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(54) MANAGING MESSAGE ARRIVAL TO ENSURE PROPER MATCHING OF UNORDERED MESSAGES

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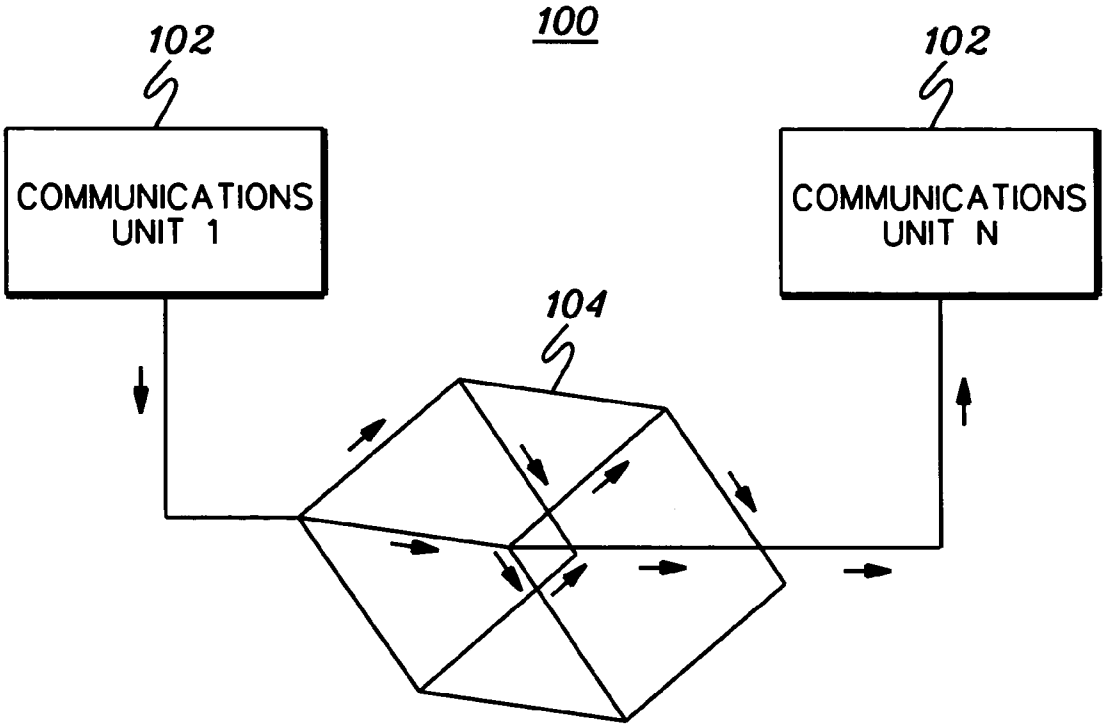
(57) **ABSTRACT**

Messages arriving at a receiver are managed to ensure proper ordering of the messages. To facilitate proper ordering, a message sequence number is used, as well as matching criteria to match a correctly sequenced message with a posted receive. In response to processing a message, a check is made as to whether previously out of order messages can now be processed.



