Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2461500 A1 2003/04/03

(21) 2 461 500

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2002/09/19
(87) Date publication PCT/PCT Publication Date: 2003/04/03
(85) Entrée phase nationale/National Entry: 2004/03/24
(86) N° demande PCT/PCT Application No.: DE 2002/003521
(87) N° publication PCT/PCT Publication No.: 2003/028321
(30) Priorités/Priorities: 2001/09/26 (101 47 423.7) DE;
2002/07/04 (102 30 127.1) DE

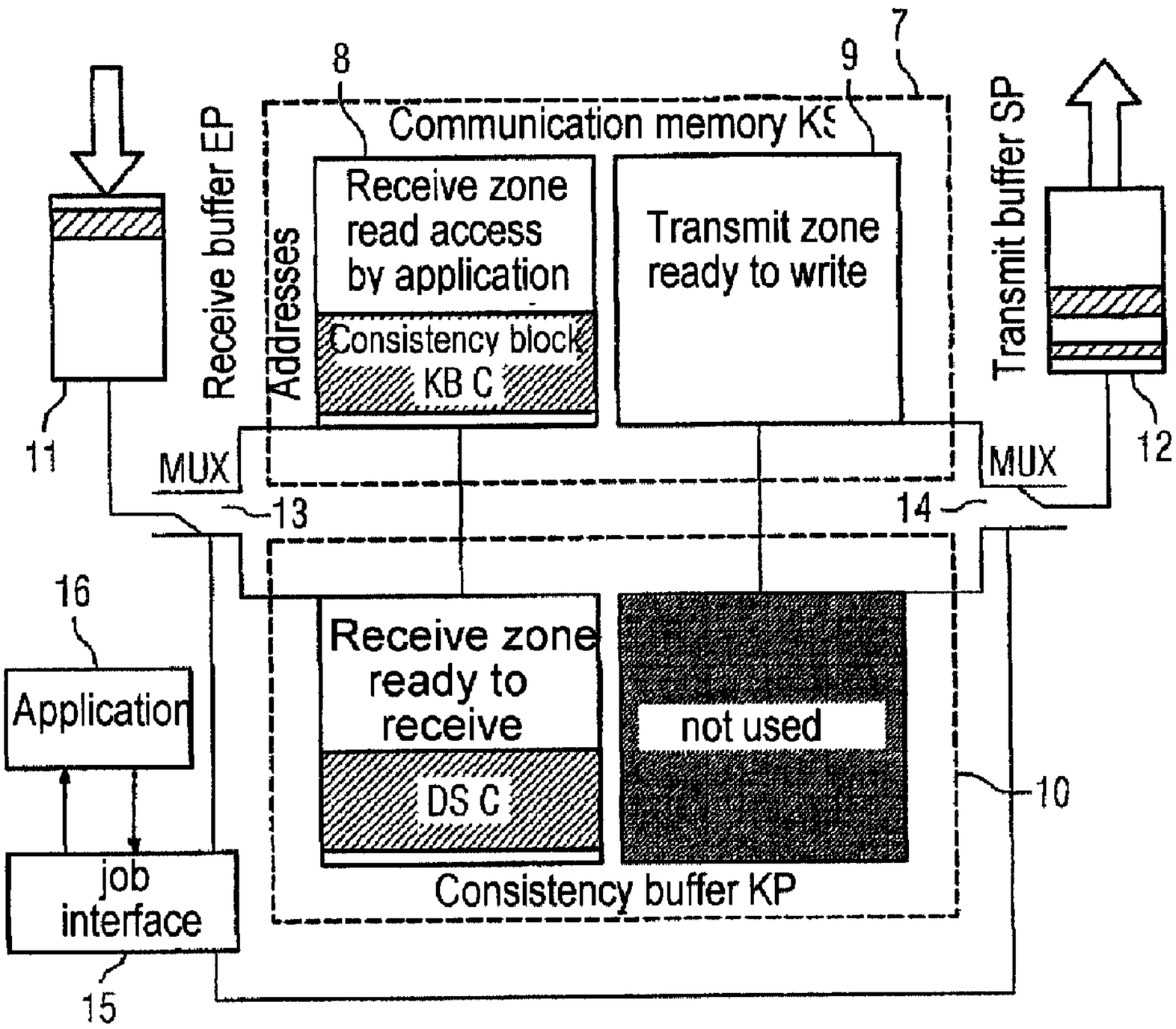
(51) Cl.Int.^{7}/Int.Cl.^{7} H04L 12/64, G06F 5/06

(71) Demandeur/Applicant:
SIEMENS AKTIENGESELLSCHAFT, DE

(72) Inventeurs/Inventors:
BRUECKNER, DIETER, DE;
GOETZ, FRANZ-JOSEF, DE;
KLOTZ, DIETER, DE

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : PROCEDE POUR TRAITER DES ENREGISTREMENTS COHERENTS
(54) Title: METHOD FOR PROCESSING CONSISTENT DATA SETS



(57) Abrégé/Abstract:
The invention relates to a method for processing consistent data sets by asynchronous application of a subscriber in an isochronous, cyclical communication system. According to the invention, by connecting a communication memory (7) and a consistency (10), transmission (12) and reception buffer (11), copying processes leading to delay can be kept to a minimum.

ABSTRACT

The invention relates to a method for processing consistent data sets by asynchronous application of a subscriber in an isochronous, cyclical communication system. According to the invention, by connecting a communication memory (7) and a consistency (10), transmission (12) and reception buffer (11), copying processes leading to delay can be kept to a minimum.

Description

Method for processing consistent data sets

The invention relates to a method for processing consistent data sets by an asynchronous application of a subscriber in an isochronous, cyclical communications system.

Data networks are formed from a number of network nodes and allow communication between a number of subscribers. Communication here means the transmission of data between the subscribers. The data to be transmitted in this case is sent as data telegrams, which means that the data is packed into one or more packets and sent in this form over the data network to the appropriate recipient. The term data packet is thus used. The term transmission of data is used in this document fully synonymously with the above-mentioned transmission of data telegrams or data packets.

