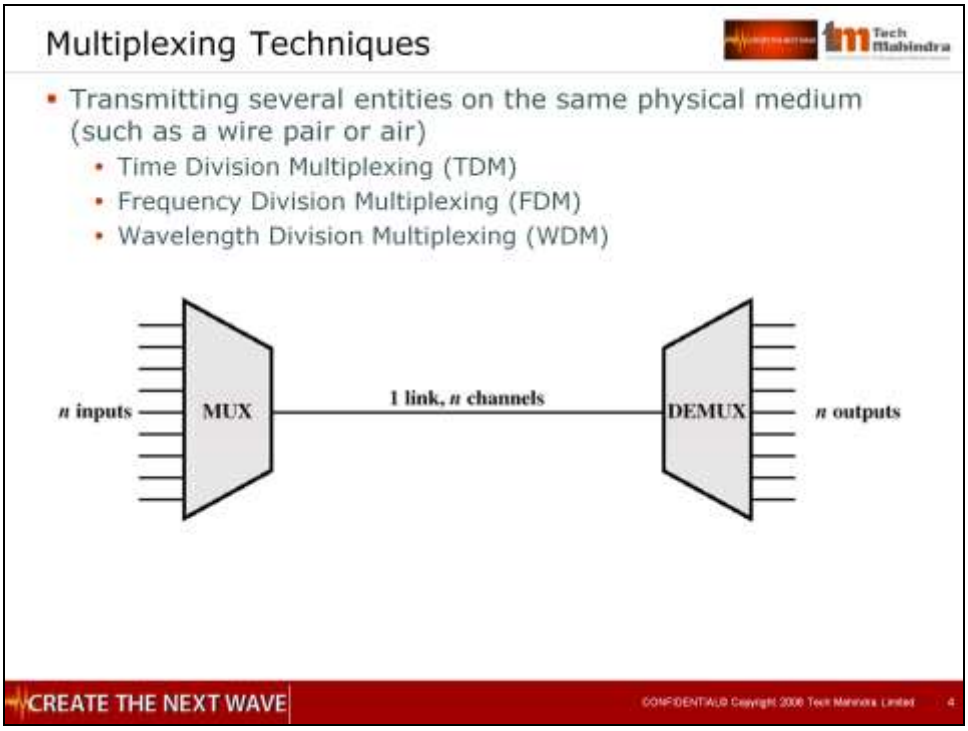
Multiplexing Techniques and PSTN Hierarchy

Objectives

- At the end of this session, you will be able to:
  - Understand the need of multiplexing/demultiplexing
  - Classify multiplexing techniques
  - Understand TDM, FDM and WDM multiplexing techniques w.r.t. concept, scheme, pros and cons
  - Draw and understand Plesiochronous Digital Hierarchy (PDH) used in American and European standard
  - Understand the difference between digital trunk lines T1, T2, T3 and T4 / E1, E2, E3 and E4

Agenda

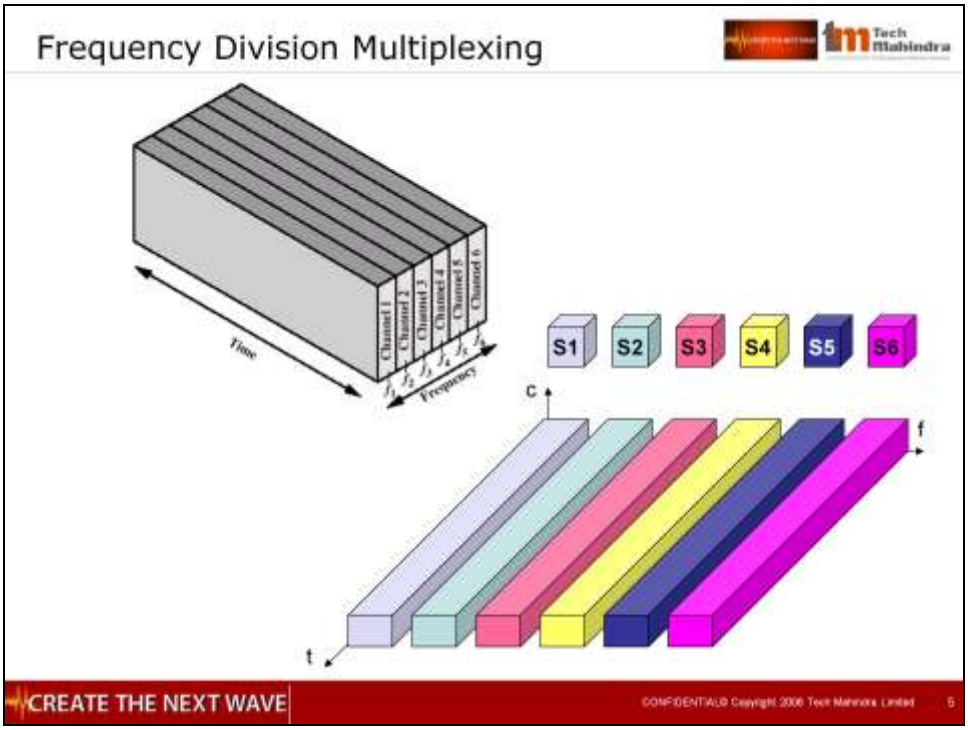
- Need of multiplexing
- Multiplexing techniques classification
- Time Division Multiplexing [TDM]
- Frequency Division Multiplexing [FDM]
- Wavelength Division Multiplexing [WDM]
- Plesiochronous Digital Hierarchy (PDH)-European and American standard



