IS2111
Computer Networks

Multiplexing | Mobile Phone Systems | PSTN

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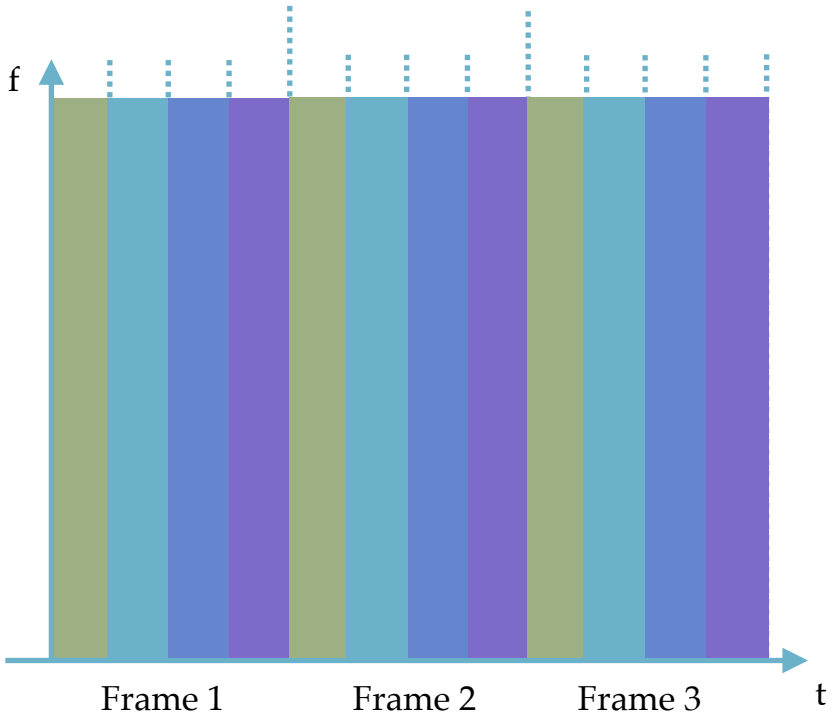
Topic to be Covered

- Multiplexing
- Public Switched Telephone Network
- Switching
- Mobile telephone systems

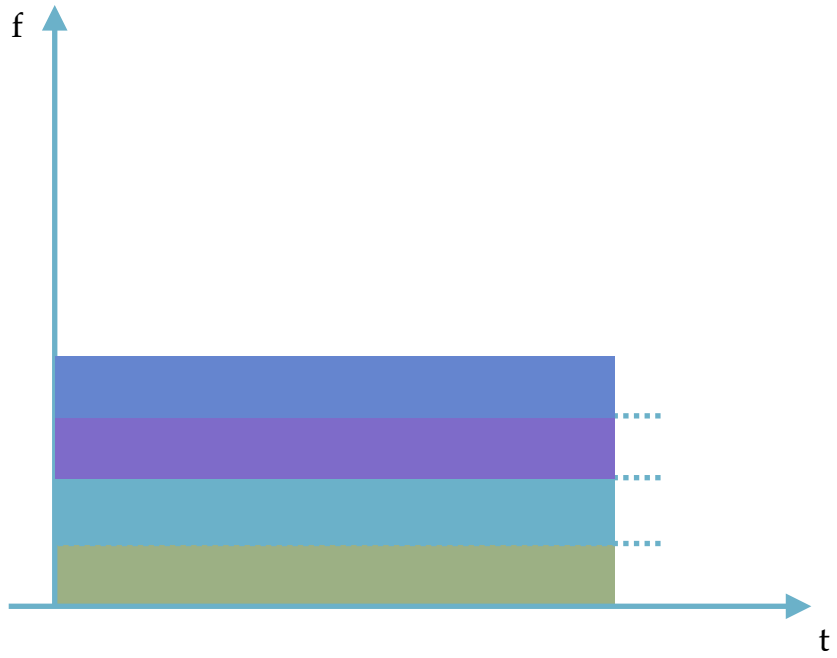
Multiplexing

- Time Division Multiplexing (TDM)

