

## Integral Equations and Fast Solution Techniques

Almost all EM areas require general purpose analysis tools: (CEM)

Surface Integral Equations  
Hybrid  
Finite Element-Boundary Integral Systems  
Volume Integral Equations  
Volume-Surface Integral Equations

Integral equations provide robust full-wave characterization

Fast Integral Equation Solver:  
Multilevel Fast Multipole Method

RCS Evaluation/Reduction  
Target Recognition/Database Construction  
RF Circuit Analysis/Design  
EMI/EMC Evaluation  
Wireless Communication Link Design  
Multifunction Antenna Design  
Conformal/Wideband Large Antenna Arrays  
Biological Tissue SOR Prediction  
Inverse Scattering

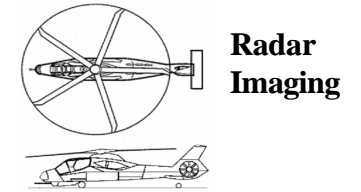
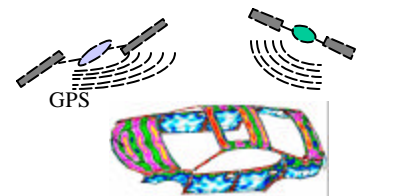
MLFMM provides fast and efficient solution of large real-life problems

## Applications Cover a Broad Range

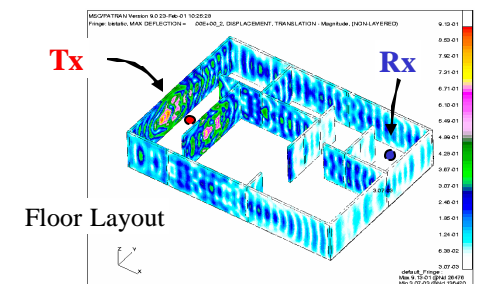


Multifunction Antennas

Satellite Communications



Radar Imaging

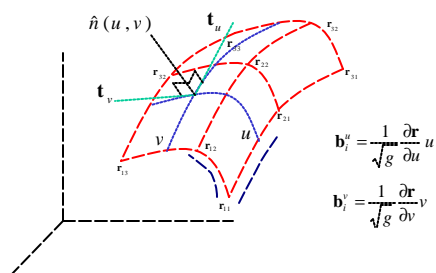


Floor Layout

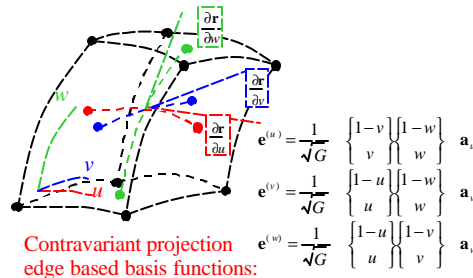
Mobile Communications

## Conformal Geometry Modeling

SIE Basis Functions:  
Bi-quadratic Surface Elements

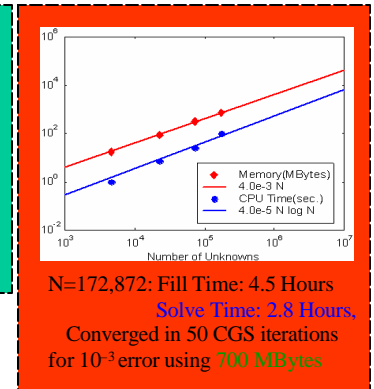
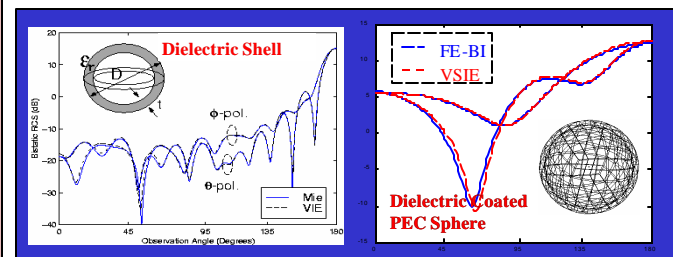
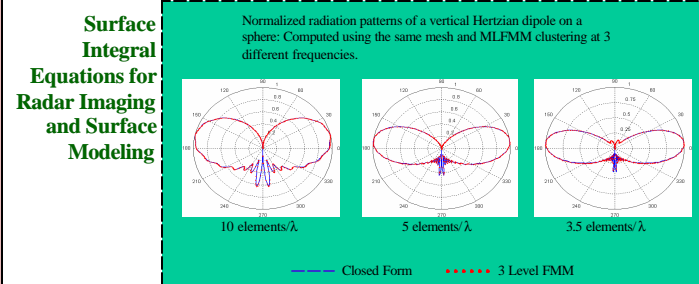


VIE Basis Functions:  
Tri-quadratic Volume Elements



Higher-order elements minimize geometry modeling error, thus may reduce system size.  
Conformal basis functions require careful singularity treatment.  
MLFMM can easily be adapted for conformal modeling.  
Parallel implementations of MLFMM enable solutions of large real-life problems.

## Examples and Performance



MLFMM for Fast Solution

Volumetric Integral Equations for Material Modeling