

# Panoramica grafica di Synchronous Digital Hierarchy (SDH)

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## [Introduzione](#)

Questo documento offre una panoramica della gerarchia digitale sincrona (SDH) rappresentata nelle immagini.

## [Prerequisiti](#)

### [Requisiti](#)

Non sono previsti prerequisiti specifici per questo documento.

### [Componenti usati](#)

Il documento può essere consultato per tutte le versioni software o hardware.

### [Convenzioni](#)

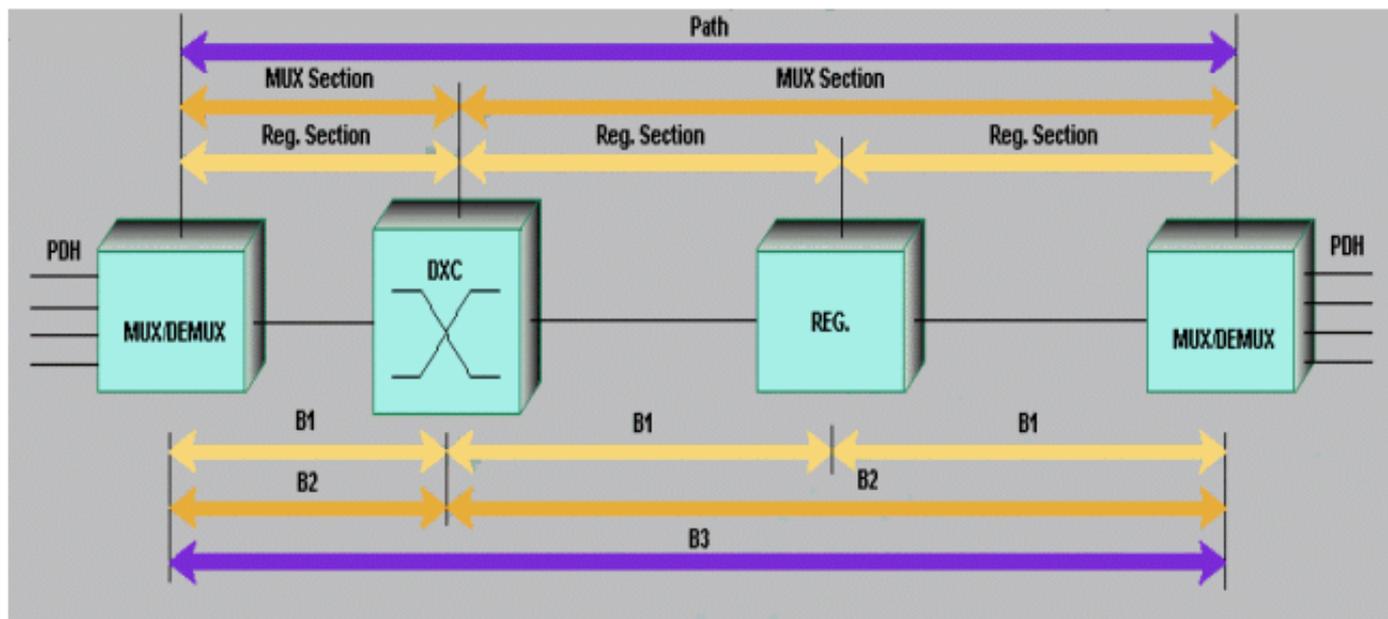
Per ulteriori informazioni sulle convenzioni usate, consultare il documento [Cisco sulle convenzioni nei suggerimenti tecnici](#).

## Analisi SDH

Queste sezioni forniscono una panoramica di SDH in formato grafico.