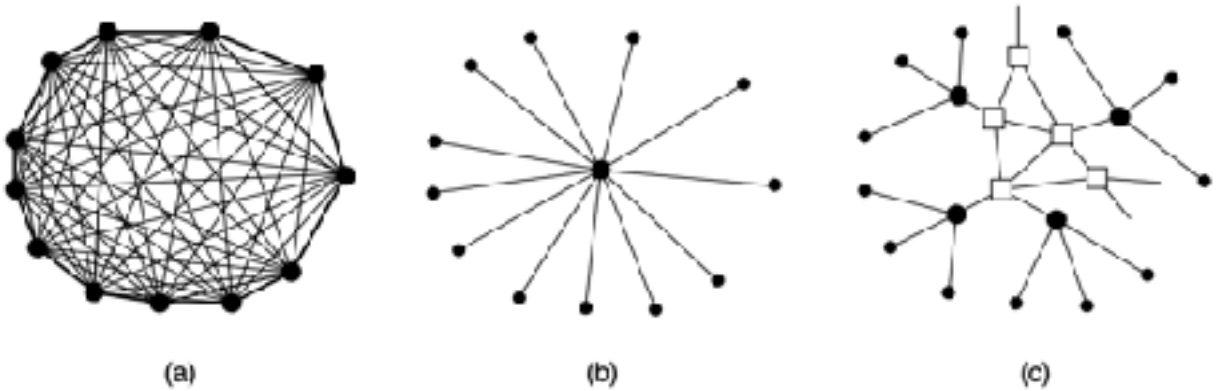


Multiplexing

- Frequency Division Multiplexing (FDM)



Public Switched Telephone Network (PSTN)

