Tandem Connection Monitoring

The principle of TCM

TCM analysis

White Paper

July 99

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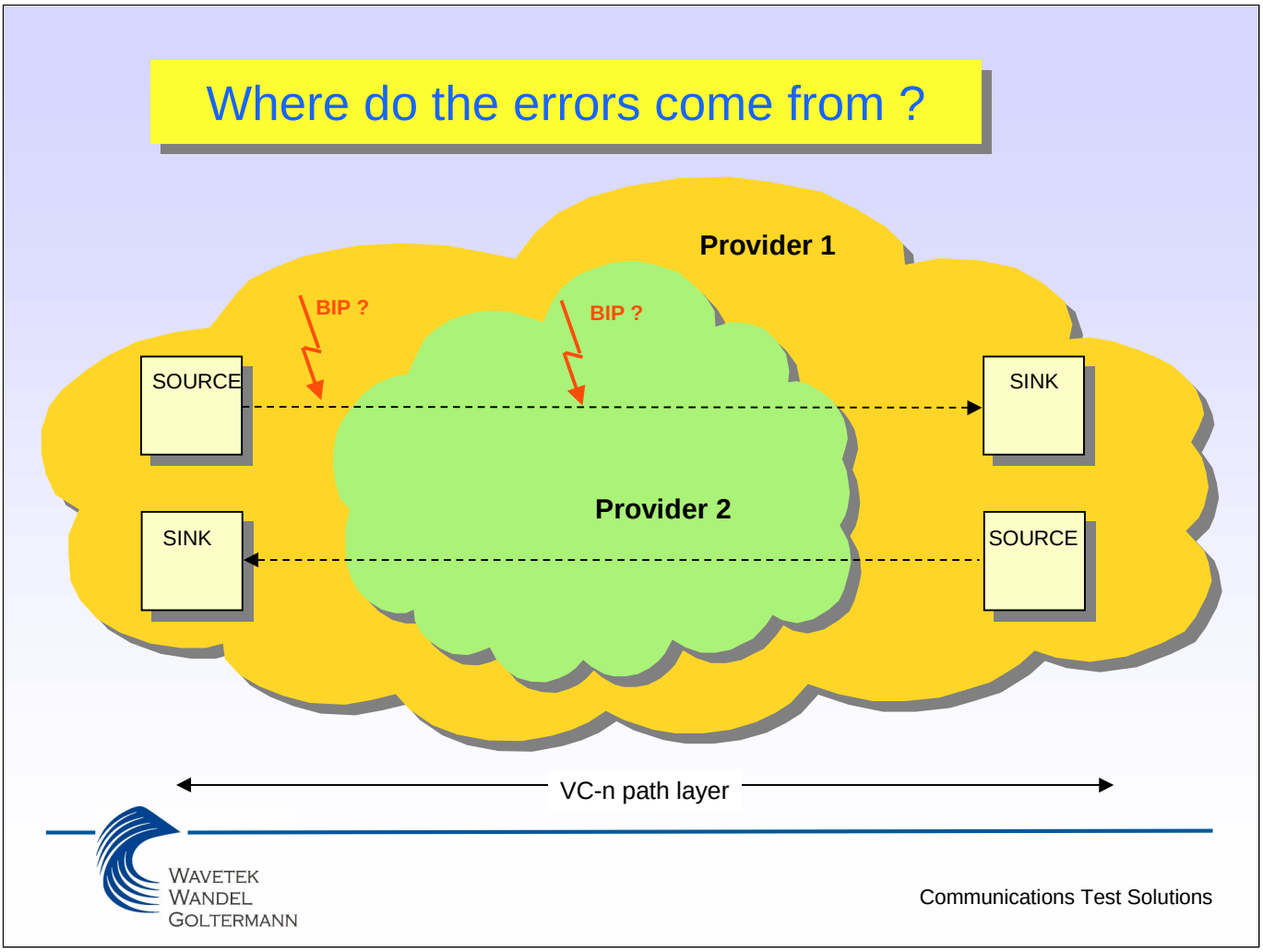


