| (51) International Patent Classification 5 : | A1 | (11) International Publication Number: | WO 94/05102 |
|---|---|---|---|
| H04J 3/02, 3/24 | | (43) International Publication Date: | 3 March 1994 (03.03.94) |

(54) Title: NETWORK SYNCHRONOUS DATA DISTRIBUTION SYSTEM

(57) Abstract

A method and apparatus for communication synchronous and asynchronous data among multiple devices which are connected by a common network. If synchronous data signals must be communicated between two or more devices the transmitting device sends asynchronous data signals to the receiving device(s) to indicate that synchronous data will follow, and to inform the receiving device(s) of the transmitting device's address. The receiving device(s) sets up a message filter (33) which looks for and accepts data packets bearing a destination address field value equal to the address of the transmitting device. The transmitting device converts the synchronous data into one or more data packets bearing destination address field value equal to the transmitting device's own address, and transmits the data packets over the network. The receiving device receives the data packets and reassembles them back into a synchronous data signal. Thus, the transmitting device needs to send the data packets only one time, rather than sending duplicate data packets to several receiving devices.

# NETWORK SYNCHRONOUS DATA DISTRIBUTION SYSTEM
## BACKGROUND OF THE INVENTION

The present invention relates, generally to systems for communicating data among remote devices, and in particular to a method and apparatus for communicating synchronous and asynchronous data between devices connected to a network or a group of interconnected networks.

Computer networks provide a way to exchange data between connected devices. The connected devices can be high speed digital computers, microprocessor based computers, simple recording devices, or a variety of other devices. Connecting multiple devices by a network and allowing the devices to exchange data eliminates the need for duplicate data storage, reduces costs, and increases productivity.

Many such network systems have been developed. They use different connection architectures, have different communications protocols, and can use either twisted pair wires, coaxial cables, optical fibers, or other physical transmission medium. Examples of common network systems are so called "local area network" systems which commonly interconnect plural "personal" computers.

In a network system, comprising plural end-user devices interconnected by a transmission medium, communications are frequently in the form of bit-serial data packets of a predetermined format. Each data packet usually contains a source address, a destination address, various supervisory or administrative data and, up to a predetermined amount of message data. An end-user device desiring to send a message to another end-user device typically accesses the transmission medium through interface units and causes the message to be communicated on the transmission medium where it is available

to be received by the other end-user devices connected to the transmission medium. Because the length of a "message" may exceed the length available in a packet, the "message" may be broken into plural serial signals each of which are transmitted in one of the data packets. To transmit data the end user device passes the data packets to the interface unit, which in turn transmits the data along the transmission path after it has determined that the transmission path is not in use. An end-user device desiring to receive the data accesses the transmission medium through interface units and obtains the desired data packets therefrom. Typically, the end-user device must re-assemble message data from plural packets to reconstruct the original message.

In any data communication, and especially in data communications networks, it is common for the transmitting device and the receiving device to engage in a protocol which controls the communications process. Typically the transmission medium interface stage does not attempt to decode or sort the data packets in order to ensure message validity but utilizes network applied check words to determine data packet integrity. If the receiving device receives a message which is correct in format, and passes the network check word tests, the receiving device may send a message to the transmitting device acknowledging receipt of a valid data packet. Likewise, if the data fails to conform to the required format, or fails a check word test, the receiving device may send a non-acknowledgment message, or send no acknowledgement back to the transmitting device. If the transmitting device fails to receive acknowledgment that a valid data packet was received, it will re-transmit the packet.

The capability of such known communications systems is necessarily limited by the bandwidth of the transmission medium. When the number of devices communicating on the transmission medium exhausts the bandwidth capability of the system, no additional devices can be connected to the system, nor can the existing devices increase their message rates.

Since only one device at a time can transmit over the transmission path, if one device takes control of the network

and sends a large amount of data, all the other devices must
wait. Likewise, if many devices are all attempting to send
data at the same time, each connected device must wait its
turn. This can lead to unacceptable transmission delays unless
some s cheme exists to allocate use of the transmission medium.

There are many known methods of allocating access to the
transmission medium. The network protocol can be such that the
connected devices take turns transmitting. In such a system
only one device at a time will have the privilege of
transmitting, while all other devices can only receive. The
privilege is passed from one device to another in a predefined
order until each connected device has had an opportunity to
transmit. Once the privilege has been passed to all devices on
the network the cycle begins all over again. When a device
gets the privilege it can transmit data if it needs to, or just
pass the privilege on to the next device.

Another method is to set a maximum transmit time period.
When a device takes control of the transmission medium it can
only transmit for a certain period of time, after which it must
relinquish control of the network.

The amount of time for a data packet to be communicated
between two devices is known as the latency. If the two
methods described above are combined, the maximum amount of
time it takes to get the opportunity to transmit a data packet
is the time it takes for the transmit privilege to complete a
cycle around the network. Since the privilege may travel in a
defined cycle, and since each device may have only a set amount
of time to transmit, the latency is deterministic. Since not
every device will necessarily want to transmit during a given
cycle of the transmit privilege, the latency will vary from
cycle to cycle, but will always be less than a known maximum
value.

If many devices are connected to the network the maximum
transmit time can be shortened to maintain a certain latency
value. If fewer devices are connected to the network the
maximum transmit time can be increased and the latency value
will remain the same.

While the allocation scheme described above is one way to achieve a bounded, deterministic latency, other schemes also exist.

In most networks, each connected device has its own address. There are two main schemes used by network systems to ensure that transmitted data packets arrive at the right receiving device. In the first, each data packet is addressed to a particular receiving device. In the second, group addresses are used.

In the first scheme each data packet has a destination address field. The transmitting device puts a value equal to the receiving device's address into the destination address field of a data packet, then transmits the packet. The receiving device constantly scans the data packets passing over the network and receives only data packets with its own address. If the transmitting device must send a particular message to several receiving devices, this addressing scheme is inefficient since the same data packets must be sent multiple times to each receiving device. This wastes network bandwidth and slows down all devices on the network.

This approach normally uses robust transport and network protocols such as Transport Control Protocol/Internet Protocol (TCP/IP) or an International Organization for Standardized (ISO) Open System Interconnection (OSI) Compliant Network and Transport Protocol to provide error handling and packet sequencing in the presence of noise and other data traffic.

The operation of this protocol may also require that a flow control mechanism such as that described in U.S. Patent Application S.N. 452,429, filed December 19, 1989, and assigned to the same entity as the assignee hereof, which is incorporated herein by reference. This patent application describes a dispersed end entity flow control technique for computer networks which can be implemented to manage data flow when the receiving device cannot accept additional data due to excessive demands on its resources.

In a group addressing system there are predefined address values corresponding to different types of data. A transmitting device will decide what type of data it is

transmitting, and will put the appropriate group address in a data packet's destination address field. A receiving device looking for a particular type of data scans the destination address field of all the data packets traversing the network and selects only those with the correct group address. Since multiple receiving devices can each receive a single transmission of data packets based on the group address, duplicate transmission of data packets is not necessary. However, group addressing imposes a rigid communications structure on connected devices. The data types must be known to all connected devices, and it is difficult, if not impossible, to change the group addresses. Similarly, it may not be possible to dynamically vary groups from message to message.

In many environments it is desirable to communicate both synchronous and asynchronous signals over the same network medium. Continuous, synchronous signals such as audio and video data must be broken down into data packets at the transmitting end, transmitted across the network, then reassembled into a synchronous signal at the receiving end. In order ensure that synchronous signals appear whole to the user at the receiving end the packets must traverse the network fast enough to be inserted back into the correct position in the outgoing synchronous data stream. In practical terms this means the delay in passing a data packet from one device to another, the latency, must be bounded and deterministic. Many network standards provide this type of environment, but a low latency is essential to proper transmission of synchronous data.

