

the northern hemisphere occurs twice a day. However, the altitude there will be very high (10,000 to 35,000 km) which, while acceptable for communication satellites, is probably too far above the earth for most roles of surveillance.

### **The Limited Manoeuvring Capability of a Satellite**

It takes a very large rocket on the launching pad to send a comparatively small payload into orbit. A typical case would have 90% of the total weight in the form of rocket fuel, with the eventual payload that goes into low-earth orbit weighing only about 2 or 3% of the original all-up launch weight. This is the fundamental reason why it has not been possible to bring the cost of putting a kilogram of payload into orbit below several thousands of dollars.<sup>31</sup>

If the satellite is to have any residual capability to manoeuvre into a different orbit, some of its very limited weight will have to include a rocket motor and unburnt fuel, leaving correspondingly less weight for whatever primary function the satellite has been sent up to perform. If it is desired to have the satellite pass above some particular place on the earth, and some delay can be accepted, by far the easiest course is to leave the satellite to follow its elliptical trajectory in space, and to wait for the combination of its and the earth's motion to bring them into the wanted relative positions. It is possible to slew certain sensors on board a spacecraft to examine a specific area; however, that area must be within the satellite's field of view.<sup>32</sup>

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<sup>31</sup> "Launching into Low Earth Orbit should be Economical and Routine", *Aviation Week & Space Technology*, 27 November 1989, p. 93. This article places launch costs on the Space Shuttle at \$6,000 - \$10,000 per pound (\$13,200 - \$22,000 per kilogram) and about half that using expendable launch vehicles. Thus the approximate cost of launching a satellite like RADARSAT (weighing around 4,000 kg), using an expendable vehicle, would be in the region of \$40 million. Building the satellite would likely cost very roughly ten times this sum.

<sup>32</sup> The Canadian remote sensing satellite, RADARSAT, will have its sensor slewed to the right during its lifetime except for two occasions when it will be slewed to the left in order to see Antarctica.