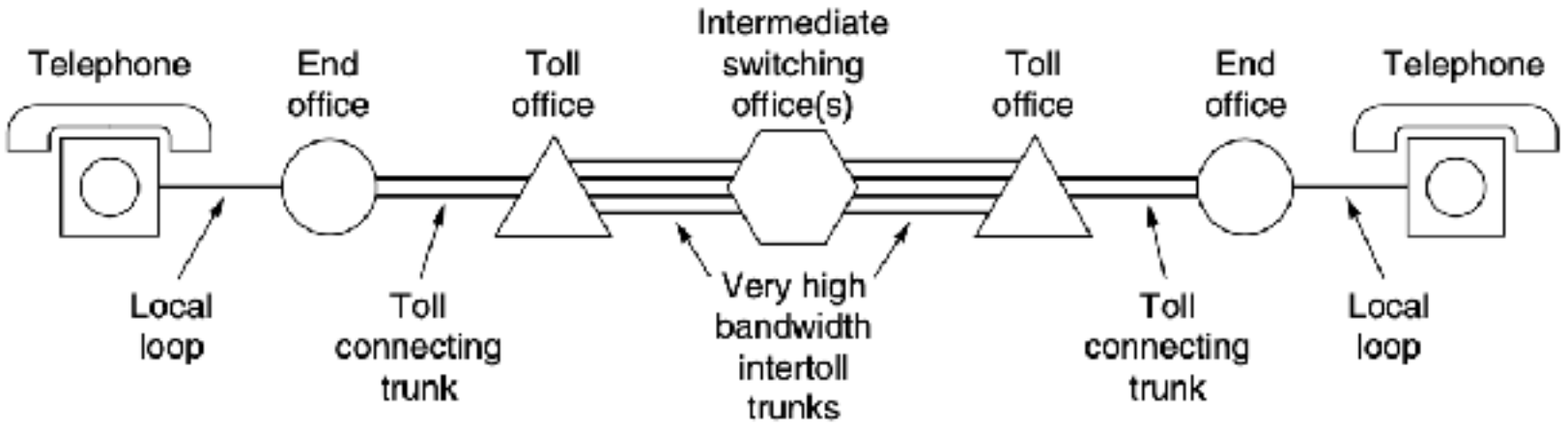


a - fully interconnected network

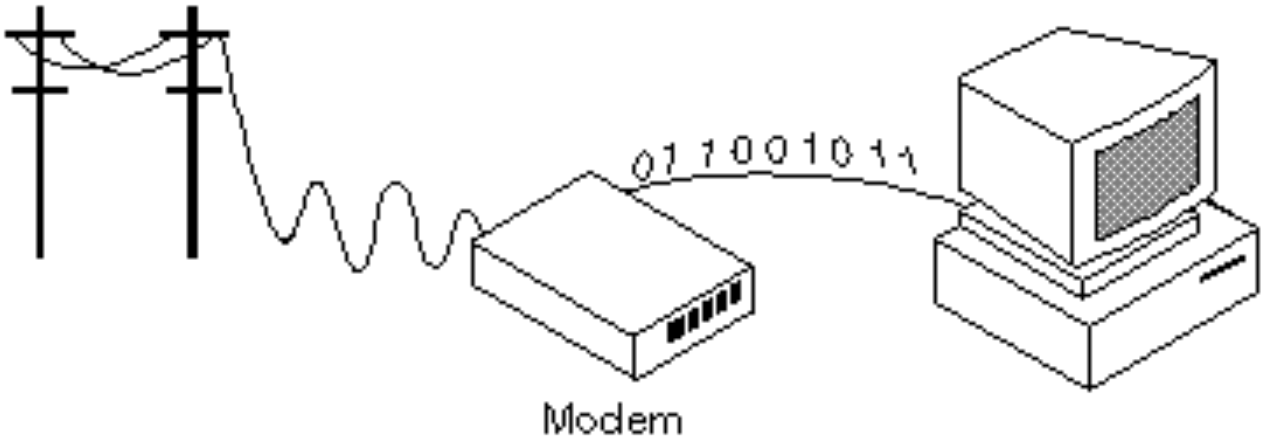
b - centralized switch

c - Two level hierarchy

Public Switched Telephone Network (PSTN)



Telephone Modems



https://www.webopedia.com/definitions/internal-modem/

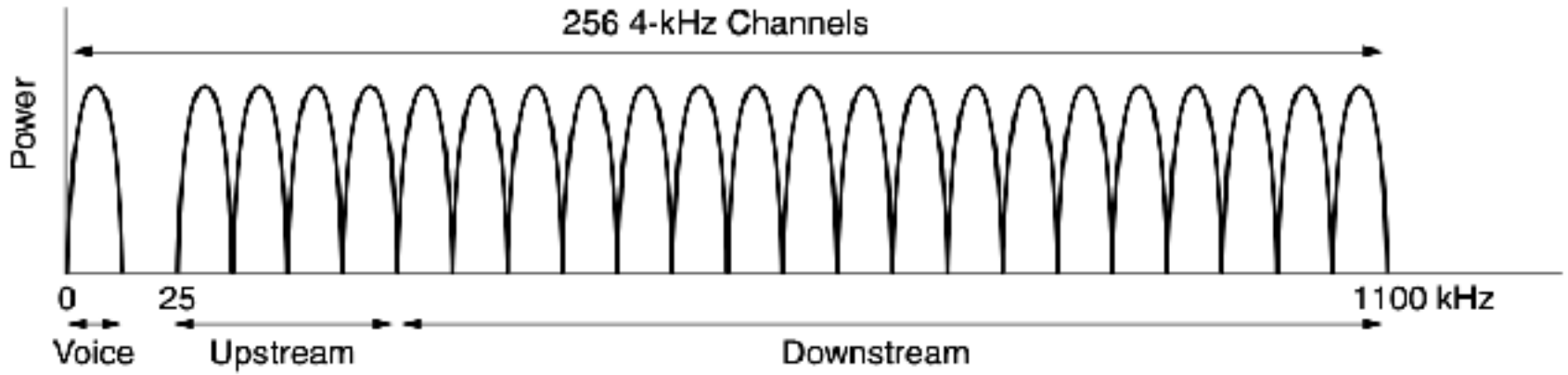
Digital Subscriber Line (DSL)

- Why modems are slow?