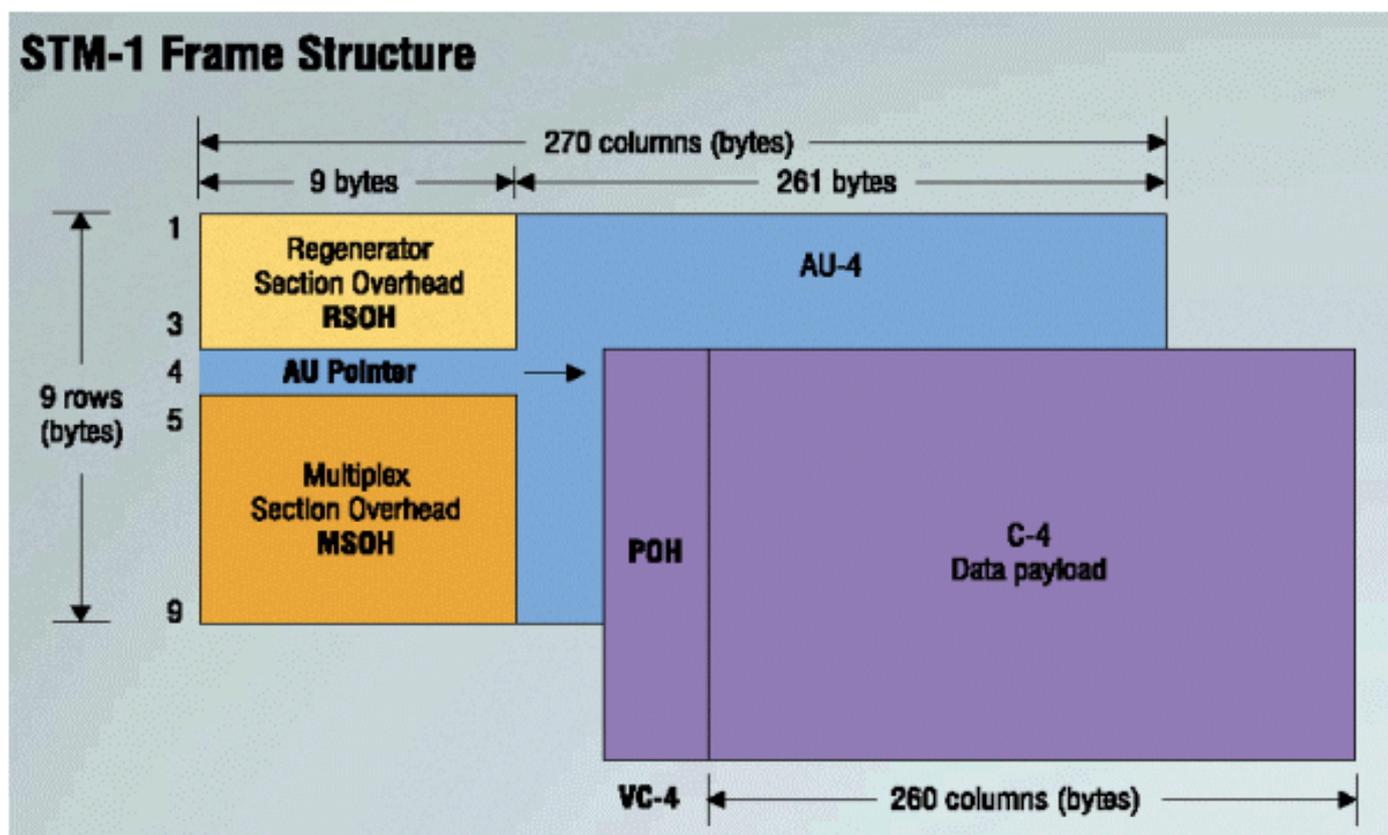
### Il collegamento SDH

Il diagramma mostra l'aspetto di un collegamento SDH.



