

SONET Statistics in Junos OS



SONET/SDH Definitions Used in this Presentation

Naming is partially following GR253 specification

An **error** is an abnormal condition in the line or the incoming frames

- At least two counters are kept for each error (“show interfaces extensive”):
 - **Seconds** that the error has been active
 - **Count** of the number of times that the error has transitioned from inactive to active
- There are two types of errors: defects and statistics

A **defect** is an error indicating a severe fault condition (e.g. LOS, AIS)

- JUNOS brings the interface down immediately by default
- There is an additional field kept for each defect
 - **State** of the defect (“OK” means the defect is not present)

A **statistic** is an error indicating bad quality in the line (e.g. BIP-B1)

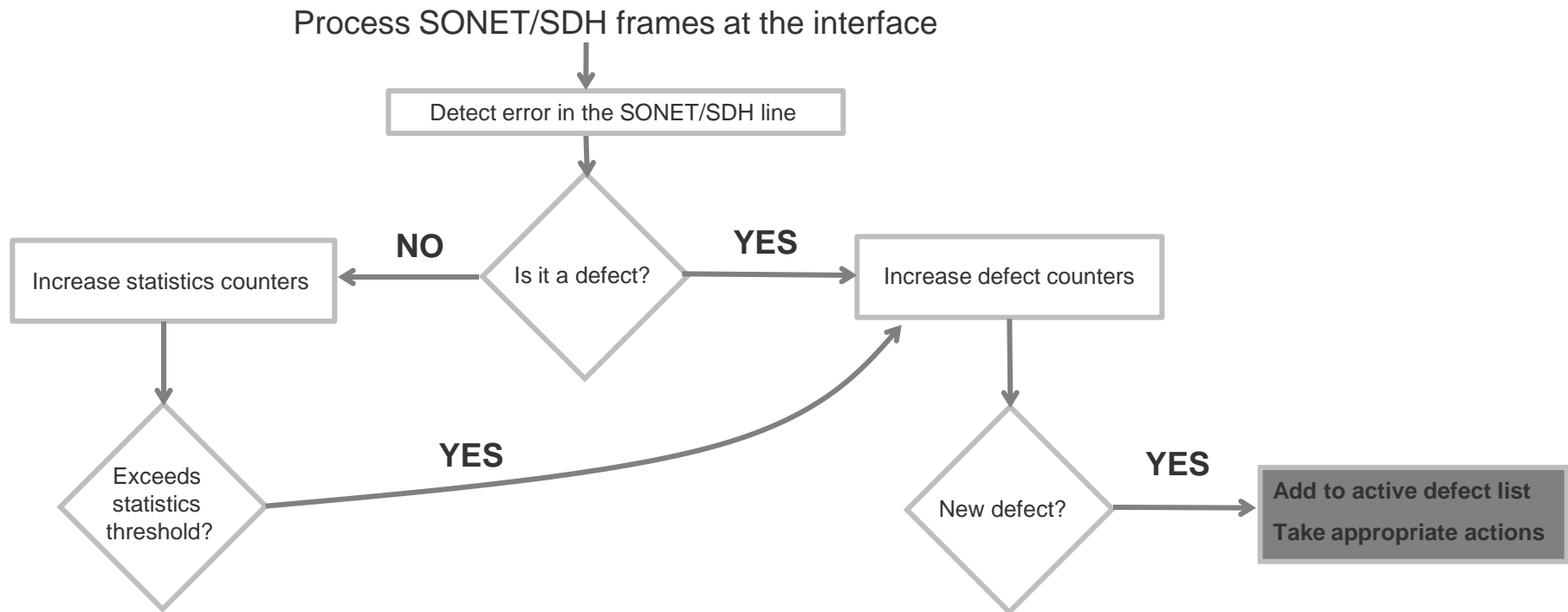
- If statistics reach a threshold, a defect is then typically generated

An **alarm** is generated when a defect is present for “some” time

SONET/SDH Defect Generation

JUNOS keeps a list of active defects per interface

Defects can be generated directly by anomalies in the line/frames, or indirectly as certain statistics exceed a threshold