For networking in switchable high-performance data networks for example, especially Ethernet, the subscribers are interlinked via coupling nodes. Each coupling node can be connected to more than two subscribers and can also be a subscriber itself. Subscribers are for example computers, Programmable Logic Controllers (PLC) or other machines which exchange electronic data with other machines and especially process it.

In distributed automation systems, for example in the area of drive technology, specific data must arrive at specific times at the intended subscribers and must be processed by the recipients. This is referred to as realtime-critical data or realtime-critical data traffic since if the data does not arrive at its intended destination at the right time this can produce undesired results at the subscriber.

Similarly the use of an isochronous, cyclical communication system is known from the prior art. This is taken to mean a system

consisting of at least two subscribers that are linked via a data network for the purposes of mutual exchange of data or mutual transmission of data. In this case data is exchanged cyclically in equidistant communication cycles which are specified by the communication clock used by the system. Subscribers, such as central automation devices, Programmable Logic Controllers, controls, checking units, computers, machines that exchange electronic data with other machines, drives, actors or sensors, execute specific applications. In this document control units are taken to mean closed-loop controllers or control units of all types. Typical examples of communication systems used for data transmission are bus systems such as Field Bus, Profibus, Ethernet, Industrial Ethernet, FireWire or also PC-internal bus systems (PCI), etc. In such systems data telegrams are fed into the data network at fixed points for transmission by a subscriber.

For synchronous applications the processing of the data is synchronized with the communication cycle. By contrast the processing of data in asynchronous applications is not synchronized with the communication cycle. This reading and writing of data by an asynchronous application can occur at any point in time. This produces special requirements for inclusion of an asynchronous application into an isochronous, cyclical communication system. Basically consistent data is to be sent and read by a subscriber. Consistent data is data which relates to the same time interval. Subscribers with asynchronous applications known from the prior art have the consistency buffer and a communication memory. If the application is to process data from a specific address range in the communication memory, this data is first copied into the consistency buffer.

Only then does the application access the data in the consistency buffer to read it. All addresses in the communication memory can thus be overridden while the application works with the consistent data in the consistency buffer.

The application first writes data into the consistency buffer while consistent data can be sent at the same time from the communication memory to further subscribers. After write access by the application and the sending of data has ended the data written in this way is copied from a consistency buffer to the communications memory. The consistent data is stored here for onwards transmission. The copying processes lead to delays in such cases.

Figure 1 illustrates a system from the prior art for processing consistent data blocks during read access. The communications memory 1 has a receive zone 2 and a transmit zone 3. The receive zone 2 is linked to the receive buffer 4 and the consistency buffer 5. The transmit zone 3 is linked to the consistency buffer 5 and the transmit buffer 6. Data set DS A from address range AB A to which the application has access for reading is located in the consistency buffer.

Figure 2 illustrates the sequence of read access by the application in the system shown in Figure 1 Before read access the data set DS A is copied from the receive zone 2 of the communication memory 1 to the consistency buffer 5. Data set A is data which can be or could be accessed by the application during a read access. Data set DS A is to be consistent during a read access and originates from the address range AB A in the receive zone 2 of communication memory 1.

Because the data of the consistency block requested by the application is saved in the consistency buffer, newly received data of receive buffer 4 which lies in the address range of the consistency block can subsequently be stored in the receive zone 2 of communication memory 1. Read access by the application to the data set DS A in the consistency buffer 5 takes place independently of this storage process. During the read access files can be copied from the receive buffer 4 into the receive zone 2 of communication memory 1.

Figure 3 shows the system from Figure 1 during a write access by the

application.

Figure 4 illustrates the sequence of a write access by the application. While the application is writing data set DS B into the consistency buffer 5 data is forwarded from the transmit zone 3 of the communication memory 1 to the transmit buffer 6. Data set DS B is to be copied into a specific address range AB B of the transmit zone 5 of the communication memory 1. Before this copying process takes place all data from the address range AB B which is to move during a copying process from the transmit zone 3 to the transmit buffer 6 should be forwarded to the transmit buffer 6. The data set DS B can thus only be copied from the consistency buffer 5 into the transmit zone 3 of the communication memory 1 once both the write access and the forwarding of data from the address range B are completed.

The object of the invention is thus to minimize delays which can arise as a result of the necessary copying processes at a subscriber with an asynchronous application into an isochronous cyclical communications system.

The object of the invention is achieved by a method with the features of the Independent Patent claims 1 and 2. Preferred embodiments of the invention are specified in the dependent patent claims.

With the method in accordance with the invention, before it can be read in the asynchronous application, data is advantageously not copied into the consistency buffer. The application accesses the communication memory directly to read the data. During read access data which is destined for an address range in the communication memory to which the application has access or could have access is copied from the receive buffer into the consistency buffer. Only this data will be copied from the consistency buffer to the communication memory at the end of the reader access. A copying process is only needed if data is received during read access from

the receive buffer which is addressed to an address range to which the application has access or could have access.

In a further method in accordance with the invention the application writes data directly into the communication memory. Data from an address range to which the application has access or could have access during writing is written into the consistency buffer before write access. Here it is ready for transmission while if the application is writing data to the communication memory. It is advantageous that the forwarding of the data from the consistency buffer to the transmit buffer can be interrupted as soon as write access to the reserved address range has been ended and instead current data can be forwarded from the communication memory to the transmit buffer.

A preferred exemplary embodiment of the invention is explained in more detail below with reference to the diagrams. The drawings show:

Figure 1 a block diagram of a system from the prior art during a read access

Figure 2 a state transition diagram during read access in accordance with the prior art,

Figure 3 a block diagram or a system from the prior art during a write access,

Figure 4 a state transition diagram during write access in accordance with the prior art,

Figure 5 a block diagram of a system in accordance with the invention during a read access

Figure 6 a state transition diagram during a read access in accordance with the invention,

Figure 7 a block diagram of a system in accordance with the invention during a write access,

Figure 8 a state transition diagram during a write access in accordance with the invention,

Figure 9 a flowchart of read access in accordance with the invention,

Figure 10 a flowchart of write access in accordance with the invention.

