# Fiber-To-The-Home (FTTH) Architecture for Mosul, Iraq

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*Abstract*—Fiber-To-The-Home (FTTH) is the most promising technology that can offer high bandwidth with more reliability and very high Quality of Service (QoS) comparing with the previous kind of traditional internet connection technologies such as DSL. This technology is based on the optical technology, which use fiber optics that connect the internet service to end-user, which is the subscriber. This work is done to investigate factors and challenges of deploying FTTH technology or a suitable architecture in Iraq. There will be challenges and issues that could be faced while implementing a certain type of FTTH architecture. This research investigated the best solution to provide an internet access to the end-user in Iraq that support higher capacity adaptability due to the increasing number of higher bandwidth access request. Firstly, current studies and works was done in order to explore knowledge about FTTH. Next, factors affecting successful deployment was identified through survey among users in Mosul (one of the main cities in Iraq) in order to generate factors by performing the analysis part based on the collected data to help proposing and choosing the suitable FTTH architecture in the end. The results of this research will be helpful for the government and companies that provide the internet access to the end-users in Iraq to deploy the technology successfully.

*Index Terms*—Fiber-To-The-Home, Fiber Optics, Fiber Optics Architecture, Network Architecture.

## I. INTRODUCTION

Internet technologies are very necessary nowadays as life dependent on digital technologies that involved approximately all of human activities such as connecting to bank accounts, watching YouTube, Facebook, Google's services, online shopping, and video calling [1]. In addition,

Information and Communication Technology (ICT) has a huge impact on the societies' economics. Subscribers to internet technologies around the globe highly need and request for a better internet line service in term of providing high bandwidth and better reliability [2]. They desired more speed and much more stable connection which DSL and Wi-Fi cannot provide. In this case, fiber optic cables is the solution which can provide high bandwidth with high throughput and low attenuation. Fiber optic cables are based on the light technology that carry the data in a light form, so the transmission of the data is enhanced by the light speed which is the ever fastest medium known until now to result in providing a huge bandwidth capacity to serve high speed data rates. The reliability of this medium comes from the lowest noise that can affect the signal because of the fact that electromagnetic interference cannot affect light which made this technology reliable. This work proposed architecture, which will be implemented in Mosul. It aimed to investigate the deployment of FTTH technology in Iraq environment, to study the recent trend of this technology and to collect enough information that will help to produce the solution for this study [4-6].

Fiber-To-The-Home (FTTH) is the most promising technology that can offer high bandwidth with more reliability and very high Quality of Service (QoS) comparing with the previous kind of traditional internet connection technologies such as DSL. This technology is based on the optical technology, which use fiber optics that connects the internet service to the end-user which is the subscriber. FTTH is an access architecture which has a number of types that will be reviewed. In addition, FTTH is very flexible technology that can be implemented and deployed in every country, but there are many differences that are found in the country policy and the geographic area of the end-user is very independent [7-9].

FTTH supports many types of locations and this will make the network infrastructure design different from each other due to the location as well as the geographical area. This paper proposed FTTH architecture to be implemented and deployed in Mosul, Iraq which will help to enhance the government internet services. The importance of the study also comes from the higher bandwidth capacity that are requested by the end-users increasingly all around the globe. In addition, this research suggests an FTTH architecture that will support the existed services as well as the future services technologies. There are lots of services that required high bandwidth support such as the High Definition TVs (HD TVs) streaming which requires Gigabit internet that can be offered by the fiber optic cables to be able to handle this load [10]. People can determine the benefit from implementing FTTH while families and friends will discover new ways to learn, work, play, and improve quality of life. Only the fiber based networks will be able to handle a huge bandwidth that requires to drive all the applications and services. Enhancing the ability to support the growth of the society need for a higher level of bandwidth. Based on the recent studies there will be an increasing number of the bandwidth requirements. Finally, the Iraq country need to be developed as soon as possible to join with the growing countries because Iraq suffers from wars since 1980's until now which resulting the destruction of its economic

infrastructure [11-13]. This paper attempt to determine and explain how to conduct the research and describe the method that will be adapted to do the work accordingly. A step by step methodology was constructed in order to make the research consistent by generated a flow chart that this research will follow along to offer an organization management for this study and provide advantages to enhance the simplicity of doing, conducting, and understanding the work from a researcher's point of view as well as the reader point of view.

