THE OVERVIEW OF WIRED AND WIRELESS NETWORKS AND THE NEED FOR THE TRANSITION FROM WIRED TO WIRELESS NETWORKS

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Abstract- This paper highlights the security and the various performance issues encountered in wired and wireless networks during data transmissions. The paper also shows how the transition from wired to wireless networks is essential despite the inadequate security of the wireless networks over wired networks and the outline of the various techniques introduced in wireless networks to make the data transmissions equally secure, if not more, as in wired networks.

Index Terms- Network Security, Network Transition From Wired To Wireless Networks, Wired Networks, Wireless Networks.

I. INTRODUCTION

The concept of networking i.e. connecting multiple devices together to promote easy communication between the connected devices came to light with the primary aim of reducing the number of resources and to promote efficient use of the limited resources. Resources, here in this context, mean data, information, or hardware like disks, cache memory, printers, scanners etc. Prior to the advent of networking there was no sharing of data or resources between systems. Every stand-alone system required its own resources to exploit their use and this resulted in inefficient use of the resources. These resources were idle when the system owning them did not require its use. To eliminate this inefficient use of resources, the concept of sharing between multiple systems was developed. This concept was achieved through networking or connecting the systems with each other based on different architectures. Based on the communication or connection medium between the systems in a network, networks are classified into two types: Wired and Wireless networks. The concept of computer networks thus reduced the inefficient use of resources, the idle time of the individual resources by sharing them with each other. The cost of systems became cheaper as they shared the resources and did not require the purchase of a separate resource for each system.

The organization of this paper is as follows. In section 2, a detailed explanation of the security and the issues that affect the performance of wired networks has been presented, followed by section 3 that describes the security and the issues that affect the performance of wireless networks, further followed by section 4 that tells about the need for the transition from wired to wireless networks. Finally, section 6 concludes the work.

II. WIRED NETWORKS

Wired networks are a group of computers or other devices like printers, scanners, disks etc. connected by network links, aimed to transmit data between the computers using optical cables or other transmission medium, or to share resources.

A. Security of wired networks

As the wired networks are composed of devices or resources of an organization owning the network, they are not susceptible to attacks from third parties because accessing the data transmitted between two computers in a wired network requires access to either one of these computers or the network jack or cable. Therefore, these networks are perceived to be more secure than wireless networks. The only type of intruders for this type of network are misfeasors who are legitimate users accessing data or resources for whom such access is not granted. Moreover, these networks are faster and the cost of wired networks is determined by the elements of the networks like the number of computers, the amount of cable required, etc. It should be noted that wired networks were developed initially to save or reduce the number of resources required by enabling sharing of resources by computers in the network thereby reducing the cost. Therefore, these networks are cheaper and more affordable than the wireless networks and signal loss and fading due to interference is less.

B. Issues that affect the performance of wired networks

As explained in the paragraph on the security of wired networks, the data transmitted in a wired network and the resources of a wired network can be accessed only by an authorized few. Some of the issues that affect the performance of wired networks are explained as follows.

1. Attenuation

When a signal is transferred from one end to the other end of a communication link, the strength of the signal is weakened due to impedance, temperature and other factors. The longer the signal travels through a communication medium, the more the effect of attenuation on the signal. When data is transmitted as signals between computers in a wired network, the attenuation may cause a weak signal to be received at the destination which cannot be interpreted correctly thus calling for an unnecessary retransmission. The attenuation per unit distance helps in determining the efficient cable for a network and also the cable length.

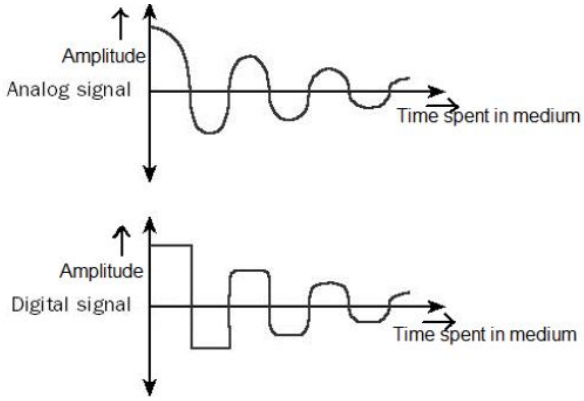

Fig 1.Decrease In Amplitude Of Both Analog And Digital Signals With Respect To Time Spent In Medium.

The figure above shows how attenuation can cause the distortion of the signals, both analog and digital. This distortion caused by the attenuation leads to the incorrect interpretation of the received signals.