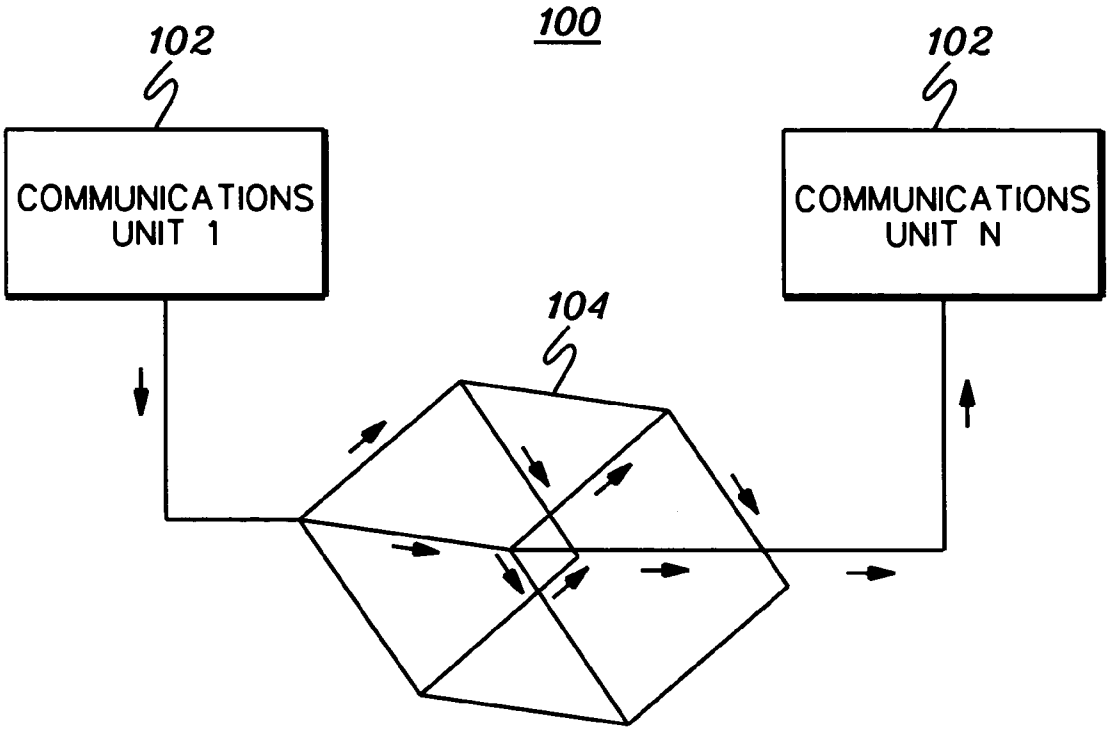

100
102
COMMUNICATIONS UNIT 1
102
COMMUNICATIONS UNIT N
104

fig. 1A

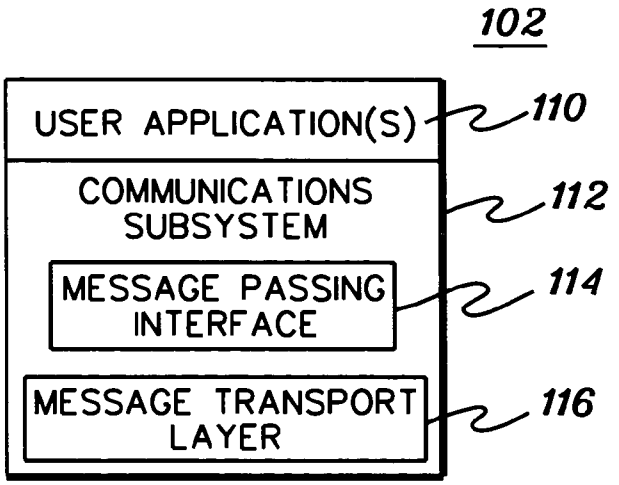

102
USER APPLICATION(S)
110
COMMUNICATIONS SUBSYSTEM
112
MESSAGE PASSING INTERFACE
114
MESSAGE TRANSPORT LAYER
116

fig. 1B

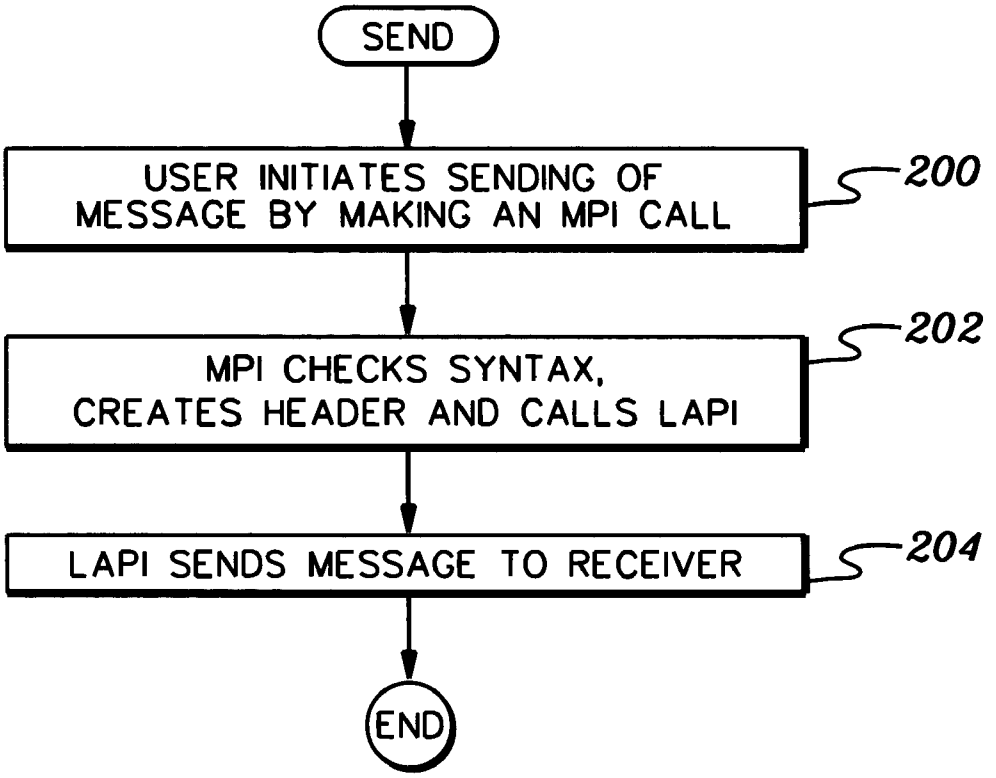

SEND
USER INITIATES SENDING OF MESSAGE BY MAKING AN MPI CALL
200
MPI CHECKS SYNTAX, CREATES HEADER AND CALLS LAPI
202
LAPI SENDS MESSAGE TO RECEIVER
204
END

