Time Division Multiplexing (TDM)

Introduction

Since it's inception, Time Division Multiplexing (TDM) continues to be a simple yet effective multiplexing technology---even today. In this TechByte, you'll be introduced to this multiplexing concept and learn what TDM is and why this simple multiplexing technology is found in voice and data applications.

The content of this TechByte is organized according to the topics shown in the drop-down list above.

To jump directly to a topic, select the topic from the drop-down list and click GO. Or click on FORWARD or NEXT to begin viewing the topics in sequence.

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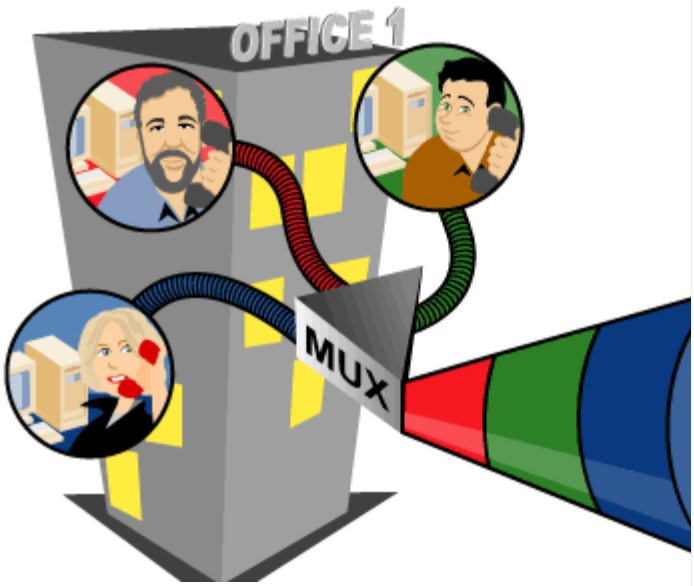

Time Division Multiplexing (TDM)

The Arrival of Multiplexing

The concept of *multiplexing* was invented because of the necessity to expand communications lines beyond its original use in connecting two users together via a single line. Imagine how many billions of cable lines would be necessary if a pair of users used an entire line each time they connected!

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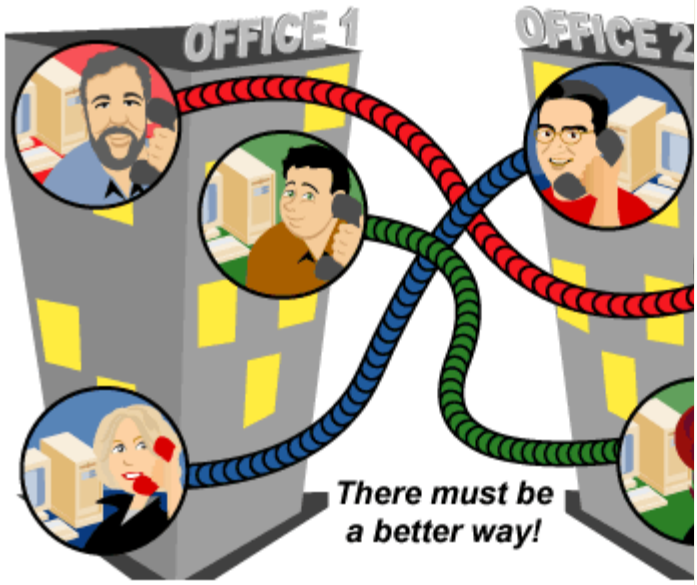

Time Division Multiplexing (TDM)

The Arrival of Multiplexing

With the creation of the multiplexer, however, the entire line's *bandwidth* is split into multiple channels allowing a number of users to transmit and receive information via one signal or common link called the composite link. This significantly eased and simplified the efforts to connect more and more users together.

