Introduction to Telecommunications
EN1052

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Lecture 5: Transmission

Transmission

- recall: the process of transporting information between end points of a system or network
- the end-to-end communication distance is often very long
- systems and network elements are connected to the other elements with connections provided by the transmission systems

Physical Media

- a physical media is necessary for transmission of signals
- any physical medium can be considered as a channel in a communication system

Physical Media [1]

- e.g.,
  - copper cables (e.g., twisted pair, coaxial cable, open wire)
  - optical fiber
  - wireless medium, e.g.,
    - microwave links between two ground stations
    - satellite link between a satellite and a ground station
    - link between a mobile phone and a base station of the service provider
    - Wi-Fi
- reading assignment: § 4.7 of [Anttalainen-2003]

[1] Details are available in [Anttalainen-2003]: *Introduction to Telecommunications Network Engineering*, by T. Anttalainen, 2003.

Transmission Vs Transportation

- an analogy:
  - physical media necessary for transmission of signals $\leftrightarrow$ physical paths necessary for transportation
  - communication network $\leftrightarrow$ internetwork of all transportation paths, such as, roads, railways, flight paths, and shipping routes, among others
  - traffic due to signals in a communication network $\leftrightarrow$ the traffic (due to vehicles) in a transportation system

Differences of Physical Media

- capacity
- interferences between neighbouring peers
- supported length
- line-of-site requirements
- multiplexing mechanisms

Capacity

- the upper bound on the rate at which information can be reliably transmitted over a communication channel

Interferences Between Neighbouring Peers

- inter-channel interference

Supported Length

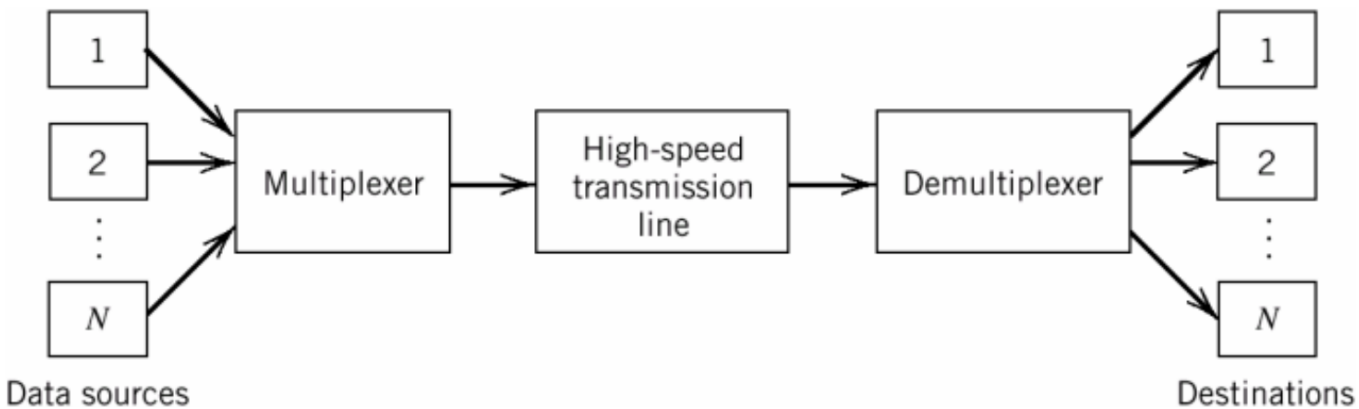
- twisted-pair cables vs wireless channel

