

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
24 December 2008 (24.12.2008)

PCT

(10) International Publication Number
WO 2008/155349 A1

(51) International Patent Classification:
H04J 3/06 (2006.01)

(74) Common Representative: **NOKIA SIEMENS NETWORKS OY**; COO RTP IPR / Patent Administration, 80240 Munich (DE).

(21) International Application Number:
PCT/EP2008/057686

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date: 18 June 2008 (18.06.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
07012007.6 19 June 2007 (19.06.2007) EP

(71) Applicant (for all designated States except US): **NOKIA SIEMENS NETWORKS OY** [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

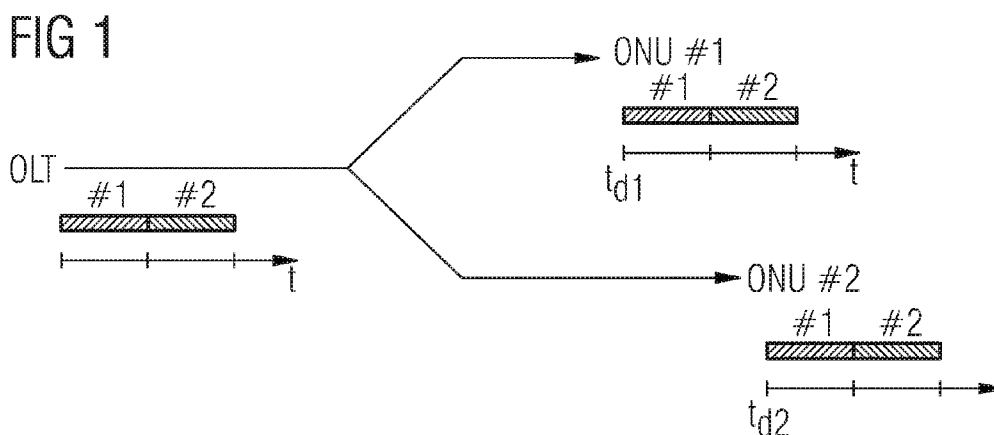
(72) Inventors; and

(75) Inventors/Applicants (for US only): **SCHUG, Winfried** [DE/DE]; Gustav Heinemann Ring 82, 81739 München (DE). **SCHWEIKL, Franz** [DE/DE]; Waldstr. 13, 85457 Wörth (DE). **WONKA, Rainer** [DE/DE]; Schaidlerstr. 17, 81379 München (DE).

Published:
— with international search report

[Continued on next page]

(54) Title: METHOD OF DATA TRANSMISSION AND ASSOCIATED TRANSCEIVER



(57) Abstract: Method of data transmission and a transceiver using the same A method of transmitting and receiving serial data over a communication link such as an optical fibre in a time-division multiple access (TDMA) scheme and a transceiver using said method of transmitting and receiving data. On the receiver side, an offset time between reception time of a synchronisation signal and a word boundary is determined and transmitted to the sender. The sender receives parallel input data and is adapted to send the parallel input data over a serial link. In order to reduce guard-times between time-slots, the sender is muted at a last word transmission end time, the last word transmission end time being a word transmission time minus the offset time after a start time of the last word transmission.

WO 2008/155349 A1



-
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

Description

METHOD OF DATA TRANSMISSION AND ASSOCIATED TRANSCEIVER

5 Background of the Invention

Field of the Invention

The invention relates to a method and an apparatus for transmitting and receiving data. More specifically, the invention relates to a method of transmitting and receiving
10 serial data over a communication link such as an optical fibre in a time-division multiple access (TDMA) scheme and a transceiver using said method of transmitting and receiving data.

Description of Related Art

15 Data transmission usually involves sending and receiving data at a maximum speed over a communication link. The communication link often allows for transmission of no more than one bit at a time such that data has to be transmitted in a serial way. To achieve high baud rates (a high number of
20 symbols, each symbol comprising one bit or a plurality of bits, per time) that may accommodate a high number of subscribers, very high serial data rates up to tens of gigabits per second have been realised. Senders and receivers communicating over such a high data-rate serial communication
25 link have to be able to send and receive data at the high transmission data rate which makes circuit design difficult and requires fast circuits which consume high power. Since higher layers of transmission protocols require complex data analysis over large sets of data and therefore a large number
30 of logic gates when realised in a microchip, serialisers and deserialisers are used to transform a parallel data stream of a low baud rate to a serial data stream of a high baud rate and vice versa. Thus, processing of high transmission
35 protocol layers can be performed on symbols of a large symbol width at a much lower baud rate (and therefore a low clock

rate of a microchip) and only a small part of the involved circuitry has to be able to run at the speed of the high transmission baud rate. However, if the serialisation/deserialisation ratio e.g. is 16 (16 bits of data input at a baud rate of $1/16^{\text{th}}$ of the transmission baud rate are serialised to a serial stream at the transmission baud rate at the sender and the serial data stream at the transmission baud rate is deserialised to $1/16^{\text{th}}$ of the transmission baud rate at the receiver), only multiples of 16 bits (a word or a word) may be sent at a time because of the input symbol width of 16 bits.