## II. METHODOLOGY

The methodology contains six steps: Construct the literature review; Identify the problem dimensions; Determine where and which data to collect; Performing analysis on collected data; Proposing a network architecture; Provide limitations, conclusion, and future work. The data has been collected from the users in Mosul, Iraq by using a Google Form survey method. The survey was designed in three parts; first part representing the personal information, second part representing the current service of the internet in Mosul, and third part representing our proposed FTTH service to be deployed in Mosul. The survey was shared and distributed to the users in Mosul. Data was organized and analysed in MS Excel sheet format.

## III. RESULTS

From the analysis, the users in Mosul are not ready to subscribe to full fiber (FTTH) service, because architecture requires high costs for implementing and maintaining the service as well as the fiber cable high costs to be fully implemented as mentioned in the literature review chapter. In this case, another architecture is choose that requires less costs and have hybrid mixing between fiber and copper cables (HFC Hybrid Fiber Coaxial) to reduce the cost that ends up with an acceptable cost for the user to subscribe to that particular service. At the same time by reducing the cost, an architecture were choose that provides balance between the cost

and bandwidth. However, Fiber-To-The-Node (FTTN) will be the most suitable architecture that can be implemented in this city. The reason of choosing FTTN is explain in details in later sections called the evaluation of the architecture. Fig. 1 illustrated the selected area for proposing and deploying the network.

Moreover, consideration is needed in providing wireless and wired connection at the end-user point, which can be achieved by providing a device (router) that offer both connections. Next, devices are placed, such as switches at the cabinet, where the fiber converted to a copper cable, which properly needs a power source to operate. Mostly, the distance between the cabinet and the user is around 1 Km, which will help to reduce the cost of distributing multiple copper cables instead of fiber cables, which will be cost effective. Fig. 2 and Fig. 3 is the proposed architecture, which has more details illustrated. In order to illustrate more on the architecture, the technology used to transmit the signal from the cabinet to the user called Very High Bit Rate Digital Subscriber Line (VDSL) Ethernet over the copper cables. This technology can support 10 to 60 Mbps bit rate.
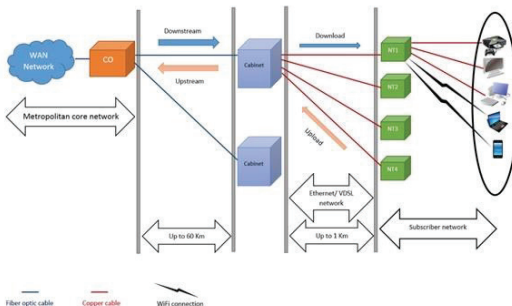

Fig. 1. Mosul left coast area.


Fig. 2. The proposed architecture chart.


Fig. 3. The proposed FTTN architecture.

To illustrate more, the calculation for the number of cabinets needed can be provided by the below equation. Equation 1: Calculating the number of needed cabinets.

$$C = \frac{A}{CD} \tag{1}$$

Referring to the equation, C represents the number of cabinets needed for that area, A is the total area of the left coast of Mosul, and CD represents the coverage area for a single cabinet. However, for the left coast of Mosul needs some additional information such as the area of that place. In this case, we use google map to calculate the area. The total area of Mosul centre is 130 Km2, so the left coast of Mosul is equal to 97 Km2. In terms of the cabinet, each cabinet can support up to 1 Km2, so we can calculate the number of needed cabinet as the below equation.