Often a synchronous signal must be sent to more than one receiving device. It is also common for the intended receiving devices to vary from message to message. If the transmitting device uses the addressing method of addressing each data packet to an individual receiving device, it allows the transmitting device to select exactly who will receive the transmission. Unfortunately, precious transmission time is wasted in sending duplicate data packets to multiple devices.

If the group addressing scheme is used the transmitting
device loses control over who will receive the message, and the
transmitting device is unable to tell individual receiving
devices to tune into a certain message.  It is impossible to
dynamically vary the groups on a message by message basis.

It is accordingly an object of the present invention to
provide a novel method and system for transmitting synchronous
data between dynamically variable groups over a standard
network having deterministic bounded latency.

It is a further object of the present invention to provide
a novel method and system for more efficiently using the
available bandwidth of a standard network having deterministic,
bounded latency during synchronous communications between
dynamically variable receiving groups.

These and other objects and advantages of the present
invention will be apparent to one skilled in the art from the
claims and from the following detailed description when read in
conjunction with the appended drawings.


## BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a functional block diagram of a typical
network in which the method and system of the present invention
could be utilized;

FIGURE 2 is a functional block diagram of a data link
front end processor which could be used in the system
illustrated in FIGURE 1.

FIGURE 3 is a functional block diagram of a typical system
processor which could be used in the system illustrated in
FIGURE 1.

FIGURE 4 is a functional block diagram of an integrated
workstation which could be used in the system illustrated in
FIGURE 1;

FIGURE 5 is a functional block diagram showing typical
devices used in a network illustrated in FIGURE 1, and
illustrating the different paths data can follow in traversing
the network;

FIGURE 6 is a functional block diagram illustrating how
two devices connected to a network system embodying the present

invention would inform each other of their intent to begin
transferring synchronous data;

FIGURE 7 is a functional block diagram illustrating how
two devices connected to a network system embodying the present
invention would set up their respective message filters;

FIGURE 8 is a functional block diagram illustrating the
transfer of synchronous data between two devices connected to a
network embodying the present invention; and,

FIGURE 9 is a functional block diagram illustrating how
two devices connected to a network system embodying the present
invention would end the transmission of synchronous data.


## DESCRIPTION OF PREFERRED EMBODIMENTS

A data communications network in which the method and
system of the present invention may be used is illustrated in
Figure 1.  With reference to Figure 1, a network transmission
medium 1 links all the devices and provides a path for data
transfer.  The particular types of devices interconnected by
the network transmission medium varies widely depending on the
function of the network.  The devices shown in the network of
Figure 1 are typical but not limiting, as is well known to
those skilled in the art.

Various system processors 3 may be connected to the
network transmission medium 1 to carry out a variety of
functions depending on the environment of the system.  The
function of a system processor 3 will vary depending upon the
data processing needs of the network and could be a recording
device, a data storage device, a text editing device, or any
other device which produces and/or consumes synchronous and/or
asynchronous data signals.

A front end processor 4 may be connected to the network
transmission medium 1 to provide an interface between the
network and a data link 8.  This interface makes it possible
for the network to receive data signals from outside sources.
The front end processor 4 receives data from the data link 8,
and formats the data in packets suitable for transmission over
the network transmission medium 1.

An audio interface 6 may be present in the network system
to allow exterior devices to exchange audio signal data with
devices connected to the network transmission medium 1.

A network gateway 7 may be present in the network system
to allow one network system to exchange synchronous and
asynchronous data signals with another network system.

An intercom interface 5 may be present in the network
system to allow devices connected to the network transmission
medium 1 to communicate with an external intercom system.

A variety of network input/output operations can be
accomplished by the audio interface 6, the network gateway 7,
or the intercom interface 5. The audio interface 6 and the
intercom interface 5 both allow devices connected to the
network to communicate with external devices using synchronous
data signals. Both the audio interface 6 and the intercom
interface 5 should be capable of formatting incoming audio
signals into standard data packets for transmission over the
network and should be capable of taking synchronous signal data
packets from the network and converting them to normal audio
signals. The network gateway 7 is a conventional method of
connecting one network system to another network system, and is
typically designed only to pass asynchronous data signals
between networks.

A variety of workstations 2 may be connected to the
network system, each of which may need to communicate
synchronous and asynchronous signals to other devices connected
to the network transmission medium 1.

As is further described in detail below, each of the
devices attached to the network transmission medium 1 transmits
and/or receives data from the medium 1, synchronously and/or
asynchronously. The sharing of the resources of the network
make efficient use of both the resources of the various devices
and of the communications network.

With reference to Figure 2, a front end processor 4, which
provides an interface between a data link and the network
transmission medium is made up of three basic elements, a link
interface 43, a link interface processor 44, and a network data
packetizer 50.

The link interface 43 contains hardware and software which enables the link interface 43 to distinguish between synchronous and asynchronous signals received via the LINK lines 42. Asynchronous signals are passed by the link interface 43 to the link interface processor 44, while synchronous signals are passed to the network data packetizer 50.

If asychronous signals received by the link interface processor 44 are received in a form which is compatible with the network the signals may be passed directly to the network through the network's normal protocol. If the asychronous signals require further processing to be compatible with the network they are passed first to the network data packetizer 50.

Synchronous signals received by the link interface unit 43 are passed to the network data packetizer 50. The synchronous signals are buffered into pages of memory 48 and as the pages of memory become full they are passed to a data packetizer 47. The data packetizer 47 takes the synchronous signals, now in memory 48, and creates data packets, adds the destination address to the data packets and passes the data packets to a network interface 45. The network interface 45 transmits the complete data packets over the network system.

Asynchronous data signals coming from the link interface processor 44 which require additional processing are passed to a task supervisor 46. The task supervisor 46 passes the asynchronous data signals to the data packetizer 47 which places the data into packets and passes the packets to a message processor 49. The message processor 49 takes care of additional message processing functions and passes the asynchronous data packets to the network interface 45. The network interface 45 transmits the asynchronous data packets over the network system.

With reference to Figure 3, a System Processor 3 provides distributed processing elements to support centralized data requirements such as system wide data bases or centralized recording functions. Data is received by the System Processors 3 through a network interface 55. The network interface 55

takes the data received from the network transmission medium 1
and passes it to a data multiplexer 56. The data multiplexer
56 then passes the signals onto various processes 57 within the
System Processor 3. A Single System Processor 3 may be capable
of supporting multiple processes such as recording functions or
database serving functions.

A System Processor 3 may be both a consumer and a producer
of synchronous and/or asynchronous data signals. If a System
Processor 3 is a producer of synchronous or asynchronous data
signals, signals created by the processors 57 would be
packetized, then passed to the data multiplexer 56 and from
there to the network interface 55. The network interface 55
would transmit the data signals in the form of data packets
over the network.

With reference to Figure 4, an integrated workstation 2
may receive, process and generate both synchronous and
asynchronous data signals. The integrated workstation 2 may
serve as the primary man-machine interface for the network
system. The integrated workstation is made up of two parts:  a
conventional workstation 61 which produces and consumes
asynchronous data signals, and an auxiliary interface and
processing unit 60 which receives and transmits synchronous
data signals.