2. Impedance and skin effect

The combination of capacitance, resistance, inductance that opposes the flow of current is the impedance. Impedance can change with kinks and bends in the cable and can cause the corruption of the data being transmitted by signal reflection or skin effect, where the signal travels over the outer skin or layer of the cable, thereby reducing the cross sectional area. The reduced cross sectional area results in an increase in resistance. Skin effect occurs during high frequency and allows the signal to escape the cable into the air while travelling over the outer skin of the cable.

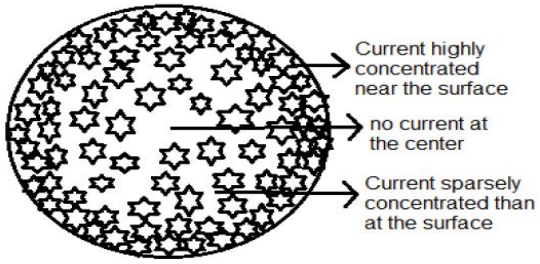

Fig 2.Cross-Sectional View Of A Cable Depicting Skin Effect.

The cross sectional view of the cable carrying the signal is shown in fig 2. The signal is concentrated near the surface and travels over the outer skin of the cable. Due to the skin effect, the concentration of the signal and in turn the current reduces from the surface to the center of the cable. The figure correctly depicts how the center of the cable has no current flow and the surface has the highest concentration of the current.

3. Delay skew

When the signal is broken down into packets and transmitted simultaneously from the source to the destination for faster transfer of data, the packets must reach the destination at nearly the same time for effective reassembly. Therefore, these packets are transmitted across the different cables at different speeds for synchronization at the reception end. If there is a delay in the reception of these packets, incorrect or incomplete reassembly of packets will arise. This common multi-routing problem is called delay skew. Delay skew disrupts the synchronization between packets to prevent correct reassembly.

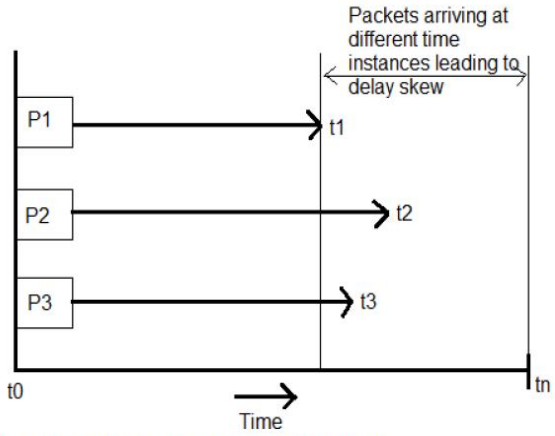

Fig 3.Delay Skew When Packets Are Sent Through Three Different Routes.

Figure 3 shows how three different packets say P1,P2,P3 sent at the same time t0 from the source through different routes reach the destination at different time instances t1,t2,t3 respectively giving rise to delay skew which causes distortion of the original data by the incorrect reassembly of the packets.

4. Network Congestion

When network is highly congested i.e. when a large number of packets are queued to be sent from source to destination, there may be a time delay during transmission and the packets spend more at each hop. When the queue is full, the packets are simply dropped leading to the loss of packets. This, in turn, restricts the throughput as a measure of the queue size.

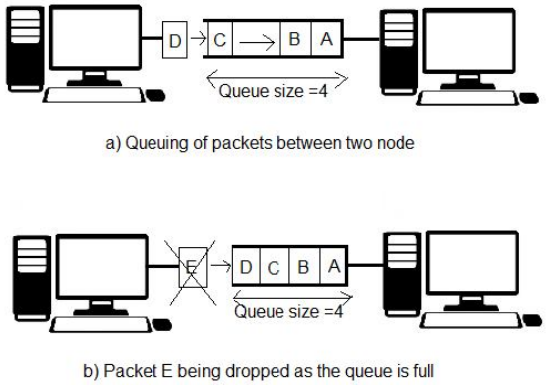

Fig 4.Network Congestion Leading To The Dropping Of A Packet.

The figure 4 shows how a packet is dropped in a congested network when the queue is full leading to the loss of data.

The second issue i.e. impedance is unique to wired networks as it is caused due to use of cables for transmission and is not possible in wireless networks. The first and the last two issues occur in both wired and wireless networks but the intensity of the malfunction caused is higher in wireless networks.

III. WIRELESS NETWORKS

Wireless networks are similar to wired networks as they are aimed at connecting different devices to enable data transmission and resource sharing with the major distinction that no cables or links exists between the connected devices. The medium of transmission is air and data is transmitted as radio or electromagnetic waves.