Figure 5 shows a system in accordance with the invention of a subscriber of an isochronous, cyclical communication system for processing consistent data blocks during a read access. The system in accordance with the invention also possesses a communication memory 7 with a receive zone 8 and a transmit zone 9, a consistency buffer 10, a receive buffer 11 and a transmit buffer 12. The system in accordance with the invention differs significantly from the prior art by linking of the receive buffer 11 and the transmit buffer 12 with the communication memory 7 and the consistency buffer 10. Using the multiplexer 13 a link can be established between both the receive buffer 11 and the consistency buffer 10 and also between the receive buffer 11 and the communication memory 7. Likewise by means of multiplexer 14 an alternative link between the transmit buffer 12 and the communication memory 7 or the consistency buffer 10 can be established. The job interface 15 controls the multiplexers 13 and 14.

In the case shown the application 16 reads data from the address range AB C of the consistency block KB C in the receive zone 8 of the communication memory 7, while data set DS C is being forwarded from receive buffer 11 to consistency buffer 10 which is actually intended for address range AB C. To ensure the consistency of the data read by the application, the data set DS C will thus be copied into the consistency buffer. The job interface 15 controls the

multiplexer 13 so that there is a connection between the receive buffer 11 and the consistency buffer 10. The read access has no effect on the forwarding of data from the transmit zone 9 to the transmit buffer 12. The transmit zone 9 is thus connected via the multiplexer 14 to the transmit buffer 12.

The use of the consistency buffer 10 during read access is thus only necessary because the data set DS C is destined for address range AB C to which the application 16 has access or could have access. Otherwise the data can be forwarded directly from the receive buffer 11 to the receive zone 8 of the communication memory 7. The job interface 15 will then establish a connection between at the receive buffer 11 and the receive zone 8.

Figure 6 illustrates the sequence of read access in accordance with the invention. During read access by the application to the receive zone 8 of the communication memory 7 a data set DS C which is destined for the address range AB C of the consistency block KB C is copied from the receive buffer 11 to the consistency buffer 10. After read access has ended the data set DS C will be copied from the consistency buffer 10 into the receive zone 8 of the communication memory 7. Data is sent and received independently of the read access.

Figure 7 shows the system from Figure 5 during a write access. The address range of the consistency block KB D will be written by application 16 directly in the transmit zone 9 of the communication memory 7. The data set DS D from the address range of the consistency block KB D is located in the consistency buffer 10. It is advantageous that in transmit buffer 12 a complete set of data 17 is "in stock" for transmission. In stock here means that the set includes all data which is to be transmitted during the next transmit procedure.

Figure 8 illustrates the sequence of a write access in accordance with the invention in the system of Figure 7. Before write access by

application 16 the data set DS D will be copied from the address range AB D of the consistency block KB D which the application can or could write to during the write access from the transmit zone 9 of the communication memory 7 to the consistency buffer 10. During write access consistent data can be transmitted from a data set DS D from the consistency buffer 10 to the transmit buffer 12. The job interface 15 therefore connects the consistency buffer 10 with the transmit buffer 12.

If write access by the application 16 is ended before the ending of the copying process of data set DS D from the consistency buffer 10 to the transmit buffer 12 the copying process will be aborted. To guarantee the transmission of a complete data set from the transmit buffer 12 a data set 17 must therefore be kept in stock in this.

After the write access data can be forwarded from the address range AB D again and from the transmit zone 9 of the communication memory 7 to the transmit buffer 12. Data which is not located in address range AB D can also be forwarded during write access from the receive zone 9 of the communication memory 9 to the transmit buffer 12. Data can be received independently of write access at the receive port and sent at the transmit buffer 12.

Figure 9 shows a flowchart of a read access in accordance with the invention. First of all an address range AB C in the receive zone of the communication memory is reserved by a consistency block KB C (step 18). „Reservation by a consistency block" means in this connection that data can neither be copied from the receive buffer into the address range occupied by a consistency block, nor from an address range occupied by a consistency block into the transmit buffer. The address range C includes addresses to which the application has access or could have access during a read access.

In the next step (step 19) the application accesses the consistency block KB C in the communication memory for reading. At the same time the data set DS C which is addressed to addresses in the address

range AB C of the consistency block KB C is copied from the receive buffer to the consistency buffer.

After the end of read access the consistency block KB C is released (step 20). The address range AB C can now be written again with data from the transmit buffer.

Data which was written during the read access into the consistency buffer can finally be copied into the address range AB C of the communication memory (step 21).

Figure 10 shows a flowchart of a write access in accordance with the invention. A data set DS D in address range AB D of the transmit zone 9 of the communication memory which is written or could be written by the application during a write access will first be copied into the consistency buffer (step 22).

The address range AB D will then be occupied by the consistency block KB D (step 23). Thus data can no longer be forwarded from the address range AB D to the transmit buffer.

During the write access however data of the data set DS D can be forwarded from the consistency buffer to the transmit buffer (step 24).

After write access has ended the consistency block KB D will be released (step 25). Data can again be forwarded from the address range AB D to the transmit buffer.

The copying process of data of data set DS D from the consistency buffer to the transmit buffer will be aborted if it is not completed before the end of write access (step 26) and replaced by the current data from the communication memory.

A current data record is then copied from the address range AB D of the consistency block KB D to the transmit buffer (step 27).

Patent claims

1. Method for processing consistent data sets by an asynchronous application (16) of a subscriber with a transmit buffer (12), a receive buffer (11), a communication memory (7) and a consistency buffer (10) in an isochronous, cyclical communications system, in which case the communication memory (7) features a receive zone (8) and a transmit zone (9), with the following steps:

- Reservation of a first address range in the receive zone (8) of the communication memory (7) by a consistency block;
- Read access by the application (16) to the first address range;
- Use of the consistency buffer (10) instead of the first address range in the receive zone (8) of the communication memory (7) for storage of a first data set from the receive buffer (11);
- Release of the consistency block after read access has ended;
- Copying of the first data set from the consistency buffer (10) into the first address range.

2. Method for processing consistent data sets by an asynchronous application (16) of a subscriber with a transmit buffer (12), a receive buffer (11), a communication memory (7) and a consistency buffer (10) in an isochronous, cyclical communications system, in which case the communication memory (7) features a receive zone (8) and a transmit zone (9), with the following steps:

- Copying of a second data set from a second address range in the transmit zone (9) of the communication memory (7);
- Occupation of the second address range by a consistency block;
- Write access by the application (16) to the second address range;
- Release of the consistency block after write access has ended.

