

Secondment Report Form

Secondee	Martin Stumpf, PhD
Host Organization	Id:
	Name: Katholieke Universiteit Leuven
Research Topic(s)	TD Green's functions for layered media,
	TD Contour Integral Method
	TD Surface impedance of a plasmonic half-space

ACTIVITIES DURING THE SECONDMENT

<Brief description of the main activities developed during the stay, and how they contributed to achieve your work plan goals (max. 3 pages)>

The research carried out during the CARE Secondment has been aimed at the computation of electromagnetic *time-domain Green's functions* connected with horizontally stratified media. Standard ways of handling such problems is to perform the computations for a large number of frequencies and use these results as inputs to the inverse Fast Fourier Transform algorithm. Apart from the fact that this is a strange way to handle physics (that manifests itself in space-time, i.e. the time-domain) the procedure does not account for the universal property of causality, but in addition it cannot handle pulsed signals whose values show discontinuities in function values or their time derivatives. A logical way to avoid this only partly successful detour, is to handle the whole problem right from the beginning in the time domain. Exactly this was the objective of the research.

The expressions for time-domain Green's functions have been constructed using the sophisticated mathematical tool known as the Cagniard-DeHoop technique. The applied technique has been originally developed for calculating seismic wave propagation in stratified media, where it is well-known as the generalized ray theory. Since the latter has never been used for EM problems, the generalized ray theory for EM fields has been developed. Only in short, it involves a consistent decomposition of relevant field quantities as well as the pertaining field equations, an application of integral representations accounting for the temporal and spatial shift invariance of the configuration in the plane parallel to the interfaces, development of the so-called wave-matrix formalism with the appropriate source-type field representations and the Cagniard-DeHoop inversion to the space-time domain. Subsequently, for the developed theory the numerical procedures have been worked out and implemented. A final output is the computational demonstration tool that is capable of providing pulsed electromagnetic Green's functions excited by an impulsive source placed in a general layered medium.

To couple the time-domain Green's function module with the existing numerical integral-equation based frameworks (e.g. MAGMAS), the Time-Domain Method of Moments numerical schemes have been tested and implemented. A final result is the 2D *Time-Domain Contour-Integral-Method* that for the time being enables us to observe a transmission of pulses over the microstrip structure under the so-called 'short-pulse approximation'. This method is a unique approach in this category and will be further developed. It also provides useful information towards a full-wave time-domain integral equation technique.

In order to account for the relaxation behavior of media involved, new approaches based on the inversion Bromwich integral have been tested and implemented. As it turned out, Boltzmann-type relaxation behavior (e.g. Lorentz-line, Drude/Debye-absorption) can be included at the expense of having to numerically evaluate a definite one-dimensional integral of a well-behaved function. *The time-domain surface impedance of half-spaces with conducting and plasmonic properties* has been derived as the first step on this subject.

Thanks to the affable support of Professor Guy Vandenbosch throughout my CARE Secondment, all scheduled tasks have been met. Achievements of the CARE secondment will be presented at the CARE Workshop organized at the international conference *EuCAP 2012* in Prague.

MAIN RESULTS OF THE STAY

< List of the publications co-written (or in progress)>

Number of Publications: <u> 2 </u>	(1) _____	Other(s):
Number of Documents/ Reports: <u> 1 </u>	(2) _____	
Number of Case Studies & Demonstrators: <u> 1 </u>	(3) _____	

Publications:

M. Stumpf and G. A. E. Vandenbosch, “*Time-domain surface impedance of conducting and plasmonic half-spaces,*” manuscript, to be submitted.

M. Stumpf and G. A. E. Vandenbosch, “*Pulsed EM waves between parallel plates: Modal-expansion vs. Generalized-ray approach,*” manuscript, to be submitted.

Report:

M. Stumpf, A. T. De Hoop and G. A. E. Vandenbosch “*Time-domain EM Green’s functions for a discretely layered medium,*” scientific report.

Demonstrator:

M. Stumpf and G. A. E. Vandenbosch, “*MATLAB computational tool for EM Green’s functions in a discretely layered medium,*” computational tool.

* Attach all relevant documentation that specifies your results

FORECAST ACTIVITIES

<Are there any envisaged activities following this secondment project, new collaborations, co directed PhD, etc>

Thanks to the CARE project, the established cooperation between BUT (Brno University of Technology, the Czech Republic) and KUL (Katholieke Universiteit Leuven, Belgium) can be further developed, e.g. through the potential study exchanges as the EU Commission's Lifelong Learning Programme (Erasmus). A new collaboration with the Agilent EESof EDA (Ghent, Belgium) is presently being negotiated.

In order to improve CARE's secondment program, please fill this short questionnaire. Use the space at the end to expand your answers, if needed. Our aim is to improve the general experience for secondees in future.

Disagree < > Agree

GENERAL

My objectives were achieved.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>
The research topics were relevant to my work.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>
I benefited from being part of a wider research culture.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>

HOST ORGANIZATION

I am satisfied with the quality and quantity of supervision I received.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>
I had access to adequate resources to support my research..	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>

SECONDMENT PROGRAM

I would recommend this secondment programme to others.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>
I believe the skills I have learned will help me to improve my job/research.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>
I would apply to another programme similar to CARE.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>
In general, how would you classify the CARE Secondment Programme?	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>

Other questions/comments to be potentially considered: _____

SIGNATURES

Candidate Martin Stumpf

Date: 2012/03/23
(year/month/day)

Signature

M. Štumpf