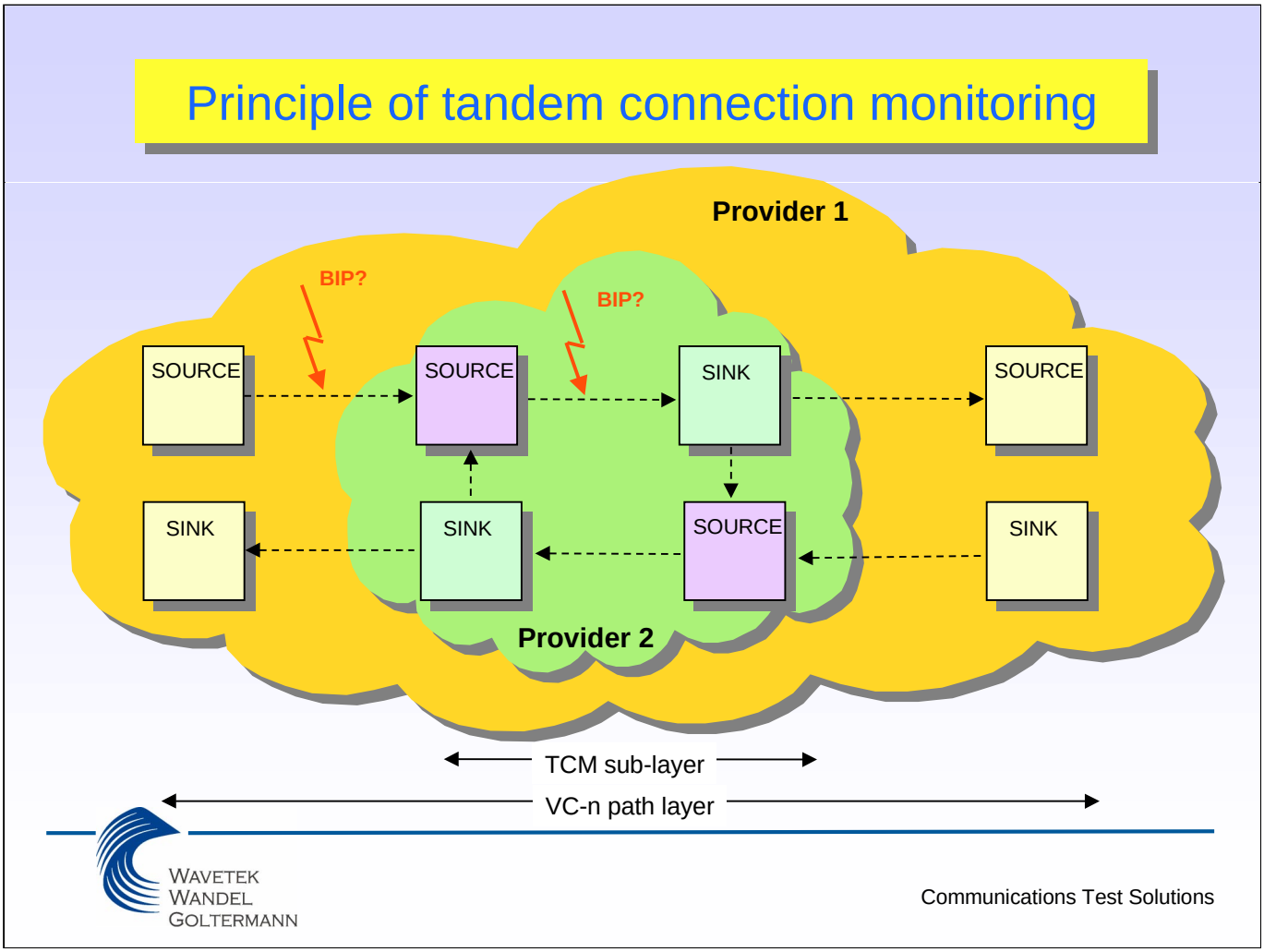
Where do the errors come from?

End-to-end quality is monitored by checking BIP parity. This gives an indication of whether errors have been generated somewhere in the entire path.

It is not possible to determine in which part of the path the error occurred.

If a sub-network provider is present (provider 2), there will always be disputes over who produced the errors on the way through the network.

An additional possibility allowing sub-network providers to demonstrate the quality of their networks from the point of receiving to the point of transmitting the signal from their network limits was therefore looked for.

