ATLAS Timing White Paper

Can ATLAS operate with more than one clock source?

The answer to this is YES, but if the clock sources are asynchronous, controlled data slips will occur. The subject of clocking is hardly ever straight forward and some understanding is necessary in order to address this question thoroughly.

T1 Format

T1 is a synchronous data format which does not have any spare bit times nor is it possible to insert any filler bits. This means that just like the water bucket if you are not taking data out exactly as fast as you are putting it in, eventually the data will either overflow or run empty. In the case of T1, we are "filling" ATLAS at 1.536(+/-) megabits per second per T1, and if the rate of the composite data "leaving" ATLAS (through V.35 ports or T1 ports) is not precisely equal (synchronous) to the composite incoming data rate, there will be a data slip. This is true for ATLAS or any system terminating multiple T1's.

Plesiochronous

In the majority of ATLAS applications, the network connections will be synchronous due to being referenced to the same timing hierarchy. If the sources are not from the same timing hierarchy and are not precisely synchronous, this would be called a plesiochronous network. (Plesiochronous is derived from Greek and means almost synchronous). In the past all of the major carriers derived their timing from AT&T and, as a result, were synchronous to each other. Today more are providing their own timing sources which are becoming more and more GPS timing sources. In all cases, in order to meet ANSI quality of service objectives, the major carrier's timing sources are precise, typically +/- 1 x 10^{-11} or better (+/- .000015 bits / second for a T1 or +/-1 bit every 18 hours).

How does ATLAS handle this?

ATLAS must derive its internal timing from only one source. In cases where more than one timing source is used (i.e. two plesiochronous carriers), frame slips will eventually occur on those links not being used as the timing source. With this in mind, ATLAS is designed with controlled slip buffers at each of the T1 interfaces. This allows ATLAS to operate in a controlled and predictable manner. With the slip buffers, when a slip occurs, a frame of data is dropped or duplicated without any loss of T1 frame synchronization.

How do other systems handle this?

Probably in precisely the same way, if designed properly. As stressed earlier, T1 is a synchronous data format without any spare time and as a result any device terminating multiple T1's with different timing sources will experience slips, but with slip buffers, the rate of occurrence and the severity of the disruption can be minimized.

Is this really a problem?

In the real world multiple timing sources from different carriers will not be a problem. As the table below shows, the rate of slips (when using controlled slip buffers) is once every 72 days for two stratum 1 (1×10^{-11}) sources. There is, as usual, a caveat. If the DS-1 service is delivered over SONET, the precision of the source's stratum 1 clock can be degraded by the pointer adjustments which occur in SONET and can result in significant jitter. The result may be an increase in the rate of frame slips. It is preferable in ATLAS, as with any system, to use a source other than SONET as the source of timing.

Probability of Slips in a plesiochronous network

	SOURCE1				
SOURCE2	**Stratum**	**1**	**2**	**3**	**4**
	1	72 days	2 hrs	27 sec	4 sec
	2	2 hrs	65 min	27 secs	4 sec
	3	27 sec	27 sec	13 sec	3 sec
	4	4 sec	4 sec	3 sec	2 sec

Where:
Stratum 1 tolerance = +/- 1×10^{-11}
Stratum 2 tolerance = +/- 1.6×10^{-8}
Stratum 3 tolerance = +/- 4.6×10^{-6}
Stratum 4 tolerance = +/- 3.2×10^{-5}
**ATLAS internal clock tolerance = +/- 2.5×10^{-5}

SUMMARY

In any synchronous T1 application involving multiple sources of clock, any equipment, including ATLAS, will eventually experience slips regardless of the size of data buffers. ATLAS's design is well thought out and accounts for this circumstance in a planned and orderly manner. Other reputable vendors (i.e. Newbridge) state the exact same thing. Based on the use of stratum 1 sources, which the carrier should be using , the rate of slips should be so low that it is not an issue.