# Homework 6 Solution Set

Blake Chapter 12 Questions 1-6
12 points (2 per problem)

1. Compare the following in terms of cost and practical communications distance: (a) repeaters on towers; (b) satellites in low earth orbit; (c) geostationary satellites

   The table below summarizes the characteristics of these systems:

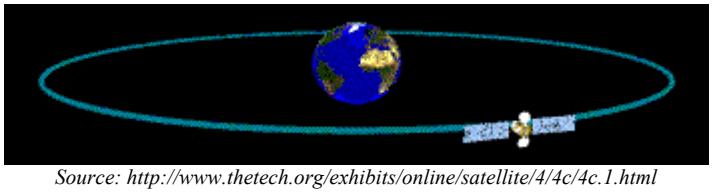
| System | Cost | Typical Coverage (Range) |
|---|---|---|
| Repeater on Tower | Lowest ($10,000 – up) | 50 to 100 mi radius, depending on install height and terrain. |
| LEO Satellite | Medium ($1,000,000 and up) | Coverage of portion of major continent possible, however, satellite-ground relationship is not fixed. Multiple sats needed for consistent coverage. |
| Geostationary Satellite | Highest (unknown cost) | Coverage of most of a hemisphere is possible, with exception of polar regions. |

2. How does the orbital period of a satellite change as it moves farther from the earth?

   According to Kepler's third Law, the orbital period increases as the average radius of the orbit increases: The square of the period of a object's orbit $p$ is proportional to the cube of its semimajor axis $a$ ($p^2 \propto a^3$). (Note that the symbol "$\propto$" means "is proportional to.")

3. Sketch the earth and the orbit of a geostationary satellite, approximately to scale.

   The figure below shows the basic relationship. Geostationary satellites must orbit in the plane of the equator.



*Source: http://www.thetech.org/exhibits/online/satellite/4/4c/4c.1.html*

4. Why do all geostationary satellites orbit the earth at the same distance and above the equator?

   The height of a satellite determines its orbital period $T$. For this period to coincide with the rotational period of the earth, the height must be about 36,000 km.

5. Why are geostationary satellites unusable from earth stations in the polar regions?

Geostationary satellites are not usable from earth stations in the polar regions because the coverage of the geostationary equatorial orbits is "horizon limited" to middle latitudes both above and below the equator.

6. What are the Van Allen belts and what effect do they have on the placement of satellites?

The Van Allen belts are regions of intense radiation located from 1,500 – 5,000 km and 13,000 to 20,000 km above the earth's surface. Satellites can't be orbited within them because the sensitive electronics on board would be damaged by the radiation. Therefore, satellites are placed in three main orbits: LEO ( 300 – 1,500 km ) ; MEO ( 8,000 – 20,000 km); and GEO (36,000 km).