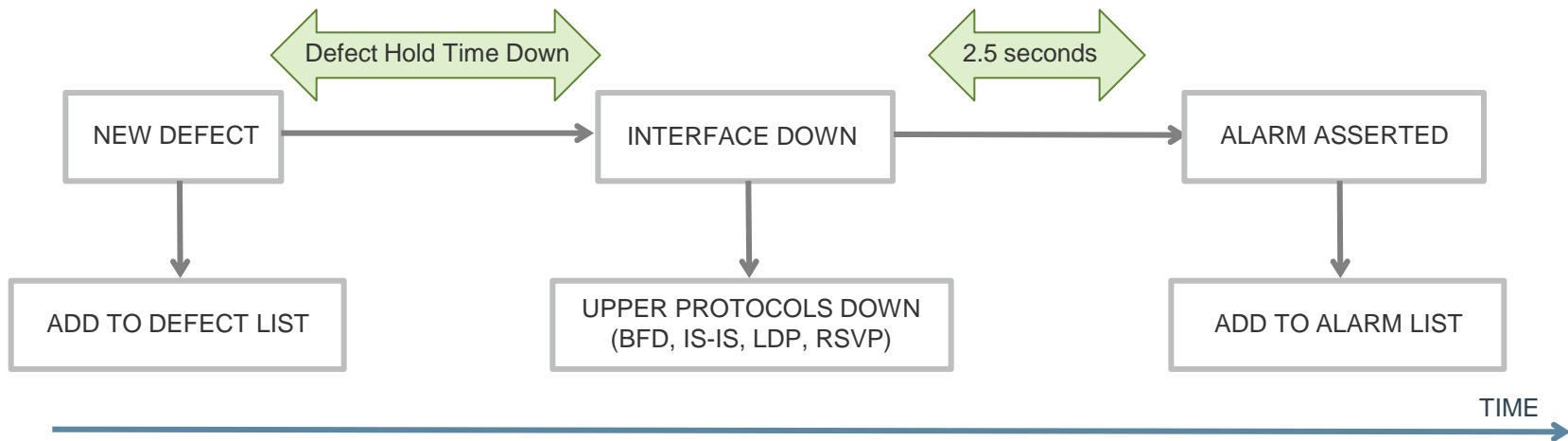


SONET/SDH Life of a Defect

By default, the apparition of a defect makes the driver bring the interface **down immediately**

- Optionally, a per-defect&interface hold-time down can be configured
- An additional global per-interface hold-time down can be configured
 - Not shown in the picture, would be added to the defect hold-time down