In a typical network setup such as a Passive Optical Network (PON) a plurality of (upstream) senders communicate with a single receiver (an access node, a repeater or such) sharing a single channel having a predetermined channel bandwidth (such as a cable, an optical fibre, or air). In such a network setup the channel bandwidth needs to be distributed among the senders by using a multiplexing scheme such that communication between the senders and the receiver is coordinated thereby avoiding interference between the individual senders. A popular multiplexing scheme is the time-division multiple access (TDMA). In a time-division multiple access network transmission time is divided into a plurality of time-slots which then are assigned to the individual senders. Each sender may only transmit data during a time-slot assigned to it and has to remain quiet during the remaining transmission time. Thus, collision between senders is avoided in a simple way.

In a TDMA scheme there is a problem that delays may occur during transmission of data. Such delays may be caused e.g. by transmission paths of different lengths, reflections, and incomplete synchronicity of clocks (clock jitter and such). In order to avoid overlap between consecutive time-slots, guard-times have to be inserted during which no sender may transmit data. The downside of this approach is that channel bandwidth is lost because the channel may not be used during

guard-times. Another problem arises from the use of
serialisers/deserialisers: since only words of a number of
bits corresponding to the serialisation/deserialisation ratio
may be input to the sender, transmission time shows a
5 relatively coarse granularity because transmission may only
be interrupted when all input bits have been sent. Thus,
guard-times have to be longer than the transmission time of
one word. With increasing transmission data rates,
serialisation/deserialisation ratios also increase which
10 entails longer guard-times.

Summary of the Invention

The invention has been made in an effort to provide an
improved ratio between channel bandwidth and effective
channel bandwidth (the part of the channel bandwidth which
15 may be used for data transmission in a TDMA scheme under
real-world conditions).

Therefore, a first aspect of the invention provides a
method of transmitting data from an upstream sender to a
receiver. The method comprises:dividing transmission time
20 into a plurality of time-slots, each of which having a start
time and an end time;

assigning a first time-slot of the plurality of time-slots
to the sender;

25 determining a plurality of first word transmission start
times between the start time and the end time of the first
time-slot;

during the first time-slot, serialising a synchronisation
signal;

30 during the first time-slot assigned to the sender, sending
the serialised synchronisation signal;

receiving the synchronisation signal at a reception time;

deserialising the synchronisation signal;

determining an offset time between the reception time of the synchronisation signal and a word boundary at the receiver;

5 transmitting the offset time to the sender;

assigning a second of the plurality of time-slots to the sender;

10 determining a plurality of second word transmission start times between the start time and the end time of the second time-slot;

determining a last word transmission start time of the plurality of second word transmission start times;

reading a first word of input data;

serialising the first word of input data;

15 at the last word transmission start time, start sending the serialised first word of input data; and

20 at a last word transmission end time, the last word transmission end time being a word transmission time minus the offset time after the last word transmission start time, muting the sender.

Thereby, despite the fact that always words of input data are read, serialised and sent, fine control of the guard-time at the end of the time-slot assigned to the sender is possible. Since the guard-time at the end of the time-slot needs not
25 take at least as long as the transmission time of a word of input data, guard-times may be reduced in a TDMA scheme according to the first aspect of the invention thereby decreasing the time during which the channel may not be used for data transmission. The invention achieves this by sending
30 a word of parallel data even when the time remaining until

the end of the time-slot is not long enough for transmission of the complete word. In order to still avoid collision between senders, the sender is muted for that part of the bits of the word that would be sent and received after the end of the time-slot. The number of bits that need to be muted is determined by sending a synchronisation signal at the beginning of the data transmission. The receiver determines the position of the synchronisation relative to a word boundary of the parallelised received data. This position corresponds to a delay between the clocks of the sender and the receiver and is usually influenced by channel delay. The delay, offset time or position is transmitted back to the sender which then can use the offset time to determine a minimum guard-time required at the end of the time-slot (i.e. continue to transmit data until shortly before the end time of the time-slot).

