Passive Optical Network (PON) and Its Current Standards

Akhilesh Patel

Indian Institute of Technology
Kanpur

11-Jan-2022

Introduction

- PON (Passive optical network) is used in point to multipoint technology.
- PONs are referred as the "last mile" between an internet service provider (ISP) and its users.
- Is a shared network with cost reduction

Figure 1: Passive Optical Network

Outline

- Why we are thinking about PONs network
  - Low cost network
  - As demand of ultra broad band services continue to grow
  - Highly reliable network practically than active components. So future development will be based on PONs technology.

Types of Optical Networks

- 1. Active Optical Network (AON)

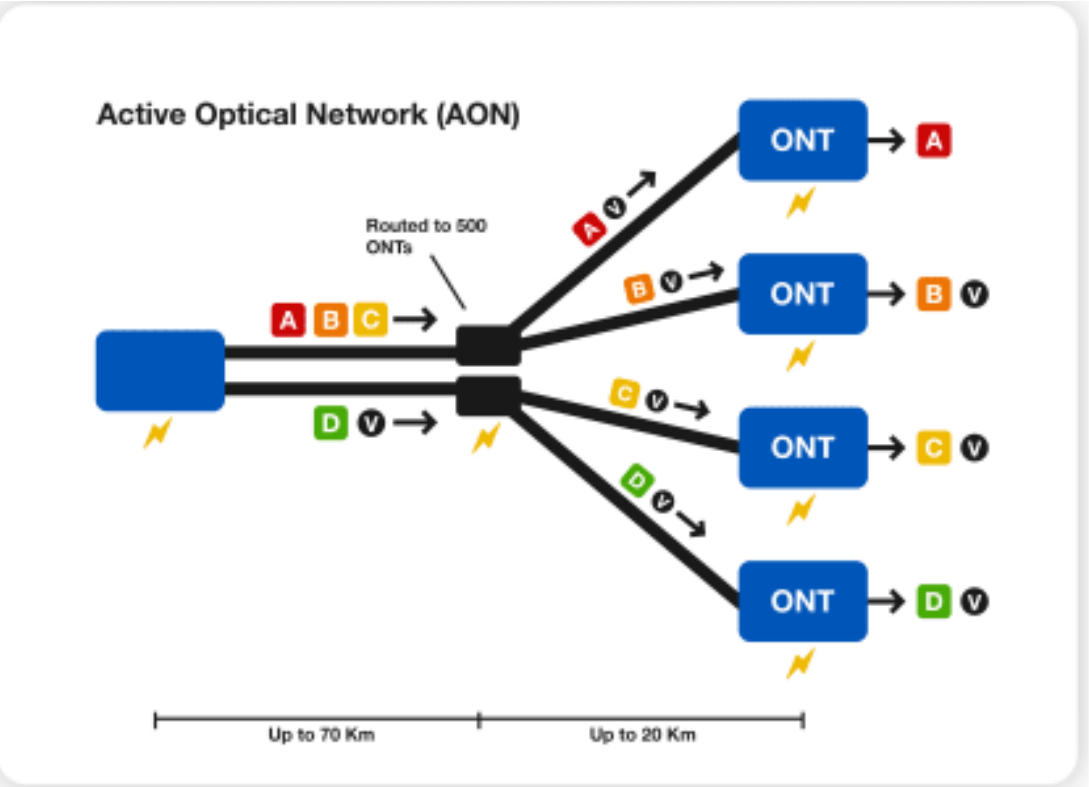


Figure 2: AON

Types of Optical Networks

- 2. Passive Optical Network (PON)

