Method and apparatus for transporting a client layer signal over an optical transport network (OTN)

1. A method of transporting a client layer signal (102) over an Optical Transport Network, said Optical Transport Network being designed for the transport of optical transport signals structured in accordance with an Optical Transport Hierarchy, said Optical Transport Hierarchy providing at least three multiplex layers k with k=1, 2, and 3 and defining corresponding Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), wherein said Optical Channel Data Units-k with k=1, 2, and 3 are of a size that four transport signals built from Optical Channel Data Units of a lower layer can be multiplexed into one transport signal built from Optical Channel Data Units of the next higher layer; wherein each Optical Channel Data Unit-k (110, ODU1, ODU2, ODU3) comprises an overhead area (114) and a payload area (113); wherein said Optical Transport Network supports at least said multiplex layer k=1 and corresponding Optical Channel Data Units-1 (110); wherein said method comprises the steps of

- generating a transport signal built from Optical Channel Data Units-0 (101), which are of a size that two transport signals built from Optical Channel Data Units-0 (101) can be multiplexed into one transport signal built from Optical Channel Data Units-1 (110),

- mapping said client layer signal (102) into the payload areas (103) of said Optical Channel Data Units-0 (101);

- multiplexing said Optical Channel Data Units-0 (101) into higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), said higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3) comprising tributary slots, which are of a size that fits to the size of said Optical Channel Data Units-0 (101); and

- providing a Multiplex Structure Identifier in an overhead field of said higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), said Multiplex Structure Identifier comprising one byte per tributary slot indicating the content of the corresponding tributary slot and identifying the Optical Channel Data Unit type of the tributary slots carrying said Optical Channel Data Units-0 as Optical Channel Data Unit-0.
A method of transporting a client layer signal (102) over an Optical Transport Network, said Optical Transport Network being designed for the transport of optical transport signals structured in accordance with an Optical Transport Hierarchy, said Optical Transport Hierarchy providing at least three multiplex layers \( k \) with \( k=1, 2, \) and \( 3 \) and defining corresponding Optical Channel Data Units \(-k\) (110, ODU1, ODU2, ODU3), wherein said Optical Channel Data Units \(-k\) with \( k=1, 2, \) and \( 3 \) are of a size that four transport signals built from Optical Channel Data Units of a lower layer can be multiplexed into one transport signal built from Optical Channel Data Units of the next higher layer; wherein each Optical Channel Data Unit \(-k\) (110, ODU1, ODU2, ODU3) comprises an overhead area (114) and a payload area (113); wherein said Optical Transport Network supports at least said multiplex layer \( k=1 \) and corresponding Optical Channel Data Units \(-1\) (110); wherein said method comprises the steps of

Comment: The G.709 specification defines the Optical Transport Hierarchy (OTH) enabling the mapping of client signals to be transported over an Optical Transport Network (OTN).

Source: Rec. ITU-T G.709/Y.1331 (12/2009), p 1
A method of transporting a client layer signal (102) over an Optical Transport Network, said Optical Transport Network being designed for the transport of optical transport signals structured in accordance with an Optical Transport Hierarchy, said Optical Transport Hierarchy providing at least three multiplex layers k with k=1, 2, and 3 and defining corresponding Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), wherein said Optical Channel Data Units-k with k=1, 2, and 3 are of a size that four transport signals built from Optical Channel Data Units of a lower layer can be multiplexed into one transport signal built from Optical Channel Data Units of the next higher layer; wherein each Optical Channel Data Unit-k (110, ODU1, ODU2, ODU3) comprises an overhead area (114) and a payload area (113); wherein said Optical Transport Network supports at least said multiplex layer k=1 and corresponding Optical Channel Data Units-1 (110); wherein said method comprises the steps of

Comment: The G.709 specification defines in particular three levels with corresponding Optical Channel Data Units-k (ODUk), with k= 1, 2 and 3.
A method of transporting a client layer signal (102) over an Optical Transport Network, said Optical Transport Network being designed for the transport of optical transport signals structured in accordance with an Optical Transport Hierarchy, said Optical Transport Hierarchy providing at least three multiplex layers $k$ with $k=1, 2, \text{ and } 3$ and defining corresponding Optical Channel Data Units $k$ (110, ODU1, ODU2, ODU3), wherein said Optical Channel Data Units $k$ with $k=1, 2, \text{ and } 3$ are of a size that four transport signals built from Optical Channel Data Units of a lower layer can be multiplexed into one transport signal built from Optical Channel Data Units of the next higher layer; wherein each Optical Channel Data Unit $k$ (110, ODU1, ODU2, ODU3) comprises an overhead area (114) and a payload area (113); wherein said Optical Transport Network supports at least said multiplex layer $k=1$ and corresponding Optical Channel Data Units-1 (110); wherein said method comprises the steps of

Comment: The G.709 specification allows for the multiplexing of four ODU1 signals into the OPU2 signal.