Preferably, after the first word of input data is read, barrel-shifting of the first word of input data by a number of bits corresponding to the offset time is performed. This has the advantage that the clocks of the sender and the receiver need not be synchronised according to the offset time determined by the receiver. Instead, the sender simply barrel-shifts the input data stream by a number of bits corresponding to the offset time thereby aligning word boundaries of the data to be sent with the word boundaries at the receiver. Thus, when the sender is muted at the end of the time-slot, always a complete word of parallel input data has been sent.

Here, barrel-shifting refers to continuously shifting a stream of parallel input data. Hence, each word of parallel data output by the barrel-shifter comprises a number of bits belonging to a first word of parallel data input to the barrel-shifter and a number of bits belonging to a second word of parallel data, immediately following the first word of parallel data. Accordingly, a barrel-shifter commonly

comprises FIFO (first-in, first-out) storage for a preceding word of parallel data.

In a preferred embodiment of the invention, the method may further comprise:

- 5 determining an early word transmission start time, the early word transmission start time being less than the word transmission time before the start time of the second time-slot assigned to the sender;

 reading a second word of input data;
- 10 serialising the second word of input data;

 at the early word transmission start time, muting the sender and start sending the serialised second word of input data; and
- 15 at an enable time, the enable time being after the start time of the second time-slot assigned to the sender and the word transmission time minus the offset time after the early word transmission start time, enabling the sender.

This embodiment of the invention has an advantage in that it also allows for reduction of time not used for sending at the beginning of the time-slot assigned to the sender. When the offset time has been determined, during the next time-slot assigned to the sender, data transmission may be started right at the beginning of the time-slot or shortly afterwards because the transmission delay is already known. Thus, data transmission can be started right at the beginning of the time-slot and not as late as at the first input clock cycle after beginning of the time-slot. Instead, the serialiser may be started even before the start time of the time-slot while keeping the sender muted. After a part of the word of data being sent that would have entered the channel too early has been output by the serialiser, the sender is enabled for transmission of the remaining bits of the word of data.

As before, this embodiment may further include a step of barrel-shifting the input data such that the first bit of a word of parallel input data is sent when the sender has just been enabled.

5 A second aspect of the invention provides a transceiver for transmitting data. The transceiver includes a serialiser having a parallel input, a sender having an input connected to the serialiser, and a receiver. The serialiser is adapted to receive parallel data at an input clock rate, to output
10 serial data at an output clock rate corresponding to the input clock rate multiplied by a serialisation ratio and to start outputting the serial data at one of a plurality of word transmission start times. The sender is adapted to receive the serial data from the serialiser and to send the
15 serial data. The receiver is adapted to receive data.

According to the invention, the receiver is further adapted to receive an offset time value and the sender comprises a first control input for a first control signal and is adapted to cease sending the serial data in response to the first
20 control signal. The transceiver further comprises a controller having a first control output connected to the first control input of the sender and a data input connected to an output of the receiver adapted to receive the offset time value. The controller is adapted to receive the offset
25 time value, the controller being adapted to determine a last word transmission start time of the plurality of word transmission start times and a last word transmission end time, the last word transmission end time being a word transmission time minus the offset time after the last word
30 transmission start time, and to output the first control signal to the sender at the last word transmission end time.

Preferably, the transceiver further comprises a barrel-shifter having a parallel output connected to the parallel input of the serialiser and a second control input connected
35 to a second control output of the controller. Then, the

controller is further adapted to output a shift value to the barrel-shifter, the shift value indicating a number of bits having a transmission time corresponding to the offset time value. The barrel-shifter is adapted to barrel-shift parallel data by the number of bits indicated by the shift value and to output the barrel-shifted parallel data to the serialiser.

In order to provide fine control of the point in time at the beginning of a time-slot assigned to the sender when the sender starts to transmit data, in a preferred embodiment of the invention, the controller is further adapted to output the first control signal until an enable time, the enable time being the offset time before a first word transmission start time of the plurality of word transmission start times.

Brief Description of the Drawings

A more complete appreciation of the present invention and many of the attendant advantages thereof, will be readily apparent as the present invention becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings, wherein:

FIG. 1 is a network diagram illustrating data transmission during downstream transmission;

FIG. 2 is a network diagram illustrating data transmission during upstream data transmission;

FIG. 3 is a timing diagram of a time-slot illustrating communication between a sender and a receiver during upstream data transmission; and

FIG. 4 is another timing diagram of the time-slot.