And since almost all communications are *full-duplex*, multiplexers (or "muxes") at the sending and receiving ends of a transmission perform the **same** two functions:

- Consolidate several channels into one line (multiplex)
- Split the line into several channels (demultiplex)

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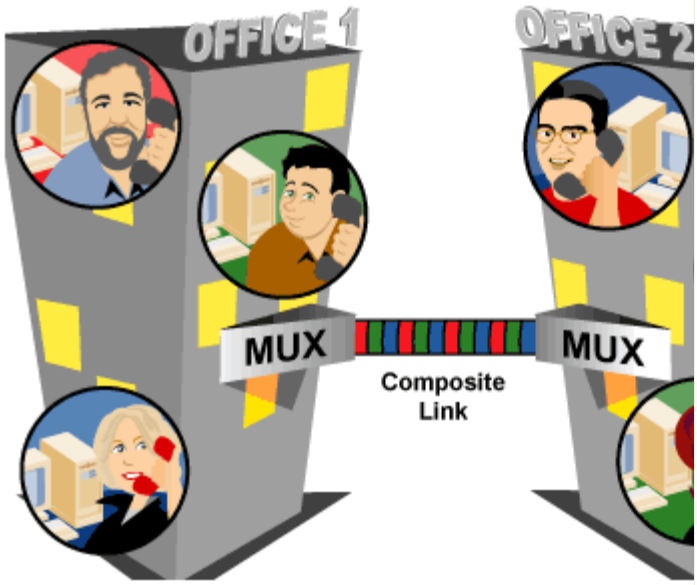

Time Division Multiplexing (TDM)

The Arrival of Multiplexing

So, what are the specifics?

The line speed of each channel multiplied by the number of channels must be less than or equal to the speed of the composite. For instance, if you have 24 channels with a transmission speed of 64 *Kbps* per channel, it would require a composite link able to handle up to 1536 Kbps (64x24), or 1.536 *Mbps*. A T1 circuit, transmitting at 1.544 Mbps, would handle the 1.536 Mbps requirement here (add 8 Kbps of bit framing overhead to the 1.536 Mbps to equal the 1.544 Mbps T1).

It's simple math!

The overall effect is that each user thinks they have their own individual, point-to-point line since the speed of the composite link is so much faster than their individual line.

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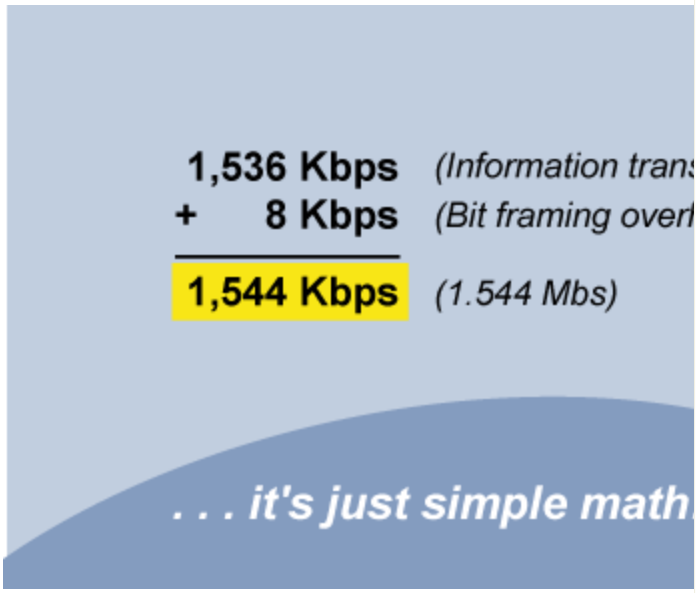

Time Division Multiplexing (TDM)

The Arrival of Multiplexing

So how does the composite link split the individual channels?

Although there are a few common methods of multiplexing, TDM involves dividing each channel into "time slots." Generally, here's how it works...

For a portion of time, the information from channel one is sent at the faster composite speed of the composite link. Then during the next period of time, the information from channel two is sent, and so on until the information is completely transmitted.

TDM and the other alternative multiplexing technologies are further explained in this Tech Byte.

