Maximise the passive optical network throughout by jitter and wander parameters.

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Chapter 1 Introduction

1.1 Background of the research

In general, fiber optics assists to transmit data through light signals. When the transmitted data goes through a fiber, it requires different ways to reach the targeted places. In addition, passive optical networks and active optical networks are the two significant types for realizing it, (Woodward *et al.* 2013). Both the optical networks provide significant ways to separate data and route the data based on the relevant places, (Weiss *et al.* 2014). With the rising demand for high bandwidth broadband, the need for technology longevity is also raising gradually that initiated the development of the passive optical network. A passive optical network is a telecommunication technology which assists to implement a point to the multipoint framework, (Ali *et al.* 2013). In addition, the unpowered fiber optical splitters formulate a single optical fiber to serve several end points including customers which in turn reduces the need for connecting individual fibers between the customer and the hub. In general, it integrated fiber to the home or FTTH, fiber to the curb or FTTC and fiber to the building or FTTB.

On the other hand, (Aminian and Dong, 2014.) suggested that jitter and wander are one of the most efficient parameters that can enhance the passive optical network. Jitter is one of the short term phase variations of a digital signal that assist to the instant the position of the signal from their ideal positions based on time. Furthermore, it is significantly generated through the integrated phase noise measurement as well as for SDH or SONET equipment which it does not exceed 0.01 UI RMS or root mean square at a cut off frequency of 12 kHz using a high pass filter (Toy, 2012). As put forwarded by (Arsenijević and Bimberg, 2017), wander is one of the 2nd parameter similar to jitter. It assists to analyze the long term variations based on the specified instants. In addition, it classifies ITU-T G.810 jitter frequencies below 10 Hz similar to wander as well as frequencies above or at 10 HZ similar to jitter, (Bergeron *et al.* 2016).

1.2 Rationale of the research

Based on the background of the research, it has been analyzed that passive optical network components are the key to enhance the bandwidth potential of fiber. In addition, integrating the technology of passive optical network with the parameters of Wander and jitter has not been performed explicitly in the past research studies. Furthermore, such advancement in technological filed with the rising demand of customers as well as with the need of companies to boost their revenue, in order to attain error free passive optical network architecture, the analysis for comprehending the impact of jitter and wanders would be relatively helpful for synchronization requirements as well as to attain smooth transmission of services at real time over the broadband networks. This research study would provide significant details about the extensive benefits of integrating passive optical network and its impact due to the parameters of jitter and wanders in a detailed manner. In addition, the relative benefits for the passive optical network in order to maximize it would also be analyzed.

1.3 Research question

- How jitter and wander parameters affect the passive optical network?
- What are the benefits associated with the passive optical network architecture without the parameters of jitter and wanders based on maximization?
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Chapter 2 Literature Review

As opined by (Chaffee *et al.* 2016), a passive optical network is a point to multipoint networking technology. The fiber in the passive optical network architecture which integrates passive optical splitters is utilized to allow a single optical fiber for performing and serve several functions. In addition, (Chang and Cheng, 2016) stated that there has been always a significant development in the telecommunication sector that enhances the lives of customers as well as offers revenue to the companies. With the progress in standards made from APON to GEPON, it can be stated that the industry of telecommunication is seeking distinct ways to offer bandwidth over longer distances compared to earlier times, (Schmukler *et al.* 2013). As stated by (Gupta *et al.* 2013) there are two distinct ways of achieving such standards. The 1st is to increase the number of optical wavelengths with the use of passive optical network fiber which in turn increases the bandwidth. The 2nd is by increasing the bandwidth efficiency of each wavelength. In addition, the literature suggests that the configuration of passive optical network assist to minimize the amount of central office equipment as well as fiber based on the point to point architecture.

On the other hand, (Dias, 2016) suggested that integration of passive optical network in the telecommunication industry has enhanced the level of technology. In addition, in order to assist and deploy a wide variety of services with the inclusion of greater speed and ease, it is significantly required to provide bandwidth based on the demand for efficient network architecture, (Schmidt *et al.* 2013). Based on such note, the integration of jitter and wander in the passive optical network could be highly credibly by maximizing the network integrated. Furthermore, the flexibility that is provided through the passive optical network would fulfill the demand and traffic patterns in future terms. As put stated by (Dong and Sadegh Aminian, 2014), there are three methods in the passive optical network for the deployment of fiber. The 1st method for the deployment to based on fiber to the curb, (Savoj *et al.* 2013). In such architecture, the terminal equipment is situated at the curb which assists to facilitate appropriate services to the area based on convenience. However, the distribution is conducted through cooper that states the significance of selecting the best terminal that takes safety factors, optimizes cost and reduces back feeding into consideration, (Ebenhag, 2013). On the other hand, the 2nd deployment method of fiber is fiber to the building. In this method, the terminal equipment is situated inside the multi-storeyed building. In addition, such method assists to bring higher bandwidth closer to the user. However, (Ghayoori, 2013) stated that the distribution

part is done through copper. Lastly, the fiber to the home or office method initiates by moving the fiber to the user premises.

