

# Dynamic Synchronous Transfer Mode (DTM) Fundamentals and Network Solutions

## Definition

Dynamic synchronous transfer mode (DTM) is an exciting networking technology. The idea behind it is to provide high-speed networking with top-quality transmissions and the ability to adapt the bandwidth to traffic variations quickly. DTM is designed to be used in integrated service networks for both distribution and one-to-one communication. It can be used directly for application-to-application communication or as a carrier for higher-layer protocols such as Internet protocol (IP).

## Overview

This tutorial explores the development of DTM in light of the demand for network-transfer capacity. DTM combines the two basic technologies used to build high-capacity networks—circuit and packet switching—and therefore offers many advantages. It also provides several service-access solutions to city networks, enterprises, residential and small offices, content providers, video production networks, and mobile network operators.

## Topics

1. Why DTM?
2. DTM Basics: Circuit Switching vs. Packet Switching
3. DTM Benefits: Combining Synchronous and Asynchronous Media-Access Schemes
4. Principles of DTM: Frames and Slots
5. DTM Services
6. The DTM Solution for Enterprise Access
7. The DTM Solution for Residential and Small-Office Access
8. The DTM Solution for Content Providers
9. The DTM Solution for Video-Production Networks

10. The DTM Solution for Mobile Network Operators

11. The Future of DTM

Self-Test

Correct Answers

Glossary

## 1. Why DTM?

Over the last few years, the demand for network-transfer capacity has increased at an exponential rate. The impact of the Internet; the introduction of network services such as video and multimedia that require real-time support and multicast; and the globalization of network traffic enhance the need for cost-efficient networking solutions with support for real-time traffic and for the transmission of integrated data, both audio and video. At the same time, the transmission capacity of optical fibers is today growing significantly faster than the processing capacity of computers. Traditionally, the transmission capacity of the network links has been the main bottleneck in communication systems. Most existing network techniques are therefore designed to use available link capacity as efficiently as possible with the support of large network buffers and elaborate data processing at switch points and interfaces. However, with the large amount of data-transfer capacity offered today by fiber networks, a new bottleneck problem is caused by processing and buffering at switch and access points on the network. This problem has created a need for networking protocols that are not based on computer and storage capacity at the nodes but that instead limit complex operations to minimize processing on the nodes and maximize transmission capacity.

Against this background, the DTM protocol was developed. DTM is designed to increase the use of fiber's transmission capacity and to provide support for real-time broadband traffic and multicasting. It is also designed to change the distribution of resources to the network nodes dynamically, based on changes in transfer-capacity demand.

## 2. DTM Basics: Circuit Switching vs. Packet Switching

In principle, two basic technologies are used for building high-capacity networks: circuit switching and packet switching. In circuit-switched networks, network resources are reserved all the way from sender to receiver before the start of the transfer, thereby creating a circuit. The resources are dedicated to the circuit during the whole transfer. Control signaling and payload data transfers are separated in circuit-switched networks. Processing of control information and

control signaling such as routing is performed mainly at circuit setup and termination. Consequently, the transfer of payload data within the circuit does not contain any overhead in the form of headers or the like. Traditional voice telephone service is an example of circuit switching.

## Circuit-Switched Networks

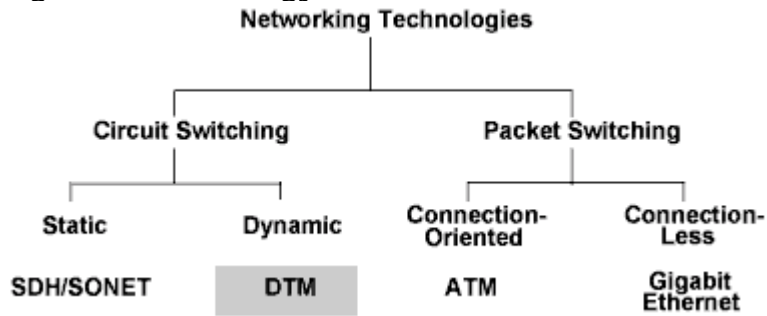
An advantage of circuit-switched networks is that they allow for large amounts of data to be transferred with guaranteed transmission capacity, thus providing support for real-time traffic. A disadvantage of circuit switching, however, is that if connections are short-lived—when transferring short messages, for example—the setup delay may represent a large part of the total connection time, thus reducing the network's capacity. Moreover, reserved resources cannot be used by any other users even if the circuit is inactive, which may further reduce link utilization.

## Packet-Switched Networks

Packet switching was developed to cope more effectively with the data-transmission limitations of the circuit-switched networks during bursts of random traffic. In packet switching, a data stream is divided into standardized packets. Each contains address, size, sequence, and error-checking information, in addition to the payload data. The packets are then sent through the network, where specific packet switches or routers sort and direct each single packet.

Packet-switched networks are based either on connectionless or connection-oriented technology. In connectionless technology, such as IP, packets are treated independently of each other inside the network, because complete information concerning the packet destination is contained in each packet. This means that packet order is not always preserved, because packets destined for the same receiver may take different paths through the network. In connection-oriented technology such as asynchronous transfer mode (ATM), a path through the network—often referred to as a logical channel or virtual circuit—is established when data transfer begins. Each packet header then contains a channel identifier that is used at the nodes to guide each packet to the correct destination.