3. Method in accordance with Claim 2 with the following further step:

- Beginning the copying of data of the second data set from the consistency buffer (10) to the transmit buffer (12) during write access by the application (16).

4. Method in accordance with Claim 3 with the following further step for the case in which the copying of data of the second data set from the consistency buffer (10) to the transmit buffer (12) is not concluded when write access ends:

- Aborting copying of data of the second data set from the consistency buffer (10) to the transmit buffer (12);

- Copying of data from the second address range to the transmit buffer (12).

5. Subscriber with an application (16), a transmit buffer (12), a receive buffer (11), a communication memory (7), a consistency buffer (10) and a job interface (15) with means for:

- reservation of a first address range in the receive zone (8) of the communication memory (7) by a consistency block;
- reading of the first address range by the application (16);

Use of the consistency buffer (10) instead of the first address range for storage of a first data set from the receive buffer (11); Release of the consistency block after read access is ended by the application (16); Copying of the first data set from the consistency buffer (19) to the first address range.

6. Subscriber with an application (16), a transmit buffer (12), a receive buffer (11), a communication memory (7), a consistency buffer (10) and a job interface (15) with means for:

- copying of a second data set from a second address range in the transmit zone (9) of the communication memory (7) into the consistency buffer (10);

- reservation of the second address range by a consistency block;

- writing of the second address range by the application (7);

- release of the consistency block after of the end of write access.

7. Subscriber in accordance with Claim 6 with a means for copying data of the second data set from the consistency buffer (10) to the transmit buffer (12).

8. Subscriber in accordance with Claim 7 with a means for copying a data from the second address range to the transmit buffer (12).

9. Subscriber in accordance with one of the Claims 5 to 8, in which case the transmit buffer (12) always has a complete data set in stock for transmission.

10. Isochronous, cyclical communication system with at least one subscriber in accordance with one of the Claims 5 to 9.

Fetherstonhaugh
Ottawa, Canada
Patent Agents

FIG 1

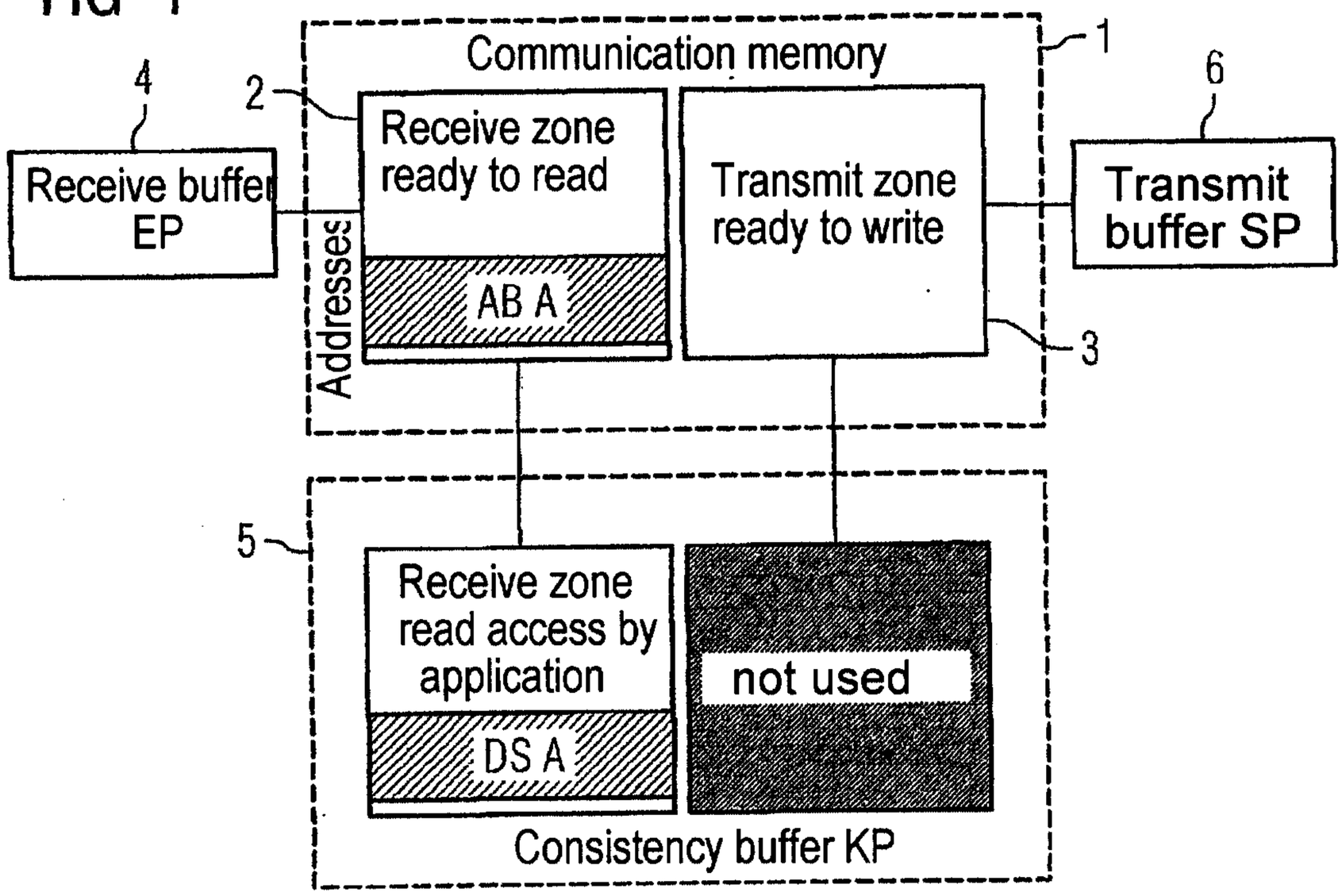


FIG 2

Status				
Copying of DS A from AB A into the KP				
Read access by the application				
Copying of data of the EP into the receive zone of the KS				
Receiving data				
Sending data				
Time interval	1	2	3	4

