Case study: network architecture of an observation satellite

October-November 2020

We propose to study network architecture of an observation satellite provided by Thalès Alenia Space. The goal will be to determine the worst case end-to-end delay for each communication flows in the network.

1 Description of the network

The proposed network architecture is depicted in Figure 1. This architecture is composed of 2 parts. On the right, the platform equipments includes a mass memory unit (SSMM), a processor module (PM) and two transmission modules (TM Ka and TM X). The processor module monitors the other nodes and sends back commands. The mass memory unit stores data from the all the nodes and sends telemetry to the TM Encoders. On the left, the application terminals (A_0 to A_8) represents the payload instruments. That includes cameras, radars or any kind of sensors. They send data to the SSMM and monitoring traffic to PM.

Each pair of nodes is connected by two links, one in each direction. However, in Figure 1, only one link by pair is represented. For each link l_i, the opposite link is named l_{i+20}. For example, the link l_{15} connects R_2 and R_3 while the link l_{35} connects R_3 and R_2. All the links have the same capacity C = 50 Mpbs.

2 Network traffic

On the network, 4 types of packets are exchanged:

- SC (SCience data): application payload, transmitted to SSMM;
- HK (HouseKeeping): monitoring data from the instruments and from the processor to the SSMM;
- CMD (CoMmanD data): commands send by the processor to SSMM or to the instruments;
- TM (TeleMetry): measured data stored into the SSMM, to be transmitted to the ground station via TM Encoders.

Table 1 gives the network path and the packet size for each class of packets.

For each type of packets, the number of the flows are given in Table 2.

For each application, the periods of the flows is given in Table 3. The period of transmission of HK and CMD flows from PM to each application node and to SSMM is 80ms. The transmission from SSMM to the TM Encoders (TM flows) is continue.

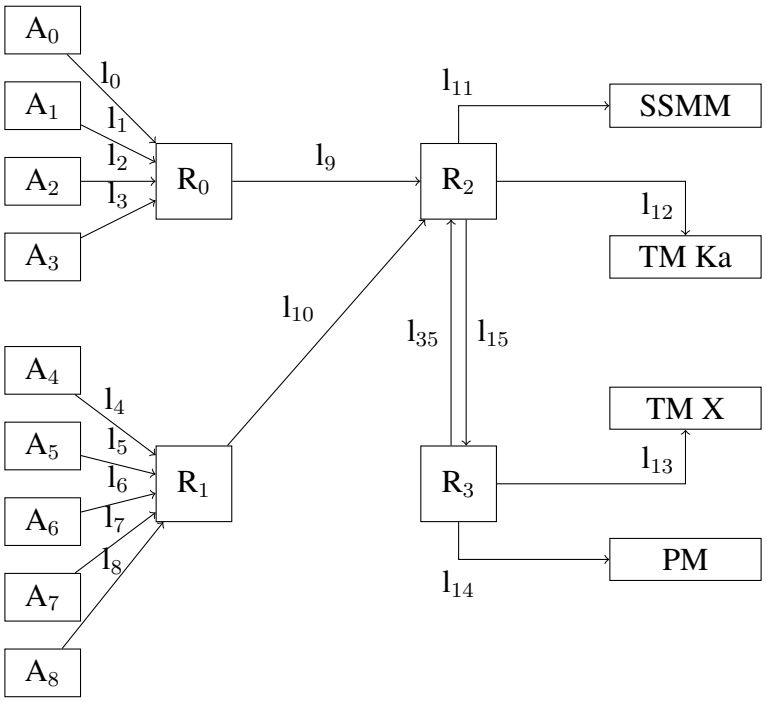

Figure 1: Network architecture

Traffic type	Trajectory	Packet size (bytes)
SC	$A_i \rightarrow$ SSMM	4000
HK	$A_i \rightarrow$ PM $\rightarrow$ SSMM	200
	PM $\rightarrow$ SSMM	1000
CMD	PM $\rightarrow$ SSMM	1500
	PM $\rightarrow A_i$	1500
TM	SSMM $\rightarrow$ TM Ka	4000
	SSMM $\rightarrow$ TM X	4000

Table 1: Network traffic

Flow number	Type	Source and destination
0 to 8	SC	$A_i \rightarrow$ SSMM
9	HK	PM $\rightarrow$ SSMM (retransmission)
10 to 18	HK	$A_i \rightarrow$ PM
19	HK	PM $\rightarrow$ SSMM (generated by PM)
20 to 28	CMD	PM $\rightarrow A_i$
29	CMD	PM $\rightarrow$ SSMM
30	TM	SSMM $\rightarrow$ TM Ka
31	TM	SSMM $\rightarrow$ TM X

Table 2: Names of the different flows

Flow Type	A_0	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
HK	160	53.3	160	5330	320	1330	20	8000	16000
SC	2.21	26.4	160	3200	7.5	98.5	400	9697	20

Table 3: Transmission periods of the flows (in ms)