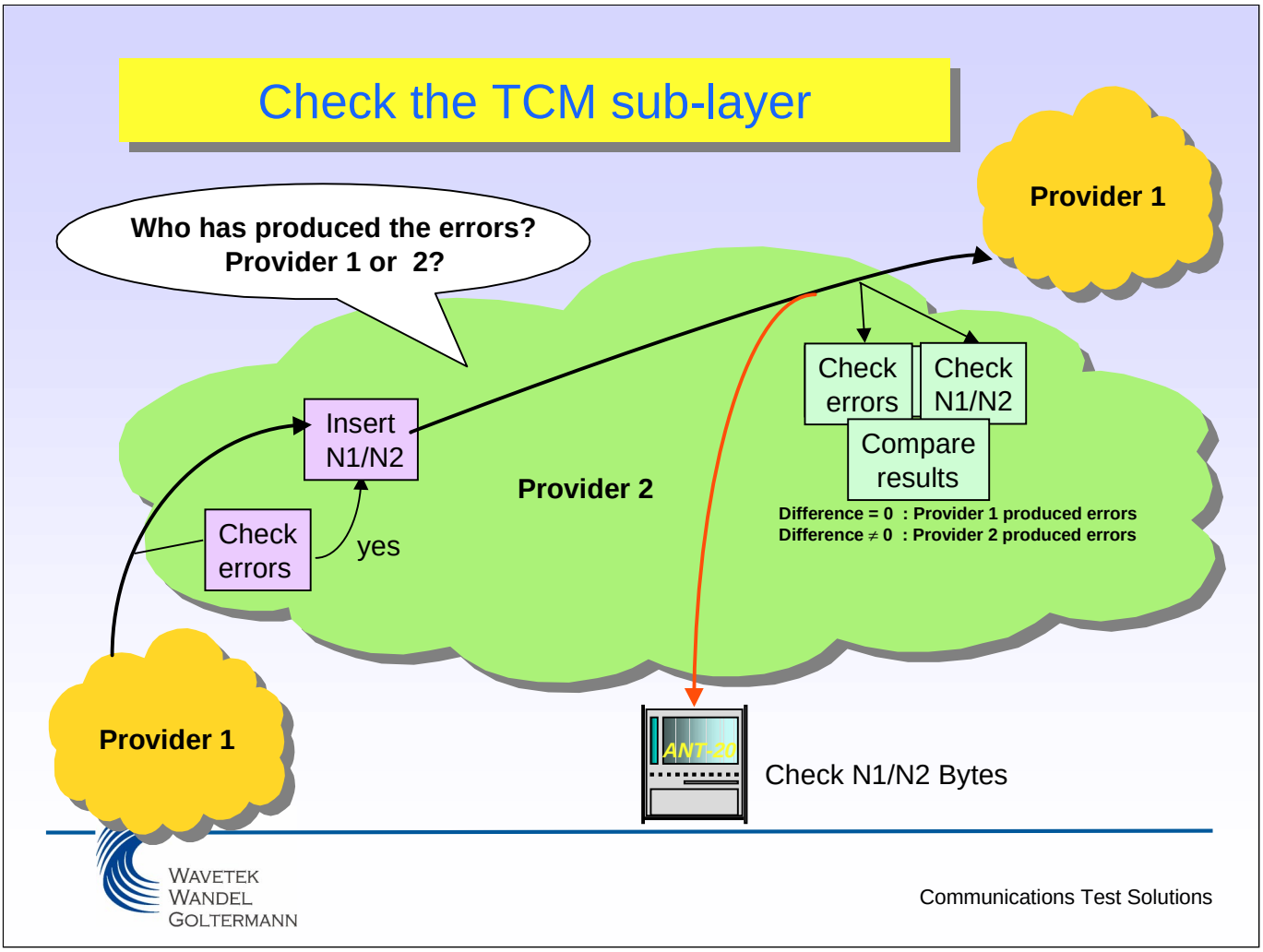


Principle of tandem connection monitoring

"Tandem Connection Monitoring" was introduced for this reason.

The principle is very simple:
The incoming and outgoing data streams (SINK and SOURCE) are each monitored at the network limits.

This allows network provider 2 to monitor own errors in the path layer independently of any received errors.

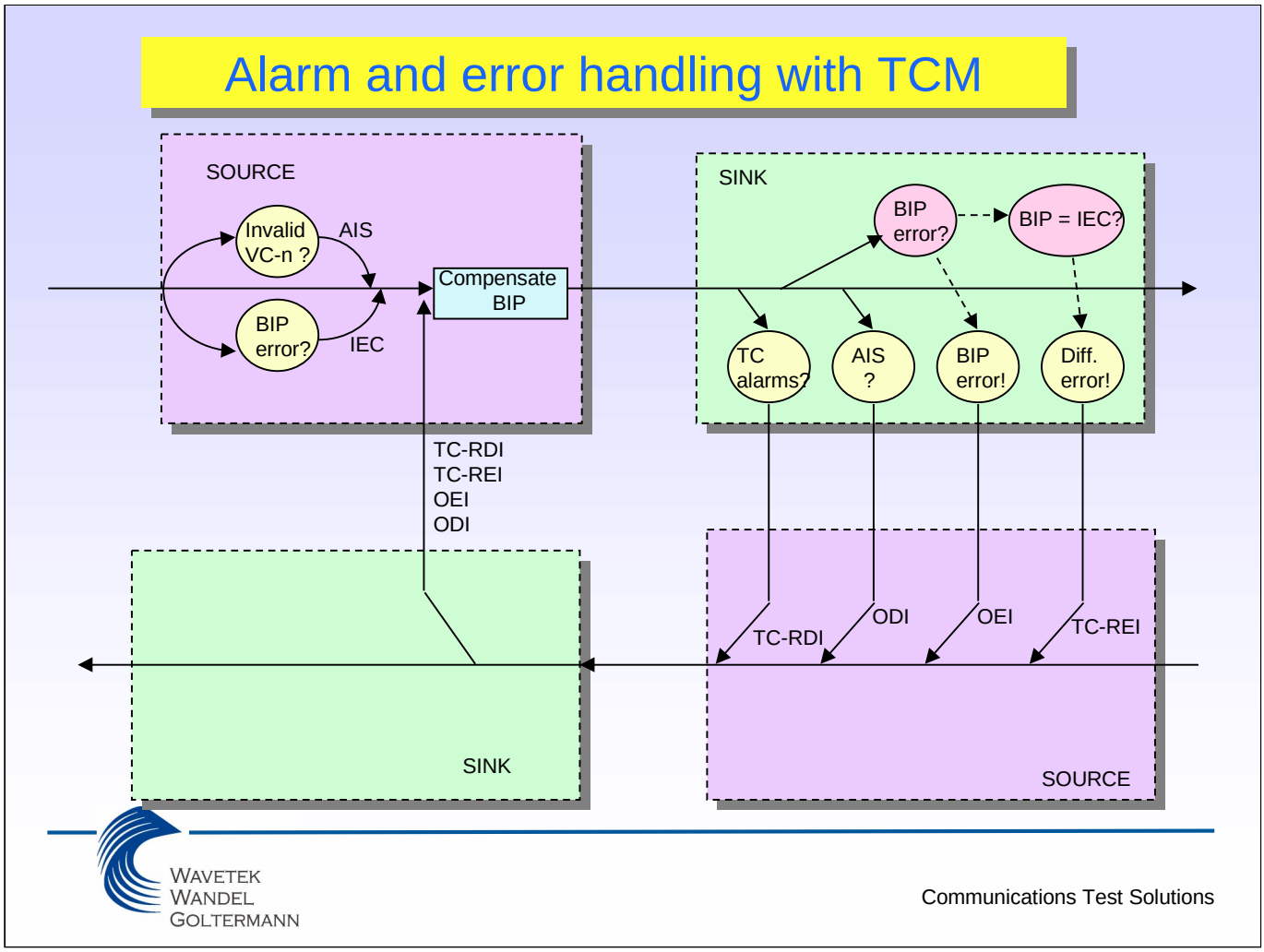


Check TCM sub-layer

Path parity errors are checked at the input to the sub-network. If errors are present, they are copied into N1/N2 bytes in the POH. The data now passes through the sub-network.
At the far end of the sub-network a check is made again: Path parity errors are checked and compared with the extracted N1/N2 bytes.

If there is a difference, the sub-network produced additional errors.
Otherwise, provider 1 is responsible for the errors.

