INCLINED ORBITS, CALENDARS AND UNIVERSAL TIME

A study of the general situation of a satellite in an inclined elliptical orbit is complicated by the
A tropical year contains 365.2422 days. In order to make the calendar year, also referred to as the civil year, more easily usable, it is normally divided into 365 days. The extra 0.2422 of a day is significant and for example, after 100 years, there would be a discrepancy of 24 days between the calendar year .
Fact that different parameters are referred to different reference frames.

The orbital elements are known with reference to the plane of the orbit, the position of which is fixed (or slowly varying) in space, while the location of the earth station is usually given in terms of the local geographic coordinates which rotate with the earth.

Rectangular coordinate systems are generally used in calculations of satellite position and velocity in space, while the earth station quantities of interest may be the azimuth and elevation angles and range.
Transformations between coordinate systems are therefore required.

Determination of the look angles and range involves the following quantities and concepts:

1. The orbital elements, as published in the NASA bulletins and described in Sec. 2.6

2. Various measures of time

3. The perifocal coordinate system, which is based on the orbital plane

4. The geocentric-equatorial coordinate system, which is based on the earth's equatorial plane
5. The topocentric-horizon coordinate system, which is based on the observer's horizon plane

The two major coordinate transformations needed are:

- The satellite position measured in the perifocal system is transformed to the geocentric-horizon system in which the earth¶s rotation is measured, thus enabling the satellite position and the earth station location to be coordinated.

- The satellite-to-earth station position vector is transformed to the topocentric-horizon system, which enables the look angles and range to be calculated

2.7 Calendars

The mean sun does move at a uniform speed but otherwise requires the same time as the real sun to complete one orbit of the earth, this time being the tropical year. A day measured relative to this mean sun is termed a mean solar day. Calendar days are mean solar days, and generally they are just referred to as days.

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Julius Caesar made the first attempt to correct for the discrepancy by introducing the leap year, in which an extra day is added to February whenever the year number is divisible by four. This gave the Julian calendar, in which the civil year was 365.25 days on average, a reasonable approximation to the tropical year.

By the year 1582, an appreciable discrepancy once again existed between the civil and tropical years. Pope Gregory XIII took matters in hand by abolishing the days October 5 through October 14, 1582, to bring the civil and tropical years into line and by placing an additional constraint on the leap year in that years ending in two zeros must be divisible by 400 to be reckoned as leap years.

This dodge was used to miss out Gregorian calendar 3 days every 400 years. The resulting calendar is the, which is the one in use today.

2.8 Universal Time

Universal time coordinated (UTC) is the time used for all civil timekeeping purposes, and as a standard for setting clocks.

The fundamental unit for UTC is the mean solar day.

The mean solar day is divided into 24 hours, an hour into 60 minutes, and a minute into 60 seconds.

Thus there are 86,400 ³clock seconds´ in a mean solar day.

Satellite-orbit epoch time is given in terms of UTC. Universal time coordinated is equivalent to Greenwich mean time (GMT), as well as Zulu (Z) time.

Distinction between system is not critical, the term universal time (UT) will be used.
Given UT in the normal form of hours, minutes, and seconds, it is converted to fractional days as

$$UT_{day} = \frac{1}{24}\left(hours + \frac{minutes}{24} + \frac{seconds}{3600}\right)$$

This is converted to degrees as

$$UT^{o} = 360 \times UT_{day}$$