UNIT 3 – NETWORK LAYER (FULL THEORY)

1. Network Layer Functionalities

- Logical addressing (IP)
- Routing
- Packet forwarding
- Fragmentation
- Congestion control
- Error handling

Point-to-point Networks (PPP, HDLC)

HDLC:

- Reliable, synchronous protocol
- I-frames, S-frames, U-frames
- Frame: Flag | Addr | Control | Data | FCS | Flag

PPP:

- Modern WAN protocol
- LCP, NCP, PAP, CHAP
- Supports multiple NL protocols

2. Logical Addressing: Classful, Classless, Subnetting

Classful:

A (0–127), B (128–191), C (192–223), D, E

Classless (CIDR):

- Variable-length prefix
- Example: 192.168.0.0/20

Subnetting:

- Dividing one network into multiple subnets
- Formula: subnets = 2^n, hosts = 2^h – 2

Supernetting:

- Combining networks
- Example: 192.168.4.0–192.168.7.0 → 192.168.4.0/22

3. Routing Concepts & Algorithms

- Static routing: Dijkstra, Flooding
- Dynamic routing: DVR, LSR, Hierarchical routing

Dijkstra:

- Finds shortest path tree

Flooding:

- Sends packets on all outgoing lines
- Uses hop count, packet ID tracking

Distance Vector Routing:

- Bellman-Ford based
- Exchanges routing tables with neighbors

Link State Routing:

- Builds network map using LSPs
- Runs Dijkstra

Optimality Principle:

- Subpaths of shortest paths are shortest

Sink Tree:

- Tree rooted at destination showing optimal paths

4. Congestion Control Techniques

Open-loop:

- Preventive

Closed-loop:

- Reactive (feedback)

Algorithms:

Leaky Bucket:
- Constant rate output
Token Bucket:
- Allows bursts; tokens required to send
5. Internetworking, IPv4 & IPv6
Internetworking Devices:
- Hub, switch, router, gateway
IPv4 Header:
- Version, IHL, TTL, Protocol, Checksum, Src/Dst IP
IPv6:
- 128-bit addressing
- Simpler header
- Flow label, hop limit
- Better security and auto-configuration