1617 – Written test verifica 2 part 4

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<Quesito> 1

Consider a packet transfer in a POS (Packet Over Sonet) scenario, using IP/MPLS over PPP. A flow of IP packets of length L bytes is transfered at a rate of R packets/s. The packets needs to be processed at IP level and not using LSPs
The MPLS header is 4 bytes long, and the PPP PDU is shown below, assume that the protocol field is 16 bits and that the FCS is 32 bits (pay attention to count the Flag field only once!).

Pacchetto MPLS

Flag	Address	Control	Protocol	Information	Padding	FCS	Flag	Inter-frame Fill
01111110	11111111	00000011	8/16 bits	*	*	16/32 bits	01111110	or next Address

L 1200 bytes
R 800 pacch/s

Evaluate the load at PPP level for the transmission of the IP flow, considering the two mechanisms for sending IP packets that need to be processed at IP level in an IP/MPLS network.

Answer:

The two mechanisms for sending IP packets that need to be processed at IP level in an IP/MPLS networks are
1) using a dummy MPLS label
2) using the protocol field to differentiate between MPLS and IP packets

In the first case the MPLS header (4 bytes) is added to the packet, in the second case it is not added.

The length of the headers and FCS to be added to the IP packet length in the two cases is:

H1 = 5 (PPP header) + 4 (MPLS header) + 4 (PPP FCS) = 13 [bytes]

H2 = 5 (PPP header) + 4 (PPP FCS) = 9 [bytes]

The load at PPP level is

R_PPP_1 = R * (H1+L) * 8 [b/s]

R_PPP_2 = R * (H2+L) * 8 [b/s]

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A voice signal is sampled with a frequency F (khz) and converted to digital with a M bit converter. The digital stream is compressed with a coder, let q be the compression factor (ratio between the original bit rate and compressed bit rate).
The coder produces a compressed packet every 12 ms.
A packetization delay of 50ms, can be accepted, select the packetization interval Tp that minimizes the rate at IP level (hint: how many compressed packets can be carried in an IP packet?)

The compressed stream is transported as an RTP stream. The IP, UDP and RTP headers are respectively 20, 8 and 12 bytes.
The Silence Suppression (SS) technique is used, which on average reduces the bit rate at 40% of the rate without the SS.
With the chosen packetization interval, evaluate the average bit rate at IP level of 30 compressed voice signals with SS.

F	16Khz
M	16 bit
q	14

Answer:

The packetization delay Dp depends on the number N of compressed voice packets that we put in a single IP packets. Dp = N * 12 ms
We want Dp <= 50 ms then N is at most floor(50/12)=4.

To evaluate the rate of each Voice flow transported in IP, let us evaluate first the compressed bit rate Rc. Let Ru be the uncompressed bit rate.

Rc = Ru/q
Ru = F*M [kb/s] = 256 kb/s

How many bits B are carried in a compressed voice packet? Let Tc=12 ms is the interval to produce a single compressed voice packet.
B = Rc * Tc = 256/14 * 12 [bit]

In a single IP packet we carry 4 compressed voice packets.
The bit rate at IP level Rip without silence suppression is

Rip = [Headers(IP/UDP/RT) + 4 * B] / Dp = [(40*8) + 4*B] / (4*12) [kb/s]

The average bit rate of a single with Silence Suppression is

RipSS = Rip * 0.4

The average bit rate of 30 flows is 30 * RipSS

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Consider a stream of IP packets, which is controlled by a Two Rate Three Color Marker (trTCM), with parameters CIR, CBS, PIR, PBS.
A burst of N IP packets of length L at IP level is sent at rate Rb. Check if all the burst can be marked “green”, if not how many bytes will be marked as “yellow”? Which is the required CBSmin so that all the burst can be sent at rate Rb?