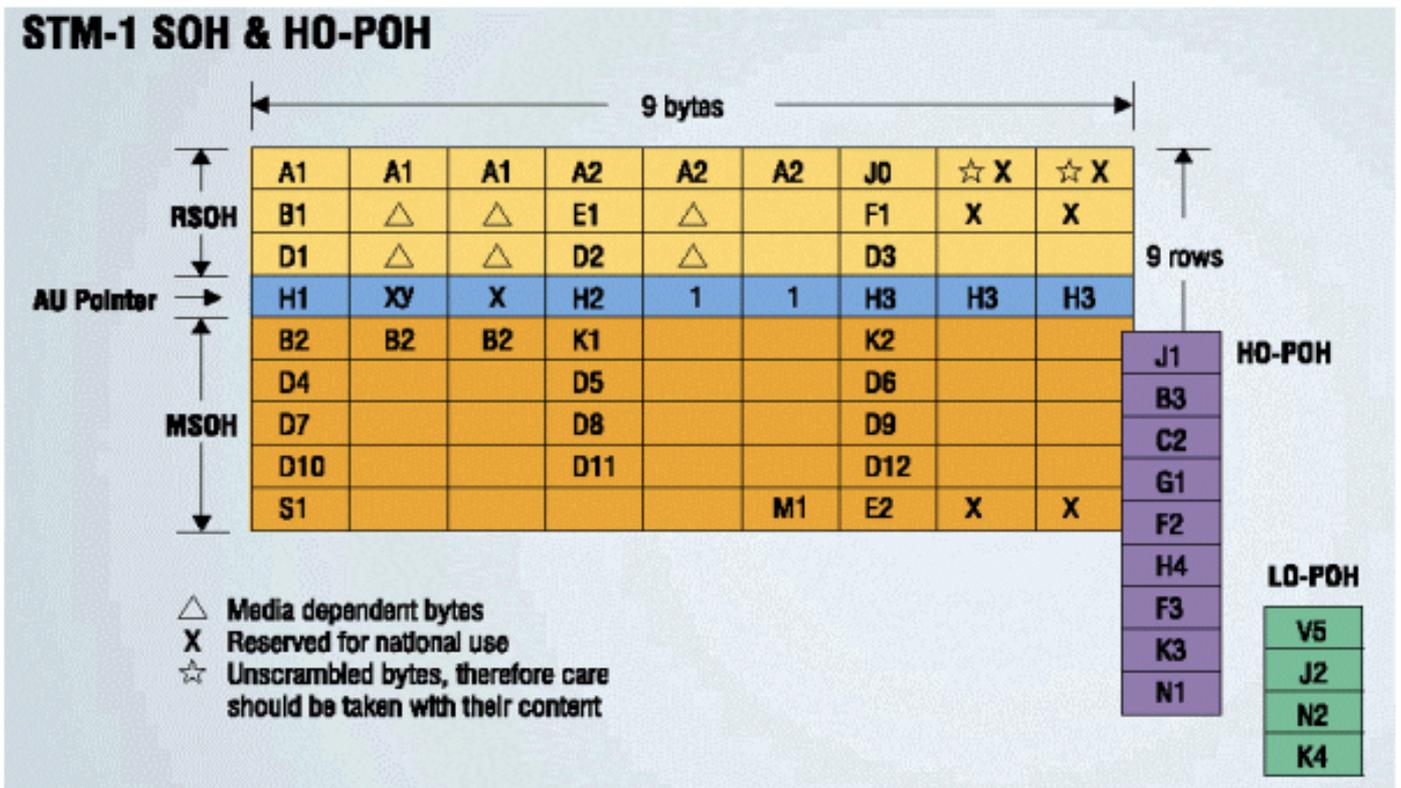
### Frame STM1

Il diagramma mostra la struttura del frame livello 1 (STM1) del modulo di trasporto sincrono.



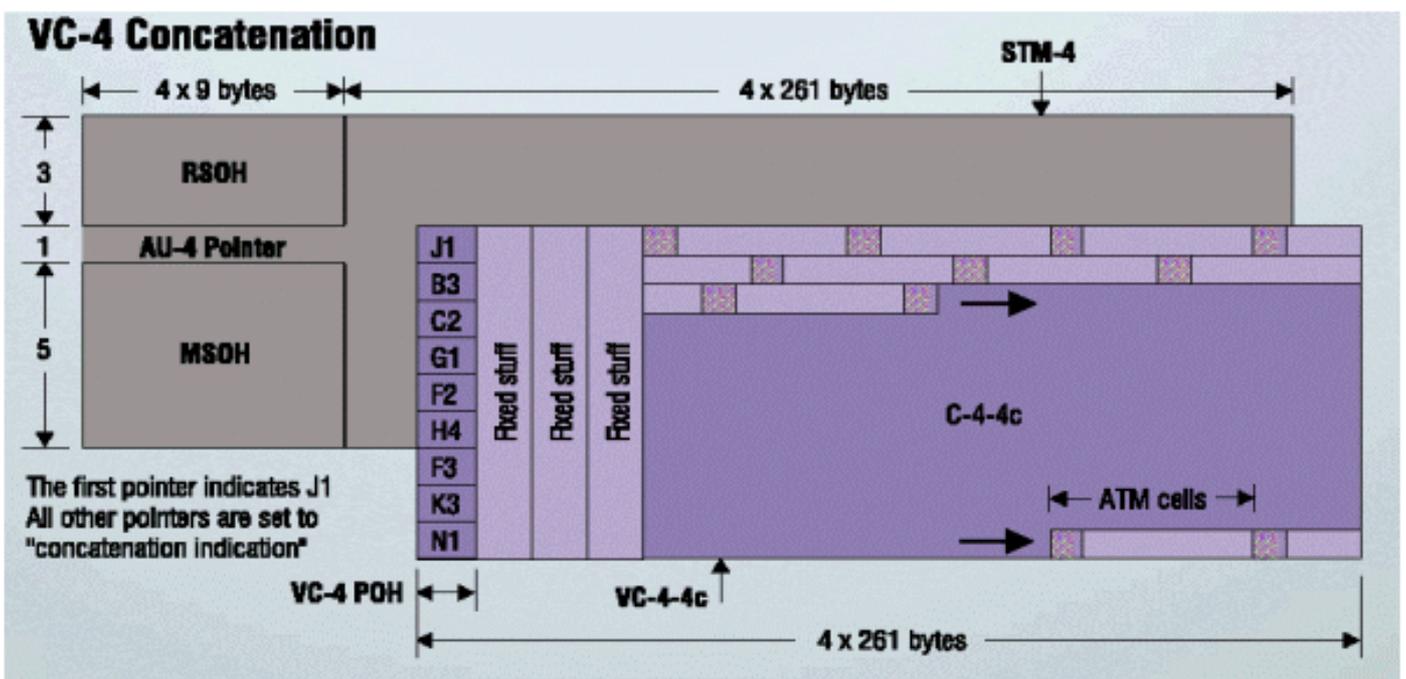
## STM1 SOH

Il diagramma mostra l'aspetto del sovraccarico di sezione STM1.



