Hand in problems Week 4

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December 2018

Exercise & Solution

1) EPON & GPON

In both EPON and GPON, the transceivers are often built with a DFB laser and an APD receiver. This type of tranceiver can be manufactured in different quality, and depending on this they are grouped in classes according to the Table 1. In the table the power budget for each class is listed, i.e. the difference between the transmitted optical power and the receiver sensitivity. Over the wavelengths used in PON, 1310 nm, the line attenuation is given by 0.38 dB/km. At each end of the communication link, at the OLT and the ONU, there is an attenuation due to connector coupling of 1 dB each. Furthermore, due to splicing of the fibers, the splitter has an addition loss of 0.2 dB. Assume that the split ratio, i.e. the number of ONUs, is a power of 2.

Class	A	B	B+	C
P_{budget}	20 dB	25 dB	28 dB	30 dB

Figure 1: Classes of tranceivers used in a EPON and GPON.

For an EPON system:

- Determine the maximum split ratio for the different classes of tranceivers when maximum length between the OLT and the ONU is 20 km.
- Determine the maximum length between the OLT and the ONU, for the different classes of tranceivers when the split ratio is N = 64. Use only integer km.

- What settings of distance and split ratio would you recommend for the different classes of tranceivers? Explain how you have prioritised between the length and split ratio.

To find the maximum split ratio for all the different classes given in Fig.1 we have to take into account the loses that are given in the system as proposed in the problem which would be the same for all the class. What changes in for the different classes is the power budget thus letting us have a lager splitting for some classes. The total losses independent of the class are given as follows,

$$P_{budget} \geq 2 \cdot L_{ONU/OLT} + L_{split} + L_{fiber} \cdot D + L_{DivPow} \tag{1}$$

Where the losses are the following $L_{ONU/OLT}$ is the loss due to the connectors between ONU/OLT in dB, L_{split} caused by the splitter in dB, L_{fiber} given by the line in dB/Km and L_{DivPow} are a loss given by the splitting into different ONU's. The values for the losses are taken form what is given for this case for a length of $D = 20\ km$, then the total loss would be :

$$P_{budget} \geq 9.8\ dB + 10 \log_{10}(N) \tag{2}$$

Taken the maximum case here the loss are equal to the power budget we can find the maximum number of split ratio that can be given in for each class, where we find that B+ and C are the largest as expected and can both take a split ratio of 1:64.

Class	N
A	1:8
B	1:32
B+	1:64
C	1:64

Table 1: Number of users per class (split ratio)

Now one could ask if i have a set amount of users (fix split ratio) what is the maximum length that i could have for this links for each class. For this we still have the same definition given in Eq,1 but are unknown variable is D the distance of the link not the amount of users since we are going to have $N = 64$ per link.

$$P_{budget} \geq 0.38 \cdot D + 20.26 \tag{3}$$

From Eq.3 we can first notice that just in lumped losses (the total loss of the system with out the L_{fiber}) is larger than the losses allowed by the class A implying that there would be no physical length allowed. Then we can find the distance for all the other classes as follows:

Class	D
A	-
B	12.47
B+	20.37
C	25.63

Table 2: Length of link per class [km]

In the previews case we looked at the extreme of the system given by the some specification in the system if we were trying to create a network where we had to recommend the best functioning parameters for each class i would have to talk in to consideration if the class could be use for short range communication (last mile like implementation), or we could use it to have long haul communication(inner network connections). The loss can be modeled the same way as they were done previously:

$$P_{budget} \geq 2.2 + 0.38 \cdot D + 10 \log_{10}(N) \tag{4}$$

In my opinion I would classify and suggest to use each class fitting it to a certain need to offer a service as follows:

Class	P_{budget}	D[km]	N[users]
A	20	3	46
B	25	10	78
B+	28	20	64
C	30	46	10

Table 3: Length of link per class [km]

This arrangement gives an option for, last mile connection with class A, a set of connection to multiple links over a long distance as can be used from a CO to access points or antennas class B, a longer range and still have multiple users as can be done when connecting a border router to multiple sets of switches that are located at a long distance class B+ and a connection between edge routers class C.

2) SDO

Enumerate your choice of top three SDOs and describe the reasons why you believe they are the most relevant for the telecommunications industry. Do illustrate your arguments with what you believe are good examples from the telecommunications industry. (Please, use short but clear motivation

Selecting three SDOs is subjective and I can only choose from what I can research online since i haven't had previous encounter with the principles of standardization previously. I'll select the SDO which I believe have had long and meaningful impact in the filed of telecommunications and if they have a interesting relevance in our course and have helped create the telecommunications system that we know and depend on today.

Institute of Electrical and Electronics Engineers (IEEE) Today this organization is considered as one of the largest for the development of standards and protocols for a large range of fields. This organization has created and pushed standards that are now part of are everyday life specially in our case for telecommunication. Where some of the most well known standard's are IEEE 802.11 which defines Wireless Networking also known as WiFi and one more relevant for our course is IEEE 802.3 which is the standard use for Fiber-optic connection. This are just two examples of the main protocols hat they have pushed forward that have revolutionized telecommunications.

International Telecommunication Union(ITU) This organization is an agency that belongs to the United Nation this agency is the one that controls telecommunication issues.Being part of an United nations gives it special relevance since it is part of a large set of intergovernmental discussions and decisions making it one of the most relevant SDO in the world. One of the most well known and important standardization's of this SDO which has great relevance for tbs course are the set used in the previews problem, known as passive optical networks (PON) reefed to as G.983, G.984 and an other important protocol would be the Optical network transport (OTN) that we also discussed briefly and are referred to by G.709 and GG.798.

The 3rd Generation Partnership Project(3GPP) This organization develops technical specifications allowing to all companies in the telecommunication business to be able to communicate with each other and share a cohesive product to the users. For example this ODS pushed the LTE technology the is used today threw out the hole world and has been able to bring a faster service over many different devices and networks. This organization has had a huge impact in the world of telecommunications as we use it today and helped expand the reach of what we know think is possible to do with hand held devices.

References

[1] R. Ramaswami, K. Sivarajan and G. Sasaki: Optical Networks: A Practical Perspective, 3rd Ed. ISBN: 978-0-12-374092-2

[2] G. P. Agrawal: Fiber-optic communication system, 4th Ed. ISBN:9780470505113