A Review of Enhancement Traditional Wide Band Networks by Using Enhanced WIMAX Technology

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ABSTRACT

The expansion of networks involved higher jump on the users utilizing the networks resources which may require extra higher bandwidth. Due to the development of technology especially those folded under the Internet of Things (IoT), the new demand of higher data rate has been witnesses among the users. In order to feed the demand of users with high data rate, broadband networks are required where high data rate can be ensured for each user. Broadband networks can be established using optical network that carries the data through wide broadband. Areas such as rural and forests sides which are witnessing plenty of natural obstacles such as mountains, trees, seas, etc. are forming big challenge for propagating a cable (wire) or optical network. Due to the limitations of the wire network, WiMAX technology has been introduced as substitutional for the broadband network. Such kind of alternative can be deployed through any geographical area without concerning on the wire paths. This review is presenting the most terminologies participating in the network backbone.

KEYWORDS: WiMAX, Fiber, Backbone, WAN, Throughput.

INTRODUCTION

Wireless means transmitting signals using radio waves as the medium instead of wires. Wireless technologies are used for tasks as simple as switching off the television or as complex as supplying the sales force with information from an automated enterprise application while in the field. Now cordless keyboards and mice, PDAs, pagers, and digital and cellular phones have become part of our daily life [1]. WiMAX systems are expected to deliver broadband access services to residential and enterprise customers in an economical way. Loosely, WiMAX is a standardized wireless version of Ethernet intended primarily as an alternative to wire technologies (such as Cable Modems, DSL and T1/E1 links) to provide broadband access to customer premises [2]. More strictly, WiMAX is an industry trade organization formed by leading communications, component, and equipment companies to promote and certify compatibility and interoperability of broadband wireless access equipment that conforms to the IEEE 802.16 and ETSI HIPERMAN standards. WiMAX would operate like Wi-Fi, but at higher speeds over greater distances and for a greater number of users. WiMAX could provide service even in areas that are difficult for wired infrastructure to reach and the ability to overcome the physical limitations of traditional wired infrastructure. WiMAX was formed in April 2001, in anticipation of the publication of the original 10-66 GHz IEEE 802.16 specifications. WiMAX is to 802.16 as the WIFI Alliance is to 802.11. WiMAX is such an easy term that people tend to use it for the 802.16 standards and technology themselves, although strictly it applies only to systems that meet specific conformance criteria laid down by the WiMAX Forum.

LITERATURE REVIEW

At [1], development of communication has triggered new technologies supporting high data transmission through the communication channels. high data rate is feasible to transmit through the optical network using the so-called wave-length division multiplexing. The communications over the optical network are taken place by accurate formation of routing request e.g., R {x, y} where routing request R is made to transmit the data from the position x to position y (destination) in the network. Coordination of x and y are standing for the location of nodes pair in the network where data is generating from and transmitting to.
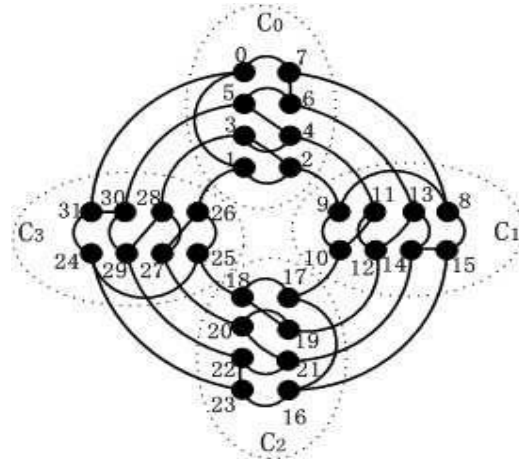
FIGURE 1, Chordal Ring Topology Hat Proposed to Support WAN.

The author of this study revealed that communication network through optical channels are dealing with variable wavelengths depending on the data and the application that network has established for. Communication network through optical channel are suffering from the variable wavelength since the fiber channel can be designed to serve particular wavelength. In order to tackle this issue, chordal ring network is established as shown in Fig.1.

At [2], researches have shown that optical network can be optimized by reducing the number of wavelengths participates in the transmission game. In most of the big communication networks, several applications are participating in the transmission such as voice transmission, video transmission and other multimedia data. Network might need to purchase new bands or channel in order to fulfil all the applications requirements. In optical network, new fiber cables might be required for allowing multiple wavelengths to be transmitted.
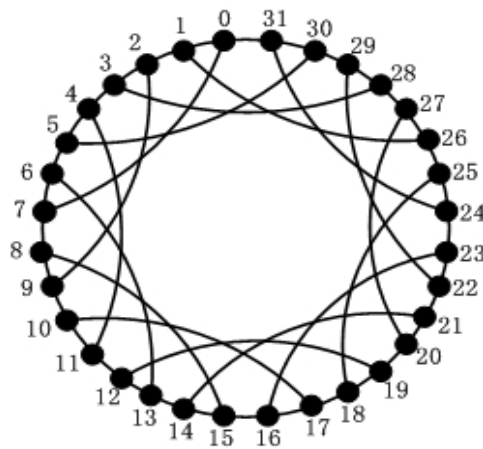

FIGURE 0, Chordal Ring Network Based on Optical Fiber Network.