fig. 2A

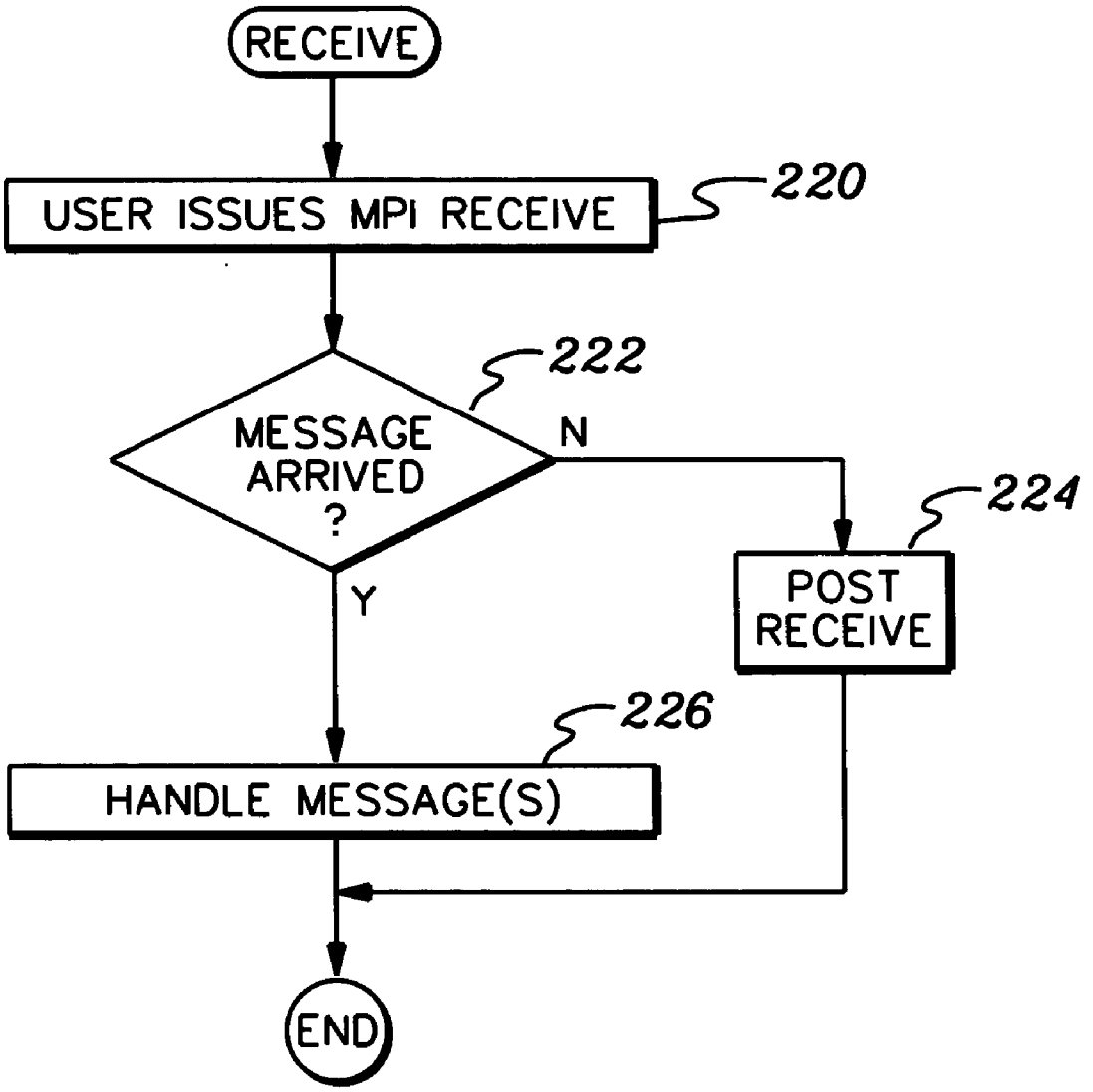

RECEIVE
USER ISSUES MPI RECEIVE
220
222
MESSAGE ARRIVED ?
N
Y
224
POST RECEIVE
226
HANDLE MESSAGE(S)
END

fig. 2B

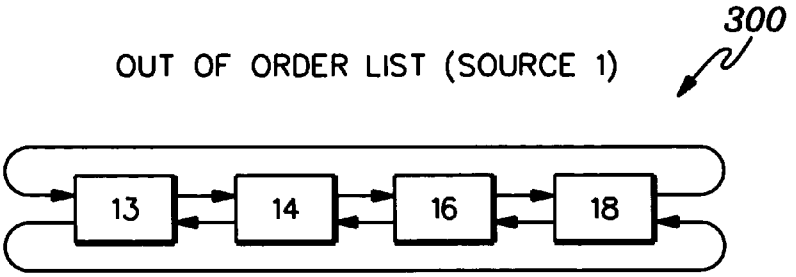


fig. 3A

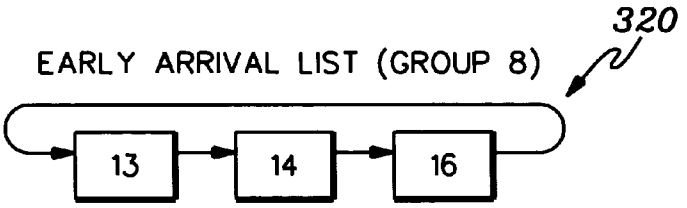


fig. 3B

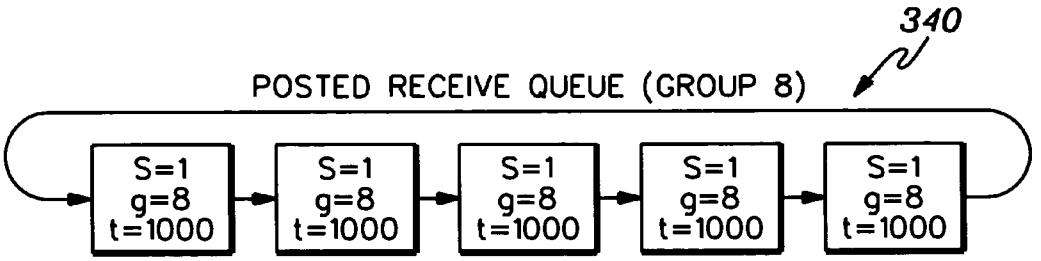


fig. 3C

360

UNMATCHED MESSAGES BUFFER

362

SEQ. No. 364	TAG 366	GROUP No. 368	SOURCE 370	DATA 372
⋮	⋮	⋮	⋮	⋮
11	1000	7	2	•••
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮
13	1000	8	1	•••
16	1000	8	1	•••
14	1000	8	1	•••
18	1000	7	2	•••
18	1000	7	1	•••
⋮	⋮	⋮	⋮	⋮

fig. 3D

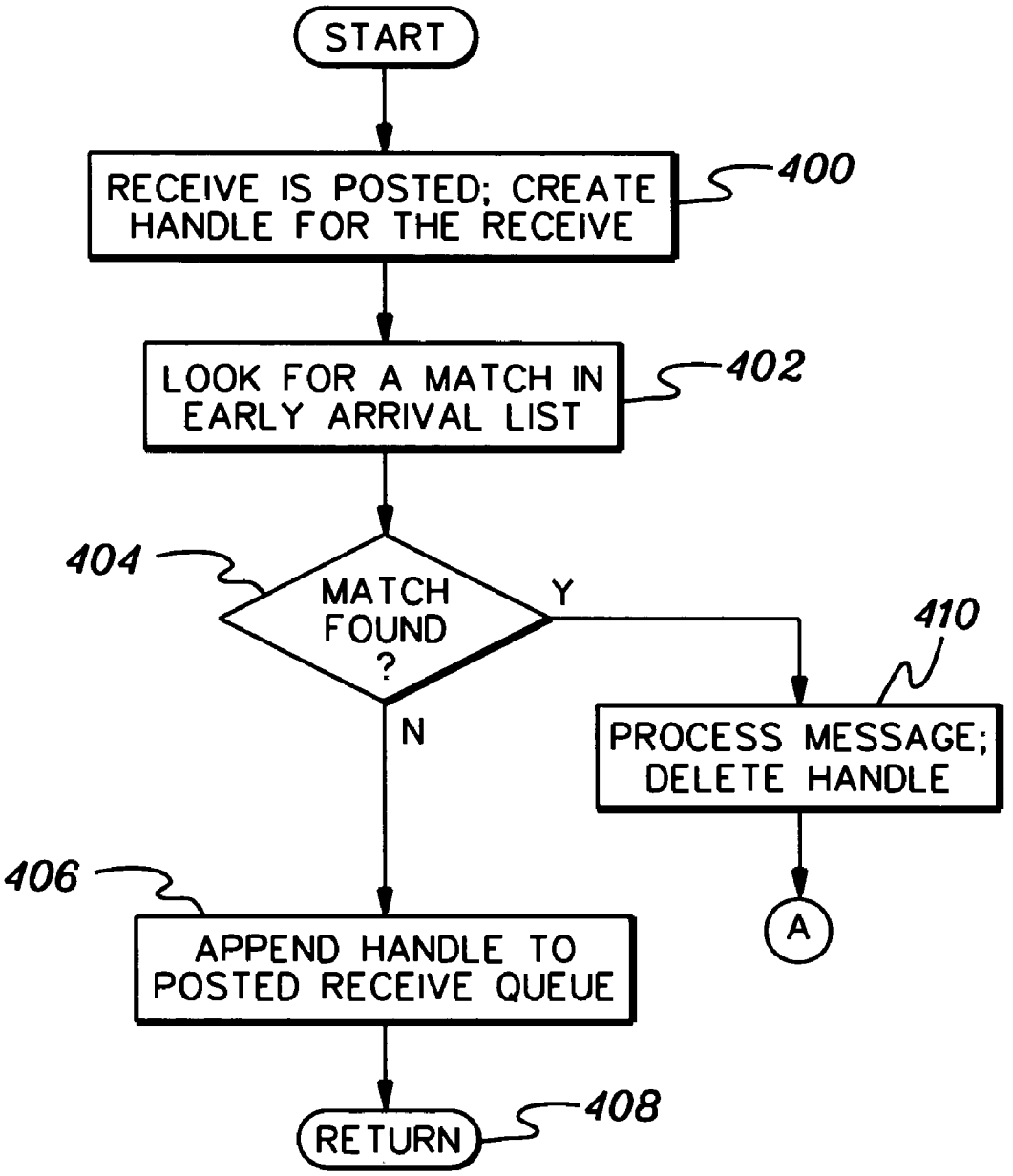

START
RECEIVE IS POSTED; CREATE HANDLE FOR THE RECEIVE
400
LOOK FOR A MATCH IN EARLY ARRIVAL LIST
402
404
MATCH FOUND ?
Y
N
410
PROCESS MESSAGE; DELETE HANDLE
A
406
APPEND HANDLE TO POSTED RECEIVE QUEUE
RETURN
408