The SONET/SDH alarm is generated 2.5 seconds after the interface is marked down

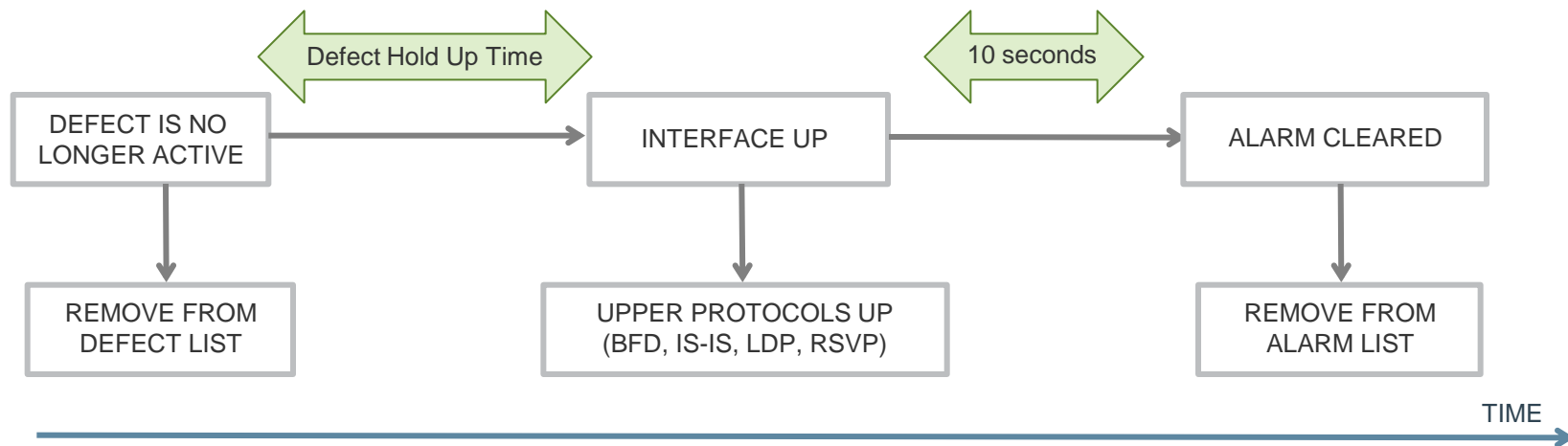


SONET/SDH End of a Defect

By default, if a defect is no longer active the driver brings the interface **up immediately**

- Optionally, a per-defect&interface hold-time up can be configured
- An additional global per-interface hold-time down can be configured
 - Not shown in the picture

The SONET/SDH alarm is cleared 10 seconds after the interface is marked up



Flaps triggered by a SONET/SDH defect

Default behavior

As soon as a defect appears, the interface is taken down

The defect needs to last at least 2.5s so as to generate an alarm

All flaps report SNMP_TRAP_LINK_DOWN/UP in the syslog

- Only those >2.5s are accompanied by a SONET/SDH alarm

SONET/SDH alarms are reported in the syslog, but defects are not

- Check “show interfaces extensive” for defect counters

The alarm is cleared ~10 seconds after the interface is marked up

```
Jan 19 09:53:27 router: mib2d[1456]: SNMP_TRAP_LINK_DOWN: [...] ifOperStatus down(2), ifName so-4/1/2
Jan 19 09:53:29 router: /kernel: so-4/1/2 link 0: Asserting SDH alarm(s) HP-AIS
Jan 19 09:54:32 router: mib2d[1456]: SNMP_TRAP_LINK_UP: [...] ifOperStatus up(1), ifName so-4/1/2.0
Jan 19 09:54:41 router: /kernel: so-4/1/2 link 0: Clearing SDH alarm(s) HP-AIS
```

If there are several defects, the most “relevant” subset generate alarms

```
user@router# run show interfaces so-0/0/1 extensive
[...]
SONET alarms      : LOF
SONET defects     : LOF, SEF, AIS-L, AIS-P, BERR-SD
```

“Primary” SONET/SDH defects

4 levels defined for SONET/SDH: physical, section, line, path

Two IP routers are typically connected by a path

- The path is composed of one or more lines
- Each line has one or more sections

Defect names typically contain a suffix related to its level

- For example, AIS-L (line), AIS-P (path)

Primary defects are direct failures or provisioning issues in the transport network

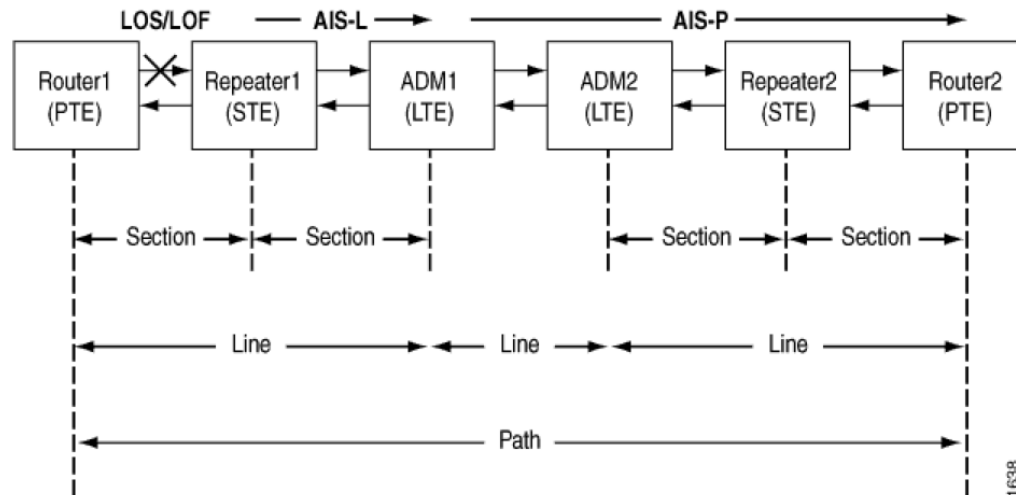
- Loss of Light (LOL), Loss of Signal (LOS), Out of Frame (OOF), Loss of Frame (LOF), Loss of Pointer (LOP), Payload Label Mismatch (PLM), Path Unequipped (UNEQ)