This demand may require to upgrade the network design. One of the feasible solutions that been proposed is using intermediate connections to link particular nodes through the network of ring topology. The nodes which are preserving a different wavelength than the main operational wavelength used in the network can be connected using additional link called as chordal link.

At [3], author defined the chordal ring network as network of Q chords number and P nodes where the number of chords should not be exceeding the fifty percent of the total number of nodes. As chordal network is basically ring network, each p node is to be interfered with p-1 and p+1 node. Author mentioned that chordal ring can be further characterized by the edges number in each node.
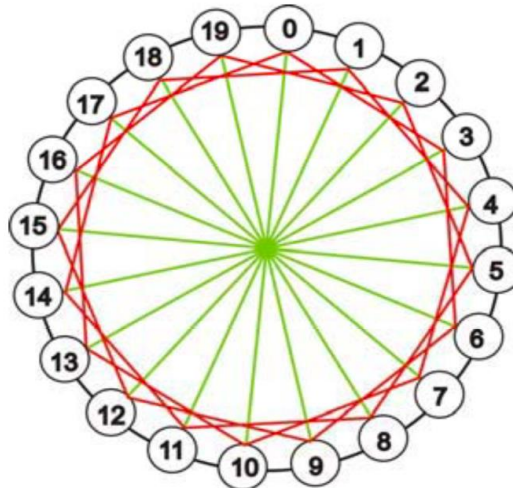
FIGURE 3, Degree Increment Impact on The Data Rate Of CRN.

The same is termed as degree; in this study author tested the performance of chordal ring by changing the topology of the network. Changing the network degree implies changing the diameter of the chordal ring as well changing the length of the chords which directly impact the network performance. In Figures 2 and 3, chordal ring with fifth degree involving twenty nodes is demonstrated.

At [4], another approach was illustrated in this study which stated about the optimization of large chordal ring network in order to preserve particular cost. Ring topology preserves number of nodes which are interfaced using optical channel. The communication between those nodes is taking place using network devices alike optical multiplexers, switches, and optical amplifiers. As the number of networks edges extends, the cost required to establish the network is also enlarged.

However, this study involves comparative analysis of seven-degree chordal ring and three-degree chordal ring network. Authors of this study stated that six-degree chordal ring network can be yields close transmission parameters of the four-degree chordal ring network. However, seven-degree chordal ring network is then replaced by three-degree chordal ring as in Fig. 3 and 4.
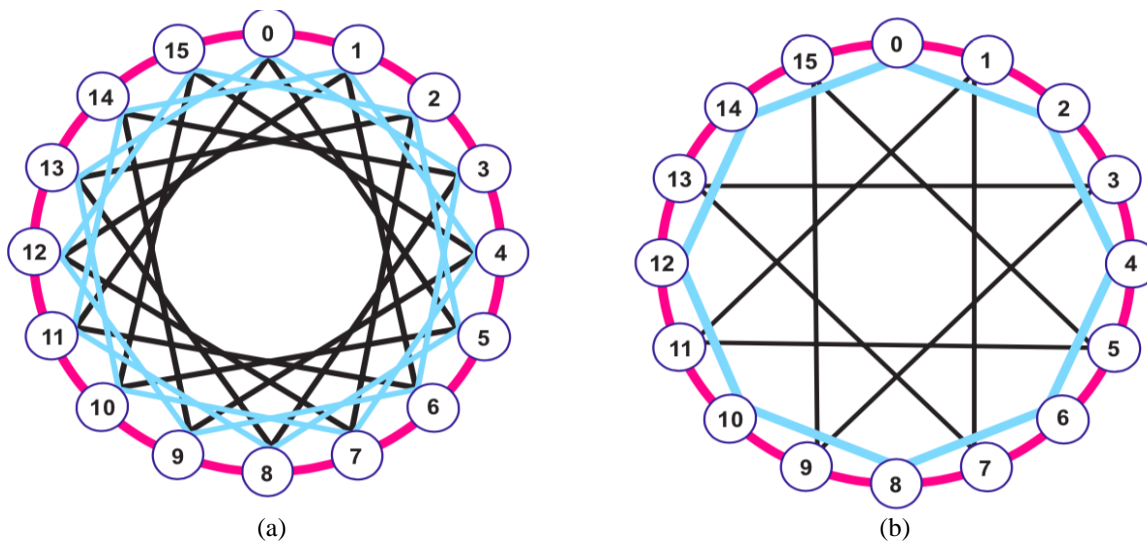

(a)   (b)

FIGURE 2, The Differences Between the Regular Degree CRN And Other Hybrid CRN.