fig. 4A

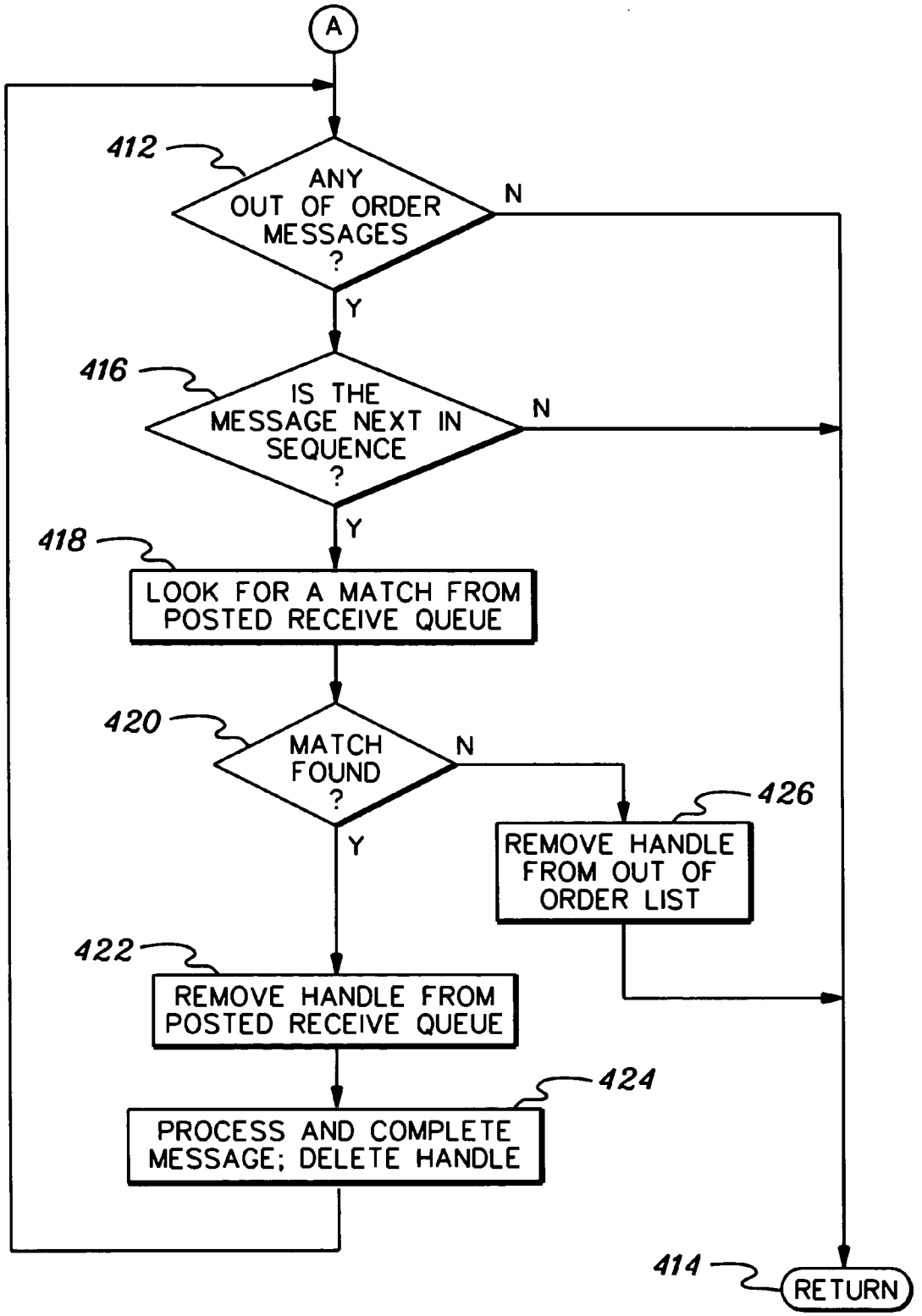

A
412
ANY OUT OF ORDER MESSAGES ?
N
Y
416
IS THE MESSAGE NEXT IN SEQUENCE ?
N
Y
418
LOOK FOR A MATCH FROM POSTED RECEIVE QUEUE
420
MATCH FOUND ?
N
Y
426
REMOVE HANDLE FROM OUT OF ORDER LIST
422
REMOVE HANDLE FROM POSTED RECEIVE QUEUE
424
PROCESS AND COMPLETE MESSAGE; DELETE HANDLE
414
RETURN

fig. 4B

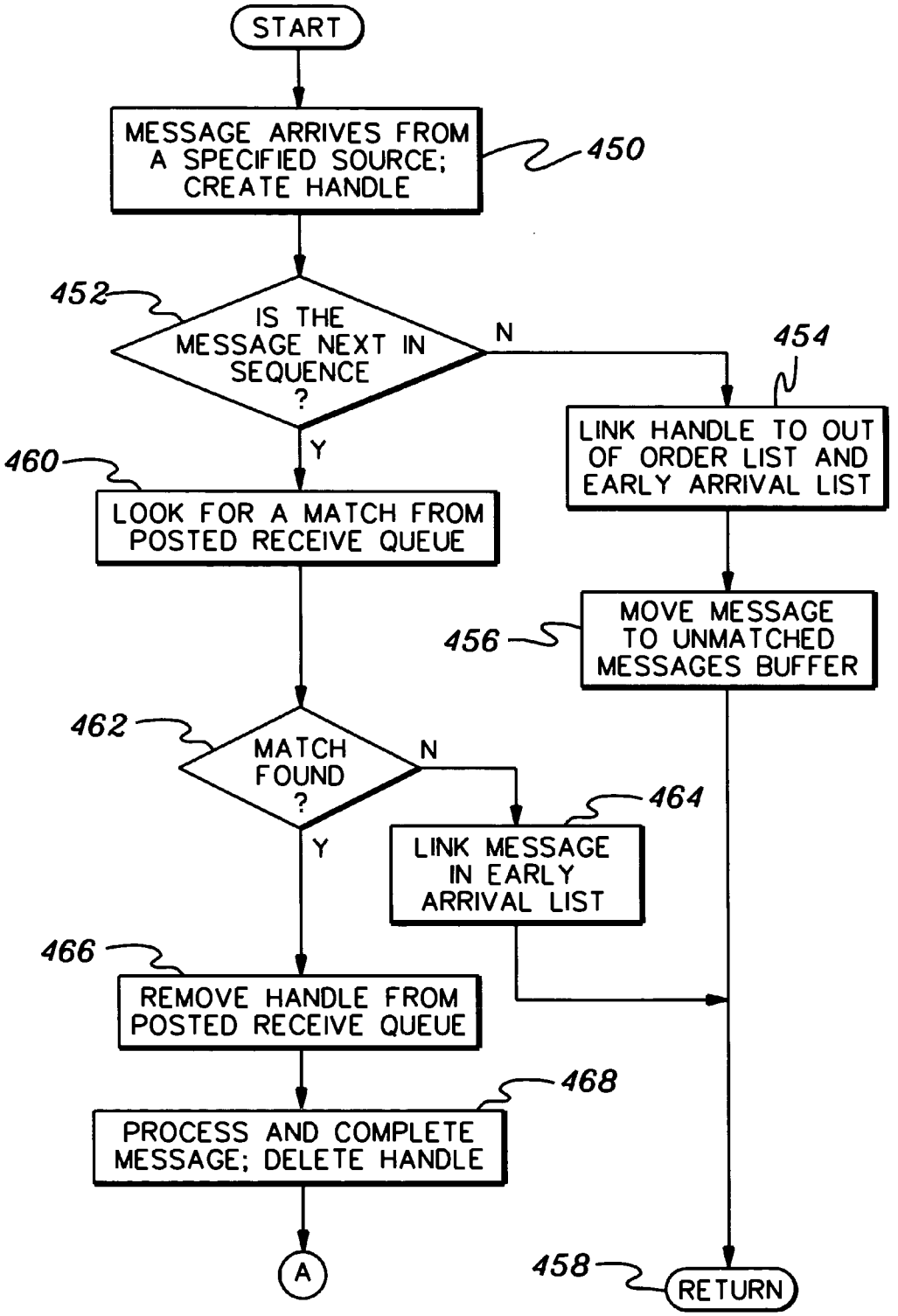

START
MESSAGE ARRIVES FROM A SPECIFIED SOURCE; CREATE HANDLE
450
452
IS THE MESSAGE NEXT IN SEQUENCE ?
N
454
LINK HANDLE TO OUT OF ORDER LIST AND EARLY ARRIVAL LIST
Y
460
LOOK FOR A MATCH FROM POSTED RECEIVE QUEUE
MOVE MESSAGE TO UNMATCHED MESSAGES BUFFER
456
462
MATCH FOUND ?
N
464
LINK MESSAGE IN EARLY ARRIVAL LIST
Y
466
REMOVE HANDLE FROM POSTED RECEIVE QUEUE
468
PROCESS AND COMPLETE MESSAGE; DELETE HANDLE
A
458
RETURN