FIG 3

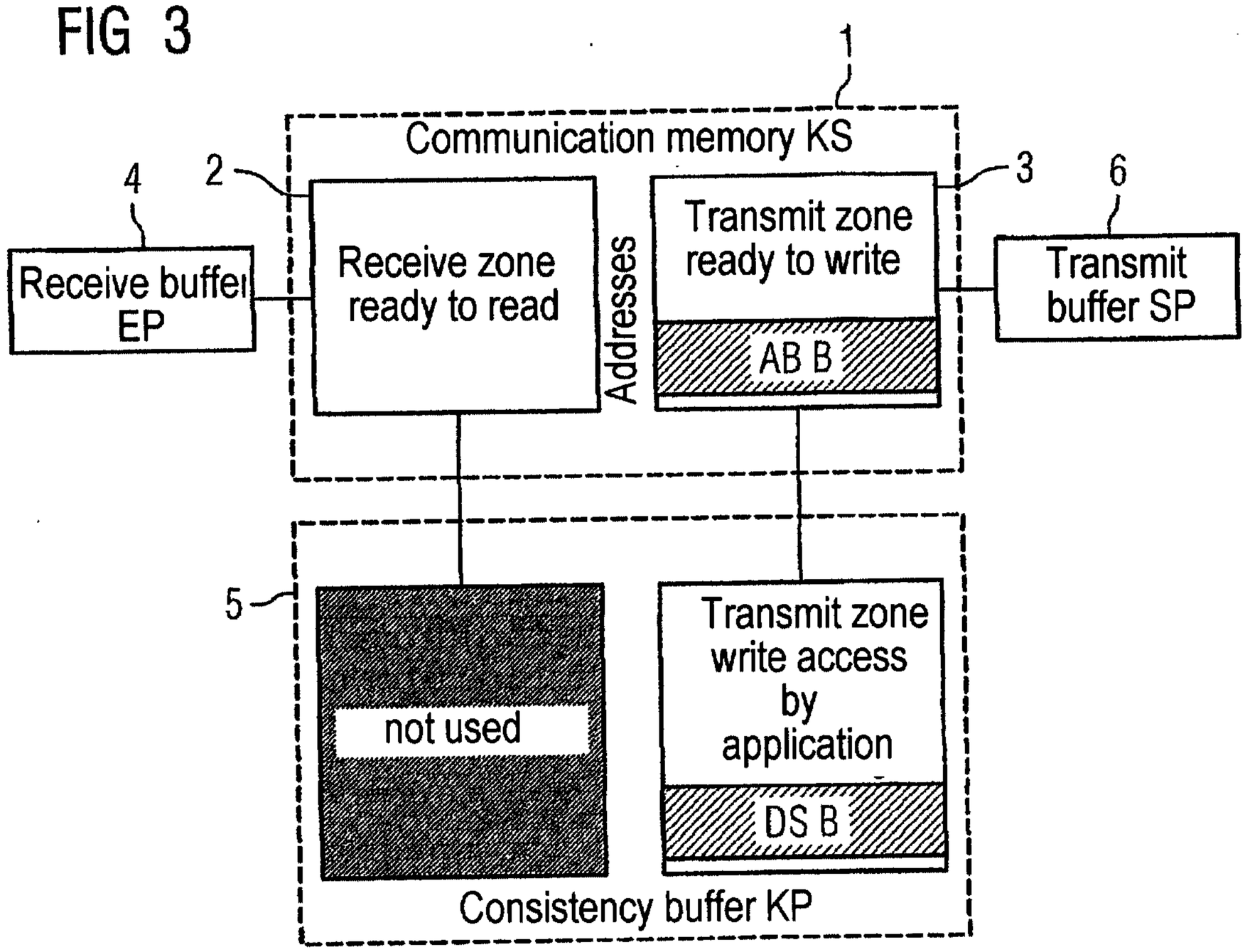


FIG 4

Status			
Write access by the application			
Copying of data from AB B to SP			
Copying from DS B into AB B			
Receiving data			
Sending data			
Time interval	1	2	3

