----------Height Speed Network----------

x.25 Interface between host and packet switched network

Defines three layers

Physical

Link

Packet

Physical Interface between attached station and link to node

DTE

DCE

Link

LAPB

LAPB Adopts HDLC

LAPB subset of HDLC

Ensure the synchronization of information between the receiver and sender

Detect and correct errors

Identify and report the procedure error

Inform the packet layer of the link layer state

Packet

External virtual circuits

Logical connections (virtual circuits) between subscribers

Virtual Circuit Service

Virtual Call Dynamically established

The connection established via X.25 protocol between two DTEs is called (VC)

VCs involve

1- Permanent Virtual Circuit

connections are always open, ready for data to be sent and/or received

2- Switched Virtual Circuit (SVC)

connections must be re-established every time a new session of data exchange is to take place, and the connections are broken at the end of the session

ATM and packet switching Transfer of data in discrete chunks

ATM and packet switching Multiple logical connections over single physical interface

Virtual Path (VP):

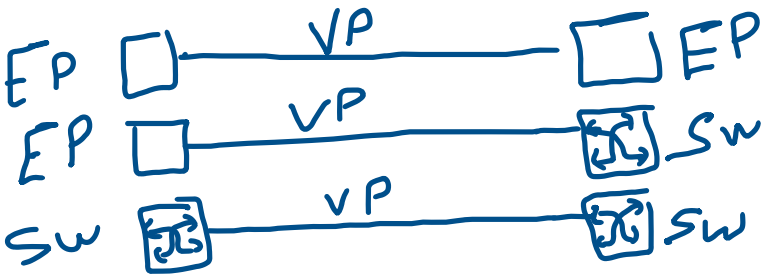
route through the network representing a group of virtual channels

VPs may exist:

Between ATM endpoints

Between ATM switches and ATM endpoints

Between ATM switches



ATM

Minimal error and flow control (Reduced overhead)

ATM Logical Connections

Virtual channel connections

Virtual path connection

Between two end users

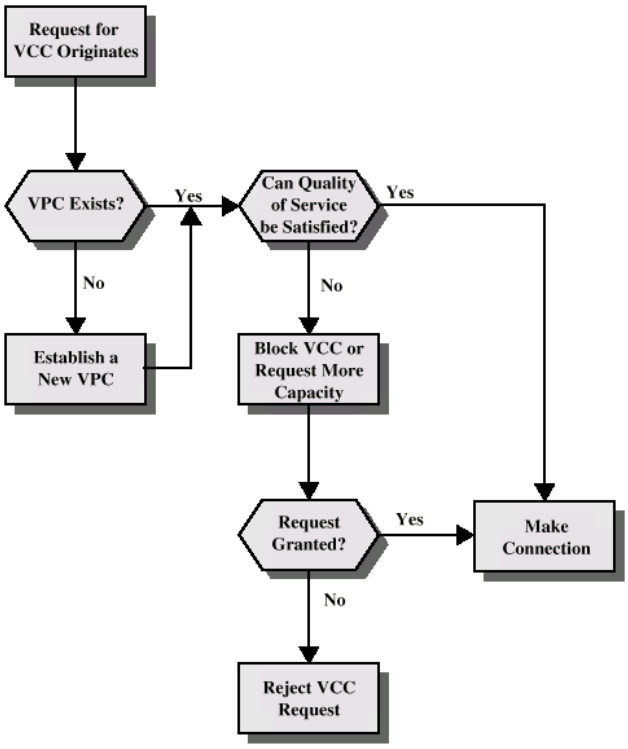
Basic unit of switching

Analogous to virtual circuit in X.25

Full duplex

Fixed size cells

Call Establishment Using VPs



ATM Cells

Fixed size

5 octet header

48 octet information field

Small cells reduce queuing delay for high priority cells

Small cells can be switched more efficiently

Easier to implement switching of small cells in hardware

Header Format

GFC, VPI, VCI , PT, CLP, HEC

ATM Service Categories

Real time	**Non-real time**
CONSTANT BIT RATE	Available bit rate
Real time variable bit rate	Non-real time variable bit rate
	Unspecified bit rate

