



EEEN 464 – DIGITAL COMMUNICATION

GIGABIT PASSIVE OPTICAL NETWORK (GPON) – TEST YOUR KNOWLEDGE

MULTIPLE CHOICE QUESTIONS

1. What does GPON stand for?
 - a) Gigabit Passive Optical Network
 - b) Gigabyte Passive Optical Node
 - c) General Purpose Optical Network
 - d) Gigabit Packet Optical Network
2. The primary standards body defining GPON is:
 - a) IEEE
 - b) IETF
 - c) ITU-T
 - d) FSAN
3. The key characteristic that makes GPON "passive" is:
 - a) No electrical power needed in the outside plant between OLT and ONUs.
 - b) ONUs operate without batteries.
 - c) OLT doesn't require cooling.
 - d) Signals propagate without amplification.
4. The typical maximum logical reach supported by standard GPON (G.984) is:
 - a) 10 km
 - b) 20 km
 - c) 60 km
 - d) 100 km
5. The most common downstream wavelength used in GPON is:
 - a) 850 nm
 - b) 1310 nm
 - c) 1490 nm
 - d) 1550 nm
6. The most common upstream wavelength used in GPON is:
 - a) 850 nm
 - b) 1310 nm
 - c) 1490 nm
 - d) 1550 nm
7. The component located at the service provider's central office/headend is the:
 - a) ONT
 - b) ONU
 - c) OLT
 - d) Splitter

8. The device located at or near the customer premises is typically called an:
 - a) OLT
 - b) ONT/ONU
 - c) Optical Amplifier
 - d) PON Card
9. A common split ratio used in GPON deployments is:
 - a) 1:2
 - b) 1:8
 - c) 1:32
 - d) 1:100
10. The primary mechanism used by the OLT to control upstream transmission from multiple ONTs and avoid collisions is:
 - a) CSMA/CD
 - b) TDMA (Time Division Multiple Access)
 - c) FDMA (Frequency Division Multiple Access)
 - d) Token Passing
11. GPON downstream traffic (from OLT to ONTs) is transmitted:
 - a) As encrypted continuous broadcast.
 - b) Using TDMA slots assigned by the OLT.
 - c) Only when requested by an ONT.
 - d) As unicast packets individually addressed.
12. The encryption standard used in GPON to secure downstream traffic is:
 - a) WPA2
 - b) SSL/TLS
 - c) AES (Advanced Encryption Standard)
 - d) DES
13. The protocol used by the OLT for management, configuration, and fault detection of ONTs is:
 - a) SNMP
 - b) TR-069
 - c) OMCI (ONT Management and Control Interface)
 - d) DHCP
14. The encapsulation method used by GPON to efficiently transport different traffic types (Ethernet, TDM, ATM) within GTC frames is:
 - a) MPLS
 - b) IPsec
 - c) GEM (GPON Encapsulation Method)
 - d) VLAN Tagging
15. A key advantage of GPON over point-to-point Ethernet fiber is:
 - a) Higher bandwidth per user.
 - b) Lower latency.
 - c) Reduced fiber count/cost in the distribution network.
 - d) Simpler active equipment at the customer premise.
16. The bandwidth profile for an ONT (e.g., max guaranteed rate, priority) is primarily enforced by the OLT using:
 - a) DBA (Dynamic Bandwidth Allocation)

- b) Firewall Rules
 - c) VLAN Prioritization (802.1p)
 - d) TCP Windowing
17. The typical downstream line rate for basic GPON (G.984) is:
- a) 155 Mbps
 - b) 622 Mbps
 - c) 1.244 Gbps
 - d) 2.488 Gbps
18. The typical upstream line rate for basic GPON (G.984) is:
- a) 155 Mbps
 - b) 622 Mbps
 - c) 1.244 Gbps
 - d) 2.488 Gbps
19. What is the primary purpose of the Fiber Distribution Hub (FDH) in a GPON network?
- a) House the OLT
 - b) Provide electrical power to ONTs
 - c) Terminate feeder fiber and house passive splitters
 - d) Act as a core router
20. Which of these services is GPON particularly well-suited to deliver? (Choose the *best* answer)
- a) Long-haul international data links
 - b) Mobile backhaul for macro cells only
 - c) "Triple Play" (Voice, Video, Data) to residential/business subscribers
 - d) Underwater cable systems

