

Validation of ground technologies for future Q/V band satellite systems: the QV – LIFT project

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Abstract— With the aim of supporting the Terabit connectivity, High Throughput Systems – HTS rely on the exploitation of Q/V band. These frequency bands offer the possibility to have larger bandwidth availability with respect to the Ka band systems, and to realize feeder links and specific segments requiring high data rates such as aeronautical in-flight services.

The design of a Ground Segment for Q/V band satellite communications implies several technological challenges. The design of antennas, power amplifiers with high efficiency and Low Noise receivers are critical, nevertheless they are fundamental to support high data rate transmissions. Furthermore, in order to counteract atmospheric impairments, a system able to implement and to manage a handover mechanism between gateways is also needed.

A Ground Segment for Q/V band high throughput system has been conceived in the project “Q/V band earth segment Link for Future high Throughput space systems” (QV-LIFT), funded by the European Commission in the framework of the Horizon 2020 program. The consolidation of crucial technologies for new generation satellite communications is addressed, with the objective to ensure space accessibility to Europe and, in particular, to foster technology readiness of European industries in space related sectors.

This paper provides the description of key hardware and software developments for next generation HTS systems operating in the Q/V band, based on core technologies for both ground and user segments currently under development for the project QV-LIFT. The system test architecture which will be used to validate the developed technology and functionalities is also presented, together with the overview of the project status and validation plan.

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ACKNOWLEDGEMENTS

Authors acknowledge the QV-LIFT project [6] funded under the European Commission Programme H2020-COMPET-2016.

REFERENCES

- [1] F. Di Cola, et al., “Alphasat Aldo Paraboni Payload IOT campaign and Status after First Year of Operation”, in proc. Aerospace Conference 2016, Big Sky, Montana(US), Jun. 2016.
- [2] T. Rossi, F. Maggio, M. De Sanctis, M. Ruggieri, S. Falzini and M. Tosti, "System analysis of smart gateways techniques applied to Q/V-band high throughput satellites," 2014 IEEE Aerospace Conference, Big Sky, MT, 2014, pp. 1-10.
- [3] F. Massaro et al. “QV-LIFT Project: Using the Q/V Band Aldo Paraboni Demonstration Payload for Validating Future Satellite Systems”, 23rd Ka and Broadband Communications Conference, Trieste, Italy, October 16 th-19th, 2017.
- [4] G. Codispoti, G. Amendola, et al., “RF Technologies for the Ground Segment of future Q/V-band Satellite Systems”, accepted for publication at 23rd Ka and Broadband Communications Conference, Trieste, Italy, October 16 - 19, 2017.
- [5] T. Rossi, M. D. Sanctis, M. Ruggieri, C. Riva, L. Luini, G. Codispoti, E. Russo, and G. Parca, “Satellite communication and propagation experiments through the alphasat q/v band aldo paraboni technology demonstration payload,” IEEE Aerospace and Electronic Systems Magazine, vol. 31, no. 3, pp. 18–27, March 2016.
- [6] Project website www.qvlift.eu

BIOGRAPHY



Giuseppe Codispoti received a degree in Electrical Engineering from the University of Calabria, Italy and a Master of Science's degree in Electrical Engineering from the California Institute of Technology in Pasadena, USA. During his graduate studies he was involved in class projects at the Caltech/ NASA Jet Propulsion Laboratory in Pasadena with the responsibility of the communication aspects. From 1993 to 2000 he was with Alenia Spazio, Rome (now Thales Alenia Space Italia) at the "On board Active Antennas Department" as designer, project and program manager in either Telecommunication and Remote Sensing programs. In March 2000 he joined ASI, the Italian Space Agency, where he has been involved in projects regarding microgravity, remote sensing and telecommunications. At the moment he works in the Telecommunication and Navigation Division and he is the responsible of the Q/V Band Program of the Agency. He has been appointed as delegate and expert of the Italian Government in delegations of international bodies such as ESA, European Space Agency and UNO, United Nations Organization. He is member of Technical and Scientific Committees of public Foundations. He is tutor of Ph.D students of Italian universities.