Click Play to see an animation representing this concept.

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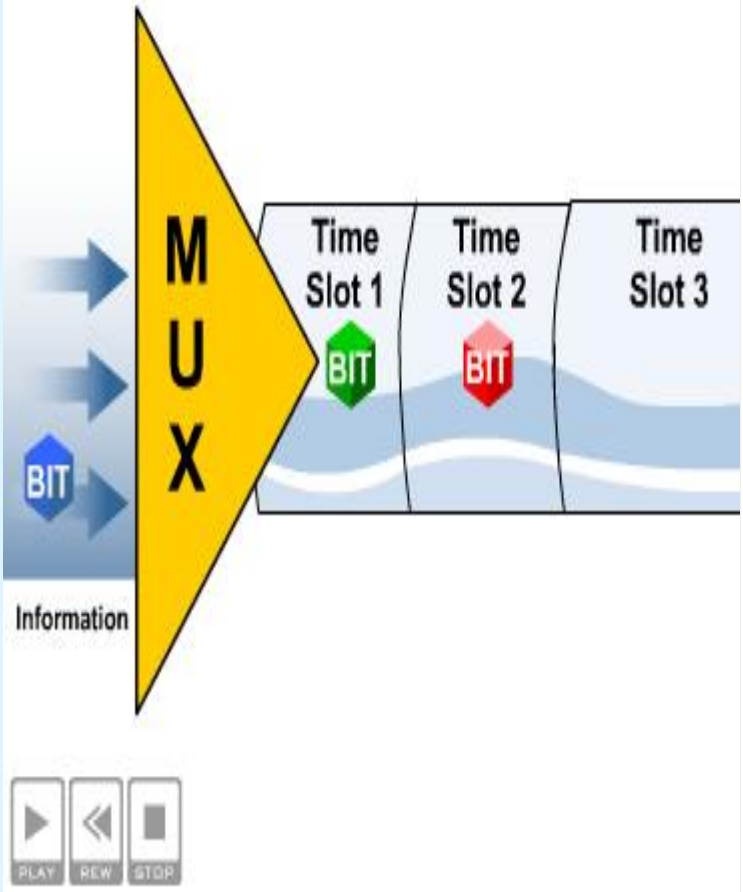
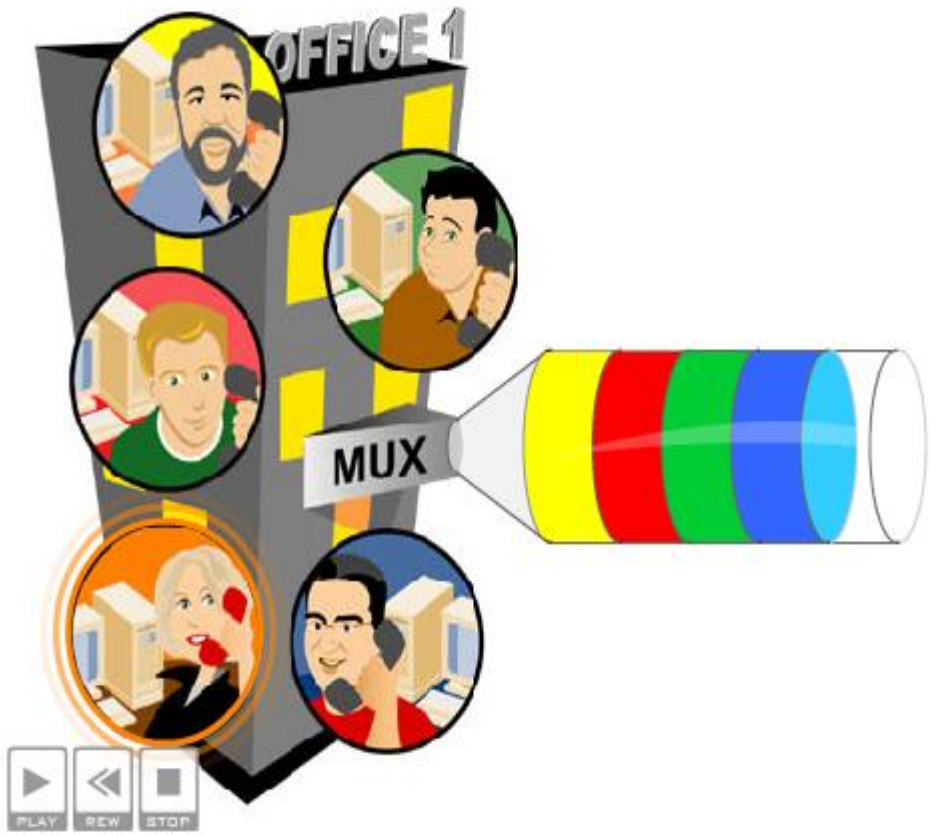


