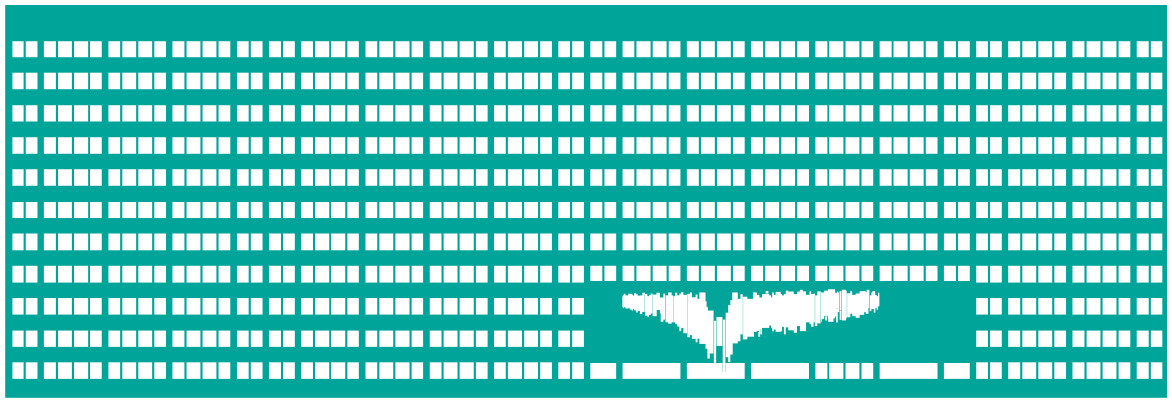
VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE | DEPARTMENT OF COMPUTER SCIENCE