The auxiliary interface and processing unit 60 provides
all of the real time processing of synchronous data signals.
Synchronous data signals are received from the network by a
network interface and message filter 33. The network interface
and message filter 33 is capable of scanning each data packet
traversing the network and selecting only those data packets
with pre-identified destination address field values. The
network interface and message filter 33 select those data
packets which it is desirable receive and passes the data
packets onto a data multiplexer 34. The data multiplexer 34
passes video synchronous signals onto a video processor 35, and
passes audio signals onto either an intercom and audio mixer 36
or a time division multiplexer 37. Since synchronous signal
data packets may be received out of order, the intercom and
audio mixer 36 takes the synchronous data packets and puts them

back into the correct temporal order and passes them to the
time division multiplexer 37. The time division multiplexer 37
may support industry standard links, such as a DS1 line
connecting to a digital recorder or an Integrated Services
Digital Network (ISDN) basic rate line (as specified in CCITT
standards I.430/I.440/ I.441/I.450/I.451) connecting to an
operator's head set. Optionally, it may consist of a simple
analog to digital, digital to analog convertor. The time
division multiplexer 37 passes demultiplexed audio signals to
end user devices such as an operators headset 40, or a
recording device 39.

Outgoing audio signals, generated by the end user are
passed to the time division multiplexer 37. The time division
multiplexer 37 takes the audio data and places it into data
packets suitable for transmission under the network protocol
and passes these data packets to the data multiplexer 34. The
data multiplexer passes data packets to the network interface
and message filter 33 which then transmits the data packets
over the network.

With continued reference to Figure 4, the work station
portion 61, of the Advanced Integrated Workstation 2 sends and
receives asynchronous data signals via its own network
interface 42. Asynchronous data signals are received from the
network over the network interface 42 and are passed onto the
workstation computer 41. Outgoing asynchronous data signals
are generated by the workstation computer 41 and are passed to
the network interface 42 for transmission over the network.

With reference to Figure 5, each different type of network
system has its own communications protocol. Typically a
communications protocol will be composed of several layers, the
bottom layers are the actual, physical transmission medium, and
the upper layers are data manipulation and data check functions
to ensure that data packets passing between devices, are in the
correct format and have not been corrupted with data errors
during transmission. One type of data network system protocol
which is capable of supporting a network system embodying the
present invention is the ANSI X3T9.5 fiber data distribution
interface and packetized local area network. A network system

operating under this standard has a communications protocol
which consists of a seven layer stack. The second layer 31 in
this system protocol is the actual, physical transmission
medium. Layers 3 - 7 of this communications protocol buffer
data packets, prepare data packets for transmission, check data
packets for errors which were introduced during transmission
and ensure the data packets are in the correct format to be
passed onto the end using device.

Above the multi-layer network system protocol rest the
various applications interconnected by the network. Typical
applications are illustrated in Figure 5: data link interface
4, system processor 3, integrated workstation 2, network
gateway 7, audio interface 6 and intercom interface 5. Each of
these applications are illustrative of the types of
applications which may be present and the present invention is
not intended to be limited to the specific applications
illustrated.

With continued reference to Figure 5, the actual path that
a data packet will traverse as it is communicated from one
connected device to another connected device is illustrated by
the lines connecting the protocol layers to the applications.

Asynchronous signals which are passed between the various
connected devices follow the normal transmission path for this
type of network system. The data packet is generated by a
connected device, is passed to layer 7, then passed down to
layer 2 of the network protocol stack where it is transmitted
over the actual physical transmission medium to another
connected device. Upon receipt at the protocol layer of a
connected device, the packet may be accepted, checked for
correct format, assembled, and error checked by the various
protocol layers before being passed to the application.

Synchronous signal data packets which are generated by a
connected device can be passed directly to the second layer of
the network protocol stack, bypassing layers 3 - 7. This saves
time which is critical when communicating synchronous data
signals.

With continued reference to Figure 5, a Front End
Processor 4 for a data link can take both asynchronous and

synchronous data signals from an external link and pass them to
a link interface 15.  If the received signals are asynchronous
data signals, they may be passed directly to the seventh layer
of the network protocol stack where they will follow the normal
network communications protocol and be transmitted
asynchronously over the network.

Synchronous and asynchronous data signals not in the
required communications format will be put through a data
formatting process where the data is converted into data
packets, given an address and passed onto the second layer of
the network protocol, which is the actual physical transmission
medium.

A System Processor 3 can receive asynchronous signals via
the second through seventh layer of the network protocol stack
or it can receive synchronous data signals directly from the
second layer of the network protocol stack.

An integrated workstation 2 can receive and transmit
asynchronous data signals via the normal seven layer protocol
stack.  It can also receive and transmit synchronous data
signals directly to and from the second layer of the network
protocol stack.

The various system input/output applications such as the
network gateway 7, the audio interface 6 and intercom interface
5 can also communicate using either asynchronous data signals
or synchronous data signals.  The asynchronous data signals
will travel through the normal seven layer network protocol
stack and the synchronous data signals will be passed directly
to and from the second layer of the network protocol stack.

If one device connected to the network needs to send
synchronous data signals to another device connected to the
network, it will first communicate using asynchronous data
signals.  The asynchronous data signals will alert the
receiving device that synchronous data will follow and will
communicate the transmitting device's address value.

The receiving device will configure its network interface
message filter to look for data packets bearing a destination
address field value equal to the address of the transmitting
device.

The transmitting device will then take its synchronous data and load it into data packets bearing a destination address field value equal to the transmitting device's address. These data packets bearing the synchronous data will then be applied directly to the actual network transmission medium bypassing levels seven through three of the network communications protocol.

The receiving device's network interface message filter will look for and pull these data packets directly into the audio and video processing portions of the connected device, bypassing layers three through seven of the network communications protocol. The data packets will be converted back into a synchronous data stream, and will be presented to the end user.

If synchronous signals must be passed back and forth between two connected devices, i.e., a full duplex circuit, the two devices will first communicate using asynchronous data signals to notify each other of their intent to pass synchronous signals and to exchange their respective address values. This process is illustrated in Figure 6 and may occur as follows:

● Operator A wants to talk to Operator B,

● Operator A uses asynchronous protocol to inform Operator B of his intent,

● Operator B informs Operator A that he will talk to him,

● Operator A tells Operator B that he will transmit on address X

● Operator B tells Operator A that he will transmit on address Y.

Each device will then configure its network interface message filter to receive data packets bearing a destination address field value equal to the address of the other device. This process is illustrated in Figure 7 and may occur as follows:

● Operator A and Operator B setup their network interface message filters to look for certain addresses in the destination address fields of data packets,

● Both Operators hear silence since no data has been transmitted yet.

When one device wishes to transmit synchronous data, it can convert the synchronous signal into data packets with its own address value in the destination address field and transmit the packets over the network.  These packets will be received by the other connected device and will be sent directly from the actual transmission medium to the audio or video processors.  This process is illustrated in Figure 8 and may occur as follows:

● Operator A starts transmitting data packets with a destination address field value of X,

● Operator B's message filter recognizes data packets with a destination address field value of X and passes the data packets to his audio mixer, which presents the audio signal to Operator B's headset,

● Operator A stops transmitting data packets,

● Operator B's message filter stops receiving the data packets and Operator B hears silence.

When one of the two devices decides to break the connection it will inform the other device either through the synchronous signal, or via asynchronous signals.  Each device will command its network interface message filter to stop receiving data packets bearing the destination address of the other device.  This process is illustrated in Figure 9 and may occur as follows:

● Operator A or Operator B wants to end the exchange of synchronous data,

● Operator A tells his message filter to stop looking for data packets with a destination address field value of Y,

● Operator B tells his message filter to stop looking for data packets with a destination address field value of X.

In both the one way communications setup and in the duplex communications setup, passing the synchronous signal data packets directly from the actual physical transmission medium to the audio or video processors saves valuable time.  Since synchronous data signals must traverse the network in time to be reassembled into the correct temporal stream, time lost in

sending the data packets through levels three through seven of
the traditional network protocol could result in garbled
transmissions or lost data.