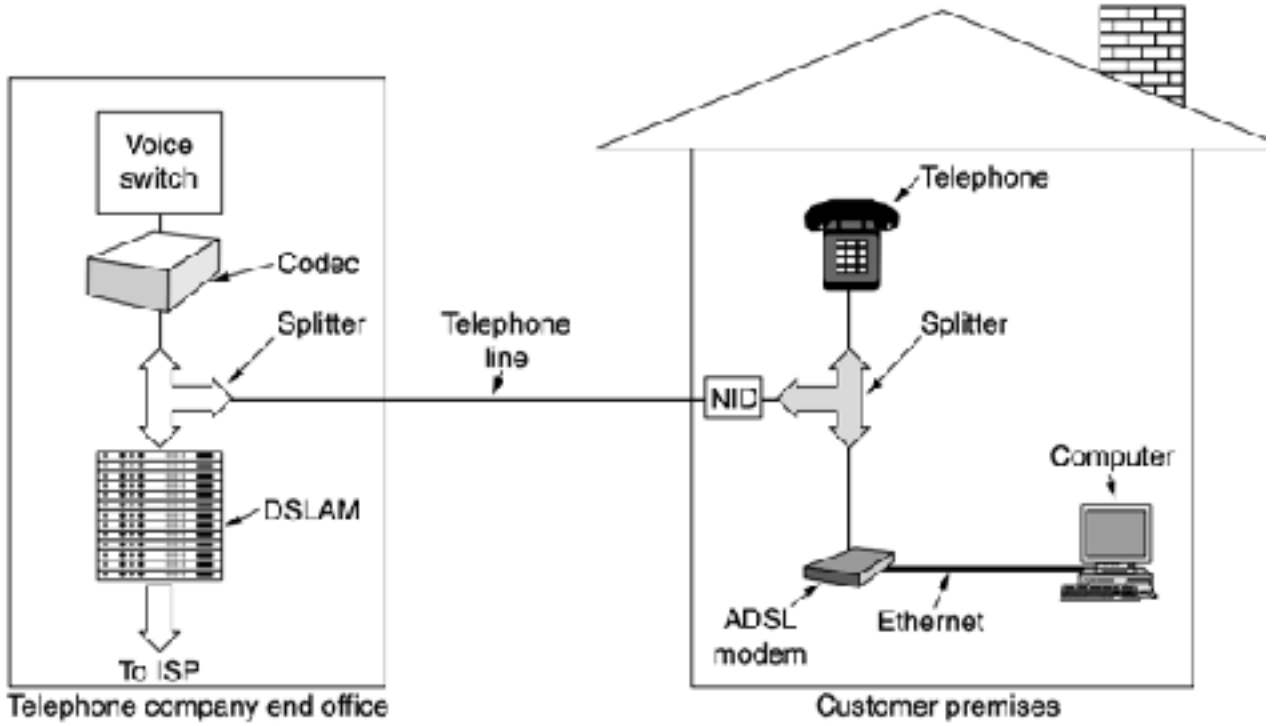
- xDSL
  - Must work with available cat3 cables
  - Must not affect the existing telephones and other devices
  - Faster than 56k

Digital Subscriber Line (DSL)