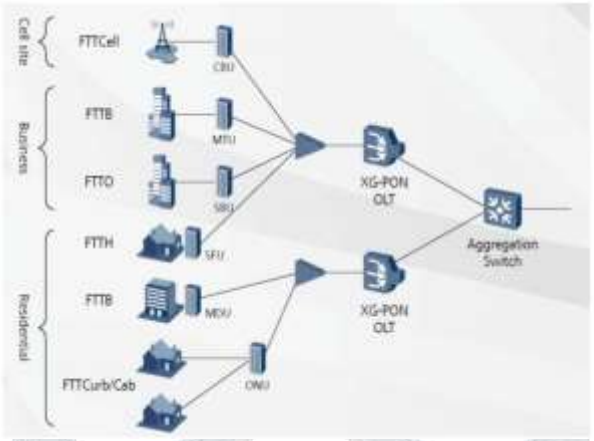

Fig: 1 (PON or Passive Optical Network)

As put forwarded by (Gorshe, 2016), jitter is in general measured and specified as maximum phase amplitude within more than one measurement bandwidth. In addition, as the amplitude, as well as the frequency of jitter, varies based on its effects, the need for specifying a single interface for serving distinct bandwidths is relatively high. The amplitude of Jitter has represented in UI or Unit Intervals which states that 1 Jitter is equivalent to 1 data bit width without the consideration of data rate, (Sadeghioon, 2013). In addition, the amplitude of jitter is quantified as peak to peak value other than the use of rms or root mean square as the bit error in the network equipment is made by the peak jitter. On the other hand, (Hastings *et al.* 2015) argued that root means square value is significantly essential in modeling and characterizing jitter accumulation based on long line system compared to the peak to peak values of jitter. As stated by (Hemmati and Caplan, 2013), the measurements of wander are closely related to the measurements of jitter. In contrary, (Hietala, 2016) argued that the measurement of wander is based on external reference clock generator along with minimal intrinsic level contrary to jitter that uses internal reference clock generator. In addition, such generator at minimum intrinsic power is used to phase the fluctuations down to approximately 0 Hz which is significant for measurement, (Kim *et al.* 2006). They integrate low frequencies based on long haul which assist to generate wander measurements consistent of hours of phase information.

Throughout the entire literature, the details of each variable including passive optical network as well as jitter and wander parameters have been discussed elaborately. In addition, the relevant analysis and details have been provided significantly that would certainly assist to formulate the present research study. On the other hand, (Kaushal and Kaddoum, 2017) also suggested that the reason behind passive optical network called passive is because there are no other active element in the access network except for central office. In addition, it offers service provider to serve an actual triple play offering of data, voice, and video which is an essential offering. In contrary (Kim, 2015) argued that it is significant to serve error free services and

transport network which cannot be viable only by deploying the passive optical network. Based on such context, this particular study would analyze both the impacts of jitter and wander parameters in the passive optical network architecture, (Popescu *et al.* 2016). In addition, it would also analyze that whether the entire architecture of passive optical network would be affected by jitter and wander parameters by conducting effective methodology presented in the next section.

Chapter 3 Methodology

3.1 Research philosophy

Without appropriate reach philosophy, the researcher cannot estimate the needed data for conducting the research. In addition, (Ritchie *et al.* 2013) stated that in order to conduct the research successfully, it is intended to attain the fundamental basic factors including positivism, realism, and interpretive for attaining fruitful research project. Based on such a context, in this research study, the researcher has considered each dimension including positivism, realism, and interpretive for proving the hypothesis by evaluating the qualitative data appropriately. The secondary data that would be attained would be analyzed through a realistic approach.

3.2 Research design

The extensive research design significantly offers a reasonable hypothetical framework by analyzing both primary and secondary data. The evaluation design has significantly covered basic three sections including explanatory, descriptive as well as exploratory research design in order to analyze the data qualitatively and attain significant results. As stated by (Houghton *et al.* 2013), research design is a significant aspect to conduct a research study in order to prove the legitimate hypothesis. In addition, without analyzing the data in an intensive style, the analysis that would be formed would not be appropriate based on the scope of the research, (Scott and Garner, 2013). Along with the descriptive design, the researcher has considered thematic analysis for conducting the research successfully. The secondary data would be significantly used in this research study by analyzing pre-published journals and articles proposed by scholarly authors.

3.3 Research approach

The approach of the research is based on thematic analysis that would be conducted by using secondary data proposed by scholarly authors. In addition, (Yilmaz, 2013) stated that research approach is an integral part for conducting the study efficiently and effectively. On the other hand, (Gale *et al.* 2013) stated that both deductive and inductive approach is highly needed for analyzing specific data from distinct sources. Based on such context, the researcher in this project integrates inductive research approach by analyzing pre-published journals, articles, and books that are proposed by scholarly authors which would certainly result in qualitative results. In addition, the inductive approach would be conducted for fulfilling the scope and rationale for the research offering a new dimension in the specified area of technology.