Multiplexing is used to reduce transmission costs - several channels along the same route share the same transmission medium, such as optical fibre

By the way, why is multiplexing required ?

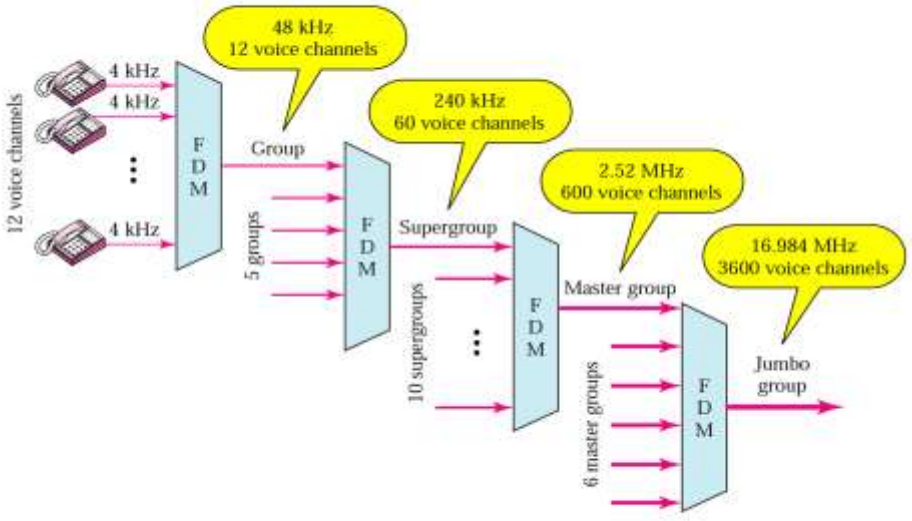
Explain concept of sharing and how to use shared medium ?

