TDMA Frame Structure

A TDMA frame contains the signals transmitted by all of the earth station in a TDMA network. It has a fixed length, and is built up from the burst transmissions of each earth station, with *guard times* between each burst. The frame exists only in the satellite transponder and on the downlinks from the satellite to the receiving earth stations. Figure 6.8 shows a simplified diagram of a TDMA frame for four transmitting earth stations. Each station transmits a preamble that contains synchronization and other data essential to the operation of the network before sending data. The earth station's transmission is followed by a guard time to avoid possible overlap of the following transmission. In GEO satellite systems, frame lengths of 125 μs up to 20 ms have been used, although 2 ms has been widely used by stations using Intelsat satellites. Earth stations must be able to join the network, add their bursts to the TDMA frame in the correct time sequence, and leave the network

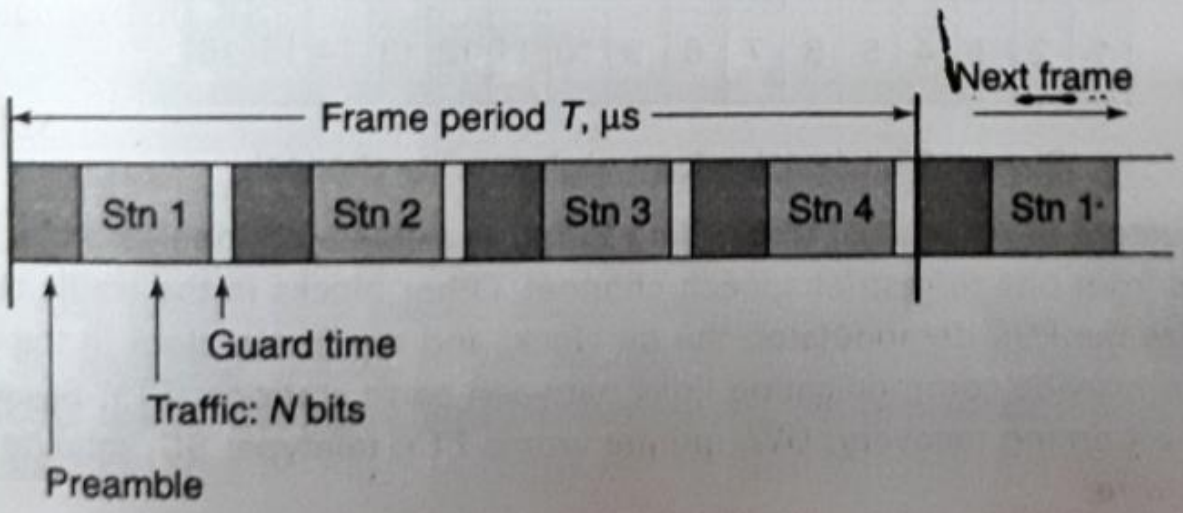

FIGURE 6.8 TDMA frame with four transmitting earth stations.

without disrupting its operation. They must also be able to track changes in the timing of the frame caused by motion of the satellite toward or away from the earth station. Each earth station must also be able to extract the data bits and other information from burst transmissions of other earth stations in the TDMA network. The transmitted bursts must contain synchronization and identification information that help receiving earth stations to extract the required information without error

These goals are achieved by dividing TDMA transmissions into two parts: a *preamble* containing all the synchronization and identification data, and a group of *traffic bits*. Synchronization of the TDMA network is achieved with the portion of the preamble transmitted by each earth station that contains carrier and bit clock synchronization waveforms. In some systems, a separate *reference burst* may be transmitted by one of the stations, designated as the master station. A reference burst is a preamble followed by no traffic bits. Traffic bits are the revenue producing portion of each frame, and the preamble and reference bursts represent *overhead*. The smaller the overhead, the more efficient the TDMA system, but the greater the difficulty of acquiring and maintaining network synchronization. The preamble of each station's burst transmission requires a fixed transmission time. A longer frame contains proportionally less preamble time than a short frame, so more revenue producing data bits can be carried in a long frame. Early TDMA systems were designed around 125 μs frames, to match the sample rate of digital speech in telephone systems, in exactly the same way that T1 24-channel systems operate. A digital telephone channel generates one 8-bit digital word every 125 μs (8 kHz sampling rate), so a 125-μs frame transmits one word from each speech channel. However, it is more efficient to lengthen the frame to 2 ms or longer so that the proportion of overhead to message transmission time is reduced. It must be remembered that a longer frame requires multiple 8-bit words when transmitting digital speech. For example, in a time period of 2 ms, a digital *terrestrial channel* will deliver sixteen 8-bit words, so a 2-ms TDMA frame requires sixteen 8-bit words from each terrestrial channel in each transmitted burst.

Figure 6.9 shows a typical TDMA frame with 2.0 ms duration used by some earth