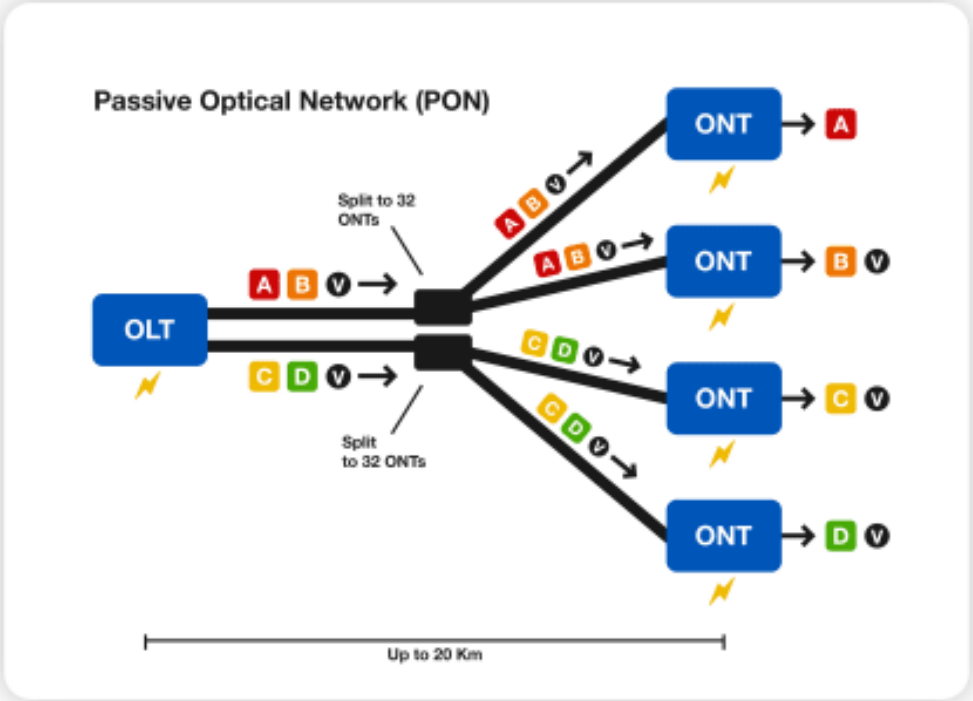


Figure 3: PON

Components of PON

- OLT (Optical Line Terminal)
- ODN (Optical Distribution Network)
- ONT/ONU (Optical Line Terminal/Optical Network Unit)