At [5], author defined the network topology as the visible interfaces between the nodes which impact the node degree, bandwidth, network diameter, etc. So-to-say, all the mentioned parameters of the network are responsible of changing the

network topology. That implies different topologies can be achieved by varying the networking (interfaces) parameters. The need of extra bandwidth in the networks are one of the major challenges of network designing. In order to create extra bandwidths, channels with particular capacities are to be established, one of the feasible solutions to establish new channels for an existed network is by assigning different degree for the nodes. This is achievable by allowing interconnections between the network nodes so that, the specific data that required to be transmitted from any node, is to be transmitted in special channel propagated from this node to the destination node.
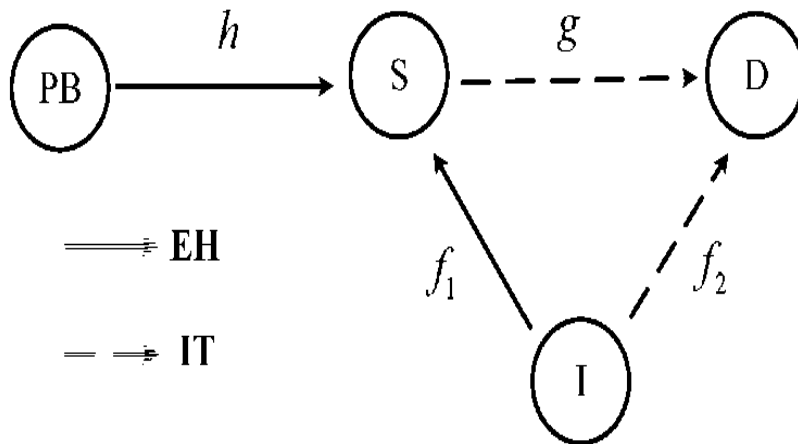

FIGURE 3, Transmission Process Between Source Node S to the Distention Node D,

FIGURE 5, Illustrates the Transmission Topology Between Source Node S to the Distention Node D, the Specific Payload from the Node S Can Be Transmitted to Node D Through Another Route Through Node I As Illustrated in the FIGURE.

At [6], the essential methodology that been used for long years for transmission of multiple channels through single communication medium (wire or wireless) is the multiplexing techniques. Multiple data streams can be multiplexed into single channel and can be sent at same time. Multiplexing technology permits transmission of data either with time constraints or frequency constrains or even by using both constraints. Data from several channels can be sent at same time by using the so-call frequency multiplexing, where the channels will be allowed to transmit the data by distributing of their frequencies depending on multiplexing technique specifications, the same is called frequency division multiplexing. The other breed of the multiplexing technology is the time division multiplexing where multiple channels can synchronously begin the transmission as demonstrated in Fig.6.
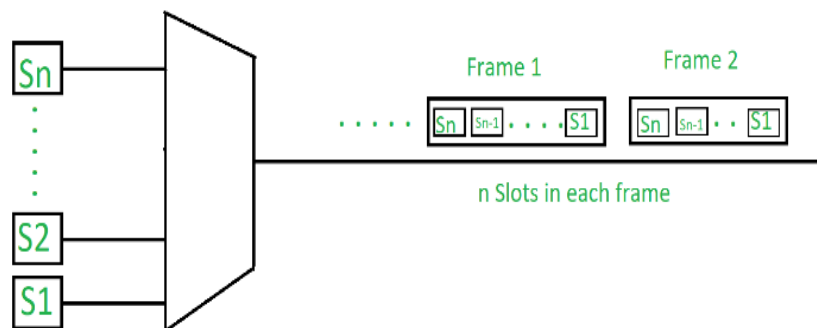

FIGURE 4, Multiplexing Technology in Communication Network.

At [7], communication networks have extended to involve vehicular communication which paved the road towards enhancing the traffic control and safety system. Vehicular network contains of three main parts: sensor arrays which to be integrated with the mobile vehicles, base stations or roadside units which are used for controlling the signaling between the mobile vehicles, ultimately, base stations are connected with each other through one getaway called the vehicle network getaway. However, this type of network is used to exchange the safety instructions between the moving vehicles through the highways in order to