If one device needs to communicate with two or more
connected devices, a communications net can be established.  To
establish a communications net, the first communications device
will send asynchronous data signals to each of the devices it
wishes to communicate with.  These asynchronous data signals
will convey its intent to communicate using synchronous data
and will inform the other devices of the first device's address
value.  Each of the devices which has been contacted will then
send its address value to each of the other devices in the
communications net.  Each device in the communications net will
then configure its network interface message filter to look for
data packets bearing the address values of each of the other
devices in the communications net.

When a device wishes to communicate with the other devices
in the net, it will take its synchronous data signal, load it
into data packets with a destination address field value equal
to the transmitting device's own address, and broadcast these
packets over the network.  Each of the other devices will
receive these data packets and convert them back into a
synchronous signal and present it to the end user.

This type of addressing scheme has several advantages over
the prior art.  Like the group addressing scheme, a signal
which needs to be sent to multiple receiving devices need only
be sent a single time.  Each of the receiving devices will be
able to receive the data packet based on the value of the
destination address field.  Since the devices can communicate
using asynchronous data signals prior to transmission of the
synchronous signal, each device can be individually notified to
look for a particular value in the destination address field.
Hence the group of devices receiving a particular synchronous
signal can vary from message to message.  Since the data
packets are passed directly to and from the actual physical
transmission medium and bypass layers three through seven of
the communications protocol, the synchronous signals are sent
as rapidly as possible between the actual devices.

The network interface message filter used in this type of
network scheme can utilize many different commercial network
interface cards based on a decoding mechanism known as "content
addressable memory". These interface cards can sort through
large numbers of packets and accept only those with a
particular destination address field value. The network
interface message filter is set up by commands from the
connected devices central processor. These commands tell the
network interface message filter which address values to look
for in the destination address fields of data packets
traversing the network. The addresses which are being filtered
for can be changed by another message from the central
processor of the connected device. Once the network interface
message filter is configured, no other processor intervention
is required. This means that synchronous data can be exchanged
between connected devices without interfering with the normal
asynchronous communications and without interfering with the
other processes which are occurring at the particular connected
device. Since the arriving synchronous data passes directly to
the appropriate synchronous data processor, there is no need to
implement a flow control mechanism for synchronous data.

In the foregoing description, certain network
communications protocols have been referenced. It is not
necessary for any particular communications protocol to be in
use in order to practice the invention. The foregoing
description is by way of illustration and is not intended to be
limiting.

These and other advantages of the present invention will
be readily apparent to one skilled in the art from the claims.
It should be understood that the foregoing description of the
preferred embodiment is illustrative only and that many
modifications may be made without departing from the spirit
thereof as defined in the claims when accorded a full range of
equivalents.

In the Claims:

1.   A data communications system for the transmission and
reception of asynchronous and synchronous data signals with a
deterministic, bounded latency comprising:

plural communicating devices connected by a common
network, each device having an associated address value;

asynchronous data signals passing between two or more of
said communicating devices indicating the intent of one of the
devices to communicate synchronous data signals and informing
the receiving communicating device of the address value of the
transmitting communicating device; said synchronous data
signals being transmitted over the network in one or more data
packets, each packet having a destination address field and
having the value stored in said address field equal to the
address value of the transmitting communicating device;

one or more of said receiving communicating devices
receiving the synchronous data signal sent by the transmitting
communicating device, each receiving communicating device
having a message filter which accepts only data packets having
a destination address field value equal to the address value of
the transmitting communicating device; said message filter
passing the selected data packets to a synchronous signal
decoder/mixer which reassembles the received data packets into
a synchronous data signal.

2.   The system of Claim 1 wherein two communicating
devices effect full duplex communication between them of
synchronous data signals.

3.   The system of Claim 1 wherein one or more of said
communicating devices are able to receive simultaneously the
synchronous data signal transmissions from two or more
communicating devices such that a communications net of
synchronous data signals can be maintained between three or
more communicating devices.

4.   The system of Claim 1 wherein the set of address
values within the message filter of a first communicating
device can be changed in response to a command from a central
processor portion of the first communicating device and in
response to an asynchronous data signal from a second

communicating device so that the first communicating device
changes the set of transmitting communicating devices from
which synchronous data signals will be received.

     5.    The system of Claim 1 wherein the message filter is
connected directly to the network transmission medium; and

        wherein received data packets bearing pre-identified
destination address field values are passed directly to the
synchronous signal decoder/mixer, thereby bypassing any error
checking or signal processing which might normally occur
according to the communications protocol in use by the system.

     6.    The system of Claim 1, wherein a communicating device
is able to invoke a flow control mechanism to control the flow
of asychronous data signals while allowing synchronous data
signals to flow unimpeded by asynchronous data signal
congestion.

     7.    In a data communications system comprising plural
communicating devices interconnected by a common network having
deterministic bounded latency, each communicating device having
an associated address value, a method of communicating
synchronous and asynchronous data comprising the steps of:

     1)   communicating asynchronous data signals between
connected devices in accordance with the communications
protocol in use by the system;

     2)   communicating asynchronous link signals to indicate
the intent of one of the devices to communicate synchronous
data signals and to inform the receiving communicating devices
of the address value of the transmitting communicating device;

     3)   configuring by the receiving device of a message
filter to accept data packets with a destination address field
value equal to the address of the transmitting device;

     4)   transmitting synchronous data signals by the
transmitting device over the network in one or more data
packets, each packet having a destination address field and
having the value stored in said destination address field equal
to the address value of the transmitting communicating device;
and

     5)   receiving by one or more of said receiving
communicating devices the synchronous data signal sent by the

