Siemens Aktiengesellschaft, incorporated in the Federal Republic of Germany, of Wittelsbacherplatz 2, D-8000 Munich 2, FEDERAL REPUBLIC OF GERMANY, hereby apply for the grant of a standard patent for an invention entitled:

Cross-Connect Method for STM-1 Signals of the Synchronous Digital Multiplex Hierarchy

which is described in the accompanying complete specification.

Details of basic application(s):-

<table>
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<tr>
<th>Basic Applic. No.</th>
<th>Country</th>
<th>Application Date</th>
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<tbody>
<tr>
<td>P3928905.2</td>
<td>DE</td>
<td>31 August 1989</td>
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<tr>
<td>P3930007.2</td>
<td>DE</td>
<td>8 September 1989</td>
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DATED this THIRTIETH day of AUGUST 1990

Siemens Aktiengesellschaft

By: [Signature]

Registered Patent Attorney

TO: THE COMMISSIONER OF PATENTS
OUR REF: 136038
S&F CODE: 61890

5845/3
COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A
CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a patent for an invention entitled: Cross-Connect Method for STM-1 Signals of the Synchronous Digital Multiplex Hierarchy

I/We Fraser Patison Old

of Spruson & Ferguson
31 Market Street
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do solemnly and sincerely declare as follows:

1. I am/We are the applicant(s) for the patent
   (or, in the case of an application by a body corporate)

2. I am/We are authorised by Siemens Aktiengesellschaft
   the applicant(s) for the patent to make this declaration on its/their behalf.

3. The basic application(s) as defined by Section 141 of the Act was/were made
   in the Federal Republic of Germany
   on 31 August 1989 and 8 September 1989
   both by Siemens Aktiengesellschaft

3. I am/We are the actual inventor(s) of the invention referred to in the basic application(s)
   (or where a person other than the inventor is the applicant)

3. Reginhard Pospischil and Horst Mueller
   of Gabr V Seidlstr 15, 8032 Graefelfing Lochham and Dammstr. 11, 8021 Hohenschaeftlarn both of the Federal Republic of Germany (respectively)
   is/are the actual inventor(s) of the invention and the facts upon which the applicant(s) is/are entitled to make the application are as follows:
   The said company is the assignee of the actual inventors.

4. The basic application(s) referred to in paragraph 2 of this Declaration was/were the first application(s) made in a Convention country in respect of the invention(s) the subject of the application.

Declared at Sydney this 8 day of October 1990

Signature of Declarant(s) 11/81
CROSS-CONNECT METHOD FOR STM-1 SIGNALS OF THE SYNCHRONOUS DIGITAL MULTIPLEX HIERARCHY

1. A cross-connect method for STM-1 signals of the synchronous digital multiplex hierarchy upon multiple employment of demultiplexing methods wherein each STM-1 signal is first divided into three AU-32, TU-32 and TUG-32 high level units, or for AU-31, TU-31 and TUG-31 high level units and these are subsequently respectively divided into subunitary units TUG-21, TU-11, TU-12, TUG-22, TU-12, TU-22 including individual outputs VC-32, VC-31 for the separation of 1544, 6312, 44736, 2048, 34368 kbit/s signals, optionally via different paths, upon multiple employment of multiplexing methods that reverse these demultiplexing methods and upon employment of methods for the operation of a switching matrix network, said method comprising the following steps wherein:

said STM-1 signals are resolved in the demultiplexing methods into virtual container groups of approximately the same length;

an individual switching matrix network clock matching pointer and an individual switching matrix network overhead are respectively attached to these virtual container groups for the formation of uniform switching matrix network input signals upon waiver of auxiliary signals that are no longer required;

controlled by the signal content of the switching matrix network input signals and/or by a network management, switching matrix...
network input signals deriving respectively from a high level unit are supplied to the switching matrix network;

the virtual containers of the switching matrix network input signals are rearranged before acceptance into the switching matrix network output signals;

the switching matrix network overheads are taken from the switching matrix network output signals and are evaluated;

the switching matrix network output signals are respectively subjected to a multiplexing method for the formation of STM-1 output signals; and

controlled by the signal content of the switching matrix network output signals and/or by the network management, respectively one path in the multiplexing method is thereby selected.
Complete Specification for the invention entitled:

Cross-Connect Method for STM-1 Signals of the Synchronous Digital Multiplex Hierarchy

The following statement is a full description of this invention, including the best method of performing it known to me/us.
CROSS-CONNECT METHOD FOR STM-1 SIGNALS OF THE SYNCHRONOUS DIGITAL MULTIPLEX HIERARCHY

The present invention relates to a cross-connect method for STM-1 signals of the synchronous digital multiplex hierarchy.