ANT-20 helps to monitor the content of the N1/N2 bytes and provides users with easy interpretation of the detailed events.



Alarm and error handling with TCM

In addition to error monitoring, alarms are also signaled in the backward direction in the same way as in the VCn layer. This allows monitoring of the entire TCM systems in the forward and backward directions.
The following events are used to signal alarms:

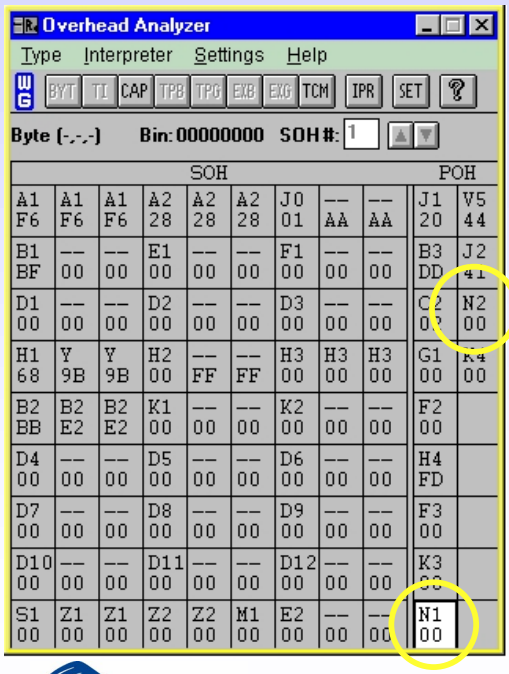
SOURCE:

- ❑ Invalid VC-n? --> Insert AIS
- ❑ BIP errors detected? --> Insert errors in IEC (incoming error count)
- ❑ Alarms received from SINK --> TC-RDI : Remote Defect Indication
  --> TC-REI : Remote Error Indication
  --> ODI : Outgoing Defect Indication
  --> OEI : Outgoing Error Indication

SINK:

- ❑ TC alarms detected? --> TC-RDI
- ❑ AIS detected? --> ODI
- ❑ BIP errors detected? --> Insert errors in OEI
- ❑ BIP = IEC? --> Insert difference in TC-REI

Structure of N1 and N2 as per ITU-T G.707/G.783



VC-11/12 POH

VC-3/4 POH

N1 byte structure

b1	b2	b3	b4	b5	b6	b7	b8
IEC				TC-REI	OEI	TC-APId, TC-RDI ODI, reserved	

N2 byte structure

b1	b2	b3	b4	b5	b6	b7	b8
BIP-2		"1"	Incoming AIS	TC-REI	OEI	TC-APId, TC-RDI ODI, reserved	

b7-b8 multiframe structure

Frame #	Bits 7 and 8 definition
1-8	Frame Alignment Signal: 1111 1111 1111 1110
9-12	TC-APId byte #1 [1 $C_1C_2C_3C_4C_5C_6C_7$]
13-16	TC-APId byte #2 [0 X X X X X X]
17-20	TC-APId byte #3 [0 X X X X X X]
:	:
:	:
:	:
65-68	TC-APId byte #15 [0 X X X X X X]
69-72	TC-APId byte #16 [0 X X X X X X]
73-76	TC-RDI, ODI and Reserved (See Table D.4)

TC-APid = access point identifier

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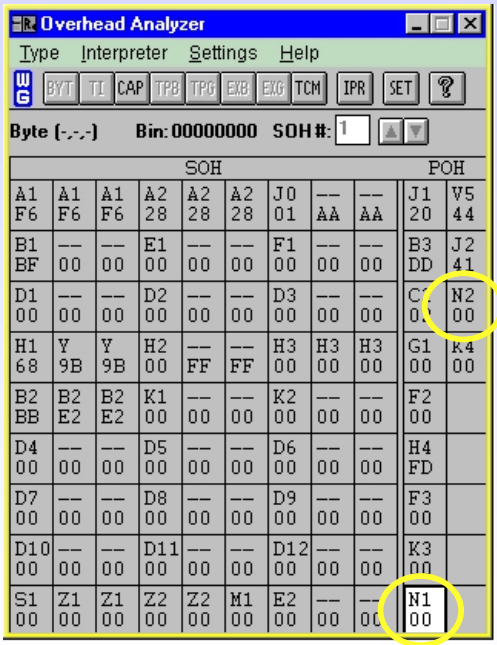
Interaction between generation and analysis of N1/N2

Detected B3 or BIP-2 errors are indicated in bytes N1/N2 of the sub-network. In the USA, only N1 (Z5) is taken into consideration.