Multiplexing of Multiple Communications on the Shared Medium

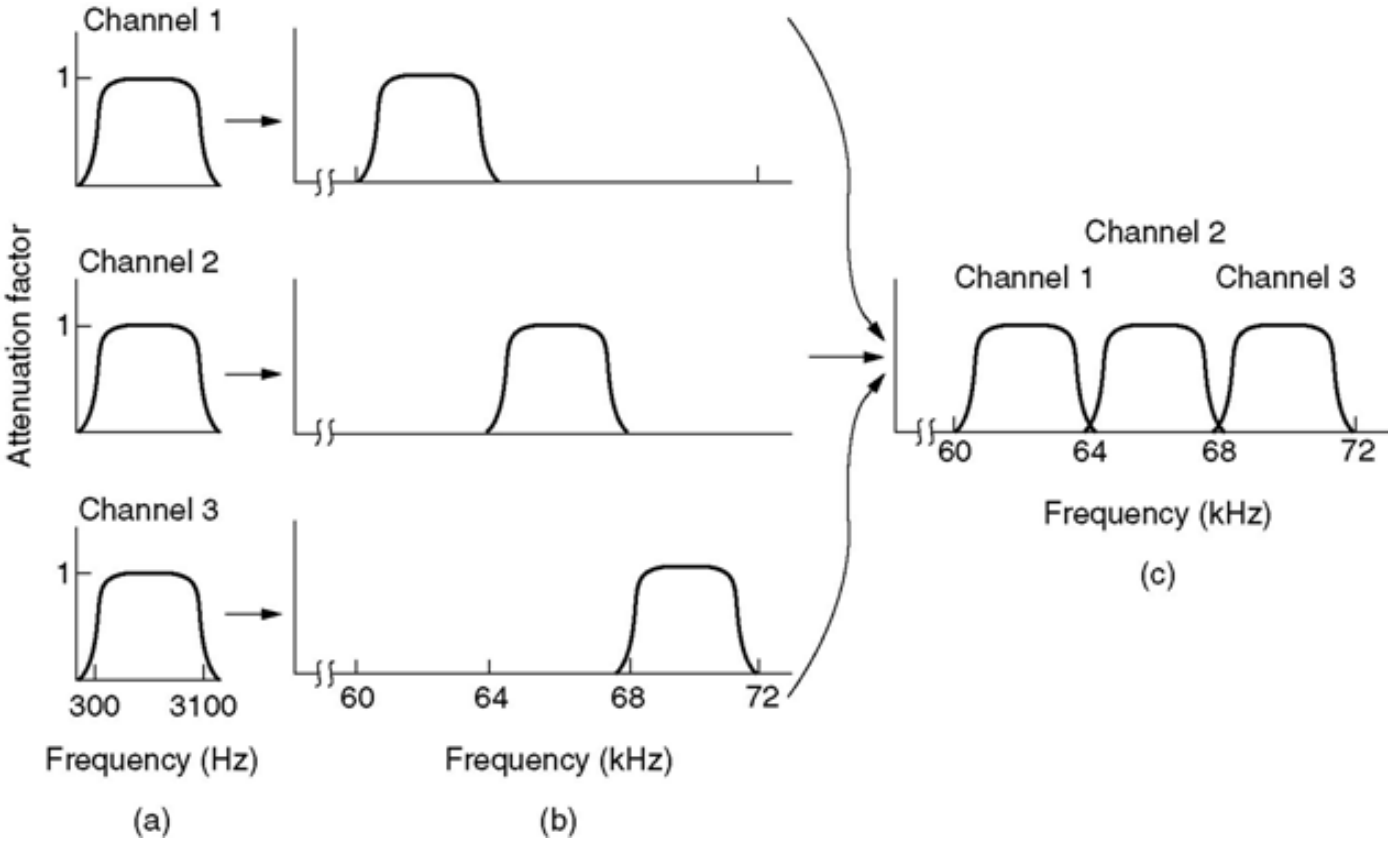


Computer Networks
Lecture 2

Multiplexing

- If the medium provides the wider bandwidth than is required by a single channel, multiple (sub)channels may share the same medium
  - Frequency-Division Multiplexing (FDM)
  - Time-Division Multiplexing (TDM)
  - Statistical Multiplexing (cells/packets)
- The medium may be shared either as a point-to-point link or by multiple transmitters and receivers (multiple access)

Frequency Division Multiplexing (FDM)



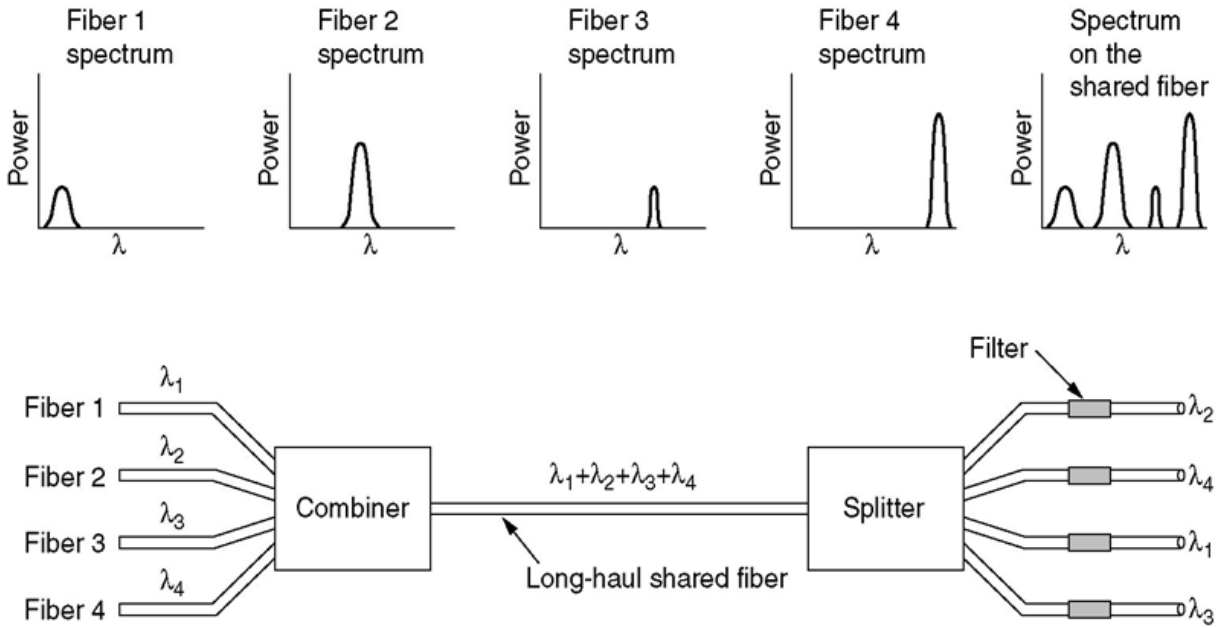
modulation, (filtering), transmission, filtering, demodulation

