



# Overview of Electromagnetic Engineering Research at the Royal Military College of Canada



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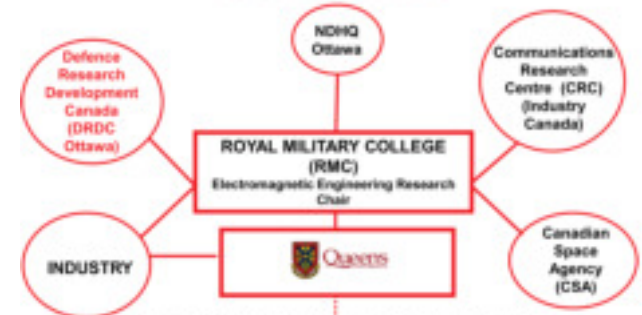
## When Did Engineering Applications of Electromagnetics Start?

Started early:

- 1834 Telegraph (Charles Wheatstone)
- 1876 Telephone
- 1879 Light bulb
- 1886 Hertz's antenna
- 1901 Marconi
- 1906 Radio broadcast
- Reginald Fessend\*  
Father of Radio
- 1930s TV, Radar (WWII)
- 1970... Communications, microwave links, satellites, wireless .....



## Collaborators



At Universities: Canada, U.S.A., Egypt, France and India...

At RMC: Dr. S. Miki (now with Univ. of New Haven, CT, USA)

Dr. S. Podlichak (now with Univ. of Edinburgh)

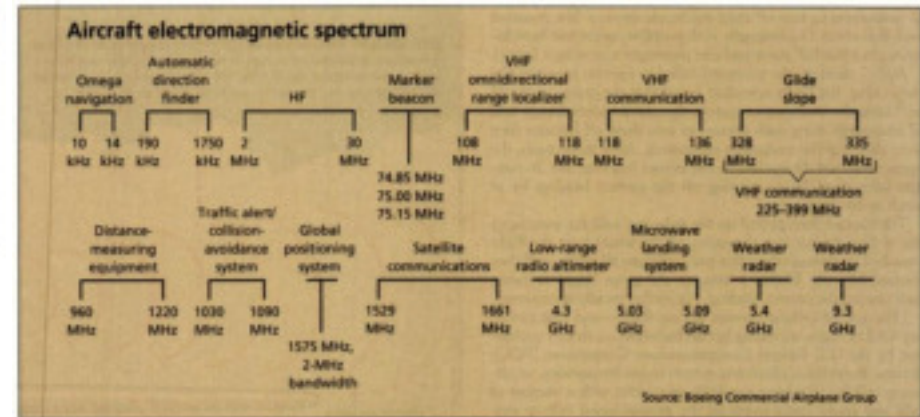
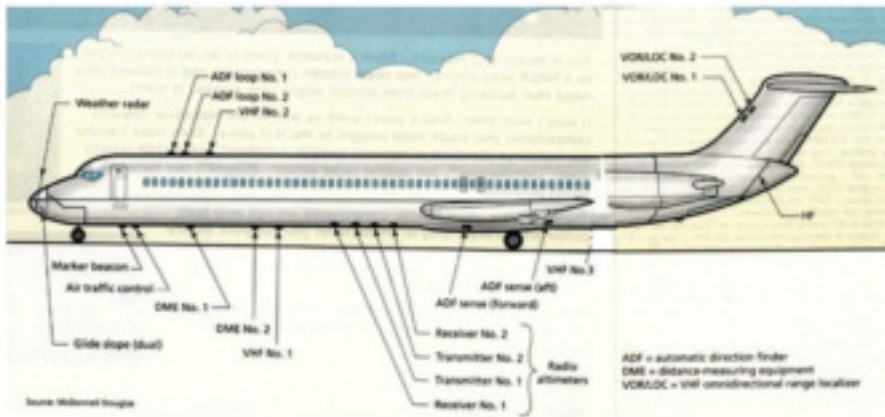
Dr. S. Clauzier, Dr. A. Chaloux, Mr. A. Alzahed, Mina Wahib, Dr. G. Behera  
(Other graduate students and visiting professors)

## RMC, DRDC and CRC Antenna Research



## Antenna and Electromagnetic Research: Why?

- Research leads to **good education**
- Research by-products:
- Technological innovations, new devices, publication of new knowledge, patents...
- Knowledge integration
- Interdisciplinary collaboration in Engineering, Physics, ICT
- Industrial collaboration and technology transfer
- Teamwork: universities (national and international), research institutions, industries
- People integration