A. Security of wireless networks

The wireless networks allow communication between two devices located geographically very far from each other that they cannot be connected using cables. They allow communication and data transmission using air as medium by transmitting data as signals either radio, infrared or other types. Since the data travels through air, it can be easily intercepted or eavesdropped by unauthorized users of the network. Various encryption mechanisms like DES (Data Encryption Standard), 3-DES (Triple DES), AES (Advanced Encryption Standard), RSA (Rivest, Shamir, Adleman) block cipher encryption algorithm etc. may be employed to overcome this. Two major types of encryption used in wireless networks WEP (Wired Equivalent Privacy) and WPA (WiFi Protected Access). Authentication of data received can be ensured by using MAC (Message Authentication Code), hash functions, DSA (Digital Signature Algorithm) and other algorithms. The wireless networks are also very unreliable as the loss of packets or acknowledgments may go untraced, breakdown of a routed may affect an entire network and the performance of a wireless network can be affected by another wireless network as these networks are often visible to each other. Techniques like Nagle algorithm are adopted to address the first reliability issue addressed in the previous sentence.

B. Issues that affect the performance of wireless networks

All the issues faced by wired networks are also faced by wireless networks but the height of the hindrance to performance caused by these issues may be higher in wireless networks when compared to wired networks.

1. Network Congestion

Excessive congestion in wireless networks due to the heavy traffic and heavy use of the network by large number of users can lead to loss of data. This loss is more than what is encountered with wired networks. The increased number of nodes automatically causes a heavy traffic leading to network congestion. The flexibility of the wireless networks of increasing the number of nodes in the network is therefore both an advantage and disadvantage by promoting easier network expansion and loss of data due to congestion.

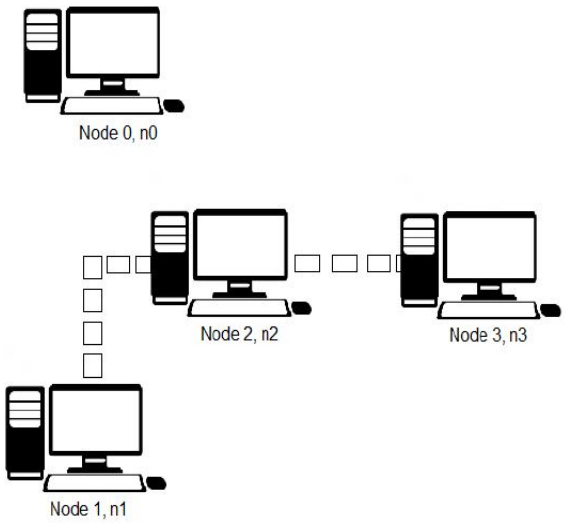

Fig 5.Network Congestion Between Two Nodes Communicating Wirelessly.

The above figure shows the communication between two nodes say n1 and n3 of a wireless network where n2 maybe a router or a switch. The network is highly congested due to the large number of packets sent between the two nodes. Congestion may also be caused due to simultaneous communication by a node with two or more nodes but this scenario is not considered here. If the congestion were to be caused solely by the number of packets sent between the nodes, the analysis of the number of packets remaining in the queue, the number of packets dequeued and the number of packets dropped as a result of this communication is tabulated below. The network congestion causes a delay in communication as the packets spend more time at each hop.

Table 1.Network Congestion leading to dropping of packets in a four node system monitored using Network Simulator, NS2.

Node link	Delay (in ms)	Queue Limit	Number Of packets remaining in the queue	Number Of Dequeued packets	Number Of dropped packets
n0-n2 n1-n2 n2-n3	3 2 3	3 3 2	190	472	98
n0-n2 n1-n2 n2-n3	5 5 5	5 3 2	190	510	60

The table above shows the number of packets remaining in the queue, the number of packets dequeued and the number of packets dropped as a result of the communication between nodes n1 and n3 as shown in figure 5 where node n2 maybe a router or a switch.

2. Propagation delay

This is analogous to the delay skew in wired networks. When packets are to be transmitted over long distances, propagation delay comes into picture. It is a grave concern in satellite communication.

Additionally there are a few other issues that affect the performance of a wireless network.

3. Interference

Multiple versions of the same signal may be received at the destination causing an effect known as fading. These versions when shifted in phase or Doppler-shifted interfere with one another leading to loss of data. Interference due to different communications occurring at the same frequency, jamming intentionally with the view of encrypting the message or interference with noise may all lead to packet loss.