Comment: The G.709 specification allows for the multiplexing of four ODU2 signals into the OPU3 signal.
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A method of transporting a client layer signal (102) over an Optical Transport Network, said Optical Transport Network being designed for the transport of optical transport signals structured in accordance with an Optical Transport Hierarchy, said Optical Transport Hierarchy providing at least three multiplex layers k with k=1, 2, and 3 and defining corresponding Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), wherein said Optical Channel Data Units-k with k=1, 2, and 3 are of a size that four transport signals built from Optical Channel Data Units of a lower layer can be multiplexed into one transport signal built from Optical Channel Data Units of the next higher layer; wherein each Optical Channel Data Unit-k (110, ODU1, ODU2, ODU3) comprises an overhead area (114) and a payload area (113); wherein said Optical Transport Network supports at least said multiplex layer k=1 and corresponding Optical Channel Data Units-1 (110); wherein said method comprises the steps of

A method of transporting a client layer signal (102) over an Optical Transport Network, said Optical Transport Network being designed for the transport of optical transport signals structured in accordance with an Optical Transport Hierarchy, said Optical Transport Hierarchy providing at least three multiplex layers k with k=1, 2, and 3 and defining corresponding Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), wherein said Optical Channel Data Units-k with k=1, 2, and 3 are of a size that four transport signals built from Optical Channel Data Units of a lower layer can be multiplexed into one transport signal built from Optical Channel Data Units of the next higher layer; wherein each Optical Channel Data Unit-k (110, ODU1, ODU2, ODU3) comprises an overhead area (114) and a payload area (113); wherein said Optical Transport Network supports at least said multiplex layer k=1 and corresponding Optical Channel Data Units-1 (110); wherein said method comprises the steps of

Comment: The G.709 specification specifies several ODUk multiplexing layers.

Comment: The G.709 specification specifies at least a multiplexing layer for k=1.

Comment: Some cited data or equivalent not in ITU-T G.709/Y.1331 (03/2003) specification.

- generating a transport signal built from Optical Channel Data Units-0 (101), which are of a size that two transport signals built from Optical Channel Data Units-0 (101) can be multiplexed into one transport signal built from Optical Channel Data Units-1 (110),

7.4 ODUk time-division multiplex

Figure 7-1A shows the relationship between various time-division multiplexing elements that are defined below, and illustrates possible multiplexing structures. Table 7-10 provides an overview of valid tributary slot types and mapping procedure configuration options.

Up to 2 ODU0 signals are multiplexed into an ODTUG1 (PT=20) using time-division multiplexing. The ODTUG1 (PT=20) is mapped into the OPU1.

Comment: Some cited data or equivalent not in ITU-T G.709/Y.1331 (03/2003) specification.

- mapping said client layer signal (102) into the payload areas (103) of said Optical Channel Data Units-0 (101);

Rec. ITU-T G.709/Y.1331 (12/2009), p 19 (Fig. 6-2)

12 Optical channel data unit (ODUk)

12.1 ODUk frame structure

The ODUk ($k = 0, 1, 2, 2e, 3, 4, \text{flex}$) frame structure is shown in Figure 12-1. It is organized in an octet-based block frame structure with four rows and 3824 columns.

Figure 12-1 – ODUk frame structure

- multiplexing said Optical Channel Data Units-0 (101) into higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), said higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3) comprising tributary slots, which are of a size that fits to the size of said Optical Channel Data Units-0 (101); and

Comment: According to the G.709 specification, two ODU0 signals are multiplexed into the OPU1 signal (the payload of an ODU1 signal) and, thus, into an ODU1 signal.

Comment: Some cited data or equivalent not in ITU-T G.709/Y.1331 (03/2003) specification.

- multiplexing said Optical Channel Data Units-0 (101) into higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), said **higher layer Optical Channel Data Units-k** (110, ODU1, ODU2, ODU3) **comprising tributary slots**, which are of a size that fits to the size of said Optical Channel Data Units-0 (101); and

Comment: An ODU1 comprises and OPU1 which is divided into two tributary slots. Each tributary slot occupies half of the OPU1 payload. Since two ODU0s are multiplexed into OPU1, each tributary slot thus fits to the size of an ODU0.

Comment: Some cited data or equivalent not in ITU-T G.709/Y.1331 (03/2003) specification.

multiplexing said Optical Channel Data Units-0 (101) into higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), said higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3) comprising tributary slots, which are of a size that fits to the size of said Optical Channel Data Units-0 (101); and

**Fig. 1**

Comment: Comparison of Fig. 1 of EP 1657839 to Fig. 19-3 of the G.709 specification.

Comment: Some cited data or equivalent not in ITU-T G.709/Y.1331 (03/2003) specification.

- providing a Multiplex Structure Identifier in an overhead field of said higher layer Optical Channel Data Units-κ (110, ODU1, ODU2, ODU3), said Multiplex Structure Identifier comprising one byte per tributary slot indicating the content of the corresponding tributary slot and identifying the Optical Channel Data Unit type of the tributary slots carrying said Optical Channel Data Units-0 as Optical Channel Data Unit-0.

- providing a Multiplex Structure Identifier in an overhead field of said higher layer Optical Channel Data Units-k (110, ODU1, ODU2, ODU3), said Multiplex Structure Identifier comprising one byte per tributary slot indicating the content of the corresponding tributary slot and identifying the Optical Channel Data Unit type of the tributary slots carrying said Optical Channel Data Units-0 as Optical Channel Data Unit-0.

Source: Rec. ITU-T G.709/Y.1331 (12/2009), p 24, Fig. 7-4

Comment: Some cited data or equivalent not in ITU-T G.709/Y.1331 (03/2003) specification.