FIG 5

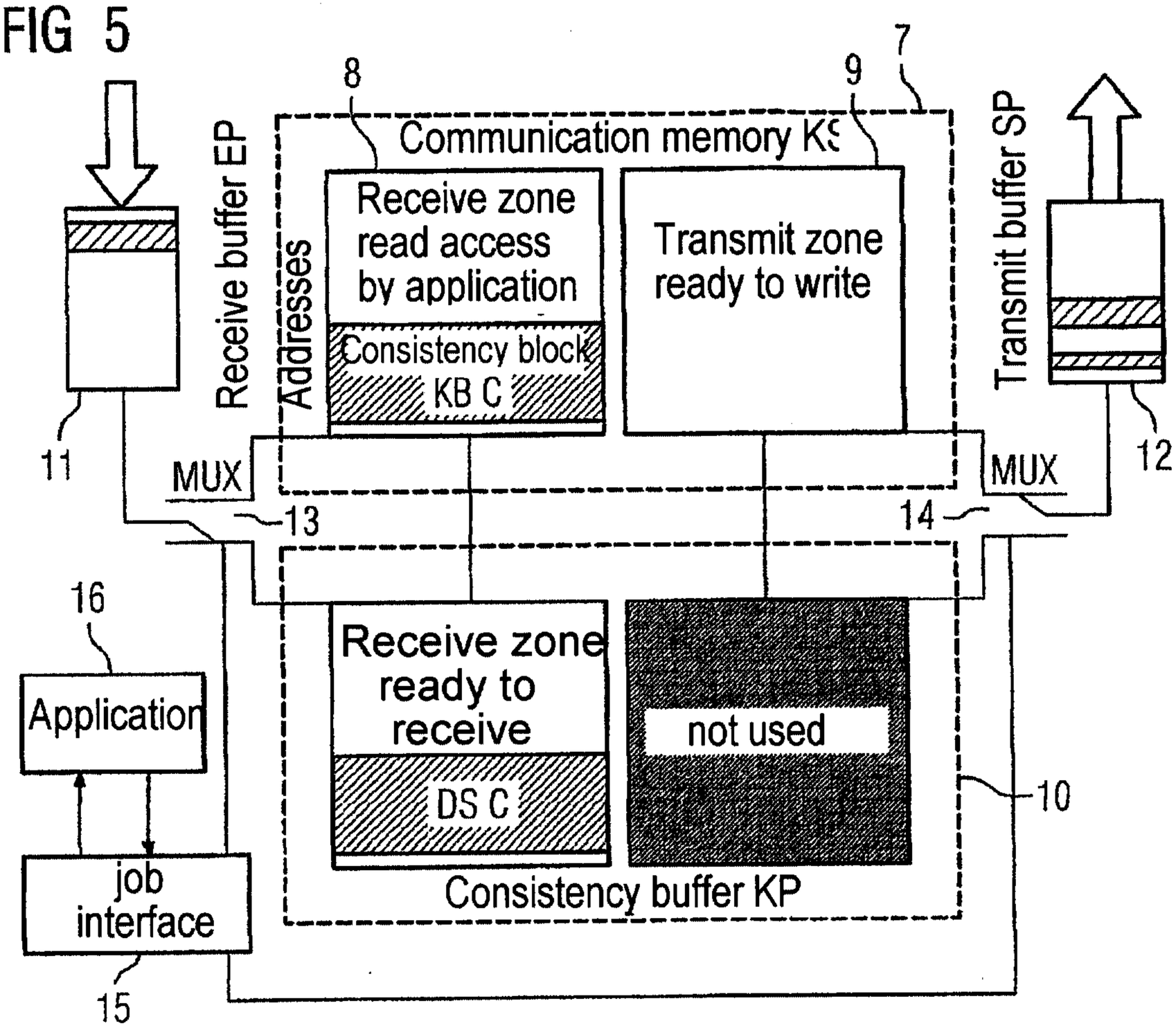


FIG 6

Status			
Read access by the application			
Copying the DS C from the EP into the KP			
Copying the DS C from the EP into the receive zone of the KS			
Receiving data			
Sending data			
Time interval	1	2	3

FIG 7

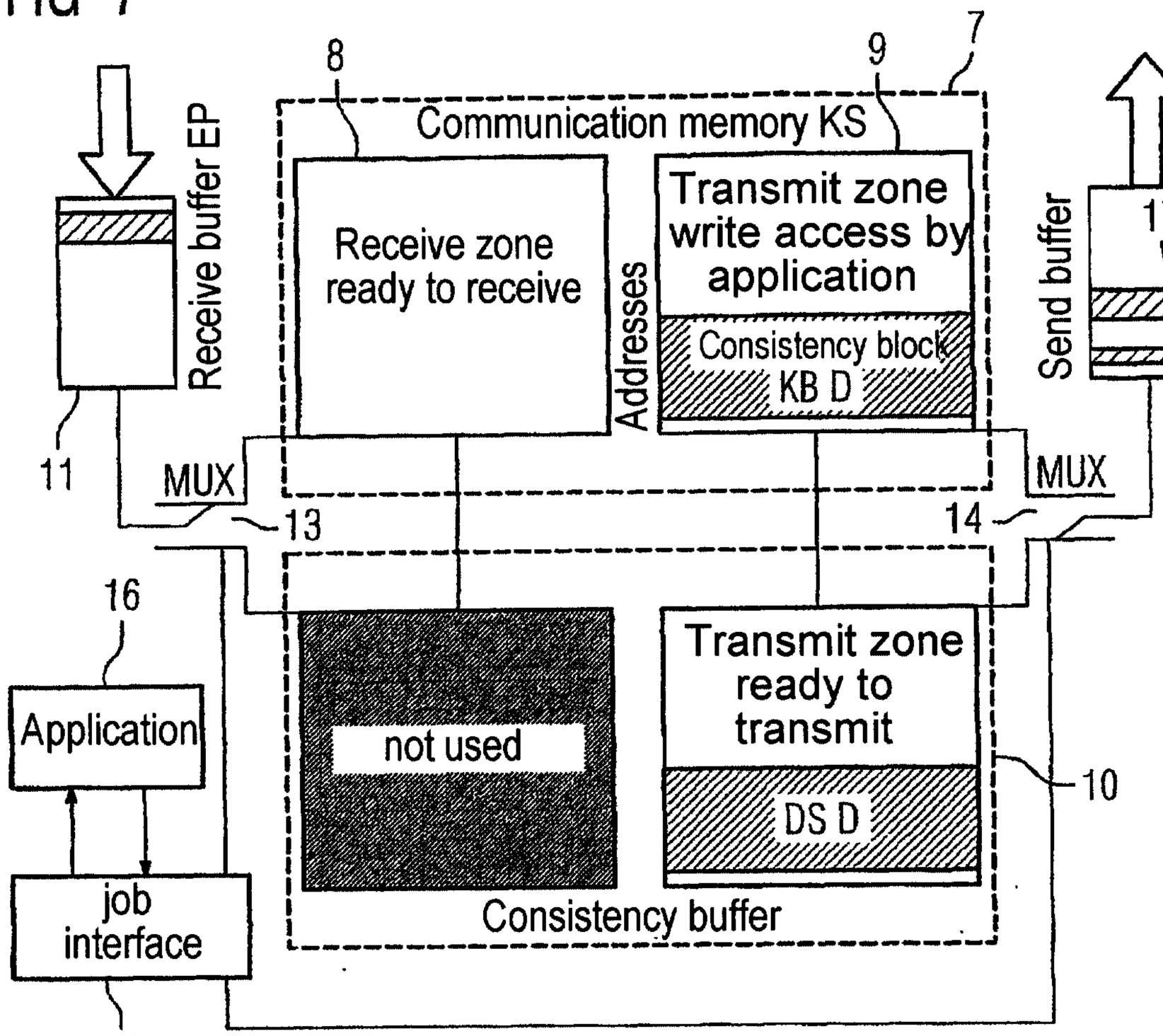


FIG 8

Status				
Copying of DS D from AB D				
Write access by the application				
Copying of data of the DS D to the SP				
Copying data from the AB D to the SP				
Receiving data				
Sending data				
Time interval	1	2	3	4

