

## **Wireless --- an “Old” Technology Turned Ubiquitous in the Modern World** (無線 – “老”科技在現代社會轉型成無所不在)

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In 1864, Maxwell predicted the existence of the electromagnetic waves by logically examining the known experimental laws: Faraday’s law, Ampere’s law, Gauss law and the charge conservation law. Maxwell’s prediction was verified by Hertz in 1887 when he propagated an electric spark across his laboratory. Within a few years of Hertz’s experiment, Marconi demonstrated the potential application of EM waves for communication by successfully propagating a telegraphic signal across the Atlantic. He coined the term Wireless when he established his Wireless Telegraph and Signal Company in 1897, and wireless communication took off.

For many years, radio signals bouncing off the ionosphere became the main carrier of the global communication networks connecting people and institutions across the Continents. In the 1960’s, when the world moved into the Space Age, satellite communication was introduced which offered faster, better and more reliable services. With this new development, the future of wireless communication was considered very promising.

However, without much warning, the optical fiber came. Broader bandwidth, more secure communication and lower costs of the optical systems made satellite communication a less attractive choice. The world seemed to be moving back to cable communication. For the two decades in the 70’s and 80’s, wireless almost became obsolete. Then mobile communication appeared and all of a sudden, thanks to the miniaturization of the devices, we are in the era of personal communication. Wireless is back. New applications are coming out almost every month. It now seems that people’s communication needs can no longer be satisfied by mobility alone. They require ubiquity which most likely can only be provided by an innovative wireless environment.

The basic physics behind wireless communication is EM wave’s ability to carry energy and information from one point in space (the sender) to another point (the receiver). This attribute of EM waves also makes them a good tool for probing something from a distance. Radar was invented in the 1930’s using precisely this property of the radio waves. Later, this new application of EM waves has developed into a thriving new discipline called Remote Sensing. New active and passive devices and systems have been invented to improve remote sensing capabilities. Nowadays data from various remote sensing techniques and equipments are providing people the necessary information to monitor the status

of the global environment, information vital to our pursuit of the sustainable development of the human society.

Sensors, algorithms and software developed for remote sensing applications can be used to build the wireless environment in one's home, at his work place or any other places he happens to be in. Wireless EM waves will provide him access to Internet, video and audio communications, intelligent utility control, entertainments and many other services any where, any time. They will help him do his job better and live a life with better quality. Just by reading the new IEEE standards for wireless applications, you know this is not futuristic. It is already around the corner.

There is another aspect of the ubiquity of the EM waves. They play a role in many other engineering disciplines, including computer engineering, mechanical engineering, chemical and material engineering, environmental and civil engineering, and bio-medical engineering. Many cutting edge developments in these disciplines such as MEMS, nano- structures, high speed chips, medical imaging and bio-sensors are all related to EM waves.

By now, I hope that I have convinced you that, as a future engineer, you can not afford not to learn electromagnetism, especially the EM waves. I will also let you in on a secret: it actually is fun to learn how EM wave works, with its mathematical beauty and ingenious engineering applications.