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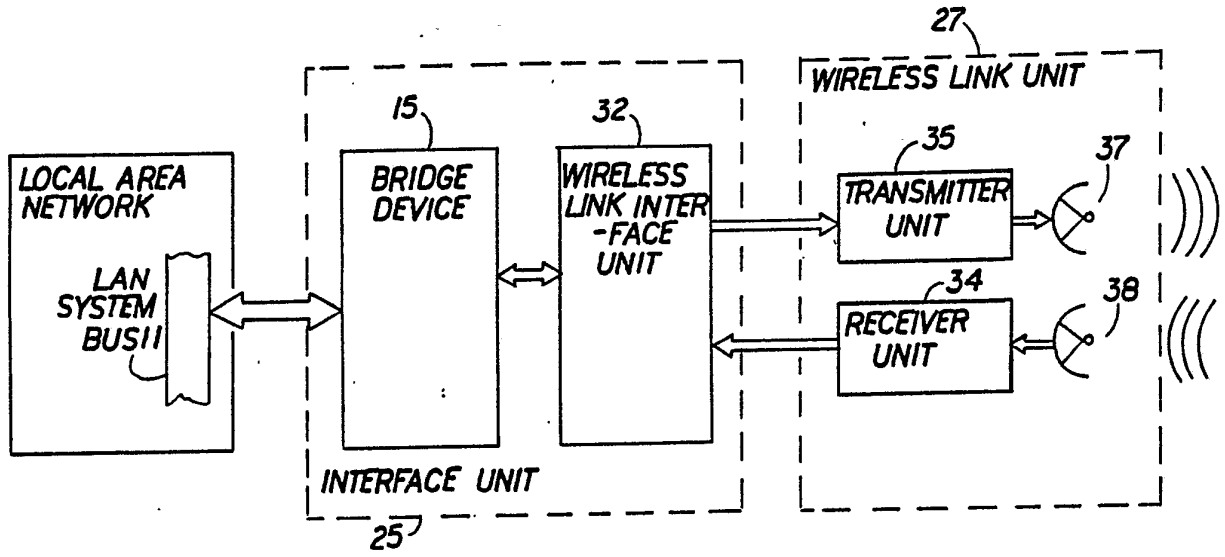
(54) Title: APPARATUS AND METHOD FOR PROVIDING A WIRELESS LINK BETWEEN TWO LOCAL AREA NETWORK SYSTEMS



(57) Abstract

In a data processing system network, apparatus and method are disclosed for coupling two local area networks (10, 10') by means of a wireless link (27). Typically, two local area network (LAN) systems are coupled by a bridge device (15), the bridge device receiving signal groups from each LAN system and selectively forwarding the signal groups to the target LAN system. In presence of the overlapping (or simultaneous) transmission of signal groups when the signal groups are applied to the target LAN system, these signal groups are reapplied to the target LAN system until a non-overlapping transmission is obtained. In the present invention, when the LAN systems are coupled by a wireless (radiation) link, an interface unit (25) is coupled between each wireless transmitter/detector (34, 35) unit and the associated LAN system. Each interface unit includes a bridge device (15) that provides the response to the overlapping signal groups.

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APPARATUS AND METHOD FOR PROVIDING A WIRELESS LINK BETWEEN TWO LOCAL AREA NETWORK SYSTEMS

Background of the Invention

Field of the Invention

This invention relates generally to networks of data processing systems and, more particularly, to the coupling of local area network (LAN) systems. In the present invention, the coupling of the two LAN systems includes a wireless link.

