Internet is basically a network of interconnection of computer networks, or packet-switching networks.

• Internet is implemented using the TCP/IP 5-layer network architecture model:

• Application layer: concern with application requirement, and relies on transport layer (top)

• Transport layer: process-to-process communications (port number)

• Network layer: host-to-host communications (ip address)

• Data link layer: node-to-node communications (Link address)

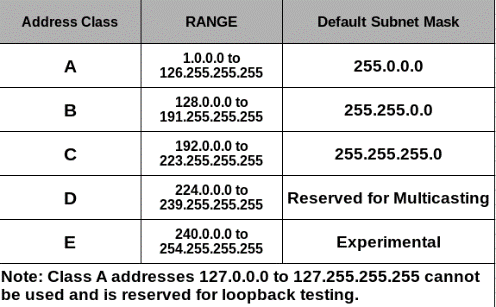
• Physical layer: actual transmissions between node-to-node (bottom)

• Protocol is needed at each layer, which defines the rules (format and order of messages) for communications.

• The collection of protocols from the various layers together form a protocol stack

Segment = layer 4 PDU, Packet = layer 3 PDU, frame = layer 2 PDU

No of ipv4: 2^32



Private IPs:

Class A: 10.0.0.0 — 10.255.255.255

Class B: 172.16.0.0 — 172.31.255.255

Class C: 192.168.0.0 — 192.168.255.255

Collision domain is the set of nodes whereby their transmitted frames could potentially collide.

The traditional definition of maximum frame length of 1518 bytes is to prevent any host from

hoarding the bandwidth. However, this was designed at the time that the standard Ethernet bandwidth was 10Mbps. Over time, this has increased to 100Mbps and today 1Gbps is the usual speed we have on LANs while backbone bandwidth is 10Gbps and more. Therefore, this maximum frame length, also known as the Maximum Transmission Unit (MTU) has increased to 9018 bytes and more. These Frames with sizes beyond the initial 1518 bytes are known as Jumbo Frames.

Before transmission at physical layer, Ethernet frame is prepended with another 8 bytes to synchronize the receiver to get ready to receive: At end of transmission, there is a mandatory 96-bit of idle time called inter-frame gap to indicate end of frame. Since the IFG is defined as the time to transmit 96-bits, depending on the speed on of the Ethernet network, the actual pause time is:

• 9.6 μs for 10 Mbit/s Ethernet

• 0.96 μs for 100 Mbit/s Fast Ethernet

• 96 ns for Gigabit Ethernet

• 9.6 ns for 10 Gigabit Ethernet.

Mac address is standardized to be 48-bit consisting of 2 fields:

• first 24-bit OUI is assigned by IEEE, and

• remaining 24-bit is assigned by the manufacturer

To determine minimum frame length, we need to consider worst case scenario where both nodes A and B are furthest apart: where τ = maximum end-to-end propagation delay tproptime to transmit minimum frame length tframe ≥ 2τBased on 10Base5 Ethernet, the minimum frame length is derived to be 64 bytes and is still being followed even till today! In 10Base5, furthest distance between A and B = 2.5kmConsider signal speed on wired medium ≈ 2 x 108 m/s end-to-end tprop = 2.5km/2 x 108 = 12.5 μs round-trip delay 2τ = 2 x 12.5 = 25 μs. In practice, we also need to include delays at repeaters, plus carrier sensing and collision detection time, and safety margin. So, IEEE defined Ethernet slot time = 51.2 μs. Therefore, minimum frame length= 10 Mbps x 51.2 μs = 512 bits = 64 bytes

Bandwidth = The “speed” of the network. A measure of how much data can be moved by the network in a finite amount of time. E.g. 1 gigabit per second (1Gbps) Latency = The time delay for a packet to go from one point to another in the network. E.g. 1ms

Round Trip Time (RTT) = the Latency of a Packet travelling from the Source to the Destination on a Network and then back again to the Source. The “ping” command causes such a packet to be sent and the RTT measured.

Long Fat Network (LFN) = A network of high bandwidth but poor Latency resulting in long RTTs. The result is that the real-world performance of the network is often only a small fraction of the available Bandwidth because of the need to wait for Acknowledgements from the Destination node.

Three phases of STP:

1. Elect a root bridge/switch

2. Each non-root bridge/switch will determine its root port

3. Each non-root bridge/switch will determine whether its non-root ports are designated ports or not

Many real-world networks have switches from different vendors. DTP only works with Cisco switches. It is better to FIX the mode of a Port to either Trunk or Access.

• The key concept to know is that a TRUNK port carries TAGGED frames. The TAG tells the switch on the receiving end, the VLAN to which the Frame should be sent.

• Frames on ACCESS ports are UNTAGGED. The Switch determines which VLAN these Frames belong to depending on the configuration of the port. When you configure an ACCESS port, you must tell the Switch which VLAN that port belongs to.

• Note that there are also UNTAGGED Frames on Trunk Ports. These Frames will be treated as belonging to the NATIVE VLAN configured on the TRUNK port.

• Also note that a TRUNK port can be configured such that only Some of the VLANs on the switch are transported by that trunk.

BID = It is an 8 byte field which is divided into two parts. The first part is a 2-byte Bridge Priority field (which can be configured) while the second part is the 6-byte MAC address of the switch.

(LOWEST BID is root) (Cost of 1Gi port is 4, while 2 trunked ones is 3)

Services provided by Internet Protocol (IP):

• Addressing – for identifying nodes at network layer

• Forwarding – determine the next node to forward the packet to

• Fragmentation and reassembly – divide data into smaller packets not exceeding MTU requirement

Service-1-Has been redefined for Differentiated Service (RFC2474) and Explicit Congestion Notification (ECN) (RFC3168) which are outside the scope of this module.

Time to live-1-Act as a counter which is decremented by one each time the IP datagram is processed by a router to ensure it will not circulate the Internet forever.

Protocol-1-Indicate the type of protocol the datagram is carrying; e.g. 0x01 for ICMP, 0x06 for TCP, 0x11 for UDP.

2nd service of IP – Packet Forwarding:

• Routing table is maintained at every host and router to determine where to forward an IP packet from source to destination;

• Routing table entries may be configured manually using static routes and default static routes.

• Route aggregation/summarization can be used to reduce size of routing table.

• Longest prefix matching rule is used to select a route in the routing table to forward an IP packet. Default gateway is a router within a subnet to enable to host to communicate beyond its subnet:

• Layer-3 switch can be configured as default gateway using switched virtual interfaces (SVIs) or routed ports.

• Redundant default gateway can be implemented using HSRP

For load-balancing, HSRP routers can be configured to be active default gateways for different subnets/VLANs and standby for others.

Administrative distance is a number used to indicate preference of a route. If 2 or more routes to the destination network exist, the route with lowest administrative distance will be selected.

Suppose we configure the port cost of SW3 Gi0/1 to 8, then to determine root port, apply the following tie-breaker rules in order:

1. Port receiving the BPDU containing lowest MyBID

2. Port receiving the BPDU containing lowest port priority in Port ID

3. Port receiving the BPDU containing lowest port number in Port ID

Table

Description automatically generated