THE QV-LIFT PROJECT: A GROUND SEGMENT FOR THE FUTURE Q/V BAND SATELLITE SYSTEMS.

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Abstract

This paper presents a summary of the design of the Q/V band Ground Segment currently under development in the framework of the project: "Q/V band earth segment LInk for Future high Throughput space systems" (QV-LIFT - www.qvlift.eu), that has recently been funded in the framework of the EU program Horizon 2020. The project is focusing on the development of up to date hardware and software technologies for the Ground Segment of the future Q/V band terabit Satcom infrastructure. In the following, a description of the system and an account of the developments related to the RF systems are presented.

Index Terms – Q/V band terabit Satcom infrastructure

I. INTRODUCTION

The European Commission defined in its Digital Agenda that all European households shall have access to internet connections of more than 30 Mbps from 2020 onwards , so the volume of digital data communications are expected to double by 2020 [1]. This calls for a dramatic improvement in the satellite communication technologies as they are a fundamental part of the global communication infrastructure. In order to provide the necessary "Terabit connectivity", an evolution to "beyond Ka-band frequencies" is necessary. In fact, the future High Throughput Satellite (HTS) systems will move up to Q and V bands (around 40 GHz for downlink and 50 GHz for uplink) since they offer larger bandwidth availability for the feeder links and the opportunity to dedicate the Ka-band to user links where revenues are generated. Moreover, Q/V-band offers attractive bandwidth for specific segments requiring high data rates such as aeronautical in-flight services. The QV-LIFT project started on November 16th 2016 and it will last for about three years developing hardware and software building blocks and integrating them in a Q/V band SatCom system. To do this, the project will integrate the Aldo Paraboni Q/V band payload host by Alphasat which will be used to set up both feeder and user links. In this paper a description of the QV-LIFT Ground Segment and an account of the developments related to the RF building blocks are presented.

II. THE QV-LIFT GROUND SEGMENT

In Fig.1 is shown the overall QV-LIFT system. It is built around the Aldo Paraboni QV band payload on board of Alphasat, developed by the Italian Space Agency (ASI) and currently in operation. The QV-LIFT ground segment includes two already operational Earth Stations, owned and operated by ASI , Earth station 1, located in Tito Scalo (Italy), and Earth Station 3, located in Spino d'Adda (Italy). A further Q/V band ground station (Earth Station 2) and a Q/V band Aeronautical Terminal are also included in the system and are both currently in development. The Earth Station and the terminal will make use of a Block Up Converters based on a power combined GaN MMICs, and high efficiency antennas developed in the project. Also shown in Fig. 1, is the Gateway Management System (GMS) which takes in charge the network control functions needed to support smart handover of communications between multiple gateway nodes (smart gateway).

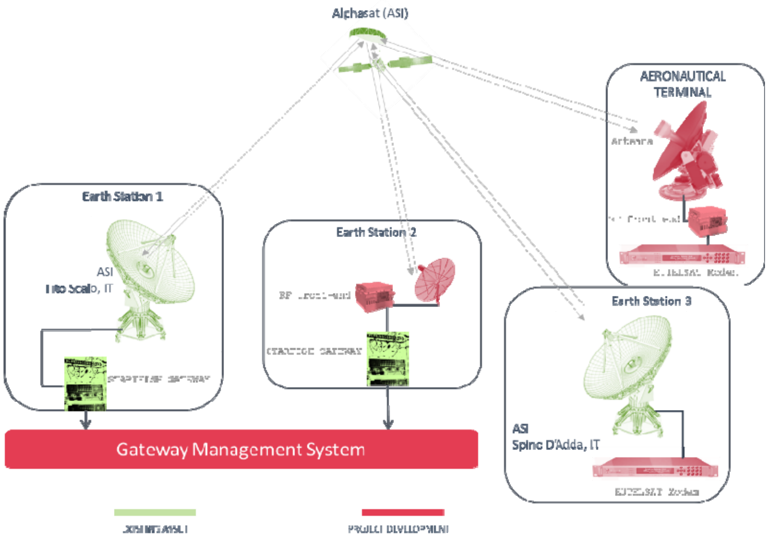


FIG. 1 – The QV-LIFT System

III. QV-LIFT RF DEVELOPMENTS

The QV-LIFT Ground System includes existing and operational earth stations available with the Italian Space Agency (ASI) and newly built systems. For the new systems, the consortium is currently developing the following major building blocks: V band MMIC amplifier, V band power combining SSPA (Solid State Power Amplifier), V band BUC (Block Up Converter), Q band LNB (Low Noise Block down converter), Q/V band (RX/TX) antennas for mobile terminals, Q/V band (RX/TX) antenna for fixed station, Tracking and pointing systems for the mobile and fixed antennas. As it will be detailed in the following sections, due to the high performance required and to the high frequency of operation, up to date technologies are needed to realize the previous components. As an example, MMIC are based on the recently delivered OMMIC GaN technology and they are power combined in a metallic waveguide divider/combiner to provide a high power SSPA. The LNB is based on a low noise GaAs LNA produced by OMMIC . The antenna for the mobile terminal is an Axially Displaced Gregorian reflector with a corrugated feed. This arrangement aims at an aperture efficiency larger than 70% which ensures good performance in both uplink and downlink. The fixed earth station is based on an Axially Displaced reflector with a 1.5m diameter. In the following the involved components will be described giving details of specifications and showing the intermediate results available.

a. **SSPA, BUC AND LNB**

The SSPA is based on a MMIC GaN amplifier currently in development. The MMIC is developed in GaN technology by OMMIC. The MMIC specs are: Bandwidth 47.2-50.2GHz; Output Power P2dB 37 dBm (5W); Output Power PSat 39dBm (8W); Gain>16dB; Gain Flatness +-1.5dB; PAE 20%.