Description of the Related Art

When a local area network system is envisioned, one of the first problems that must be addressed is the avoidance of data integrity compromise resulting from simultaneous or overlapping application of signal groups to the system communication channel by a plurality of the system components. Several techniques have been developed to address the problem of overlapping signal groups in the communication channel. According to a first technique, a system component is selected to apply signals to the communication channel while the other components assume the role of signal group receivers. Techniques such a "token rings" provide a flexible procedure for designating a (signal group) transmitting component and thereby avoiding the problem of overlapping signal groups in the communication channel (i.e., applied to the system bus). Other strict protocol techniques, such as "round-robin" protocol can designate the current system component permitted to apply signal groups to the system bus. Another technique for avoiding the overlapping of signal groups on a local area network system bus is to multiplex the system bus in the time domain and assign a time "slot" to each system component. Because the communications

emanating from each system component can only occur a predetermined times, overlapping of signal groups is avoided. A third technique permits the system components to apply signal groups to the communication channel in a generally random fashion subject to the restriction that the signal groups are not to be applied to the communication channel when the communication channel is busy. As will be clear, in this technique overlapping signal groups can be applied to the (apparently available) communication channel at substantially the same time, resulting an overlapping of signal groups (i.e., a collision) and consequently in a compromise of signal group integrity. In this technique, the presence of overlapping signal groups, generally referred to as signal group 'collisions', is detected and the signal groups are reapplied to the communication channel until the transfer is successful (i.e., has not been compromised by overlapping signal group). This technique or LAN system implementation is generally referred to as a CSMA/CD (Carrier Sense Multiple Access/Collision Detect) system. The ETHERNET system of Digital Equipment Corporation is implemented in this fashion.

In order to increase the usefulness of LAN systems, techniques have been developed to couple two LAN systems together. Referring to Fig. 1, the general configuration of such a coupling is illustrated. A first local area network 10 includes a LAN system bus 11 over which information is transferred by data processing or communication systems coupled to the system bus 11. Similarly, local area network 10' includes a system bus 11' over which information is transferred by data processing system or communication systems coupled to the system bus 11'. A bridge device 15 is coupled to

system bus 11 and to system bus 11'. The function of the bridge device 15 is to identify those signal groups that on the system bus of a first LAN system that are intended for distribution on the system bus of the second LAN system and to transfer those signal groups to the second LAN system bus. For the selected transmitting component technique or the time domain multiplexing technique, the bridge device 15 can be implemented as another system component, a system component synchronized with the two coupled LAN systems. The bridge device CSMA/CD type LAN system is somewhat more complicated because, for example a signal group thought to be successfully transmitted by a component of the first LAN system can encounter a collision in the second LAN system. Therefore, in the bridge devices provided for CSMA/CD LAN networks, separate transmission apparatus is provided for transmitting signal groups in either direction. In addition, temporary signal storage apparatus is provided for both sets of transmission apparatus to store signal groups successfully transmitted from a first LAN system, but encountering a collision in the second LAN system. The storage apparatus permits the signal group, compromised by a collision in the second LAN system, to be reapplied to the second LAN system from the bridge device rather than from the originating component in the first LAN system.

A pair of LAN systems can be so positioned that it is impractical to provide a physical communication channel, such as a bus, to couple the systems. If a bridge network that included a wireless link were available, then the communication between the LAN systems can be implemented. For bridge networks that couple non-CSMA/CD LAN systems, the presence of the

wireless link can be accommodated by extension of the collision avoidance techniques used by the LAN systems. However, in coupling the CSMA/CD LAN systems the problem of the overlapping signal groups is more severe because of the lack of a physically available channel of communication, especially of the detection of a collision between signal groups.

A need has therefor been felt for a technique of coupling two CSMA/CD LAN systems by a bridge network that includes a wireless link that would be capable of identifying and responding to simultaneous exchange of information signals over the wireless link.

Features of the Invention

It is an object of the present invention to provide an improved technique for coupling together a plurality of data processing units.

It is a feature of the present invention to couple two local area networks by a wireless (i.e., radiation) link.

It is a more particular feature of the present invention to couple two local area networks using the Carrier Sense Multiple Access/Collision Detect (CSMA/CD) implementation by a wireless (i.e., radiation) link.

It is another particular feature of the present invention to provide a wireless link between two ETHERNET systems using as many existing components as possible.

