Clock Synchronization
In TDM Fiber Transmission

The Problem:

Packet networks, e.g., LANs, operate asynchronously, but TDM networks using T1/E1 or T3/E3 are synchronous networks where a master clock controls the timing. In a TDM network the synchronization between sender and receiver is critical for reliable communications. If the timing of arrival or transmission is off, then the information will be distorted. Regardless of whether voice, data, video, or imaging traffic is being sent on a TDM network, reliable network communication is contingent upon a timed arrival between the two ends.

The Solution:

One way to accomplish synchronization is through bit synchronization. As a digital stream of 1s and 0s is delivered to the line, the timing (or clocking) of the bit is important. The transmitter should be sending bits at the same rate the receiver can take them in. Any difference, faster or slower, could result in lost bits. Therefore, the bits must occur at a fixed time interval.[1]

TDM data is carried over copper lines using either AMI (Alternate Mark Inversion) or B8ZS(Binary 8 Zero Substitution) to encode both the data and clock information. A similar scheme, HDB3 (High Density Bipolar 3), is used for encoding E1 data and clock information. These encoding schemes require a transport medium (copper) which can carry electrical (positive and negative) pulses

Fiber, on the other hand, does not support these schemes. The Metrobility TDM interface, which converts the TDM data stream to fiber, supports a proprietary self-clocking code which translates the zeros and ones using a Pulse Width Modulation (PWM) scheme that converts TDM clock data to a format suitable for very reliable fiber optic communication. *(See page 3 for a more detailed discussion of PWM)*.

[1] Voice and Data Communications Handbook, McGraw-Hill; Bud Bates and Donald Gregory; 1996

The Benefit:

Metrobility's TDM Interface ensures that clock information is encoded along with the data traffic minimizing jitter and ensuring very reliable traffic.

The Radiance TDM Interface is

- Scalable – purchase only the number of connections required, add additional line cards as needed.
- Integrated with data traffic in the same chassis – utilize the same rack space to provide both data and voice traffic.
- Cost effective – eliminate complicated protocols and traffic prioritization.

Product Information

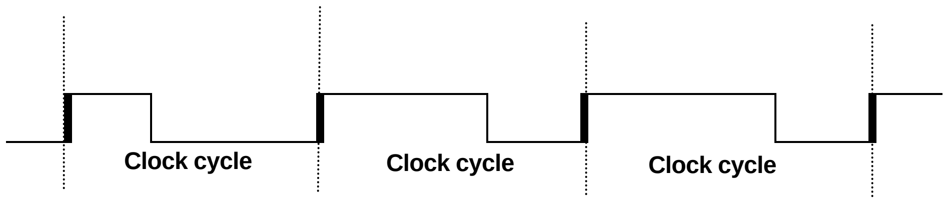
T1/E1 is available in the following models:

Radiance Line Card	Standalone	Description
R105-13	2105-13-01	T1 TP to T1 Fiber MM/SC
R105-14	2105-14-01	T1 TP to T1 Fiber SM/SC
R105-15	2105-15-01	T1 TP to T1 Fiber MM/ST
R105-16	2105-16-01	T1 TP to T1 Fiber SM/ST
R105-17	2105-17-01	T1 TP to T1 Fiber SM/SC LH (40km)
R105-1J	2105-1J-01	T1 TP to T1 Fiber SM/SC EX (100km)
R165-13	2165-13-01	E1 TP to E1 Fiber MM/SC
R165-14	2165-14-01	E1 TP to E1 Fiber SM/SC
R165-15	2165-15-01	E1 TP to E1 Fiber MM/ST
R165-16	2165-16-01	E1 TP to E1 Fiber SM/ST
R165-17	2165-17-01	E1 TP to E1 Fiber SM/SC LH (40km)
R165-1J	2165-1J-01	E1 TP to E1 Fiber SM/SC EX (100km)

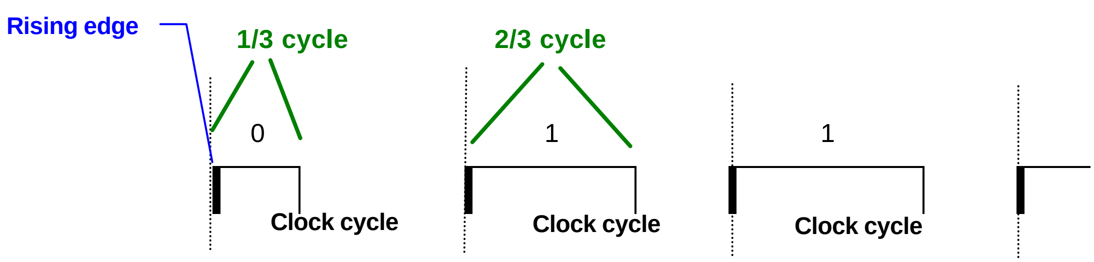
For additional information Metrobility's products, contact Metrobility Optical Systems at 1.877.526.2278 or 1.603.880.1833, or visit us at www.metrobility.com.

Pulse Width Modulation (PWM)

PWM provides a composite pulse for each incoming data bit, ensuring that the original timing information for each bit is transferred and recoverable. The fiber transmitter generates a non-return to zero (NRZ) pulse every clock cycle (648ns for T1 and 488ns for E1).



The rising edge of each pulse is a stable T1 or E1 clock, synchronous to the input and output data clocks. To convert from copper to fiber, the copper port of theT1/E1 interface produces NRZ data and an input clock for the fiber receiver. Using the rising edge of each pulse, PWM codes a "0" as 1/3 of a cycle and a "1" as 2/3 of a cycle as shown below: No synchronizing headers are required, resulting in faster recovery from lost signal error and ensuring timing transparency and the accurate transfer of data.



To convert from fiber to copper, an output clock is produced which identifies the beginning of each cycle and is cleared in the middle of each cycle. The PWM data value is sampled and NRZ output data is generated. During normal operation, the transmit (TX) and receive (RX) paths are clocked independently. If a receive line fails, the TDM interface generates a local clock to keep the transmit line alive.