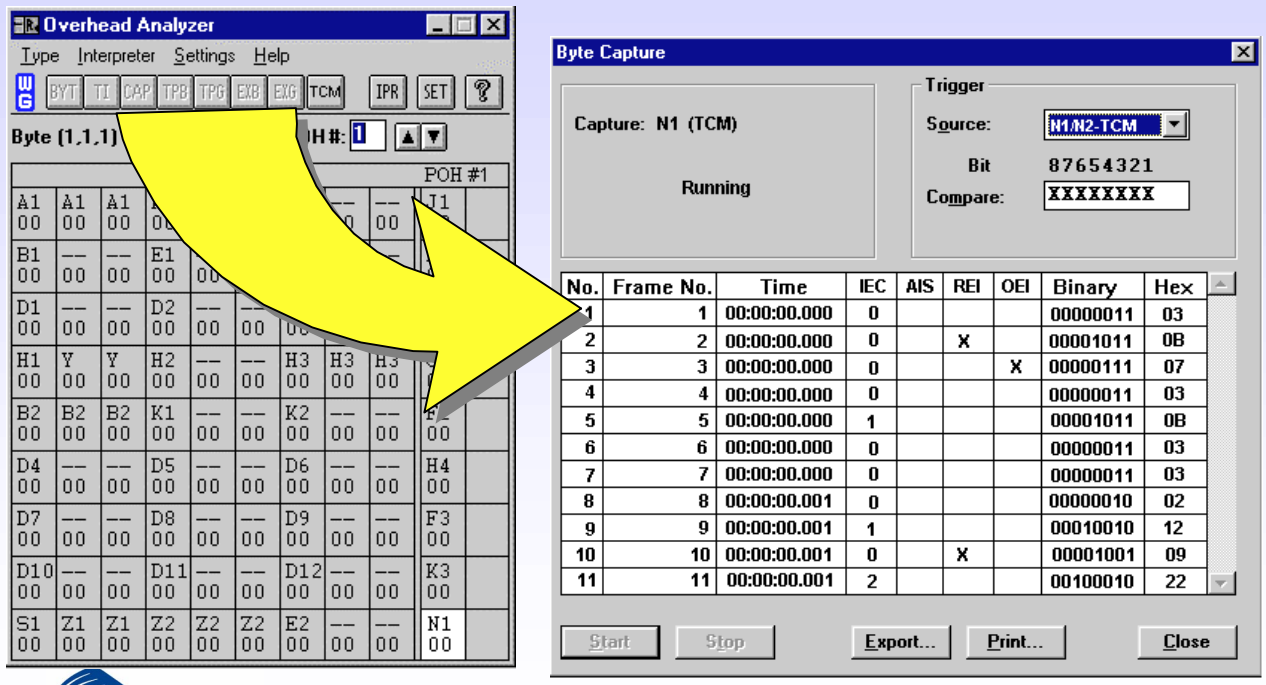
The right-hand figure shows the TCM sink and source functions. There is an exchange of errors and alarms in the incoming and outgoing data signals. N1/N2 produce a multiframe with 76 frames which allows transportation of different alarms. N1 also transports the number of B3 errors counted, and N2 transports the value of BIP-2 errors.
Recommendations G.707 and G.783 cover SDH.
T1.105 and T1.105.05 apply to SONET (Bellcore GR-253 only refers to the ANSI recommendation).
ANT-20 can capture 3 x 76 frame blocks and show the bit combinations of each N1/N2 byte.
This allows users to check for frame start and event information content.

ANT-20 facilitates verification of TCM



- Capture N1/N2 with manual trigger
- Capture with TCM trigger (M frame)
- Interpretation of TCM events
- TCM alarm and trace monitoring
- TCM error measurement

Capture with TCM trigger and interpretation



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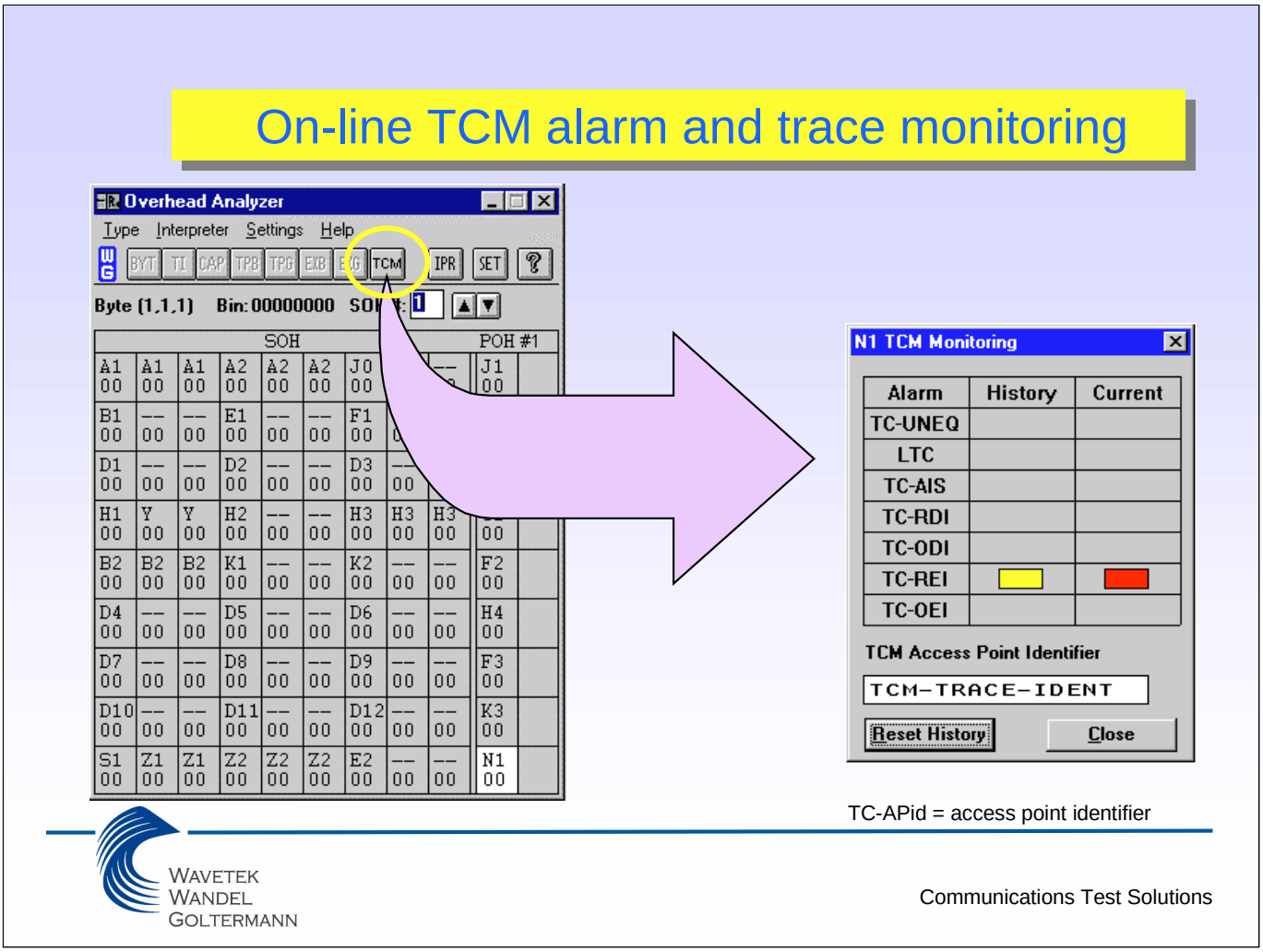
Recording with TCM trigger and event interpretation