Summary of the Invention

The aforementioned and other features are accomplished, according to the present invention, by providing a pair of radiation transmitter/receiver units for the exchange of modulated radiation signals over a wireless link. Coupled between each transmitter/receiver unit and an associated LAN system

is an interface unit. The interface unit includes apparatus for identifying the presence of signal groups being simultaneously transmitted in both directions over the wireless link. Both bridge units can identify the simultaneous transmission of data and can notify the respond in a manner insuring transmission of uncompromised data.

These and other features of the present invention will be understood upon reading of the following description along with the drawings.

Brief Description of the Drawings

Figure 1 is a block diagram of the coupling of local area networks according to the prior art.

Figure 2 is a block diagram of a apparatus coupling two CSMA/CD local area networks by a wireless communication channel according to the present invention.

Figure 3 is a block diagram illustrating additional components of the apparatus linking two data processing system networks.

Figure 4 is a block diagram of the components of interface unit according to the present invention.

Figure 5 is a block diagram of the present invention when the wireless link is implemented by a microwave link.

Detailed Description of the Preferred Embodiment

Detailed Description of the Figures

Fig. 1 has been previously discussed with reference to the prior art.

Referring next to Fig. 2, the component block diagram of the coupling of a first CSMA/DC local area network having a LAN system bus 11 and with a second CSMA/CD local area network having a LAN system bus 11' is shown. Interface network 25 exchanges signal with the LAN system bus 11 and with with the wireless link

unit 27. Similarly, interface unit 25' exchanges signals with the LAN system bus 11' and the wireless link unit 27'. The wireless link units 27 and 27' transmit signal groups to and receive signal groups from the other other wireless link unit.

Referring next to Fig. 3, major components of the interface unit 25 and the wireless link unit 32 are shown. With respect to the interface unit 25, the bridge device 15 exchanges signal groups with the LAN system bus 11. The bridge device 15 is the same bridge device 15 shown in Fig. 1 for coupling two CSMA/CD LAN systems. The bridge device 15 exchanges signal groups with wireless link interface unit 32 which couples the interface unit 25 to the wireless link unit 27. The transmitter unit 33 of the receives signal groups from the wireless link interface unit 32 and applies signal groups to the antenna/transmitter element 37. The receiver unit 34 of wireless link unit 27 receives signals from antenna/receiver element 38 and applies signal groups to the wireless interface unit 27.

Referring next to Fig. 4, a component block diagram of the wireless link interface unit 32 is shown. The detector unit 43 converts the signal groups from the receiver unit 34 of wireless link unit 27 into a format compatible with the LAN system signal groups and applies the resulting signals to logic OR gate 44 and to signal detection unit 47. The bridge device interface receiver unit unit 41 receives outgoing signal groups from the bridge device 15 and applies signals to logic OR gate 44, signal detection unit 48 and driver unit 42. The driver unit 42 reformats the signal groups into signals signal that are applied, in suitable format, to transmitter unit 33 of wireless link unit 27. The output signals of logic OR gate 44 are applied

to bridge device interface transmitter unit 45 and the output signals from bridge device interface transmitter unit 45 are applied to bridge device 15 as incoming signal groups. The output signals from the signal detection unit 47 and the signal detection unit 48 and applied to logic AND gate 46, a positive output signal from logic AND gate 46 activating signal generator unit 49. The output signal from the signal generator unit 49 is applied to the bridge device 15 as collision detect signals. (When the present invention is implemented in an ETHERNET environment, the signal generator 49 is typically a 10 MHz oscillator activated by a signal from logic AND gate 46.) The logic OR gate 44 provides a path by which the transmitted signal groups can be monitored by the transmitting system.

Referring next to Fig. 5, the implementation of the wireless link 27 by means of a microwave link is shown. The microwave technology permits a single antenna 52 to receive and to transmit the microwave signals. A microwave mixer unit 51 exchanges signals with antenna 52, receives signals from transmitter unit 51 and applies signals to receiver unit 34. Detector unit 43 is implemented as receiver unit for signals from the microwave (wireless) link unit having a 1 volt peak-to-peak value from a 75 ohm source modulated in the Manchester code format. The driver unit 43 provides a 1 volt peak-to-peak signal to a 75 ohm impedance modulated in the Manchester code format.