Figure 1. Technology Overview



In many aspects, a packet-switched network is a network of queues. Each network node contains queues where incoming packets are queued before they are sent out on an outgoing link. If the rate at which packets arrive at a switch point exceeds the rate at which packets can be transmitted, the queues grow. This happens, for example, if packets from several incoming links have the same destination link. The queuing causes delay, and if the queues overflow, packets are lost, which is called congestion. Loss of data generally causes retransmissions that may either add to the congestion or result in less-effective utilization of the network. The ability to support real-time traffic in packet-switched networks thus calls for advanced control mechanisms for buffer handling and direction. As a result, the complexity and necessary ability to process information, and therefore the need for computer power, increases sharply when striving for high transmission capacity.

### 3. The DTM Advantage: Combining Synchronous and Asynchronous Media-Access Schemes

In view of the above, DTM was developed in an effort to combine the simple, nonblocking, real-time traffic-supporting properties of circuit-switching technology with the dynamic resource-handling properties of packet-switching technology. Combining the advantages of synchronous and asynchronous media-access schemes, DTM forms a transport-network architecture that enables high transfer capacity with dynamic allocation of resources.

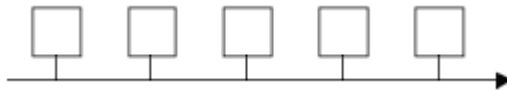
As will be shown in the following sections, DTM is fundamentally a circuit-switched, time division multiplexing (TDM) scheme, and, like other such schemes, it guarantees each host a certain bandwidth and uses a large fraction of available bandwidth for effective payload data transfer. In common with asynchronous schemes such as ATM, DTM supports dynamic reallocation of bandwidth between hosts. This means that the network can adapt to variations in the traffic and divide its bandwidth between nodes according to demand.

DTM, like existing transport networks, uses a similar kind of framing structure—synchronous digital hierarchy (SDH)/synchronous optical network (SONET) (i.e., 8-kHz frame repetition frequency)—and is extended with dynamic reallocation of resources. DTM operates at layers one to three in the open systems interconnection (OSI) model and includes switching, control signal for setup, routing, and support functions for easy management. In contrast to SDH/SONET, multirate channels or circuits can be established on demand in DTM, and the capacity of a channel can be changed according to traffic characteristics during operation. Because the distribution of resources among nodes on a ring or bus can be changed, free resources are allocated to nodes with the highest demands, providing an autonomous and efficient dynamic infrastructure. Also, an important aspect of DTM is that it provides a multichannel interface similar to the one provided by ATM.

## 4. Principles of DTM: Frames and Slots

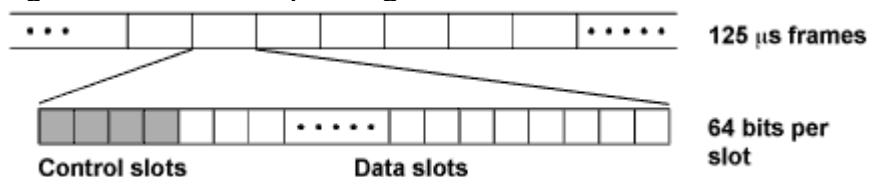
DTM is designed for a unidirectional medium with multiple access—for example, a medium with capacity shared by all connected nodes. It can be built on several different local topologies such as ring, double ring, point to point, or dual bus.

Figure 2. DTM Multiplexing Medium with Multiple Access



DTM is based on TDM, whereby the transmission capacity of a fiber link is divided into small time units. The total link capacity is divided into fixed-size frames of 125 microseconds. The frames are further divided into a number of 64-bit time slots. The number of time slots per frame is dependent on the bit rate. Using a bit rate of 2 Gbps, the number of time slots within each frame totals approximately 3900. The selected use of a frame length of 125 microseconds and 64 bits per time slot enables simple adaptation to digital voice and plesiochronous digital hierarchy (PDH) transport.

Figure 3. DTM Multiplexing Format



The time slots within each frame are separated into data slots and control slots. At any point in time, a slot is either a data slot or a control slot. However, if needed, data slots may be converted into control slots and vice versa.

The right to write data slots and control slots is distributed among the nodes attached to the link. Consequently, each node attached to the link will typically have write-access to a set of data and control slots, and these time slots will occupy the same time-slot position within each frame of the link. Each node has write-access to at least one control slot that the node uses for sending control messages to the other nodes. Control messages can be sent upon request from a user served by the node, in response to control messages from other nodes, or spontaneously for network-management purposes. The control slots constitute only a small fraction of the total capacity, while the majority of the time slots are data slots carrying payload. The signaling overhead in DTM varies with the number of control slots but is typically low. For a ring with 20 attached nodes and a bit rate of 2 Gbps, the signaling overhead is typically less than one percent.

As stated, data slots are used for carrying payload data. Each node typically has write-access to a pool of free data slots, which will occupy the same time-slot positions within each frame of the link. When establishing communication channels, a node will allocate a portion of the data slots available in the node's pool of free data slots to the channel, as will be discussed further in the next section.

A summary of DTM fundamentals includes the following:

- The globalization of network traffic and the transmission of integrated data, audio, and video are increasing the demand for network transfer capacity.
- The transmission capacity of optical fibers is today growing significantly faster than processing power, which moves the traffic bottleneck towards processing and buffering in switches and access nodes in the network.
- DTM is a technique designed for full control of network resources. It is built to increase the utilization of optical fibers and minimize the load of the nodes. DTM is also designed to support real-time broadband traffic, multicasting, and the ability to adopt to traffic variations in the network dynamically.
- DTM combines the simple, nonblocking, real-time traffic capabilities of circuit switching with the dynamic resource-handling of packet-switching technology. This covers a gap in available techniques on the market and meets the demands of strict quality of service (QoS) requirements for high-bandwidth communications.
- DTM offers at least three types of reservation schemes: guaranteed bandwidth, on-demand bandwidth, and on-demand bandwidth with best effort.