fig. 4C

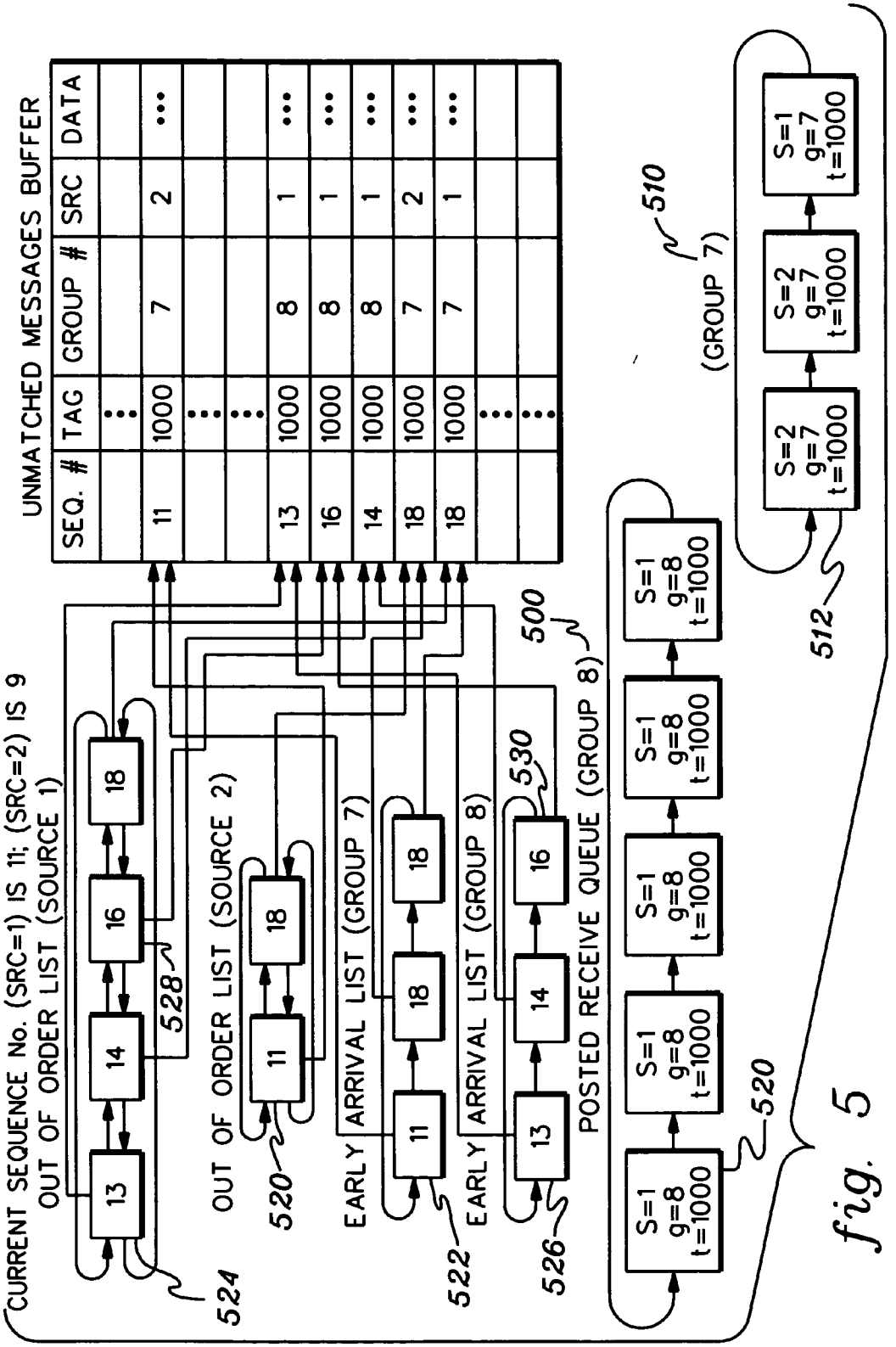

UNMATCHED MESSAGES BUFFER
SEQ. #
TAG
GROUP #
SRC
DATA
CURRENT SEQUENCE No. (SRC=1) IS 11; (SRC=2) IS 9
OUT OF ORDER LIST (SOURCE 1)
OUT OF ORDER LIST (SOURCE 2)
EARLY ARRIVAL LIST (GROUP 7)
EARLY ARRIVAL LIST (GROUP 8)
POSTED RECEIVE QUEUE (GROUP 8)
(GROUP 7)
S=1 g=8 t=1000
S=2 g=7 t=1000
S=1 g=7 t=1000
500
510
512
520
522
524
526
528
530

fig. 5

MANAGING MESSAGE ARRIVAL TO ENSURE PROPER MATCHING OF UNORDERED MESSAGES

TECHNICAL FIELD

[0001] This invention relates, in general, to message handling, and in particular, to managing out of order messages received by a receiver.

BACKGROUND OF THE INVENTION

[0002] There are various types of communications environments, and each type may handle messages differently. In one type of communications environment, messages are transported from a sender of the environment to a receiver of the environment, but the order of the messages is not guaranteed. For example, in the Internet Protocol Suite/User Datagram Protocol (UDP/IP), user datagrams (packets) can be dropped in the communications network, causing out of order arrivals when packets are retransmitted. For those environments in which ordering is not guaranteed, measures need to be taken to ensure proper processing of messages.

[0003] For environments such as the Transmission Control Protocol (TCP/IP), in which a sequential byte stream is to be presented to the user, a sequence number within the fixed-length UDP/IP datagram suffices to determine the memory location into which the packet is copied. As long as all the packets arrive, there is no requirement that they be stored in any particular order.

[0004] Another type of communications environment is a message passing environment, in which the receiver specifies selection criteria for matching incoming messages. Arriving messages that cannot be immediately matched are stored in an unmatched message queue, which is searched each time a receiver provides a new set of specification criteria (called posting a receive). Examples of such systems include the IBM Parallel Environment Message Passing Interface.

[0005] Up to now, message passing environments have been built on top of lower level subsystems that provide an in-order delivery of messages, such as TCP/IP. However, the advent of multi-link, high performance packet switched networks has led to the development of message delivery subsystems that do not promise in-order message delivery. Thus, a need exists for a capability that efficiently handles out-of-order delivery in a message passing environment.