Operation of the Preferred Embodiment

In the preferred embodiment of the present invention, the LAN systems are implemented using a Carrier Sense Multiple Access/Collision Detect CSMA/CD technique. In this implementation technique, the collisions (overlapping) of signal groups is

accommodated rather than avoided as with the other LAN system implementation techniques. With the presence of a wireless link in coupling two CSMA/CD LAN systems, this accommodation becomes more difficult due to the lack of communication across the link. Thus, the problem of accommodation of a collision involving a signal group already transmitted must be addressed.

In the present invention, this problem is addressed by providing two bridge devices 15 that normally couple two CSMA/CD networks. These devices act in the usual manner with respect to the coupled LAN systems. With respect to signal groups that are transmitted over the wireless link, additional apparatus is provided to detect the presence of a signal group collision occurring over the wireless link. Both bridge devices receive signals indicating that a signal group being transmitted only the wireless link has been involved in a collision. As a result, the bridge device can retain a copy of the uncompromised signal group and can retransmit the signal group over the wireless link when a collision has been detected.

The situation is further complicated by the implementation technique whereby the signal groups are arranged in packets, the packets having a minimum time period or duration. Because the collision must be detected by both interface units 25 and 25' (i.e., activation of by signal generator 49 both interface units) and because of the potential duration of the packet being the minimum value, the distance between the antennas in the wireless link must be arranged so that a packet detected by signal detection unit 48 could be transmitted to the target wireless link unit and returned to the transmitting link unit in time so that signal detection unit 46 along with signal detection

unit 47 could activate signal generator 49. When the wireless link unit in used in conjunction when ETHERNET systems and the wireless link is implemented in microwave technology, the maximum distance between microwave antennas is approximately 4 miles.

Although the implementation of the wireless link has been described in terms of a microwave link, the present invention can be applied to optical links, infrared links, laser links etc. with the proper implementation of the interface units.

The foregoing description is included to illustrate the operation of the preferred embodiment and is not meant to limit the scope of the invention. The scope of the invention is to be limited only by the following claims. From the foregoing description, many variations will be apparent to those skilled in the art that would yet be encompassed by the spirit and scope of the invention.

Claims

1. Apparatus for coupling two data processing system networks by means of a wireless link comprising:

a first and a second transmitter/receiver unit for transmitting and detecting radiation;

a first and a second local area network each including a local communication channel and local components coupled to said communication channel, said local component applying signals to and receiving signals from said communication channel;

a first bridge circuit coupled to said first transmitter/receiver unit and to said first local area network for transferring information packets therebetween; and

a second bridge circuit coupled to said second transmitter/receiver unit and said second local area network for transferring information packets therebetween, wherein said first and said second bridge circuits include apparatus for identifying simultaneous transfer of information packets therethrough.

2. The apparatus for coupling said two local area networks of Claim 1 further comprising circuit means in said first and said second bridge circuit for retransmitting an information packet for which simultaneous transfer with another information packet has been identified.

3. The apparatus for coupling said two local area networks of Claim 1 wherein said local area networks are implemented using Carrier Sense Multiple Access/Collision Detect techniques.

4. The apparatus for coupling two local area networks of Claim 3 wherein said local area networks use the ETHERNET protocols.

5. The apparatus for coupling two local area networks of Claim 4 wherein said first and second bridge circuits are bridge circuits used to couple two ETHERNET systems.

6. The apparatus for coupling two local area networks of Claim 5 wherein said wireless link is a microwave link.

7. The apparatus for coupling two local area networks of Claim 6 wherein said wireless link has maximum distance between antennas of said wireless link.