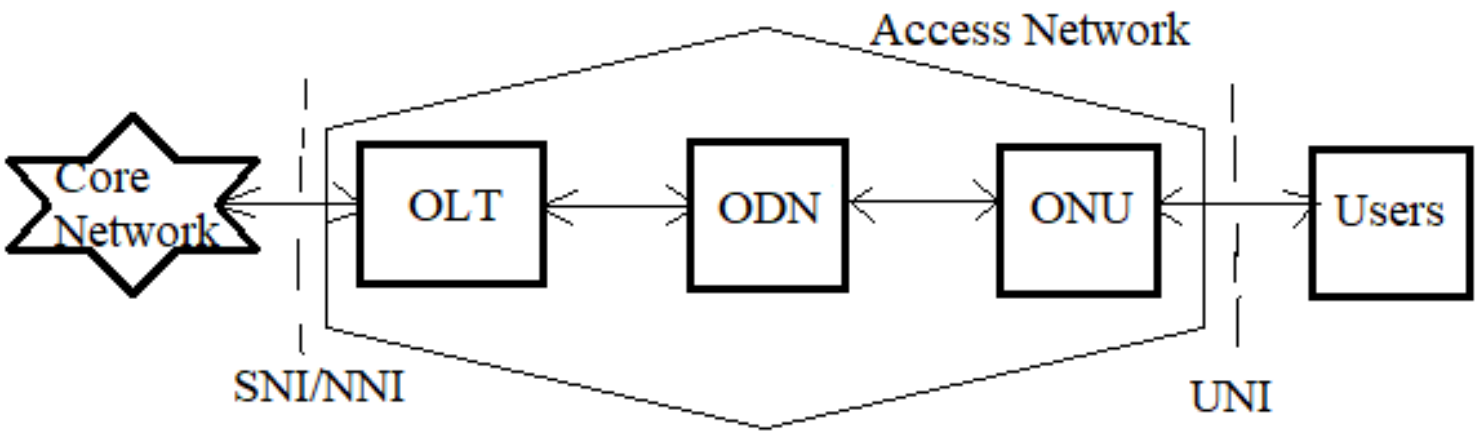


Figure 4: Passive Optical Network

Modulation Schemes in PON network

- TDM-PON
- WDM-PON
- TWDM-PON

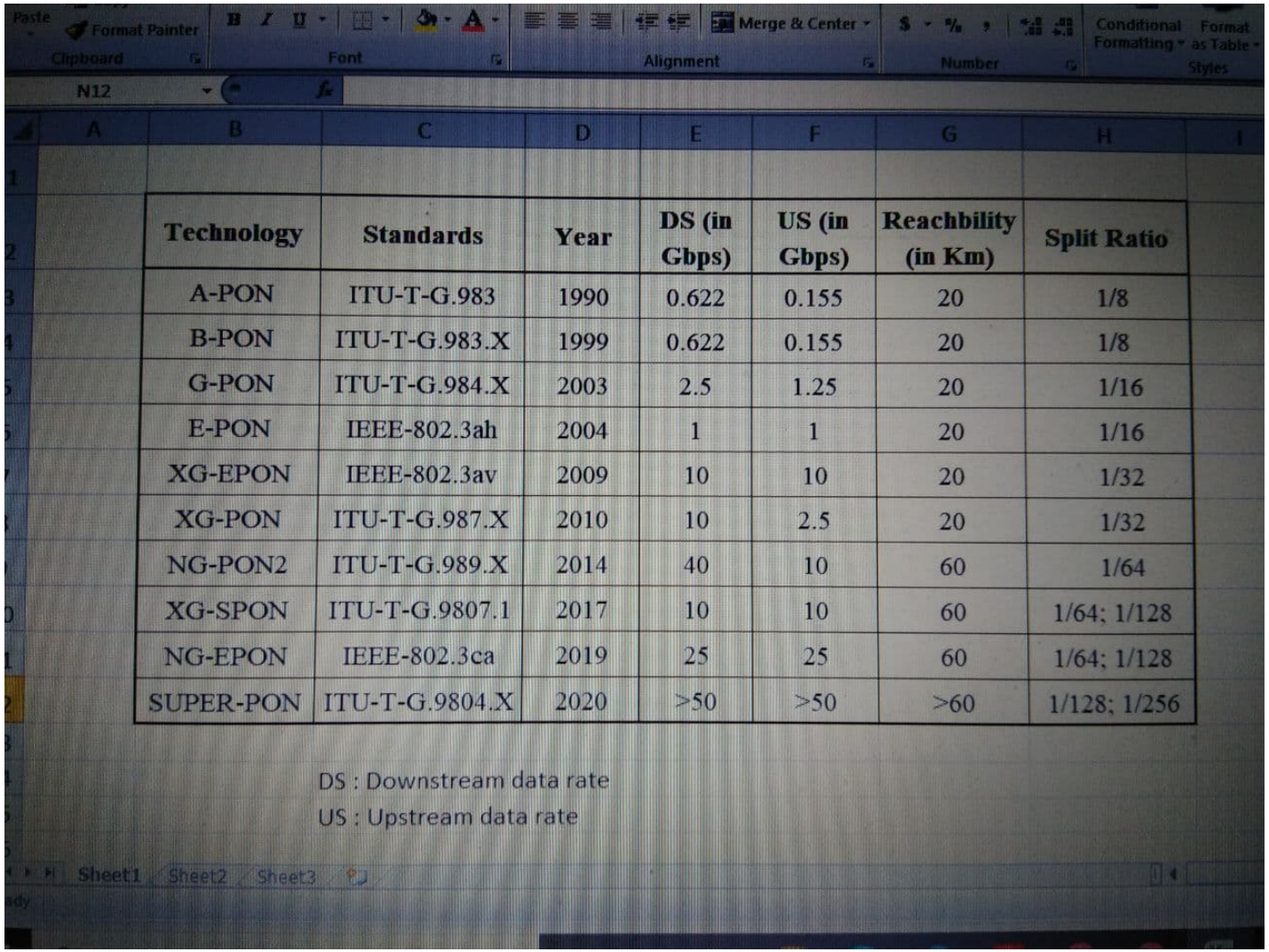
Benefits of PON

- Low cost
- Highest available speed
- More than internet
- Flexibility as per need
- Secured Broadband

Limitations and Uses of PON

- Limitations of PON
  - Protection methods are required
  - Transport to limited distance than AON
- Uses of PON
  - To support the FTTX services
  - Used in 5G technology

