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## IEEE WAVES: Parallel-MLFMA Solutions of Lge-Scale Probs Involv.Dielectric & Composite Stru

**Start Date:** 7/17/2015    **Start Time:** 10:30 AM  
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#### Event Description:

### Parallel-MLFMA Solutions of Large-Scale Problems Involving Dielectric and Composite Metamaterial Structures

**SPEAKER:** Prof. Levent Gürel  
CEO, [ABAKUS Computing Technologies](#)  
Adjunct Professor, Dept. of ECE  
[University of Illinois at Urbana-Champaign](#)

**DATE:** Friday, July 17, 2015

**TIME:** 10:30 AM

**LOCATION:** Rm: E1-270  
Engineering & Information Technology Complex (EITC)  
University of Manitoba (Fort Garry Campus)



#### ABSTRACT

It is possible to solve extremely large electromagnetics problems accurately and efficiently by using the multilevel fast multipole algorithm (MLFMA) and parallel MLFMA. This has important implications in terms of obtaining the solution of previously intractable physical, real-life, and scientific problems in various areas, such as (subsurface) scattering, optics, bioelectromagnetics, metamaterials, nanotechnology, remote sensing, etc. Accurate simulations of such real-life electromagnetics problems with integral equations require the solution of dense matrix equations involving millions of unknowns. Most recently, we have achieved the solutions of larger than 1,000,000,000x1,000,000,000 (one billion!) dense matrix equations! Solutions of these extremely large problems cannot be achieved easily, even when using the most powerful computers with state-of-the-art technology. Instead, we have been solving some of the world's largest integral-equation problems in computational electromagnetics by employing fast algorithms implemented on parallel computers. For more information: [www.abakus.computing.technology](http://www.abakus.computing.technology).

In this talk, following a general introduction to our work in computational electromagnetics, I will present integral-equation and MLFMA formulations of dielectric/composite structures. Then, I will continue with rigorous modeling of three-dimensional optical metamaterial and plasmonic structures that are composed of multiple coexisting dielectric and/or conducting parts. Such composite structures may possess diverse values of conductivities and dielectric constants, including negative permittivity and permeability. It is possible to formulate and use different types of integral equations depending on which ones have better conditioning properties. I will briefly mention the development of

effective Schur-complement preconditioners specifically for dielectric problems. Solutions of complicated real-life problems involving metamaterial structures, red blood cells, and dielectric photonic crystals will be presented. If time permits, various challenges encountered during the solutions may be touched upon.

## BIO

Prof. Levent Gürel (Fellow of IEEE, ACES, and EMA) received the M.S. and Ph.D. degrees from the University of Illinois at Urbana-Champaign (UIUC) in 1988 and 1991, respectively, in electrical and computer engineering. He worked at the IBM Thomas J. Watson Research Center, Yorktown Heights, New York, in 1991-94. During his 20 years with Bilkent University, he served as the Founding Director of the Computational Electromagnetics Research Center (BiLCEM) and a professor of electrical engineering. He is also an Adjunct Professor at UIUC. Prof. Gürel is the Founder and CEO of ABAKUS Computing Technologies, a company that is geared towards advancing the use of cutting-edge computing technologies for solving difficult scientific problems with important real-life applications and societal benefits. He is conferred the UIUC ECE Distinguished Alumni Award in 2013 and the IEEE Harrington-Mitra Award in Computational Electromagnetics in 2015. He was named an IEEE Distinguished Lecturer for 2011-2014 and is still serving in emeritus capacity. He was invited to address the 2011 ACES Conference as a Plenary Speaker and a TEDx Conference in 2014. Among other recognitions of Prof. Gürel's accomplishments, the two prestigious awards from the Turkish Academy of Sciences (TUBA) in 2002 and the Scientific and Technological Research Council of Turkey (TUBITAK) in 2003 are the most notable. Since 2003, Prof. Gürel has been serving as an associate editor for Radio Science, IEEE Antennas and Wireless Propagation Letters, IET Microwaves, Antennas & Propagation, JEMWA, PIER, ACES Journal, and ACES Express.

## CONTACT US

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