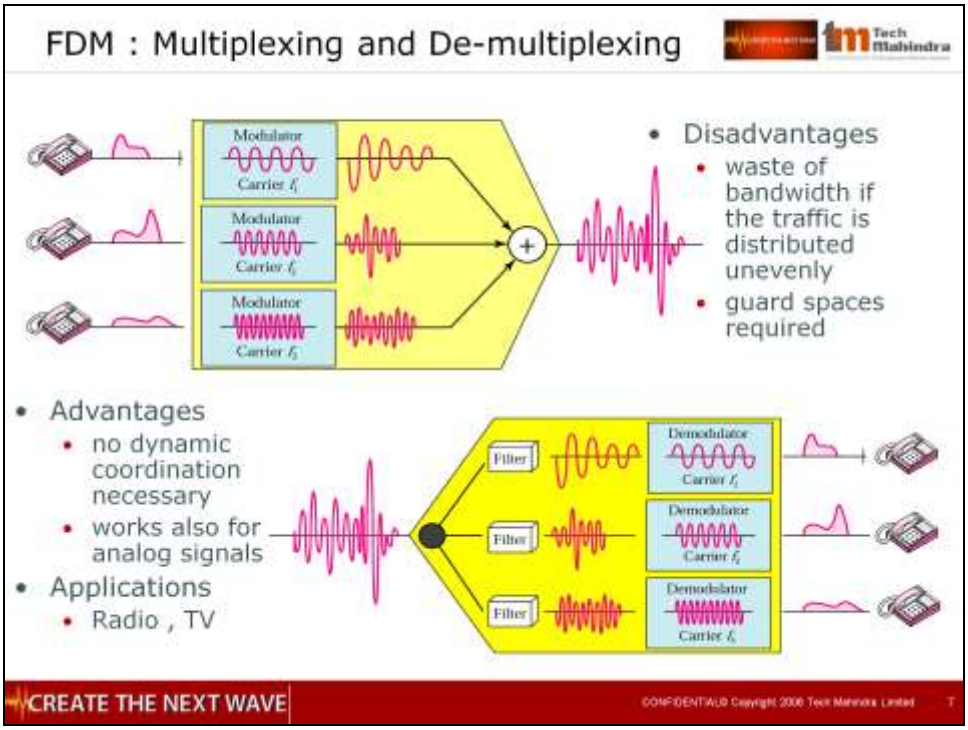


Separation of the whole spectrum into smaller frequency bands

A channel gets a certain band of the spectrum for the whole time

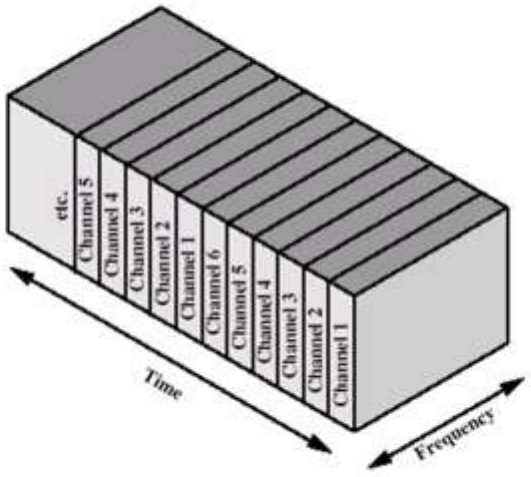
Analog Mux hierarchy



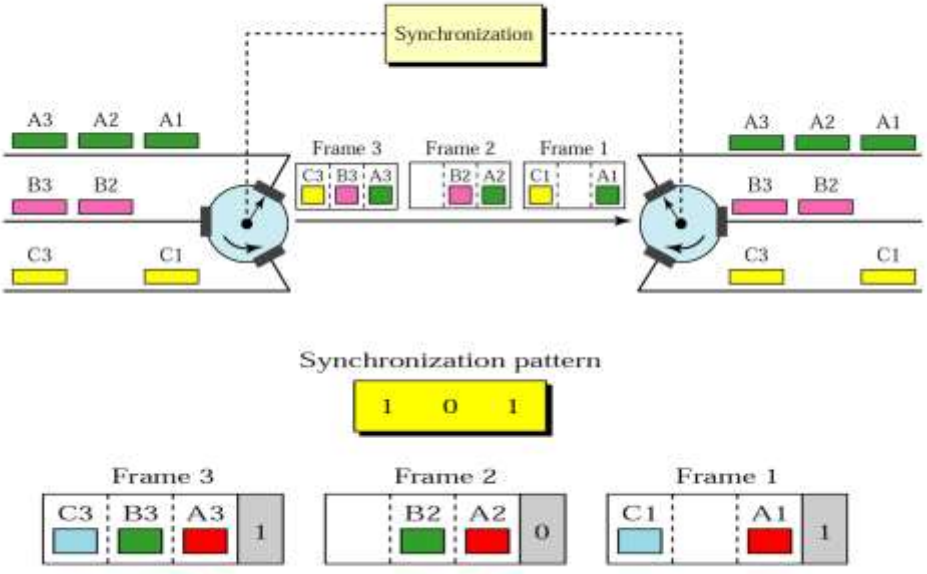


Analogy is : Express high way with lanes where is multiple cars are going simultaneously…In a sense, here bandwidth of road is divided..