The selected N1 or N2 byte is recorded by triggering on the start of the TCM frame.

All changes in TCM are displayed with frame precision together with the time.

The contents are interpreted in detail:

- TCM alarms
- TCM errors
- Byte contents in binary and ASCII

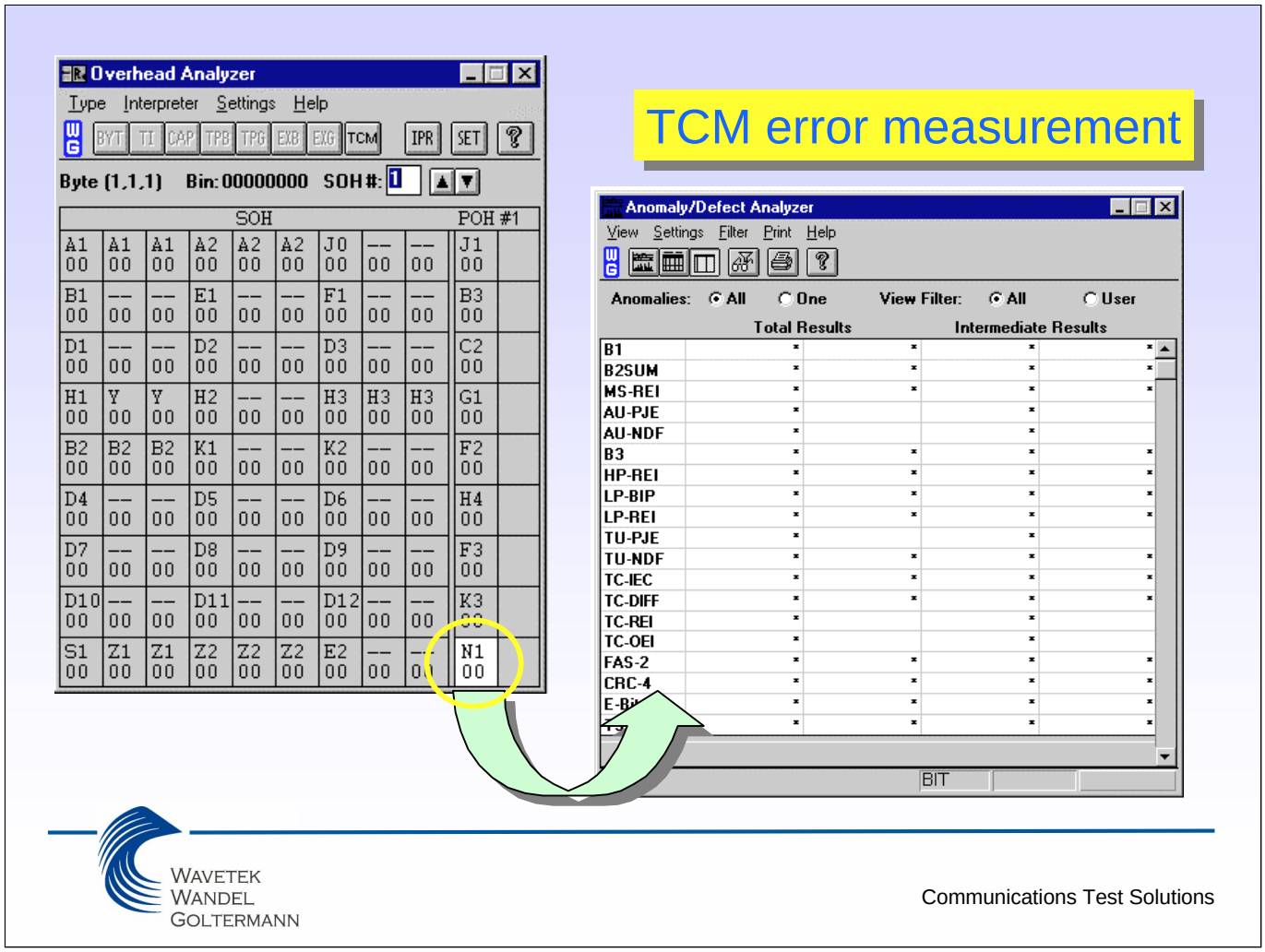


On-line monitoring of alarms and trace identifier

The ANT-20 acts as an on-line TCM monitor when the system is in-service. It synchronizes to the TCM frame and evaluates the alarm events and the trace identifier.

Display is by means of “software” LEDs that provide "History" and "Actual" functions.
In-service changes and actions can thus easily be detected.

The TCM access point identifier indicates the source to which the B errors in the N bytes are transmitted. The identifier is displayed on-line.