Recent Progress in PON Standards



Technology	Standards	Year	DS (in Gbps)	US (in Gbps)	Reachbility (in Km)	Split Ratio
A-PON	ITU-T-G.983	1990	0.622	0.155	20	1/8
B-PON	ITU-T-G.983.X	1999	0.622	0.155	20	1/8
G-PON	ITU-T-G.984.X	2003	2.5	1.25	20	1/16
E-PON	IEEE-802.3ah	2004	1	1	20	1/16
XG-EPON	IEEE-802.3av	2009	10	10	20	1/32
XG-PON	ITU-T-G.987.X	2010	10	2.5	20	1/32
NG-PON2	ITU-T-G.989.X	2014	40	10	60	1/64
XG-SPON	ITU-T-G.9807.1	2017	10	10	60	1/64; 1/128
NG-EPON	IEEE-802.3ca	2019	25	25	60	1/64; 1/128
SUPER-PON	ITU-T-G.9804.X	2020	>50	>50	>60	1/128; 1/256

DS : Downstream data rate
US : Upstream data rate

Figure 5: Table-1

Current Research in PON

- NG-PON2
- Super PON

- Planning to do work in:
  1. Design the circuit for NG-PON2 and Super PON.
  2. analyze and optimization of various Protection schemes.

Why NG-PON2 and Next?

- Larhe number of ONUs in broadcast network
- Traditional TDM-PON not enough
- Have the ability to reuse the existing investment in the ODN.

NG-PON2 and Next?

- There is a 80 Gbps symmetrical NG-PON2 network with 1024 ONUs
- Eight wavelengths starting from 1596 nm with 0.8 nm channel spacing are multiplexed at the central office (CO) for downstream.
- For the downstream signals labels from λ_1 to λ_8 are used.
- The λ_1 is 1596 nm and the downstream wavelength assigned to the n^th RN can be calculated by the following equation.