The multiplexing and demultiplexing methods addressed therein are known, for example, from CCITT Recommendation G.709, Fig. 1.1/G.709 and from a multiplex structure that was discussed at the European Transmission Standards Institute ETSI at the TM3 Meeting (Transmission and Multiplexing) in Brussels between April 24 and 28, 1989.

German Published Application DE 35 11 354 A1 discloses a method and a switching equipment for distributing plesiochronic broadband digital signals, whereby these signals, controlled by a central clock, are converted into intermediate digital signals containing auxiliary signals upon stuffing and, after passing through a switching matrix network, are in turn reconverted into plesiochronic broadband digital signals.

In an earlier proposal (P 38 31 944.6), data blocks of different multiplexing levels are converted into cross-connected data blocks that are ordered in a fixed super-frame for a transmission bit rate of 38 912 kbit/s (039 signal).

An object of the invention is to specify a method with which data blocks having differing multiplex structure can be converted into cross-connect data blocks.

In accordance with the present invention there is disclosed a cross-connect method for STM-1 signals of the synchronous digital multiplex hierarchy upon multiple employment of demultiplexing methods wherein each STM-1 signal is first divided into three AU-32, TU-32 and TUG-32 high level units, or four AU-31, TU-31 and TUG-31 high level units and these are subsequently respectively divided into tributary units TUG-21, TU-11, TU-12, TUG-22, TU-12, TU-22 including individual outputs VC-32, VC-31 for the separation of 1544, 6312, 44736, 2048, 34368 kbit/s signals, optionally via different paths, upon multiple employment of multiplexing methods that reverse these demultiplexing methods and upon employment of methods for the operation of a switching matrix network, said method comprising the following steps wherein:

- said STM-1 signals are resolved in the demultiplexing methods into virtual container groups of approximately the same length;
an individual switching matrix network clock matching pointer and an individual switching matrix network overhead are respectively attached to these virtual container groups for the formation of uniform switching matrix network input signals upon waiver of auxiliary signals that are no longer required;

controlled by the signal content of the switching matrix network input signals and/or by a network management, switching matrix network input signals deriving respectively from a high level unit are supplied to the switching matrix network;

the virtual containers of the switching matrix network input signals are rearranged before acceptance into the switching matrix network output signals;

the switching matrix network overheads are taken from the switching matrix network output signals and are evaluated;

the switching matrix network output signals are respectively subjected to a multiplexing method for the formation of STM-1 output signals; and

controlled by the signal content of the switching matrix network output signals and/or by the network management, respectively one path in the multiplexing method is thereby selected.

Developments of the method may be derived from the subclaims.

A virtual container group is composed of one or more virtual containers, tributary units or tributary unit groups.

A converter for transition from the structure of a tributary unit group TUG-31 or TUG-32 to the structure of a tributary unit
TU-31 or TU-32 can be realized with this method. This method is likewise suited for constructing what is referred to as a drop insert multiplexer for the synchronous digital multiplex hierarchy.

FIG. 1 shows a first multiplexing structure;
FIG. 2 shows a tributary unit super-frame;
FIG. 3 shows a second multiplexing structure;
FIG. 4 shows a virtual container VC-4 with one tributary unit TU-31 and three tributary unit groups TUG-31;
FIG. 5a shows a first demultiplexer;
FIG. 5b shows a first multiplexer;
FIG. 6a shows a second demultiplexer;
FIG. 6b shows a second multiplexer; and
FIG. 7 shows a second demultiplexer and multiplexer controlled in common.

FIG. 1 shows the multiplexing structure of CCITT Recommendation G.709, FIG. 1.1/G.709. AU denotes administration unit, C denotes container, H denotes digital signal, STM denotes synchronous transport module, TU denotes tributary unit, TUG denotes tributary unit group and VC denotes virtual container.

