



data communications

Technology Backgrounder

T1 Environment

1. Overview.....	1
2. F-bit Utilization.....	1
3. T1 Line Signal.....	2
4. T1 Alarm Conditions.....	3
5. 64 kbps Channel Characteristics	3
6. Timeslot Handling	3
7. Unframed Mode.....	4

1. Overview

The T1 line operates at a nominal rate of 1.544 Mbps. The data transferred over the T1 line is organized in frames. Each T1 frame includes 193 bits.

The 193 bits consist of 24 timeslots of eight bits each. An additional timeslot, including one bit (the F bit), carries framing and supervision information. As a result, the data rate supported by each payload timeslot is 64 kbps. The data rate of the framing slot is 8 kbps.

The T1 frame does not include a dedicated timeslot for the transfer of channel signaling. When end-to-end transfer of signaling is necessary, a technique called “robbed-bit signaling” is used. The robbed bit is the least significant bit (bit 8) of the channel byte, and is actually “robbed” only once in every six frames.

In order to enhance link/system supervision capabilities, the frames are organized in larger patterns, called super-frames. Two types of super-frames are used:

- SF (also called D4), consists of 12 T1 frames
- Extended SF (ESF), consists of 24 T1 frames.

The SF format provides limited supervision capabilities such as end-to-end reporting of local loss-of-signal (yellow alarm).

The ESF format provides improved supervision capabilities, and allows better utilization of the 8 kbps framing timeslots. The major advantage of the ESF format is that it supports on-line link performance monitoring (by means of a 2 kbps Cyclic Redundancy Check (CRC) channel) and in addition provides a 4 kbps end-to-end supervision and control data link. The T1 frame format is shown in [Figure 1](#).

2. F-bit Utilization

The implementation of the multiframing format is based on the use of various F-bit patterns. The F-bit pattern is used to perform three functions:

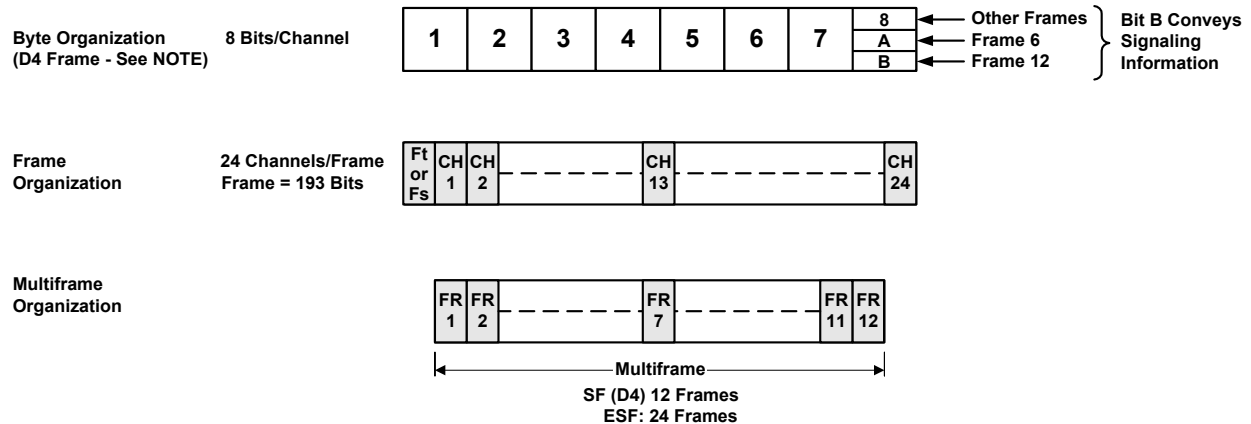
- Framing Pattern Sequence (FPS), defines frame and multiframe boundaries.
- Facility Data Link (FDL), allows transfer of supervisory data, e.g., alarms, error performance, test loop commands, etc., to be passed through the T1 link. When SNMP management is used, the FDL is also used to carry the IP traffic.
- Cyclic Redundancy Check (CRC), allows the measurement of the bit error rate and enhances the reliability of the framing algorithm.

The F-bit pattern defines the structure of frames and multiframes. In the D4 (SF) frame format, the F-bit of consecutive frames is alternately interpreted as an F_t bit (terminal framing bit) or F_s bit (frame signaling bit).

- F_t pattern: alternating 0's and 1's, defines the frame boundaries.

- F_s pattern: fixed 001110 pattern, defines the multiframe boundaries, so that one frame may be distinguished from another. In particular, the F_s pattern is needed so that frames 6 and 12 may be identified to enable recovery of signaling bits.