Detailed Description of the Invention

FIG. 1 shows a network diagram illustrating data transmission during downstream data transmission in a passive optical

network (PON). The network comprises an OLT (Optical Line Termination) and two ONUs (Optical Network Units) ONU #1 and ONU #2 which are connected to the OLT over an optical fibre which is indicated by a line. The network has a tree-type configuration wherein the ONUs are connected to the OLT over at least one split in the data line. Thus, each ONU in the PON represents a leaf of the tree-type configuration.

The OLT is connected to other networks via a backbone (not shown) in order to provide data service from the backbone to the customers. The ONUs #1 and #2 are situated at the sites of two respective customers and function to connect the customers' local networks to the MAN or LAN.

The term "downstream data transmission" denotes data transmission from the backbone via the OLT to the customer, while "upstream data transmission" refers to the opposite direction of data flow from the customer over the backbone. The direction of data flow is indicated in both FIGS. 1 and 2 by arrow heads attached to the lines representing the fibres.

In downstream data transmission the OLT transmits data in a TDM scheme where data for each ONU is interleaved with data for the remaining ONUs in the network. The data may be interleaved on a byte-by-byte basis or by larger blocks of data. All ONUs in the network will physically receive the same data signal but will only read and deserialise the portion of the downstream data that is directed to the specific ONU. In Fig. 1, data directed to ONU #1 is labelled #1 and data directed to ONU #2 is labelled #2. The data diagram at the OLT depicts how data for ONU #1 and ONU #2 are sent in a consecutive manner without any guard-time in between. A guard-time is not required because during downstream data transmission there is only one data source. As can be seen from the timing diagrams of ONU #1 and ONU #2, the downstream data arrives at the ONUs delayed by the channel delay which largely depends on the distance between the OLT and the respective ONU. Since ONU #1 is situated

closer to the OLT, the channel delay t_{d1} is lower than the channel delay t_{d2} of ONU #2. However, the channel delays are irrelevant during downstream data transmission as mentioned above.

5 FIG. 2 is a network diagram of the same network as that of FIG. 1 illustrating data transmission during upstream data transmission. Now, the direction of data flow is from the ONUs to the OLT. Since during upstream data transmission there are more than one data sources, the channel has to be
10 divided using a TDMA scheme. The OLT assigns to each ONU a respective time-slot for transmitting upstream data. Because of the different channel delays between the ONUs and the OLT, guard-times have to be introduced between the time-slots to avoid data collision. If guard-times are too short, the last
15 sets of data that have entered the network on a distant ONU during the assigned time-slot will only arrive at a network junction close to the OLT when data from another ONU is already being fed into the network. Hence, guard-times have to be chosen to accommodate the channel delays present in the
20 network.

The relation between data transmissions from the ONUs is illustrated in FIG. 2. ONU #1 starts to send a data package #1 shortly after the beginning of the time-slot assigned to ONU #1. ONU #2 has to remain silent during this time and wait
25 for its time-slot in order to transmit its data package #2. ONU #2 starts sending its data right at the beginning of its time-slot. Since ONU #2 is located farther away from the OLT, data package #2 arrives later within the time-slot assigned to ONU #2 than data package #1 in the respective time-slot.

30 In the example of FIG. 2 data arrives at the OLT within their respective time-slots and no data collision happens. However, transmission of package #1 was started late. ONU #2 could only transmit all of its data with the time-slot because it started transmission right at the beginning of the time-slot.
35 Accordingly, the guard-times of FIG. 2 are set to the

required minimum. If ONU #2 is not able to commence data transmission right at the beginning of the time-slot as is ONU #1, guard-times have to be increased. However, granularity of time is low on the sender side because data is input at the sender in words due to the use of serialisers and deserialisers. Hence, in a conventional setup the sender may only be started at times corresponding to multiples of the input word length. As data rates keep increasing, so do serialisation/deserialisation ratios and therefore granularity of time gets more and more coarse relative to the data rate. Thus, fine control of the start time of data transmission at the sender in order to reduce guard-times to a required minimum is not possible in a traditional setup.

FIG. 3 is a timing diagram of a time-slot illustrating communication between a sender and a receiver during upstream data transmission. The time-slot starts at a start time t_s , the receiver starts operation shortly afterwards at a time t_1 which in some embodiments of the invention may be the same time as the start time t_s . The sender starts sending data at a time t_2 which is safely within the time-slot assigned to the sender. Here, the clocks of the sender and the receiver according to which parallel data is read and serialised at the sender and deserialised and output at the receiver, respectively, have a clock offset of t_2 minus t_1 . In addition to this, there is a channel delay t_3 minus t_2 where t_3 is the time at which the receiver receives the first bit or symbol sent by the sender at the time t_2 . The clock offset and the channel delay yield an offset time Dt . The guard-times of a time-division multiple access scheme will be chosen with regard to the expected delays/offsets. Thus, in a system where long delays/offsets may occur, guard-times will be long.