avoid car crashes. Such networks are termed as VANET and being populated by their simplicity and easy of implementations. Throughput and coverage of this network is being also challengeable and being enhanced using more roadside units (base stations). Fig.7 demonstrates the structure of vehicle network.
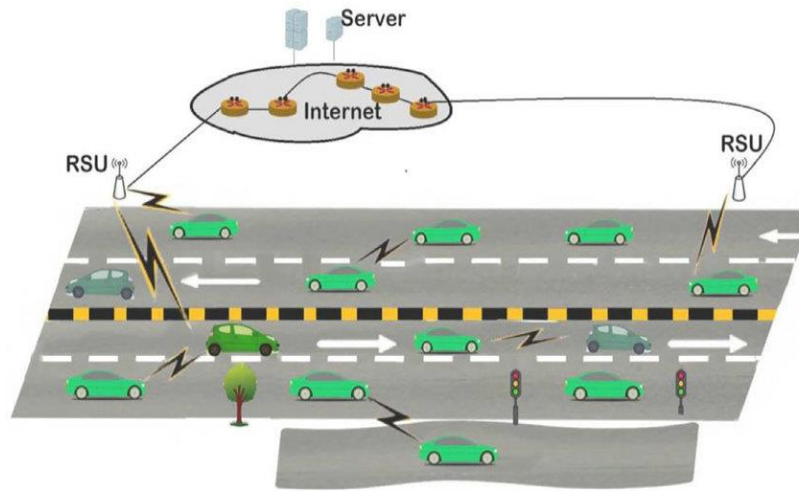

FIGURE 5, Wireless Sensor Network Supporting the Road Traffic Safety.

At [8], mobile computing has gained big interest is todays researches; said by the authors. The development of mobile technology triggered large expansion in data amounts that being shared through the networks. At the same time, new technologies had come to the light demanding new bandwidth. In the wireless communication as well as wire communication, bandwidth allotment will require large budgets. In the context of wireless network, all the applications that not assigned to radio band are termed as secondary spectrum users. The spectrum itself is suffering from utilization matters as many of the primary users (licensed users) are not fully utilizing the spectrum. One of the proposed approaches for utilizing the empty spectrum (when the licensed users are not online) is by adopting the cognitive radio network. Cognitive radio system is working to sense the spectrum and assign the unlicensed users to the empty spectrum bands. Fig.8. demonstrates the procedure of communication in cognitive radio network.
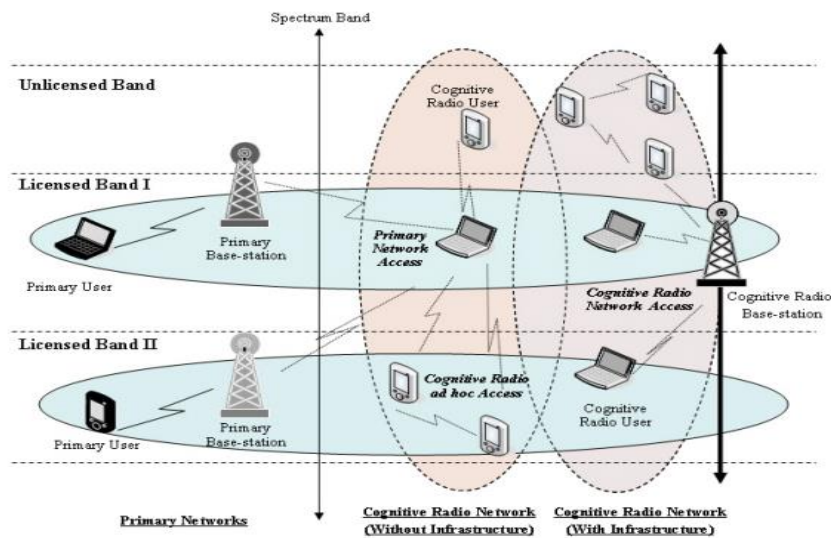

FIGURE 6, The Procedure of Communication in Cognitive Radio Network.

At [9], routing the data in the communication systems is essential process performing by the communication network. Routing the data or network payload from the source node into the destination node may take place through a particular path in the network. The selection of that path is happening by fulfillment the delay and throughput tradeoff formula. Network may employ the so-called routing protocols in order to route the data (payload) through the nodes. The main function of routing protocols is finding the shortest path with minimal losses to route the data packets. One of the essential technologies to ease the routing process is using the packet switching network where data payload is converted into smaller blocks called packets and those packets are then segregated across the network by different paths reaching the destination. Fig.9. demonstrates the process data routing in cellular network.
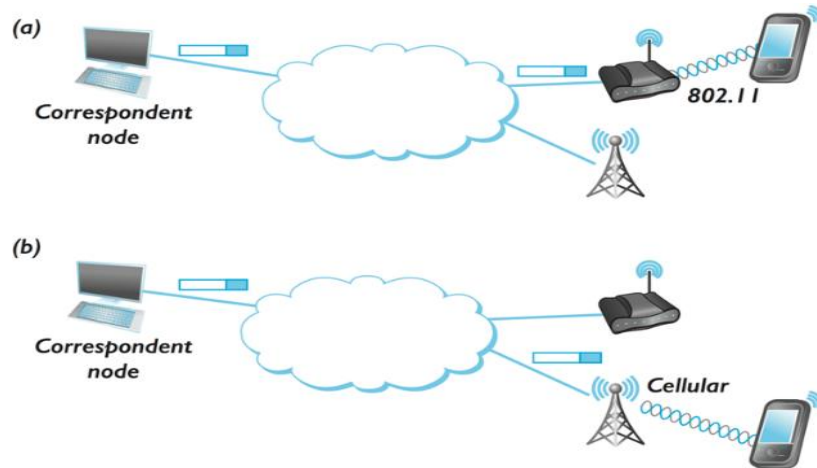

FIGURE 7, The Process Data Routing in Cellular Network.