In the ESF frame format, the multiframe structure is extended to 24 frames, but the frame and channel structure are the same as in the D4 (SF) format.



NOTE:
In addition, ESF has a C-bit in frame 18 and a D-bit in frame 24

Figure 1. T1 Frame Format

3. T1 Line Signal

The basic T1 line signal is coded using the alternate mark inversion (AMI) rules. In the AMI format, “ones” are alternately transmitted as positive and negative pulses, whereas “zeros” are transmitted as a zero voltage level. The AMI format cannot transmit long strings of “zeros”, because such strings do not carry timing information. Therefore, the AMI signal source must generate a signal with guaranteed minimum “ones” density.

The minimum average “ones” density is 1:8, so when a T1 signal is transmitted over an AMI line each frame timeslot must include at least one “1” bit. In certain applications, this would effectively reduce the data rate available to the user to only 56 kbps per timeslot, and would preclude the provision of clear channel capability (CCC). To circumvent this problem, modified line codes, which perform zero suppression by substituting special codes for long strings of “zeros”, are used.

A widely used zero suppression method is B8ZS. The B8ZS zero suppression method provides clear channel capability, and the “ones” density requirement no longer restricts user data characteristics. This means that each T1 frame timeslot can support the full 64 kbps.

4. T1 Alarm Conditions

The basic alarm conditions are the red alarm and the yellow alarm.

Red Alarm – A red alarm is generated when the local unit has lost frame synchronization for more than 2.5 consecutive seconds. Loss of frame synchronization may be caused by F_s or F_t errors, by the reception of an AIS signal, or by the loss of the input signal.

In accordance with AT&T TR-62411, a system automatically recovers synchronization when there has been a period of 10 to 20 consecutive seconds free of the loss of sync condition.

Yellow Alarm – A yellow alarm is sent from the remote unit to inform the local unit that a red alarm exists at the remote end.

Alarm indication signal (AIS) – The AIS signal is an unframed “all-ones” signal, and is used to maintain line signal synchronization when an alarm condition occurs in the equipment that supplies the line signal.

5. 64 kbps Channel Characteristics

Timeslots 1 through 24 carried by the T1 frame are available to the user. The timeslots may be used as transparent data carriers for fractional T1 data, or for audio (voice) transmission. When voice digitizing is made by PCM, ITU-T Rec. G.711 recommends that in T1 systems the non-linear encoding law designated the μ -law be used

The selected signaling transfer mode (common channel signaling - CCS, or channel associated signaling - CAS) applies to all the channels. The selection of a signaling transfer mode affects the transfer of the channel bits, a characteristic of importance in applications in which a trunk carries data channels together with voice channels:

- In the CCS mode, the bits are transparently transferred.
- In the CAS (robbed bit signaling) mode, the signaling information overwrites the least significant bit of the channel once in every six frames.

Thus, when signaling must be transferred for data channels, it is necessary to implement the system using CCS (this requires reserving a timeslot for the transfer of the CCS data).

6. Timeslot Handling

When operating in any of the framed modes, T1 devices allow the user to configure the routing of the individual timeslots for each channel. The routing can be modified during system operation, without disrupting the service to users of timeslots that are not rerouted. The routing capabilities depend on the port type:

- You can specify, for each timeslot, the payload type (voice or data) carried in the timeslot. This enables correct handling of timeslots and of the associated

signaling information during alarm conditions.

To expedite routing, the following “bundle” routing modes are supported:

- Sequential “bundle” routing mode (B8ZS line coding): one “bundle” (group of consecutive timeslots, identified by the number of the starting timeslot and the total number of timeslots) can be routed to the corresponding main link timeslots, where they are inserted in the main link frame sequentially, in consecutive timeslots.
- Alternate “bundle” routing, which is similar to the sequential mode, except that only every second timeslot within the bundle of timeslots specified by the user is actually connected.

This limits the total capacity to a maximum of 12 out of the 24 slots of a T1 frame, which is equivalent to a maximum user data rate of 672 kbps for 56kbps per timeslot, and 768 kbps for 64 kbps per timeslot. In this case, a special user selected code is transmitted in the free timeslots.

- For data channels, the user can either individually select the main link timeslots in which the user’s data is to be inserted, or can use the “bundle” routing mode. Timeslots connected to data channels are always defined as data timeslots.

7. Unframed Mode

In the unframed mode, the data stream is transferred transparently at 1544 kbps.