Time Division Multiplexing (TDM)

What is TDM?

As the name suggests, Time Division Multiplexing (TDM) separates bits or bytes of information into time slots sequenced over a single composite link. Configured this way, TDM allows users to utilize the entire bandwidth of the composite link to transmit and receive information in pre-determined periods of time.

Each user's channel connects to a multiplexer where it is transformed into the single, faster composite link. The composite link utilizing TDM has a pre-determined number of users dedicated to use the bandwidth. As each user transmits a bit/byte of information, it's reserved in a time slot. Each user waits in turn for their bit/byte of information to be picked-up by their slot, regardless if the other users are transmitting information or not. Keep in mind that this is at the bit and byte level. The fact that each user waits in turn is an almost trivial issue when today's transmission levels typically exceed 28,000 bits per second (28 Kbps). When the composite link reaches the destination, the channels are once again divided (or



Time Division Multiplexing (TDM)

How does TDM Work?

Let's look at an example of how TDM works.

If a multiplexer supporting 5 users on a TDM composite link has only 2 users transmitting information, the information from those 2 users would wait sequentially for the time slots of the other 3 non-transmitting users to pass before being able to transmit the next group of information bits/bytes.

What happens if the code a user transmits has fewer characters than another user? If our first user, John, is transmitting a strand of information (e.g., 12345) and another user, Mary, is transmitting a shorter strand of information (e.g., ABC), TDM leaves one of Mary's empty slots between John's code characters 4 and 5.

Click Play to see an animation representing this concept.

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Time Division Multiplexing (TDM)

Where is TDM Used?

Historically, TDM allowed telephone companies to convert long-distance trunks from analog transmission to digital transmission.

Today, TDM is still widely used in public telephone networks (North American T1 and European E1 carrier systems) and expanded its application into narrow-band *ISDN (Integrated Services Digital Network)*, and *SONET (Synchronous Optical Network)*.

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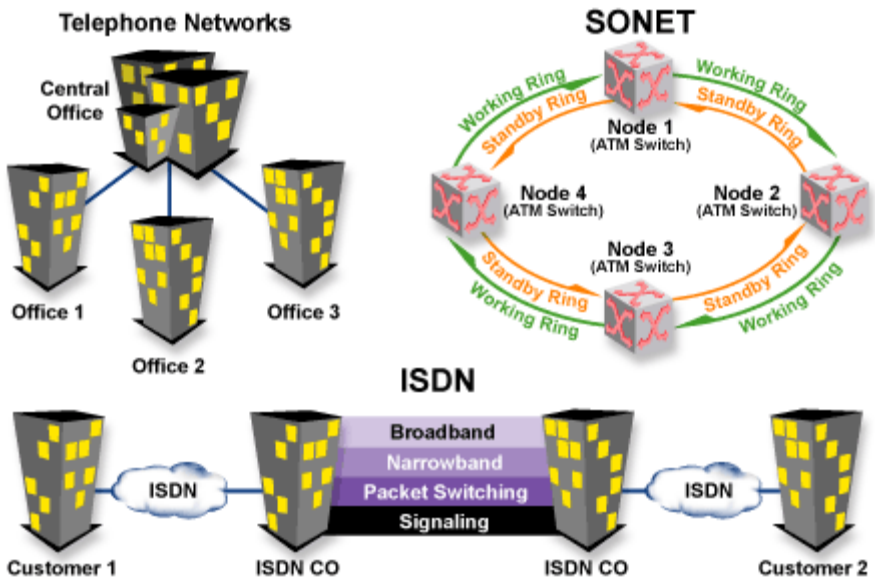