At [10], delay and throughput tradeoff are important challenge in each communication network. The problem raised when some application alike real-time video broadcasting are concerns about time delay where minimum time delay is required in order fulfil the live broadcasting requirements. However, other applications such as files uploading, and data backup are more concerned about the throughput of the network rather than the time delay. In order to fulfil the requirements of different kinds of applications, two approaches have been proposed namely: packet switching network and circuit switching network. Using the circuit switching network allows data to be transmitted in small time delay value from source node to the destination node. From the other hand, data can be sent with good throughput by using the packet switching networks. Fig.10. illustrates the packet switching and circuit switching networks.
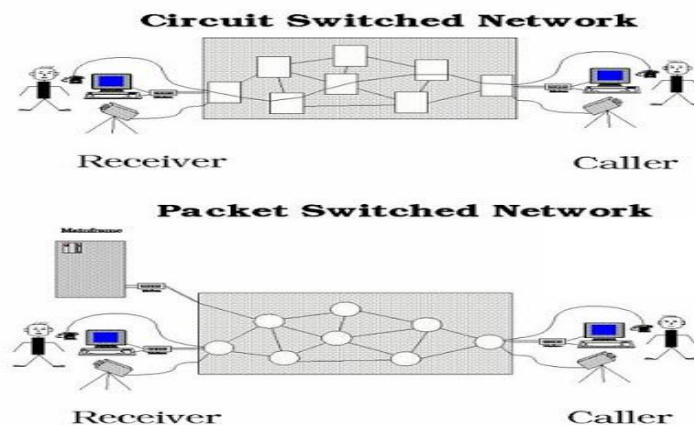

FIGURE 8, Illustrates the packet switching and circuit switching networks.

At [11], packets transmission technology is one of the vital means to enhance the network resistivity to the jitter and noise. It is clearly known that networks are susceptible noise and other performance degradation phenomena. This degradation sources are leading to the so-called packet drops. However, in the packet switching network, data block is sub-divided into smaller

blocks called as packets. Each packet is allotted with unique ID and sent throughout the network through different paths. Eventually, those paths are reaching the destination and the original order of the packets can be avail with help of packet ID number. In case of jitter of packet dropping, network may lose some packets form the original data and the rest of the transmitted packets can reach the destination. From the other hand, at circuit switching network, if any jitter or drop happened, it will lead to lose the entire data. Fig.11. demonstrates the data transmission at circuit switching network.
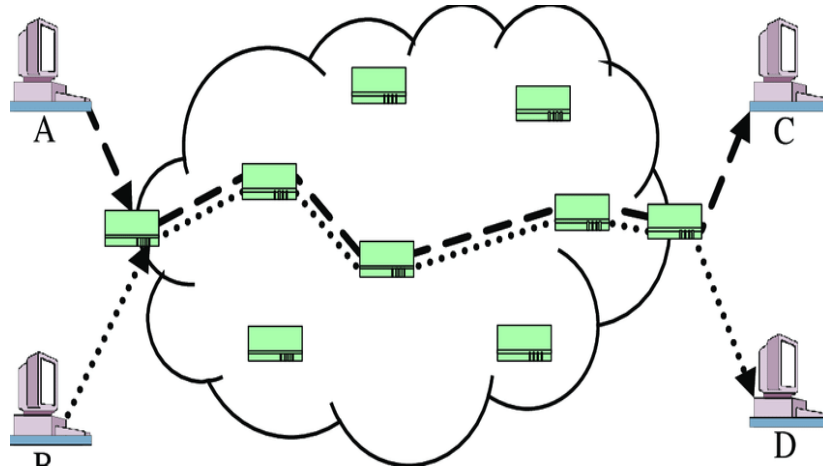

FIGURE 9, The data transmission at circuit switching network.