The digital signals to be transmitted are inserted into containers C-n at the input node to the synchronous network with positive stuffing. Every container is augmented to form a virtual container VC-n by attaching a path overhead POH, these virtual containers being periodically transmitted. The first byte of a virtual container is indicated by a pointer PTR whose chronological position in the transmission frame is fixed. The virtual container of a higher hierarchy level usually serves as such. A virtual container VC-n together with the pointer allocated to it forms a tributary unit TU-n. A plurality of these having the same structure can in turn be combined to form a
tributary unit group TUG-n. The afore-mentioned CCITT Recommendations cite tributary unit groups TUG-21 for the North American 1.5 Mbit/s hierarchy and TUG-22 for the 2-Mbit/s hierarch that, among other things, is standard in Europe.

FIG. 1 shows the various ways via which a multiplexing or demultiplexing is possible. Thus, for example, sixty-four H12 signals can be inserted into the virtual container VC-4 either directly via the tributary unit group TUG-22 or via the route via the virtual container VC-31 and the formation of the tributary unit TU-31.

As FIG. 2 or the CCITT Recommendation G.709, FIG. 3.13/G.709 show, the tributary units TU-12 or, respectively, TU-22 are subdivided in super-frames of 500 μs each. Such a super-frame contains four frames having a period duration of 125 μs. The first byte V1, V2, V3 and V4 of each and every frame is defined in the CCITT Recommendation G.709. The bytes V1 are always situated in the first line of a super-frame. The path overhead POH of the virtual container VC-31 or, respectively, of the virtual container VC-4 defines the super-frame with a byte H4. The first line is identified by a byte J1. Given the direct insertion of the tributary unit group TUG-22 into the virtual container VC-4, thus, the path overhead POH of the virtual container VC-4 determines the position of the bytes Vn, whereas, given an insertion via the virtual container VC-31, the path overhead VC-31 POH of the virtual container VC-31 defines the arrangement of the bytes Vn.

Both methods have their advantages and disadvantages. The same multiplexing equipment, however, are required at both ends of a connection when a converter is not inserted into the connection that, for example, shapes the sixteen tributary unit groups TUG-22 of the one path into four tributary units TU-31 of
the other path. This is also valid for the transmission of a maximum of sixteen 8448 kbit/s signals or for a mixing of 8448 kbit/s signals and 2048-kbit/s signals (H12 signals). The analogous case is true for the formatting of the virtual container VC-4 via twenty one tributary unit groups TUG-21 or three tributary units TU-31 for the 1.5 Mbit/hierarchy in the upper part of FIG. 1.

34368-kbit/s signals (H21 signals) can be inserted only by way of the virtual container VC-31 and the tributary unit TU-31. A mixing of n x 4 tributary unit groups TUG-22 with 4 - n tributary units TU-31 with n = 1, 2, 3 or 4 is not provided according to CCITT Recommendation G.709.

The arrangement of FIG. 3 of ETSI differs from that of FIG. 1 by the omission of the way from the tributary unit group TUG-22 via the virtual container VC-31 and the tributary unit TU-31 to the virtual container VC-4. On the other hand, it is possible to construct virtual containers VC-4 with a mixture of n x 4 tributary unit groups TUG-22 and 4 - n tributary units TU-31. Four tributary unit groups TUG-22 form one tributary unit group TUG-31. By contrast to a tributary unit TU-31, this does not have its own pointer and also does not have a common path overhead. However, the pointers of the tributary units TU-12 or TU-22 belonging to a tributary unit group TUG-31 are regularly arranged. Their position is defined by the path overhead VC-4 POH of the virtual container VC-4. In such a mixture, the first four columns of a container C-4 contain the TU-31 pointers or a fixed pattern (stuffing).

FIG. 4 shows an example wherein two tributary unit groups TU-31, one tributary unit TU-31 and a third tributary unit group TUG-31 are inserted in alternation in a virtual container VC-4 by columns. On the basis of an evaluation of the first four columns
with fixed stuff bytes FS and a pointer TU-31 PTR, one obtains information as to whether a tributary unit group TUG-31 or a tributary unit TU-31 is involved. The virtual container VC-31 that is shown at the bottom right is inserted by rows in alternation into the third of four columns after the path overhead VC-4 POH, whereby the position of the byte J1 is described by the pointer TU-31 PTR. The tributary unit groups TUG-31 begin in the first, second and fourth columns with a respective byte V1, there being forty-eight of these in this example.

