Contributo presentato alla Riunione GTTI-SIEm, Pavia 26-28 giugno 2019

Chip and System level research activities for highly efficient Optical Communications

J. Nanni [(1*)], G. Bellanca[(2)], V. Tralli[(2)], M. Barbiroli[(1)], F. Fuschini[(1)], G. Tartarini[(1)] , P. Bassi[(1)]

[(1)] *DEI-Università di Bologna, Bologna, Viale del Risorgimento 2 (*email :jacopo.nanni3@unibo.it)*

[(2)] *Dipartimento di Ingegneria, Università di Ferrara, Ferrara, via Saragat 1*

This abstract presents the research activities currently carried out at the Department of Electrical, Electronic and Information Engineering of University of Bologna in the field of optical communication systems. These activities include the design and characterization of optical components, in collaboration with the University of Ferrara, and design of optical system for radiofrequency communications. The major results of these two activities are shown briefly hereafter.

Optical Wireless Networks on-Chip

The constant increase of computational capacity demand is nowadays a key point for the future of the information and telecommunication technologies and industrial engineering. A possible solution is the realization of chip multiprocessors (CMP) systems where thousands of processing unit are integrated together processing the data simultaneously. Because of the necessity of high efficiency and low latency communication between this huge amount of chips, in recent years the study of networks on chip has taken a crucial role. In particular, our research is devoted to the realization of wireless and optical networks for chip-to-chip communication, with the advantage of reaching low latency and low network complexity, together with an easier integration of the antennas. Figures 1 shows the Vivaldi plasmonic antenna [1] that has been designed to be integrated in chip structures for communicating at 1550nn, while Figure 2 shows the recent results obtained by modeling the propagation in the SiO_2 comparing different types of Vivaldi antennas through a *ray tracing* approach [2] showing that the received power might be greater than the corresponding free-space case thanks to a guiding effect triggered by the multi-layer environment present within the chip. In a multi-link on-chip scenario, interference issues rise up, and the ray-tracing investigation of the signal-to-interference ratios can finally lead to the bit-error probability for different network layout. The fabrication and experimental evaluation of the proposed devices will be performed in the next months.

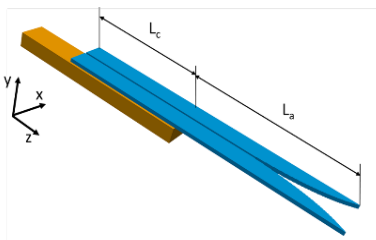

Figure 2: Plasmonic Vivaldi antenna.

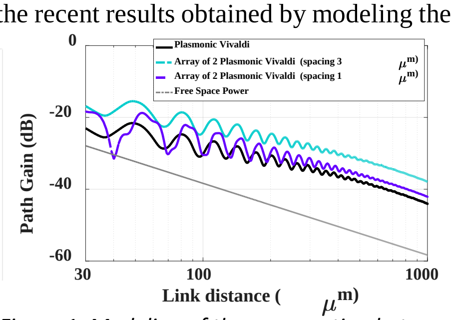

Figure 1: Modeling of the propagation between different Vivaldi antennas.

Radio-over-Fiber systems for cellular network infrastructures

Radio-over-Fiber (RoF) systems are currently used for transporting any type of RF signal (LTE, Wi-Fi, RF sky signals[3], etc..). In telecommunications scenarios it is used where the wireless transmission is not achievable (i.e. trainway tunnels), rather that crowded and dense places (e.g. stadiums). Our research focuses on possible cost and consumption reduction of these systems using 850nm Vertical Cavity Surface Emitting Lasers (VCSELs) which have the great advantage to reach low manufacturing costs compared to any other semiconductor lasers. The combined use of this laser with the standard single mode fiber (SSMF) can provide significant cost reduction, thanks to the possible reuse of the already existing fiber infrastructure. In our recent works, we studied the implementation of such type of link, analyzing in detail intermodal dispersion and modal noise effects of the bi-modal propagation at 850nm within SSMF. We demonstrate that a mitigation of both effects is possible if the SSMF is optimally excited, for example through a short span of truly single-mode (at 850nm) fiber placed right before the SSMF [4]. With this solution we were able, for example, to achieve 256-QAM transmission of 5 LTE channels of 20MHz bandwidth in the km range at 800 MHz.

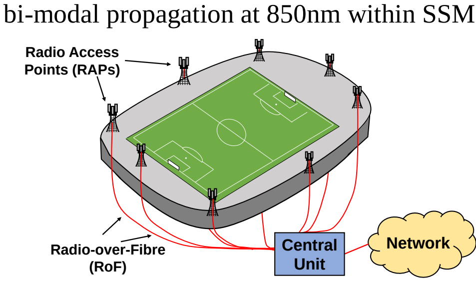

Figure 3: Example of RoF infrastructure for TLC scenario.

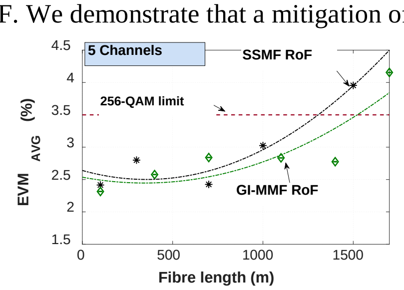

Figure 4: Error Vector Magnitude (EVM) for 5 LTE channels RoF system.

References

[1] G. Bellanca *et al.*, *OSA Optics Express*, 2017, 25, pp. 16214-16227.

[2] B. Alam,*et al.*, *4th Int. Workshop on Advanced Interconnect Solutions for Emerging Computing Systems, Jan 2019, Valencia, Spain..*

[3] J. Nanni *et al.*, *21th International Conference on Transparent Optical Networks (ICTON)* 2019, Fr.D2.4.

[4] J. Nanni *et al.*, *IEEE/OSA J. Lightw. Technol.*, 2018, 36, (19), pp. 4430-4437