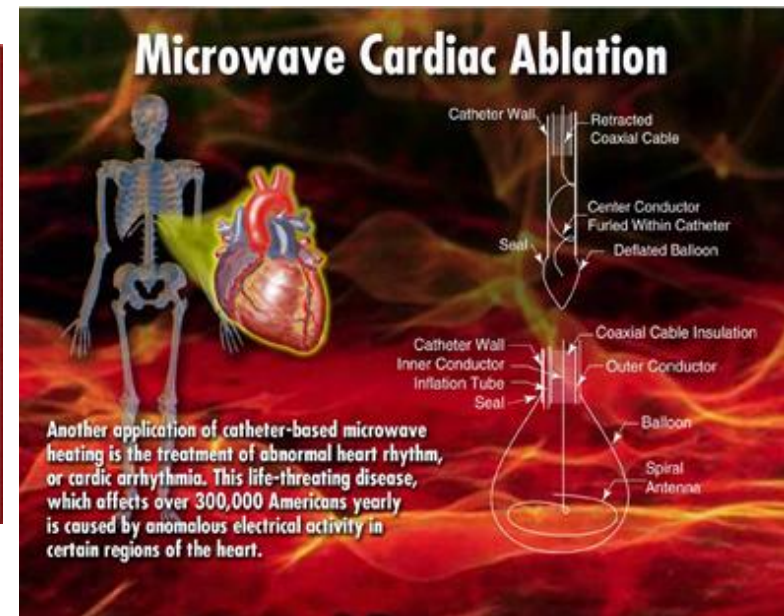
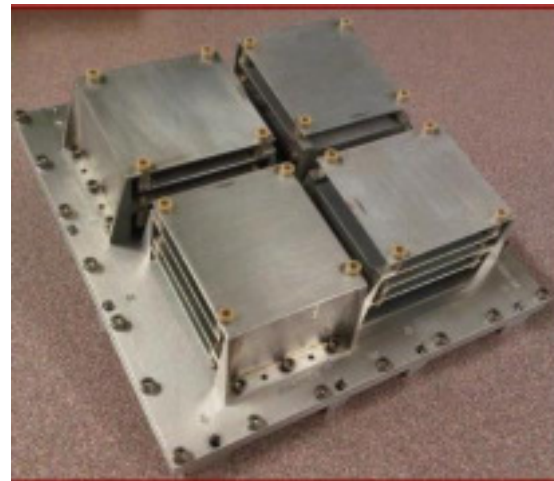
## Crowded Electromagnetic Environment

### An Example of Unique Antenna Design

- Frequency 400 MHz ( $\lambda=75\text{cm}$ )
- Area 15cm x 15cm

**Challenge:** Need a compact, small size antenna with good performance

**Designed at RMC (in collaboration with CRC and COMDEV). Received Best Antenna Design Award at the European Conference on Antennas and Propagation (EuCAP)**

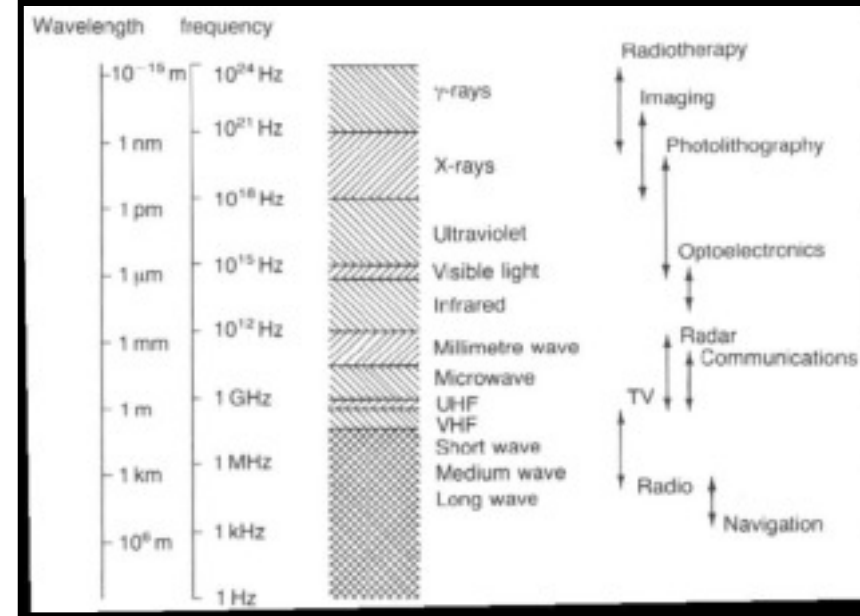




## Topics for IEEE AP Distinguished Lectures

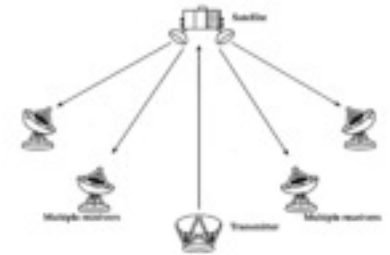
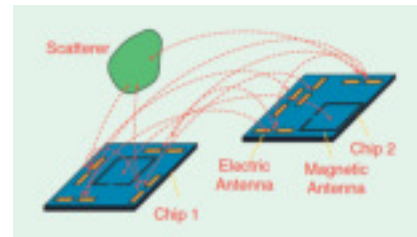
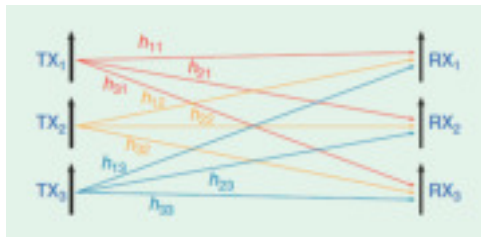
- *Dielectric Resonator Antenna for Wireless and Other Applications*
- *.New Considerations for Antenna Electromagnetic Near Fields*
- *A Class of Printed Leaky Wave Antennas*

## Electromagnetic Waves (Radio Spectrum)



## MIMO (Multiple input Multiple output) Systems

A MIMO system (Multi-Input / Multi-Output) uses the multipath propagation to increase the data transmission and the link range (without additional bandwidth and transmit power).