- The DTM link capacity is divided into frames of 125 microseconds. Each frame is then divided into 64-bit slots. Using a bit rate of 2 Gbps, the number of slots is around 3,900.
- In DTM, data is transported in channels. A channel consists of a number of 64-bit slots.

## 5. DTM Services

The DTM solution is designed to transport common communication protocols over optical fibers. DTM provides several simple and commonly used services in one integrated network. It results in better utilization of the fiber and of the node equipment and simple management and operation of the network.

Data communications—particularly IP traffic—are becoming the main traffic source in the networks. DTM has been specifically developed for efficient transport of this type of traffic. However, a large part of the network traffic is still PDH-based, and, therefore, DTM products also transport PDH traffic.

There are a number of traffic types that can be integrated advantageously in a DTM network. Among such alternatives, the following traffic types will be implemented in the first stage:

- IP over DTM
- DTM local area network (LAN) emulation (DLE)
- PDH transport
- SDH/SONET tunneling
- Transport of 270-Mbps studio video

DTM today offers two different techniques for transmitting IP traffic: IP over DTM and DLE. IP over DTM is a technique that fully utilizes the DTM networks in transmitting IP traffic on a hop-by-hop basis via shortcuts. DLE is used to establish virtual LANs across the DTM network and makes it possible to attach IP nodes to the DTM network efficiently, for example.

DLE makes the attached nodes believe they are part of a widespread LAN (802.3 Ethernet). DLE is used to connect geographically distributed LANs by transferring Ethernet packets over DTM channels. Virtual private networks (VPNs) are effectively supported using DLE.

More than 90 percent of today's LANs are Ethernet-based, and the market-share is increasing. Because applications believe they are sending data onto an Ethernet

LAN, no change to applications is necessary for using DLE. In addition, DLE is Layer-3 independent and therefore enables different Layer-3 protocols such as IP, NetBIOS, and IPX to be used.

E1/T1 is supported and the E3/T3 interface will be supported in the future. The E1/T1 transport can be used for interconnecting telephone switches such as AXEs or for leased-line services. DTM networks also support transparent PDH transport equivalent with PDH support in SDH/SONET networks. A DTM network differs from SDH/SONET in that the former has a distributed approach to the add-drop multiplexer functions. This feature provides flexible utilization of the fiber resources and a dynamic approach to protection switching.

## **6. The DTM Solution for Enterprise Access**

### **How Is an Enterprise Connected?**

With DTM, service providers are able to provide large enterprises with all their communication needs via one network-access point. DTM allows services to be integrated on a transport level and thus optimizes the utilization of network access. The solution for the large enterprise is a DTM access device that provides service access via several Ethernet ports and some E1/T1 ports on the same device. The upper link runs DTM directly on fiber from the access device toward the network. That gives the network provider a simple network structure with DTM as the only protocol needed in the aggregation loops for all services offered.

### **Bandwidth between 512 Kbps and Full Link Bandwidth**

With the integration of services on the transport level, QoS is kept clean and simple without the use of any complex priority schemes. The high granularity (steps of 512 kbps) and bandwidth scalability (from 512 kbps to 850 Mbps) of DTM channels also allows for flexible price differentiation. When using the DTM access device, it is even possible to provide company control of its bandwidth resources and then bill upon resource (bandwidth) utilization. Typical services for enterprises that can be offered through the access device are voice VPN via private branch exchange (PBX) interconnection, corporate data network solutions, Internet access, and firewall solutions.

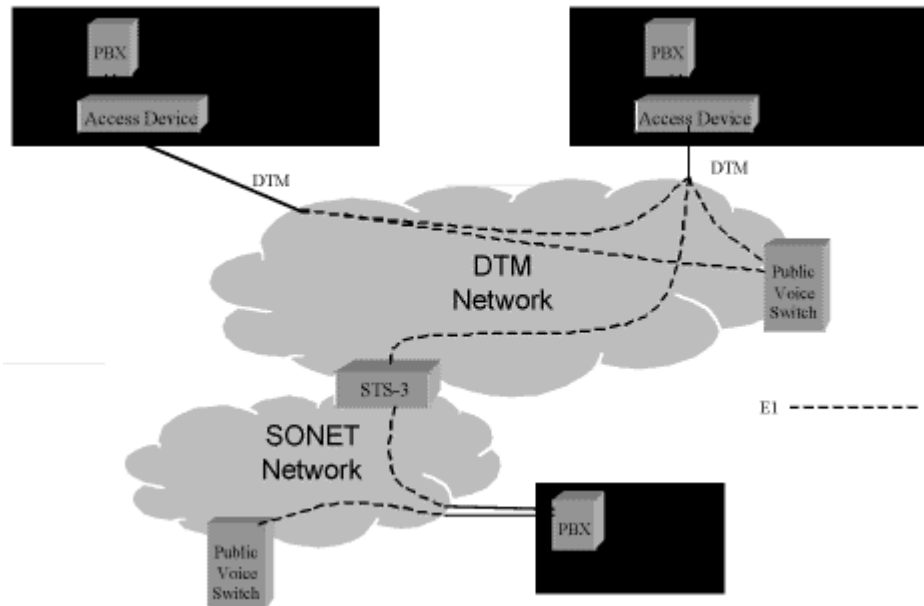
### **Voice Interconnect**

The voice VPN is simply built by interconnecting PBXs via the PDH transport service. By interconnecting PBXs via a transparent PDH architecture on an E1/T1



basis, voice quality is preserved and all types of signaling protocols used for different voice solutions are supported transparently.