Time Division Multiplexing (TDM)

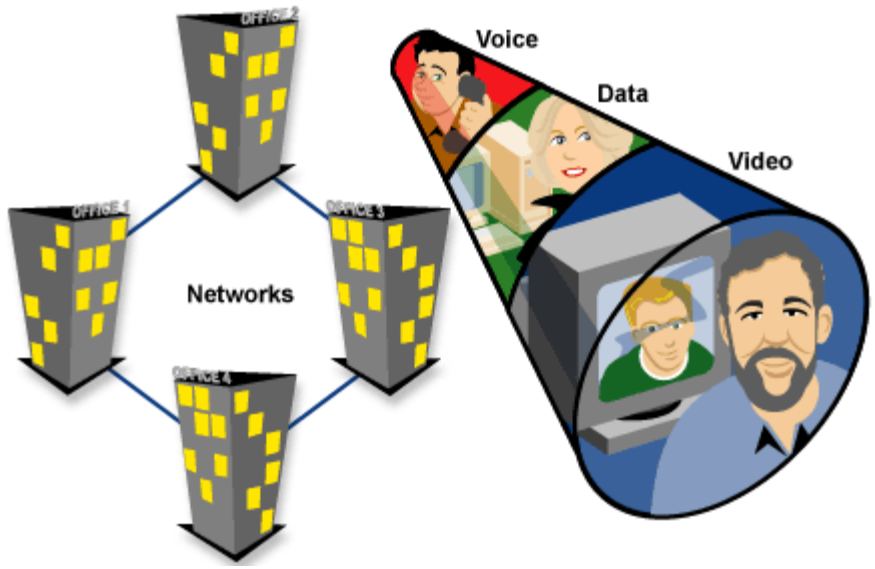
Benefits of TDM

Why use TDM?

For one, TDM hardware is moderately inexpensive and a relatively simple multiplexing arrangement. This makes it an attractive solution to building a cost-effective network that is dependent on varying node count, geographic, capacity, and speed issues.

Secondly, it carries any sequence of information bits without regards to whether the bit is used for voice, data, or video purposes.

Also, TDM is a multiplexing technology. Consider the alternative: if a user purchases 20 channels (two wires each) at 64 Kbps between two long distant locations, uses 20 individual repeaters to ensure the transmission reaches the destination per channel, and requires 20 times the power, the possibility of failure in some way to some channel is also 20 times as great! By multiplexing to a composite link (e.g., a T1), the long distance between the two long distance locations is carried on a single line, thus saving more money



Time Division Multiplexing (TDM)

Limitations of TDM

Why not use TDM?

To utilize TDM in the most efficient manner means having all dedicated users sending information all the time. Otherwise, bandwidth time-slots are wasted and inefficiency becomes an issue. Time slots that remain idle mean money and bandwidth wasted.