During a first time-slot assigned to the sender, the sender sends a stream of data packages (a, b, c, d) which are received within a stream of data packages (A, B, C, D, E) at the receiver. According to the invention, the offset time

between the sender and the receiver is determined in order to reduce the idle time at the beginning of the time-slot. This is accomplished by sending a synchronisation signal (e.g. a byte of data containing a predetermined symbol, marked black in FIG. 3) which may be detected by the receiver regardless of the offset time. The receiver is adapted to search every two consecutive words of parallel output data for the synchronisation word and to determine the offset time. The offset time corresponds to the offset of the first bit of the synchronisation word to the first bit of the word of parallel data (that is the word boundary of the deserialised data) wherein the first bit of the synchronisation word is found multiplied by the transmission time of a bit. „Transmission time of a bit“ or „bit transmission time“ must not be misunderstood as the time a bit requires to travel from the sender to the receiver, in the scope of this document these terms refer to the reciprocal value of the data rate and hence to the time during which a bit is output by the sender. Accordingly, „word transmission time“ or „transmission time of a word“ refers to the bit transmission time multiplied by the serialisation/deserialisation ratio. Because of the fixed relation between a bit or a number of bits and the transmission time, a time such as the offset time may be expressed by means of a number of bits and vice versa.

The receiver sends the determined offset time Δt to the sender (thus, both the sender and the receiver are transceivers because they both comprise a respective sender and receiver circuit; when referring to FIGS. 1 and 2, the term „sender“ refers to the data source and „receiver“ to the data sink rather than the actual components performing the sending/receiving action). During the next time-slot the sender reduce the idle time at the beginning of the time-slot by referring to the offset time sent back by the receiver. Thus, idle time between the end time t_e of a previous time-slot and the start time t_s of the current time-slot can be shorter than in traditional systems. Only before the offset time is known, the sender must wait until some time after the

start time t_s of the time-slot thereby effectively increasing the guard-time to the time required in a traditional system.

FIG. 4 is another timing diagram of the time-slot showing communication between the sender and the receiver after the offset time Δt has been sent back to the sender. The sender now starts operation at an early start time t_{se} which is one word transmission time before the previous time t_2 (relative to the start times of the respective time-slots) at which the sender started operation when the offset time was still unknown. In the example of FIG. 4, the early start time t_{se} is even before the start time t_s of the time-slot. In order to not send data outside the time-slot assigned to the sender, the output of the sender is disabled (muted) for a time corresponding to a word transmission time minus the offset time Dt . When the output of the sender is enabled a time t_0 , the sender starts sending data over the channel. t_0 is the offset time before the time t_2 at which the sender had started operation in the previous occurrence of the time-slot. Thus, the data sent starting from t_0 will arrive at the receiver at the time t_1 when the receiver starts receiving the first word of data. In this way, the time during which the sender does not send data is controlled with a granularity corresponding to a bit transmission time and therefore with a much finer granularity than in traditional systems. This enables reduction of idle times at the beginning of time-slots because the time during which the sender is active may be controlled more precisely.

In the same way, the sender can be controlled to reduce an idle-time at the end of the time-slot and hence to make use of the whole time-slot. This is accomplished by continuing to send data during a last word transmission that would not finish before the end time of the time-slot. In order to not violate the restrictions set by the time-slot, the sender is muted at a time t_4 one offset time before the end of the last word transmission.

Thus, the invention has an advantage in that control of active time during which the sender is active and of idle time during which the sender may not send data over the channel is possible with a fine granularity and independent
5 from the length and phase offsets of a word transmission at the sender and the receiver. In order to send the desired data over the channel, the input data should be aligned with the active time of the sender (i.e. the time between t_0 and t_4 in FIG. 4). An embodiment of the sender therefore
10 comprises a barrel-shifter which is adapted to barrel-shift the parallel input data by a number of bits corresponding to the offset time Δt . Then, transmission of the first bit of serial data starts precisely at the time t_0 when the sender is enabled. Since the whole stream of input data is barrel-
15 shifted by the number of bits corresponding to the offset time Δt , the last bit of input data has been sent when the sender is muted at the time t_4 . In FIG. 4, word boundaries of the input data prior to barrel-shifting are marked by vertical lines and a changing pattern inside the words of
20 data a, b, c, d, e, f.