transmitting communicating device, the message filter in the
receiving device accepting the selected data packets to
reassemble the received data packets into a synchronous data
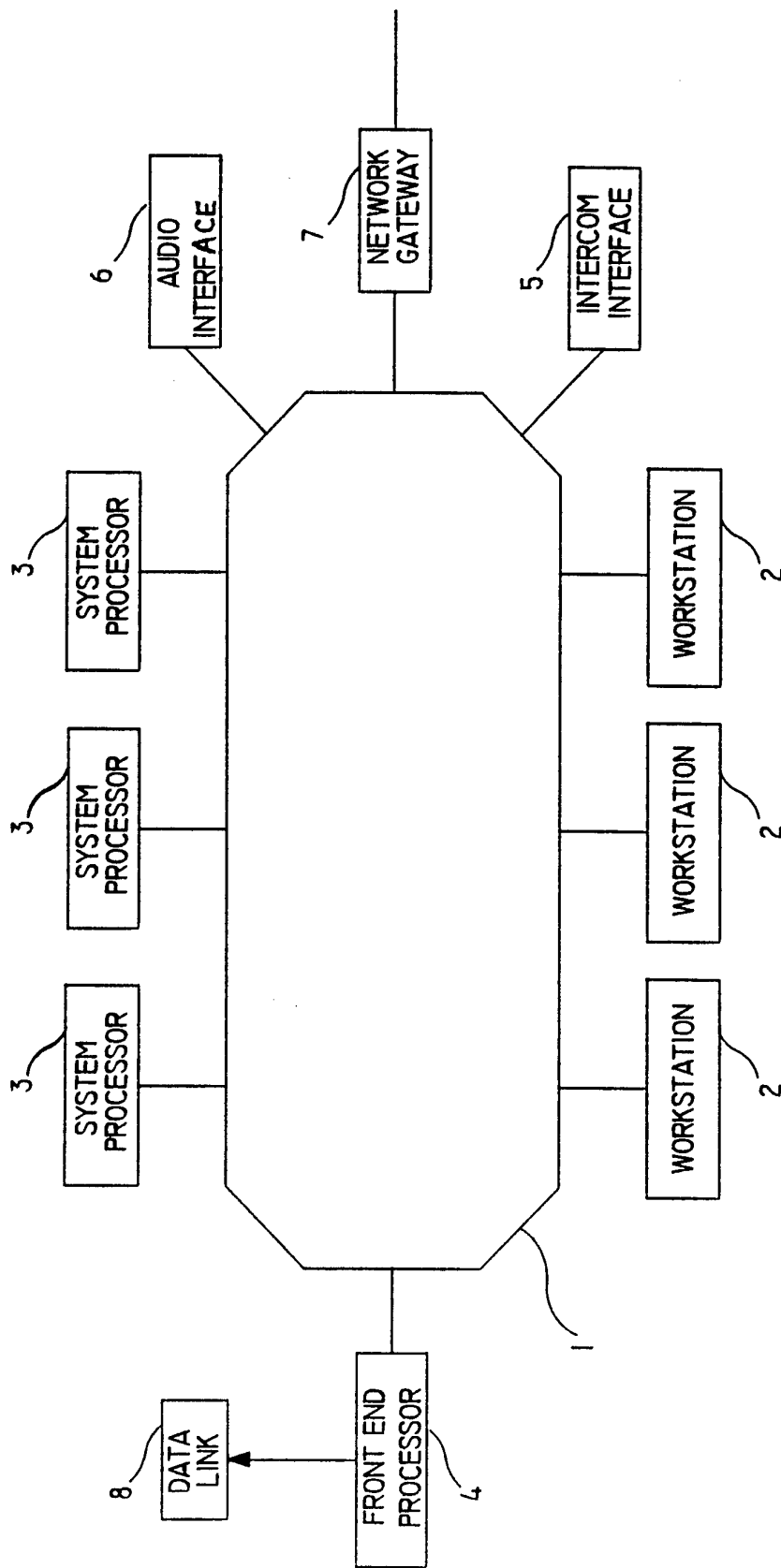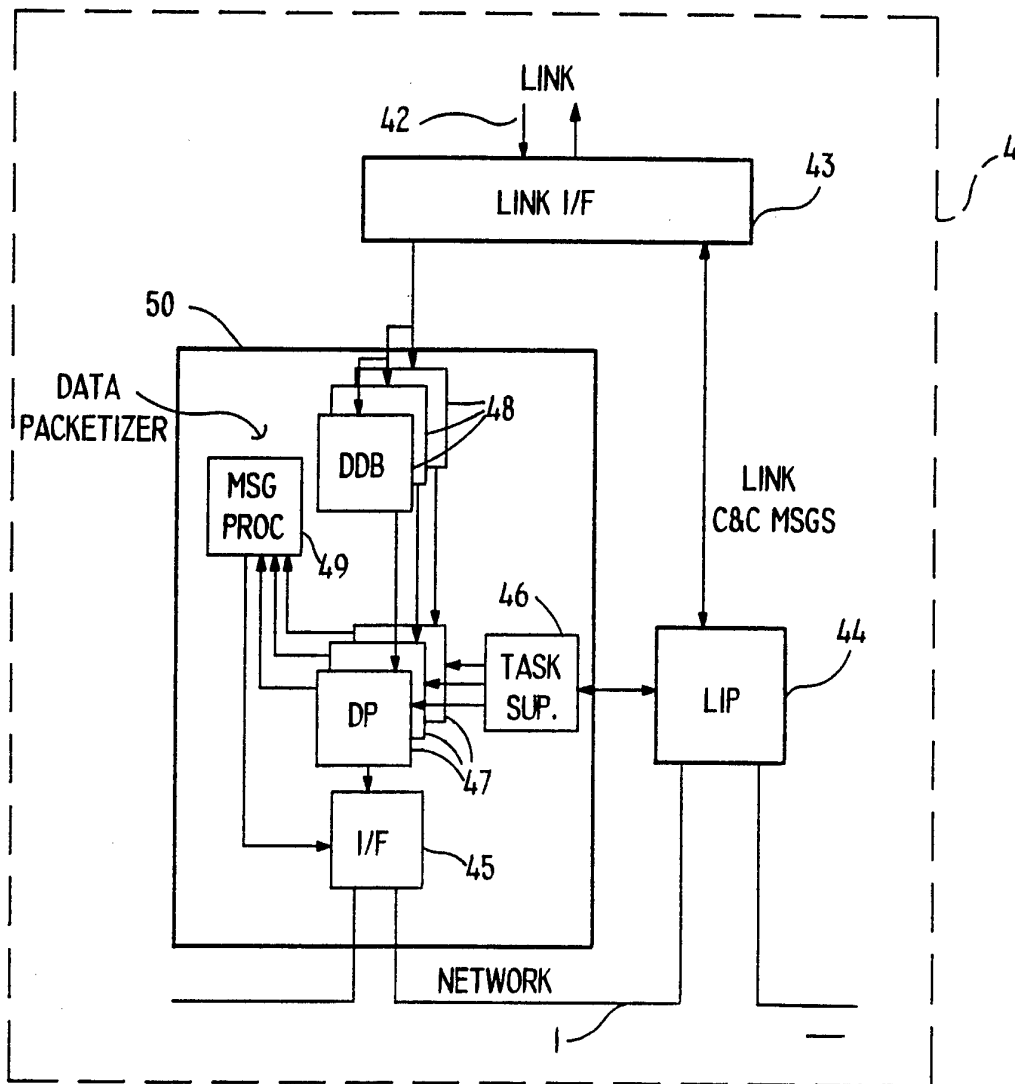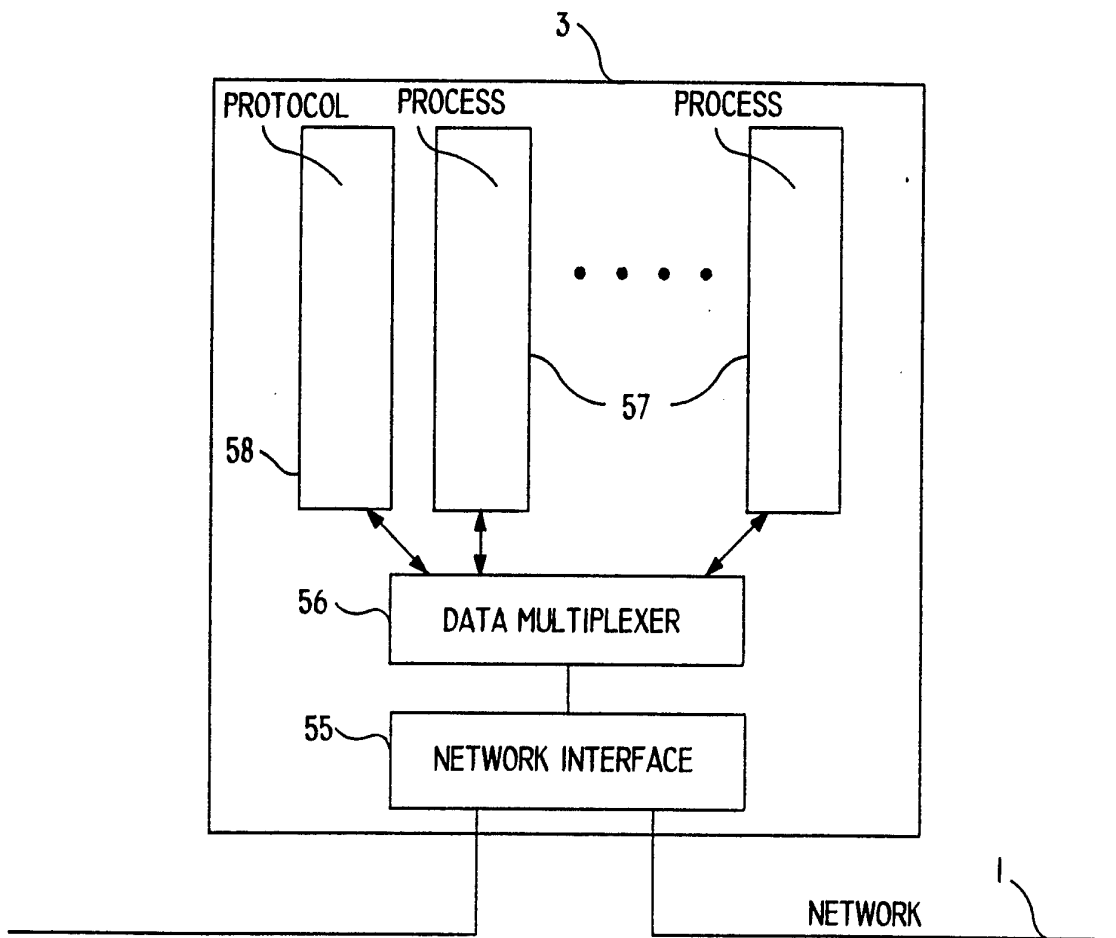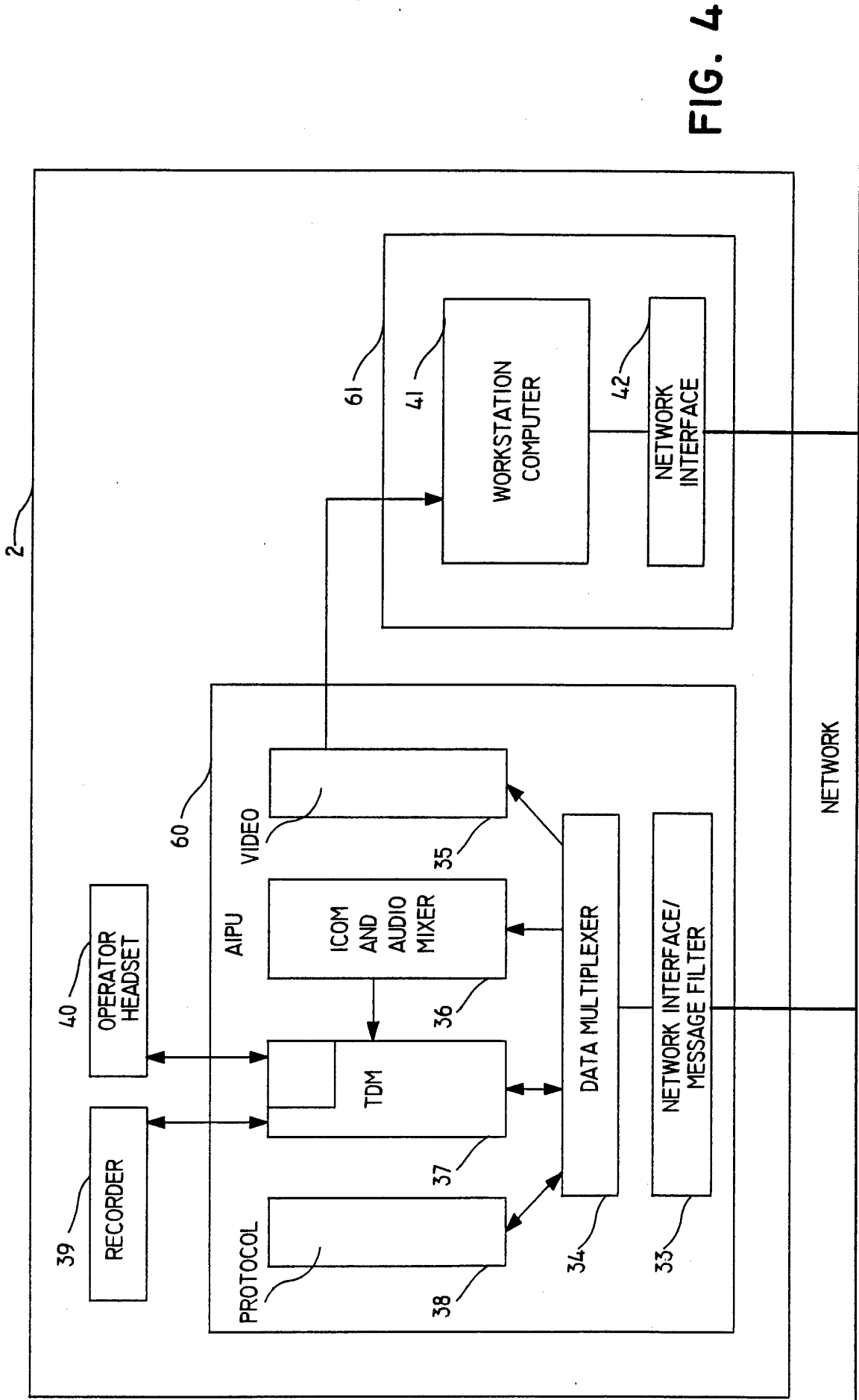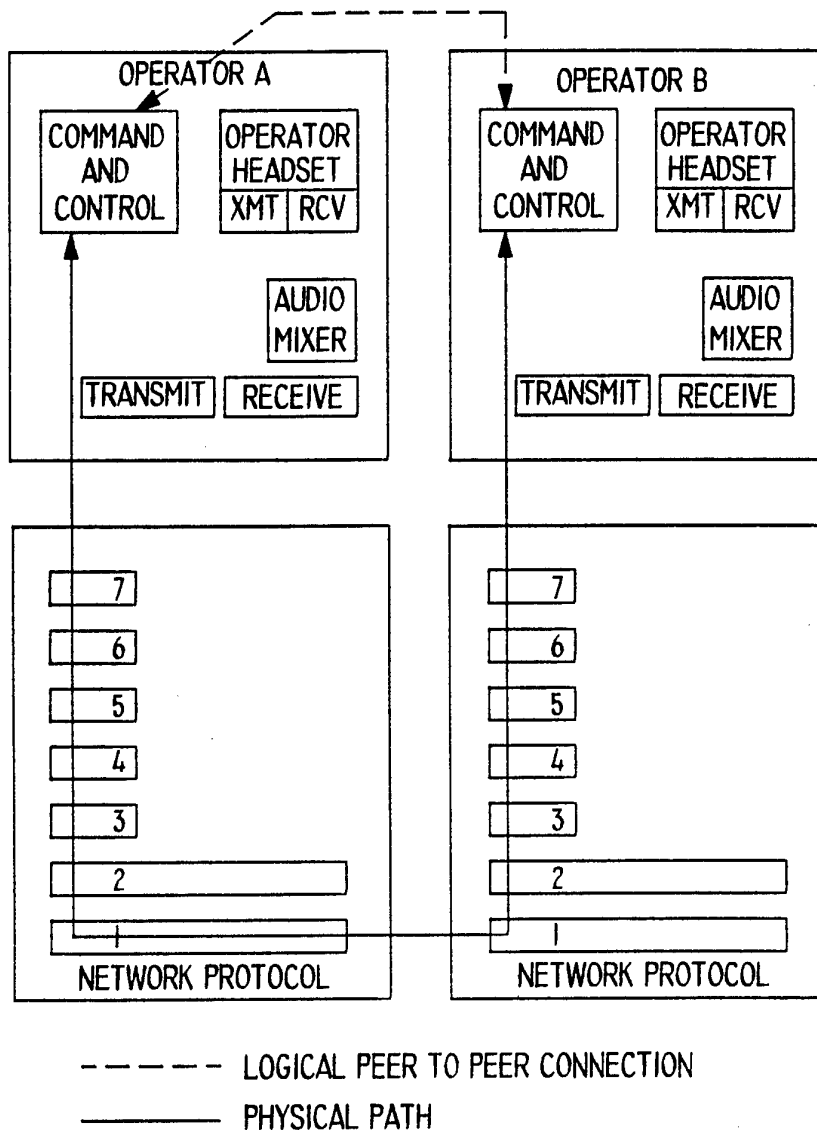signal.