At [12], mobile to mobile communication is another technique of data routing in communication networks without needing to purchase new channel. The resent trend of mobile communications is deploying the so-called device to device transmission. Device to device involve sending the data from a mobile unit which is out of the coverage through connecting it with coverage area by using anther mobile unit canned as relay unit. This relay unit is a mobile unit located in the network coverage area and only to be used for connecting the device which are out of the coverage to the network. In other word, data from the out of coverage mobile unit can be routed to the network through the nearest operational mobile unit. mobile to mobile communication is being illustrated in Fig.12.
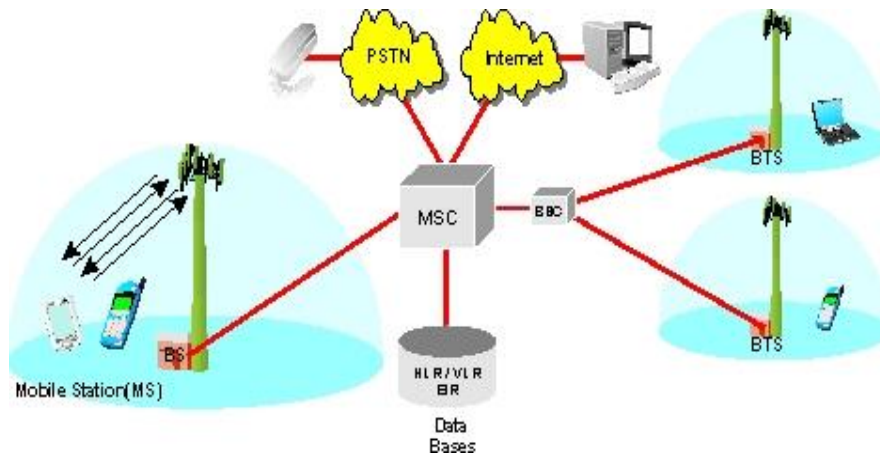

FIGURE 10, Mobile to mobile communication.

At [13], routing throughout any type of network is taking place with help of routing protocols. Assuming a node A willing to transfer the packets to node B, routing protocol will ensure delivery of node A payload to the node B without packet dropping. Author mentioned in this study that simplest way of data routing was taking place by using the so-called chordal networks. Chordal network can be established between any couple of nodes inside the network and permit the data transmission between them according to the path specifications e.g. (wavelength, bandwidth, losses, etc.).

At [14], studies shown that two main sorts of the chordal network are available namely: node symmetrical chordal ring and periodic regular chordal ring network. In node symmetrical chordal ring network, nodes are connected with same degree of

chords and hence, same diameter and same specifications. The node symmetrical chordal ring is demonstrated in Fig.13. shown that identical distances between each chordal link and same number of chords have been connected to each node. However, Fig.13. depicts the case of periodic regular chordal ring, the nodes are connected with none identical chords.
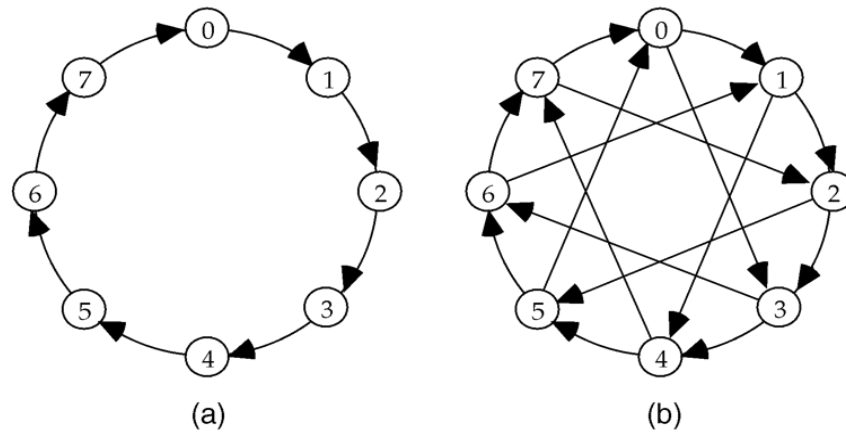

(a)   (b)

FIGURE 11, Depicts the case of periodic regular chordal ring, the nodes are connected with none identical chords.

NETWORKS TOPOLOGIES

Networks have been established for providing more services for individual computers. Single computer can avail specific services when it joins a network. The first insight of computer network was for sharing the office equipments such as printers, Fax machine, scanner, etc. amongst few host computers. Further, networks are developed to include other services such as file sharing and web exploring. During that time, servers were not enough populated; it was firstly developed as supper computer (supper host computer preserving more processing power and storage capacity than other hosts) to share the files and other dedicated services. servers are then developed further to provide advance services; web-based computing is being provided. Networks are developed further to involve large number of hosts and to provide big computational service. Local area network is small, scaled network that attend a good performance in connecting hosts computers. Local area network can be extended to cover a complete building. Performance of local area networks as in Fig.14. depends on the routing mechanism as well as the medium of transmission. Generally, it permits good data rates as well as low transmission delay [15].
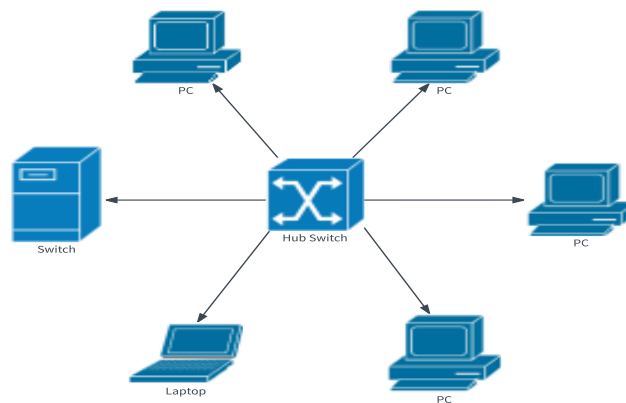

FIGURE 14, Local area network topology.

