APPLICATION NOTE 8
STRATUM LEVEL BREAK DOWN

This document breaks down stratum levels and defines minimum performance requirements for digital network synchronization. Clock systems provide a stable frequency source during circuit impairments resulting in the connected equipment not being affected until the clock holdover drift results in a slip. Since occasional slips will always occur, the best one can do is to minimize their rate of occurrence. Through careful network engineering of the clock systems, near perfect timing may be achieved at a reasonable cost with excellent reliability and maintainability.

A stable clock will change a network that experiences problems two or three times a day to one that maintains timing through a major trunk outage. The network will continue to operate without impairment until the outage is repaired, as long as the repair time is comparable to the time of the first frame slip (see Table 1).

The requirements for the stratum levels are shown in Table 1, which provides a comparison and summary of the drift and slip rates for the strata clock systems. Clocks of higher stratum levels can be used to control lower strata levels. In a case where more than one Stratum 1 source is used, it is advisable to trace these clocks back to some other standard to ensure that these sources are accurate.

Stratum	Accuracy	Stability	Pull-In-Range	*Time to first Frame Slip
1	.01ppb	N/A	N/A	72 Days
2	16ppb	.1ppb/Day	16ppb	7 Days
3	1ppm	10ppb/Day	4.6ppm	3.5 Hours
3E	4.6ppm	370ppb/Day	4.6ppm	6 Minutes

* To calculate slip rate from drift, one assumes a frequency offset equal to the above drift in 24 hours, which accumulates bit slips until 193 bits have been accumulated. Drift rates for various atomic and crystal oscillators are not usually linear or not necessarily continually increasing.

Stratum 1 is defined as a completely autonomous source of timing, which has no other input, other than perhaps a yearly calibration. The usual source of Stratum 1 timing is an atomic standard (Cesium Beam or Hydrogen Maser) or reference oscillator (OCXO). A properly calibrated source will provide bit-stream timing that will not slip relative to an absolute or perfect standard more than once every 4 to 5 months. Atomic standards, such as Cesium clocks, have far better performance. A Stratum 1 clock is a Primary Reference Source. An example is: a clock system employing direct control from Coordinated Universal Time (UTC) frequency and time services, such as a Global Positioning System (GPS). The GPS System may be used to provide high accuracy, low cost timing of Stratum 1 quality.

A Stratum 2 clock system tracks an input under normal operating conditions, and holds to the last best estimate of the input reference frequency during impaired operating conditions. Typical examples of Stratum 2 clocks are Rubidium Standards and Double Oven OCXO's.

Stratum 3 is defined as a clock system which tracks an input as in Stratum 2, but over a wider range. Some Stratum 3 clock equipment is not adequate to time SONET network elements. Stratum 3E is a new standard created as a result of SONET equipment requirements.