Giorgia Parca Master degree in Telecommunications Engineering (2006) and PhD in Telecommunications and Microelectronics Engineering (2010) at University of Rome Tor Vergata, Electronic Engineering Department. Main research topics have been fiber optics, optical wireless, inter-satellite broadband technologies. Post-Doctoral fellowship at the Portuguese Telecommunications Institute, on optical telecom systems and devices for all optical data/image processing. She joined the Italian Space Agency in 2013, firstly with the Telecommunications and Navigation Division and currently with the Scientific Research Division. Main research areas are on enabling technologies for space communications, with particular focus on Ka, Q/V band, optical broadband telecommunication systems, Deep Space communications and ground operations. She is coauthor of several papers on international journals and conferences proceedings.



Mauro De Sanctis received the "Laurea" degree in Telecommunications Engineering in 2002 and the Ph.D. degree in Telecommunications and Microelectronics Engineering in 2006 from the University of Rome "Tor Vergata" (Italy). In autumn of 2004, he joined the CTIF (Center for TeleInfrastruktur), a research center focusing on modern telecommunications technologies located at the University of

Aalborg (Denmark). He was with the Italian Space Agency (ASI) as holder of a two-years research fellowship on the study of Q/V band satellite communication links for a technology demonstration payload, concluded in 2008; during this period he participated to the opening and to the first trials of the ASI Concurrent Engineering Facility (ASI-CEF). From the end of 2008 he is Assistant Professor in the Department of Electronics Engineering, University of Roma "Tor Vergata" (Italy), teaching "Information and Coding Theory". From January 2004 to December 2005 he has been involved in the MAGNET (My personal Adaptive Global NET) European FP6 integrated project and in the SatNEx European network of excellence. From January 2006 to June 2008 he has been involved in the MAGNET Beyond European FP6 integrated project as scientific responsible of WP3/Task3. In 2006 he was a post-doctoral research fellow for the European Space Agency (ESA) ARIADNA extended study named "The Flower Constellation Set and its Possible Applications". In 2009 he was involved in the ESA project on Multipurpose Constellation. From 2010 to 2011 he has been involved in the ESA project TESHEALTH (Telemedicine Services for Health). He has been involved in research activities for several projects funded by the Italian Space Agency (ASI): DAVID satellite mission (Data and Video Interactive Distribution) during the year 2003; WAVE satellite mission (W-band Analysis and VERification) during the year 2004; FLORAD (Micro-satellite FLOWer Constellation of millimeter-wave RADiometers for the Earth and space Observation at regional scale) during the year 2008; CRUSOE (CRUising in Space with Out-of- body Experiences) during the years 2011/2012. He has been involved in several Italian Research Programs of Relevant National Interest (PRIN): SALICE (Satellite-Assisted Localization and Communication systems for Emergency services), from October 2008 to September 2010; ICONA (Integration of Communication and Navigation services) from January 2006 to December 2007, SHINES (Satellite and HAP Integrated Networks and Services) from January 2003 to December 2004, CABIS (CDMA for Broadband mobile terrestrial-satellite Integrated Systems) from January 2001 to December 2002. In 2007 he has been involved in the Internationalization Program funded by the Italian Ministry of University and Research (MIUR), concerning the academic research collaboration of the Texas A&M University (USA) and the University of Rome "Tor Vergata" (Italy). From 2011 to 2014 he has been the scientific responsible of the activities of the University of Roma Tor Vergata for the TETRis project (Innovative Open Source Services over TETRA), funded by the MIUR, grant "P.O.N. Ricerca e Competitivita' 2007-2013". He is involved in the coordination of the Alphasat "Aldo Paraboni" Payload (Technology Demonstration Payload - TDP 5) scientific experiments for broadband satellite communications in Q/V band, funded jointly by ASI and ESA. Presently, he has research collaboration with the Peoples' Friendship University of Russia (RUDN University), Moscow, Russian Federation. He is serving as Associate Editor for the Space Electronics and Communications area of the IEEE Aerospace and Electronic Systems Magazine. His main areas

of interest are: wireless terrestrial and satellite communication networks, data mining and information theory. He co-authored more than 80 papers published on journals and conference proceedings. He was co-recipient of the best paper award from the 2009 International Conference on Advances in Satellite and Space Communications (SPACOMM 2009).