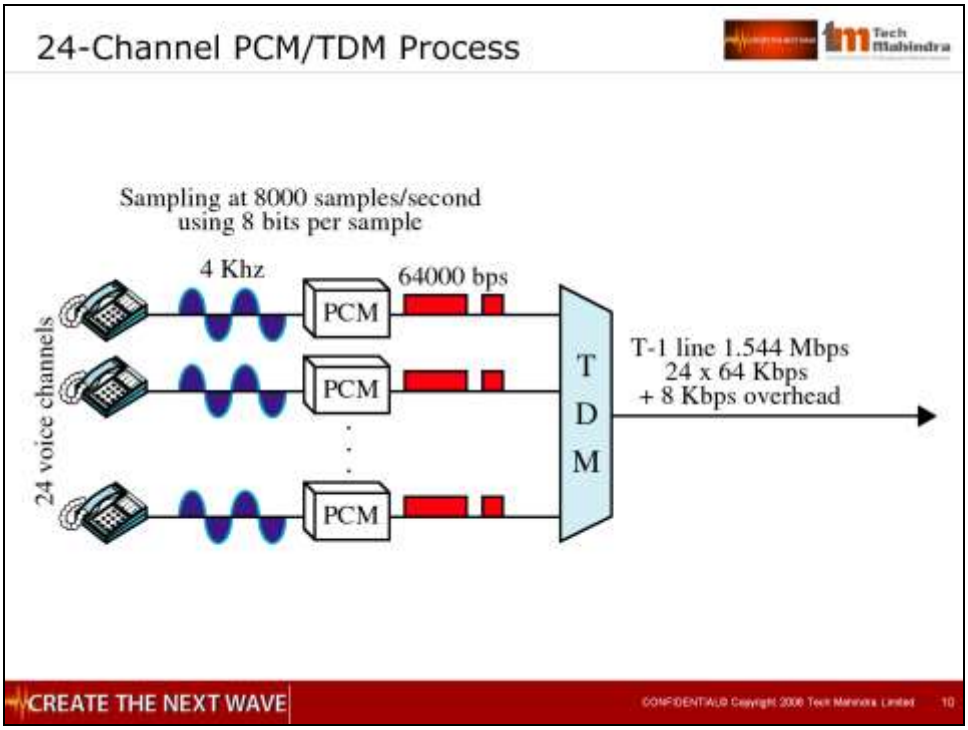
Time Division Multiplexing



Time Division Multiplexing



Synchronization pattern



Advantages

- only one carrier in the medium at any time
- throughput high even for many users

Disadvantages

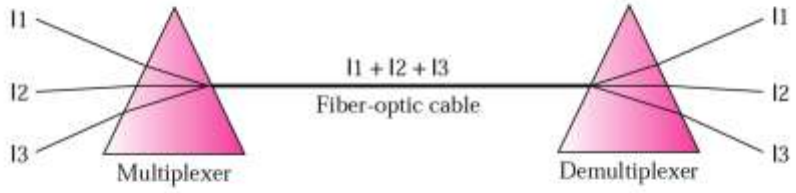
- precise synchronization necessary
- Wastage of bandwidth of if nothing present at that timeslot

Applications

- Telephony

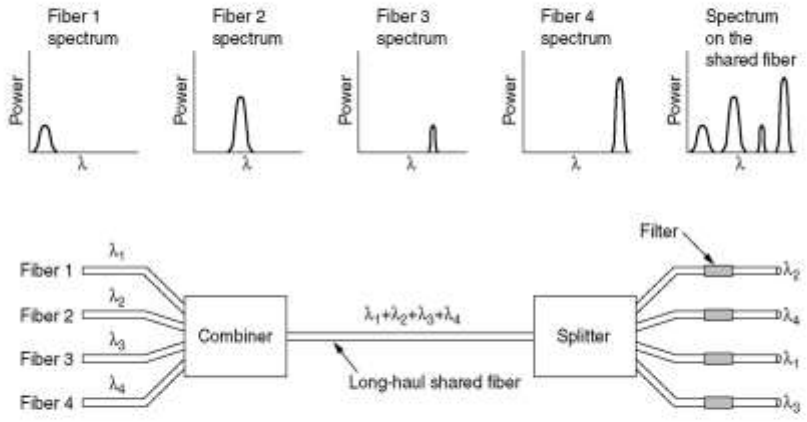
Wavelength Division Multiplexing [WDM]