From the other hand, network can be extended to cover big compound even to cover cities, in that new network topology is established which called as wide area network. This type of network is usually used as backbone network that connects different locations within the city. Where inside each location a local area network might be operative. Fig.15. demonstrates the wide area network structure. Other breeds of network are also popular such as wireless local area network and reginal local area network. Such types of networks are being used for serving particular demand such as wireless based applications. The

examples of those networks can be the WIFI and ground television broadcasting which considered as applications of wireless local area network and reginal area network respectively [16].
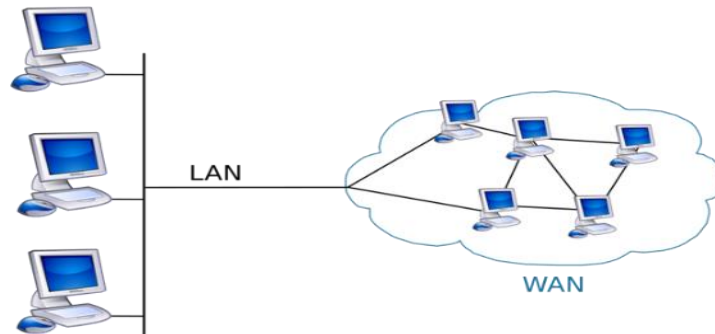

FIGURE 15, Wide area network structure.

During the internet development, the necessity of wire network is not preserved as it was in the past. New type of networks (e.g., cloud network) have been established to pride services throughout the internet without need physical connectivity. Cloud based computing has grabbed the interest of individual developers as well as organizations and industries. Since the cost and the efficiency are the main key players in the network context. Some of computing services such as office and design programs are not easily available for individuals due to the license price of the software. Some software is demanding large storage space with high RAM power which are not available at all computers. However, the cloud computing is paved the road for easing all these challenges by providing all those service one could and can be accessed using the internet. Cloud services can be illustrated in Fig.16.

FIGURE 16, Cloud computing-based network services.

Packet Networks

Data transmission in computer networks is controlled under the so-called two-ways-hand-shaking. If the transmission between two parties; source nodes and sink node, each one of the source nodes is willing to send its payload into the sink node. In packet networks, the payload from each particular node is being broken up into set of smaller blocks called as packets as depicted in Figure 17. In order to propagate packets throughout the nodes, it required to be assigned to some information such as source address, destination address, packet sequence number, acknowledgment number and mac number. The mentioned information is integrated into each packet header and used as legend for packets voyage from source node into sink node [17].
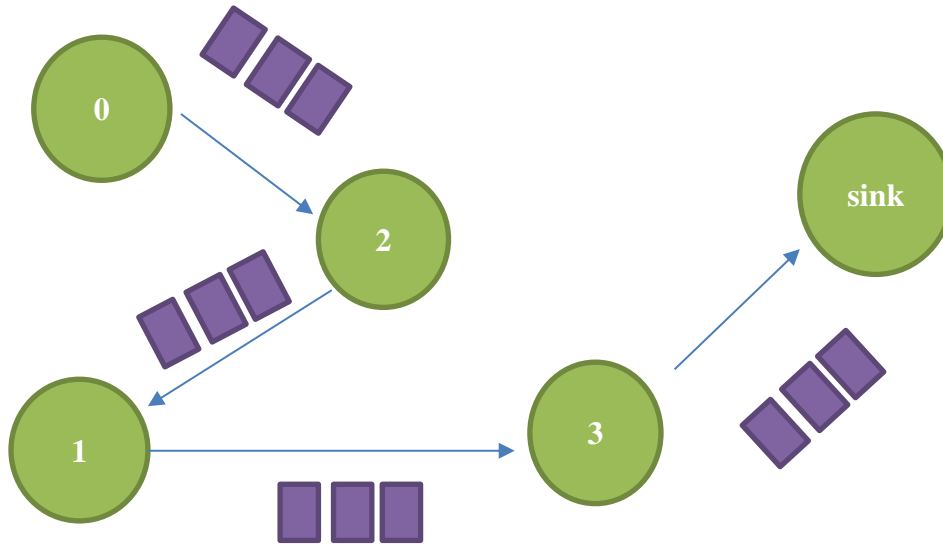
FIGURE 17, Structure of packets network (transmission overview).

