Transforming metropolitan areas into "smart" cities, one of the focal research areas at the University of Toronto, requires the large-scale deployment of enabling information and communication technologies. From smart-grid monitoring to wireless control of mass transit systems, point of care and public safety applications, these technologies are based on geographically distributed wireless access points. The financial feasibility of installing and maintaining such networks of access points, meeting standards for "green" (energy efficient) and safe (in terms of radiation exposure of the population) operation, depends on the availability of computational planning tools integrating the physics of radiowave propagation with communication theory and network protocol design.

This talk will present recent research on computational electromagnetic techniques formulated to address some of these challenges:
- Hybrid propagation models (combining vector parabolic equation and ray-tracing methods) for train stations and subway tunnels and their use in the deployment of communication-based train control (CBTC) systems, which are aimed at replacing conventional rail signaling with wireless train control enabled by the communication between the train and a network of access points.
- Uncertainty quantification techniques for such models, efficiently incorporating various uncertainties in the geometry specification of real-life models of indoor and outdoor environments; extensions of these techniques for fabrication uncertainties arising in microwave and optical devices will also be discussed.
- Robust optimization methods for multiple-input, multiple-output wireless power transfer systems, illuminating their rich underlying physics and the possibility for "power networking", whereby multiple distributed transmitters would be coordinated to charge multiple devices in a cooperative fashion.