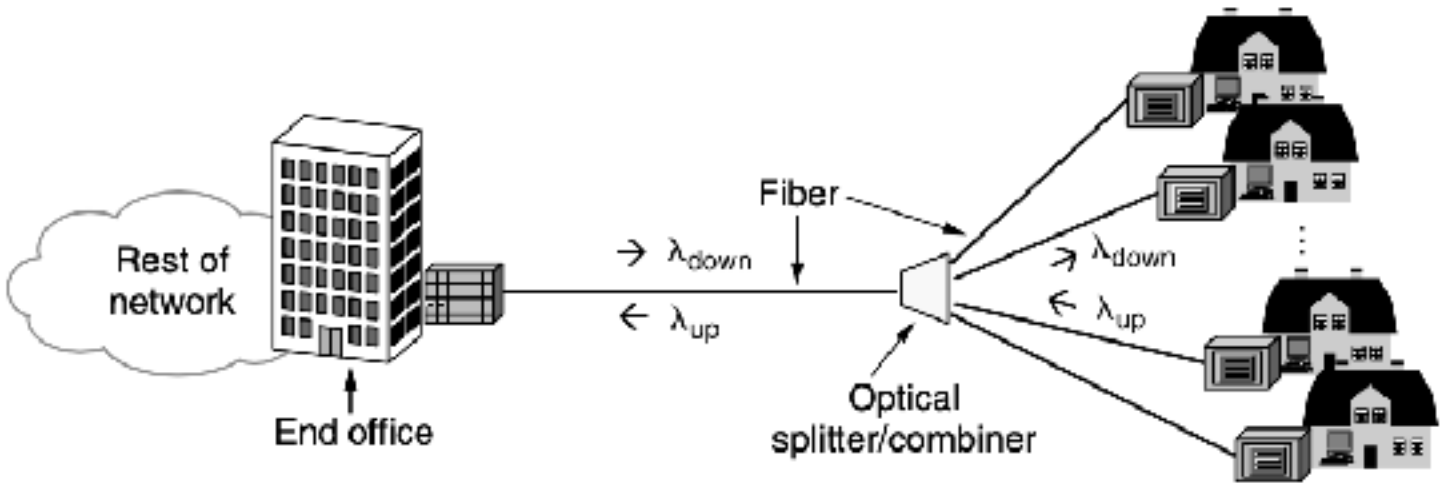
- SDSL
- ADSL



Digital Subscriber Line (DSL)



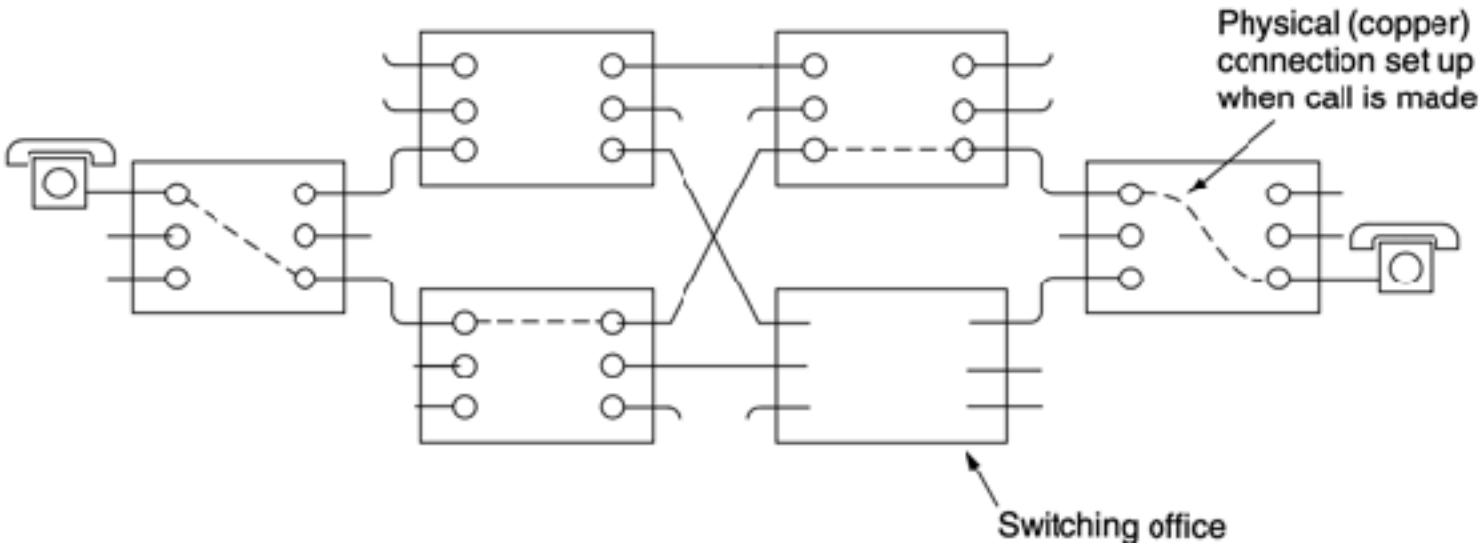
Fiber


Rest of network
End office
Fiber
λ_{down}
λ_{up}
Optical splitter/combiner
λ_{down}
λ_{up}

