Available online at www.journalijmrr.com

INTERNATIONAL JOURNAL OF MODERN RESEARCH AND REVIEWS

Int. J. Modn. Res. Revs.

Volume 5, Issue 6, pp 1577-1579, June, 2017

ISSN: 2347-8314

WIRELESS NETWORKS MODELLING OF LOGICAL AND PHYSICAL ARCHITECTURE

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Article History: *Received 7th June ,2017, Accepted 29th June,2017, Published 30th June2017*

ABSTRACT

The present study is aimed to observe the topology of a wired network refers to the physical configuration of links between networked devices or nodes, where each node may be a computer, an end-user device such as a printer or scanner, or some other piece of network hardware such as a hub, switch or router. The building block from which different topologies are constructed is the simple point-to-point wired link between two nodes, repeating this element results in the two simplest topologies for wired networks — bus and ring. For the ring topology, there are two possible variants depending on whether the inter-node links are simplex (one-way) or duplex (two-way). In the simplex case, each inter-node link has a transmitter at one end and a receiver at the other, and messages circulate in one direction around the ring, while in the duplex case each link has both transmitter and receiver (a so-called transceiver) at each end, and messages can circulate in either direction.

Keywords: wireless networks, logical and physical architecture, (LLC plus MAC) and PHY layers ,OSI model

1.INTRODUCTION

The logical architecture is introduced in terms of the 7 layers of the OSI network model and the protocols that operate within this structure, with an emphasis on the Network and Data Link aspects that are most relevant to wireless networking — IP addressing, routing, link control and media access. The physical architecture of wireless networks is described, focussing on wireless network topologies and hardware devices. At each stage, some of the key characteristics of wired networking technologies are also briefly described, as a preliminary to the introduction of wireless networking technologies, at each stage, some of the key characteristics of wired networking technologies are also briefly described, as a preliminary to the introduction of wireless networking technologies, in order to provide a background to the specific challenges addressed by wireless technologies, such as media access control.

Since logical connections operate over physical links, the logical and physical architectures rely on each other, but the two also have a high degree of independence, as the physical configuration of a network can be changed without changing its logical architecture, and the same physical network can in many cases support different sets of standards and protocols.

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2.OSI NETWORK MODEL

The Open Systems Interconnect (OSI) model was developed by the International Standards Organisation (ISO) to provide a guideline for the development of standards for interconnecting computing devices. The OSI model is a framework for developing these standards rather than a standard itself — the task of networking is too complex to be handled by a single standard. The OSI model breaks down device to device connection, or more correctly application to application connection, into seven so-called “layers” of logically related tasks. (Senbeta, *et al.*, 1999)

How these layers combine to achieve a task such as sending and receiving an e-mail between two computers on separate local area networks (LANs) that are connected via the Internet. The process starts with the sender typing a message into a PC e-mail application. When the user selects “Send”, the operating system combines the message with a set of Application layer (Layer 7) instructions that will eventually be read and actioned by the corresponding

Operating system and application on the receiving computer. Transmission of the message across the Internet is achieved through a number of device-to-device hops involving the PHY and Data Link layers of each routing or relaying device in the chain. At each step, the Data Link layer of the receiving device determines the MAC address of the next immediate destination, and the PHY layer transmits the packet to the device with that MAC address.

3.RESULT AND DISCUSSIONS

The logical architecture of a wireless network is determined principally by standards that cover the Data Link (LLC plus MAC) and PHY layers of the OSI model. The following sections will give a preliminary introduction to these standards and protocols, while more detailed descriptions will be found in Parts III to V where Local Area (LAN), Personal Area (PAN) and Metropolitan Area (MAN) wireless networking technologies are described respectively.

Table: 1. Seven Layers of the OSI Model

Layer	*Description*	*Standards and Protocols*
7 — Application layer	Standards to define the provision of services to applications — such as checking resource availability, authenticating users, etc.	HTTP, FTP, SNMP, POP3, SMTP
6 — Presentation layer	Standards to control the translation of incoming and outgoing data from one presentation format to another.	SSL
5 — Session layer	Standards to manage the communication between the presentation layers of the sending and receiving computers. This communication is achieved by establishing, managing and terminating "sessions".	ASAP, SMB
4 — Transport layer	Standards to ensure reliable completion of data transfers, covering error recovery, data flow control, etc. Makes sure all data packets have arrived.	TCP, UDP
3 — Network layer	Standards to define the management of network connections — routing, relaying and terminating connections between nodes in the network	IPv4, IPv6, ARP
2 — Data link layer	Standards to specify the way in which devices access and share the transmission medium (known as Media Access Control or MAC) and to ensure reliability of the physical connection (known as Logical Link Control or LLC).	ARP Ethernet (IEEE 802.3), Wi-Fi (IEEE 802.11), Bluetooth (802.15.1)
1 — Physical layer	Standards to control transmission of the data stream over a particular medium, at the level of coding and modulation methods, voltages, signal durations and frequencies.	Ethernet, Wi-Fi, Bluetooth, WiMAX

Network Layer Technologies

The Internet Protocol (IP) is responsible for addressing and routing each data packet within a session or connection set up under the control of transport layer protocols such as TCP or UDP (see Glossary). The heart of the Internet Protocol is the IP address, a 32-bit number that is attached to each data packet and is used by routing software in the network or Internet to establish the source and destination of each packet. While IP addresses, which are defined at the Network layer, link the billions of devices connected to the Internet into a single virtual network, the actual transmission of data frames between devices relies on the MAC addresses of the network interface cards (NICs), rather than the logical IP addresses of each NIC's host device. This process uses two more 32-bit numbers, the "subnet mask" and the "default gateway". A device determines the network ID for a data packet destination by doing a "logical AND" operation on the packet's destination IP address and its own subnet mask. The device determines its own network ID by doing the same operation using its own IP address and subnet mask.