8. The apparatus for coupling two local area networks of Claim 1 wherein said apparatus for identifying simultaneous transfer has a first signal detection unit producing a first signal during transmission of an information packet, a second signal detection unit producing a second signal during reception of an information packet and a signal generator applying a collision signal to an associated bridge circuit in response to said first and said second signal.

9. An interface unit for coupling a LAN system bridge device and a wireless link unit forming a portion of a coupling system coupling two LAN systems comprising:

detection means for detecting an overlapping of a signal received from said wireless link and a signal applied to said wireless link; and

signal means for signaling said simultaneous presence to said bridge device.

10. The interface unit of Claim 9 wherein said LAN systems are implemented with Carrier Sense Multiple Access/Collision Detect technology.

11. The interface unit of Claim 10 wherein said LAN systems are implemented using ETHERNET protocols.

12. The interface unit of Claim 9 wherein said detection means includes:

a signal detection unit generating a first signal during said application of a signal to said wireless link; and

a signal detection unit generating a second signal during said receipt of a signal from said wireless link.

13. The interface unit of Claim 12 wherein said signal means includes a logic AND circuit providing a signal in response to said first and said second signal.

14. The interface unit of Claim 13 further comprising means for converting signals received from said wireless link into signals in the LAN system format and means for converting signals in said LAN format into signals suitable for application to said wireless link.

15. The method of coupling two local area network systems with a wireless link comprising the steps of:

storing and transmitting selected signal groups over said wireless link;

detecting simultaneous transmission of said signal groups over said wireless link; and

retransmitting a signal group for which simultaneous transmission has been detected.

16. The method of coupling two local area network systems with a wireless link the storing and transmitting step include storing and transmitting said signal groups in a bridge circuit used to connect two local area networks.

17. The method of coupling two local area network systems with a wireless link of Claim 16 further comprising the step of implementing the local area networks in Carrier Sense Multiple Access/Collision Detect technology.

18. The method of coupling two local area network systems with a wireless link of Claim 17 further comprising the step of implementing said local area networks with ETHERNET protocols.

19. The method of coupling two local area network systems of with a wireless link of Claim 18 further comprising the step of implementing said wireless link in microwave technology.

20. The method of coupling two local area network systems with a wireless link of Claim 15 wherein said detecting step includes the steps of:

generating a first signal during a transmission of a signal group over said wireless link;

generating a second signal during receipt of a signal group from said wireless link; and

generating a collision signal when said first and said second signal are present.

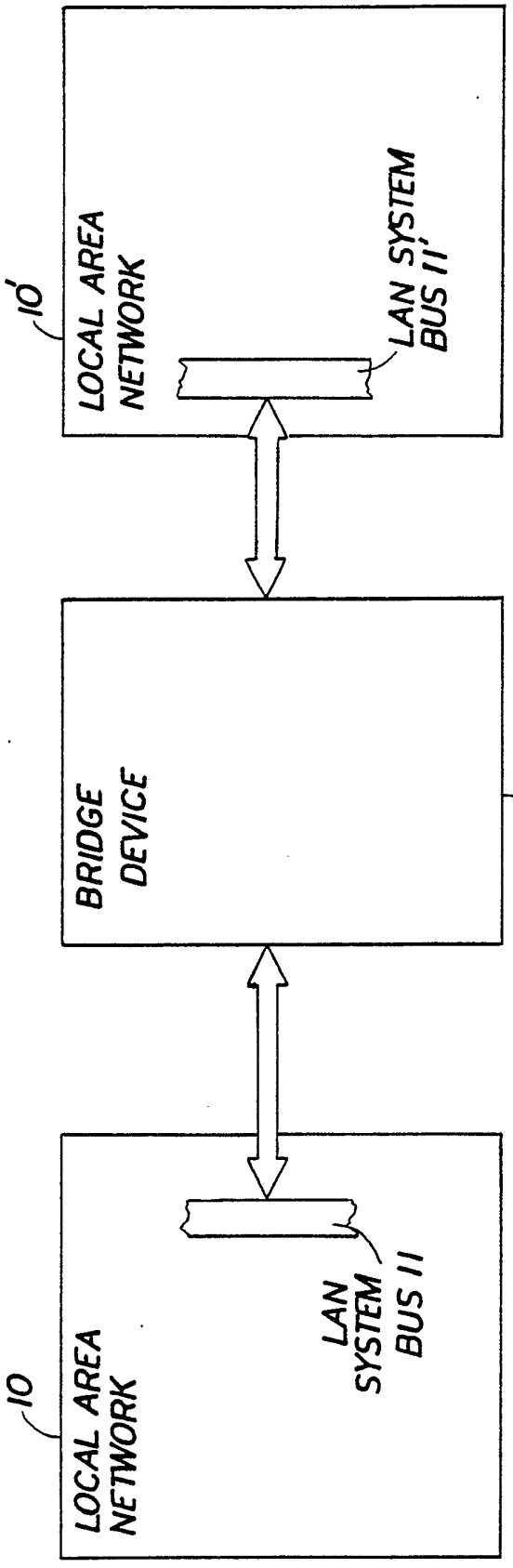
10'
LOCAL AREA NETWORK
LAN SYSTEM BUS 11'
BRIDGE DEVICE
15
10
LOCAL AREA NETWORK
LAN SYSTEM BUS 11