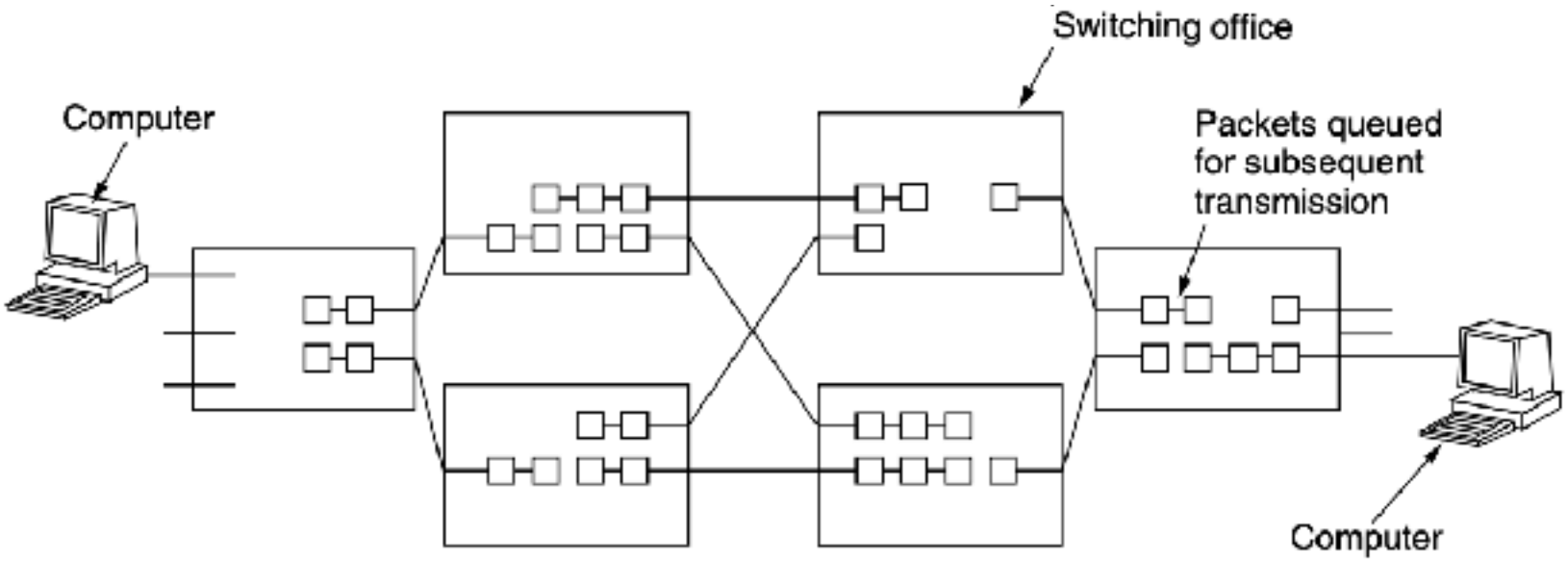
Switching

- Circuit switching
- Packet switching

Switching - Circuit switching



Switching - Packet switching



Switching

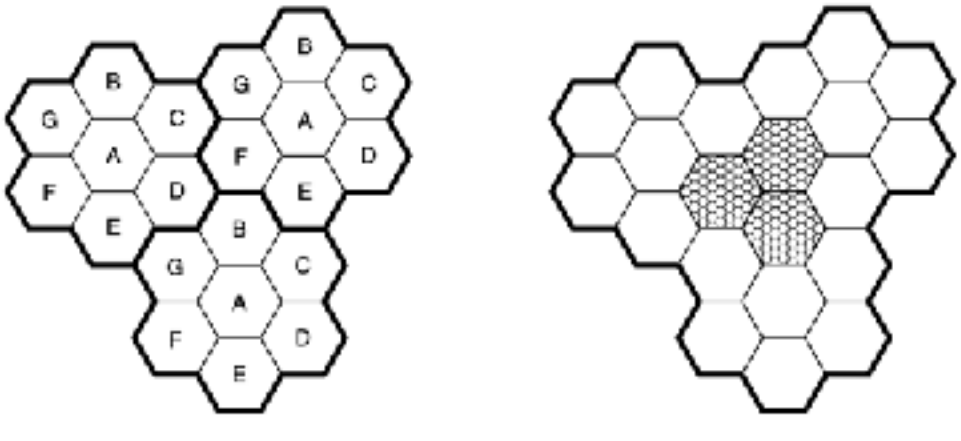
Item	Circuit switched	Packet switched
Call setup	Required	Not needed
Dedicated physical path	Yes	No
Each packet follows the same route	Yes	No
Packets arrive in order	Yes	No
Is a switch crash fatal	Yes	No
Bandwidth available	Fixed	Dynamic
Time of possible congestion	At setup time	On every packet
Potentially wasted bandwidth	Yes	No
Store-and-forward transmission	No	Yes
Charging	Per minute	Per packet

Mobile telephone systems

- Generations
  - 1G
  - 2G
  - 3G
  - 4G
  - 5G

Mobile telephone systems

- 1G
  - Analog Voice
  - Push-to-talk systems
  - Advanced mobile phone system (AMPS)



Mobile telephone systems

- 1G
  - Advanced mobile phone system (AMPS)
    - AMPS uses FDM to separate the channels.
    - The system uses 832 full-duplex channels, each consisting of a pair of simplex channels.
    - Since the same frequencies cannot be reused in nearby cells and 21 channels are reserved in each cell for control, the actual number of voice channels available per cell is much smaller than 832, typically about 45.