Real Time Services

Amount of delay

Jitter

Adaptation a Services

Handle transmission errors

Segmentation and re-assembly

Handle lost and mis-inserted cells

Flow control and timing

FRAME RELAY

high-performance WAN protocol

operates at the physical and data link layers

Originally designed for use across ISDN interfaces

An example of packet-switched technology

described as a streamlined version of X.25

Frame Relay vs. X.25

Frame Relay is a **Layer 2** protocol suite, X.25 provides services at **Layer 3**

Frame Relay offers higher performance and greater transmission efficiency than X.25

Frame Relay Devices

DTE

DCE

Frame Relay Virtual Circuits

provides connection-oriented data link layer communication

logical connection between two DTE across a Frame Relay

provide a bi-directional communications path from one DTE device to another

Switched virtual circuits (SVCs)

- *Call Setup*
- *Data Transfer*

- *Idle*
- *Call Termination*

Permanent Virtual Circuits (PVCs)

- *Data Transfer*
- *Idle*

Congestion Control Mechanism

Forward-explicit congestion notification (FECN)

Backward-explicit congestion notification (BECN)

Frame Relay Discard Eligibility (DE)

(DE) bit is used to indicate that a frame has lower importance than other frames

When the network becomes congested, DCE devices will discard frames with the DE bit

في حال ازدحمت الشبكة جهاز DCE راح يتجاهل الفريم اللي محتواه DE

Frame Relay Error Checking

known as the cyclic redundancy check (CRC)

CRC compares two calculated values to determine whether errors

Frame Relay Network Implementation

consists of a number of DTE devices connected to remote ports on multiplexer equipment via traditional point-to-point services

widely-spread protocols:

SLIP

PPP

SLIP

extending TCP/IP networking with dial-up serial connection

Users

UNIX

Advantage

Very simple protocol

Easy implementation

Disadvantage

Does not support error detection and correction

Support only ip

Requires advance knowledge of the peer's ip address

Is not approved internet standard

Does not provide any form of authentication

PPP

Support multiple network protocols

Link configuration

Error detection

Establishing network addresses

Authentication

Extensibility

PPP relies on another DLP – HDLC – to perform some basic operations

After the initial handshake, PPP executes its own handshake

PPP itself consists of two protocols:

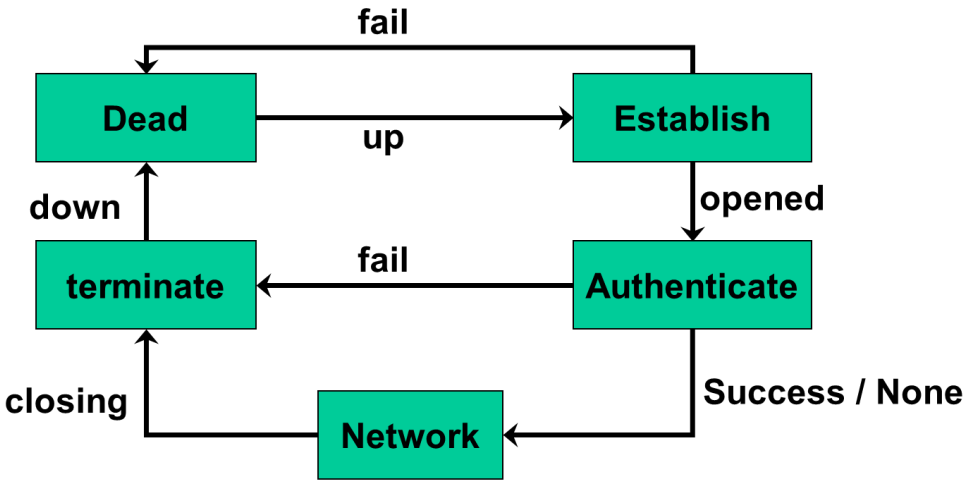
LCP – Link Control Protocol

NCP – Network Control Protocol

Differences Between SLIP & PPP

S. No.	SLIP	PPP
1.	SLIP stands for Serial Line Internet Protocol.	PPP stands for Point-to-Point Protocol
2.	SLIP does not perform error detection & correction.	PPP performs error detection & correction.
3.	SLIP supports only IP.	PPP supports multiple protocols.
4.	IP address is assigned statically.	IP address is assigned dynamically
5.	SLIP does not provide any authentication.	PPP provides authentication.
6.	SLIP is not approved Internet standard.	PPP is approved Internet standard.