DEFINITION / SHORT ANSWER QUESTIONS

21. Define the purpose of a **GEM Port** within the GPON protocol stack.
22. What is the function of a **Planner** (or **Fused Biconical Taper - FBT**) splitter in GPON?
23. What is the primary difference between an **ONU** and an **ONT**? (Hint: Location/Function)
24. What does **DBA (Dynamic Bandwidth Allocation)** dynamically adjust based on?
25. What is the main purpose of the **Physical Layer OAM (PLOAM)** channel in GPON?

SHORT EXPLANATION QUESTIONS

26. Explain why **ranging** is a critical process during ONT activation/registration in GPON.
27. Briefly describe the **"Triple Play" service delivery model** over GPON. Mention how each service type is typically handled.
28. Explain the key difference in **bandwidth sharing** between the downstream and upstream directions in GPON.
29. What is the primary purpose of the **FEC (Forward Error Correction)** mechanism in GPON, and what trade-off does it involve?
30. Describe one significant **advantage** and one significant **limitation** of GPON technology.

MODEL ANSWERS

MULTIPLE CHOICE QUESTIONS

1. a) Gigabit Passive Optical Network
2. c) ITU-T (G.984 series)
3. a) No electrical power needed in the outside plant (only passive splitters).
4. b) 20 km (Physical reach can be up to 60km with optics, but 20km is the standard *logical* max for timing/ranging).
5. c) 1490 nm (Data), d) 1550 nm is also common for overlay RF Video.
6. b) 1310 nm
7. c) OLT (Optical Line Terminal)
8. b) ONT/ONU (Optical Network Terminal / Optical Network Unit)
9. c) 1:32 (1:64 is also common, 1:16 & 1:8 used for longer reach/premium)
10. b) TDMA (Time Division Multiple Access) - OLT grants specific timeslots.
11. a) As encrypted continuous broadcast. (ONTs filter based on Port-ID/GEM Port).
12. c) AES (Advanced Encryption Standard)
13. c) OMCI (ONT Management and Control Interface) - Embedded channel within GTC.
14. c) GEM (GPON Encapsulation Method) - Fragments packets into fixed-size frames.
15. c) Reduced fiber count/cost (One fiber serves up to 64+ users via passive split).
16. a) DBA (Dynamic Bandwidth Allocation) - Assigns upstream timeslots based on profiles/reporting.
17. d) 2.488 Gbps
18. a) 155 Mbps, b) 622 Mbps, c) 1.244 Gbps (All defined, c) 1.244 Gbps is most common baseline).
19. c) Terminate feeder fiber and house passive splitters (Central distribution point).
20. c) "Triple Play" (Voice, Video, Data) to residential/business subscribers (Core FTTH application).

DEFINITION / SHORT ANSWER QUESTIONS

21. **GEM Port:** A logical connection endpoint within the GPON protocol stack (GTC layer) used to map specific client traffic flows (e.g., an Ethernet service, a TDM circuit) between the OLT and a specific ONT. Identified by a Port-ID.

22. **Splitter Function:** Passively divides the optical signal power from one input fiber (feeder) equally among multiple output fibers (distribution), enabling point-to-multipoint architecture. (Planner/FBT refers to common manufacturing types).

23. **ONU vs ONT:** Functionally equivalent. **ONU (Optical Network Unit)** is a generic term for the user-side device. **ONT (Optical Network Terminal)** specifically implies the device is located *at the end-user's premises*. (An ONU could be located elsewhere, like a curb, feeding other CPE).