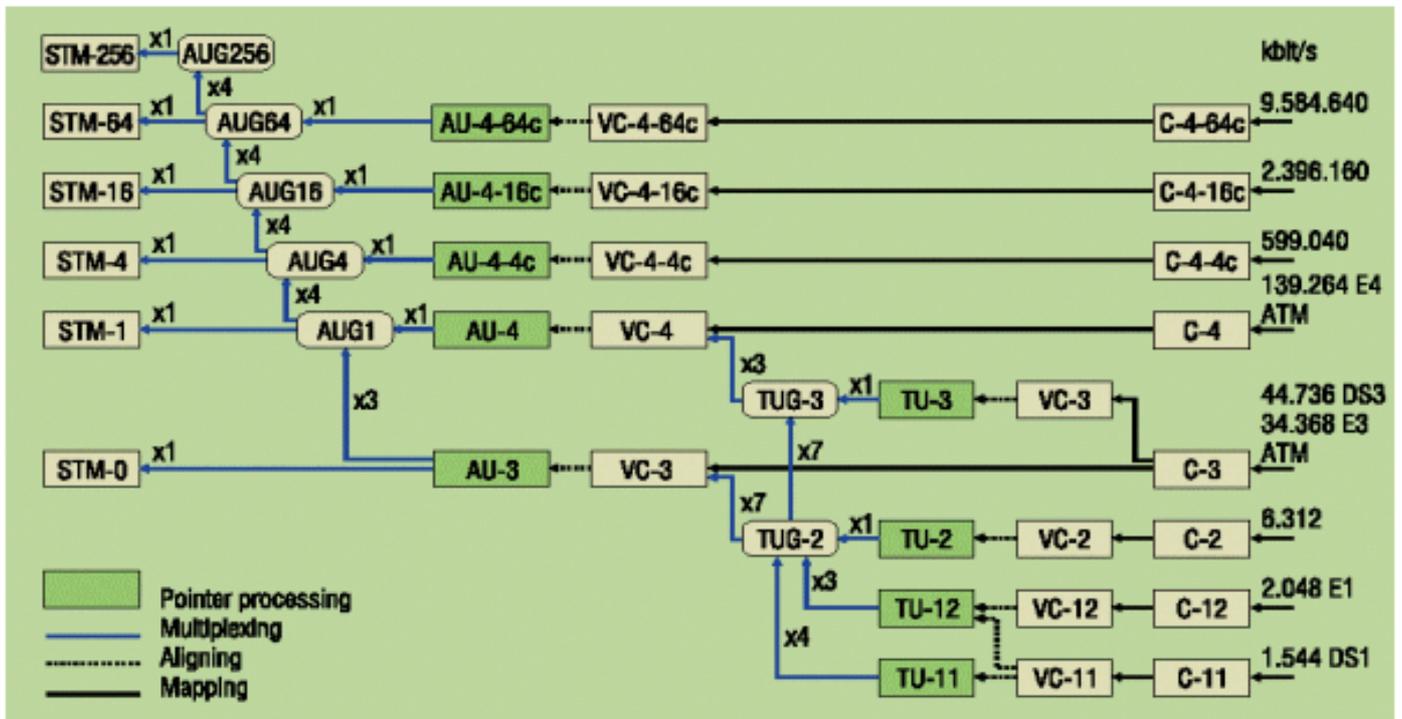
## Concatenazione VC4

In questo diagramma viene illustrata la concatenazione VC4.