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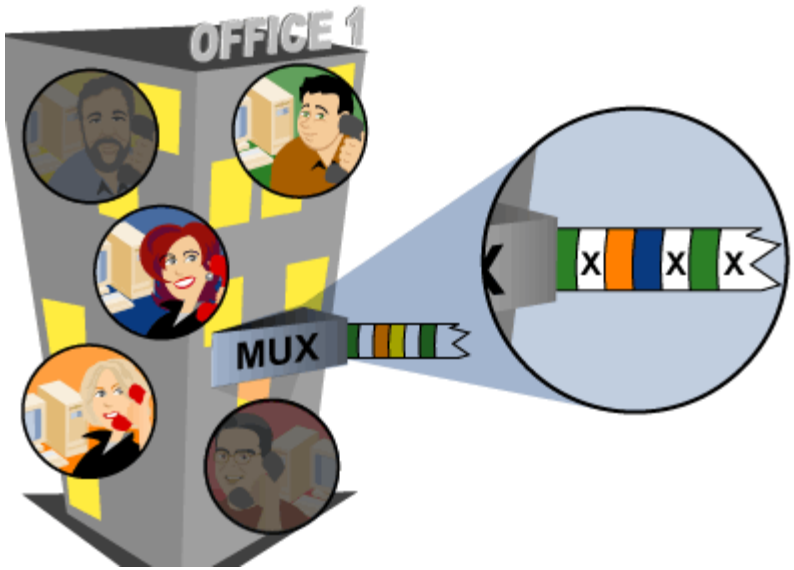


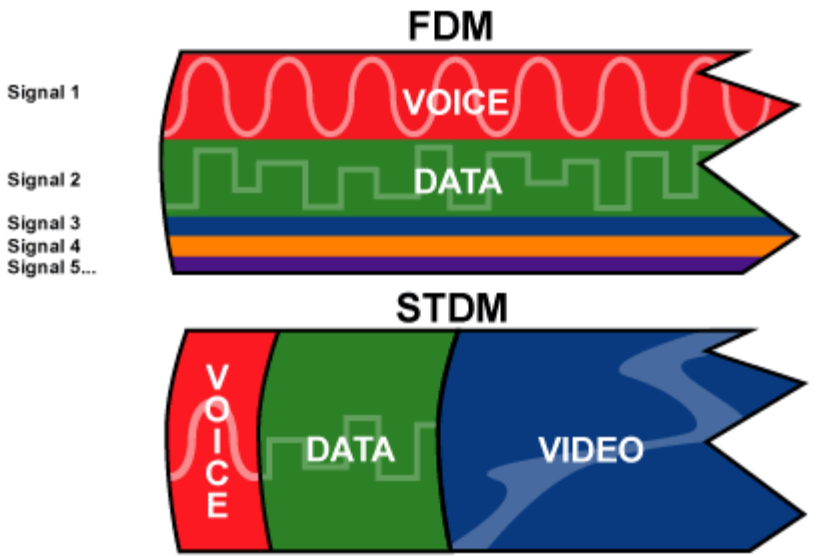
Time Division Multiplexing (TDM)

Alternative Technologies to TDM

TDM is one of three typical network, multiplexing technologies. Below are two alternatives:

- **Frequency Division Multiplexing (FDM)** is an analog technology in which each signal is assigned a different frequency in the bandwidth channel. FDM is sometimes referred to as Wave Division Multiplexing, WDM, since it is another frequency division type of multiplexing. Television employs FDM multiplexing.

- **Statistical Time Division Multiplexing (STDM)** is a variation of TDM in which time slots are assigned to signals that better utilize the bandwidth than traditional TDM. STDM analyzes what time slots are active and allocates more time to users with more information to transmit. Concurrently, STDM also senses what users are inactive or less active and provides less time to those users who aren't transmitting



Time Division Multiplexing (TDM)

Quick Facts Summary

In this TechByte, you learned about the necessary arrival of multiplexing and why the simple, multiplexing technology of Time Division Multiplexing (TDM) will continue to be used in both data and voice applications.

The following Quick Facts summarize what was presented in this TechByte:

- Multiplexing is the act of splitting and transmitting several channels over a single communications composite link. It provides the effect that each user thinks he/she has his/her own individual, point-to-point line since the speed of the composite link is so much faster than the user's individual line.
- TDM separates bits or bytes of information into time slots sequenced over a single composite link. The composite link has a pre-determined number of users dedicated to the bandwidth who wait in sequential turn to transmit information into their time slot (regardless if the other users are