In digital cross-connectors, as in drop insert multiplexers, all signals that are to be combined to form a new output signal must be synchronized to the clock and to the frame of the output signal. All output signals STM-1 of a network node have the same clock and the same frame in the synchronous digital multiplex hierarchy. All signals that are passed through closed, are divided into tributary units and are again combined after a switching matrix network must therefore be synchronized to one another before their combination.

FIG. 5a shows a demultiplexer that precedes the switching matrix network at the input side. The arrangement contains an AU-4-PTR out-coupling means and evaluator 2, a VC-4-POH out-coupling means and evaluator 4, a container demultiplexer with synchronization means 6, a parallel brancher 7, a first path having a TU-3x-PTR-out-coupling means and evaluator 8, with a TU-3x switching matrix network clock matching pointer in-coupling means 10, and with a switching matrix network auxiliary information insertion means 12, contains a second path having a fixed stuff byte out-coupling means 14, having a multiple TU-ly-PTR out-coupling means and evaluator 16, having a multiple TU-ly switching matrix network clock matching pointer in-coupling and
synchronizing means 18, and having a switching matrix network auxiliary information insertion means 20 as well as, further, a signal switch-over means 22. The units 7-22 are present four times for the 2-Mbit/s hierarchy and are present three times for the 1.5-Mbit/s hierarchy, this being indicated for the former instance by the four outputs of the container demultiplexer with the synchronizing means 6. What is valid for the European hierarchy is \(x = 1\) and \(y = 2\); what is valid for the U.S. hierarchy is \(x = 2\) and \(y = 1\). The buffer memories required for every clock matching are not shown here and in the following figures for the sake of clarity.

The AU-4 administration unit of a synchronous transport module STM-1 is supplied to the input 1. The AU-4-PTR pointer is output and interpreted via an output 3 from the AU-4-PTR out-coupling means and evaluator 2. The remaining VC-4 virtual container proceeds to the VC-4-POH out-coupling means and evaluator 4 that evaluates the VC-4-POH path overhead and outputs it at its output 5. The information about the container start and the super-frame status are communicated to the following circuits 6, 18, 14, 16, 18 and 20. The C-4 container proceeds to the container demultiplexer with synchronizing means 6. Therein, it is divided into four TU-3x tributary units for the 2-Mbit/s hierarchy and into three TU-3x tributary units, four TUG-3x tributary unit groups or a mixture of the two for the 1.5-Mbit/s hierarchy. Either a respective TU-3x tributary unit or a TUG-3x tributary unit group are supplied to the four parallel branchers 7.

A check to see whether a TU-3x-PTR pointer or whether fixed stuff bytes FS are present is carried out in the TU-3x-PTR out-coupling means and evaluator 8 in the first path and in the fixed stuff byte out-coupling means 14 in the second path. When a TU-
3x-PTR pointer is present, this is evaluated and output via an output 9. The information about the container start and the super-frame status are communicated to the following circuits 10 and 12. When fixed stuff bytes FS are present, these are output via an output 15.

A VC-3x virtual container with its source clock may be available at the output of the TU-3x-PTR out-coupling means and evaluator 8. In the TU-3x switching matrix network clock matching pointer in-coupling means 10, this VC-3x virtual container is synchronized to the local switching matrix network clock derived from the network node clock upon insertion of a TU-3x-PTR-(KF) pointer for clock matching and, in the switching matrix network auxiliary information insertion means 12, is inserted into a switching matrix network super-frame together with the switching matrix network auxiliary information KFOH at the input 13. When the output 23 is connected via the signal switch-over means 22 to the output of the switching matrix network auxiliary information insertion means 12, a D39 digital signal is available at the output for \( x = 1 \) and a D52 digital signal is available thereat for \( x = 2 \). This can be supplied either to a demultiplexer (not shown) for resolution of the VC-3x virtual container or to a multiplexer according to FIG. 5b for constructing a new AU-4 administration unit.

