Advanced Network Protocols

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The exam is composed of three sections: a multiple choice and two open question ones. Please do NOT write your answers on the exam text. Rather, hand them in on a separate sheet of paper. State your name, surname and student number in capital letters.

OPEN QUESTIONS SECTION 4points each (Between 15 and 20 lines per answer)

Q1 List the major techniques used for spectrum manipulation in wireless network, discussing their advantages.

Q2 What is a T-1 connection? How is it related to DS-1? Does it come in fiber optics or copper wire? Explain.

Q3 Explain why Dense Wavelength Division Multiplexing (DWDM) networks can simultaneously carry different types of traffic at different speeds over an optical channel.

Q4 Explain via an example the purpose of OSPF-TE and the difference with ordinary OSPF.

Q5 Explain with an example the notion of "in-band" and "out-band" signaling. How do these notion relate to the SS7 protocol?

MULTIPLE CHOICE QUESTIONS (2 points each)

1. Currennt wireless MACs are based on

- CSMA/CD

- CSMA/CA

- Hybrid technique depending on traffic

- Hybrid technique with fixed time partitions

2. The initialization vector (IV) is used in the framework of

- WEP security protocol

- 802.11 MAC

- Slotted Aloha networks

3. Low battery level will cause a mobile device to

- Avoid competing for contention slots

- Shift to receive-only mode

- Shut down altogether

4. Advanced TCP window control is especially relevant

- On circuit switching optical networks

- On wireless networks

- On TDM multiplexers

5. The "cocktail party" effect in cellular networks can be prevented by

- Code modulation

- Flattening the spectrum of the transmitted signal

- A collision avoidance wireless MAC

MULTIPLE CHOICE ANSWER KEY
Answer key: 1b, 2c, 3b, 4c, 5a, 6a, 7b, 8e

ANSWERS TO DATA COMMUNICATION OPEN QUESTIONS

Q1
OC is short for *Optical Carrier,* used to specify the speed of fiber optic networks conforming to the SONET standard. The following table shows the speeds for common OC levels.

Optical Carrier	Speed
OC-1	51.85 Mbps
OC-3	155.52 Mbps
OC-9	466.56 Mbps
OC-12	622.08 Mbps
OC-19	933.12 Mbps
OC-24	1.244 Gbps
OC-36	1.866 Gbps
OC-48	2.488 Gbps
OC-96	4.977 Gbps
OC-192	9.953 Gbps
OC-768	40 Gbps
OC-3072	160 Gbps

Each channel is 51.85 Mbps. An OC-**3**, for example, has **3** channels adding up to 155.52 Mbps. Currently, Cisco CRS-1 System features OC-768 line cards. These cards are currentlypriced at **$2,000,000 USD** each.

Q2
   a. Each OC level can be a ring interface to a UPSR (Unidirectional Path Switched Ring) or BLSR (Bi-directional Line Switched Ring). On these rings, generally one line goes east, and another west. If one side fails, individual STS channels (UPSR) or the entire line (BLSR) can be switched to the other path or span, depending on the technology
   b. SDH is the European/Asian version of SONET. Its channels are called STM. The following correspondences hold:
        a. STS-3c = STM-1
        b. STS-12c = STM-4

c. STS-48c = STM-16
d. STS-192c = STM-64

Q3

A T-1 is a dedicated phone connection supporting data rates of 1.544Mbits per second (US) and 2.0 Mbps (Europe). A T-1 line consists of 24 individual channels, each of which supports 64Kbits per second. Each 64Kbit/second channel can be configured to carry voice or data traffic. Most telephone companies allow you to buy just some of these individual channels, known as fractional T-1 access. T-1 lines are a popular leased line option for businesses connecting to the Internet and for Internet Service Providers (ISPs) connecting to the Internet backbone. The Internet backbone itself consists of faster T-3 connections. T-1 lines are sometimes referred to as DS1 lines.. T-1 comes in either copper or fiber optics.

Q4

DWDM is short for Dense Wavelength Division Multiplexing, an optical technology used to increase bandwidth over existing fiber optic backbones. DWDM works by combining and transmitting multiple signals simultaneously at different wavelengths on the same fiber. In effect, one fiber is transformed into multiple virtual fibers. So, if you were to multiplex eight OC -48 signals into one fiber, you would increase the carrying capacity of that fiber from 2.5 Gb/s to 20 Gb/s. Currently, because of DWDM, single fibers have been able to transmit data at speeds up to 400Gb/s. And, as vendors add more channels to each fiber, terabit capacity is on its way. A key advantage to DWDM is that it's protocol and bit-rate independent.

Q5

The right answer is b. The customer will be reached by fiber optics cabling supporting Ethernet-on-fiber and will have to install a Gigabit switch with a **GBIC** (Gigabit Interface Converter) connected to the fiber optic cable

Q6

The picture shows a rack of Fujitsu SDH Multiplexers for multiplexing incoming and outgoing flows from/to customers. Due to adaptation (NOT fragmentation) problems, IP is not layered over SDH directly. Rather, an intermediate ATM or Ethernet level is interposed. This arrangement does not neatly fit into ISO/OSI layered architecture.

Q6

"Fiber to the Building" (FTTB) refers to installing optical fiber from the telephone company central office to a specific building such as a business or apartment house.

"Fiber to the Home" (FTTH) is a network technology that deploys fiber optic cable directly to the home or business to deliver voice, video and data services. By leveraging the extremely high bandwidth capacity of fiber, FTTH can deliver more bandwidth Fiber to the home is deployed in two primary architectures - point-to-point and passive optical network (PON). While both have their place in solving the last-mile bottleneck, a point-to-point architecture is generally deployed to businesses in metro and urban areas, while a PON is a more cost-effective solution for small- to medium-sized businesses and residences. A PON architecture allows a single fiber from the central office (CO) or head-end to be split up to 32 ways, delivering high-bandwidth converged services to multiple residences or businesses, using a single optical transceiver in the CO. In a point-to-point configuration, an optical transceiver for each subscriber is required in the CO, thus substantially increasing the total cost of deployment."Fiber to the neighborhood" (FTTN) refers to installing it generally to all curbs or buildings in a neighborhood. Hybrid Fiber Coax (HFC) is an example of a distribution concept in which optical fiber is used as the backbone medium in a given environment and coaxial cable is used between the backbone and individual users (such as those in a small corporation or a college environment)

TELEPHONY OPEN QUESTIONS: ANSWERS

T1 Trunk circuit is a single time slot, which is used to carry voice bits (PCM) on a trunk (or span or channel) between two switches. Telephony switches are addressable by Point Codes (The SS7 equivalence of IP address).

T2 SS7 is the classic out-of-band signaling protocol for circuit switched. Mostly it does basic telephony signaling (ISUP), Intelligent network signaling (TCAP) and cellular signaling (MAP).

T3 PCM stands for Pulse Code Modulation. TDM stands for Time Division Multiplexing. Both pertain to the way analog signals, such as voice are sampled, encoded as digital bits, and transmitted over the digital wire (or wireless in some cases...).

T4 Yes, these are just two synonyms of the same thing. It is needed for making sure the other end point is there and is willing to take the call. In addition it is needed for the telephony network to allocate all necessary resources for the call, make other necessary preparations (e.g. open billing records, open stat records, prepare lawful intercept hooks) and potentially run call setup time services (e.g. translation, call forwarding). In the VoIP world call setup also enables the end points exchange information about their media capabilities (e.g. codecs which can be supported) and media properties (e.g. IP address for media exchange, port number, protocol).