Figure 4. Interconnection of PBXs



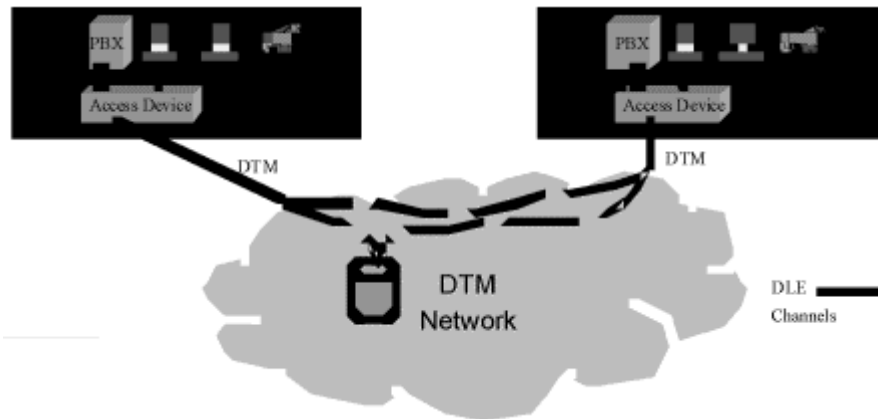
## Private Data Networking

Corporate data networks can simply be built by interconnecting office LANs with DLE service. The DLE service provides a flexible high-speed LAN-to-LAN network which is Level-3 independent and, hence, could be used for many kinds of protocols and applications supporting Ethernet. Supporting DTM short-cut establishment with channel isolation ensures high-quality communication with short delays that preserves communication security. The DLE service is therefore ideal for demanding applications such as videoconferences.

Because the DLE service supports Ethernet transparently, most office LAN architectures can be preserved, and interoperability, with all kinds of standard Ethernet equipment, is ensured. When using an access device at the customer premises, no additional equipment with gateway functions (such as a router) is actually needed for LAN interconnection, and thus much of the network management can be reduced.

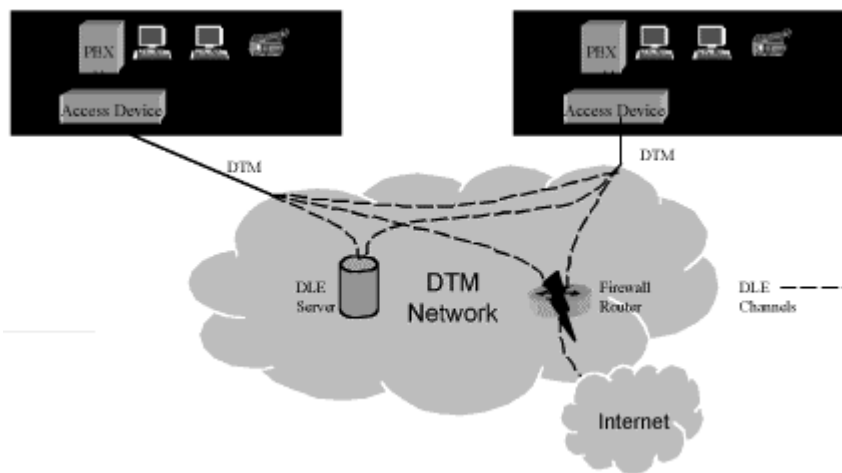
For larger data networks it may, for manageability reasons, be desirable to build hierarchical networks using routers. The DLE service and any standard router with Ethernet support may be used for that purpose.

Figure 5. Corporate Data Network using the DTM LAN Emulation (DLE) Service



By combining the DLE service with an IP–routing solution, the same Ethernet access may be used for both the corporate-data network and the company's Internet access. The IP–routing solution has a built-in firewall that permits the same access to be used. Because the DLE service isolates DTM channels for flows between different Ethernet segments, all Internet communication will be separated from corporate data, even though these are defined on the same DLE segment. It is thereby possible to separate the Internet from corporate-data traffic completely.

Figure 6. Corporate Data Network Combined with an Internet Connection



Benefits of the access device as a service integration device include the following:

- One network layer exists between the user and the service access points.

- Synchronous circuit switching enables a guarantee for QoS to customers.
- High granularity and scalability in bandwidth allow for pricing differentiation.
- Customers can be guaranteed control of bandwidth and can be billed for it.
- Transparent support of PDH ensures voice quality and interoperability.
- Layer-3-independent data link escape (DLE) service ensures interoperability and preserves existing LAN architectures.
- DTM short-cut establishment ensures high-quality communication for special needs such as video conferences.
- Internet traffic can be controlled so as not to interfere with the corporate-data network.

## 7. The DTM Solution for Residential and Small-Office Access

The DTM network solution has several features that make it suitable to handle aggregate traffic from emerging residential communications. The possibility for residents of modern society to use information technology (IT) in their daily life has increased during the last decade, mainly through the widespread use of the personal computer (PC), the expansion of the Internet, and the growth of services for the home market. With the fast development and deployment of new access technologies such as digital subscriber line (DSL), a high-speed communication infrastructure becomes a reality. The availability of high-speed access to the home will establish new requirements for the network that aggregate traffic up to the service-access points.