If, however, fixed stuff bytes were to be recognized in the fixed stuff byte out-coupling means 14, a TUG-3x tributary unit group would appear at its main output, and this would be composed either of sixteen TU-12 tributary units or of twenty eight TU-11 tributary units (m TU-ly tributary units). In the multiple TU-ly-PTR out-coupling means and evaluator 16, m TU-ly-PTR pointers would be evaluated and eliminated via an output 17. m VC-ly virtual containers would proceed from the multiple TU-ly-PTR out-
coupling means and evaluator 16 to the multiple TU-ly switching matrix network clock matching pointer in-coupling and synchronizing means 18. Upon insertion of m TU-ly-PTR-(KF) pointers, it would be synchronized there to the local switching matrix network clock and, via an input 21, would be embedded into the switching matrix network super-frame in the switching matrix network auxiliary information insertion means 20 upon supply of the switching matrix network auxiliary information KFOH. If the signal switch-over means 22 were now to connect the output 23 to the main output of the switching matrix network auxiliary information insertion means 20, either a D39 digital signal or a D52 digital signal would likewise proceed to the output 23.

The switching matrix network overhead insertion means 20 expediently also contains a "router" function (time switching matrix network) with which the chronological sequence of the m VC-ly virtual containers can be varied.

The D39 or D52 digital signal now available at the output 23 can be supplied via a time slot-controlled switching matrix network either to a demultiplexer (not shown) for resolution of the individual VC-ly virtual containers into plesiochronic signals Hly via C-ly containers or can be supplied to a multiplexer conforming to FIG. 5 for constructing new AU-4 administration units.

FIG. 5b shows a multiplexer for the transmission side of the switching matrix network. The arrangement contains a parallel brancher 25, a first path having a switching matrix network overhead out-coupling means 26, having a TU-3x switching matrix network clock matching pointer out-coupling means and evaluator 28 and having a TU-3x-PTR in-coupling means 30, further contains a signal switch-over means 32, a container multiplexer 33, a VC-4-POH in-coupling means 34, an AU-4-PTR in-coupling means 36,
contains a second path having a switching matrix network overhead out-coupling means 39, having a multiple TU-1y switching matrix network clock matching pointer out-coupling means and evaluator 41, having a multiple TU-1y-PTR in-coupling means 43 and having a fixed stuff byte in-coupling means 45.

The multiplexing method is executed in the inverse sequence of the demultiplexer according to FIG. 5a. First, the switching matrix network overhead KFOH is out coupled, evaluated and output via the output 27 in the switching matrix network overhead out-coupling means 26. The TU-3x-PTR-(KF) pointer is evaluated and output via the output 29 in the TU-3x switching matrix network clock matching pointer out-coupling means and evaluator 28. A TU-3x-PTR pointer is attached to the remaining VC-3x virtual container in the TU-3x-PTR in-coupling means 30. However, no clock matching by stuffing is thereby required since all D39 or, respectively, D52 digital signals have already been synchronized to the network node clock before the switching matrix network.

In the case of the D39 or D52 digital signal, the switching matrix network overhead information KFOH is evaluated in the switching matrix network overhead out-coupling means 39 and is output via the output 40. The remaining m TU-1y tributary units proceed to the multiple TU-1y switching matrix network clock matching pointer out-coupling means and evaluator 41 where the m TU-1y-PTR-(KF) pointers are evaluated and output via the output 42. Here, too, no clock matching by stuffing is required since all D39 or, respectively, D52 digital signals were already synchronized to the network node clock before the switching matrix network. m TU-1y-PTR pointers are supplied to the remaining m VC-1y virtual containers in the multiple TU-1y-PTR in-coupling means 43 via an input 44. Fixed stuffed bytes FS are attached into the output TUG-3x tributary unit group in the fixed
stuff byte in-coupling means 45.

The position of the signal switch-over means 32 is based on the signal content of the D39 or, respectively, D52 signal or is defined by a network management. Ensuing in the container multiplexer 33 is a byte-by-byte n string of four TU-3x tributary units for the 2-Mbit/s hierarchy and of three TU-3x tributary units and/or TUG-3x tributary unit groups for the 1.5-Mbit/s hierarchy. A VC-4-POH path overhead is attached to the C-4 container in the VC-4-POH in-coupling means 34 via an input 35. An AU-4-PTR pointer is attached to the VC-4 virtual container formed in this way in the AU-4-PTR in-coupling means 36, so that an AU-4 administration unit of a synchronous transport module STM-1 can be output at the output 38.