PPP state machine



43

Almost universal on packet switched networks and packet switching in ISDN [T or F]

LAPB can directly carry non-X.25 upper layer protocols for data transmission [T or F]

…….. Transmit the data effectively between DTE and DCE

Exists logically and is distinct from the physical circuit in circuit switching in nature called (……)

In VC when establishing a connection between two DTE what protocol is used?

packet switching Transfer of data in discrete chunks [T or F]

In ATM flow on each logical connection is in fixed sized packets called ……

virtual channel connection is the end-to-end connection [T or F]

On which layers does frame relay work?

X.25 a streamlined version of frame relay [T or F]

DCE is owned by the carrier [T or F]

……provide clocking and switching services in a network

Establishing PPP communication requires transitioning a connection **through several states** [T or F]

----------Wireless Network----------

Wireless Network

wireless local area network that uses radio waves as its carrier.

Complete Wireless Networks

Referred to as ad hoc networks

Are self-organizing networks without any centralized control

Suited for temporary situations such as meetings and conferences.

How are WLANs Different?

They use specialized physical and data link protocols

They let you stay connected as you roam from one coverage area to another

unique **security**

Different hardware

Different performance

Wireless Access Points: small device that bridges wireless traffic to your network.

Roaming:

user maintain a continuous connection as they roam from on physical area to another

Methods: DHCP, Mobile IP

Defines 802.11 standard for WLANs using the following four technologies

Frequency Hopping Spread Spectrum (FHSS)

Direct Sequence Spread Spectrum (DSSS)

Infrared (IR)

Orthogonal Frequency Division Multiplexing (OFDM)

Version: 802.11a, 802.11b, 802.11g, 802.11e, 802.11f, 802.11i

Standard	**802.11a**	**802.11b**	**802.11g**	**802.11n (Draft)**
Band	5GHz	2.4GHz	2.4 GHz	2.4 or 5GHz
Speed	54Mbps	11Mbps	54Mbps	700Mbps
Range	50 feet	100 feet	100 feet	50 feet
Cost	More expensive.	Least expensive	less costly than 5 GHz	
	Less prone to interference.	Prone to interference	Prone to interference	
power	Power consumption	Less Power consumption	Less Power consumption	

Properties of ad-hoc

- Requires devices to cooperate autonomously
- Without user intervention
- Rapid self-organizing wireless network
- Independent of infrastructure
- Heterogeneous & adaptive

sensor

A transducer

converts physical phenomenon e.g. heat, light, motion, vibration, and sound into electrical signals

sensor node

basic unit in sensor network

contains on-board:

- sensors
- processor
- memory
- transceiver
- power supply

sensor network

consists of a large number of sensor nodes

nodes deployed either inside or very close to the sensed phenomenon.

Wireless Sensor Networks Applications

1. Military Applications
    a. Monitoring friendly forces, equipment
    b. Battlefield surveillance
    c. Targeting
    d. Battle damage assessment
    e. Nuclear, biological, and chemical attack detection
    f. Reconnaissance of opposing forces and terrain
2. Environmental Applications
    a. Forest fire detection
    b. Bio-complexity mapping of environment
    c. Flood detection
    d. Precision Agriculture
    e. Air and water pollution
3. Health Applications
    a. Telemonitoring of human physiological data
    b. Tracking and monitoring doctors and patients inside a hospital
    c. Drug administration in hospitals
4. Home and Office Applications
    a. Home and office automation
    b. Smart environment
5. Automotive Applications
    a. Reduces wiring effects
    b. Measurements in chambers and rotating parts
    c. Remote technical inspections
    d. Conditions monitoring e.g., at a bearing