FIG 1

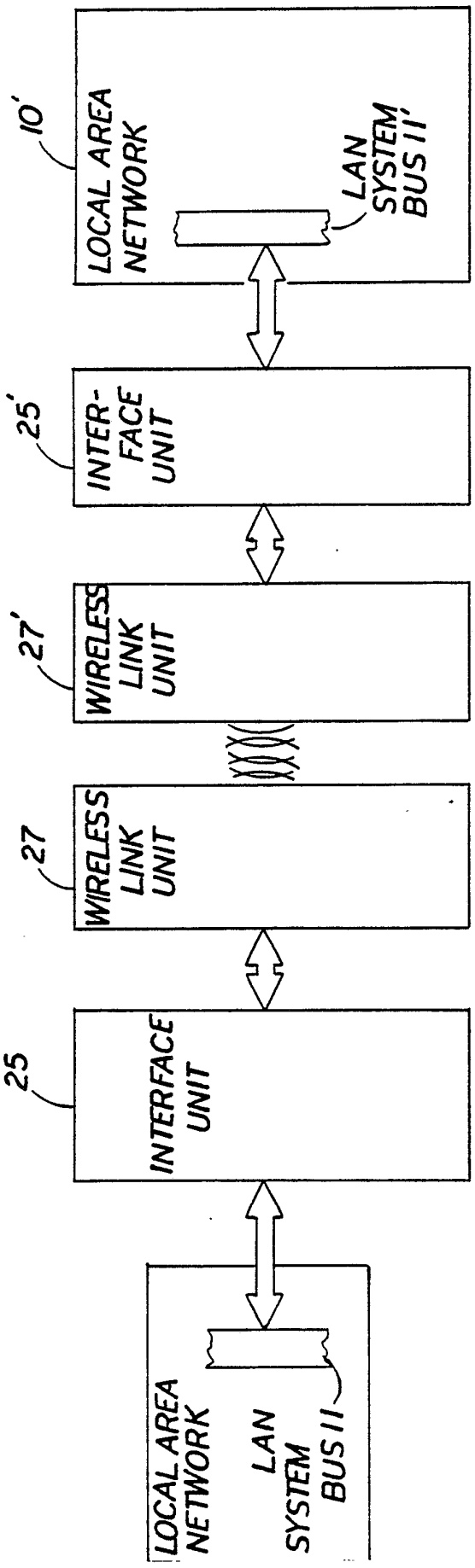
10'
LOCAL AREA NETWORK
LAN SYSTEM BUS II'
25'
INTER-FACE UNIT
27'
WIRELESS LINK UNIT
27
WIRELESS LINK UNIT
25
INTERFACE UNIT
LOCAL AREA NETWORK
LAN SYSTEM BUS II