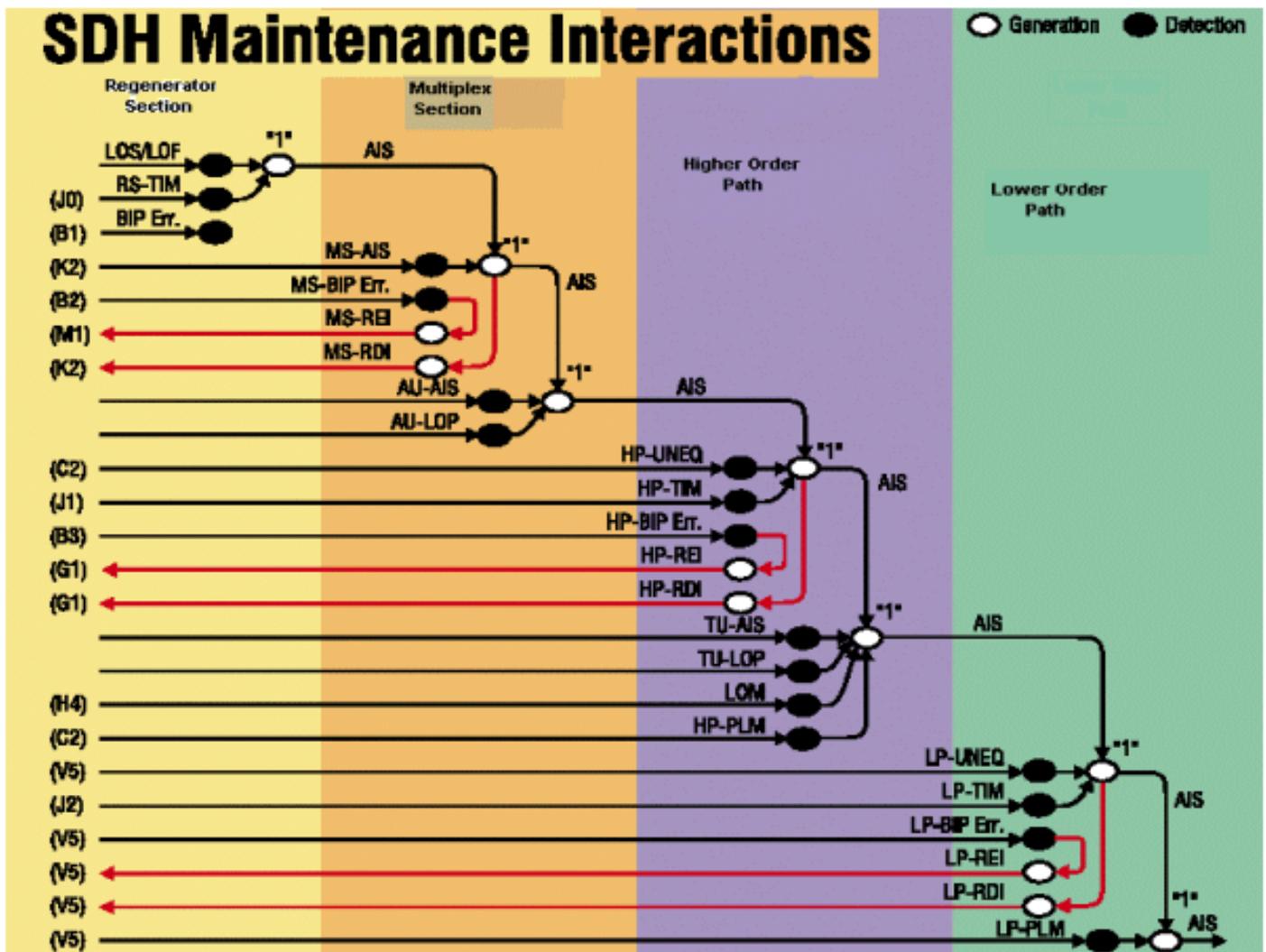
## Gerarchia SDH

Questo diagramma mostra la gerarchia SDH.



## Interazioni per la manutenzione SDH

Questo diagramma mostra l'aspetto delle interazioni di manutenzione SDH.



## Allarmi e criteri di rilevamento

Questa tabella esamina il significato degli allarmi e i relativi criteri di rilevamento.

|                     | Anomalies/Defects                             | Detection criteria  | ITU-T Rec. |
|---------------------|---|---|------------|
| <b>LOS</b>          | Loss of Signal                                | Drop of incoming optical power level causes high bit error rate   | G.958      |
| <b>OOF</b>          | Out of Frame                                  | A1, A2 incorrect for $\geq 625 \mu s$   | G.783      |
| <b>LOF</b>          | Loss of Frame                                 | If OOF persists for $\geq 3 ms$ (to be defined)   | G.783      |
| <b>RS BIP Error</b> | Regenerator Section BIP Error (B1)            | Mismatch of the recovered and computed BIP-8 covers the whole STM-N frame   | G.783      |
| <b>RS-TIM</b>       | Regenerator Section Trace Identifier Mismatch | Mismatch of the accepted and expected Trace Identifier in byte J0   | G.783      |
| <b>MS BIP Error</b> | Multiplex Section BIP Error (B2)              | Mismatch of the recovered and computed N x BIP-24 covers the whole frame, except RSOH   | G.783      |
| <b>MS-AIS</b>       | Multiplex Section AIS                         | K2 (bits 6, 7, 8) = 111 for $\geq 3$ frames   | G.783      |
| <b>MS-REI</b>       | Multiplex Section Remote Error Indication     | Number of detected B2 errors in the sink side encoded in byte M1 of the source side   | G.707      |
| <b>MS-RDI</b>       | Multiplex Section Remote Defect Ind.          | K2 (bits 6, 7, 8) = 110 for $\geq z$ frames ( $z = 3 - 5$ )   | G.783      |
| <b>AU-AIS</b>       | Administrative Unit AIS                       | All *1* in the AU pointer bytes H1, H2  | G.783      |
| <b>AU-LOP</b>       | Administrative Unit Loss of Pointer           | 8 - 10 NDF enable, 8 - 10 Invalid pointers  | G.783      |
| <b>HP BIP Error</b> | HO Path BIP Error (B3)                        | Mismatch of the recovered and computed BIP-8 covers entire VC-n   | G.783      |
| <b>HP-UNEQ</b>      | HO Path Unequipped                            | C2 = "0" for $\geq 5$ frames  | G.783      |
| <b>HP-TIM</b>       | HO Path Trace Identifier Mismatch             | Mismatch of the accepted and expected Trace Identifier in byte J1   | G.783      |
| <b>HP-REI</b>       | HO Path Remote Error Indication               | Number of detected B3 errors in the sink side encoded in byte G1 (bits 1, 2, 3, 4) of the source side   | G.707      |
| <b>HP-RDI</b>       | HO Path Remote Defect Indication              | G1 (bit 5) = 1 for $\geq z$ frames ( $z = 3, 5$ or 10)  | G.783      |
| <b>HP-PLM</b>       | HO Path Payload Label Mismatch                | Mismatch of the accepted and expected Payload Label in byte C2  | G.783      |
| <b>TU-LOM</b>       | Loss of Multiframe                            | H4 (bits 7, 8) multiframe not recovered for X m, X = 1 - 5 ms   | G.783      |
| <b>TU-AIS</b>       | Tributary Unit AIS                            | All *1* in the TU pointer bytes V1, V2  | G.783      |
| <b>TU-LOP</b>       | Loss of Pointer                               | 8 - 10 NDF enable, 8 - 10 Invalid pointers  | G.783      |
| <b>LP BIP Error</b> | LO Path BIP Error                             | Mismatch of the recovered and computed BIP-8 (B3) or BIP-2 (V5 bits 1, 2) covers entire VC-n  | G.783      |
| <b>LP-UNEQ</b>      | LO Path Unequipped                            | VC-3: C2 = "0" for $\geq 5$ frames, VC-m ( $m = 2, 11, 12$ ): V5 (bits 5, 6, 7) = 000 for $\geq 5$ multiframe   | G.783      |
| <b>LP-TIM</b>       | LO Path Trace Identifier Mismatch             | Mismatch of the accepted and expected Trace Identifier in byte J1 (VC-3) or J2  | G.783      |
| <b>LP-REI</b>       | LO Path Remote Error Indication               | VC-3: Number of detected B3 errors in the sink side encoded in byte G1 (bits 1, 2, 3, 4) of the source side, VC-m ( $m = 2, 11, 12$ ): If one or more BIP-2 errors detected in the sink side, byte V5 (bits 3) = 1 on the source side | G.707      |
| <b>LP-RDI</b>       | LO Path Remote Defect Indication              | VC-3: G1 (bit 5) = 1 for $\geq z$ frames, VC-m ( $m = 2, 11, 12$ ): V5 (bit 8) = 1 for $\geq z$ multiframe ( $z = 3, 5$ or 10)  | G.783      |
| <b>LP-PLM</b>       | LO Path Payload Label Mismatch                | Mismatch of the accepted and expected Payload Label in byte C2 or V5 (bits 5, 6, 7)   | G.783      |