Line-of-Site Requirements

- optical fiber cables vs microwave links

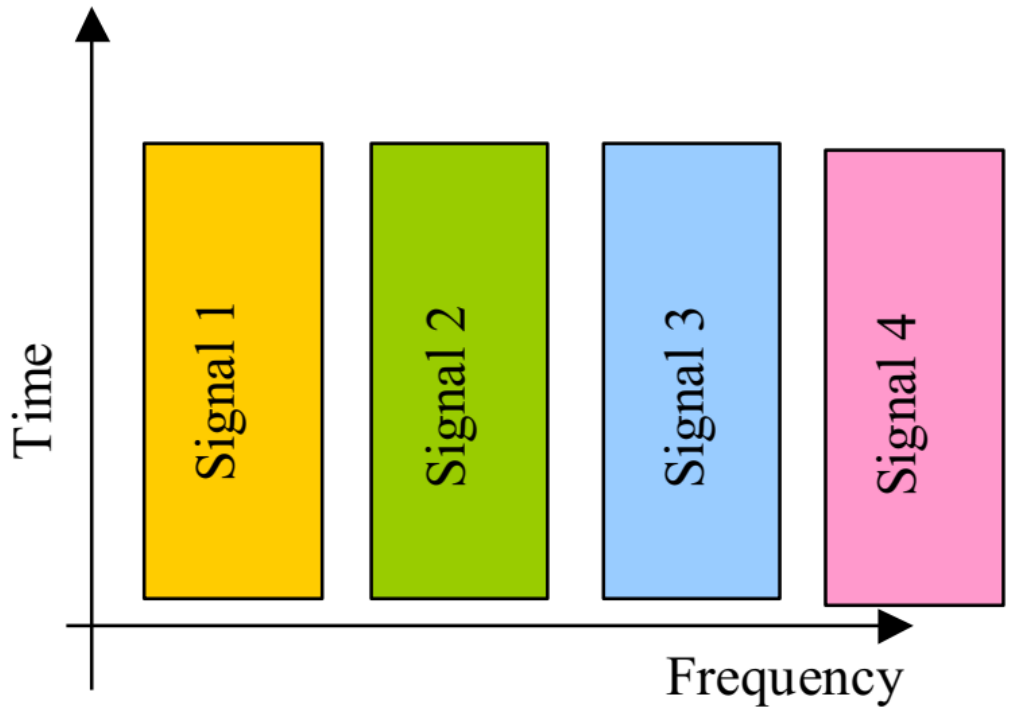
Multiplexing

- the process of bundling many signals together, so that they can be sent over a high-capacity physical medium (channel)
- allows channel capacity to be shared
- multiplexing must be followed, at some stage of the communication system, by a demultiplexing stage
- can be done in different stages of a communication system



Frequency Division Multiplexing (FDM)

