TCP/IP Protocol

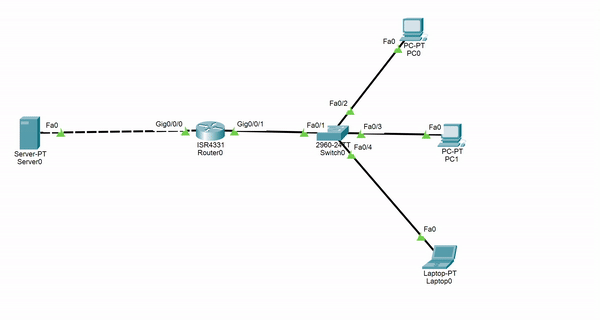
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Introduction

Transmission Control Protocol/Internet Protocol (TCP/IP) is a communication model developed by 2 scientists, Vint Cerf and Bob Kahn from the Defense Advanced Research Project Agency which was inspired by CYCLADES. CYCLADES is the first packet switching which aims to change from network-centric to host-centric reliability which uses datagram communication instead of virtual circuits. Thus, instead of allowing the network to be responsible for safely sending data to the recipient, this responsibility is now on the host which needs to take care of error handling and send the data packets or datagrams to the respective hosts without guaranteeing successfully receiving of the individual datagram. Hence, this inspired the creation of the TCP/IP model which has an end-to-end principle that can allow the network to stay simple, decentralized, secure with more nodes of devices that can be added and integrated into the network without much hassle. The TCP/IP model has a layer architecture system inspired by CYCLADES.

TCP/IP 

Starting from Laptop0, a ping command is inputted into the command prompt, targeting the server's IP address. The network packet sent uses ICMP instead of TCP. Unlike TCP, which is a connection-oriented protocol that guarantees data delivery, ICMP is connectionless and does not guarantee delivery. This makes ICMP ideal for error reporting, with smaller packet sizes.

When the user initiates the ping command, it generates an ICMP Echo Request. Since ICMP is used for error-checking, it does not carry data like other application protocols. Thus, the ICMP message is directly encapsulated within an IP Packet at the Internet Layer which includes both the source and destination IP addresses for proper identification and routing. Next, at the Network Access Layer, the IP Packet is further encapsulated within an Ethernet Frame. This Ethernet frame contains source and destination MAC addresses, which are used for local communication within the physical network.

When the packet reaches the Router, the Ethernet Frame is stripped away. Since MAC address is only for local physical addressing, hence the destination MAC must be changed with each hop. The IP packet is then re-encapsulated into a new Ethernet frame with the router's MAC address as the source, and the destination MAC address of the next hop.

Once the ICMP Echo Request reaches the server, the packet undergoes the reverse process. The Ethernet frame is stripped away, and the ICMP Echo Request is processed at the IP layer. The server then generates an ICMP Echo Reply, which follows the same steps in reverse: it is encapsulated in an IP packet, then re-encapsulated into an Ethernet frame with the appropriate MAC addresses for the return path.

As the reply packet travels back through the network, it is de-encapsulated at each router. The destination MAC address is replaced at each hop, and when it reaches the initial router, it strips away the Ethernet frame and forwards it to the end device. Lastly, the response is delivered to the Application Layer on Laptop0, where the ping result is displayed.

Now, let’s delve into the benefits of the TCP/IP model when compared to the OSI model. I will raise a few benefits.

1. TCP/IP has only 4 layers unlike OSI’s 7 layers structure which makes it more streamlined and eliminates any unnecessary complexity. For instance, web browsing which protocols like HTTP works with TCP to deliver the content without needing to navigate the Presentation and Session Layer. For practicality’s sake, it is easier to start and troubleshoot when implementing it in a real-world network without needing to adhere to the rigidness of the theoretical framework.
2. TCP/IP model is more inclined as a practical model whereas OSI model is more inclined as a theoretical framework. OSI modularity and abstract focus of not explicitly stating the usable protocols in each layer unlike TCP/IP which defines the usable protocols like TCP, UDP etc. Thus, professionals can make use of this direct implementation for quicker adoption.
3. Expanding on point 2, the OSI model is too detailed and by leaving out the usable protocols in each layer caused it causes greater difficulty in incorporating modern protocols and technologies. This is unlike the TCP/IP model where it is less compartmentalized and new protocols and technology can be incorporated easily at the Internet layer. For instance, if Ipv6 were to be incorporated into the OSI model then due to the Ipv6’s hierarchical addressing and autoconfiguration, address length, new address formatting like hexadecimal notation and new address type, the network layer in the OSI model needs to be changed substantially. Additionally, some networks might also need to implement both Ipv4 and Ipv6 simultaneously and thus, there may need to have additional functionality within the OSI model like address translation between v4 and v6 and handling of IPV6 specific protocols like Neighbor Discovery Protocol. Thus, with the TCP/IP model, it has a more flexible design and backward capability especially at the network layer which allows new technological protocols to work with older protocols thus making it easier to implement.

Conclusion

Overall, the simplicity, practicality and adaptability of the TCP/IP model has made it an industry standard which is more streamlined and made for real-world implementation. By embracing the end-to-end principle, decentralization, and ease of integration, the TCP/IP model provides a scalable solution for handling the increased complexity of networks, making it a reliable protocol for networking professionals. However, each of the 2 models have their own usages and the OSI model is useful for explaining the intricates of the networking layers and its functions and deeper theoretical analysis.

**References**

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