## STM1 SOH, HO-POH e LO-POH Byte

Questi diagrammi forniscono una descrizione di tutti i byte di STM1 SOH, High Order Path Overhead (HO-POH) e Low Order Path Overhead (LO-POH).

## **RSOH Regenerator Section Overhead**

**A1, A2:** Indicates the beginning of the STM-1 frame (A1:11110110, A2:00101000). The frame alignment word of an STM-N frame is composed of 3\*N A1 bytes followed by 3\*N A2 bytes.

**J0:** Regenerator section trace. Used to transmit a section access point identifier so that a section receiver can verify its continued connection to the intended transmitter.

**Z0:** Spare. Reserved for future international standardization.

**B1:** Regenerator section error monitoring. The BIP-8 is computed over all bits of the previous STM-N frame after scrambling and is placed in the B1 byte of the current frame before scrambling.

**E1:** Provides orderwire channels for voice communication between regenerators.

**F1:** Reserved for user purposes (e.g. temporary data/voice channel connections for special maintenance purposes).

**D1 - D3:** Data communication channels (DCC). A 192 kbit/s channel used from a central location for alarms, control, monitoring and administration functions.

## **AU Pointers**

**H1, H2:** Pointer bytes. The pointer contained in these bytes designates the location of the VC-n frame. The last ten bits (b7 - b16) carry the pointer value (binary number with a range of 0 to 782).

**H3:** Pointer action byte. It is used for frequency justification. Depending on the pointer value, this byte is used to adjust the fill input buffers. It only carries valid information in the event of negative justification, otherwise it's not defined.

## **MSOH Multiplex Section Overhead**

**B2:** Multiplex section error monitoring. The BIP-N \*24 is used to determine if a transmission error has occurred over a multiplex section. It is computed over all bits of the previous STM-N frame except for the first three rows and is placed in the B2 byte of the current frame.

**K1, K2:** Allocated for APS (Automatic Protection Switching) signaling for the protection of the multiplex section.

## Linear APS messages

| ITU-T G.841<br>protection switching protocol |                                      |
|--|--------------------------------------|
| K1 byte                                      | Condition                            |
| <b>b1 - b4</b>                               |                                      |
| 1111   | Lockout of protection                |
| 1110   | Forced switch                        |
| 1101   | Signal fail high priority            |
| 1100   | Signal fall low priority             |
| 1011   | Signal degrade high priority         |
| 1010   | Signal degrade low priority          |
| 1001   | Unused                               |
| 1000   | Manual switch                        |
| 0111   | Unused                               |
| 0110   | Wait-to-restore                      |
| 0101   | Unused                               |
| 0100   | Exercise                             |
| 0011   | Unused                               |
| 0010   | Reserve request                      |
| 0001   | Do not revert                        |
| 0000   | No request                           |
| <b>b5 - b8</b>                               | Selects channel used by APS messages |

| K2 byte        | Condition  |
|----------------|--|
| <b>b1 - b4</b> | Selects bridged channel used   |
| <b>b5</b>      | Determines automatic protection switch architecture  |
| <b>b6 - b8</b> | 000 = Reserved for future use<br>001 = Reserved for future use<br>010 = Reserved for future use<br>011 = Reserved for future use<br>100 = Reserved for future use<br>101 = Reserved for future use<br>110 = MS-RDI<br>111 = MS-AIS |