- channel sharing is done in frequency

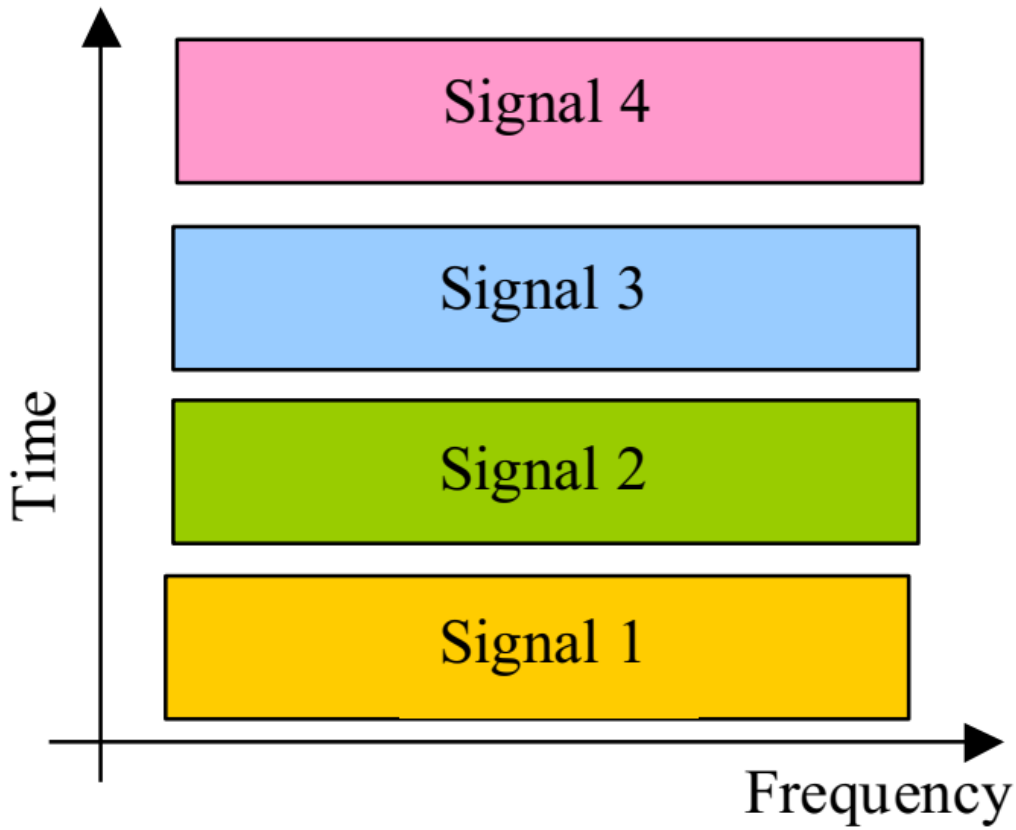


Frequency Division Multiplexing (FDM)

- channel sharing is done in frequency
- e.g., in analog communication system
  - each signal from different users is first modulated on a sub-carrier
  - the composite signal is then modulated on the final carrier and transmitted via wireless medium
  - demodulation?

Time Division Multiplexing (TDM)

