

# CHAPTER 1: INTRODUCTION

## 1.1 Background

The Fiber To The Home (FTTH) communication with optical network media is not expensive anymore. Personal users can now use the fiber transmission media to pass the triple-play services, video, internet data, and telephone. These three kind services have different characteristics in terms of consumption of bandwidth demand. Therefore, it needs different setting scale on the data sent for each service in which the optic technology did not apply the fairness standardization yet among the delivered services.

The FTTH communication with optic media is the combination of optic media as the backbone and another optic media as the last mile to approach the end users [1]. In the last mile, the commonly used system is Passive Optical Network (PON) since it has ability to save the budget and the demand of configuration is quite simple.

With Orthogonal Frequency Division Multiplexing (OFDM) on the optic channel, reference [1] explains some techniques of optical carrier modulation into 3 types, namely All Optical-OFDM (AO-OFDM) with the pure channel carrier from the data change to the optic by raising the optical tone itself (for example, Mach Zender Modulation), so it is considered more natural with the ability to be used in long-haul transmission [2], Direct Detection-OFDM (O-OFDM) and Coherent Detection-OFDM (CO-OFDM) using Optical Modulation (OM) to change RF signal in the optic form.

O-OFDM has a simpler, cheaper system, so many researchers start exploring O-OFDM + TDMA to be tested and developed into the access domain [3] [4]. Although it cannot be applied in the market, many researches use O-OFDM + TDMA on the Passive Optical Network (PON) system with several methods to increase the spectral efficiency and fairness among the users (Optical Network Unit - ONU).

Unlike the fairness among users, the fairness on service is a part of QoS that should be ensured based on Service Level Agreement (SLA) on the users based on the characters of the service itself. This research is focused on the scalability on the service type and scheduling to maintain the fairness of service based on the characters.

## 1.2 Conceptual Framework/Paradigm

Like the majority of communication in any system, the downstream traffic (toward users) will be larger in general than the upstream traffic (from the users). In the PON system, the downstream traffic drains the traffic from Optical Line Terminal (OLT) to Optical Network User (ONU) with Point to Multipoint topology [20]. The downstream flow is the majority of

service data flow consumed by users, so the measurement on the downstream flow will be used in this research.

The objective of this thesis is to make the system configuration in form of the combination of OFDM + FDMA technique through optic channel with algorithm focused on the scale of sub-carrier number allocation to increase bandwidth efficiency in congest traffic condition and meet throughput required by every service type. The scheduling will be conducted with Fixed Burst Transmission (FBT) with Round Robin method by changing the time-based period [4] into the basis of Sub-Carrier (SC) number.

### **1.3 Statement of Problem`**

A part of QoS that is often neglected is the priority on the different service management. Most of previous researches focus on the data transmission among the users, but they still generalize all service types carried. Therefore, this research is focused on the scalability on the service type and scheduling to maintain the fairness of service based on the characters and the bandwidth demand of the service itself.

### **1.4 Theoretical Framework**

With traffic pattern recognition introduced in [5] there is categorization into three main traffic patterns, namely Variable Bit Rate (VBR), Constant Bit Rate (CBR), and Self-similar data transmission in which it needs different bandwidth consumption according to [10] this service character.

Unlike previous researches [1] and [3] regulating the multiple access based on the TDM system, this research uses FDMA since it is oriented to the bandwidth scale required for every service character served. It is distributed evenly to the connected users and the different priority scales on every service type is also conducted.

### **1.5 Assumption**

Some assumptions related to this research are as follows:

1. Downstream is taken since the traffic is higher in form of service and the scale is predictable, and downstream is the way traffic distribute to user access.
2. It uses OFDM since it has ability to divide the traffic into small sub-carriers to be transmitted.
3. FDMA is used since it has ability to manage the multiple users based on the frequency (Sub-Carrier) that will be related to the bandwidth scale to be transmitted per service.

4. Service traffic in the global internet can be divided into three types of services that are often referred to tripleplay services, namely video, data internet, and voice.
5. We differentiate into 7 types of consumer users, ie users who consume video only, data internet only, voice only, video and data, video and voice, data and voice, and consume all the tripleplay service.
6. 6:3:1 scale is used since based on the [15], bandwidth consumption on the video service is bigger than for the Data-Internet service. Moreover, Voice/Telephone is the service type with the smallest bandwidth demand since telephone service (VoIP) can be sampled until the most minimum sample, while the message and the tone of voice can be listened and understood.
7. The scheduling scheme teori has three stages according to [10], namely classing, marking, and queuing. In this research we assume that 2 first stages are done. The output that will be use as the input of 3rd stage is a data with the information of service type that will be queuing to delivered to ONUs after they occupied the SC that has been allocated by using the additional scale algorithm.
8. The amount of bandwidth on the setup in each FONT has 8 variations, ie, 1Mbps, 2Mbps, 3Mbps, 5Mbps, 10Mbps, 20Mbps, 50Mbps and 100Mbps

## 1.6 Scope and Limitation

To gain the values which are expected of the reserch, limiting problems The research will be focused on downstream direction on Passive Optical Network (PON) system. The steps and mechanisms which are influencing the research will be described as follows:

- a. Fairness in this research is the fairness in service to the needs of Bandwidth they were supposed to get according to the character of service itself, this research will use standard HD quality as the comparation in Video services.
- b. The test is conducted on the downstream transmission direction from OLT to some ONUs.
- c. The tested system uses Optical-OFDM + FDMA system with additional algorithm for scalability.
- d. With the scale of data to test, the monte charlo method will be used for simulation test.
- e. Traffic type represents the carried service and it can be categorized into three patterns, namely VBR, CBR, and self-similar data transmission [4].
- f. Scale between services are assume to usage of consume bandwidth per services on Internet global [15].
- g. All ONU users are simulated both by using homogeneous and heterogeneous allocation bandwidth ONU, with the heterogeneous of 7 user types.

- h. The input data to test were classified and marked [4] based on three service types to be scheduled.

### **1.7 Hypothesis**

Using the OFDM capability to divide the carrier into some smaller sub-carriers with the support of FDMA to make it flexible in the setting on the divided sub-carrier allows the addition of algorithm to place the sub-carrier as needed from the carried service type. It is expected to maintain the fairness in terms of service, so the throughput for every service will be in accordance with the demand. When it is conducted periodically in order to detect the number of involved users, it is also expected to maintain the fairness among the users.