FIG 2

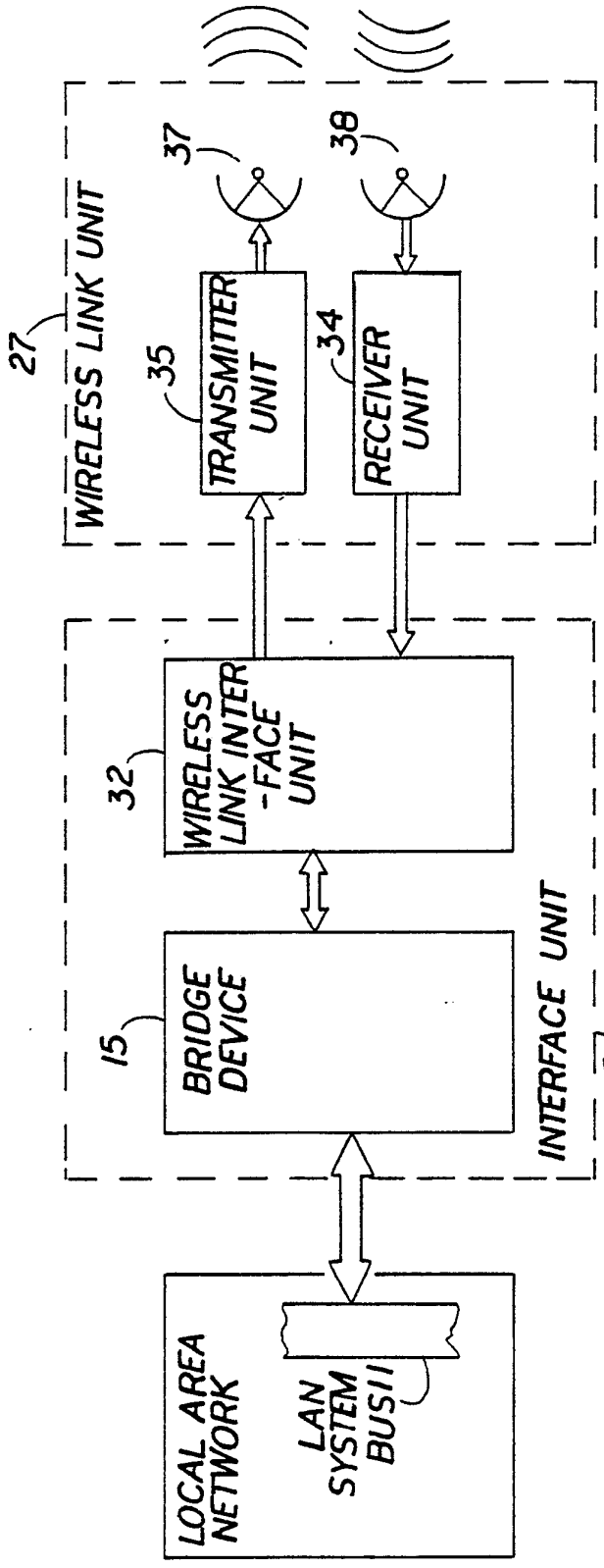
WIRELESS LINK UNIT
27
37
38
35
TRANSMITTER UNIT
34
RECEIVER UNIT
32
WIRELESS LINK INTER -FACE UNIT
15
BRIDGE DEVICE
INTERFACE UNIT
25
LOCAL AREA NETWORK
LAN SYSTEM BUS 11