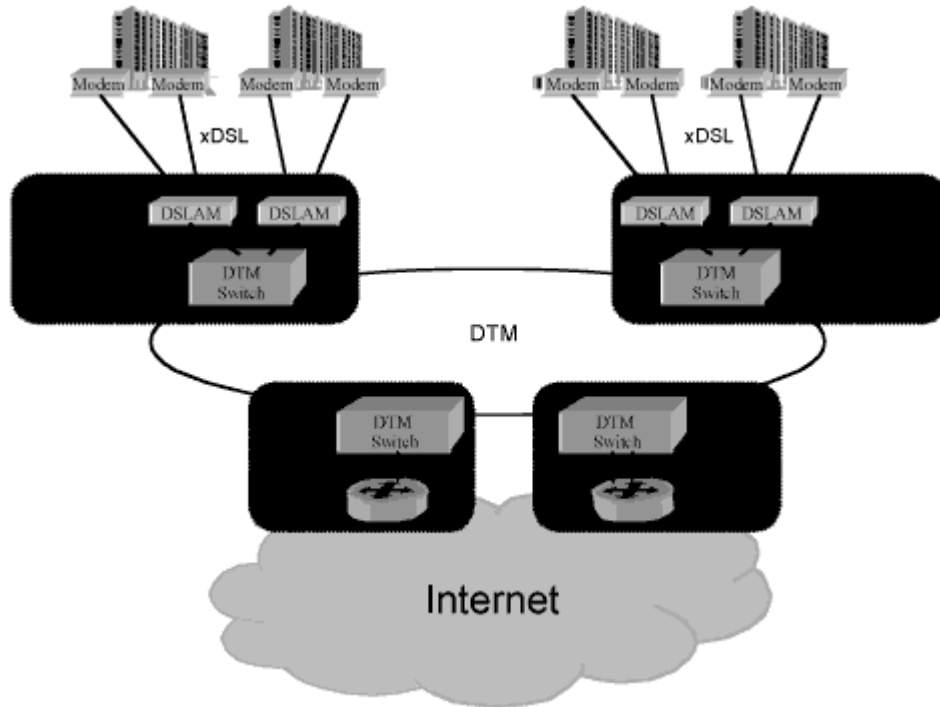
The future aggregation network must have the following qualities:

- capable of handling large amounts of traffic
- capable of handling different types of traffic streams such as synchronous video, bursty data, and synchronous voice
- adaptable to traffic variations
- scalable in connections as well as capacity

- easy to manage

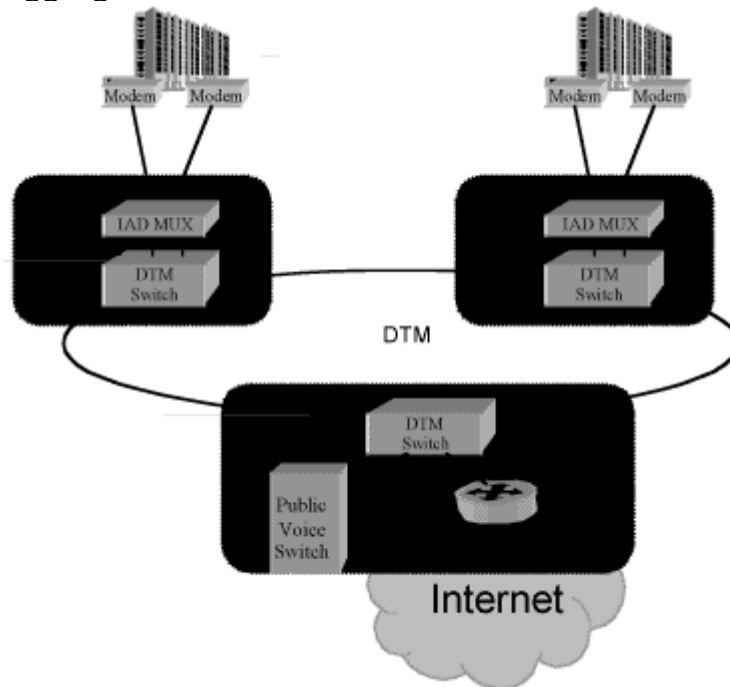
Digital subscriber line access multiplexers (DSLAMs) are often used to aggregate traffic from subscribers connected with DSL modems. Many of the DSLAMs are built with an ATM user network interface (UNI) on the uplink or an Ethernet interface. DTM can efficiently be used to transport heavy traffic introduced by DSL users from the DSLAMs to the service-access point, which is normally the Internet point of presence (PoP).

Figure 7. DSLAM Aggregation Network for Internet Connections



Integrated access devices are used to offer homes and small offices voice services as well as data services over the same physical line. The physical medium may be copper, radio link, or other media, but the concept is likely to be the same. A subscriber modem combines the telephone and data services over the media and connects to an integrated access multiplexer that separates voice traffic to E1s and data traffic to Ethernet. The DTM transports the divided traffic up to the service-access points—the voice switch and the Internet PoP—by supporting both Ethernet and E1s efficiently.

Figure 8. DTM Network for Integrated-Access-Device Aggregation



The benefits of using a DTM network for DSLAM and integrated-access-device aggregation include the following:

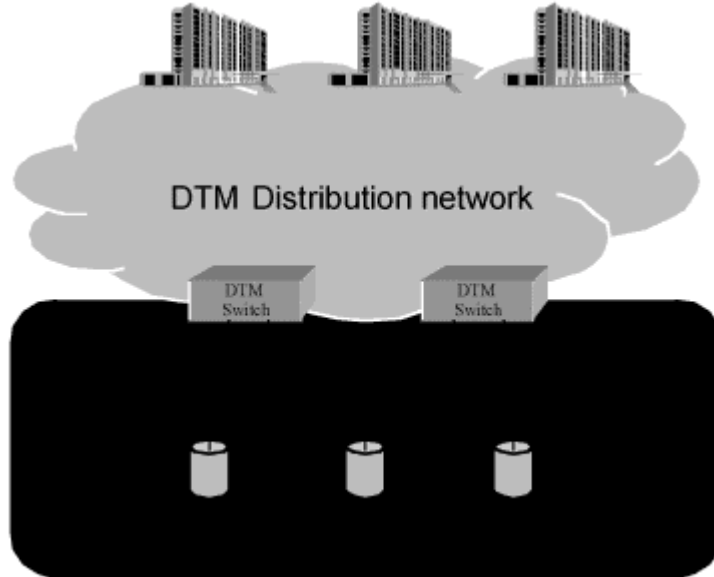
- DTM may dynamically adapt to traffic generated by the DSLAMs and thus eliminate the need for over-dimensioning.
- DTM may dynamically distribute bandwidth resources (time slots) between the DSLAMs, which allows for better over-time utilization.
- By using 10/100 Base-T interfaces and the DLE service, only one network layer is required between the DSLAMs or integrated-access devices and the Internet PoP.
- The transparent support of E1 ensures interoperability.
- New DSLAMs, integrated-access devices, and service-access points can be added easily to the DTM architecture.

## 8. The DTM Solution for Content Providers

The high-capacity protocol control information (PCI) adapter card for DTM can be used to build highly efficient service networks for content server providers. Network and service providers searching for new business opportunities can use

DTM to build high-capacity marketplaces for content providers with high-capacity and reliability requirements such as Web hotels, MPEG2 providers, and public databases.

Figure 9. Service Marketplace for High-Speed Content Servers



Benefits of using DTM as a content-server network include the following:

- DTM allows scalability in capacity from 512 kbps to transmission speeds close to the utilization of the fiber.
- DTM can use the fibers as shared medium, which allows for redundant topologies that are easy to expand.
- DTM provides isolated synchronous channels, which ensures service quality.
- DTM channels are unidirectional and resource usage is optimized for the traffic characteristics of content servers (asymmetric traffic load).
- Billing per usage of resources is possible.

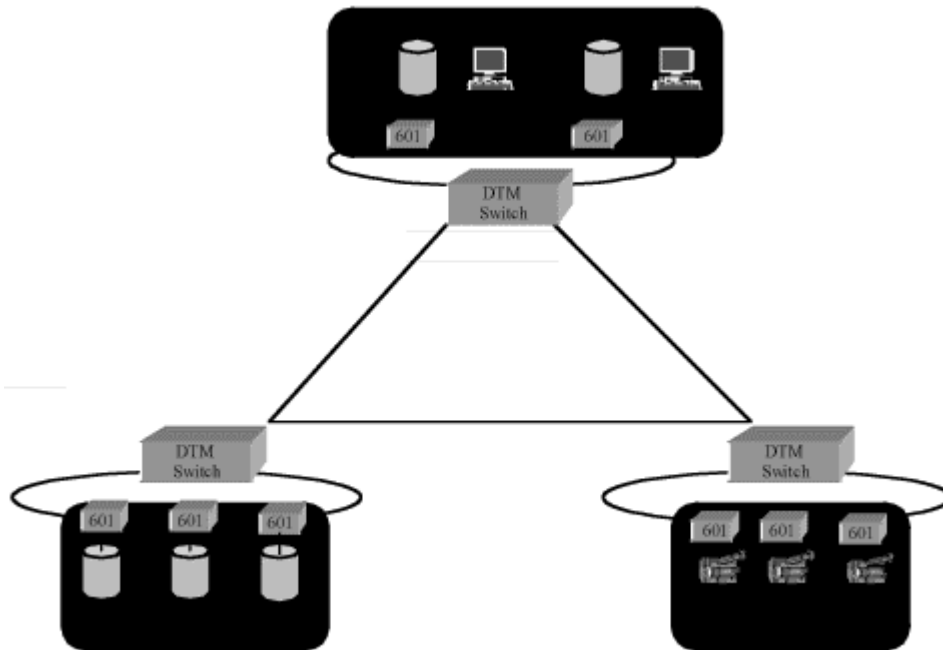
## 9. DTM Solution for Video-Production Networks

For video-producing companies such as TV producers, film producers, and commercial movie producers, a DTM network can provide a distributed real-time video network. By transporting real-time video streams in the International

Telecommunications Union (ITU)–R BT 601 format, different production units can be connected in a video-production network. The possibility of establishing an International Telecommunications Union (ITU)–R BT 601 connection on demand provides an opportunity for new services. For example, TV producers may accomplish the following:

- set up film banks and sell raw film material to other TV producers
- do real-time editing from different locations