·1/9



FIG. I

**FIG. 2**

FIG. 3

FIG. 4

# FIG. 5

FIG. 6

7/9
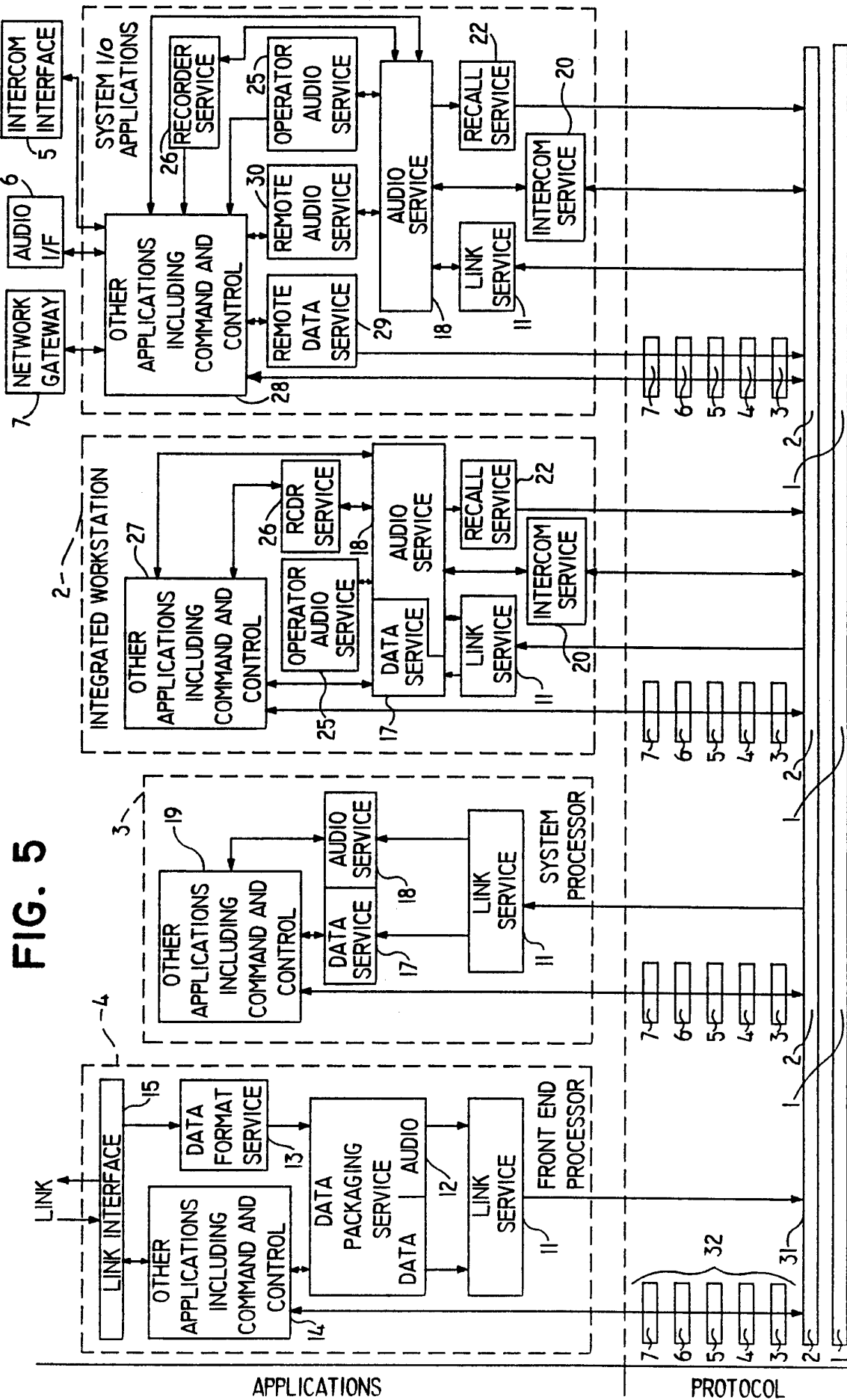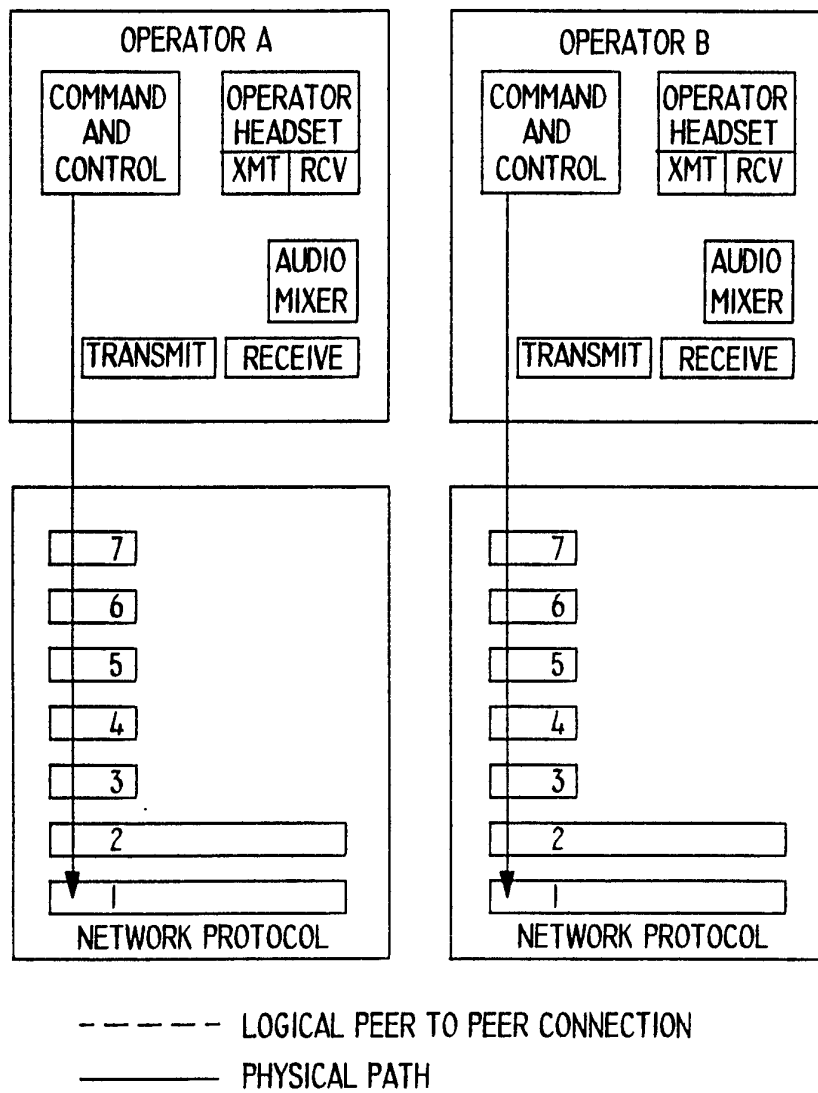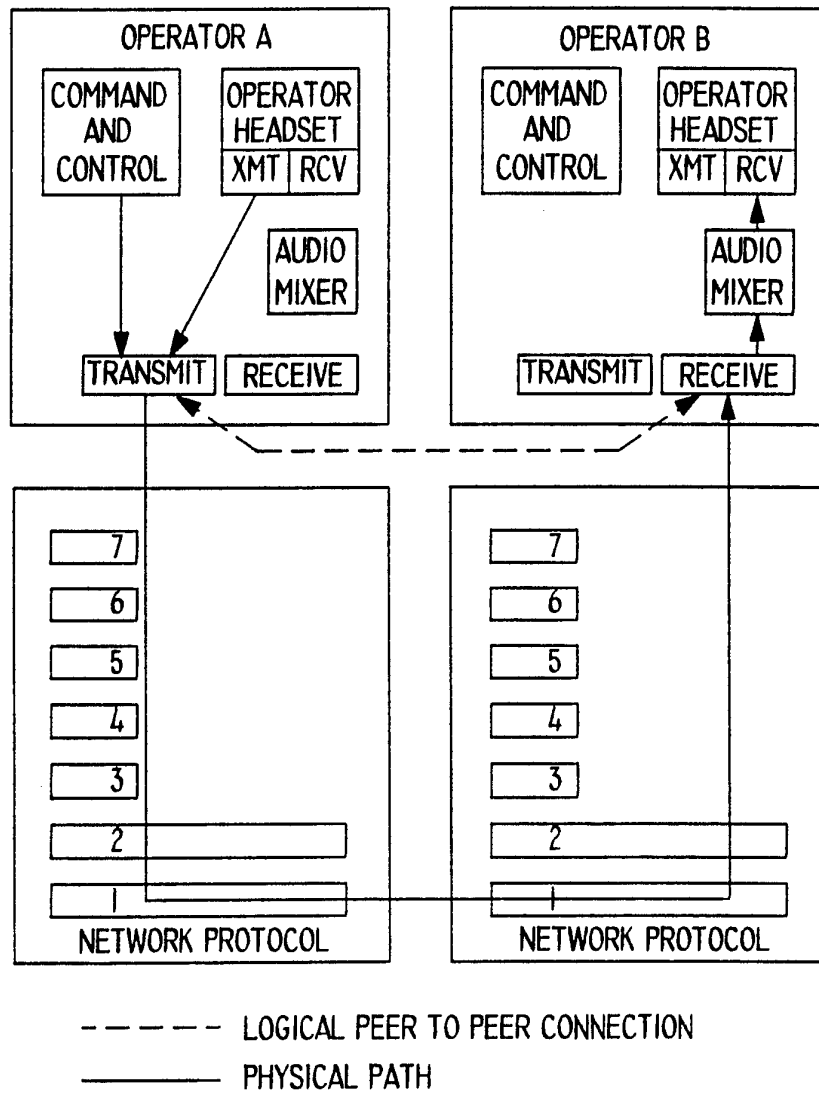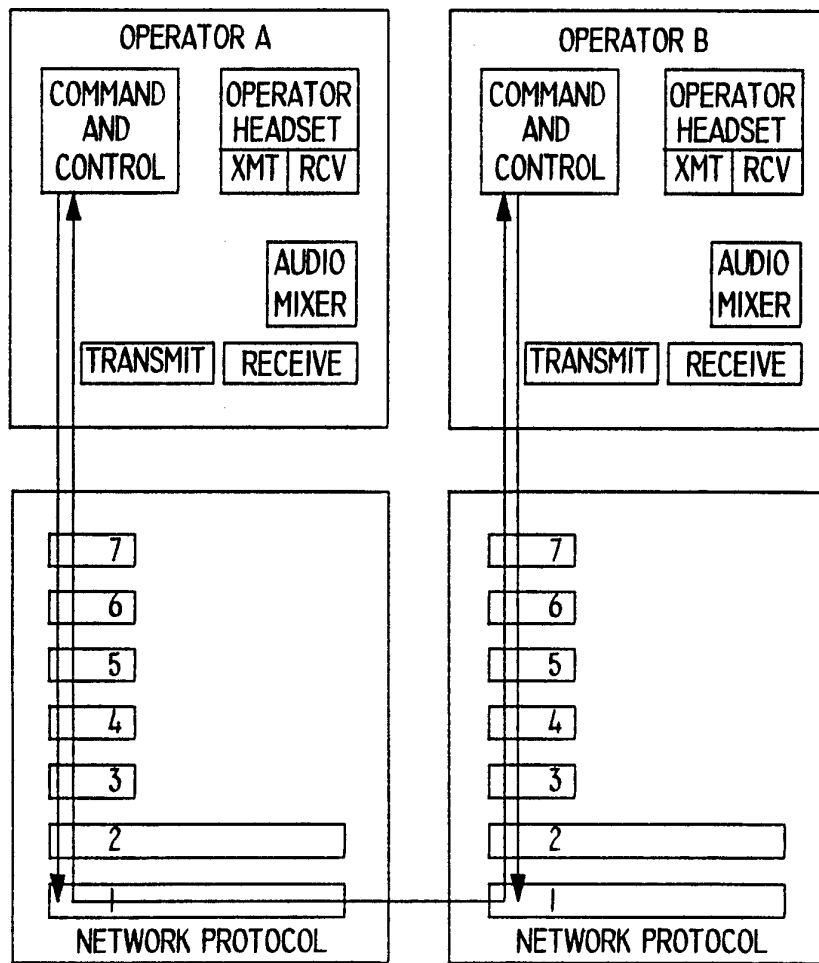