SUMMARY OF THE INVENTION

[0006] The shortcomings of the prior art are overcome and additional advantages are provided through the provision of a method of managing message arrival at a receiver of a communications environment. The method includes, for instance, determining whether a message received by the receiver is in sequence order, the determining using a sequence number of the message; and attempting to match the message with a posted receive, in response to the determining indicating that the message is in sequence order.

[0007] System and computer program products corresponding to the above-summarized methods are also described and claimed herein.

[0008] Additional features and advantages are realized through the techniques of the present invention. Other embodiments and aspects of the invention are described in detail herein and are considered a part of the claimed invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0010] **FIG. 1***a* depicts one embodiment of a communications environment incorporating and using one or more aspects of the present invention;

[0011] **FIG. 1***b* depicts one embodiment of further details associated with a communications unit of the communications environment of **FIG. 1***a*, in accordance with an aspect of the present invention;

[0012] **FIG. 2***a* depicts one embodiment of the logic associated with sending a message from a sender to a receiver, in accordance with an aspect of the present invention;

[0013] **FIG. 2***b* depicts one embodiment of the logic associated with receiving by a receiver a message sent by a sender, in accordance with an aspect of the present invention;

[0014] **FIG. 3***a* depicts one embodiment of an out of order list used in accordance with an aspect of the present invention;

[0015] **FIG. 3***b* depicts one embodiment of an early arrival list used in accordance with an aspect of the present invention;

[0016] **FIG. 3***c* depicts one embodiment of a posted receive queue used in accordance with an aspect of the present invention;

[0017] **FIG. 3***d* depicts one embodiment of an unmatched messages buffer used in accordance with an aspect of the present invention;

[0018] **FIGS. 4***a*-**4***c* depict one embodiment of the logic associated with handling messages received by a receiver, in accordance with an aspect of the present invention; and

[0019] **FIG. 5** illustrates one example of information stored in the various data structures used during processing of an aspect of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0020] In accordance with an aspect of the present invention, a capability is provided for managing message arrival at a receiver of a communications environment. This management includes, for instance, ensuring the proper sequencing of the messages arriving at the receiver. In one example, proper sequencing is provided through using a combination of message sequence numbers with matching criteria to determine whether a message is ready to be processed.

[0021] One embodiment of a communications environment incorporating and using one or more aspects of the present invention is described with reference to **FIG. 1***a*. As

shown in **FIG. 1***a*, a communications environment **100** includes, for instance, a plurality of communications units **102** coupled to one another via a connection **104**. As an example, the communications environment is a parallel operating environment and communications unit **102** includes a pSeries server executing AIX, offered by International Business Machines Corporation, Armonk, N.Y. Details regarding a parallel operating environment for AIX are described in a publication entitled, "Operation and Use, Volume 1 Using the Parallel Operating Environment," Publication Number SA22-7425-01, Version 3 Release 2, Second Edition (December 2001), http://publib.boulder.ibm.com/doc_link/en_US/a_doc_lib/sp34/pe/html/am102mst.html, which is hereby incorporated herein by reference in its entirety.

[**0022**] Connection **104** may include various types of connections, such as any type of wire connection, token ring or network connection to name just a few examples. In the example shown, the connection is a multi-route interconnect in which a message can take one of several routes through the interconnect with the result that messages may arrive out of order compared to the order in which they were sent. One example of such an interconnect is the SP Switch2 available from International Business Machines Corporation, Armonk, N.Y.

[**0023**] Further details regarding a communications unit are described with reference to **FIG. 1***b*. In one embodiment, communications unit **102** includes one or more user applications **110** executing thereon and a communications subsystem **112** used in communicating between the communications units.

[**0024**] Communications subsystem **112** includes, for instance, a message passing interface **114** and a message transport layer **116**. One example of a message passing interface is the industry-established MPI Standard available at http://www-unix.mcs.anl.gov/mpi/index.html, which is hereby incorporated herein by reference in its entirety. The message passing interface includes a library that is responsible for providing a set of subroutines to be called by applications to cause messages to be sent or received. The library is responsible for implementing the proper rules for matching messages according to MPI standards. With the message passing interface protocols, messages sent by a sender are to be matched to specifications posted by a receiver that specify the messages for which the receiver is waiting. The MPI library is responsible for maintaining the internal data structures used in matching the messages. It is also responsible for returning status to the user, such as the length of the message. Features of MPI are described in an IBM Publication SA22-7422-01 entitled, "MPI Programming Guide" Version 3, Release 2, (December 2001), http://publib.boulder.ibm.com/doc_link/en_US/a_doc_lib/sp34/pe/html/am106mst.html, which is hereby incorporated herein by reference in its entirety.

[**0025**] The message transport layer **116** is responsible for taking the specification of a message and its data and transporting them reliably to a destination. It notifies the agent (e.g., MPI) on the receiver side that the message is there. While the transport layer reliably sends a message, it does not guarantee that messages arrive in any particular order. In one example, the message transport layer includes a Low-Level Application Programming Interface (LAPI). LAPI is described in articles entitled, "Understanding the LAPI" and "Using the LAPI" available from IBM and at http://www.research.ibm.com/actc/opt_lib/LAPI-_under.htm, as well as in "Parallel System Support Programs for AIX—Administration Guide," IBM Publication Number SA22-7348-05, May 2003; and "Parallel System Support Programs for AIX—Command and Technical Reference," Volume 2—SA22-7351-05, May 2003, each of which is hereby incorporated herein by reference in its entirety.

[**0026**] An overview of sending a message from one communications unit to another communications unit is described with reference to **FIGS. 2***a*-**2***b*. In this example, one communications unit is a sender and another is a receiver. Each communications unit may be a sender, a receiver or both depending on the call that is issued by the user. The communications subsystem in this example uses MPI and LAPI, but in other examples, it may use other interfaces and/or transport layers in which the receiver provides message matching specifications.

[**0027**] Referring to **FIG. 2***a*, a user application has an area of memory in a sender that includes data called a message that is to be sent to a receiver. The user initiates the sending of the message by making an MPI send call, STEP **200**. The call identifies the address of the message to be sent, the destination of the receiver, as well as other information relating to the message. This information includes, for instance, a tag which identifies the message; a group which identifies a communication sub-domain (e.g., a set of messages for one particular part of the application or an MPI Communicator); and the length of the message.

[**0028**] When the MPI library receives the MPI send call, it checks the syntax of the call and creates a header (sometimes called an envelope) for the message, STEP **202**. The header includes the source, destination, group, tag, and message sequence number. The sequence number is an increasing number that is associated with a message. This message sequence number is distinct from the packet sequence numbers associated with the packets of a message, that may be used by the transport layer. MPI passes this larger message (e.g., header plus data, including user's message buffer) to LAPI.

[**0029**] In response to receiving the call, LAPI takes the message and decomposes it into one or more packets, each of which is sent out over the interconnect, STEP **204**.