FIG 9

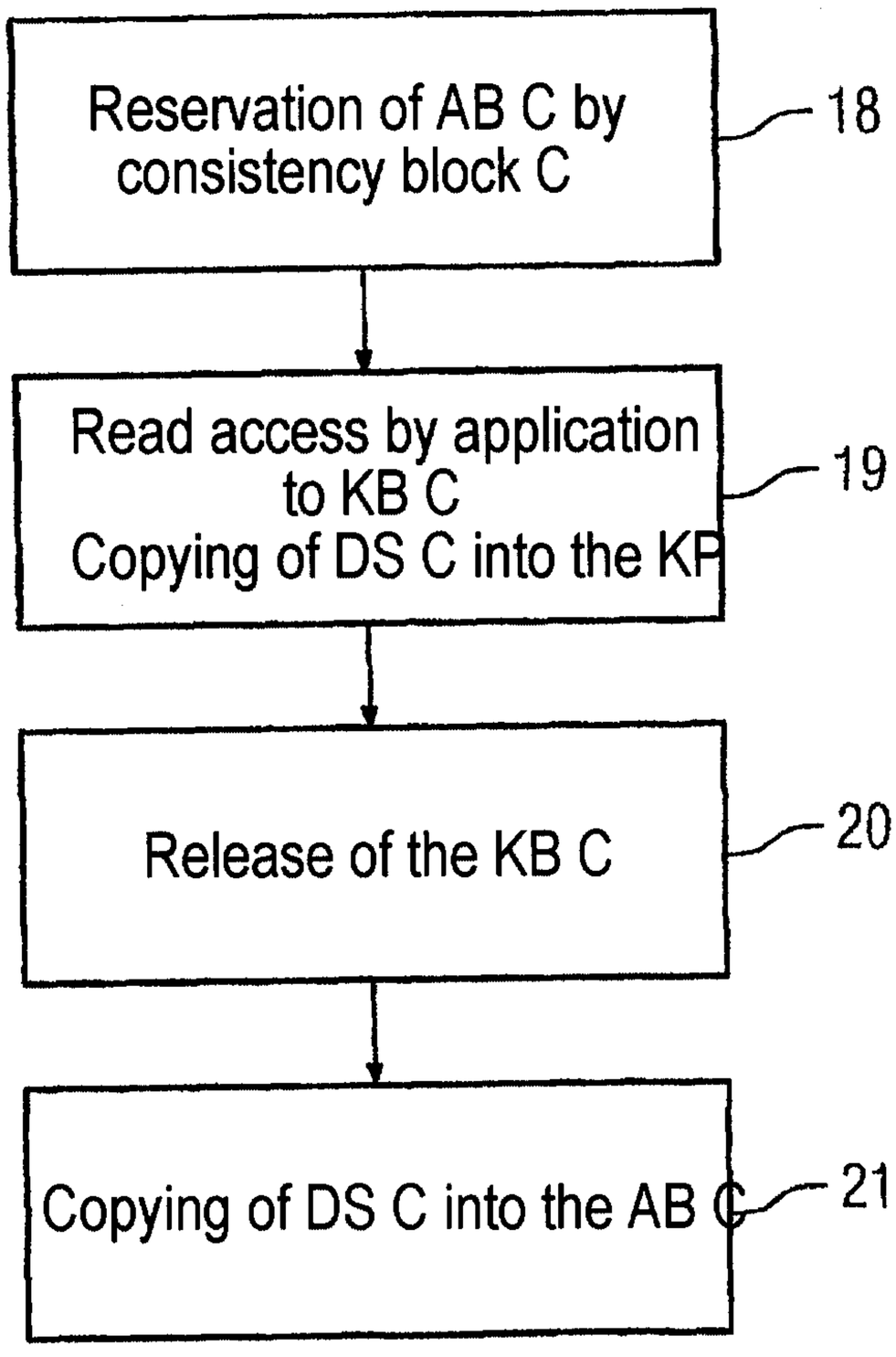
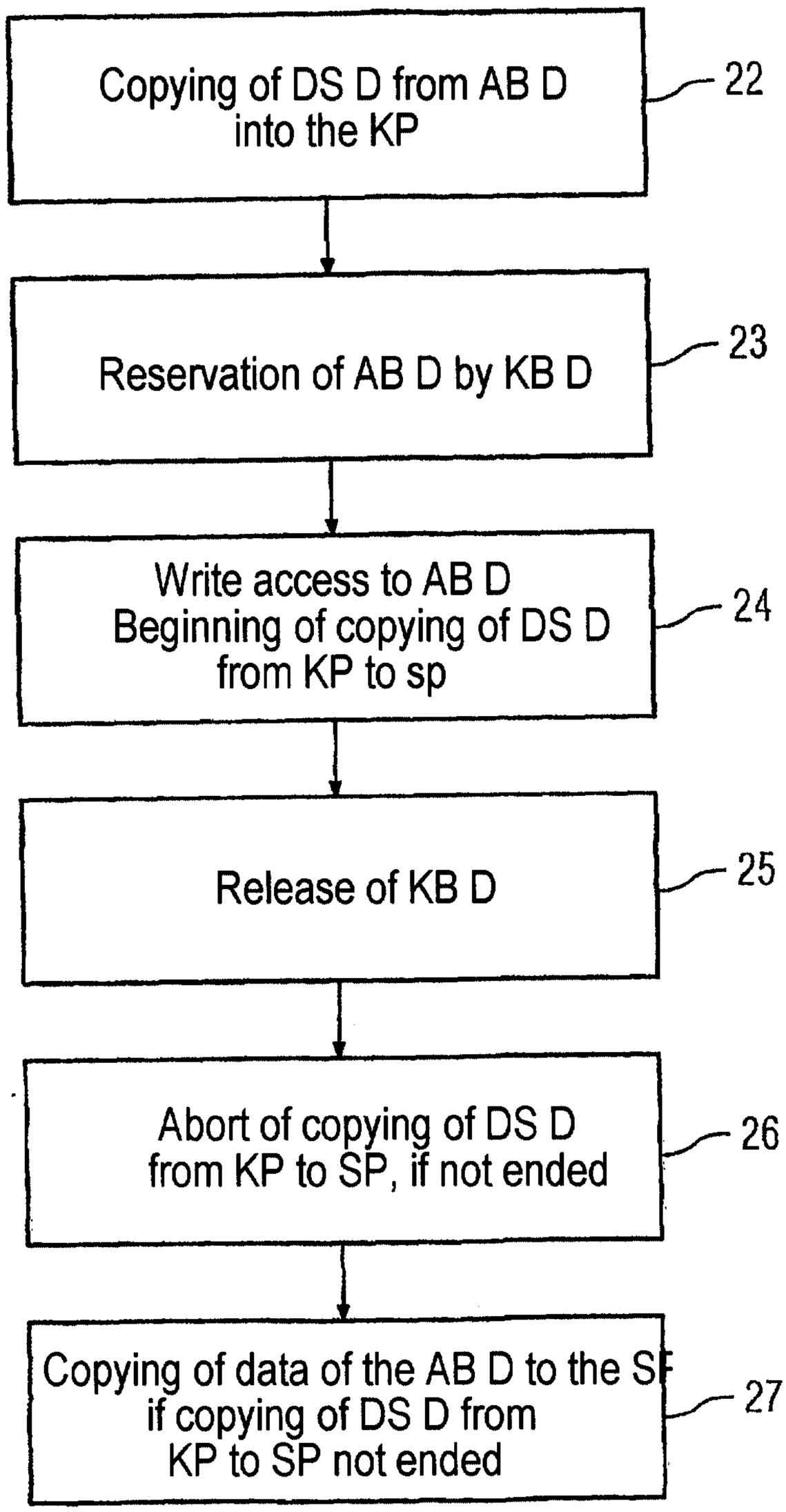
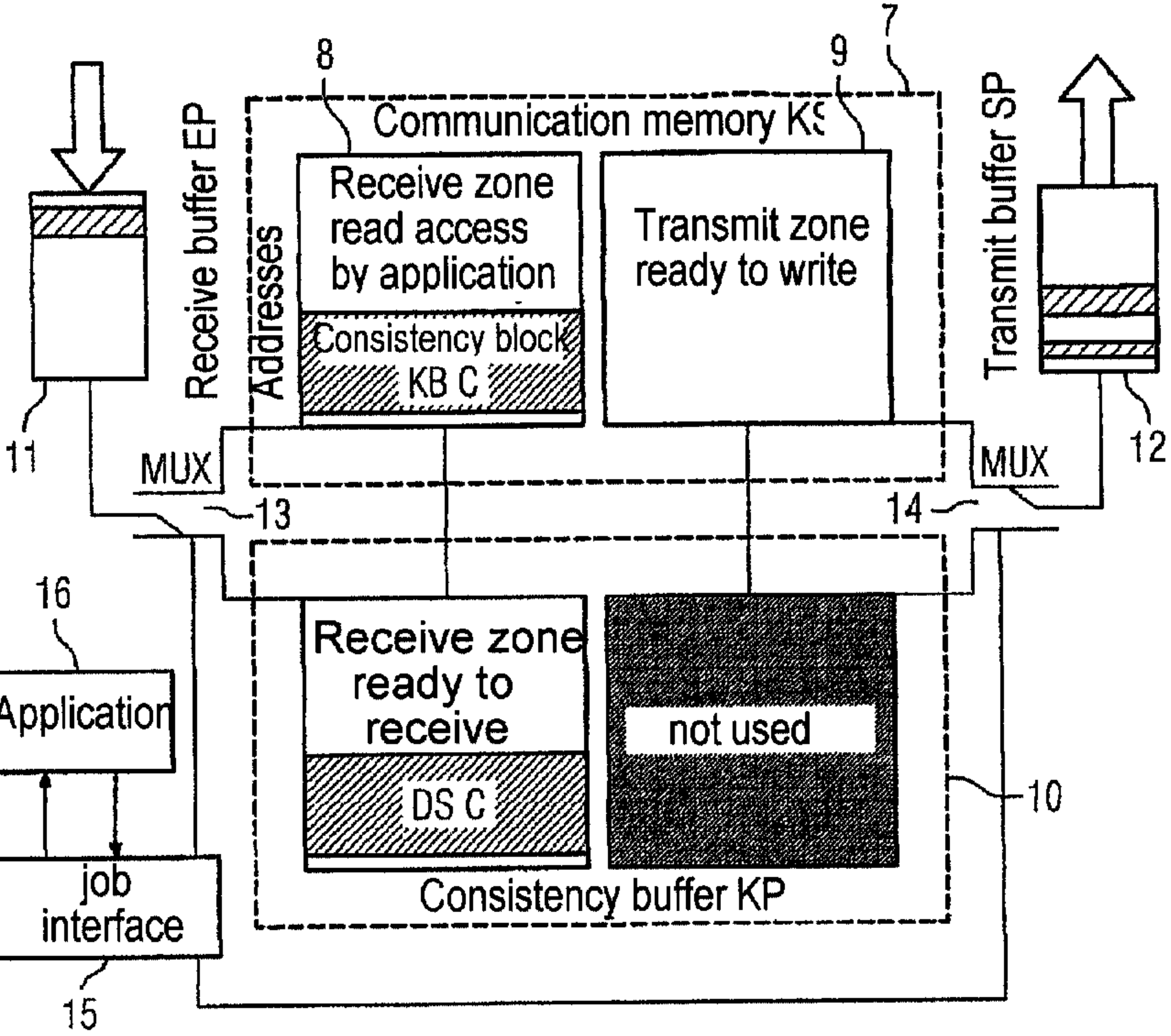

Reservation of AB C by consistency block C
18
Read access by application to KB C
Copying of DS C into the KP
19
Release of the KB C
20
Copying of DS C into the AB C
21

FIG 10


Copying of DS D from AB D into the KP
22
Reservation of AB D by KB D
23
Write access to AB D
Beginning of copying of DS D from KP to sp
24
Release of KB D
25
Abort of copying of DS D from KP to SP, if not ended
26
Copying of data of the AB D to the SP if copying of DS D from KP to SP not ended
27


7
8
9
Communication memory KS
Receive buffer EP
Addresses
Receive zone
read access
by application
Consistency block
KB C
Transmit zone
ready to write
Transmit buffer SP
11
12
MUX
MUX
13
14
16
Application
Receive zone
ready to
receive
DS C
not used
10
job
interface
Consistency buffer KP
15