S-72.423 Exercise 1. SOLUTIONS

Return your answer no later than on Tuesday 12.10.2004 at 16:00 into the course's P.O. box at the third floor of the E-wing.

Please, include the following information in your answers:
- Your name (+ team member names)
- Your student number (+ team member student numbers)

It may be that you won't find answers to the questions straight from the lecture material. You may have to look for information from the textbooks and Internet. Good luck for information search!
To this exercise you may answer in English, Finnish or Swedish.

1. **In telecommunications**, bit rate (or bitrate) is the speed at which bits are transmitted via radio or wire. It is usually expressed as bits per second, abbreviated bit/s, b/s, or informally bps. In telecommunications bit rates are impressed with SI-prefixes.
   What are the (nominal) bit rates of
   (Please, use the prefixes and also write the bit rates out; for example: 1,2 kbit/s = 1200 bit/s)

   I) N-ISDN (narrowband-ISDN, usually written "ISDN")
   II) Modem V.34
   III) LAN, 10baseT

   In computing, common usage of "kilobyte" means 1024 bytes, while the SI kilo means 1000. So there is a risk of confusion and we have to be very careful what those prefixes means.

   Find and write out how many bytes and bits can be stored in:

   IV) 1.44 MB floppy disk
   V) 512 MB RAM (computer memory)

   SOLUTION

   I) N-ISDN : 2B+D = 2 * 64 kbit/s + 16 kbit/s = 2 * 64 000 bit/s + 16 000 bit/s (Also the bit rate of one B-channel (64 000 bit/s) is accepted)

   II) Modem V.34: 33.6 kbit/s = 33600 bit/s

   III) LAN, 10 BaseT: 10 Mbit/s = 10 000 000 bit/s

   IV) 1.44 MB floppy disk: 1.44 × 1000 × 1024 bytes = 1474560 bytes = 11796480 bits

   V)) 512 MB RAM : 512 * 2^{20} bytes = 536870912 bytes = 4294967296 bits

2. **Define, what is meant by value added services. Mention at least 5 of them**.

   SOLUTION:

   (See Understanding Telecommunications A.6.3)

   Value-added services are not included in the basic service of a subscription. This means that the call does not terminate in any ordinary B-subscriber equipment but in some other point.

   The foundation of this area is information: information retrieval, storage of information or the processing and distribution of information.

- home banking
- Videotex (Minitel, VDU text)
- stock-exchange quotations
- recipes
- weather forecasts
- voice mailbox
- voice mailbox for cellular systems
- fax mailbox
- e-mail (X.400)
- paging
- entertainment
- distance learning
- conferencing.

3. Describe how operation and maintenance functions are categorized and realized in the PSTN; briefly explain the functions.

SOLUTION:

(See Understanding Telecommunications B.8.2.1 & B.8.2.2)

Operational functions:
I) Functions for gathering statistics
- from where and to whom do subscribers call
- What are the

II) Administrative functions
Add, change or remove data or They also allow an operator to order printouts showing the current state of the subscriber database, trunk circuits and signalling etc.

Maintenance functions:
The SPC (stored program control) exchanges allowed operators to automate many maintenance functions. In most cases, the network operator sets limit values for supervisory functions: an isolated fault that does not disturb traffic need not trigger an alarm, but personnel are alerted if things get worse. Alarms are usually divided into different urgency classes. Programs are provided for troubleshooting, fault diagnosis and, possibly, fault correction. Hardware faults are isolated, and faulty units are taken out of operation.
See also: http://www.ericsson.com/support/telecom/images/part_b/b_8/b_8_2-2.gif

4. Write in full length the following acronyms: *SOLUTION*
- OSI *Open Systems Interconnection (ISO 9646-1)*
- PSTN *Public Switched Telephone Network*
- N-ISDN *Narrowband Integrated-Services Digital Network*
- GSM *Global System for Mobile communications (Groupe Speciale Mobile)*
- ATM *Asynchronous Transfer Mode*
- WCDMA *Wideband Code Division Multiple Access*
- SS7 *Signaling System 7*
- IP *Internet Protocol*
- IN *Intelligent Network*
- SMS *Short Message Service*
- PLMN *Public Land Mobile Network*
- TCP *Transmission Control Protocol*
- UDP *User Datagram Protocol*
- LAN *Local Area Network*
- SDH *Synchronous Digital Hierarchy*

- STM *Synchronous Transfer Mode*
- EDGE *Enhanced Data rate for GSM Evolution*
- QoS *Quality of Service*
- TDMA *Time Division Multiple Access*

5. Fill the missing words:

- PSTN switching is based on (A) CIRCUIT SWITCHING . ATM uses (B) PACKET switching.

- Recommendation (C) G.711 specifies PCM (Pulse Coded Modulation) of voice frequencies. To generate a PCM signal, an analogue speech signal is sampled at (D) 8000 Hz and converted into a (E) 8 bit code word. Two encoding laws are recommended and these are commonly referred to as the (F) A-law and the (G) μ-LAW .

- Attenuation of voice signals represented a problem for network planners - solution is to use (H) LOADING COILS (also some other answers are accepted).

- Modern telephone terminals use (I) DUAL-TONE dialing. Earlier (J) PULSE SELECTION was applied (very rare nowadays).

- The hybrid circuit transforms (K) 2-wire connection into (L) 4-wire connection.

6. Bonus (not compulsory): SHANNON'S THEOREM

[Reference: Voipio, Uusitupa: Tietoliikenneaapinen (in Finnish) or Internet]

a) Shannon's third and the most famous theorem 'information capacity theorem' determines a theoretical upper limit to an error-free transmission. Up to this limit it is possible to reduce amount of errors into arbitrarily small by choosing a suitable error coding.

$$C = B \cdot \log_2(1 + \frac{P}{N_0 B}) \ \frac{bit}{s}$$

, where C is the highest possible bit rate, B is a bandwidth of the channel, P is an average received power and term N_0 is caused by a Gaussian distributed noise (additive white Gaussian noise, AWGN) whose one-sided power spectral density is N_0.

Calculate the maximum theoretical bit rate if the signal to noise ratio (SNR) of a telephone connection is 30 dB. The bandwidth of the connection is 3,1 kHz.

SOLUTION

$$30\,dB \mathrel{\hat{=}} 1000$$

$$X \ \frac{bit}{s} = 3100\ Hz \cdot \log_2(1+1000) \ \approx 30898,4 \frac{bit}{s}$$