[**0030**] On the receive side, the user creates one or more data areas in the memory of the receiver and issues an MPI receive that specifies one of the data areas, as well as the source, tag and group from which it is to be matched by an incoming message, STEP **220** (**FIG. 2***b*). In one example, the receive is a non-blocking receive, and thus, if the message has been sent and is matched, it will be provided to the user. Therefore, a determination is made as to whether any message has arrived, INQUIRY **222**. If no message has arrived, then the receive is posted, STEP **224**, and an indication of such is provided to the user. However, if a message has arrived, then that message and possibly others are handled by the MPI library, as described in further detail below, STEP **226**.

[**0031**] The message transport layer (e.g., LAPI) being used in this example does not guarantee that messages will be received in the order that they are sent. However, the MPI

Standard requires that messages be matched in order (i.e., the order in which they are sent (MPI calls this non-overtaking)). Therefore, logic is provided on the receiver, in accordance with an aspect of the present invention, to ensure proper ordering of the messages. To facilitate this proper ordering, a number of data structures are used, which are described with reference to **FIGS. 3***a*-**3***d*. Each of the data structures is maintained by MPI, for instance, in memory of the receiver.

[**0032**] As one example, one or more out of order lists **300** (**FIG. 3***a*) are provided. Each list includes a list of messages received from a particular source (e.g., sender) that are out of order. In one example, there is an out of order list per source, and each list is a double linked list maintained in sequence order.

[**0033**] One or more early arrival lists **320** (**FIG. 3***b*) are also provided, each of which includes messages that have been received prior to receives being posted for those messages on the receive side. In one example, there is an early arrival list for each group maintained in sequence order.

[**0034**] One or more posted receive queues **340** (**FIG. 3***c*) are also used. Each queue includes the receives that have been posted. In one example, there is a posted receive queue for each group and it is ordered by the time of posting.

[**0035**] Additionally, an unmatched messages buffer **360** (**FIG. 3***d*) is provided. The unmatched messages buffer includes a plurality of entries **362**. Each entry is used to identify an unmatched message (e.g., a message that has arrived, but is out of sequence or a message for which no receive has been posted), and each entry includes, for instance, a sequence number **364**, which is the message sequence number; a tag **366** used to identify the message; a group **368** indicating the group to which this message belongs; a source **370** identifying the sender of the message; and data **372**.

[**0036**] The data structures are used to ensure the proper ordering of messages at the receiver. For example, when a message arrives at the receiver, processing is performed using the structures to determine whether the message is in proper sequence and whether it can be matched. One embodiment of the logic associated with handling messages and ensuring proper sequencing is described with reference to **FIGS. 4***a*-**4***c*. This logic is, for instance, implemented by MPI on the receiver. Although a particular processing order is described herein for clarity, it will be understood by those skilled in the art that many of the steps can occur in a different order than discussed herein. For instance, the posting of receives is discussed prior to receiving messages; however, a message can be received prior to a posting, etc.

[**0037**] Referring initially to **FIG. 4***a*, a receive is posted and a handle for the receive is created, STEP **400**. Then, the early arrival list is checked for a match, STEP **402**. That is, the early arrival list (which points to the unmatched messages buffer) is searched for a message that corresponds to the posted receive (e.g., same source, group, tag) and whose sequence number is next in order from that source. If a match is not found, INQUIRY **404**, then the handle is appended to the posted receive queue, STEP **406**, and processing returns, STEP **408**.

[**0038**] Returning to INQUIRY **404**, if, however, a match is found, then the message is processed and the handle is deleted, STEP **410**. Processing of the message includes, for instance, copying the message from the communications subsystem into the user's buffer and returning status to the user.

[**0039**] Thereafter, processing continues with determining whether any previously considered out of order messages can now be processed. Thus, an inquiry is made as to whether there are any out of order messages, INQUIRY **412** (**FIG. 4***b*). For instance, the out of order message list for the source of the message just processed is checked for out of order messages. If no out of order messages are on the list, then processing returns, STEP **414**. However, if there is one or more out of order messages on the list, then a further determination is made as to whether the message is next in sequence, INQUIRY **416**. If not, then processing once again returns. However, if the message is next in sequence, then a check is made for a match from the posted receive queue, STEP **418**. If a match is found, INQUIRY **420**, then the handle is removed from the posted receive queue, STEP **422**, and the message is processed and completed, STEP **424**. Additionally, the handle is deleted, and the message is removed from the out of order list.

[**0040**] Returning to INQUIRY **420**, if a match is not found, but the sequence is correct, then the handle is removed from the out of order list, STEP **426**, and processing returns, STEP **414**.

[**0041**] Referring to **FIG. 4***c*, in response to a message arriving from a specified source, a handle is created, STEP **450**. Then, a determination is made as to whether the message is next in sequence for that source, INQUIRY **452**. If the message is not next in sequence, then the handle is linked to the out of order list and early arrival list, STEP **454**. Additionally, the message is moved to the unmatched messages buffer, STEP **456**. Processing then returns, STEP **458**.

[**0042**] Returning to INQUIRY **452**, if, however, the message is next in sequence, then the posted receive queue is searched for a match, STEP **460**. If a match is not found, INQUIRY **462**, then the message is linked in the early arrival list, STEP **464**, and processing returns, STEP **458**. However, if a match is found, then the handle is removed from the posted receive queue, STEP **466**. Additionally, the message is processed and completed, and the handle is deleted, STEP **468**.

[**0043**] Thereafter, a determination is made as to whether there are any out of order messages, INQUIRY **412** (**FIG. 4***b*). If there are out of order messages, then processing continues as described above. Otherwise, processing returns.

[**0044**] Described in detail above is a capability for ensuring that messages are matched in the proper order. One example of this processing is described with reference to **FIG. 5**. In the example, it is assumed that there are no unprocessed posted receives; Sequence Number **11** from Source **1** has been processed; Sequence Number **9** from Source **2** has been processed; all messages have Tag **1000**; and the data structures are initially empty.

[**0045**] Initially, a receive for a message in Group **8**, Source **1**, Tag **1000** is posted. In proceeding through the logic of **FIG. 4***a*, it is indicated that no match in the early arrival list is found, and therefore, an entry is added to the posted receive queue for Group **8** (**500**—**FIG. 5**). A receive is posted four more times, and in each time, no match is found,

and therefore, an entry is added to the posted receive queue. The results are the five entries in the posted receive queue for Group **8**, as shown in **FIG. 5**.

[**0046**] Then, a receive is posted for a message in Group **7**, Source **2**, Tag **1000**. Again, following the logic of **FIG. 4***a*, no match is found in the early arrival list, and therefore, an entry is added to the posted receive queue for Group **7** (**510**). The same logic is repeated two more times for Group **7** (once for Source=2, and once for Source=1), and therefore, the posted receive queue of Group **7** includes three entries.

[**0047**] Further on, a message from Source **2**, Sequence **11**, Group **7**, Tag **1000** arrives. Thus, the logic of **FIG. 4***c* is processed. The message is not next in sequence, since the last message processed for Source **2** is Sequence **9**; therefore, the handle is linked to the out of order list and early arrival queue, as shown at **520** and **522**, respectively. Next, a message from Source **1**, Sequence **13**, Group **8**, Tag **1000** arrives. Again, following the logic of **FIG. 4***c*, it is indicated that message **13** is out of sequence, since the next message expected for Source **1** is Sequence **12**. Thus, Sequence **13** is placed in the out of order list for Source **1**, as shown at **524**, and in an early arrival list for Group **8**, as shown as **526**. Next, a message from Source **1**, Sequence **16**, Group **8**, Tag **1000** arrives. Again, the logic of **FIG. 4***c* is followed and Sequence **16** is placed in the out of order list for Source **1**, shown at **528**, and the early arrival list for Group **8**, shown at **530**. Similar logic is applied for Sequence **14**, Group **8**, Source **1**; Sequence **18**, Group **7** Source **2**; and Sequence **18**, Group **7**, Source **1**. Thus, after all of these messages arrive, the data structures include the information that is shown in **FIG. 5**.