The remaining bits of parallel input data at the beginning (between t_{se} and t_0) and at the end (after t_4) can be filled with arbitrary data or simply ones or zeroes as they never enter the channel. A positive side-effect of the barrel-
25 shifting is that data will be aligned with the output clock at the receiver.

Determining of the offset time Δt can be performed only once at the start of the communication or several times during the communication (e.g. periodically) depending on channel
30 characteristics. E.g. an optical fibre will provide constant characteristics over a long time such that the offset time Δt will also remain constant and determination of the Δt is only needed once. For channels with variable characteristics such as air periodical determination of the offset time Δt
35 will be necessary.

Claims:

1. A method of transmitting data from a sender to a receiver,
the method comprising:

dividing transmission time into a plurality of time-
5 slots, each of which having a start time and an end time;

assigning a first time-slot of the plurality of time-
slots to the sender;

determining a plurality of first word transmission start
times between the start time and the end time of the first
10 time-slot;

during the first time-slot, serialising a
synchronisation signal;

during the first time-slot, sending the serialised
synchronisation signal;

15 receiving the synchronisation signal at a reception
time;

deserialising the synchronisation signal;

determining an offset time between the reception time of
the synchronisation signal and a word boundary at the
20 receiver;

transmitting the offset time to the sender;

assigning a second of the plurality of time-slots to the
sender;

determining a plurality of second word transmission
25 start times between the start time and the end time of the
second time-slot;

determining a last word transmission start time of the
plurality of second word transmission start times;

reading a first word of input data;

serialising the first word of input data;

at the last word transmission start time, start sending the serialised first word of input data; and

5 at a last word transmission end time, the last word transmission end time being a word transmission time minus the offset time after the last word transmission start time, muting the sender.

2. The method of claim 1, further comprising: after reading
10 the first word of input data, barrel-shifting the first word of input data by a number of bits corresponding to the offset time.

3. The method of one of claims 1 or 2, further comprising:

determining an early word transmission start time, the
15 early word transmission start time being less than the word transmission time before the start time of the second time-slot;

reading a second word of input data;

serialising the second word of input data;

20 at the early word transmission start time, muting the sender and start sending the serialised second word of input data; and

at an enable time, the enable time being after the start time of the second time-slot and the word transmission time
25 minus the offset time after the early word transmission start time, enabling the sender.

4. The method of claim 3, further comprising: after reading the second word of input data, barrel-shifting the second

word of input data by the number of bits corresponding to the offset time.

5. A transceiver for transmitting data with:

5 a serialiser having a parallel input, the serialiser being adapted to receive parallel data at an input clock rate, to output serial data at an output clock rate corresponding to the input clock rate multiplied by a serialisation ratio and to start outputting the serial data at one of a plurality of word transmission start times;

10 a sender having an input connected to the serialiser, the sender being adapted to receive the serial data from the serialiser and to send the serial data during a word transmission time; and

a receiver adapted to receive data;

15 characterised in that

the receiver is further adapted to receive an offset time value;

the sender comprises a first control input for a first control signal and is adapted to cease sending the serial data in response to the first control signal; and in that

20

the transceiver further comprises a controller having a first control output connected to the first control input of the sender and a data input connected to an output of the receiver and adapted to receive the offset time value, the controller being adapted to determine a last word transmission start time of the plurality of word transmission start times and a last word transmission end time, the last word transmission end time being a word transmission time minus the offset time after the last word transmission start time, and to output the first control signal to the sender at the last word transmission end time.

25

30

6. The transceiver of claim 5, further comprising a barrel-shifter having a parallel output connected to the parallel input of the serialiser and a second control input connected to a second control output of the controller, wherein the
5 controller is further adapted to output a shift value to the barrel-shifter, the shift value indicating a number of bits having a transmission time corresponding to the offset time value, and wherein the barrel-shifter is adapted to barrel-shift parallel data by the number of bits indicated by the
10 shift value and to output the barrel-shifted parallel data to the serialiser.

7. The transceiver of one of claims 5 or 6, wherein the controller is further adapted to output the first control signal until an enable time, the enable time being the offset
15 time before a first word transmission start time of the plurality of word transmission start times.