## Ring APS messages

| ITU-T G.841<br>protection switching protocol |  |
|--|--|
| K1 byte                                      | Condition  |
| <b>b1 - b4</b>                               |  |
| 1111   | Lockout of protection (span) or signal fall (protection) |
| 1110   | Forced switch (span)                                     |
| 1101   | Forced switch (ring)                                     |
| 1100   | Signal fall (span)                                       |
| 1011   | Signal fail (ring)                                       |
| 1010   | Signal degrade (protection)                              |
| 1001   | Signal degrade (span)                                    |
| 1000   | Signal degrade (ring)                                    |
| 0111   | Manual switch (span)                                     |
| 0110   | Manual switch (ring)                                     |
| 0101   | Wait-to-restore  |
| 0100   | Exerciser (span)   |
| 0011   | Exerciser (ring)   |
| 0010   | Reserve request (span)                                   |
| 0001   | Reserve request (ring)                                   |
| 0000   | No request   |
| <b>b5 - b8</b>                               | Destination node ID                                      |

| K2 byte        | Condition  |
|----------------|--|
| <b>b1 - b4</b> | Source node ID   |
| <b>b5</b>      | Path code: 0 = short path; 1 = long path   |
| <b>b6 - b8</b> | 000 = Idle<br>001 = Bridged<br>010 = Bridged and switched<br>011 = Reserved for future use<br>100 = Reserved for future use<br>101 = Reserved for future use<br>110 = MS-RDI |

**D4 - D12:** Data communication channels (DCC). A 576 kbit/s channel is used from a central location for alarms, control, monitoring and administration functions.

**S1:** Synchronization status. Bits 5 - 8 are used to carry the synchronization messages. The following is an assignment of bit patterns to the four synchronization levels agreed to within ITU-T.

| <b>S1 byte<br/>b5 - b8</b> | <b>SDH synchronization quality level description</b> |
|----------------------------|--|
| 0000                       | Quality unknown (existing synchronization network)   |
| 0001                       | Reserved   |
| 0010                       | Rec. G.811   |
| 0011                       | Reserved   |
| 0100                       | SSU-A  |
| 0101                       | Reserved   |
| 0110                       | Reserved   |
| 0111                       | Reserved   |
| 1000                       | SSU-B  |
| 1001                       | Reserved   |
| 1010                       | Reserved   |
| 1011                       | (SEC) SDH Equipment Source                           |
| 1100                       | Reserved   |
| 1101                       | Reserved   |
| 1110                       | Reserved   |
| 1111                       | Do not use for synchronization                       |

**M1:** Allocated for use as a multiplex section REI. Conveys the count of interleaved bit blocks detected in error by B2.

**E2:** Provides orderwire channels for voice communication between multiplexers.

## **H0-POH** Higher Order Path Overhead

**J1:** The first byte in the virtual container. Its location is indicated by the AU pointer. A 64-byte free format string or a 16-byte frame is transmitted so that a path receiving terminal can verify its continued connection to the intended transmitter.

**B3:** Higher order path error monitoring. The BIP-8 is calculated over all bits of the previous VC-n. Computed value is placed in the B3 byte.

**C2:** Signal label. Indicates the composition or the maintenance status of the VC-n.

## C2 byte coding

| b1 - b4 | b5 - b8 | Hex code | Interpretation  |
|---------|---------|----------|---|
| 0000    | 0000    | 00       | Unequipped or supervisory-unequipped  |
| 0000    | 0001    | 01       | Equipped – nonspecific  |
| 0000    | 0010    | 02       | TUG structure   |
| 0000    | 0011    | 03       | Locked TU-n   |
| 0000    | 0100    | 04       | Asynchronous mapping of 34 368 kbit/s or 44 736 kbit/s into the container-3 (C-3) |
| 0001    | 0010    | 12       | Asynchronous mapping of 139 264 kbit/s into the container-4 (C-4)                 |
| 0001    | 0011    | 13       | ATM mapping   |
| 0001    | 0100    | 14       | MAN (DQDB) mapping  |
| 0001    | 0101    | 15       | FDDI mapping  |
| 0001    | 0110    | 16       | Mapping of HDLC framed signal   |
| 1100    | 1111    | CF       | Mapping of HDLC framed signal   |
| 1111    | 1110    | FE       | Test signal, 0.181 specific mapping   |
| 1111    | 1111    | FF       | VC-AIS  |

**G1:** Path status. Conveys the path status and performance back to the trail termination source as detected by a trail termination sink.

| REI |    |    |    | RDI |    |    | Spare |
|-----|----|----|----|-----|----|----|-------|
| b1  | b2 | b3 | b4 | b5  | b6 | b7 | b8    |



### G1 (b5 - b7) coding and Interpretation

| b5 - b7 | Meaning                    | Triggers                          |
|---------|----------------------------|-----------------------------------|
| 000     | No remote defect           | No remote defect                  |
| 001     | No remote defect           | No remote defect                  |
| 010     | Remote payload defect      | LCD                               |
| 011     | No remote defect           | No remote defect                  |
| 100     | Remote defect              | AIS, LOP, TIM, UNEQ (or PLM, LCD) |
| 101     | Remote server defect       | AIS, LOP                          |
| 110     | Remote connectivity defect | TIM, UNEQ                         |
| 111     | Remote defect              | AIS, LOP, TIM, UNEQ (or PLM, LCD) |

**F2, F3:** Path user channels. Allocated for user communication purposes between path elements and are payload dependent.