24. **DBA Adjustment:** Dynamically adjusts the upstream bandwidth allocation (timeslot size/grant frequency) to ONTs based on their *real-time reported buffer occupancy* (via DBRu reports) and their assigned service level agreement (SLA) profile (e.g., fixed, assured, maximum, priority).

25. **PLOAM Channel Purpose:** Provides a low-level, physical-layer management channel for critical functions: ONU activation (Serial Number, Password), Encryption key exchange, DBA grant signaling, alarms, and diagnostics. Ensures basic control before higher-layer management (OMCI) runs.

SHORT EXPLANATION QUESTIONS

26. **Ranging Importance:** Measures the **round-trip delay (RTD)** from the OLT to each ONT. This is crucial because ONTs are at different physical distances. Ranging allows the OLT to calculate an **Equalization Delay (EqD)** for each ONT. The OLT instructs the ONT to apply this EqD to its upstream transmissions. This ensures that bursts from all ONTs arrive at the OLT *synchronized* within their designated TDMA timeslots, preventing collisions. Without ranging, upstream signals would overlap.

27. **Triple Play over GPON:** GPON delivers three primary services over a single fiber:

* **Data (Internet):** Typically carried as native Ethernet frames over GEM ports. Handled by the ONT's Ethernet ports.

* **Voice (Telephony):** Often carried as VoIP (Voice over IP) packets encapsulated within Ethernet frames over a dedicated GEM port/service flow with QoS. Alternatively, legacy TDM voice can be emulated (CESoP). Connects to phones/POTS ports on the ONT.

* **Video:** Typically delivered via:

* **IPTV:** Streamed as multicast IP packets over Ethernet/GEM (requires IGMP snooping).

* **RF Video Overlay:** Broadcast analog/digital TV signals modulated onto a separate 1550nm wavelength downstream (requires ONT with RF video port).

28. **Bandwidth Sharing Difference:**

* **Downstream: Broadcast.** The OLT transmits a continuous 2.5 Gbps stream. All ONTs receive all data but only process frames addressed to their specific GEM Port-IDs. Bandwidth is *shared statistically*; all ONTs contend for the full downstream capacity.

* **Upstream: TDMA (Time-Shared).** The OLT grants specific timeslots to individual ONTs. Only one ONT transmits upstream at any given moment (1.25 Gbps max *shared* among all active ONTs). Bandwidth is *dynamically allocated* by the OLT's DBA mechanism based on demand and SLAs.

29. **FEC Purpose & Trade-off:**

* **Purpose:** To detect and correct bit errors introduced during optical signal transmission (e.g., due to noise, dispersion, attenuation). Improves link budget/margin and allows longer reach or higher split ratios by enabling operation at lower received signal quality (BER).

* **Trade-off:** Adds **overhead** (extra bits for parity/encoding). This reduces the *net usable payload bandwidth* available for user data on the link. (e.g., ~7-8% overhead common).

30. Advantage & Limitation:

Advantages

- a) **Significant Reduction in Fiber Infrastructure:** One feeder fiber serves many users (32-64+), drastically reducing fiber count/cost compared to point-to-point.
- b) **Passive Outside Plant:** No power or active electronics needed between CO and users, leading to lower OpEx, higher reliability, and easier deployment.
- c) **High Bandwidth:** Capable of delivering Gigabit+ speeds to end-users.
- d) **Convergence:** Efficiently carries diverse traffic types (Triple Play) over a single platform.

Limitations

- a) **Shared Upstream Bandwidth:** Upstream capacity (1.25 Gbps) is shared among all ONTs on a PON port. Heavy usage by one user can impact others. (Less deterministic than dedicated links).
- b) **Single Point of Failure (OLT/PON Port):** Failure of an OLT or a single PON port card affects all users connected to that port (though OLTs are highly redundant).
- c) **Security Concerns:** Downstream broadcast nature requires strong encryption (AES). Physical tapping is detectable but possible.
- d) **Limited Reach/Split vs Active:** Compared to active Ethernet, reach/split is constrained by optical power budget (though sufficient for most FTTH).