FIG 1

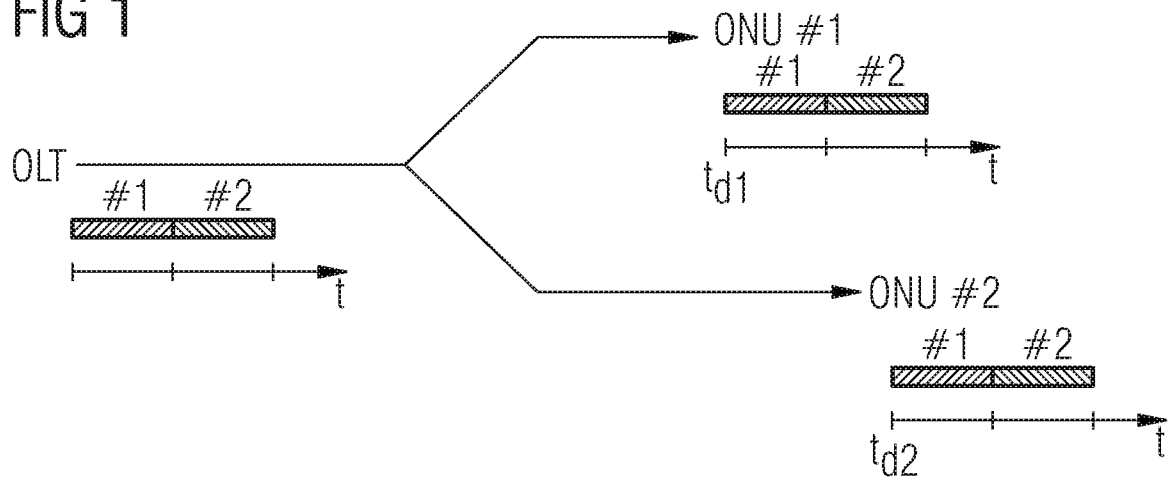


FIG 2

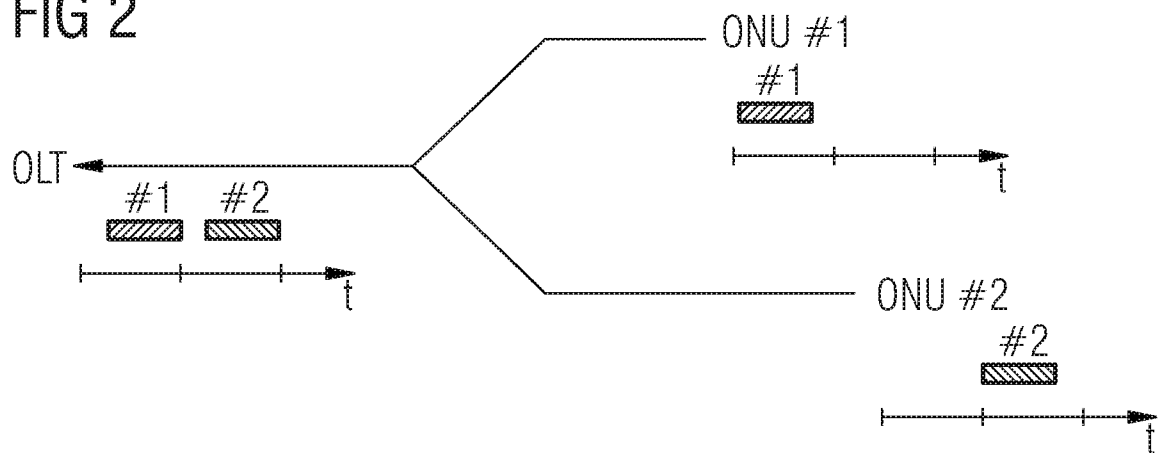


FIG 3

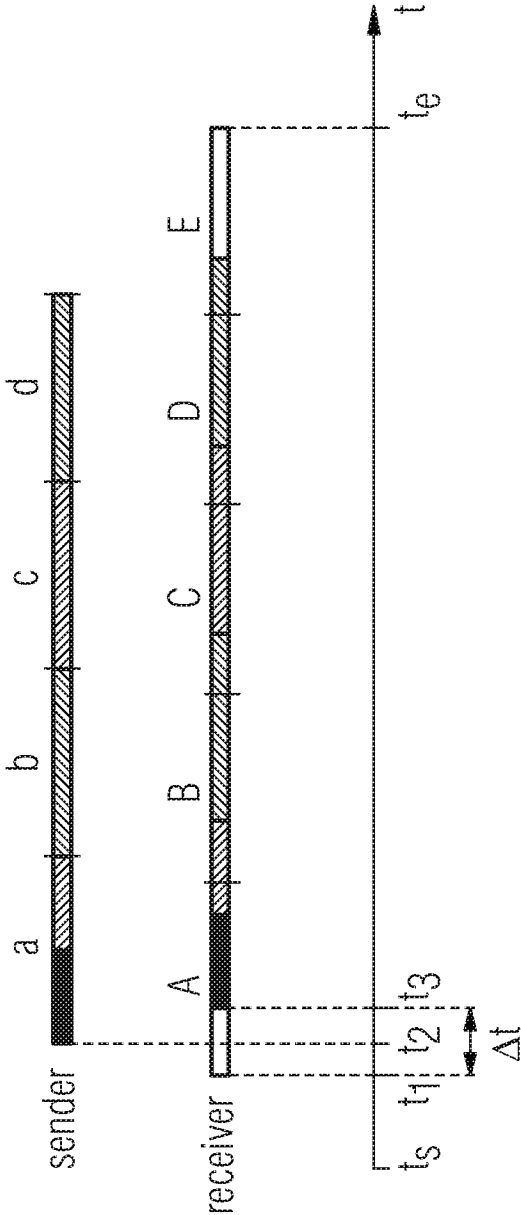
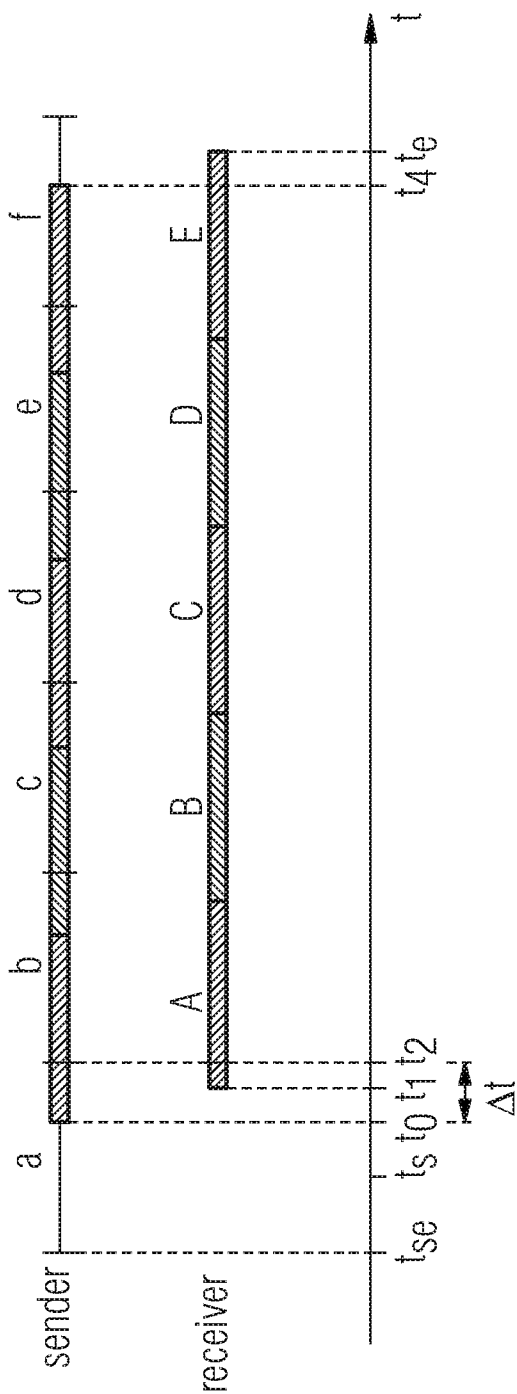


FIG 4



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/057686

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04J3/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched: (classification system followed by classification symbols)

H04J H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 678 989 A (ITALTEL SPA [IT] ITALTEL SPA [IT]; SIEMENS AG [DE]) 25 October 1995 (1995-10-25) abstract column 2, lines 45-56 column 3, line 3 - column 4, line 12 column 5, line 10 - column 6, line 51 figures 1-3 claims	1-7
A	WO 99/00922 A (BOSCH GMBH ROBERT [DE]) 7 January 1999 (1999-01-07) the whole document	1-7
	-/--	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

30 September 2008

Date of mailing of the international search report

10/10/2008

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Dejonghe, Olivier

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/057686

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 710 765 A (LEE XIAOYANG [US] ET AL) 20 January 1998 (1998-01-20) abstract column 2, line 34 - column 3, line 5 column 3, line 66 - column 4, line 47 column 5, line 17 - column 6, line 9 column 10, lines 16-57 figure 8	1-7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/057686

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
EP 0678989	A	25-10-1995	DE	69534072 D1	21-04-2005
			DE	69534072 T2	23-02-2006
			IT	1270046 B	28-04-1997
WO 9900922	A	07-01-1999	DE	19727547 A1	07-01-1999
			EP	0992137 A1	12-04-2000
US 5710765	A	20-01-1998	JP	9233034 A	05-09-1997