Assessment of FETI DDM methodologies for the simulation of High Gain Ka-Band Transmit arrays

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Ka-band high gain satellite antennas providing broadband access services are required for installation on High Throughput Satellites (HTS) and high altitude platforms (HAPs). Recent works show the interests of a Fresnel plate lens used for ground terminal to conciliate high gain (30 dBi) with wide beam scanning (0 to 50°) and antenna height (F/D≤1), for example: (E B. Lima, S A. Matos, J R. Costa, C A. Fernandes, N J. G. Fonseca, IEEE TAP, 2015, No 12, DOI: 10.1109/TAP.2015.2484419).
The full wave simulation of these Fresnel lenses requires considerable computation effort. Indeed, the dimensions of the lens of 30 dBi gain are approximately 20 λ x 15 λ and the electromagnetic problem to be solved is non-periodic. Indeed, in our application, the lens is composed of 4524 phase-shifting cells chosen from 63 different constitutive cells. The periodic simulation methods are therefore unusable here, whereas conventional simulators require very important computing times as well as RAM memory.
The objective of this presentation is to evaluate the potentialities of the domain decomposition method FETI-2LM for the simulation of large transmit arrays on massively parallel clusters using MPI programming. For this purpose, recent results obtained in the context of RCS reduction, using the FETI-2LM technique (S. Varault, M. Soiron, A. Barka and all, IEEE TAP, 2016, Issue 99, DOI: 10.1109 / TAP.2016.2637860) and (F. X. Roux, A. Barka, IEEE TAP, 2016, accepted paper) have been completed for antenna gain simulations. They rely on finite element resolutions of the local problems of each of the phase-shifting cells and an iterative connection of the subdomains with the implementation of Robin type transmission conditions on the interfaces. The 30 dBi lens problem required 1 Billion unknowns and is solved at 30 GHz on 5522 Intel E5-2690 cores in 10 minutes. During the conference cross-comparisons of calculation and measurements results as well as simulation times will be presented.

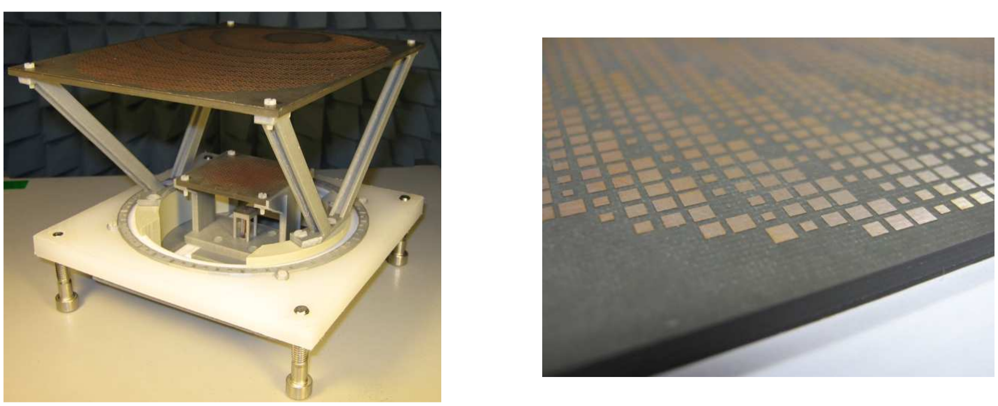

Figure 1. 30 dBi lens antenna and zoom of the transmit array (DOI: 10.1109/TAP.2015.2484419)