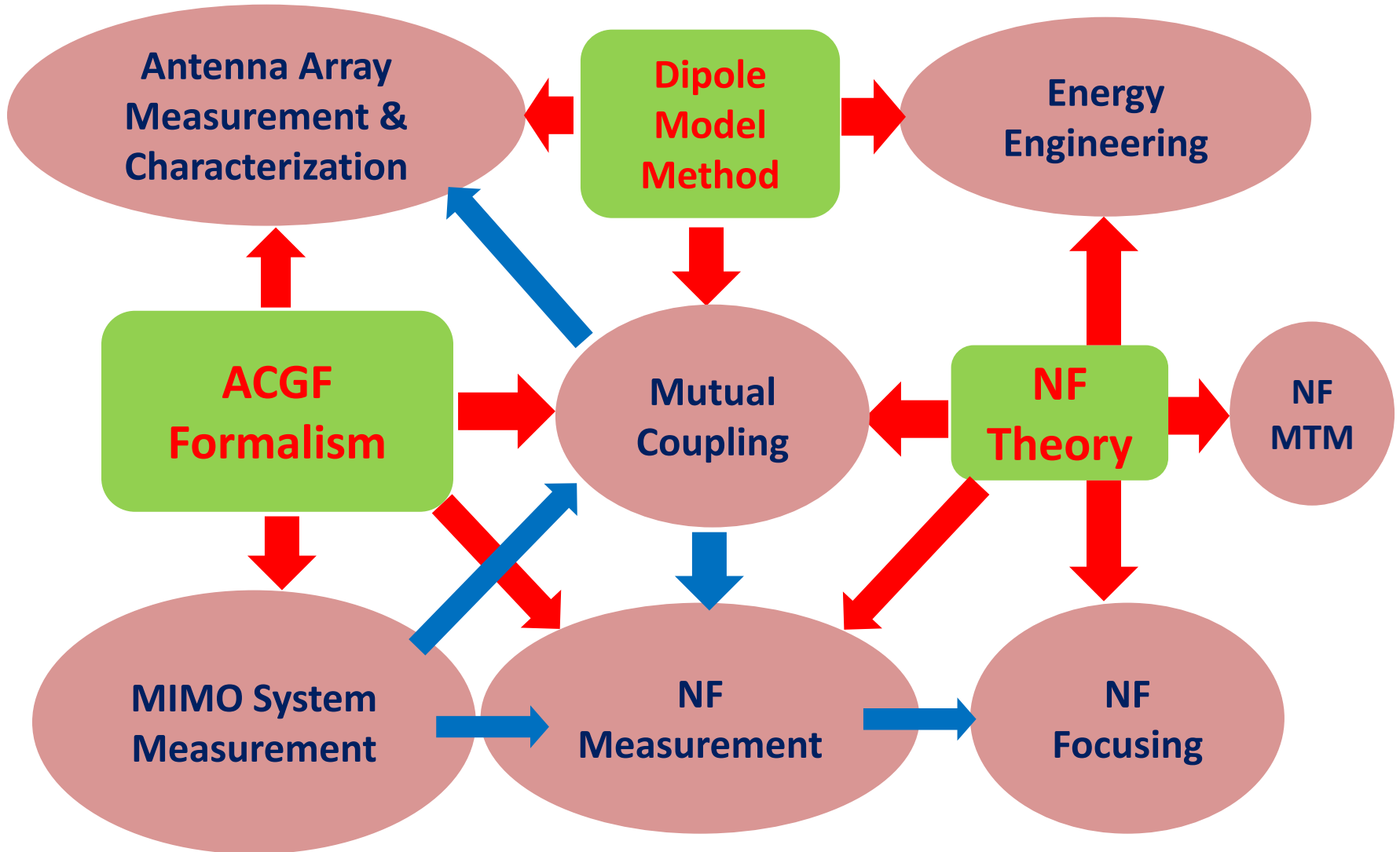
## Main challenges in MIMO systems:

- The mutual coupling between the antenna elements
- Optimization of Space and Location
- Optimization of Current (amplitude and phase)

## LEO (Low Earth Orbiting Satellites) Constellations Phased Array Antennas

- Use many antennas as radiators
- Conventionally limited to military applications.

# Bird's Eye View of Some Recent Progress



Three major developments, and



How they interconnect with Current and Emerging applications