The "Arreghini's Problem" challenge

One of my numerous interactions with Dave Giri

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Abstract—This paper will introduce the Arreghini-problem proposed by Dave Giri to validate Multiconductor Transmission Line Networks (MTLN) solvers. The topology of the problem together with its analytical solution are presented. Then various evolutions are showed to demonstrate recent evolutions on Current-Return-Networks (CRN) and Field-to-Transmission-Lines (FTL) problems. Finally, complex applications of such problems, made possible by those modified Arreghini's problems, are illustrated.

Keywords - EM-Topology, MTLN, BLT equation

I. INTRODUCTION

My interactions on EM with Dave Giri have been numerous since I have been knowing him and since I began to present my results in conferences. While I progressively became one of Carl Baum's "protégés" as he used to say it, I also began having interactions with Dave Giri and progressively we became friends. Particularly, I had the chance to be invited in the academy of the HPE-courses, which offered me the opportunity of having so many fructuous scientific exchanges with Dave and brilliant scientists.

In the HPE courses, I taught EM Topology and MTLNs, both of them illustrated by a demo with the BLT-based MTLN CRIPTE code. It happens that in the 2007-Bonascre, France, edition (close to Toulouse), Dave challenged me with a problem that he had solved several years before for one of his former EMP-course (the former name of HPE-courses) student. This student was named, "Franck Arreghini" and without any intentional purpose, this name eventually became famous in many of my activities. Mr. Arreghini's problem is presented in Figure 1, formulated by Dave Giri's hand himself. On my side, it became Arreghini's challenge, exactly formulated as follows by Dave:
- "*Goal: compute currents and voltages in time domain*"
- *Purpose: do the problem analytically, so that time domain computer codes can be tested in special simple cases*"

II. ANALYTICAL RESOLUTION

The problem is indeed very simple in terms of application case but its resolution requires a non-negligible amount of mathematical development that must be done with care in order to establish the exact solution. This development also shows why MTLN computer tools become unavoidable as soon as the topology of the problem becomes slightly more complex (more branches, more wires in branches, cable-shields, various positions and distributions of sources), not to mention physical properties of the wiring (frequency dependence, losses..) or EM-coupling physics (FTL, CRN…).

However, Arreghini's problem is of real interest for MTLN computer code validations because of its branched topology involving transmission-lines and junctions. As far as frequency domain solvers are concerned, such as CRIPTE, the time-domain voltage excitation becomes a specific challenge that requires appropriate signal processing based on well-dimensioned Fourier Transform operations.
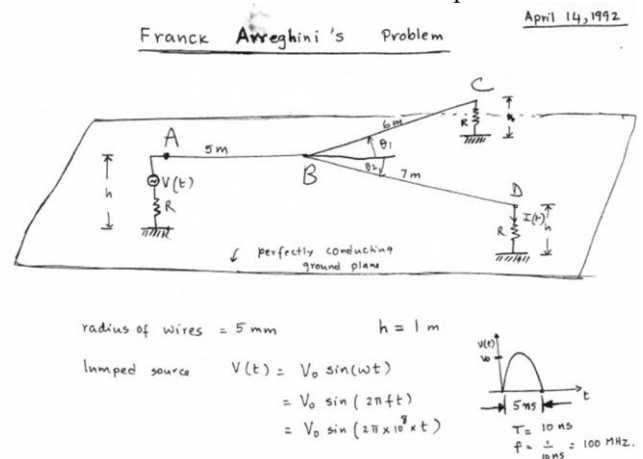

Figure 1. Arreghini's problem description by Dave Giri's hand.

II. AREGHINI'S TEST-CASE OFFSPRING

The Arreghini's problem topology has finally provided the validation for many improvements that we have made in the last 10 years in the CRIPTE code. This will be illustrated with complex CRN [1, 2] and FTL [2, 3] problems.

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