Figure 10. Distributed Video-Production Network



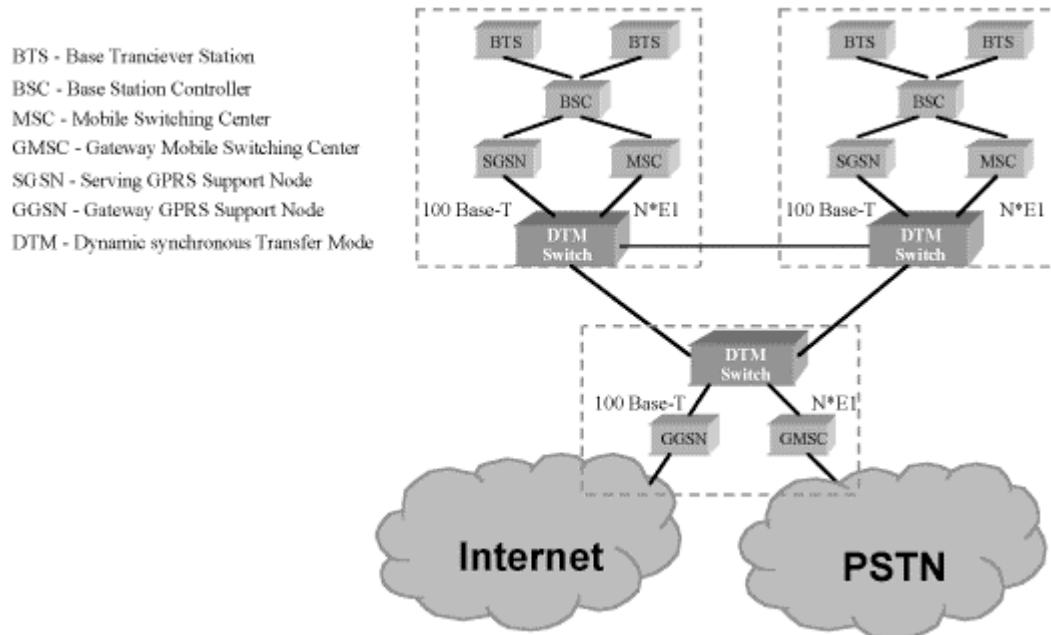
Benefits of the use of DTM as a video-production network include the following:

- DTM enables 270 Mbps ITU–R BT 601 channels to be switched on demand.
- A real-time video-production network enables film production companies to edit films remotely and, hence, reduce production costs.
- A public real-time video-production network gives a new perspective on film production, leading to new services and markets.

# 10. The DTM Solution for Mobile Network Operators

The combination of the DLE and the PDH transport service in the DTM products makes it a suitable solution for mobile service providers building a backbone for general packet radio service (GPRS). By connecting the serving GPRS support node and mobile switching center to DTM nodes, a flexible GPRS backbone used for transportation of the GPRS and the global system for mobile communications (GSM) traffic to centralized Internet and public switched telephone network (PSTN) gateways can be built.

Figure 11. Mobile Network Supported by DTM



## Benefits of the Use of DTM As a General Packet Radio Service Backbone

- DTM can serve as a common backbone for both GSM and GPRS.
- DTM can, over time, reallocate bandwidth resources to the mobile switching center (MSC) that currently needs them.
- DTM provides isolated synchronous channels for packet transfer, which ensures QoS for individual subscribers.



- DTM is a future-safe solution that can adapt to the capacity requirements of universal mobile telecommunication system (UMTS), the new standard for broadband mobile networks.
- The backbone consists of a single network layer, resulting in reduced management and maintenance.

## 11. The Future of DTM

Network bandwidth is expected to increase by a factor of 10 each year over the next several years. Dense wavelength division multiplexing (DWDM) is becoming the dominant choice of transport for all fiber. Even though DWDM equipment today carries only a few wavelengths, 40 to 100 wavelengths carried on one single fiber will be possible in the near future.

An integrating technology like DTM, having been developed for exactly this situation, is then needed for operators to be able to supply real-time video to the end user in an efficient way. As the bottlenecks of networks move from the transfer capacity of the network links to the processing capacity of the network nodes, DTM aims to reduce network complexity to provide full access to available bandwidth.

A community generates a great amount of information, but the information does not become true information until it is copied and provided to a receiver. The most efficient and easiest way to gain knowledge is through images. As we all know, children manage to attain a tremendous amount of knowledge by watching and listening. The use of real-time video and audio for transferring knowledge is almost always more efficient than the use of textbooks. In schools and at home, children are already starting to use interactive video over computer networks as a key tool for learning.

## Self-Test

1. Over the last few years, the demand for network-transfer capacity has decreased at an exponential rate.
  - a. true
  - b. false
2. Of the two basic technologies used for building high-capacity networks, circuit rather than packet switching provides more support for real-time traffic.
  - a. true

- b. false
3. The DTM solution is designed to transport common communication protocols over copper wire.
- a. true
  - b. false
4. Although combining the DLE service with an IP routing solution is beneficial, it does not enable the complete separation of Internet from corporate-data traffic.
- a. true
  - b. false
5. DTM can serve as a common backbone for both the GSM and the GPRS.
- a. true
  - b. false
6. All but which of the following are characteristics of circuit-switched networks?
- a. The transfer of payload data within the circuit does not contain overhead.
  - b. Control signaling and payload data transfers are separated.
  - c. Reserved resources can be used by other users if the circuit is inactive.
  - d. Support for real-time traffic is provided.
  - e. Processing of control information and control signaling is performed mainly at the circuit setup and termination.
7. All but which of the following are characteristics of packet-switched networks?
- a. Real-time traffic is supported without advanced control mechanisms for buffer handling and direction.
  - b. Each network node contains cues.
  - c. Connectionless as well as connection-oriented technology may form the basis of the network.

- d. Bursts of random traffic are more easily accommodated.
  - e. Each packet contains address, size, sequence, and error-checking information.
8. DTM is based on all but which of the following principles?
- a. Link capacity is divided into frames of 125 microseconds.
  - b. Data is transported in channels.
  - c. At least three types of reservation schemes are offered.
  - d. Network resources may be fully controlled.
  - e. Fiber transmission capacity is not growing fast enough for available processing power.
9. All but which of the following are characteristics of service integration devices?
- a. One network layer exists between the user and the service access points.
  - b. Internet and corporate-data traffic intermingle.
  - c. Customers can be guaranteed control of bandwidth.
  - d. Synchronous circuit switching enables guaranteed QoS.
  - e. Transparent support of PDH ensures voice quality.
10. All but which of the following are characteristics of DTM as a content-server network?
- a. Scalability in capacity is allowed from 512 kbps to transmission speeds close to the utilization of the fiber.
  - b. Isolated synchronous channels are provided.
  - c. Fiber as a shared medium may be used.
  - d. Channels are multidirectional.
  - e. Billing per usage of resources is possible.

