

Long-Distance Communication (carriers and modems)

Sending signals over long distances

Modems

Leased serial data circuits

Optical, radio and dialup modems

Multiplexing

DSL and Cable modems

Signalling across long distances

- Resistance in wires => signal loss => current cannot be propagated over long distances
- A continuous oscillating signal will propagate further than other signals

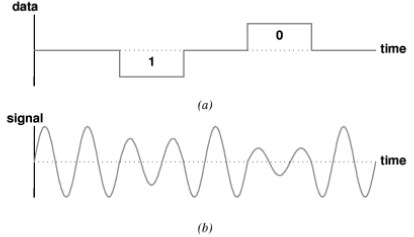


Modulation

- Send an oscillating carrier wave and then modulate it in some way
- Technique originated with radio and TV (stations use different carrier frequencies)
- Transmitter generates carrier and modulates according to data, receiver discards carrier
- Two approaches from radio are frequency modulation (FM) and amplitude modulation (AM)

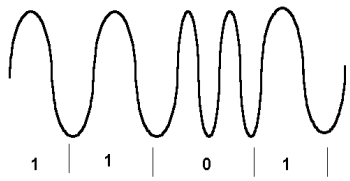
Amplitude modulation (AM)

- Change amplitude of the carrier according to the data



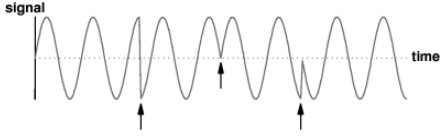
Frequency modulation (FM)

- Slightly change frequency of the carrier according to the data



Phase shift keying (PSK)

- FM and AM require at least one wave cycle to send a bit
- Phase shift changes the timing of the carrier and can send several bits per cycle



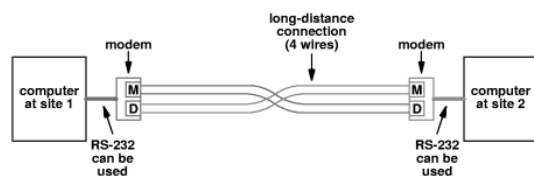
Phase shift modulation 2

- Amount of phase shift can be measured
 - How much of sine wave is "skipped"
 - Example shows 1/4, 1/2 and 3/4 cycle
- Each phase shift can be used to carry more than one bit. In example:
 - 00 - no shift
 - 01 - 1/4 phase
 - 10 - 1/2 phase
 - 11 - 3/4 phase
- Thus, each phase shift carries 2 bits

Modems

- Hardware that takes bits and applies modulation is a *modulator*
- Hardware that takes a modulated wave and extracts bits is a *demodulator*
- Full duplex communication requires a combined modulator-demodulator (MODEM) at both ends

Example modem connection



Leased serial data circuits

- Long distance four wire circuits can be leased from a phone company (spare circuits are often included in trunk cables for expansion purposes)
- Often called a serial line or serial data circuit

Optical, radio and dialup modems

- Modems also used with optical fibre, radio and conventional phone connections
- Dial-up modems work with the existing phone system
 - mimic telephones
 - use a carrier that is an audible tone
 - use a single voice channel (2 wire circuit) and co-ordinate to achieve full duplex communication

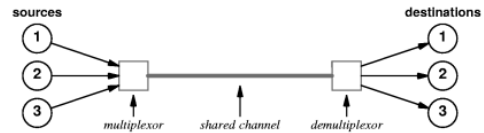
Dial-up modem configuration



Analogue and Digital Data And Signalling

	Signal	
	Analogue	Digital
Data	Analogue	Telephone
	Digital	MODEM
		CODEC
		Digital Transmitter

Multiplexing



- Two or more signals with different carrier frequencies transmitted over one medium
- Several logical connections share a single physical connection - Frequency Division Multiplexing (FDM)

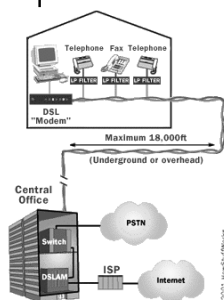
Frequency division multiplexing

- Minimum frequency separation => requires high bandwidth connection
- Broadband (vs. baseband) technology
- Spread spectrum - use of multiple carriers to improve reliability
- Also, single logical channel may simultaneously use multiple carriers to improve performance

Time division multiplexing

- TDM is an alternative to FDM where the sources sharing the medium take turns
 - Synchronous Time Division Multiplexing – round robin
 - Statistical Multiplexing – skips a source if it does not have data to send

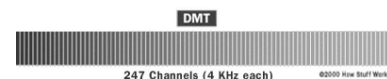
Digital Subscriber Line (DSL)



- Uses the two-wire local loop from telephone company end office to homes
- Normal telephone lines are limited to the frequency range of human voices (0-3400 Hz)
- DSL uses the entire bandwidth of the local loop
- However, capacity decreases with connection distance
 - limit 18,000 feet (5,460 m)

Digital Subscriber Line (DSL)

- DMT (Discrete MultiTone) divides the data into 247 separate channels, each 4 KHz wide

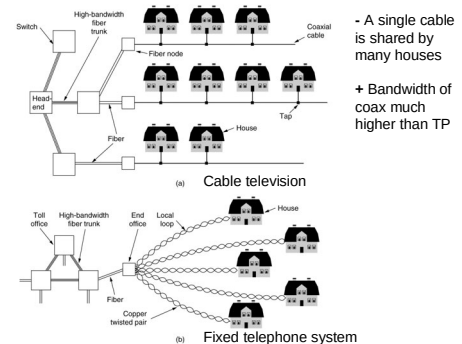


- equivalent of 247 modems connected to your computer at once!
- Channel 0 is used for voice
- Usually 80-90% of the rest of the channels are used for downstream communication (Asymmetrical DSL)

Digital Subscriber Line (DSL)

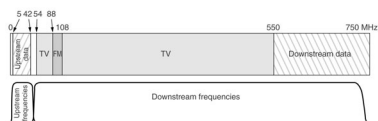
ADSL speed	Downstream	Upstream
Maximum	8Mbps	1Mbps
Typical	768Kbps or 1.5Mbps	128Kbps or 256Kbps

Cable Connection



Cable Connection

- Sharing the cable for Internet and TV



- To cope with long coaxial cables analog modulation is needed
 - downstream channels – a form of AM
 - upstream channels – a form of PSK
- A cable modem connect a computer (through USB or Ethernet interface) to the cable network

Summary

- Signals degrade over distance
- Oscillating waves propagate further
- Modulation - FM, AM and phase shift
- Modems, including dial-up modems
- Multiplexing - FDM and TDM
- DSL and Cable connection

Summary of Part 1: data transmission

- Transmission media
- Local asynchronous communication and RS-232
- Long distance communication
- Sample exam question:
<http://www.crg.cs.nott.ac.uk/~bnk/Teaching/INC/>