Tommaso Rossi received his University Degree in Telecommunications in 2002, MSc Degree in Advanced Communications and Navigation Satellite Systems in 2004 and PhD in Telecommunications and Microelectronics in 2008 at the University of Rome Tor Vergata where he is currently an Assistant Professor (teaching Digital Signal Processing, Multimedia Processing and Communication and Signals). His research activity is focused on Space Systems, EHF Satellite and Terrestrial Telecommunications, Satellite and Inertial Navigation Systems, Digital Signal Processing for Radar and TLC applications. He is currently CoInvestigator of the Italian Space Agency Q/V-band satellite communication experimental campaign realized through the Alphasat Aldo Paraboni payload. He is Associate Editor for the Space Systems area of the IEEE Transactions on Aerospace and Electronic Systems.



Marina Ruggieri is Full Professor of Telecommunications Engineering at the University of Roma Tor Vergata and therein member of the Board of Directors. She is co-founder and Chair of the Steering Board of the interdisciplinary Center for Teleinfrastructures (CTIF) at the University of Roma Tor Vergata. The Center, that belongs to the CTIF global network, with nodes in USA, Europe and Asia, focuses on the use of the Information and Communications Technology (ICT) for vertical applications (health, energy, cultural heritage, economics, law) by integrating terrestrial, air and space communications, computing, positioning and sensing. She is Principal Investigator of the 40/50 GHz TPD5 Communications Experiment on board the European Alphasat satellite (launched on July 2013). She is Sr. past President of the IEEE Aerospace and Electronic Systems Society (2010-2011), where she served as Member of Board of Governors since 2000 for three terms; Founder and Chair of the Space Systems Panel (2002-2010); Editor for Space Systems in the Transactions on Aerospace and Electronic Systems (2001-present), Associate/Sector Editor and Assistant Editor of the Systems Magazine (2005-2009); International Director of Italy & Western Europe (2005- 2014); Chair of the N&A Committee (2012-2013). She is IEEE Division IX Director (2014-2015) and hence sitting member of the Board of Directors and the Technical Activities Board. She has been member of TAB Strategic Planning Committee (2011-2014), TAB Representative in the Women in Engineering Committee

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Carlo Riva (male), received the Laurea Degree in Electronic Engineering (cum laude) and the PhD degree in Electronic and Communication Engineering, from Politecnico di Milano, Italy, in 1990 and 1995, respectively. He joined in 1999 the Electronics, Information Science and Bioengineering Department at Politecnico di Milano, where, since 2006, he has been an Associate Professor of electromagnetic fields. Since 1992, he participated in the Olympus, Italsat and Alphasat 'Aldo Paraboni' propagation measurement campaigns, in the COST255, COST280 and COSTIC0802 international projects on propagation and telecommunications and in the Satellite Communications Network of Excellence (SatNEx). In 2010, he has been Director of the 49° Course "Radiowave Propagation" in the frame of the 'International School of Quantum Electronics' at Erice. In 2011 he has been nominated to the Steering Committee of ESA's Network of Experts as Italian Representative. In 2012 he has been appointed Principal Investigator by the Italian Space Agency for the Alphasat Aldo Paraboni propagation experiment. Since 2015 he is Chairman of Working Party 3J ('Propagation Fundamentals') of the ITU-R Study Group 3. He is the author of more than 150 papers published in international journals or international conference proceedings. His main research activities are in the fields of atmospheric propagation of millimeterwaves, propagation impairment mitigation techniques, and satellite communication adaptive systems.



Giandomenico Amendola is professor of electromagnetic fields at the University of Calabria-Italy. His research interests focus mainly on antennas, integrated front ends and millimeter waves. Recently he focused his activities to satcom terminals and high speed, millimeter waves, terrestrial links.



Fabrizio Massaro works as Communication Engineer at the Innovation Department of Eutelsat. In particular, he is involved in R&D activities related to Hub and user terminal technologies for video broadcast and IoT connectivity applications. His experience is very diversified and spans from developing activities for small satellite platforms to research activities in the field of signal processing for satellite receiver