Sensor Node Components

- Sensing Unit
- Processing Unit
- Transceiver Unit
- Power Unit
- Location Finding System (optional)
- Power Generator (optional)

Factors Influencing WSN Design

- Fault tolerance
- Scalability
- Production costs
- Hardware constraints
- Sensor network topology
- Environment
- Transmission media
- Power Consumption
- Sensing, Communication, and Data processing

A Few WSN Protocols

Sensor management protocol

Sensor query and data dissemination protocol

Directed diffusion

Sensor MAC (S-MAC)

IEEE 802.15.4

WSN Operating Systems

TinyOS, Contiki, MANTIS, BTnut, SOS, Nano-RK

WSN Simulators

NS-2, GloMoSim, OPNET, SensorSim, J-Sim, OMNeT++, Sidh, SENS

The last link with the users is wireless [T or F]

The backbone network usually uses cables [T or F]

The wireless LAN dos does not need connects to a wired LAN [T or F]

…… small device that bridges wireless traffic to your network.

converts physical phenomenon e.g., heat, light, motion, vibration, and sound into electrical signals called …….

consists of a large number of sensor nodes called …….

----------Multimedia----------

QoS

network provides application with *level of performance needed for application to function.*

Classes of MM applications:

1) stored streaming

2) live streaming

3) interactive, real-time

Fundamental characteristics

typically delay sensitive

end-to-end delay

jitter

loss tolerant

loss intolerant but delay tolerant.

Jitter is the variability of packet delays within the same packet stream

Stored streaming：

- media stored at source
- transmitted to client
- streaming: client playout begins before all data has arrived

streaming: at this time, client playing out early part of video, while server still sending later part of video

Streaming Stored Multimedia: Interactivity

- VCR-like functionality: client can pause, rewind, FF, push slider bar
  - 10 sec initial delay OK
  - 1-2 sec until command effect OK
- timing constraint for still-to-be transmitted data: in time for playout

Streaming *Live* Multimedia

- Streaming (as with streaming stored multimedia)
  - playback buffer
  - playback can lag tens of seconds after transmission
  - still have timing constraint
- Interactivity
  - fast forward impossible

- rewind, pause possible!

- end-end delay requirements:
  - audio: < 150 msec good, < 400 msec OK

A few words about audio compression

analog signal sampled at constant rate

عبارة عن إشارة تناظريه بمعدل ثابت

telephone: 8,000 samples/sec

CD music: 44,100 samples/sec

كل ما زادت العينة كل ما زادت الدقة

each sample quantized, i.e., rounded

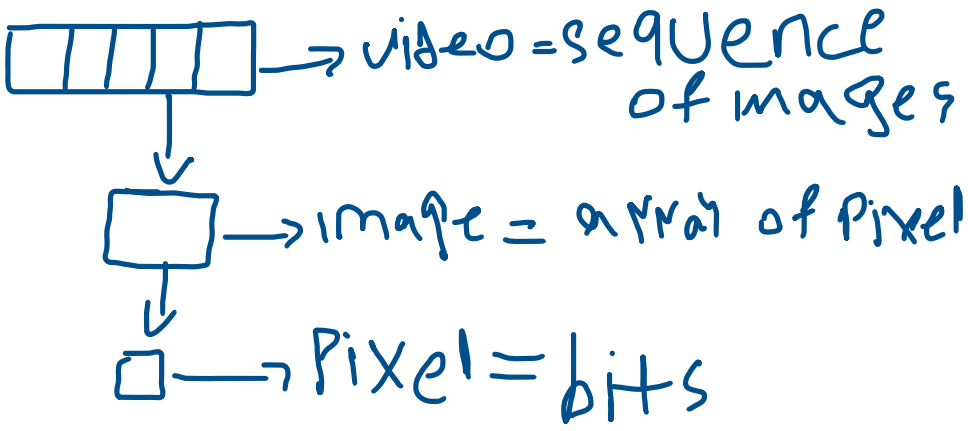
تحويل الإشارة التناظرية الى رقميه

A few words about video compression

video: sequence of images displayed at constant rate

digital image: array of pixels

each pixel represented by bits



redundancy

- spatial (within image)
- temporal (from one image to next)

application-level streaming techniques for making the best out of best effort service:

- client-side buffering
- use of UDP versus TCP
- multiple encodings of multimedia

Media Player

- jitter removal
- decompression
- error concealment
- graphical user interface

Internet multimedia

1) simplest approach

no, “pipelining,” long delays until playout!

files transferred as HTTP object

received in entirety at client

then passed to player

2) streaming approach

browser GETs metafile

browser launches player, passing metafile

player contacts server

server streams audio/video to player

Streaming from a streaming server

allows for non-HTTP protocol between server, media player

UDP or TCP for step (3), more shortly

Streaming Multimedia: UDP or TCP?

UDP

- server sends at rate appropriate for client (oblivious to network congestion !)
  - often send rate = encoding rate = constant rate
  - then, fill rate = constant rate - packet loss
- short playout delay (2-5 seconds) to remove network jitter
- error recover: time permitting

TCP

- send at maximum possible rate under TCP
- fill rate fluctuates due to TCP congestion control
- larger playout delay: smooth TCP delivery rate

- HTTP/TCP passes more easily through firewalls

User Control of Streaming Media: RTSP

HTTP

- does not target multimedia content
- no commands for fast forward, etc.

RTSP: RFC 2326

- client-server application layer protocol
- user control: rewind, fast forward, pause, resume, repositioning, etc…

Real-time interactive applications

- PC-2-PC phone
  - skype
- Pc-2-phone
  - Net2phone
- videoconference with webcams
  - polycom

Internet Phone: Packet Loss and Delay

- network loss: IP datagram lost due to network congestion **(router buffer overflow)**
- delay loss: **IP datagram arrives too late** for playout at receiver

Real-Time Protocol (RTP)

RTP specifies packet structure for packets carrying audio, video data

RFC 3550

RTP packet provides

- payload type identification
- packet sequence numbering
- time stamping

RTP runs in end systems

RTP packets encapsulated in UDP segments

interoperability: if two Internet phone applications run RTP, then they may be able to work together

RTP runs on top of UDP

RTP does **not** provide any mechanism to ensure timely data delivery or other QoS guarantees

Real-Time Control Protocol (RTCP)

works in conjunction with RTP.

each participant in RTP session periodically transmits RTCP control packets to all other participants.

each RTCP packet contains sender and/or receiver reports

RTCP Packets

Receiver report packets :fraction of packets lost, last sequence number, average interarrival jitter

Sender report packets : SSRC of RTP stream, current time, number of packets sent, Number of bytes sent

SIP: Session Initiation Protocol [RFC 3261]

All telephone calls, video conference calls take place over Internet

people are identified by names or e-mail addresses, rather than by phone numbers

you can reach callee, no matter where callee roams, no matter what IP device callee is currently using

SIP	H.323
SIP comes from IETF	H.323 comes from the ITU (telephony).
SIP is a single component. Works with RTP	H.323 is a complete,
Web flavor	telephony flavor.
UDP\TCP	TCP

Call Admission

R-spec: defines the QOS being requested

T-spec: defines traffic characteristics

RSVP: overview of operation

RTSP doesn’t specify how media player buffers audio/video [T or F]

RTSP doesn’t define how audio/video is encapsulated for streaming over network [T or F]

RTSP doesn't restrict how streamed media is transported (UDP or TCP possible) [T or F]

client playout begins before all data has arrived called ……

…….. libraries provide transport-layer interface that extends UDP

SIP long-term vision [T or F]

----------IP----------

Virtual circuits	Datagram network
each packet carries VC identifier	packets forwarded using destination host address
call setup, teardown for each call	no call setup
every router on source-dest path maintains state	no state about end-to-end

OSPF	RIP
LINK STATE	DISTANCE VICTOR
OPEN (FREE)	NOT OPEN
multiple same-cost paths allowed	ONLY ONE PATH
Security (authenticated)	No authenticated
INTEGRATED UNI-AND MULTICAST	does not support INTEGRATED UNI-AND MULTICAST