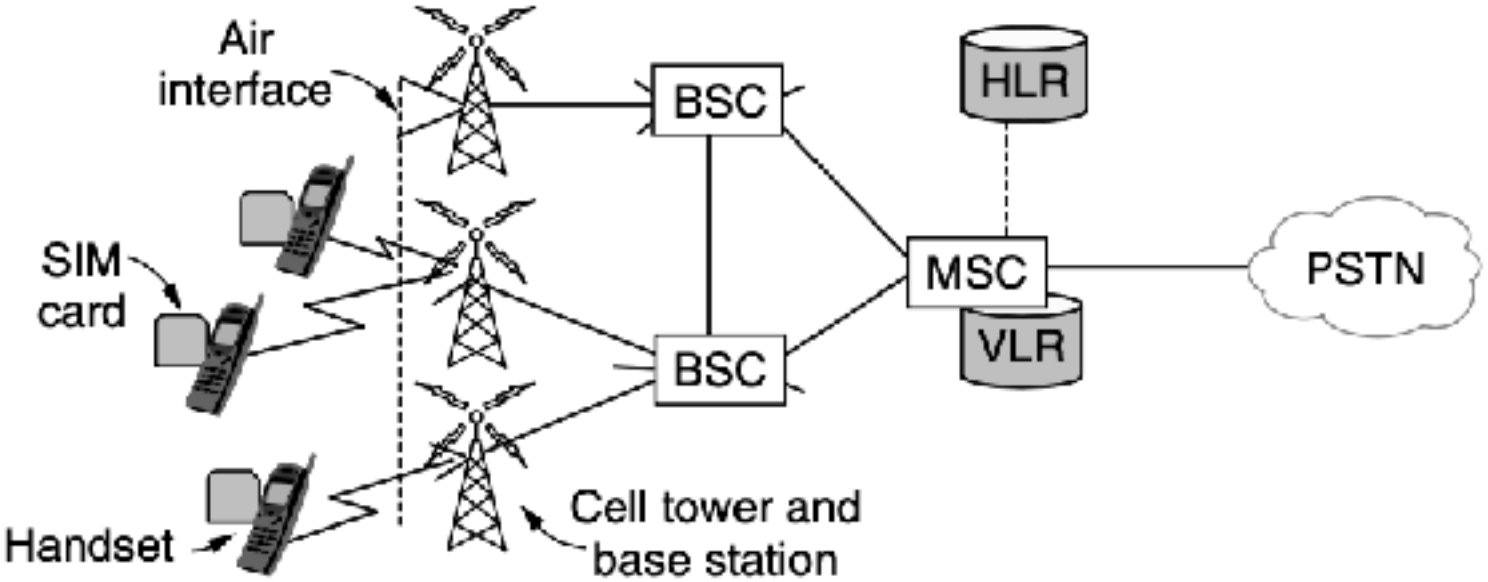
Mobile telephone systems

- 2G
  - DigitalVoice
  - Improves security by allowing voice and control signals to be encrypted
  - SMS
  - D-AMPS(Digital Advanced Mobile Phone System) is a digital version of AMPS that coexists with AMPS and uses TDM to place multiple calls on the same frequency channel.

Mobile telephone systems

- 2G
  - GSM (Global System for Mobile communications)
  - GSM is based on a mix of FDM and TDM
    Handset and a removable chip(SIM card, short for Subscriber Identity
    Module)
  - GSM is a frequency division duplex cellular system, like AMPS
  - However, unlike with AMPS, with GSM a single frequency pair is split by time-division multiplexing into time slots. In this way it is shared by multiple mobiles.