A primary defect triggers AIS in the downstream direction, and RDI in the upstream direction

Alarm Indication Signal (AIS)

AIS is sent **downstream** upon primary failure

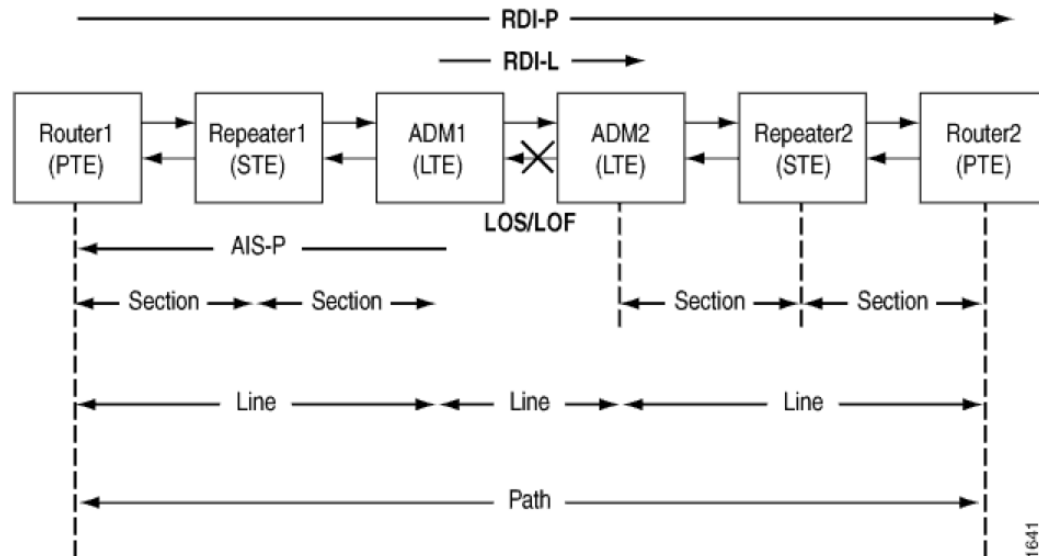
- In the picture, a LOS/LOF primary defect detected by a repeater at the section level is signaled as AIS at the line, then path levels



Remote Defect Indication (RDI)

RDI is sent **upstream** as a response for a detected failure

- Can be triggered by a primary failure or by reception of AIS
- In the picture, the router is sending RDI-P as a response to AIS-P



SONET/SDH Statistics

The parity of the received frame bits is continuously checked

Parity errors stored as Bit-Interleaved Parity (BIP) code statistics

- BIP-B1/B2/B3 @ section/line/path levels respectively
- They are not defects as such, so no link down is directly triggered

BIP errors signaled upstream via Remote Error Indication (REI)

- Also considered a statistic (not a defect)
- BIP-B2 triggers REI-L notification upstream at the line level
- BIP-B3 triggers REI-P notification upstream at the path level