Packets train from node (0) are heading towards node (sink) through the path (0-2-1-3-sink). Figure 18 demonstrates the headers in each packet overhead. However, the information mentioned in above section e.g., source address, destination address, packet sequence number, acknowledgment address and mac number are used for directing data packets between the nodes. The allotment of header's information is performing by the routing protocol, the amount of data at the packet's overhead is one of the performance limitations factors. Adding more information in the header will lead to increase the payload of the packet and hence will cause a noticeable delay.
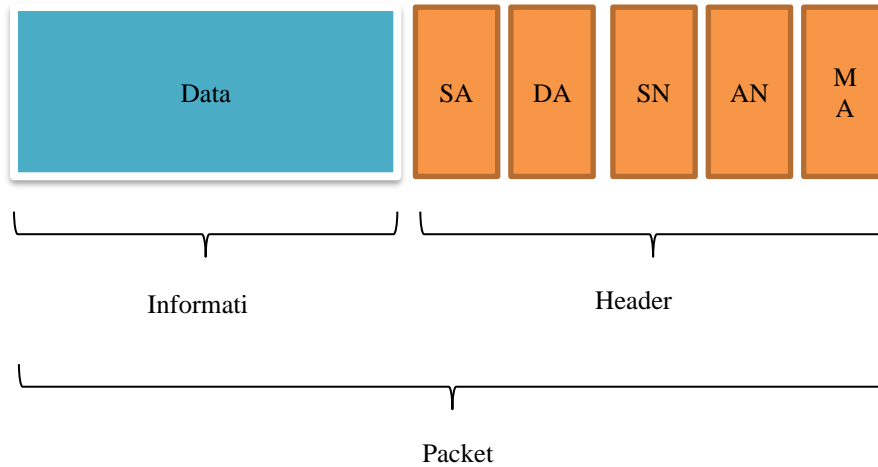
FIGURE 18, Packets frame structure including the headers and payload.

Header may involve information that helps to prevent the malicious attacks in the network. Mac address is important field in the header which involves the mac protocol unique address of each node which cannot be faked by the malicious nodes. The other fields such as sequence number (SA) and acknowledgment number are used in accordance with the routing table which is formed in each node by the routing protocol. It also linked with the two-ways-hand-shaking process that ensure the packets delivery without drop [18].

CHANNEL MODELING

Channel Overview

Transmission of information through the communication network required a medium of transmission to hold the data from one point to other point within the network. The physical medium in networks terminology is referred as channel. Data voyage through the channel may account several performance degradations such as additive white Gaussian noise, fading effect and doppler effects. Depending on the channel specifications (e.g., bandwidth) and type (wire or wireless), communication systems are being established [19].

Channels are being modeled as random process where the anticipation of noise level as well as other performance degradations is governed by the probability rules. In mobile communication; as user moves from the base station, signal may start facing doppler impact. From the other hand, fading is another phenomenon taking place. The presence of physical and natural objects (obstacles) at the vicinity of the communication channel trigger multipath propagation. Signal (transmitted) is getting reflected by the near-by objects and hence, a multiple copy of the original signal reaches the receiver end. In the wire network context, channel is forming by propagating a physical wire. Depending on the network bandwidth specifications, wire line can be changed between (coaxial cable, broadband cable (twisted pairs cable) and optical cable. Those three types of cables are differed by their wavelength as well as the bandwidth. Twisted pair is providing bigger bandwidth than the coaxial cable while the optical cable has the top most data rate and bandwidth over all available channels. In wireless communication e.g., mobile communication, satellite transmission, walkie-talkie, etc. channel is subdivided into two bands, uplink and down link [20].

Channel Allocation

The expansion of technological applications due to internet development has triggered the so-call bands congestion. New applications that required new band allotment have been left without bands. All popular communication networks such as mobile communication, satellite communications, etc. are working in particular frequency bands. if new technology arrived, it may be facing a band reject. Naturally, the licensed bands are allocated for particular applications (licensed users) cannot permit unlicensed user transmission. Technology is addressing of unlicensed users' problems by promoting the so-call band utilization approach. This approach is attempting to sense the licensed band in periodic fashion and check for any empty (free) slot in the band. Upon finding free slot in the band, unlicensed users can be placed on those free slots. One of the existed approaches for doing this task is called as cognitive radio network. This technology is helping to utilize the free bands in the existing licensed band without violating the licensed user activity routine [21].

CONCLUSION

One of the fundamental approaches to allow multiple users accessing the same bandwidth without collision are multiplexing technologies. It is basically varying into three trends: time, frequency, and space multiplexing. Channels can be divided in time between the users where every user can begin the transmission during the time slots defined by the time division multiplexing system. One of the important features of time division multiplexing system is allowing the full bandwidth (frequency) to be used from every user. From the other hand, frequency division multiplexing is another approach proposed for ensuring that each candidate of the spectrum operating full time. The frequency in this case is to be compromise between the candidates. Frequency of the channel to be divided amongst the users so that each user will use smaller slow of bandwidth all the time for data transmission. One other approach that was proposed for allowing multiple users band occupancy is called space multiplexing and can be interpreted as hybrid multiplexing approach that add both time and frequency constraints are applied. Space division multiplexing permits different bandwidth to operates at different times, granting the advantages of time division multiplexing and frequency division multiplexing to each candidate in spectrum.

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