The MMIC is realized with the Ommic D01GH – 100nm. Simulated results for Gain, Output Power, Power Added Efficiency are shown in fig. 2 for three compression levels (1dB, 2dB, 3dB).

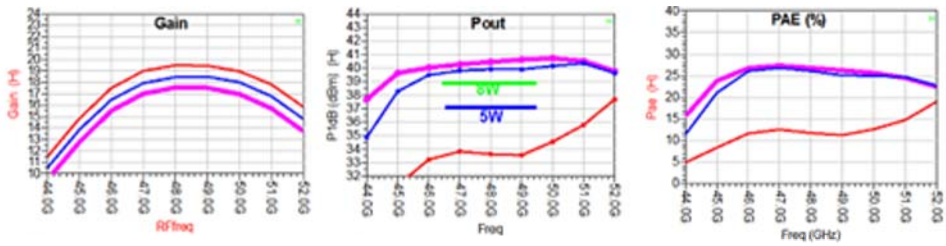


FIG. 2 – Simulated Output Parameter of the V band GaN MMIC amplifier under development

4 MMICs will be power combined in waveguide to reach the power level needed by the BUC. The power dividing and combined structure is based on 4X1 (1X4) metallic waveguide T magic with low insertion loss. The power combining/dividing structure is designed to cover the bandwidth from 46.5GHz to 49.5GHz.

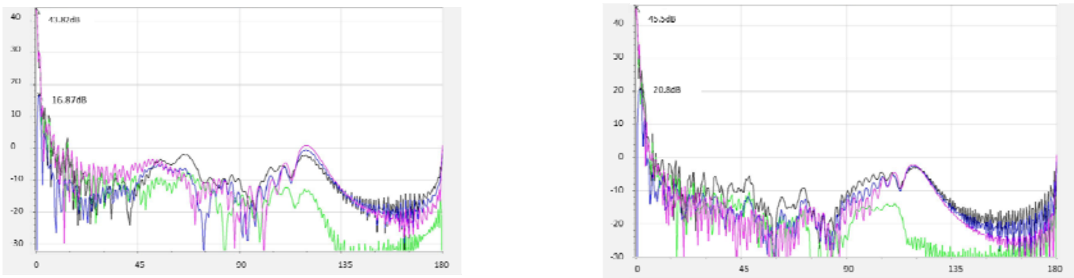
The BUC specifications are : Input frequency 1.5 GHz; Bandwidth 500 MHz; Output frequency 46.5 – 49.5 GHz; Output power 15 W (41.7 dBm); Gain 40 - 60 dB; S11, S22<-10 dB. The LNB specifications are : Input frequency 37.5 – 42.5 GHz; Bandwidth 500 MHz; Output frequency 1.25 – 1.75 GHz; Input power -130 dBm; Noise Figure <3.5 dB; Gain>50 dB; S11, S22<-10 dB.

The LNB is based on the CGY2122XUH/C2 LNA developed by OMMIC with NF=1.5dB. The LNB has a bandwidth from 37.5GHz to 42.5GHz and output Gain > 50 dB. The simulated Noise Figure is 3dB.

b. **ANTENNAS**

Link budget analysis [4] indicates the adoption of high efficiency antennas. In particular, considering a link margin larger than 2.5 dB,

one needs antennas with G/T > 14dB/K and EIRP > 56 dBW. Considering antennas with diameters 45cm and 60 cm and the BUC and the LNB presented in the previous section, one finds that antenna needs to have 70% aperture efficiency. These performances may be reached with axially displaced reflectors which can maintain very good performance on a large frequency band.
In Fig. 3 are shown the radiation diagram of the 45 cm antenna at 37.5GHz (RX) and 48.5 GHz (TX). Also indicated is the maximum gain achieved which is 43.82 dB in RX and 45.5 dB in TX which correspond to an aperture efficiency close to 80%. The antenna is able to cover from 37GHz to 50 GHz with a good match. Similar results are achieved for the 60 cm antenna which shows 45.9 dB in RX and 47.7 dB in TX. The 1.5 m antenna is currently under development but preliminary results show an aperture efficiency of 60% which is already enough to close the link budget thanks to the large antenna size.



(a) (b)

Fig. 3. Radiation diagram of the 45cm mobile terminal antenna at 37.5GHz (a) and 48GHz (b)

IV. Conclusion

The QV-LIFT project, funded by EU in the framework of the H2020 program, aims at realizing the software and hardware building blocks for the Ground Segment of the future Q/V band satellite links. In this paper we have presented a short description of the system under development and the characteristics of some of the RF blocks. A more detailed account of the system and the most recent results will be given in the course of the presentation.

References

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