The demultiplexer shown in FIG. 5a and the multiplexer shown in FIG. 5b is suitable for "drop and insert" functions, for "routing" functions and cross-connects for signals at the nodes of TUG-3x tributary unit groups of the ETSR proposal according to FIG. 3.

With the additional functions shown in FIGS. 6a and 6b, TUG-2y tributary unit groups of FIG. 1 can also be conducted into the VC-4 virtual container via VC-3x virtual containers and TU-3x tributary units and can be handled in a corresponding way.

By contrast the to the demultiplexer of FIG. 5a, the demultiplexer of FIG. 6a additionally contains a third path having a parallel branching 47, having a VC-3x-POH out-coupling means 48 and having a signal switch-over means 50. By contrast to the multiplexer of FIG. 5b, the multiplexer of FIG. 6b additionally contains a third path having a switch-over means 51, having a VC-3x-POH in-coupling means 52 and having a parallel branching 54. When a VC-3x virtual container is to be through-connected in closed form, then the path leads via the units 47,
10, 12 and 22 or, respectively, 25, 26, 28 and 51. When, however, a VC-3x virtual container is to be divided into its TU-ly tributary units, then the paths via the units 47, 48, 50, 16, 18, 20 and 22 or, respectively, 25, 39, 41, 43, 54, 52 and 51 are activated. The VC-3x-POH path overhead is taken from a VC-3x virtual container and evaluated in the VC-3x-POH out-coupling means 48 via an output 49. This indicates the start byte and super-frame affiliation for the C-3x container. The content of the C-3x container has the same structure as a TUG-3x tributary unit group and can therefore be handled farther via the units 16, 18 and 20 as in FIG. 5a.

Correspondingly, a VC-3x-POH path overhead is attached to the VC-3x-POH in-coupling means 52 [sic] in FIG. 6b via input 53.

The functions in the respectively first and second paths shown in FIGS. 5a, 5b, 6a and 6b largely coincide. In FIGS. 5a and 5b, thus, the pointer column of an incoming TU-3x tributary unit is investigated and gated out in the units 8 and 14. The units 10 and 18 serve the purpose of inserting the TU-3x-PTR-(KF) pointer synchronized to the switching matrix network clock and super-frame and the units 12 and 20 serve the purpose of inserting the switching matrix network overhead KFOH. The analogous case applies to the multiplexer side in FIGS. 5b and 6b.

FIG. 7 shows an arrangement in which these parallel functions are respectively executed by a single function unit. These are given reference characters wherein the two, original reference characters are joined by a slash. The VC-3x-POH out-coupling means 48' and the VC-3x-POH in-coupling means 52' must also assume through-connection functions for the respectively first and second path.
An AU-4 administration unit incoming at the input 1 is edited in the equipment 2, 4 and 6, is synchronized to the network node clock and divided into its TU-3x tributary units or TUG-3x tributary unit groups. A determination is made in the unit 8/14 to see whether the first pointer column contains a TU-3x-PTR pointer or fixed stuff bytes FS. In the former instance, only the first three bytes of the column are evaluated and taken from the signal. In the second instance, by contrast, the entire column having nine bytes is taken. If the TU-3x tributary unit or the TUG-3x tributary unit group is to be divided farther, for example into their m TU-1y tributary units, then the VC-3x-POH path overhead is first resolved in the unit 48' for a TU-3x tributary unit. This step is eliminated given a TUG-3x tributary unit group. Subsequently, the m TU-1y-PTR pointers must be evaluated in the unit 16 with the assistance of the byte H4 from the VC-4-POH path overhead or from the VC-3x-POH path overhead. The synchronization to the switching matrix network clock and super-frame and an insertion of the TU-3x-PTR-(KF) pointer or TU-1y-PTR-(KF) pointer of the switching matrix network ensues in the unit 10/18. The D39 or, respectively, D52 signal is formed by attaching the switching matrix network overhead KFOH in the unit 12/20.