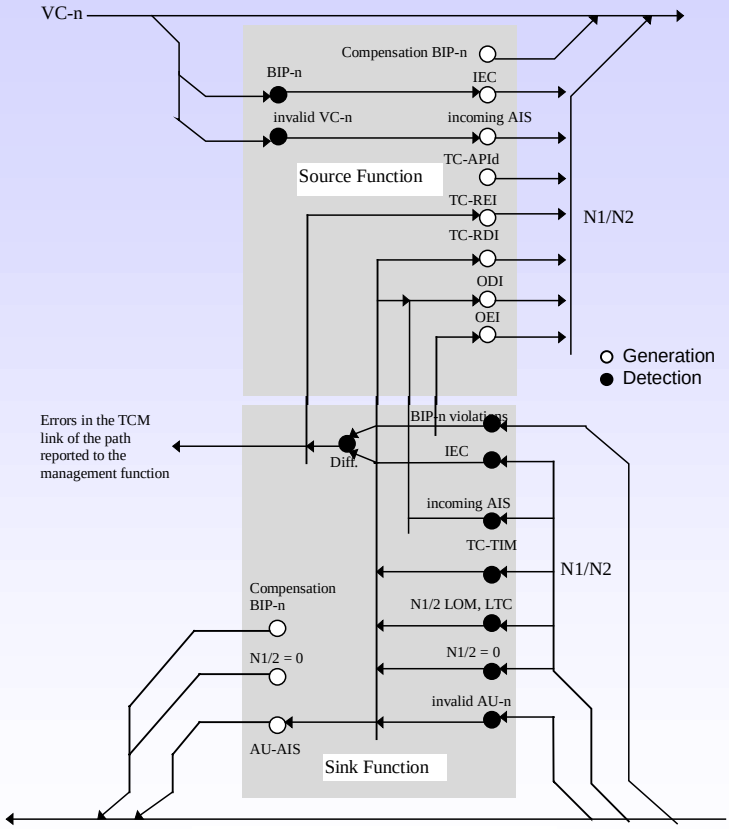


TCM error measurement

TC-OEI contains the acknowledgements of the BIP errors detected in the receiver.
These can be evaluated.

They are available as counter results and in the histogram in the Anomaly / Defect Analyzer.

Detailed TCM SINK and SOURCE functions



TCM source and sink functions

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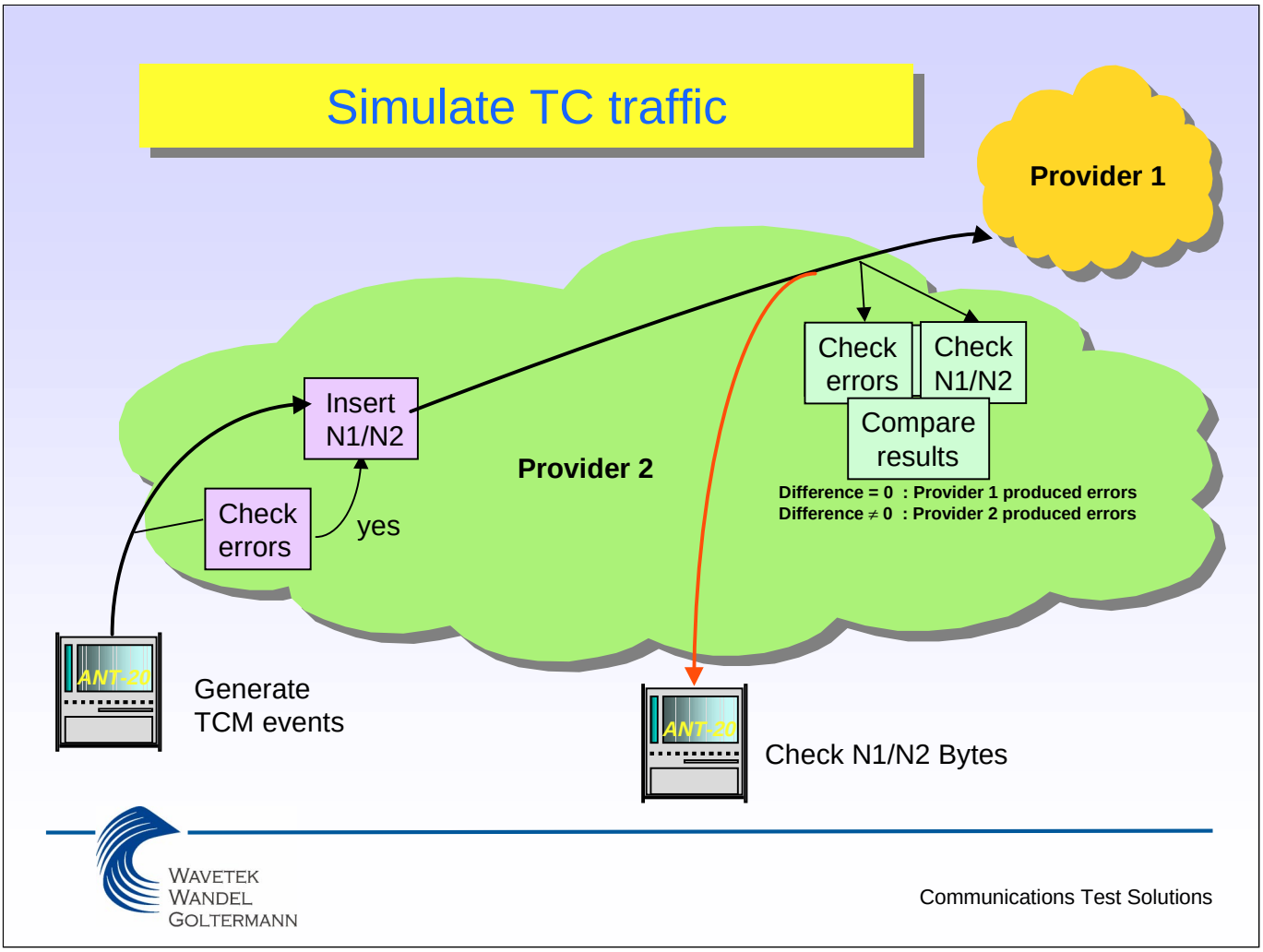
Communications Test Solutions