Table: 2. Local and Remote IP Addresses

<u>Sending Device</u>		
IP Address:	200.100.50.10	11001000.01100100.00110010.00001010
Subnet Mask:	255.255.255.240	11111111.11111111.11111111.11110000
Network ID:	200.100.50.000	11001000.01100100.00110010.00000000
<u>Local IP address</u>		
IP Address:	200.100.50.14	11001000.01100100.00110010.00001110
Subnet Mask:	255.255.255.240	11111111.11111111.11111111.11110000
Network ID:	200.100.50.000	11001000.01100100.00110010.00000000
<u>Remote IP address</u>		
IP Address:	200.100.50.18	11001000.01100100.00110010.00010010
Subnet Mask:	255.255.255.240	11111111.11111111.11111111.11110000
Network ID:	200.100.50.016	11001000.01100100.00110010.00010000

Internet Protocol Version 6 (IPv6)

With 32 bits, a total of 232 or 4.29 billion IP addresses are possible — more than enough one would think for all the computers that the human population could possibly want to interconnect. However, the famous statements that the world demand for computers would not exceed five machines, probably incorrectly attributed to Tom Watson Sr., chairman of IBM in 1943, or the statement of Ken Olsen, founder of Digital Equipment Corporation (DEC), to the 1977 World Future Society convention that "there is no reason for any individual to have a computer in his home", remind us how difficult it is to predict the growth and diversity of computer applications and usage.

Address Resolution Protocol

As noted above, each PHY layer data transmission is addressed to the (Layer 2) MAC address of the network interface card of the receiving device, rather than to its (Layer 3) IP address. In order to address a data packet, the sender first needs to find the MAC address that corresponds to the immediate destination IP address and label the data packet with this MAC address. This is done using Address Resolution Protocol (ARP). Conceptually, the sending device broadcasts a message on the network that requests the device with a certain IP address to respond with its MAC address. The TCP/IP software operating in the destination device replies with the requested address and the packet can be addressed and passed on to the sender's Data Link layer.

Routing

Routing is the mechanism that enables a data packet to find its way to a destination, whether that is a device in the next room or on the other side of the world. A router compares the destination address of each data packet it receives with a table of addresses held in memory the router table. If it finds a match in the table, it forwards the packet to the address associated with that table entry, which may be the address of another network or of a "next-hop" router that will pass the packet along towards its final destination. If the router can't find a match, it goes through the table again looking atjust the network ID part of the address (extracted using the subnet mask as described above). If a match is found, the packet is sent to the associated address or, if not, the router looks for a default next-hop address and sends the packet there. As a final resort, if no default address is set, the router returns a "Host Unreachable" or "Network Unreachable" message to the sending IP address.

Network Address Translation

As described in the Section "Private IP Address, p. 15", RFC 1918 defined three sets of private IP addresses for use within networks that do not require Internet connectivity. However, with the proliferation of the Internet and the growing need for computers in these previously private networks to go online, the limitation of this solution to conserving IP addresses soon became apparent. How could a computer with a private IP address ever get a response from the Internet, when its IP address would not be recognised by any router out in the Internet as a valid destination? Network Address Translation (NAT) provides the solution to this problem. When a computer sends a data packet to an IP address outside a private network, the gateway that connects the private network to the Internet will replace the private IP source address (192.168.0.1 by a public IP address (e.g. 205.55.55.1). The receiving server and Internet routers will recognise this as a valid destination address and route the data packet correctly.

Logical Link Control

Logical Link Control (LLC) is the upper sub-layer of the Data Link layer and is most commonly defined by the IEEE 802.2 standard. It provides an interface that enables the Network layer to work with any type of Media Access Control layer. A frame produced by the LLC and passed down to the MAC layer is called an LLC Protocol Data Unit (LPDU), and the LLC layer manages the transmission of LPDUs between the Link Layer Service Access Points of the source and destination devices. A Link Layer Service Access Point (SAP) is a port or logical connection point to a Network layer protocol. In a network supporting multiple Network layer protocols, each will have specific Source SAP (SSAP) and Destination SAP (DSAP) ports. The LPDU includes the 8-bit DSAP and SSAP addresses to ensure that each LPDU is passed on receipt to the correct Network layer protocol.

Media Access Control In Wired Networks

If two devices transmit at the same time on a network's shared medium, whether wired or wireless, the two signals will interfere and the result will be unusable to both devices. Access to the shared medium therefore needs to be actively managed to ensure that the available bandwidth is not wasted through repeated collisions of this type. This is the main task of the MAC layer.

Physical Layer Technologies — Wireless Networks

The PHY layer technologies that provide the Layer 1 foundation for wireless networks will be described further in Parts III, IV and V, where LAN, PAN and MAN technologies and their implementations will be covered in detail. Each wireless PHY technology, from Bluetooth to ZigBee, will be described in terms of a number of key aspects, the range and significance of the issues vary depending on the type of technology (Ir, RF, Near-field) and its application (PAN, LAN or WAN).

4.CONCLUSION

The OSI network model provides the conceptual framework to describe the logical operation of all types of networks, from a wireless PAN link between a mobile phone and headset to the global operation of the Internet. The key features that distinguish different networking technologies, particularly wired and wireless are defined at the Data Link (LLC and MAC) and physical (PHY) layers. Reveal the fascinating variety of different techniques that have been harnessed to bring wireless networks to life.

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