received by the antenna in such a way that a picture of the target is obtained. A conventional imaging radar's resolution depends on the wavelength of the energy emitted, the length of its antenna, and the distance of the antenna from the target. Side Looking Airborne Radars (SLARs) have been used extensively in airborne remote sensing. However this type of imaging radar is not practical for a satellite because the antennas would have to be kilometres long in order to identify targets consistent with surveillance requirements. Synthetic Aperture Radar overcomes this problem by utilizing a clever signal processing procedure whereby the Doppler shift of the returning radar wave is used in conjuction with the velocity and orbit position data of the spacecraft, and consequently the effective length, or aperture size, of the antenna appears to be orders of magnitude larger than its physical dimension. A SAR-equipped surveillance spacecraft with an antenna ten to twenty metres long would be able to perform many surveillance tasks because it could provide resolution on the order of one to five metres.[4]

Radar waves penetrate clouds, and the instruments can be used night or day. The first SAR to confirm the potential of imaging the earth from a satellite was SEASAT A, which in its short lifetime gave us a wealth of data on ocean characteristics. Right now Japan and Europe are both developing SAR equipped space missions for commercial remote sensing.

Table 3 summarizes several noteworthy SAR missions:[1,6]

TABLE 3 Satellites with Synthetic Aperture Radars

Mission	*Radar Characteristics*
NASA's SEASAT, launched in June 1978 into an 800 kilometre orbit; it mapped 95% of the world's ocean every 36 hours	L-band*** SAR with a 2.1 by 10.7-metre antenna, yielding resolution of 25 metres by 6 metres along a 100-metre wide swath
Shuttle Imaging Radar (SIR-A), flown in 1981	Modified SEASAT SAR with a 9.4-metre antenna, yielding resolution of 40 metres
European Space Agency's ERS-1, to be launched in 1989 into a 777-kilometre orbit, to provide 36-hour full-earth coverage	C-band SAR with a 1.0 by 10-metre antenna, requiring 4.8 kilowatts of peak power, to yield 30 metre resolution
Japan's ERS-1 (same name) to be launched in 1991 into a 570-kilometre circular orbit	L-band SAR with a 2.4 by 12 metre antenna, requiring 1.0 kilowatt of power, to yield 25 metre resolution

Over the past ten years Canada has been planning Radarsat which was to be a SAR-equipped remote sensing satellite. Generally, the studies recommended a high inclination circular orbit at an altitude between 800 to 1000 kilometres, SAR operation at 5.3 Gigahertz (C band), and ground resolution around 25 metres with a ground swath of approximately 200 kilometres, multiple beams, and a steerable antenna.[6] In May 1986 the Minister of Science and Technology announced that the programme was losing government financial support and industry was challenged to develop a strategy to finance it from the private sector. This activity is now underway. On the other hand, the designs and technology which were developed will also be useful for any derivative programme, including that of a verification mission. Aside from Radarsat, Canada is participating in the European Space Agency's (ESA) ERS-1 program by providing the SAR's ground processing system.

On the airborne side, CCRS contracted a British Columbia firm to develop one of Canada's first SAR systems and it is now being used on CCRS's Convair 580 research aircraft.[16] Side Looking Airborne Radars (SLAR's) have been used extensively in Canada and a number of commercial organizations have developed applications methodology and provide airborne remote sensing services. Other Canadian companies design and build world leading, high performance SLARs.

Multispectral Scanners (MSSs)

These instruments are the mainstay of present remote sensing satellite technology. They are basically electronic cameras which operate in the visible light to near-infrared region, utilizing a number of discrete spectral bands. The motion of the satellite or aircraft is used to sweep the field of view of the MSS over the target. A scanning mirror can also be used. The target is viewed simultaneously in each band, and after data processing, an effective "colour" image is produced. Very often false colours are used to aid interpretation.

Commercial multispectral scanning from satellites began with Landsat A. Landsat's imagery is familiar because of its beauty; Landsat pictures appear frequently in magazines such as *National Geographic*. The programme was transferred from NASA to the National Oceanic and Atmospheric Administration (NOAA) and within the past year was taken over by EOSAT, a private sector corporation. Landsat D, the most recent in the series, has a

*** "L-Band" designates microwaves with wavelengths in the neighborhood of 20 centimetres and "C-Band" designates wavelengths in the neighborhood of 5 centimetres.