LOGICAL PEER TO PEER CONNECTION

PHYSICAL PATH

FIG. 7

8/9



FIG. 8

FIG. 9

# INTERNATIONAL SEARCH REPORT

## A.  CLASSIFICATION OF SUBJECT MATTER
IPC(5)  :HO4J 3/02, 3/24
US CL  :370/85.16, 94.1, 85.7, 92; 340/825.47
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)

U.S.  :  Please See Extra Sheet.

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 practicable, search terms used)

## C.  DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US, A, 4,764,920 (FURUYA) 16 AUGUST 1988 SEE COL. 1, LINES 36-44, COL. 2, LINES 51-63, COL. 6, LINES 46-53 | 1-7 — |
| A | US, A, 4,792,947 (TAKIYASU ET AL) 20 DECEMBER 1988 SEE COL. 3, LINES 1-3, COL. 7, LINES 1-14 | 1-7 — |
| A | US, A, 5,136,580 (VIDELOCK ET AL) 04 AUGUST 1992 SEE COL. 3, LINES 20-33 | 1-7 — |

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

| * | Special categories of cited documents: | "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 |
|---|---|---|---|
| "A" | document defining the general state of the art which is not considered to be part of particular relevance | | |
| "E" | earlier document published on or after the international filing date | "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 |
| "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 | "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 |
| "P" | document published prior to the international filing date but later than the priority date claimed | "&" | document member of the same patent family |

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 21 SEPTEMBER 1993 | DEC 02 1993 |
| Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 | Authorized officer DOUGLAS OLMS |
| Facsimile No.  NOT APPLICABLE | Telephone No.    (703) 308-6602 |
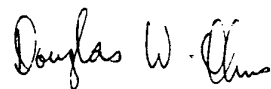
Form PCT/ISA/210 (second sheet)(July 1992)★

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

370/85.16, 94.1, 85.7, 92; 340/825.47; 370/85.13, 94.2, 93, 92, 85.5, 29; 340/825.07, 825.08, 825.03, 825.44, 825.47, 825.52, 825.53