**H4:** Position and sequence indicator. Provides a multiframe and sequence indicator for virtual concatenation and a generalized position indicator for payloads.

**K3:** (b1 - b4) are allocated for higher order path Automatic Protection Switching (APS). (b5 - b8) are allocated for future use. Have no defined value. The receiver is required to ignore their content.

**N1:** Network operator byte. Allocated to provide a Tandem Connection Monitoring (TCM) function.

# N1 byte structure

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



| 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 <sub>1</sub> C <sub>2</sub> C <sub>3</sub> C <sub>4</sub> C <sub>5</sub> C <sub>6</sub> C <sub>7</sub> ] |
| 13 - 16                      | TC APId byte #2 [ 0 X X X X X X X ]  |
| 17 - 20                      | TC APId byte #3 [ 0 X X X X X X X ]  |
| ⋮                            | ⋮  |
| ⋮                            | ⋮  |
| 65 - 68                      | TC APId byte #15 [ 0 X X X X X X X ]   |
| 69 - 72                      | TC APId byte #16 [ 0 X X X X X X X ]   |
| 73 - 76                      | TC-RDI, ODI and reserved   |

## Structure of frames # 73 - 76 of the b7 - b8 multiframe

### TC-RDI, ODI and reserved capacity

| Frame # | b7 definition            | b8 definition            |
|---------|--------------------------|--------------------------|
| 73      | Reserved (default = "0") | TC-RDI                   |
| 74      | ODI                      | Reserved (default = "0") |
| 75      | Reserved (default = "0") | Reserved (default = "0") |
| 76      | Reserved (default = "0") | Reserved (default = "0") |

# LO-POH Lower Order Path Overhead

(for VC-11, VC-12, VC-2)

**V5:** Provides the functions of error checking, signal label and path status.

|              |    |            |            |                     |    |    |            |
|--------------|----|------------|------------|---------------------|----|----|------------|
| <b>BIP-2</b> |    | <b>REI</b> | <b>RFI</b> | <b>Signal label</b> |    |    | <b>RDI</b> |
| b1           | b2 | b3         | b4         | b5                  | b6 | b7 | b8         |



| b5 | b6 | b7 | Meaning                              |
|----|----|----|--------------------------------------|
| 0  | 0  | 0  | Unequipped or supervisory-unequipped |
| 0  | 0  | 1  | Equipped – nonspecific               |
| 0  | 1  | 0  | Asynchronous                         |
| 0  | 1  | 1  | Bit synchronous                      |
| 1  | 0  | 0  | Byte synchronous                     |
| 1  | 0  | 1  | Reserved for future use              |
| 1  | 1  | 0  | Test signal, 0.181 specific mapping  |
| 1  | 1  | 1  | VC-AIS                               |

**J2:** Lower order path trace Identifier. A 16-byte frame is transmitted so that a path receiving terminal can verify its continued connection to the intended transmitter.

**N2:** Network operator byte. Allocated to provide a Tandem Connection Monitoring (TCM) function

## N2 byte structure

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



### b7 - b8 multiframe structure

| Frame # | b7 - b8 definition  |
|---------|---|
| 1 - 8   | Frame alignment signal: 1111 1111 1111 1110   |
| 9 - 12  | TC-APId bytes #1 [ 1 C <sub>1</sub> C <sub>2</sub> C <sub>3</sub> C <sub>4</sub> C <sub>5</sub> C <sub>6</sub> C <sub>7</sub> ] |
| 13 - 16 | TC APId byte #2 [ 0 XXXXXXXX ]  |
| 17 - 20 | TC APId byte #3 [ 0 XXXXXXXX ]  |
| ⋮       | ⋮   |
| 65 - 68 | TC APId byte #15 [ 0 XXXXXXXX ]   |
| 69 - 72 | TC APId byte #16 [ 0 XXXXXXXX ]   |
| 73 - 76 | TC-RDI, ODI and reserved  |

| Frame # | b7 definition            | b8 definition            |
|---------|--------------------------|--------------------------|
| 73      | Reserved (default = "0") | TC-RDI                   |
| 74      | ODI                      | Reserved (default = "0") |
| 75      | Reserved (default = "0") | Reserved (default = "0") |
| 76      | Reserved (default = "0") | Reserved (default = "0") |

**K4:** (b1 - b4) are allocated for higher order path Automatic Protection Switching (APS). (b5 - b7) are reserved for an optional use. If this option is not used, these bits shall be set to "000" or "111" and the receiver is required to ignore their content.

## K4 (b5 - b7) coding and triggers

| b5 | b6 | b7 | Meaning                   | Triggers         |
|----|----|----|---------------------------|------------------|
| 0  | 0  | 1  | No remote defect          | No remote defect |
| 0  | 1  | 0  | E-RDI payload defect      | PLM              |
| 1  | 0  | 1  | E-RDI server defect       | AIS, LOP         |
| 1  | 1  | 0  | E-RDI connectivity defect | TIM, UNEQ        |

## Informazioni correlate

- [Pagine di supporto dei prodotti ottici](#)
- [Documentazione e supporto tecnico – Cisco Systems](#)