

SDH Telecommunications Standard

► Primer

Automatic Protection Switching

Automatic Protection Switching (APS) is the capability of a transmission system to detect a failure on a working facility and to switch to a standby facility to recover the traffic. This capability has a positive effect on the overall system availability.

Only the Multiplex Section in SDH is protected in this automatic fashion. The Multiplex Section protection mechanisms are coordinated by the K1 and K2 bytes in the Multiplex Section Overhead. Path protection is managed at a higher level by network management functions.

Multiplex Section Protection, K1/K2 Bytes

In SDH, the transmission is protected on optical sections from the Near End (the point at which the MS Overhead is inserted) to the Far End (the point where the MS Overhead is terminated).

Bytes K1 and K2 in the MS Overhead of the STM-1 signal carry a Multiplex Section Protection (MSP) protocol used to coordinate protection switching between the Near End and the Far End.

Protection switching is initiated as a result of one of the following situations:

- Signal failure
- Signal degradation
- In response to commands from a local craft terminal or a remote network manager

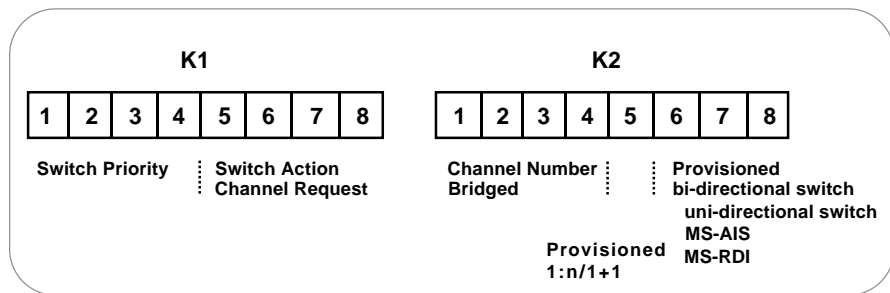
Two modes of APS are provided: 1+1 protection switching and 1:N protection switching.

The K1 byte (see Figure 16) contains both the switching pre-emption priorities (in bits 1 to 4), and the channel number of the channel requesting action (in bits 5 to 8).

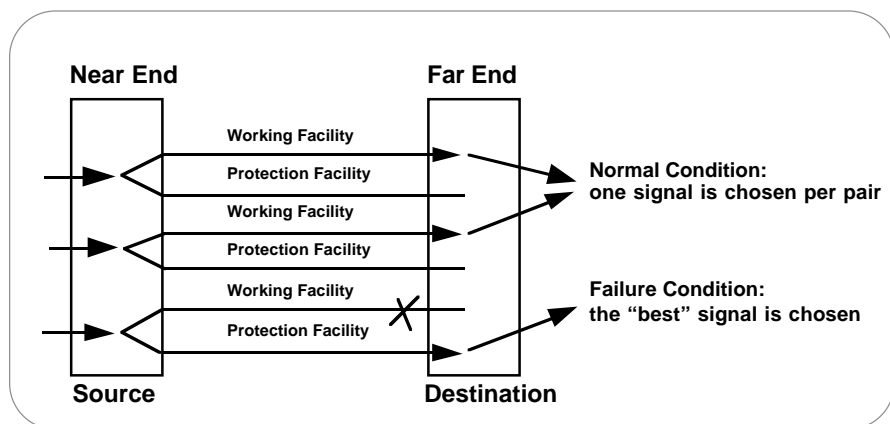
The K2 byte contains the channel number of the channel that is bridged onto protection (bits 1 to 4), and the mode type (bit 5); as well, bits 6 to 8 contain various conditions such as MS-AIS, MS-RDI, indication of uni-directional or bi-directional switching.

1+1 Protection

In 1+1 protection switching, there is a protection facility (backup line) for each working facility (see Figure 17).



► **Figure 16.** APS/ MSP, K1/K2 byte functions.



► **Figure 17.** 1+1 protection switching.

At the Near End of the section, the optical signal is bridged permanently (split into two signals) and sent over both the working and the protection facilities simultaneously, producing a working signal and a protection signal that are identical.

At the Far End of the section, both signals are monitored independently for failures. The receiving equipment selects either the working or the protection signal. This selection is based on the switch initiation criteria which are either a signal fail (hard failure such as the loss of frame (LOF) within an optical signal), or a signal degrade (soft failure caused by the error rate exceeding some pre-defined value).

Normally, 1+1 protection switching is uni-directional, although if the line terminating equipment at both ends support bi-directional switching, the uni-directional default can be overridden.

Switching can be either revertive (the flow reverts to the working facility as soon as the failure has been corrected) or non-revertive (the protection facility is treated as the working facility).

In 1+1 protection architecture, all communication from the Near End to the Far End is carried out over the APS channel, using the K1 and K2 bytes. In 1:1 bi-directional switching, the K-byte signaling indicates to the Near End that a facility has been switched so that it can start to receive on the now active facility.

1:N Protection

In 1:N protection switching, there is one protection facility for several working facilities (the range is from 1 to 14). In 1:N protection architecture, all communication from the Near End to the Far End is carried out over the APS channel, using the K1 and K2 bytes. All switching is revertive; that is, the traffic reverts to the working facility as soon as the failure has been corrected.

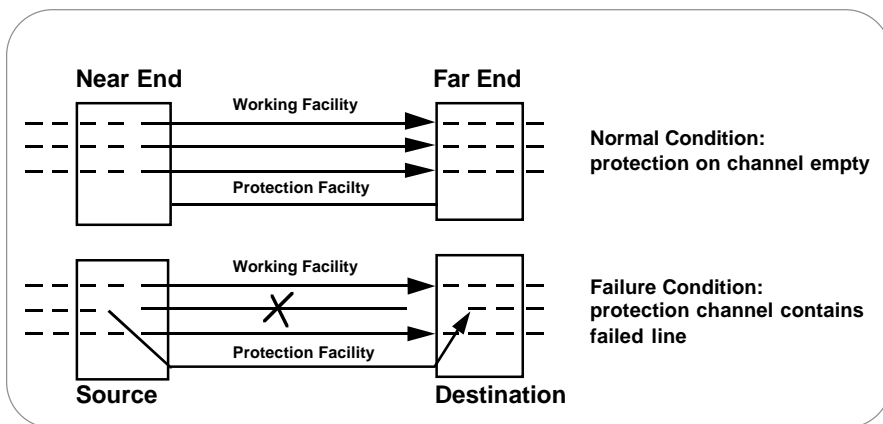
In 1:N protection switching, optical signals are normally sent only over the working facilities, with the protection facility being kept free until a working facility fails. Let's look at a failure in a bi-directional architecture (see Figure 18). Suppose the Far End detects a failure on working facility 2. The Far End sends a message in bits 5 to 8 of the K1 byte to the Near End over the protection facility requesting switch action. The Near End can act directly, or if there's more than one problem, the Near End decides which is top priority. On a decision to act on the problem on working facility 2, the Near End carries out the following steps:

1. Bridges working facility 2 at the Near End to the protection facility.
2. Returns a message on the K2 byte indicating the channel number of the traffic on the protection channel to the Far End.
3. Sends a Reverse Request to the Far End via the K1 byte to initiate bi-directional switch.

On receipt of this message, the Far End carries out the following steps:

1. Switches to the protection facility to receive.
2. Bridges working facility 2 to the protection facility to transmit back.

Now transmission is carried out over the new working facility.



▶ **Figure 18.** 1:N protection switching.