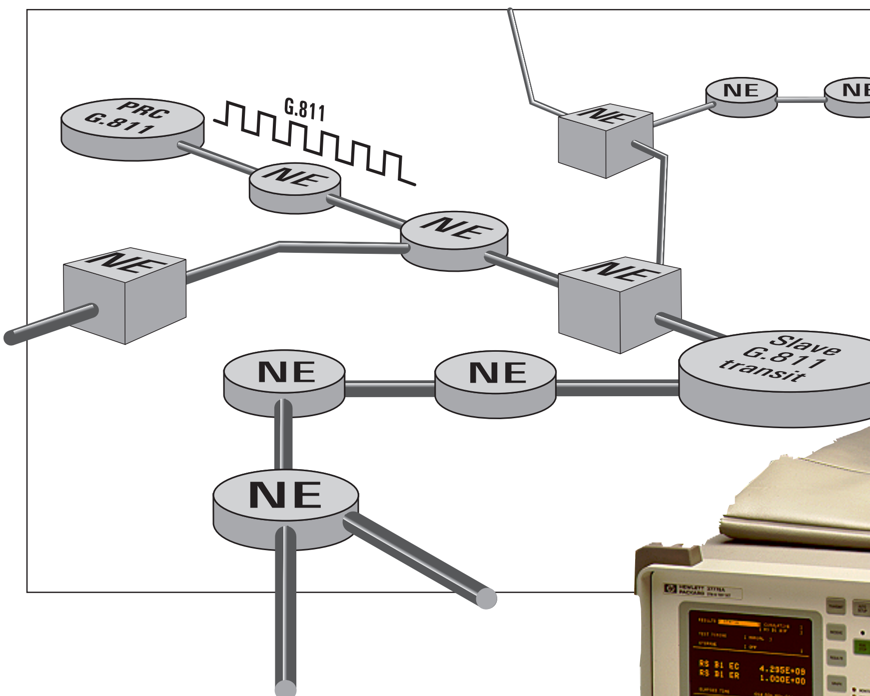
Avoiding synchronization problems in SDH networks

Product note

HP 37778A
STM-16/OC-48 test set



Network synchronization is a fundamental issue facing installers and maintainers of SDH equipment. Increasingly complex SDH networks have placed even greater demands on network-wide synchronization, where transmission quality is directly related to the accuracy and performance of network timing.

A timing hierarchy where the primary reference clock (master clock) is poorly distributed to network elements (NEs) lower down the hierarchy can seriously impact network performance. At best, there may be an increase in pointer activity resulting in increased tributary jitter as pointer hits filter down through the network. At worst, excessive pointer activity may lead to the corruption or even loss of payload data.

This application note describes the key measurements required to ensure network synchronization is maintained and discusses the reasons for performing them.

Checking the timing distribution and synchronization of SDH networks

Introduction

Failure to efficiently distribute timing information around an SDH network contributes to the introduction of jitter and wander. This inevitably undermines the network's synchronization performance.

There are two key elements to precise and reliable SDH network synchronization. The first is an accurate primary reference clock (PRC); the second is ensuring that timing information from the PRC is routed accurately to all nodes in the network.

Timing information in an SDH network is typically distributed around the network from the PRC via a network reference chain (see figure 1). The chain comprises transit or local nodes with chains of NEs connected between them. Each clock throughout the chain derives its timing information from the optical carrier.

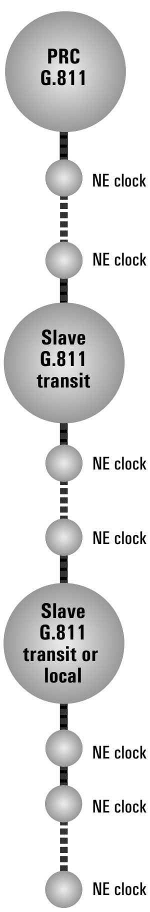


Figure 1: SDH synchronization network reference chain. Maximum number of PRC slaves allowed is 10. Maximum number of NE clocks between slaves is 20 with the total number in the network limited to 60.

Checking that the PRC provides the elements in the chain with precise timing information requires three separate tests:

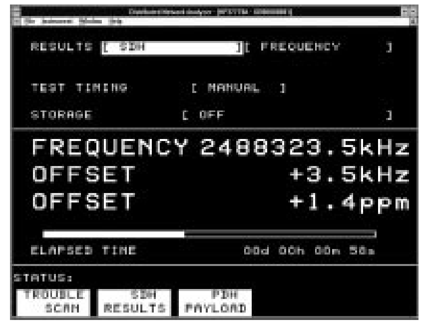
- Line frequency measurents to identify the accuracy of an NEs timing source.
- Monitoring of pointer activity to provide an early indication of deterioration of timing integrity.
- Decoding of the synchronization status byte (S1 byte) to help pinpoint breaks in the timing chain.

Line frequency measurements

Measuring the SDH line rate from an NE provides an indication of how accurate its timing source is. A large frequency offset from the nominal line frequency indicates that the NE has lost tracability to the PRC.

Measuring the SDH line frequency requires that an SDH test set is connected to a suitable monitor point in the network. If no monitor point is available, an optical splitter must be used.

To display the STM-16 line frequency and line offset of the NE's signal using the HP 37778A STM-16/OC-48 test set, select 'results' and 'frequency measurement' on the results screen shown above.