Characteristics of the FDM

- The number of subchannels and utilized frequencies are fixed and highly dependent on a circuitry design (capabilities of the analog part)
- The frequency band is not fully utilized as we need to maintain gaps between subbands
  - or to solve problems related to partial overlap of subchannels bands
- FDM is efficient for a fixed number of users that fully utilize a dedicated band all the time
  - e.g. bundling of voice channel on POTS trunks

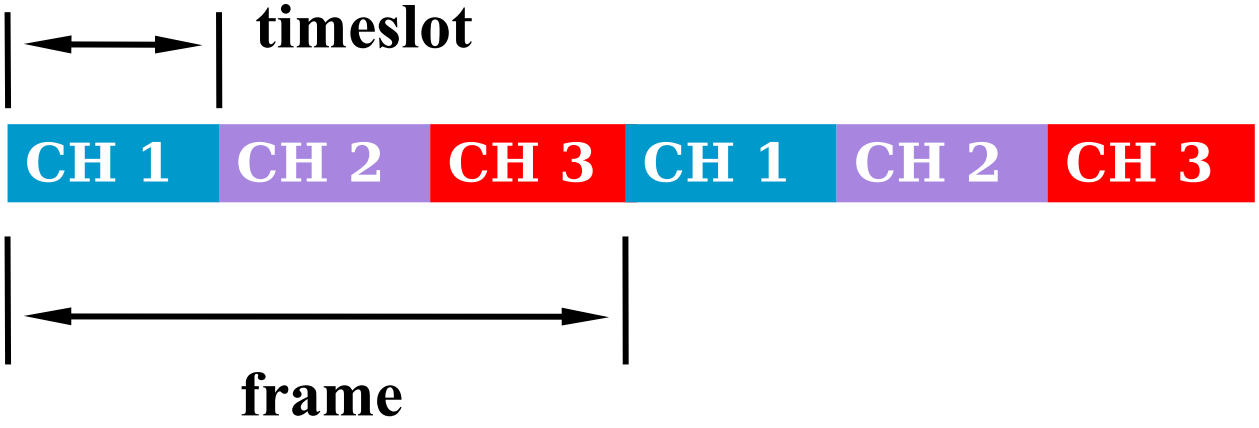
Wave Division Multiplexing (WDM)

- Special case of FDM
- May be implemented by a purely passive (and thus reliable) system (prism)
- Used in high-speed WANs and FTTC optical networks



Time Division Multiplex (TDM)

- Timeslots are organized into repeating frames
- Mechanisms for bit synchronization and frame synchronization have to be implemented
- The technical implementation may be rather flexible
  - The frame structure (e.g. the number of timeslots) may be configurable in software without a need to change the circuitry



