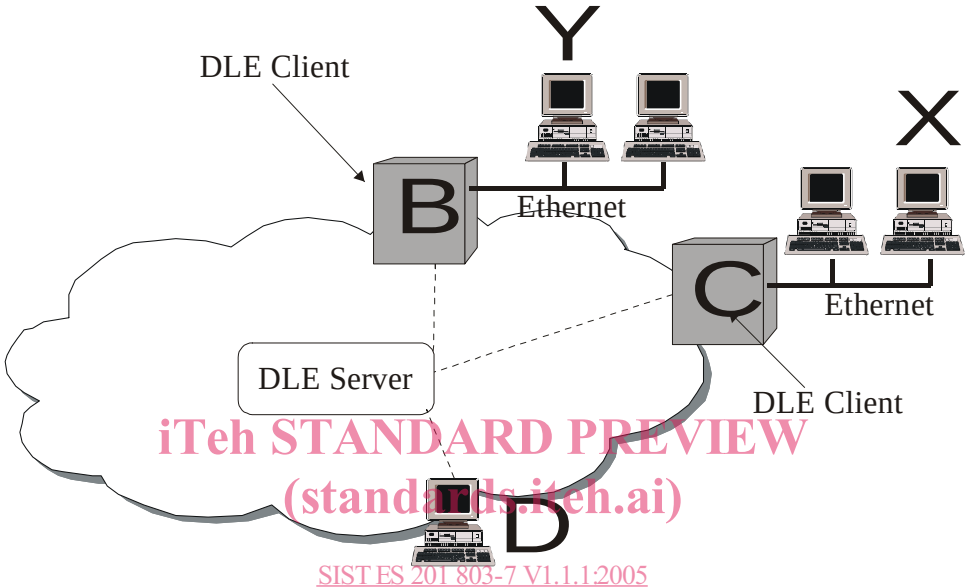

Figure 2: Example of a DLE network

In figure 2, B and C are DLE Clients in DTM to Ethernet Gateways. D is a DLE Client in a node with direct DTM connectivity. X and Y are two Ethernet attached nodes. All the Ethernet nodes in the picture have connectivity on the Ethernet level without passing through any router.

5 System overview

5.1 DLT system overview

The DTM LAN Transport (DLT) is a very simple protocol using a single protocol message (DLT_REGISTER) that the clients use to register with each other and perform an optional authentication. When the clients have registered, they can send Ethernet PDUs encapsulated in DCAP-1 between them.

5.1.1 Channels in DLT

To connect two DLT clients to each other, one (or several) DTM channels are established in each direction. Each channel should be established by the sender for that channel. The bit rate of the channel is configured at the source.

The Channel Multiplexing Identifier (CMI) in the DCAP-1 header is used to multiplex traffic on the channels. There are three different values defined for DLT. One is used for DLT control messages, one for Ethernet packets without a VLAN tag and one for Ethernet packets with a VLAN tag. The reason for having two different CMI values for Ethernet packets is that the packet format can then be optimized to make sure that the Ethernet data in the packet is always 64-bit aligned. The use of untagged transport format is limited to point-to-point Ethernet transport where the external interface does not use VLAN tagged format.

The Ethernet broadcast and multicast traffic is bound to a DTM channel (unicast or multicast). This implies that the broadcast or multicast traffic only reach the connected clients.

5.1.2 DLT client traffic forwarding

The DLT client should forward all PDUs (unicast, multicast and broadcast) that it receives from the logical Ethernet switch on its outgoing channel. All PDUs that it receives on the incoming DTM channel should be forwarded to the logical Ethernet switch.

All Ethernet PDUs forwarded between the DLT client and the logical Ethernet switch should have a VLAN associated with it. If no VLAN tag is present on the incoming Ethernet frame a default VLAN is attached to the frame.

5.2 DLE system overview

A DLE segment connects a number of DLE Clients on Ethernet MAC layer, i.e. to the participating nodes it looks as if they are all connected to the same Ethernet LAN. In each DLE segment, there are one or several DLE Servers and one or several DLE Clients.

The DLE Server provides the following functions:

1) Address resolution between Ethernet and DTM egresses;

2) Forwards multicast and broadcast traffic to all DLE Clients;

3) Forwards unicast traffic from a DLEC when a direct channel to the destination DLEC has not been established. It also forwards packets for which an addresses resolution in the ingress DLEC has not been performed.

If more than one DLE Server is used in a DLE segment, they act as backups for each other. The DLE Server can be located anywhere in the DTM network as long as the node where the DLES is running has DTM connectivity to each of the other nodes.

The DLE Client forwards Ethernet frames to other DLE Clients in the DLE segment based on address information distributed from the DLE Server. The information is retrieved from the DLE Server by an address resolution process. If no relevant address resolution is present in the DLE Client or if there is not a direct channel established to the destination DLE Client, the Ethernet frames are forwarded to the DLE Server. As soon as the address is resolved and/or the channel is established, the Ethernet frames should be directly sent to the destination DLE Client.

The DLE Client can be an interface towards higher layer protocols, such as IP, or in an interworking function (bridging) between DTM and Ethernet.

A DLEC operates on the Ethernet MAC layer and forwards Ethernet frames between one or several Ethernet interfaces and other DLECs. Such DLEC can serve several Ethernet attached nodes simultaneously.