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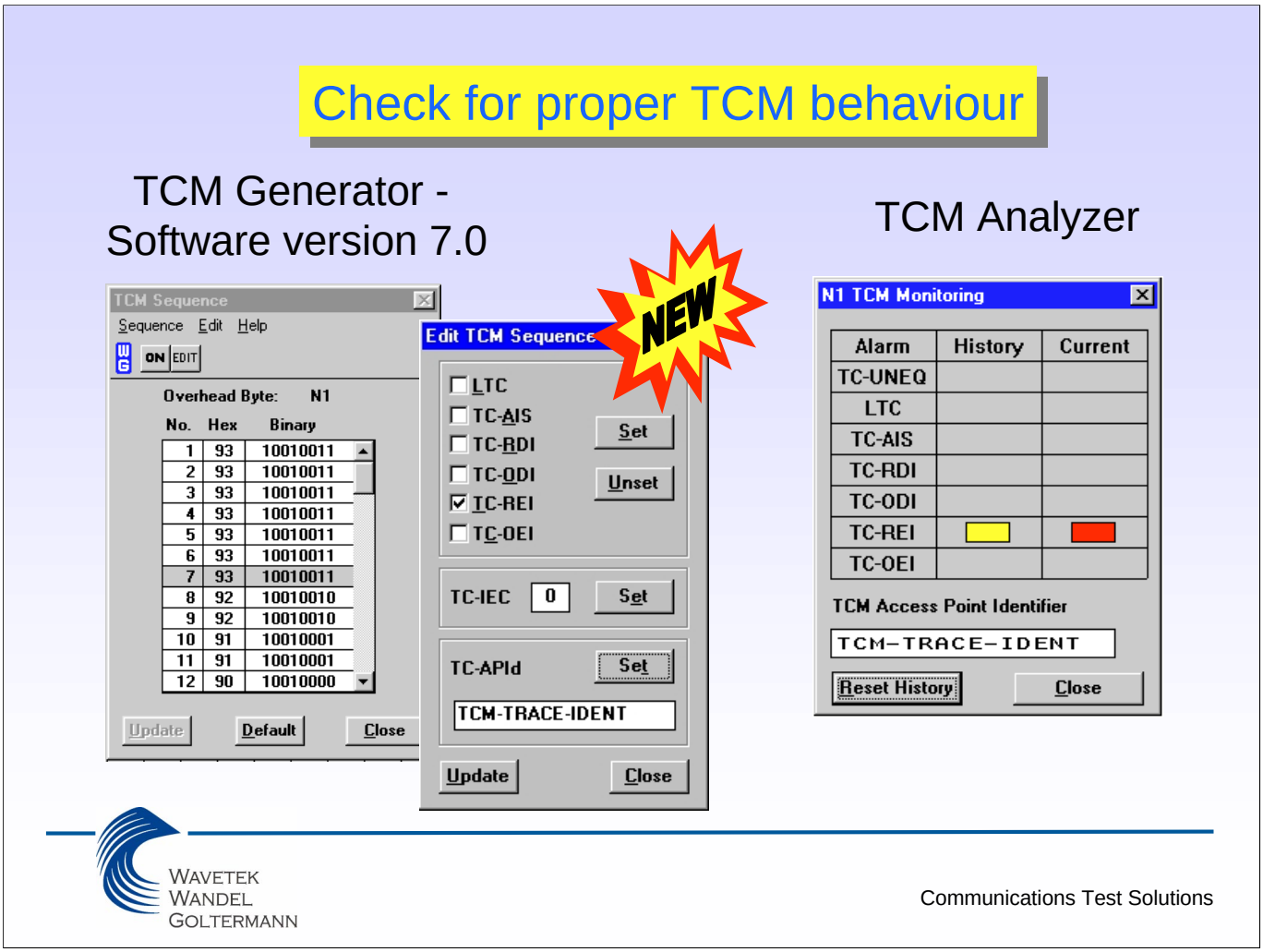

Check for proper TCM behaviour

ANT-20 provides all generation and analysis tools to verify proper TCM behaviour.

Generator (available with version 7.0 Option 3035/90.15) :
Each Byte of the TCM frame is editable to set specific stress patterns during R&D.
Additionally major events may be simulated, like alarms, errors and the trace.
LTC : Loss of Tandem Connection
ODI : Outgoing Defect Indication (respond to received AIS, TIM)
OEI : Outgoing Error Indication (respond to received BIP-n violations)
IEC : Incoming Error Count (B3-errors detected at entance of TC-sub-net)
APId: Access Point Identifier (source of Tandem Connection)

Analyzer
At the receiving side events are evaluated with current and historic soft LEDs. The events are present in the Anomaly/Defect Analyzer for histogramm and counter analysis.

This set of TC-test-functions allow a complete verification of proper function of TC-sub layer nets

Be the First - Be Certain - Protect your Investment

G.707 / G.783

- Capture N1/N2
- Online Interpretation of TCM events
- Monitoring alarms and errors
- Monitoring trace

- Simulate TC events