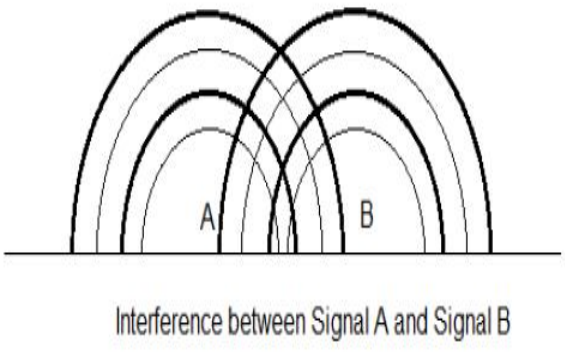

Fig 6.Interference Between Two Signals Shown In The Form Of Ripples.

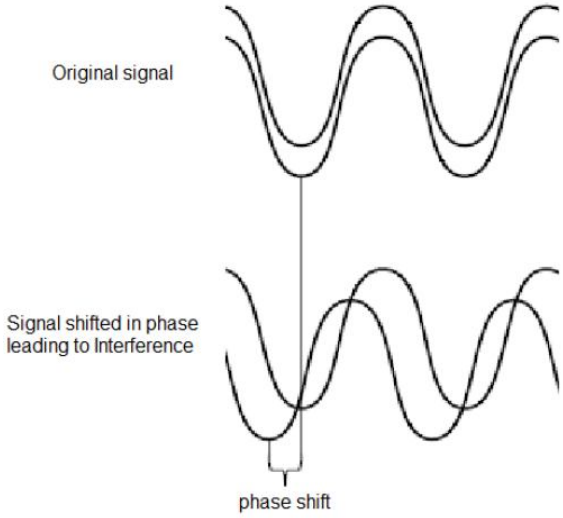

Fig 7. Interference between 2 versions of the same signals Original unaltered signal and the phase shifted version.

The figures 5 and 6 show the interference between two signals say A and B and the interference between a signal and its phase shifted version. Interference may be caused by noise or by the same signal. This is possible by the concept of phase shifting where the same signal is shifted in phase to represent a new version of the signal. These different versions of the signal can interfere leading to the loss of data.

4. Contention for access

Networks like MANET (Mobile Ad-hoc NETwork) may not have a coordinator to grant access to nodes for a shared channel and these nodes may enter into a contention for the shared channel leading to collisions, loss of data and delay. A priority scheme may be adopted to overcome this problem and to reduce the time wasted due to contention.

IV. NEED FOR TRANSITION FROM WIRED TO WIRELESS

The section highlights the need for the replacement of wired networks by wireless networks. Several advantages of wireless networks over wired networks have paved way for this transition despite its lower security levels. Security in wireless networks can be attained by using encryption and authentication algorithms discussed under the section “Security of wireless networks”.

The following are some of the advantages of wireless networks over wired networks.

1. Installation

These networks are easier to install as no cables and links need to be established between the nodes. Even though the cost of installation is more for wireless networks, they are still preferred due to this advantage of easy installation. This is particularly helpful when

the nodes of the network span over a larger geographical area where installing cables between nodes would be tedious and laborious.

2. Network Expansion

Wireless networks can be easily expanded to span a larger area than the original area by the addition of new nodes. New nodes can be added to the network leading to expansion. When new nodes are to be added frequently, this advantage of wireless networks leads to lower cost as the new nodes can be added to the network without laying cables to establish connection with a hub or other nodes which promotes connectivity with the rest of the network.

3. Remote access or mobility

In areas where laying communication lines are not possible, wireless networks can be used. It helps in connecting remote nodes situated in areas of hilly terrains where connection through cables is simply not possible or very expensive. It allows communication between nodes situated at a very large distance from each other than the wired networks. The area covered by wireless networks is always much greater than that covered by wired networks.

V. COST OF MAINTENANCE

Although the initial cost of investment if higher for wireless networks, the cost of maintenance is comparatively lower. This is due to the fact that the wireless networks do not involve the maintenance of any communication links and therefore no cost in spent in the replacement of tampered cables or wires. Long term cost benefits of wireless networks make them a significant and essential replacement for wired networks.

Although wireless networks are expensive, unreliable, slower and less secure than the wired networks, the advantages mentioned above make the transition from wired to wireless networks absolutely essential especially in organizations where the number of nodes or participants of the network cannot be determined beforehand. The flexibility of adding new nodes without much cost spent in installation and connectivity to remote nodes are the two main advantages for this transition. Security is always an issue in wireless networks but the encryption mechanisms like WPA, WEP make the network more reliable and secure if not fully reliable and secure.

CONCLUSION

Therefore, the security and the various issues that affect the performance of wired and wireless networks have been analyzed and the need for transition from wired to wireless networks despite the added risk of security deficiency has been justified.

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