[**0048**] Next, a message from Source **1**, Sequence **12**, Tag **1000**, Group **8** arrives. This time, when processing the logic of **FIG. 4***c*, the message is next in sequence, since Sequence **11** was the last message processed for Source **1**. Therefore, the posted receive queue is checked and a match is found. The handle from the posted receive queue is removed and the message is processed and completed. This includes moving the message to the user's buffer. The handle is then deleted. Processing then continues with handling the out of order messages for Source **1**. In this example, three receives match and are removed from the posted receive queue, and Sequence Numbers **13** and **14** are removed from the out of order list and the early arrival queue.

[**0049**] Thereafter, a message from Source **1**, Sequence **15**, Tag **1000**, Group **8** arrives. The logic of **FIG. 4***c* is followed, which results in two receives being matched and removed from the posted receive queue, and Sequence Number **16** being removed from the out of order list and early arrival queue. Sequence **18** from Source **1** and Sequence **18** from Source **2** still exist in the early arrival list for Group **7** and also in the out of order list for their sources.

[**0050**] Described above is a technique for managing the arrival of messages at a receiver to ensure that messages that may arrive out of order are matched by the receiver in order. This technique uses, for instance, a message sequence number in combination with matching logic to ensure the proper sequencing. Data structures maintained in a particular order are used to facilitate and add efficiency to the ordering. For example, an entire list may not need to be searched to check for an out of order message.

[**0051**] Although a communications environment is provided herein, this environment is only one example. Many other types of communications environments may include and/or use one or more aspects of the present invention. For example, the communications environment need not be a parallel environment. Further, the communications units of the environment may be other than pSeries servers, and they can be homogeneous or heterogeneous. The connection may also vary. Further, the environment may include other than computing units. As a further example, the communications protocol may be other than MPI and/or LAPI.

[**0052**] Additionally, although various types of data structures have been described herein, others may be used without departing from the spirit of the present invention. Further, even though the sequence order described herein is an ascending sequence order, other sequence orders are possible (such as descending order or other predictable or agreed upon orders) and are considered a part of the claimed invention.

[**0053**] The present invention can be included in an article of manufacture (e.g., one or more computer program products) having, for instance, computer usable media. The media has therein, for instance, computer readable program code means or logic (e.g., instructions, code, commands, etc.) to provide and facilitate the capabilities of the present invention. The article of manufacture can be included as a part of a computer system or sold separately.

[**0054**] Additionally, at least one program storage device readable by a machine embodying at least one program of instructions executable by the machine to perform the capabilities of the present invention can be provided.

[**0055**] The flow diagrams depicted herein are just examples. There may be many variations to these diagrams or the steps (or operations) described therein without departing from the spirit of the invention. For instance, the steps may be performed in a differing order, or steps may be added, deleted or modified. All of these variations are considered a part of the claimed invention.

[**0056**] Although preferred embodiments have been depicted and described in detail herein, it will be apparent to those skilled in the relevant art that various modifications, additions, substitutions and the like can be made without departing from the spirit of the invention and these are therefore considered to be within the scope of the invention as defined in the following claims.

What is claimed is:

1. A method of managing message arrival at a receiver of a communications environment, said method comprising:

determining whether a message received by the receiver is in sequence order, said determining using a sequence number of the message; and

attempting to match the message with a posted receive, in response to the determining indicating that the message is in sequence order.

2. The method of claim 1, wherein the attempting comprises comparing one or more attributes of the message with one or more attributes of an entry of a posted receive data structure.

3. The method of claim 1, further comprising processing the message, in response to a match between the message and the posted receive.

4. The method of claim 3, further comprising:

determining whether an earlier message that was previously out of sequence is now in sequence, in response to the processing; and

performing one or more tasks associated with the earlier message, in response to the determining indicating that the earlier message is now in sequence.

5. The method of claim 4, wherein the performing comprises:

determining whether there is a posted receive for the earlier message; and

processing the earlier message, in response to the determining indicating that there is a posted received.

6. The method of claim 5, further comprising removing the earlier message from an out of order data structure, in response to the determining indicating that there is no posted receive.

7. The method of claim 1, further comprising linking the message to an early arrival data structure, in response to a failed attempt to match.

8. The method of claim 1, further comprising linking the message to an early arrival data structure and an out of order data structure, and placing the message in an unmatched messages buffer, in response to the message not being in sequence order.

9. A system of managing message arrival at a receiver of a communications environment, said system comprising:

means for determining whether a message received by the receiver is in sequence order, said means for determining using a sequence number of the message; and

means for attempting to match the message with a posted receive, in response to the determining indicating that the message is in sequence order.

10. The system of claim 9, wherein the means for attempting comprises means for comparing one or more attributes of the message with one or more attributes of an entry of a posted receive data structure.

11. The system of claim 9, further comprising means for processing the message, in response to a match between the message and the posted receive.

12. The system of claim 11, further comprising:

means for determining whether an earlier message that was previously out of sequence is now in sequence, in response to the processing; and

means for performing one or more tasks associated with the earlier message, in response to the determining indicating that the earlier message is now in sequence.

13. The system of claim 12, wherein the means for performing comprises:

means for determining whether there is a posted receive for the earlier message; and

means for processing the earlier message, in response to the determining indicating that there is a posted received.

14. The system of claim 13, further comprising means for removing the earlier message from an out of order data structure, in response to the determining indicating that there is no posted receive.

15. The system of claim 9, further comprising means for linking the message to an early arrival data structure, in response to a failed attempt to match.

16. The system of claim 9, further comprising means for linking the message to an early arrival data structure and an out of order data structure, and placing the message in an unmatched messages buffer, in response to the message not being in sequence order.

17. An article of manufacture comprising:

at least one computer usable medium having computer readable program code logic to manage message arrival at a receiver of a communications environment, the computer readable program code logic comprising:

determine logic to determine whether a message received by the receiver is in sequence order, the determining using a sequence number of the message; and

attempt logic to attempt to match the message with a posted receive, in response to the determining indicating that the message is in sequence order.

18. The article of manufacture of claim 17, further comprising:

process logic to process the message, in response to a match between the message and the posted receive;

determine logic to determine whether an earlier message that was previously out of sequence is now in sequence, in response to the processing; and

perform logic to perform one or more tasks associated with the earlier message, in response to the determining indicating that the earlier message is now in sequence.

19. The article of manufacture of claim 18, wherein the perform logic comprises:

determine logic to determine whether there is a posted receive for the earlier message; and

process logic to process the earlier message, in response to the determining indicating that there is a posted received.

20. The article of manufacture of claim 17, further comprising link logic to link the message to an early arrival data structure and an out of order data structure, and place logic to place the message in an unmatched messages buffer, in response to the message not being in sequence order.

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