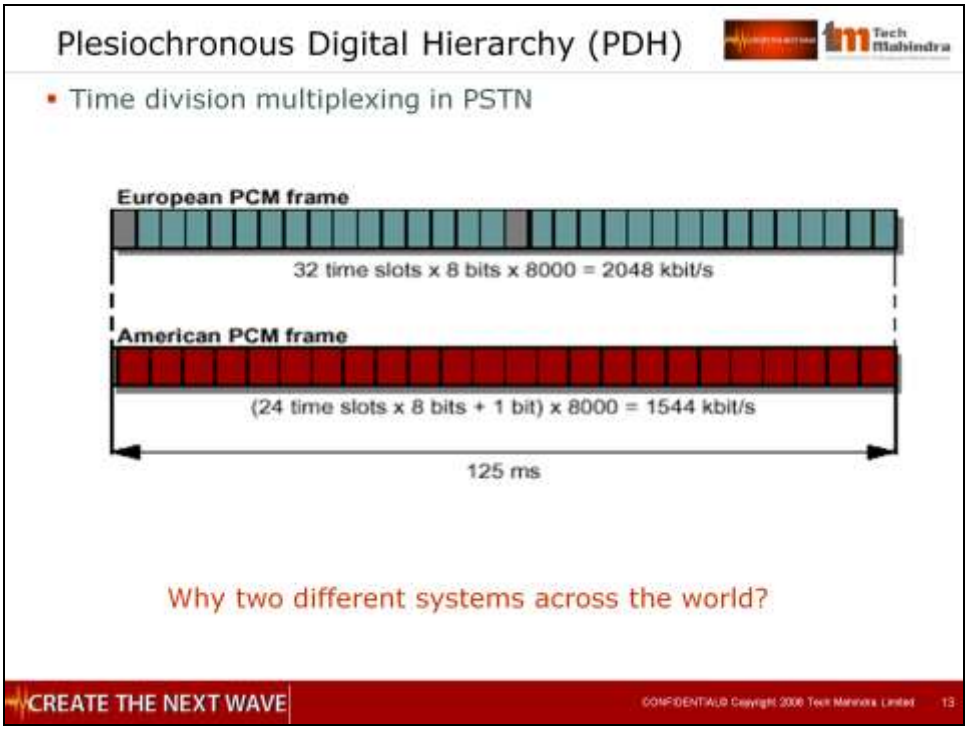
What do you divide here ?



Prisms in WDM multiplexing and demultiplexing

Wavelength Division Multiplexing

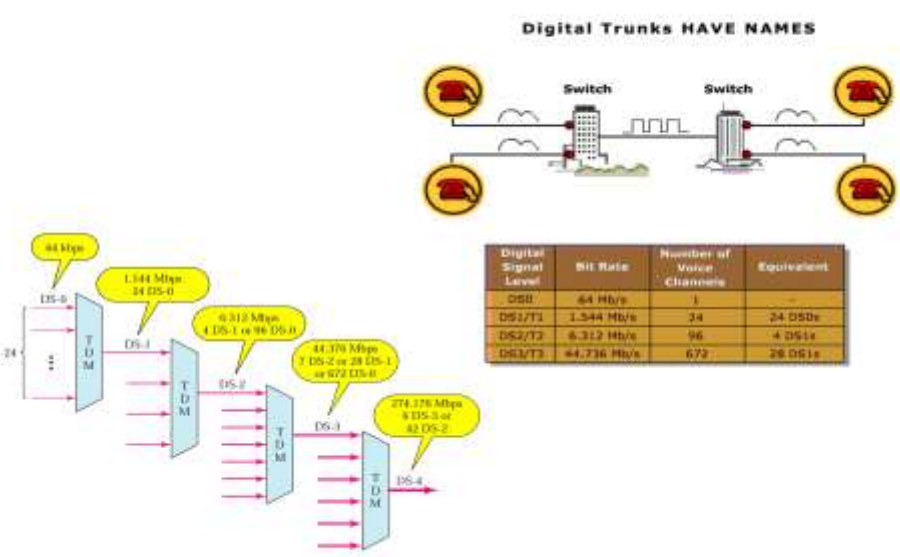




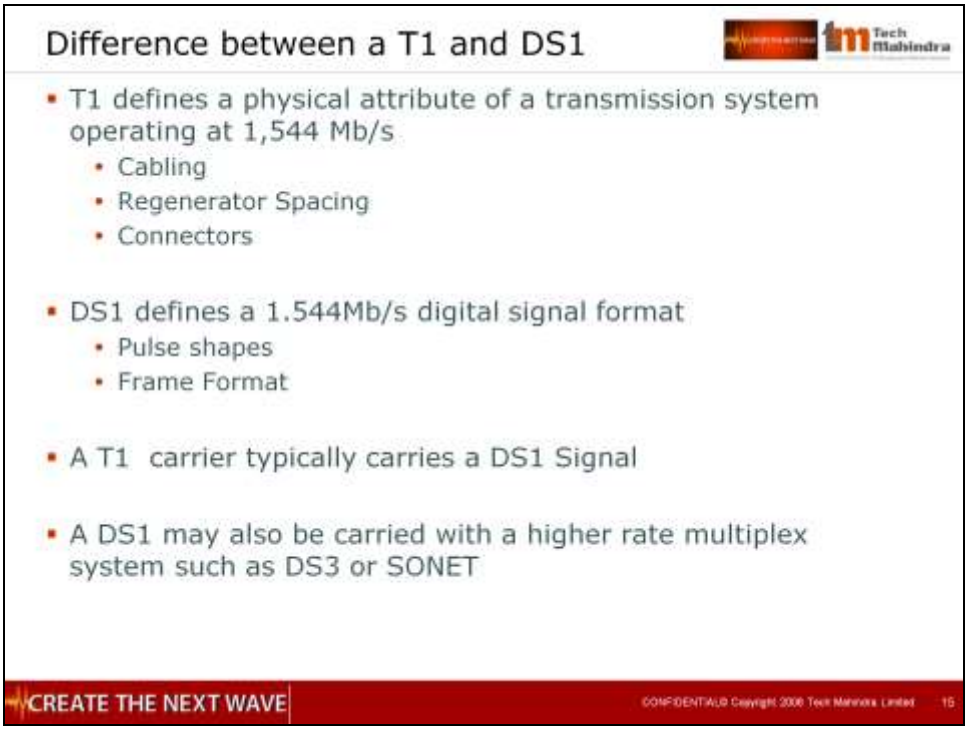
The NA & Europeans decided on 2 different compression techniques base on μ-Law & A-law respectively.

