



EEEN 464 – DIGITAL COMMUNICATION

SYNCHRONOUS OPTICAL NETWORK (SONET) - TEST YOUR KNOWLEDGE

SECTION A: FUNDAMENTALS & DEFINITIONS

1. What does SONET stand for?
2. What is the fundamental difference in clock synchronization between SONET and PDH?
3. What is the primary purpose of the SONET/SDH transport layer?
4. What is the base electrical signal level in SONET (before optical conversion)?
5. What is the base optical signal level in SONET?
6. What is the name of the equivalent international standard to SONET?
7. What is the fundamental building block of the SONET frame structure?

SONET FRAME STRUCTURE & OVERHEAD

8. What is the duration of a SONET STS-1 frame?
9. How many bytes are in an STS-1 frame?
10. How is an STS-1 frame organized (rows x columns)?
11. What is the purpose of the Section, Line, and Path overhead layers?
12. What critical function does the *Pointer* (H1, H2, H3 bytes) in the Line Overhead perform?
13. What is an SPE (Synchronous Payload Envelope)?
14. How many bytes in the STS-1 frame are dedicated to transport overhead?
15. What overhead byte is primarily used for Section error monitoring (BIP-8)?

SECTION C: SONET RATES & MULTIPLEXING

16. What is the bit rate of an STS-1 signal?
17. How many STS-1 signals are multiplexed to form an STS-3 signal?
18. What is the bit rate and common name of an STS-3c signal?
19. What is the equivalent SDH signal level to SONET's STS-3?
20. What is the bit rate of an OC-192 signal?
21. How does *byte-interleaved multiplexing* work in SONET?
22. What is a *Concatenated* signal (e.g., STS-3c)? Why is it used?
23. How many DS3 (44.736 Mbps) signals can be carried within a single STS-1 SPE?

SECTION D: SONET LAYERS, PROTECTION & OPERATIONS

24. What are the four SONET Layer functions defined in the standard (corresponding to overhead layers)?
25. What is the most common type of SONET ring protection (using 2 fibers)?
26. What does APS stand for in the context of SONET protection?
27. What is the typical switching time guarantee for SONET protection mechanisms?
28. What overhead byte carries the automatic protection switching (APS) channel for rings?

29. What overhead byte carries the Path Trace identifier (J1)?
30. Besides core transport, name two significant applications or advantages SONET offered over PDH.

MODEL ANSWERS

Section A: Fundamentals & Definitions

1. **Synchronous Optical Network.**
2. **SONET:** All network elements are tightly synchronized to a highly stable Primary Reference Clock (PRC). **PDH:** Clocks are plesiochronous (nearly synchronous, with allowed variations).
3. **To transport digital signals (voice, data) efficiently and reliably over optical fibre with extensive management capabilities.**
4. **STS-1 (Synchronous Transport Signal level 1)** - Electrical level (51.84 Mbps).
5. **OC-1 (Optical Carrier level 1)** - Optical level (51.84 Mbps).
6. **SDH (Synchronous Digital Hierarchy).**
7. **STS-1 Frame (for SONET) / STM-1 Frame (for SDH).**

SECTION B: SONET FRAME STRUCTURE & OVERHEAD

8. **125 microseconds (μ s).** (Same as SDH, derived from 8000 frames/sec sampling).
9. **810 bytes** (9 rows x 90 columns).
10. **9 rows by 90 columns.**
11. **Section Overhead (SOH):** Manages signal between adjacent network elements (e.g., regenerators). **Line Overhead (LOH):** Manages signal between multiplexers (e.g., STS-N assembly/disassembly, pointers). **Path Overhead (POH):** Manages the end-to-end path of the payload (e.g., SPE integrity, user comms).
12. **Locates the start of the Synchronous Payload Envelope (SPE) within the frame.** (Compensates for minor frequency/phase differences).
13. **Synchronous Payload Envelope:** The portion of the SONET frame (87 columns) that carries the actual user data plus Path Overhead. It can "float" within the frame.
14. **27 bytes** (First 3 columns: 9 rows x 3 columns = 27 bytes).
15. **B1 Byte (in Section Overhead).**

SECTION C: SONET RATES & MULTIPLEXING

16. **51.84 Mbps.**
17. **3.** (STS-3 = 3 x STS-1 = 155.52 Mbps).

18. **155.52 Mbps, OC-3c.** ('c' denotes concatenated - payload is treated as a single entity).
19. **STM-1 (Synchronous Transport Module level 1).**
20. **9,953.28 Mbps** (approx 10 Gbps). (OC-192 = 192 x OC-1 = 192 x 51.84 Mbps).
21. **Bytes from the constituent STS-1 signals are taken in sequence (1 byte from STS-1 #1, then 1 byte from STS-1 #2, etc.) and interleaved to form the higher-rate STS-N frame.**
22. **A signal where multiple STS-1s are linked together to carry a *single* payload larger than one STS-1.** (Used to transport high-speed data streams like ATM cells or IP packets efficiently without fragmentation).
23. **1 DS3.** (A DS3 fits entirely within the payload capacity of one STS-1 SPE).

SECTION D: SONET LAYERS, PROTECTION & OPERATIONS

24. **Photonic (Physical/Optical), Section, Line, Path.**
25. **Two-Fiber Bidirectional Line Switched Ring (BLSR/2).** (Also common: Unidirectional Path Switched Ring - UPSR/2).
26. **Automatic Protection Switching.**
27. **50 milliseconds (ms).**
28. **K1/K2 Bytes (in Line Overhead).** (K1 signals failure/switch request, K2 signals status/protection channel ID).
29. **J1 Byte (in Path Overhead).**
30. Any two of the following.
 1. **Robust Operations, Administration, Maintenance, and Provisioning (OAM&P)** via extensive overhead bytes.
 2. **Direct Add/Drop Multiplexing (ADM)** - Access lower-rate signals without full demux.
 3. **Standardized Optical Interfaces** enabling multi-vendor interoperability.
 4. **Fast Automatic Protection Switching (APS)** for high availability (<50ms).
 5. **Seamless Transport of Asynchronous Signals (like PDH, ATM, IP).**
 6. **Foundation for Dense Wavelength Division Multiplexing (DWDM).**

STUDY/TEST TIPS

1. Memorize key rates: **STS-1/OC-1 (51.84 Mbps), STS-3/OC-3/STM-1 (155.52 Mbps), OC-12 (622.08 Mbps), OC-48 (2488.32 Mbps), OC-192 (~10 Gbps).**
2. Understand the **role of pointers** (H1-H3) in handling frequency/phase differences.
3. Distinguish **Section, Line, and Path** overhead functions and locations.
4. Know the **differences and mapping between SONET (STS-N/OC-N) and SDH (STM-M).**
5. Recall the **protection schemes (BLSR, UPSR)** and their characteristics (switching time, fiber usage).
6. Appreciate how SONET solved the major **limitations of PDH.**