The formatting of the multiplex signal in the opposite direction ensues correspondingly between the input 24 and the output 38. All function units are controlled via a bus system 57 by a microprocessor 55 that is connected to a network management system via a terminal 56.
The claims defining the invention are as follows:

1. A cross-connect method for STM-1 signals of the synchronous digital multiplex hierarchy upon multiple employment of demultiplexing methods wherein each STM-1 signal is first divided into three AU-32, TU-32 and TUG-32 high level units, or four AU-31, TU-31 and TUG-31 high level units and these are subsequently respectively divided into low level units TUG-21, TU-11, TU-12, TUG-22, TU-12, TU-22 including individual outputs VC-32, VC-31 for the separation of 1544, 6312, 44736, 2048, 64448, and/or 34368 kbit/s signals, optionally via different paths, upon multiple employment of multiplexing methods that reverse these demultiplexing methods and upon employment of methods for the operation of a switching matrix network, said method comprising the following steps wherein:

   said STM-1 signals are resolved in the demultiplexing methods into virtual container groups of approximately the same length;

   an individual switching matrix network clock matching pointer and an individual switching matrix network overhead are respectively attached to these virtual container groups for the formation of uniform switching matrix network input signals upon waiver of auxiliary signals that are no longer required;

   controlled by the signal content of the switching matrix network input signals and/or by a network management, switching matrix network input signals deriving respectively from a high level unit are supplied to the switching matrix network;

   the virtual containers of the switching matrix network input signals are rearranged before acceptance into the switching matrix network output signals;

   the switching matrix network overheads are taken from the switching matrix network output signals and are evaluated;
the switching matrix network output signals are respectively subjected to a multiplexing method for the formation of STM-1 output signals; and controlled by the signal content of the switching matrix network output signals and/or by the network management, respectively one path in the multiplexing method is thereby selected.

2. Method according to claim 1, characterized in that a switching matrix network frame recognition word, switching matrix network route addresses, and switching matrix network quality monitoring information are provided as switching matrix network overhead.

3. Method according to claim 1, characterized in that a switching matrix network overhead is attached only to the switching matrix network input signals supplied to the switching matrix network.

4. Method according to claim 1, characterized in that virtual container groups 16 x VC-12, 4 x VC-22, 1 x VC-31, 20 x VC-11 and/or 5 x VC-21 are provided; switching matrix network clock matching pointers TU-12 PTR (KF), TU-22 PTR (KF), TU-31 PTR (KF), TU-11 PTR (KF) and/or TU-21 PTR (KF) are provided; and switching matrix network input signals and output signals (D39) having a bit rate of 38912 kbit/s are provided.

5. Method according to claim 1, characterized in that virtual container groups 28 x VC-11, 7 x VC-21, 1 x VC-32 and/or 21 x VC-12 are provided; switching matrix network clock matching pointers TU-11 PTR (KF),
TU-21 PTR (KF), TU-32 PTR (KF) and/or TU-12 PTR (KF) are provided; and switching matrix network input signals and output signals (D52) having a bit rate of 51968 kbit/s are provided.

6. Method according to claim 1 for the input side of the switching matrix network, whereby a VC-4 virtual container is taken from a STM-1 signal from its AU-4 administration unit upon out-coupling and evaluation of an AU-4-PTR administration unit pointer, whereby the C-4 container is taken from the VC-4 virtual container upon out-coupling and evaluation of its VC-4-POH path overhead, and whereby the C-4 container is divided into four alternative pairs each respectively composed of one TU-3x tributary unit or of one TUG-3x tributary unit group, characterized in that each alternative pair is supplied to two paths connected at the input side and alternately through-connectable to the switching matrix network at the output side:
in that, in the first path, the VC-3x virtual container is taken from a TU-3x tributary unit upon out-coupling and evaluation of the TUG-3x-PTR tributary unit pointer and a TU-3x-PTR-(KF) switching matrix network clock matching pointer and a switching matrix network overhead (KFOH) are attached to the VC-3x virtual container; and
in the second path, a fixed stuffing (FS) and a plurality m of TUG-1y-PTR tributary unit pointers are taken from a TUG-3x tributary unit group upon evaluation and a plurality m of TU-1y-PTR-(KF) switching matrix network clock matching pointers and a switching matrix network overhead (KFOH) are attached to the remaining plurality m of VC-1y virtual containers for the formation of a switching matrix network input signal (D39, D52)
(x = 1 and y = 2 or x = 2 and y = 1).