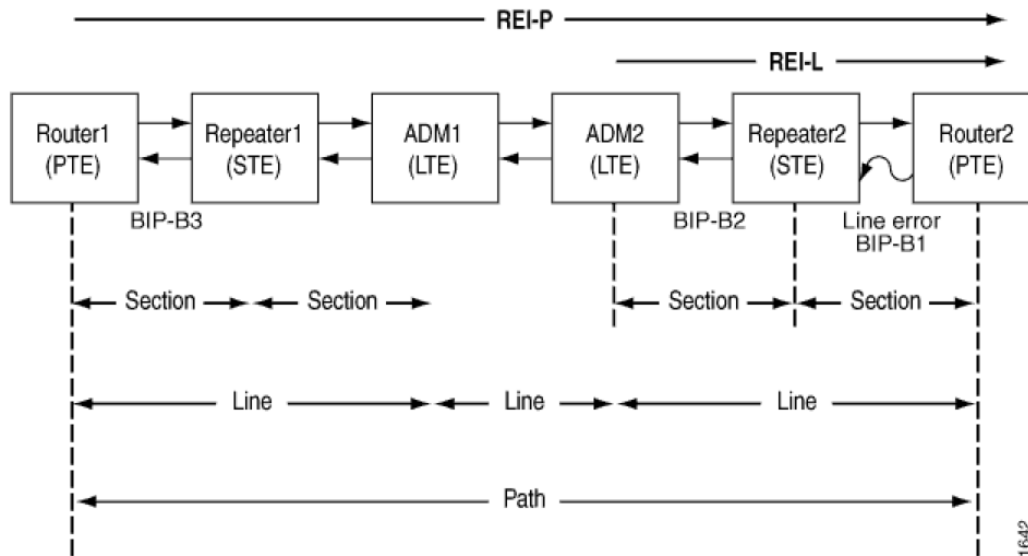
High rate of BIP-B2 errors triggers Bit Error Rate (BERR) defects

- BERR-SD (signal degrade) when a bit error rate of 10^{-6} is reached
- BERR-SF (signal failure) when a bit error rate of 10^{-3} is reached
- B1 and B3 errors typically coexist with B2 errors

Remote Error Indication (REI)

Detection of BIP parity errors in reception triggers the generation of REI statistics signaled upstream

- REI-L upstream upon detection of BIP-B2
- REI-P upstream upon detection of BIP-B3



SONET vs SDH Terminology – Physical Layer

The following slides detail the specific names used in the output of “show interfaces extensive” for each type of framing (SONET/SDH)

Two alarms are defined at the physical level, with identical names for both types of framing

- PLL Locked (Phase-locked loop) – Internal clocking failure
- PHY Light – Loss of optical signal
 - Also referred to as LOL (Loss of Light)

SONET vs SDH Terminology – Section Layer

The Section layer is referred to as Regenerator Section in SDH

The name of each error varies from SONET to SDH

- BIP-B1 = RS-BIP8, SEF = OOF

Error Type	SONET	SDH	Description
	Section	Regenerator Section	
Defects	SEF	OOF	Severely Errored Framing / Out of Frame
	LOS	LOS	Loss of Signal
	LOF	LOF	Loss of Frame
Statistics	BIP-B1	RS-BIP8	B1 Parity Errors
Errored Seconds	ES-S	RS-ES	Errored Seconds
	SES-S	RS-SES	Severely Errored Seconds
	SEFS-S	RS-SEFS	Severely Errored Framing Seconds

A new group of errors called Errored Seconds is displayed

- Indirect errors computed as a sum of other defect/statistics counters
- Useful to have an aggregate view of the errors at each layer

SONET vs SDH Terminology – Line Layer

The Line layer is referred to as Multiplex Section in SDH

The name of each error varies from SONET to SDH

- RDI-L = MS-FERF (Multiplex Section – Far-End Remote Fail)
- REI-L = MS-FEBE (Multiplex Section – Far-End Block Error)
- BIP-B2 = MS-BIP24

Error Type	SONET	SDH	Description
	Section	Multiplex Section	
Defects	RDI-L	MS-FERF	Remote Defect Indication
	AIS-L	MS-AIS	Alarm Indication Signal
	BERR-SF	BERR-SF	Bit Error Rate Fault - Signal Failure
	BERR-SD	BERR-SD	Bit Error Rate Defect - Signal Degradation
Statistics	BIP-B2	MS-BIP24	B2 Parity Errors
	REI-L	MS-FEBE	Remote Error Indication
Errored Seconds	ES-L	MS-ES	Errored Seconds - Near-End Line
	SES-L	MS-SES	Severely Errored Seconds - Near-End Line
	UAS-L	MS-UAS	Unavailable Seconds - Near-End Line
	ES-LFE	MS-ES-FE	Errored Seconds - Far-End Line
	SES-LFE	MS-SES-FE	Severely Errored Seconds - Far-End Line
	UAS-LFE	MS-UAS-FE	Unavailable Seconds - Far-End Line