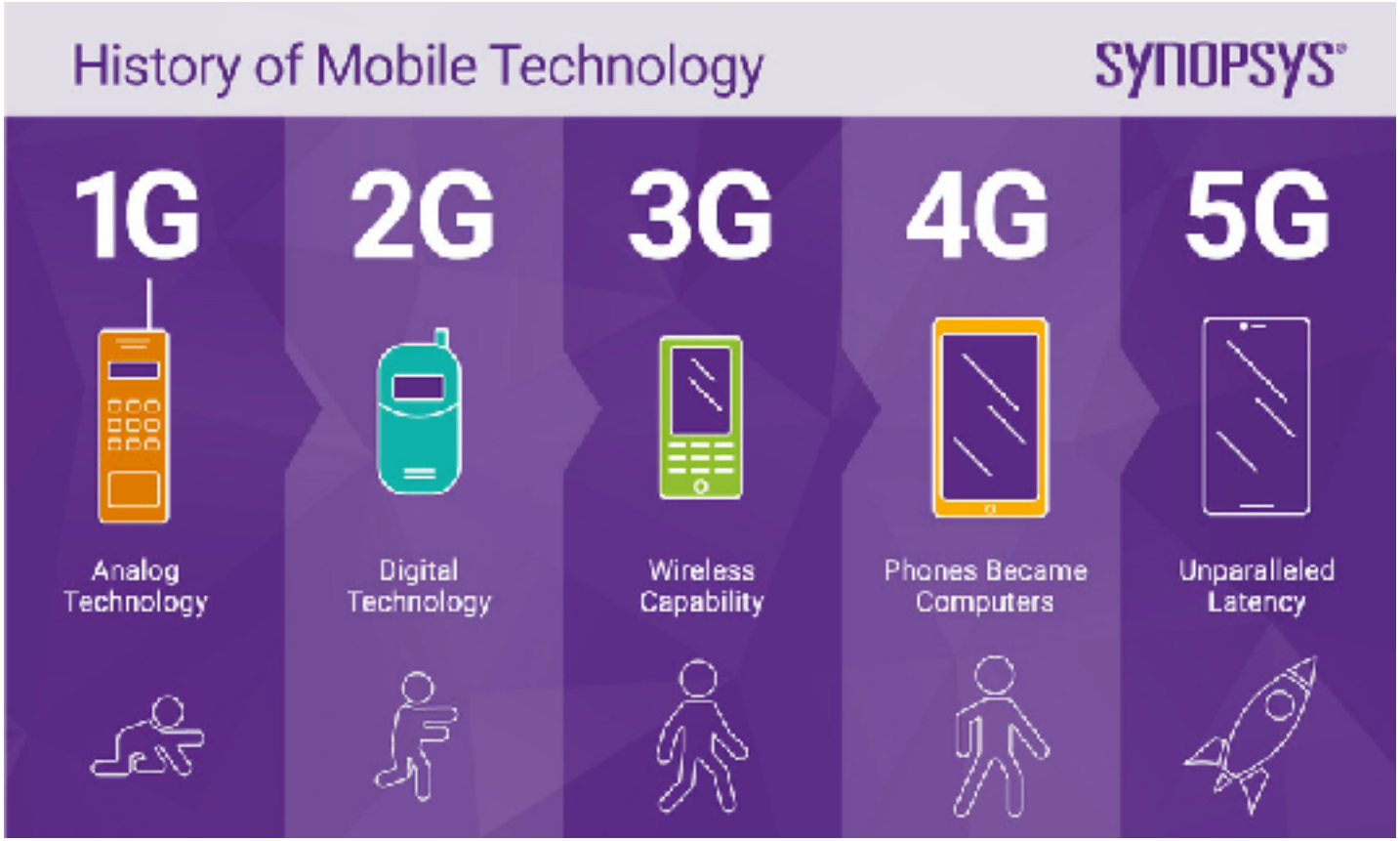
Mobile telephone systems



Mobile telephone systems

- 3G
  - Digital Voice and DATA
  - Data traffic increased - Entertainment, Email and all
  - W-CDMA - Erricson, CDMA2000 Qualcomm
  - By June 2007, the 200 millionth 3G subscriber had been connected
  - Download speeds of up to 7.2Mbps

4G and 5G



https://www.synopsys.com/5g/5g-vs-4g.html