7. Method according to claim 6, characterized in that the VC-3x virtual container is supplied to a third path that branches off from the first path;
the C-3x container is taken from the VC-3x virtual container on the third path upon out-coupling of its VC-3x-POH path overhead;
and
instead of a TUG-3x tributary unit group without fixed FS stuffing, this C-3x container is supplied into the remaining part of the second path upon disconnection of the corresponding, first part of the second path.

8. Method according to claim 1 for respectively four switching matrix network output signals, whereby a respective VC-4-POH path overhead is attached to the C-4 containers for the formation of a VC-4 virtual container, and whereby a respective AU-4-PTR pointer is attached to the VC-4 virtual containers for the formation of AU-4 administration units of STM-1 signals, characterized in that groups of four switching matrix network output signals are formed;
each switching matrix network output signal (D39, D52) is supplied to two paths that are connected at the input side and are alternately through-connectable at the output side;
the switching matrix network overhead (KFOH) and the TU-3x-PTR-(KF) switching matrix network clock matching pointer are taken in the first path for acquiring a TU-3x tributary unit and a TU-3x-PTR pointer is attached;
the switching matrix network overhead (KFOH) and a plurality m of TU-1y-PTR-(KF) switching matrix network clock matching pointers are taken in the second path for acquiring a TUG-3x tributary
unit group and a plurality m of TU-1y-PTR pointers and a fixed stuffing (FS) are attached; and either the TU-3x tributary unit or the TUG-3x tributary unit group of each of the four alternative pairs is respectively inserted into a C-4 container (x = 1 and y = 2 or x = 2 and y = 1).

9. Method according to claim 8, characterized in that the TUG-3x tributary unit group without fixed stuffing (FS) is supplied to a third path branching off from the second path after the in-coupling of a plurality m of TU-1y-PTR pointers; a VC-3x-POH path overhead is attached to the C-3x container in the third path for the formation of a VC-3x virtual container; and this VC-3x virtual container is supplied into the remaining part of the first path for the acceptance of a TU-3x-PTR pointer upon disconnection of the corresponding, first part of the first path.

10. Method according to claim 6, 7, 8 or 9, characterized in that identical method steps are implemented in the first and second path with respectively one arrangement in time-division multiplex.

11. Method according to claim 6, 7, 8 or 9, characterized in that switching-over steps are triggered by the signal content and/or by the network management.

12. Method according to one of the preceding claims, characterized in that the method steps are controlled by a microprocessor.
13. Method according to one of the preceding claims, characterized by the execution thereof in an integrated circuit.

14. A cross-connect method for STM-1 signals of the synchronous digital multiplex hierarchy substantially as described herein with reference to any one of the drawings.

DATED this THIRD day of MAY 1991

Siemens Aktiengesellschaft

Patent Attorneys for the Applicant
SPRUSON & FERGUSON
FIG 2

H4-byte

xxxxxx00

V1

125μs

V2

250μs

V3

375μs

V4

500μs

V5

TU

VC

VC-11 VC-12 VC-21 VC-22

26 35 107 143

26 35 107 143

26 35 107 143

26 35 107 143

104 140 428 572

byte/500 μs
FIG. 3

- AU-32
- VC-32
- TU-32
- TUG-32
- AU-4
- VC-4
- TU-31
- TUG-31
- AU-31
- VC-31
- TU-22
- TUG-22
- C-31
- C-32
- C-21
- C-11
- C-12
- C-4

- STMn
- STM1

- x1
- x3
- x4
- x5
- x7

- 44736 kbit/s
- 6312 kbit/s
- 1544 kbit/s
- 139264 kbit/s
- 2048 kbit/s
- 8448 kbit/s
- 34368 kbit/s
FIG 4

<table>
<thead>
<tr>
<th>J1</th>
<th>B3</th>
<th>C2</th>
<th>G1</th>
<th>F2</th>
<th>H4</th>
<th>Z3</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>V1</td>
<td>V1</td>
<td>V1</td>
<td>V1</td>
<td>V1</td>
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</tr>
</tbody>
</table>

TU-31PTR

TU-12 PTR

260

VC-4 POH

FS

VC-31 POH

VC-4

VC-31

C-4

C-31