$$\lambda_n = \lambda_1 + (\mathrm{n} - 1) \times 0.8 \text{ nm}$$

80 Gbps NG-PON2

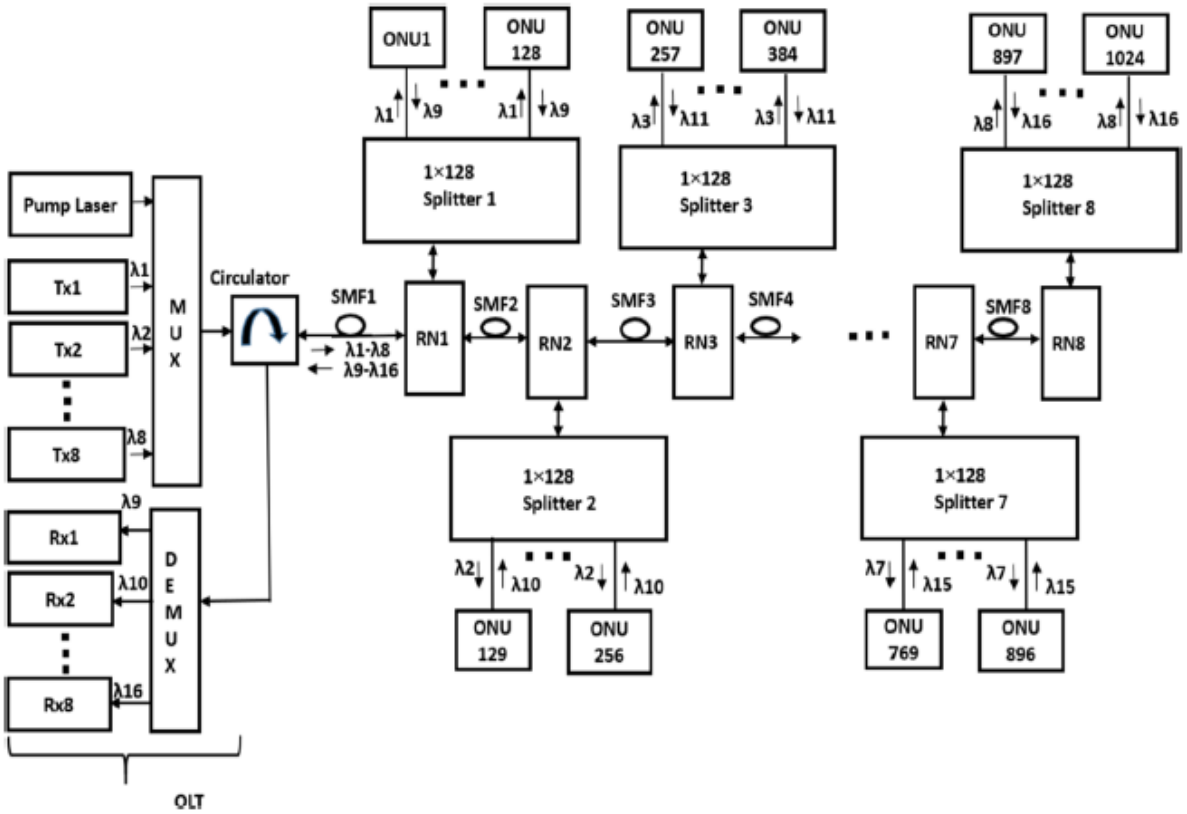


Figure 6: Architecture of 80 Gbps NG-PON2 with Bus topology

Entirely passive remote node design and system architecture for bus topology based 80Gbps symmetrical NG-PON2 https://doi.org/10.1007/s11082-021-03319-7

80 Gbps NG-PON2

- The first upstream wavelength λ_9 of 1524 nm is assigned for upstream from the ONUs of RN1.
- The dedicated upstream wavelength for the ONUs operating at the n^th RN can be calculated by the following generalized equation.

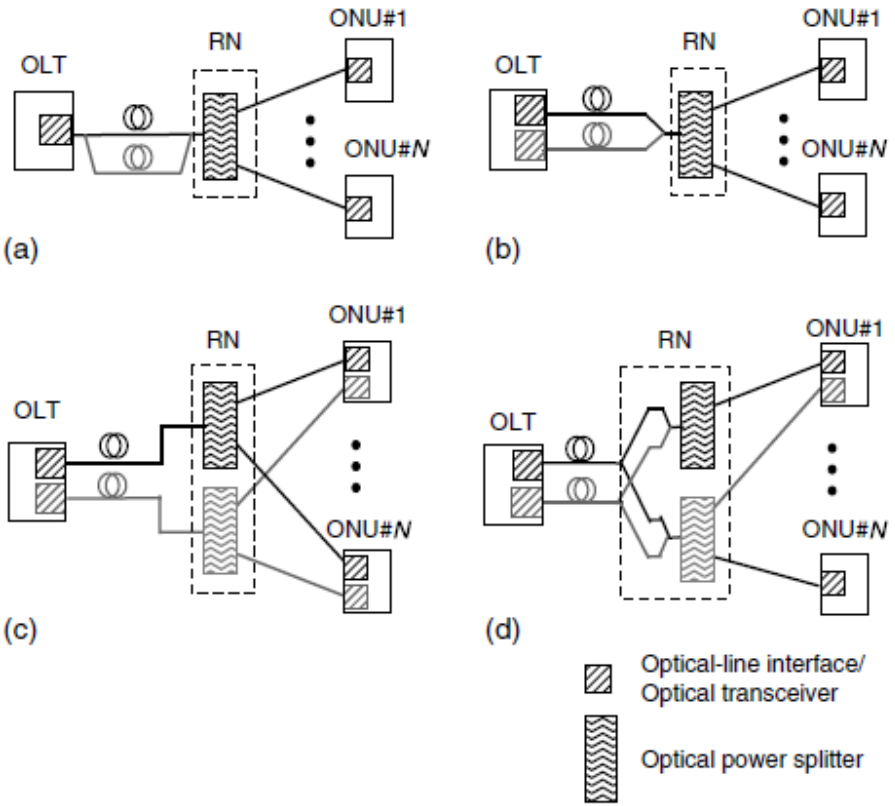
$$\lambda_(n+8) = \lambda_9 + (\mathrm{n} - 1) \times 0.8 \text{ nm}$$

PROTECTION ARCHITECTURES in PON

- Survivable network architectures for PONs is based on both tree and ring topologies.

PROTECTION ARCHITECTURES in PON

- Tree Topology



Protection switching architectures suggested by ITU-T G.983.1.

Figure 7: Protection switching architecture

Cedric F. Lam - Passive optical networks- principles and practice-Elsevier

THANKS


भारतीय प्रौद्योगिकी संस्थान कानपुर
INDIAN INSTITUTE OF TECHNOLOGY KANPUR