A Contribution to Perspectives of W-band for Satellite Communications

In the framework of modern Information Society, broadband satellite communication systems, with their global access and broadcasting capabilities, are assuming an increasing relevance. These systems could greatly benefit from the use of Extremely High Frequency (EHF) [1]; in particular “beyond Ka-band” frequencies can provide the advantage of large bandwidth availability but also smaller antenna size for a fixed gain, or conversely, higher antenna gain for a fixed size. The drawback of radiowaves at these frequencies is the high impairments caused by the lower part of the atmosphere (troposphere) hence research activities on techniques for propagation impairments mitigation are needed, which are able to dynamically adapt the system to the channel conditions; in particular Adaptive Coding and Modulation (ACM), Data Rate Adaptation (DRA), up-link power control, spatial diversity (both using classical site diversity approach or smart gateways approach) and on-board adaptive power allocation can be efficiently adopted to improve EHF satellite systems performance.

Currently the use of Ka-band is the benchmark for broadband satellite communications commercial application, while Q/V band is under scientific investigation through European experimental campaigns. In this framework, great scientific interest is pointed towards W-band satellite communications, 10 GHz of uncrowded spectrum, both for uplink and downlink (71-76 GHz, 81-86 GHz), being available (ITU regulations) for Fixed Satellite Services. As a matter of fact, no satellite propagation or communication experimental campaigns have been conducted using W-band; hence, in order to efficiently exploit this band, strong research efforts are needed.

A proven experience in the system design of “beyond Ka-band” systems both for satellite and terrestrial applications has been gathered by the authors in previous programs. In particular, University of Roma Tor Vergata (URTV) and Politecnico di Milano (POLIMI) cooperate since ten years in many research project for the exploitation of W-band. In the frame of satellite communications, two projects, funded by the Italian Space Agency (ASI), have been coordinated by URTV with the support of POLIMI: DAVID (Data and Video Interactive Distribution) [2] and WAVE (W-band Analysis and Verification) [3-4]. The first one is a scientific mission of the Italian Space Agency (ASI) “Programme of Small Mission for Science and Technology” for the development of a pre-operative W-band satellite data relay telecommunication system (based on a LEO satellite); DAVID phase B has been completed in 2002. The second one is a feasibility study for the development of W-band payloads (embarked on HAP, LEO and GEO satellites) both for scientific experiments and pre-operative missions; WAVE phase A2 has been completed in 2011.

Both projects have been carried out with the contribution of a large team of more than 15 Partners involving large and medium companies (including Thales Alenia Space Italy, Space Engineering, Rheinmetall) and research institutions.

URTV and POLIMI have also a proven experience in the design and execution of EHF satellite experiments and optimization of PIMT [5-7], being POLIMI and URTV the Principal Investigators of propagation and communication experiments that are currently carried out through the Aldo Paraboni Q/V band payload embarked on the Alphasat satellite [8-9]. Authors have also conducted preliminary experimental terrestrial communication test using W-band with the support of Rheinmetall and ARES Consortium [10-11] and theoretical studies on propagation at W band [12-14].

In addition URTV has also a proven experience in actual design of W-band subsystems. In particular, MIMEG group is equipped with a Vector Network analyzer capable of performing S-parameter measurements in the frequency band from 40MHz up to 110GHz in a single sweep. The possible use include not only two-port characterization up to such frequencies, but also device modelling, both of the linear, non-linear and noise type. Regarding the expertise in actual circuit design, the team designed in MMIC technology several functionalities operating at W band. Among them, a low-noise amplifier over the full W Band in several versions (see e.g. http://www.ommic.fr/produits/w2190c2-15), a X8 frequency multiplier, mixers and several others.

In the context of R&D activities in W-band, URTV and POLIMI are working with universities and research centers for basic research and with industries for design-operational aspects. In this regard, recently, through the Consortium ARES, it was signed with the company CGS / OHB a collaboration agreement for the development of system and components in W-band, both for space and ground segment.

In the workshop presentation the authors will provide their experience in W-band satellite systems, and their vision on the future perspectives for the use of this band.