This led to 2 different incompatible PCM systems throughout the world.

Digital Trunks - T1 T2 and T3



Digital Signal Level	Bit Rate	Number of Voice Channels	Equivalent
DS0	64 Mb/s	1	-
DS1/T1	1.544 Mb/s	24	24 DS0s
DS2/T2	6.312 Mb/s	96	4 DS1s
DS3/T3	44.736 Mb/s	672	28 DS1s



Now one question that often comes up at this point is T1, and DS1. It is known that they both operate at 1.5 Mb/s, so they say, "Well, what's the difference between the two? Why do I need two words to mean the same thing?" It turns out that they are oftentimes confused, or oftentimes used interchangeably; but there is a difference between them, that if you use them properly, you can avoid some confusion.

T1 refers to the physical transport facility. So, for example, T1 is the connectors, the cabling, the repeater spacing—all the things you need to electrically send the signal at 1.5 Mb/s over twisted wire pair. So we're sending this 1.544 million b/s signal over twisted wire pair using T1 electronics.

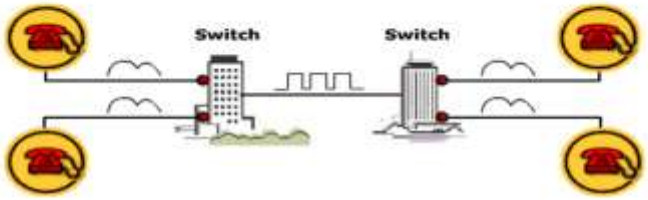
Digital Signal Level 1(DS1), is a particular signal format operating at that same 1.5 Mb/s rate. So DS1defines things like the pulse shapes and their spacing, and the framing format and channelization. So in essence, T1 Carrier defines the electrical system to carry the signal; DS1 defines the actual signal. Where you start seeing differences is, for example, a T1 line operating at 1.5 Mb/s, carry a signal format other than a DS1. Similarly, a DS1 signal can be carried on physical facilities other than aT1; for example, over a radio link.

Also, as I go up to the transmission hierarchy— a DS3 carries 28DS1 signals, but it's not carrying any T1s because a T1 is a physical facility . So for a DS3 (which is carried on a T3, by the way) I could have coming in 28 T1s, each of those 28 T1s, is carrying a DS1 signal. I take those DS1 signals off of the T1s, multiplex them together to form a DS3 signal that we'll then carry on a T3.

So the T is the physical facility and its implementation; the DS is the actual signal format that you're carrying. The DS will go on other kinds of physical facilities; the T is a fixed type of physical facility.

Digital Trunks - E1 E2 E3 and E4

Digital Trunks HAVE NAMES
EUROPEAN HIERARCHY



Carrier Name	Line Rate (Mb/s)	Number of Voice Channels	Equivalent
E1	2.048	30	-
E2	8.448	120	4 x E1
E3	34.368	480	4 x E2
E4	139.264	1920	4 x E3

End of the session…

Summary

- In this session, we have learned:
  - Need of multiplexing/demultiplexing
  - Classification of multiplexing techniques
  - TDM, FDM and WDM multiplexing techniques w.r.t. concept, scheme, pros and cons
  - Plesiochronous Digital Hierarchy (PDH) used in American and European standard
  - Difference between digital trunk lines T1, T2, T3 and T4 / E1, E2, E3 and E4

Thank You