# Correct Answers

1. Over the last few years, the demand for network-transfer capacity has decreased at an exponential rate.
  - a. true
  - b. false**See Topic 1.
2. Of the two basic technologies used for building high-capacity networks, circuit rather than packet switching provides more support for real-time traffic.
  - a. true**
  - b. falseSee Topic 2.
3. The DTM solution is designed to transport common communication protocols over copper wire.
  - a. true
  - b. false**See Topic 5.
4. Although combining the DLE service with an IP routing solution is beneficial, it does not enable the complete separation of Internet from corporate-data traffic.
  - a. true
  - b. false**See Topic 6.
5. DTM can serve as a common backbone for both the GSM and the GPRS.
  - a. true**
  - b. falseSee Topic 10.

6. All but which of the following are characteristics of circuit-switched networks?
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  - e. Processing of control information and control signaling is performed mainly at the circuit setup and termination.

See Topic 2.

7. All but which of the following are characteristics of packet-switched networks?
- a. Real-time traffic is supported without advanced control mechanisms for buffer handling and direction.**
  - b. Each network node contains queues.
  - c. Connectionless as well as connection-oriented technology may form the basis of the network.
  - d. Bursts of random traffic are more easily accommodated.
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See Topic 4.

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  - d. Channels are multidirectional.**
  - e. Billing per usage of resources is possible.

See Topic 8.

## Glossary

### **access node**

a network component that provides access for devices to the network; examples include radio base stations and ISDN remote switching stages

### **ARP**

address resolution protocol; a protocol used to determine which physical network address (PNA) corresponds to a specific IP address in the packet

### **BGP**

border gateway protocol; an IP routing protocol for use between backbone routers

**cell**

a unit of transmission in ATM; a fixed-size packet consisting of a 5-octet header and a 48-octet payload

**control signaling**

sending control messages between protocol entities; for example, between two node controllers using DCP or between a node controller and a DTM device using DTM UNI

**control slot**

a DTM frame is divided into data slots for transferring user data and control slots for sending control messages (DCP messages) between DTM nodes; there are static control slots that are set up initially and cannot be altered and dynamic control slots that can be set up on demand to change the signaling capacity of a node; dynamic control slots can be point-to-point, multicast, or broadcast; static control slots are broadcast

**DLE**

DTM LAN emulation; Ethernet emulation over DTM providing unicast, multicast, and broadcast support

**DTM**

dynamic synchronous transfer mode

**DTM channel**

DTM channel is a physical end-to-end channel from a sending resource or device; there may exist several DTM channels between two resources; a DTM channel has a specific capacity corresponding to a certain number of slots; one slot corresponds to a reserved capacity of 512 kbps

**DTM frame**

a DTM frame is 125 ms; a DTM frame consists of control slots and data slots; the number of slots depends on the bit rate of the DTM link; a DTM frame starts with a DLP frame-start slot; the number of frames per second should be the same for all DTM links in a DTM network; this should be arranged by the DTM synchronization scheme

**DTM switching**

ability of the DTM network to switch connections between originating and terminating network ports; connection bandwidth is selectable by the resource or device that requests the service; addressing of channels in DTM networks is done by means of DTM-specific channel identities; network ports are identified by means of IP addresses; services are requested by a uniform DTM service interface

**DSL**

a group of technologies that deliver high-speed connections over telephone copper wiring

**FC**

fiber channel

**FEG**

fast Ethernet gateway

**IRS**

IP routing server; the main task of the IRS is to distribute associations between IP and DTM addresses; the IRS interacts with IP routers connected to the DTM network and with the NCs to obtain IP addresses and the corresponding route; the IRS provides some redundancy and authentication mechanisms

**IPOD**

IP over DTM; IPOD will provide IP connectivity over DTM over multiple dynamic channels

**link**

in the local DTM topology, a link is a ring, double ring, point-to-point, or dual bus connection

**LLC**

a protocol standardized by the IEEE 802.2; it is used for data link-level transmission control; LLC works with the media access control (MAC) protocols

**MAC address**

media access control address; a hardware address that uniquely identifies each node of a network

**MPLS**

multiprotocol layer switching; a tag-switching mechanism targeted for multiple protocols

**NHRP**

next hop resolution protocol; NHRP provides an extended address-resolution protocol that permits next hop clients (NHCs) to send queries between different logical IP subnets; queries are propagated using next hop servers (NHSs) along paths discovered by standard routing protocols such as RIP and OSPF; this enables the establishment of DTM channels (or ATM SVCs) across subnet boundaries, allowing intersubnet communications without using intermediate routers for qualified data flows

**NC**

the node controller of a DTM node handles the communication with other nodes using DCP and the communication with DTM devices and DTM resources using DTM UNI; it also handles resource management and network management



**OSPF**

open shortest path first; one of the IP routing protocols used for routing in a local domain

**PBX**

a private branch exchange is a telephone switch that typically is used at a small-to-medium-sized company

**PCI**

peripheral component interconnect; a PC bus that is available in both 32-bit and 64-bit modes running as well as 33-MHz and 66-MHz clock speeds

**QoS**

quality of service

**RSVP**

reservation setup protocol; a standard to allow applications to dynamically reserve network resources

**SNAP**

subnetwork access protocol (SNAP) is a frame format often used for TCP/IP and Apple's EtherTalk on 802.3 LANs

**UNI**

the specification of an interface between a user's equipment and the network