A reading of 2.48832 Gb/s ± 4.6 ppm indicates that the NE is within the timing constraints that the network requires. A reading of >4.6 ppm could, however, indicate a break in the timing chain from the PRC. Decoding the synchronization status byte (the S1 byte in the path overhead section of the SDH signal) at the point of frequency drift will provide more insight into the reason for the drift in accuracy.

Pointer analysis

Although simple line frequency checks are useful for identifying timing problems, not all timing problems are visible at the line rate. For example, an STM-16 signal running at the nominal line rate does not provide any information on the health of the sixteen STM-1 tributaries carried within the higher rate signal.

Checking pointer activity is the only indication that a poorly synchronized STM-1 is carried within the STM-16 signal. Occasional positive and negative adjustments are expected during normal network operation as NEs compensate for differences in their phase and frequency. However, if excessive pointer activity is present in a tributary, then jitter hits are passed down to the destination of that tributary signal resulting, typically, in payload errors.

Using an HP 37778A STM-16/OC-48 test set, it’s possible to check pointer activity on all sixteen STM-1 tributary signals simultaneously. Simply select 'results' and 'pointer values' from the results screen and monitor the condition of any STM-1 pointer.

Once a problem tributary is identified further troubleshooting can be performed at the tributary level to correct the fault and remove any jitter hits.

Synchronization status decode

Network synchronization is now so important that the ITU-T have defined a synchronization status byte, the S1 byte (see ITU-T Recommendation G.707), in the multiplexer overhead section of the SDH signal. The byte is used to convey information about the quality of timing signals passing between NEs (see Table 1). In addition, decoding the S1 byte sent by an NE quickly identifies the timing source for that NE. When an NE is timed directly from a PRC, the decoded S1 byte message is “G.811”, indicating the NE is receiving its timing from a PRC that conforms to IUT-T Rec. G.811.

When the NE is timed indirectly from the PRC, the decoded S1 byte is “G.812” indicating the NE is receiving timing from a slave of the PRC which conforms to ITU-T Rec. G.812. If there is a break in the synchronization chain, the S1 byte message is “quality unknown” or “do not use for synchronization”. By definition, this almost certainly means troubleshooting to find out where in the network timing distribution has broken down.

Using an HP 37778A STM-16/OC-48 test set, the S1 byte can be automatically decoded to determine the S1 byte message. To do this, select 'results' and 'S1 byte decode' from the receiver screen as shown opposite.

By tracing back through the network and reading the S1 byte status, the point of breakdown of synchronization can easily be identified and corrected.

Automatic decode of the S1 byte provides a valuable time-saving aid to verifying the timing integrity of an NE and detecting where the synchronization chain is broken.

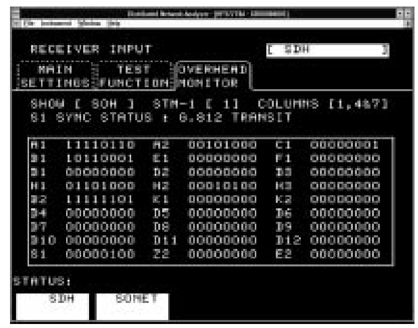


Table 1: S1 byte definition

S1 byte definition		
Bits b5-b8	**Decoded message**	**Description**
0000	Quality unknown	Not a recognized timing reference
0001	Reserved	For future use
0010	G.811	NE timed from PRC conforming to G.811
0011	Reserved	For future use
0100	G.812 transit	NE timed from transit PRC slave conforming to G.812
0101	Reserved	For future use
0110	Reserved	For future use
0111	Reserved	For future use
1000	G.812 local	NE timed from local PRC slave conforming to G.812
1001	Reserved	For future use
1010	Reserved	For future use
1011	Synchronous	NE timed from synchronous source equipment timing source
1100	Reserved	For future use
1101	Reserved	For future use
1110	Reserved	For future use
1111	Do not use for synchronization	NE not timed from a recognised timing source

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HP 37778A STM-16/OC-48 test set

Offers a field-portable solution for the installation and maintenance of SONET and SDH network equipment operating at 2.488 Gb/s. It provides electrical interfaces at 155.52 Mb/s (STS-3/STM-1) along with electrical and optical interfaces at 2.488 Gb/s (STS-48/STM-16). Test capability includes comprehensive analysis of embedded overhead bytes, multiplexer tributary/line testing at STS-3/STM-1 and STS-48/STM-16 with mapped 2, 34 and 140 Mb/s payloads, 2.488 Gb/s thru-jitter and measurement, non-intrusive monitoring of live traffic and detection of alarms, simultaneously, at the STS-3/STM-1 and STS-48/STM-16 level. Testing at 1310 nm or 1550 nm is also supported.

Related literature

- HP 37778A product overview, 5965-7588E
- HP 37778A technical specifications, 5962-5273E
- HP 37778A configuration guide, 5965-7587E

Other references/trademark acknowledgments

ITU-T G.707 network node interface for the synchronous digital hierarchy (SDH).

Synchronizing the ring and chains of SDH (Telecom Solutions 1994).

Timing solutions for communications networks (Hewlett-Packard June 1996)

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Printed in USA
Data subject to change
5965-4910E (2/97)