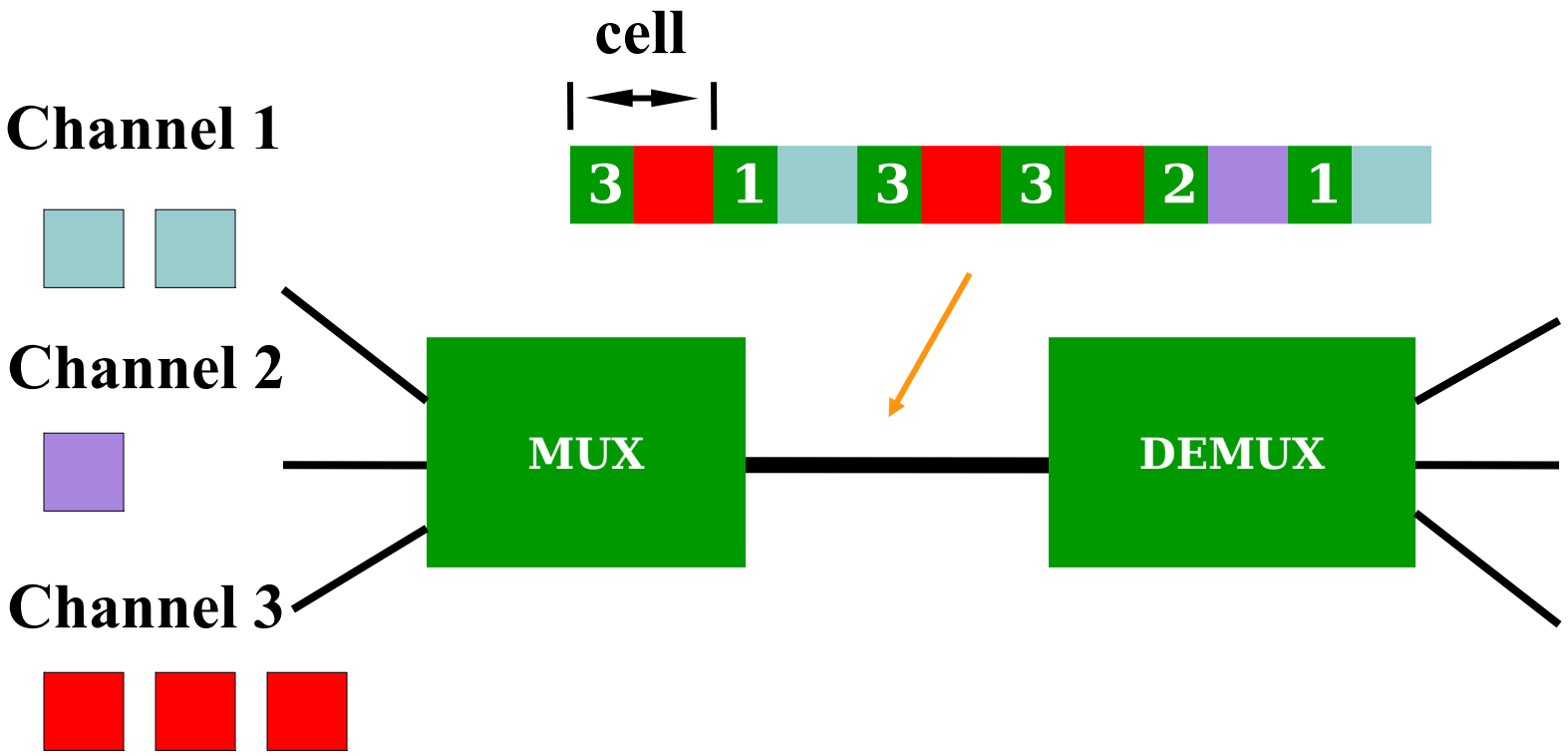
Statistical Multiplexing (1)

- The most of data transfers between computer systems are bursty
  - The peak-to-average ratios of 1000:1 are common
- It is inefficient to dedicate a guaranteed capacity for individual communications
- The disadvantage of TDM is the fixed assignment of timeslots to subchannels
  - that does not reflect the bursty nature of the subchannels' traffic

Statistical Multiplexing (2)

- The problem may be solved using a statistical multiplex scheme, in which data are transmitted in packets/cells with headers identifying the source/destination pair
  - Either the variable-length packets or fixed-length cells may be used
    - the latter is more predictable so QoS implementation is easier
- Individual packets/cells may be multiplexed arbitrarily on the medium at the transmitter side
  - The demultiplexer on the receiving side may differentiate data of individual subchannels using headers
- The link may be reasonably oversubscribed

An Example of Statistical Multiplexing: Asynchronous Transfer Mode Networks



Combination of the Multiplexing Methods

- GSM: FDM + TDMA
  - Each GSM cell serves multiple channels on various frequencies
  - Every channel is further divided using TDM
- WiFi
  - FDM + TDMA (some parts)/ + Statistical multiplex
- Optical WDM Internet links (IP)
  - FDM + Statistical multiplex