3.4 Sampling

A sample design includes each relevant material that would fulfill the basic criteria of the project, (Marshall *et al.* 2013). As the research project is based on thematic analysis and qualitative assumptions, the sampling design is based on secondary data by using credible sources including Google Scholar, Google.com and other relevant websites. In addition, the information that has been provided by past research authors in relation to journals and articles would be also evaluated for attaining desired and accurate results.

3.5 Sample size and data collection method

As the research would initiate the inductive approach, the sample size is not considered for conducting the study. Furthermore, the researcher has used credible resources based on which the thematic analysis have been conducted. As put forwarded by (Miles *et al.* 2013), thematic analysis is a significant approach that offers qualitative results that fulfil the scope of the research project. Based on such context, the data collection method chosen for conducting this research project is based on gathering relevant information from credible resources using journals, articles, books, and websites.

Chapter 4 Result and Discussion

Based on the credible source (literature.cdn.keysight.com, 2018), it has been identified that the integration of jitter and wander would certainly reduce the efficiency of optical network architecture. In addition, it has been also observed that the jitter and wander parameters have variations in telecom signal timing that certainly creates error data. However, it states that with a significant deployment of jitter and wanders parameters the passive optical network can be highly minimized as it reduces bit data and increasing the noise. In addition, it has been also analyzed that jitter prevents correct sampling as well as closes the horizontal axis that in turn results in bit errors. On the other hand, (Lee, 2014) stated that jitter and wander does not cause the error itself rather it lowers the margin of noise in the passive optical network architecture which in turn leads to huge errors.

On the other hand, the credible source (lightwaveonline.com, 2018) depicts that jitter and wander defects move along in the broadband network. In addition, it also illustrates that in the fiber optic networks, the jitter and wander are the data edge phase variations specifically in the transmitted digital signals that degrade the video, voice and data services by creating synchronization and clock problems. Furthermore, (Lindsay and Swenson, 2010) states that in the broadband networks specifically in the architecture of passive optical network both the jitter and wander parameters must be efficiently monitored for analyzing deleterious effects. On the other hand, the source also depicts that in order to control and manage jitter and wander parameters in the passive optical network, ITU-T sets interface and equipment jitter and wander specifications must be analyzed in order to limit its impact based on the standards published by ANSI. On the other hand, (Moloisane *et al.* 2014) stated that there are three principles sources of jitter and wander

parameters. These are: drift in synchronization circuits in passive optical network, change in delay because of temperature which leads to cable expansion and improper or reconfiguration of the synchronization path.

In addition, (association for passive optical LAN, 2018) the credible source explicitly illustrates the advantages of the passive optical network without any parameters of jitter and wander. The technical advantage of a passive optical network is it assists to flatten the entire network area by simplifying the changes, moves and adds in the network. In addition, the network is not limited to any specified distance or any constraints of bandwidths, (Paquot, 2014). It is highly secured by design as it is based on built-in encryption and optical fiber. Furthermore, (Lindsay, 2012) states that the economic advantages of the passive optical network are that it can prohibit any wiring closets as well as reduces the need for cooling infrastructure, midspan electronic and power. In addition, it uses less expensive, smaller and lighter cables in order to reduce the space and pathway requirements. On the other hand, it also virtually eliminates the requirement of refresh infrastructure of cabling and only needs a refresh of active endpoints, (Papadopoulos, 2013).

Chapter 5 Conclusion

Summary

After conducting the entire research, it has been analyzed that both the jitter and wander parameters affect the efficiency passive optical network creating bit errors. In addition, the jitter and wander parameters have a significant impact on the viability of fiber networking architecture affecting voice, video, and data of the entire architecture. On the other hand, without such criticality in the architecture, the passive optical network architecture is highly efficient to offer point to multipoint services to the users enhancing its viability and credibility in the technological world. The strategy that has been proposed by ANSI is also credible to reduce the errors provided due to jitter and wander. In addition, based on the discussion it has been analyzed that the jitter and wander parameters creates miss-timing which is induced due to pattern dependency or the noise sources. However, it has been concluded that jitter and wander prevent sampling appropriately creating bit errors which affect the entire architecture of the passive optical network.

Limitations of the research

As very limited information has been provided by the scholarly authors in this particular area, the availability of credible sources has been limited which is one of the significant limitations of the study. In addition, the particular analysis using the passive optical network and the impact of jitter and wander parameters have not been evaluated in past research studies explicitly. Based on such note, such limitations have affected the research project at a certain extent.

Future scope of the research

As the scope of the research was limited to jitter and wander parameters and its impact on the passive optical network, future studies can focus extensively in the area more critically by analyzing quantitative results as well. Furthermore, in order to reduce the effect of jitter and wander certain strategies and reinforcement can be also analyzed in future studies that would offer a new direction in this particular field.

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