SONET vs SDH Terminology – Path Layer

The name of each error varies from SONET to SDH

- RDI-P = HP-FERF (High-Order Path – Far-End Remote Fail)
- REI-P = HP-FEBE (High-Order Path – Far-End Block Error)
- BIP-B3 = HP-BIP8

Error Type	SONET	SDH	Description
	Section	Multiplex Section	
Defects	LOP-P	HP-LOP	Loss of Path
	RDI-P	HP-FERF	Remote Defect Indication
	AIS-P	HP-AIS	Alarm Indication Signal
	UNEQ-P	HP-UNEQ	Unequipped Path
	PLM-P	HP-PLM	Payload Label Mismatch
Statistics	BIP-B3	HP-BIP8	B3 Parity Errors
	REI-P	HP-FEBE	Remote Error Indication
Errored Seconds	ES-P	HP-ES	Errored Seconds - Near-End Line
	SES-P	HP-SES	Severely Errored Seconds - Near-End Line
	UAS-P	HP-UAS	Unavailable Seconds - Near-End Line
	ES-PFE	HP-ES-FE	Errored Seconds - Far-End Line
	SES-PFE	HP-SES-FE	Severely Errored Seconds - Far-End Line
	UAS-PFE	HP-UAS-FE	Unavailable Seconds - Far-End Line

SONET/SDH errors in “show interfaces extensive”

Errors in red relate to **defect** counters

- With default configuration, the interface has flapped at least once since the counters were last cleared

Errors in green are **statistics** counters

- MS-BIP24 has not reach a threshold to generate BERR defects

Errored Seconds counters are also in the command output (ommitted)

```
user@router> show interfaces so-7/1/0 extensive
Physical interface: so-7/1/0, Enabled, Physical link is Up
[...]
SDH  alarms      : None
SDH  defects     : None
SDH PHY:                Seconds      Count  State
  PLL Lock          0             0  OK
  PHY Light         0             0  OK
SDH regenerator section:
  RS-BIP8           120            598
  OOF                25             29  OK
  LOS                0              0  OK
  LOF                0              0  OK
[...]
SDH multiplex section:
  MS-BIP24           120            156
  MS-FEBE           131            2062
  MS-FERF            0              0  OK
  MS-AIS             25             28  OK
  BERR-SF            0              0  OK
  BERR-SD            0              0  OK
[...]
SDH path:
  HP-BIP8            116            151
  HP-FEBE            127            557
  HP-LOP             0              0  OK
  HP-AIS             0              0  OK
  HP-FERF             2              2  OK
  HP-UNEQ            0              0  OK
  HP-PLM             23             25  OK
[...]
```

SONET/SDH errors in “show interfaces media”

The “show interfaces media” command is useful to have a quick view at the most relevant statistics (BIP-B1/B2/B3 and REI-L) and spot signs of degradation in the traffic

- RS-BIP8 = BIP-B1, MS-BIP24 = BIP-B2, HP-BIP8 = BIP-B3, MS-FEBE = REI-L, HP-FERF = RDI-P

In order to have a full view of the defect and statistics counters, it is preferable to use “show interfaces extensive” instead

```
user@router> show interfaces so-6/2/0 media
Physical interface: so-6/2/0, Enabled, Physical link is Up
  Interface index: 168, SNMP ifIndex: 189
  Description: Core link
  [...]
  SDH  alarms   : None
  SDH  defects  : None
  SDH  errors:
    RS-BIP8: 34, MS-BIP24: 9, MS-FEBE: 396, HP-BIP8: 9, HP-FERF: 54,
  TU-BIP2: 0
  Received path trace: 10.1.1.1
  Transmitted path trace: neighbor_router so-6/2/0
```



everywhere