- channel sharing is done in time

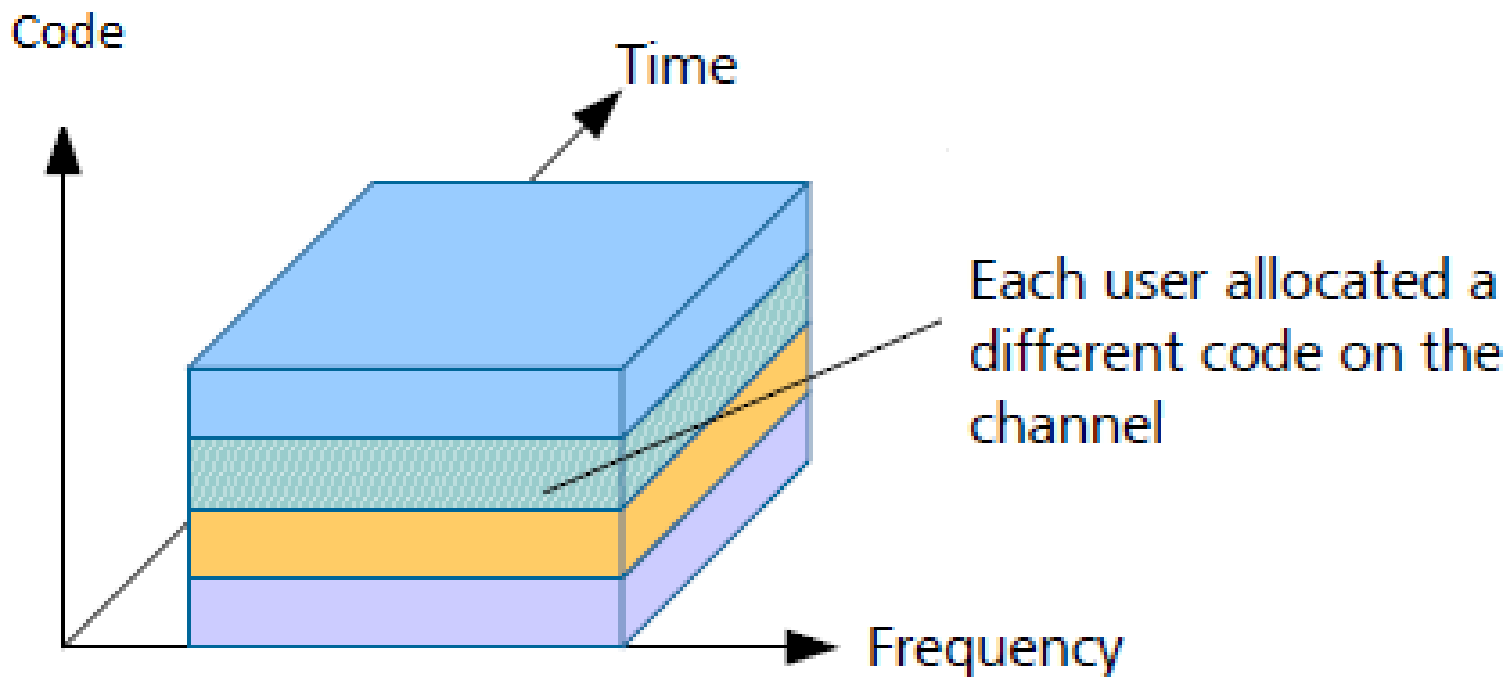


Time Division Multiplexing (TDM)

- channel sharing is done in time
- e.g., in digital communication system
  - samples of voice signals from different signal are interleaved in time
  - then digitized using PCM
  - modulation (e.g., pulse modulation and bandpass modulation) is performed and transmitted via the wireless medium
  - demodulation?

Code Division Multiplexing (CDM)

- channel sharing is done by using codes

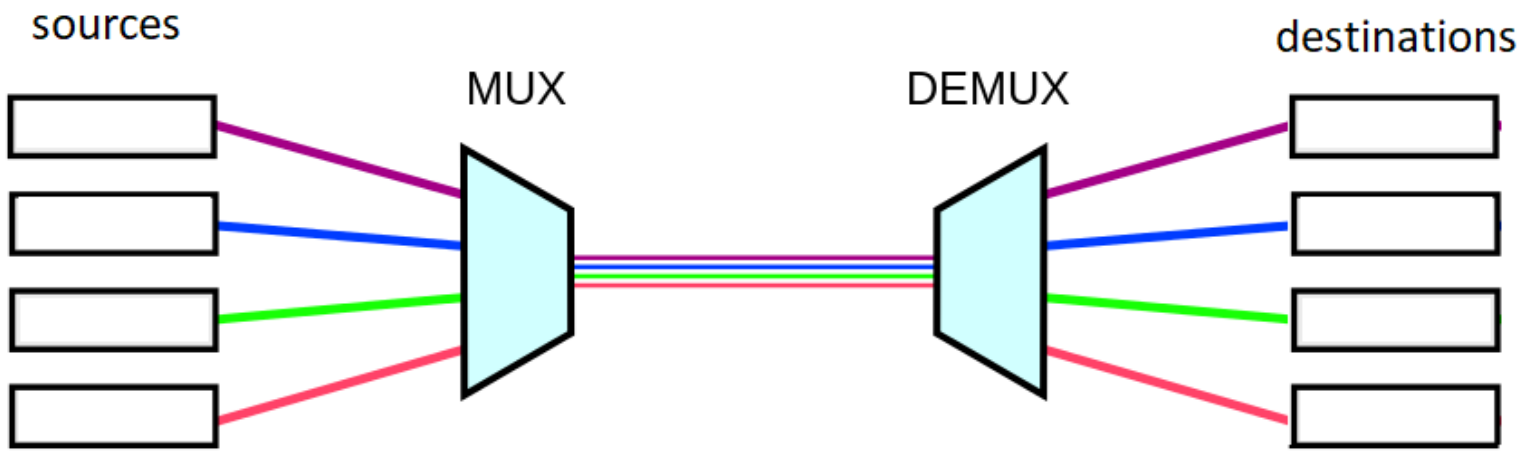


Code Division Multiplexing (CDM)

- channel sharing is done by using codes
- each user's signal is spread over the entire bandwidth
- demodulation? when demodulating any particular user's data, other users' signals appear as noise
- an analogy: in a room with many pairs of people (source-destination), each pair uses a different language compared to others $\rightarrow$ no interference

Wave Division Multiplexing (WDM)

- channel sharing is done in wavelength



Wave Division Multiplexing (WDM)

- channel (optical fiber) sharing is done in wavelength
- numerous data streams are modulated by using optical carrier signals of varying wavelengths (colours) of laser light, one for each user's signal
- the resultant signal is transmitted by using a single optical fiber
- demodulation? when demodulating optical devices are used to separate different colours (i.e., different users)