$$C = \frac{97}{1} = 97 \tag{2}$$

This is the total number of needed cabinets (97) to cover the left coast of Mosul. Of course, this is a big number to start deploying with, so in this case we can begin deploying at only the very populated places. As a beginning, we can start with 30 cabinets and then the rest of the cabinets can be installed in a scaling trend, which will end up covering the whole area. In terms of the fiber optic cables that will be installed from the central office to the cabinet we propose a single mode fiber optic cables to be

used in this case. The advantages of using these cables because it runs for far distance compared to other types of fiber. The single mode fiber cable proposed type have the Wave length 1550 nm, which uses FCPC connector type, the distance that this fiber type can cover is 60 Km. In this case, the distance is not a problem with this type of fiber to be deployed in Mosul city. FTTN is an access architecture uses the shortest fiber cables compared to the other three types (Zidane & Huberman 2013) in order to reduce the cost of the deployment. This type basically has a terminal at a main street which is usually far away from the subscriber with a distance approximately to 3000 feet. The cable connected between the operator and the terminal is fiber optics and then the subscriber connected to the terminal using copper cables (Jana et al. 2007). FTTN uses VDSL Ethernet access technology and provide 10 to 60 Mbps speed which can be considered quit good speed.

## IV. DISCUSSION

The proposed architecture has the scalability consideration which means that the network can be grown up to cover more users and to increase the bandwidth as well in the future. We can notice that the copper cables can be replaced by fiber cables in the future to support full bandwidth and can be easily converted to FTTH architecture. Moreover, the coverage area can be doubled or tripled without affecting the speed or bandwidth, because the bandwidth capability of the fiber optics that reaches into the cabinet located at 1 Km far from the users can provide unlimited bandwidth. In other words, we can add more users to the cabinet in the future without affecting the performance or the bandwidth capacity. The proposed architecture is fully effective and usable, because it provides many advantages to the company that deploy it and to the users as well. The FTTN architecture is effective and cost saving, which make it usable. This architecture is also needed by the users and it will be popular and successful, because it will offer higher bandwidth compared to the current service in the city, which has better QoS. Moreover,

another advantage is having the device at the end-user home, which will offer wireless (WLAN) and wired connection (LAN) to the user. This will be useful if the user has different types of devices such as Laptops, Desktops, Smart phones, Smart TVs and etc. In terms of maintenance, fiber optic cables will need less maintenance if it is well installed and protected when the deployment happens. Also the lifetime for the fibers is longer than the copper cables and noiseless because it adopts the light method to transfer data, unlike the copper cables where it transfer data using electric pulses, which is affected by the electromagnetic fields. However, the copper cables will need more maintenance compared to the fiber optics. Eventually, the copper cable maintenance will cost less than fiber maintenance. In terms of cost factor, the proposed architecture is optimized, which means it offers the maximum bandwidth at that cost. The only expensive things will be the devices in the cabinet (Switches) that joins the fiber optics with the copper cables. Also, the fiber optic cables will be expensive, because it runs for a long distance. The price will be acceptable comparing with the service that will be offered to users. In terms of the service cost, there will be several packages that will be offered to the user, which will help him to choose what they need. In terms of costs that will be charged to the company, which is the maintenance duties, as we mentioned in the maintenance point, the cost will be low, because mostly the copper cables are used in our architecture that as we know it has low cost and easy to maintain at the same time. Eventually, the cost is optimized to provide the highest possible bandwidth at the lowest cost.

## V. CONCLUSION

In summary, the research proposed the most suitable architecture, which decided by considering the analysis results based on the data collection. FTTN architecture were proposed to be deployed in Mosul. Calculation of how many cabinets were proposed in order to operate the service in that area (Left coast of Mosul), which is 97 cabinets needed to cover the

whole coast. FTTN uses a hybrid cabling, which is using fiber cables from the central office to the cabinet that is 1 Km far from the end-user, and then from the cabinet to the end-users the cables used are copper based cables for the sake of reducing the costs. However, FTTN architecture provides 10 to 60 Mbps bandwidth service, which is more than enough now.

## ACKNOWLEDGMENT

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