CIR	4 MB/s	
PIR	16 MB/s	
CBS	20 KB	
Rb	10 MB/s	
N	200	packets
L	800	bytes

Answer

The size S [bytes] of the burst is
S = N * L [bytes] = 160000 [bytes] = 0.16 [MB]

The time Tb needed to send the burst at rate Rb is
Tb = S / Rb = 0.16 / 10 = 0.016 s = 16 ms

We assume that the bucket is full at the start of the transmission.

The bucket empties at a rate Re = Rb – CIR = 10 – 4 = 6 MB/s
The time Te at which the bucket becomes empty

Te = CBS / Re = 0.02 / 6 = 0.00333 [s] = 3.33 ms

The burst cannot be transmitted fully in-profile

The bytes that are marked yellow Y are
Y = (Tb-Te) * (Rb – CIR) [bytes]

All packets can be marked green if Te = Tb, from this condition we evaluate CBS_min

CBS_min / Re = Tb
CBS_min = Tb * Re = 0.016 * 6 = 0.096 MB = 96 KB

<Quesito> 4

Consider an application that is sending a stream of IP packets, which is controlled by a Two Rate Three Color Marker (trTCM) with parameters CIR, CBS, PIR, PBS. The application is using a UDP connection. The length of IP+UDP headers is 28 bytes. The IP packet length is L=1500 bytes.
The application sends a continuous stream of packets at a rate Rpc = 150 packet/s.
In addition, the application sends a block of data of size M = 800 KB (M is the payload to be carried in UDP) at a rate Rb every T1=2 s.

CBS	200KB (kbytes)
CIR	2 MB/s
PIR	20 MB/s

Rb 10 MB/s

The application does not adapt to the token bucket marker, so the packets that are out of the traffic profile (CIR, CBS) are marked yellow.

At time T=0 the bucket is full, the application starts sending the first block of data and at the same time starts sending the continuous stream of packets.

1) Evaluate the time needed to send the block of data at rate Rb.

2) Evaluate if all packets are marked green. If not, evaluate how many bytes are marked yellow in the first interval of duration T1.

3) Assume that it is possible to change the CBS, choose a CBS_1 that allow all the traffic to be marked green.

4) Assume that it is possible to change both the CIR and CBS parameters. Choose the minimum CIR (CIRmin) that can support the application requirements (to have all packets marked green), and the corresponding CBS (CBS_2) that is needed to have all packets marked green.

Answer:

The continous stream has a rate at IP level
Ripc = Rpc * 1500 B/s = 150 * 1500 = 225000 B/s = 225 KB/s

The size of the block of data at IP level is
Mip = 1500/(1500-28) * M = 815.22 KB/s

The time needed to send each block of data is
Tb= Mip/Rb = 0.08152 [s] = 81.52 [ms]

Starting from T=0 the application is sending both the continuos stream of packets and the first block of data, so its aggregated sending rate is Rb+Ripc

The time to empty the bucket is
Te = CBS / (Rb + Ripc – CIR) = 200 / 8225 = 0.02432 [s]

Te is smaller than Tb, therefore a part of the bytes will be marked yellow

The number of bytes that will be marked yellow is:
(Tb-Te) (Rb + Ripc – CIR) = 470.52 KB

In order to evaluate CBS_1, we want that the bucket becomes empty when the application ends the transmission of the block:

Te = Tb that is:
CBS_1 / (Rb + Ripc – CIR) = Mip/Rb
CBS_1 = Tb * (Rb + Ripc – CIR) = 0.08152 * 8225 = 670.52 KB

Then we need to check that we have enough time after the block is transmitted and before the start of the transmission of the next block (T1) so that the bucket can become full again
$(T1-Tb)*(CIR-Ripc) > CBS\_1$
This is equivalent to check that the CIR is larger than the average rate:
$CIR > Ripc + Mip / T1$

If it is possible to change CIR and CBS, we evaluate the minimum CIR:
$CIR\_2 = Ripc + Mip / T1$
and CBS_2 needs to be evaluated as usual…