FIG 3

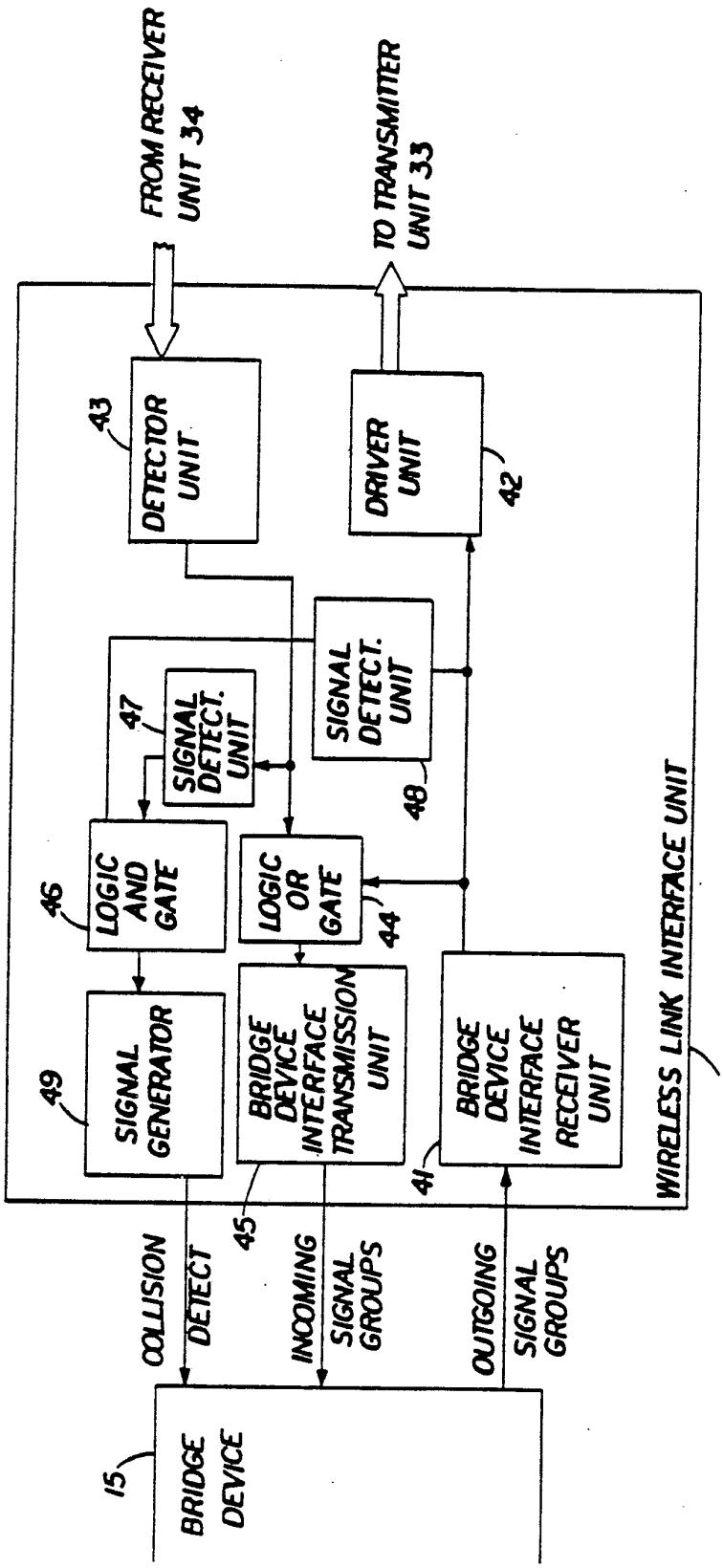
FROM RECEIVER UNIT 34
TO TRANSMITTER UNIT 33
43
DETECTOR UNIT
DRIVER UNIT
42
47
SIGNAL DETECT. UNIT
SIGNAL DETECT. UNIT
48
46
LOGIC AND GATE
LOGIC OR GATE
44
49
SIGNAL GENERATOR
BRIDGE DEVICE INTERFACE TRANSMISSION UNIT
BRIDGE DEVICE INTERFACE RECEIVER UNIT
41
45
WIRELESS LINK INTERFACE UNIT
32
COLLISION DETECT
INCOMING SIGNAL GROUPS
OUTGOING SIGNAL GROUPS
15
BRIDGE DEVICE

FIG 4

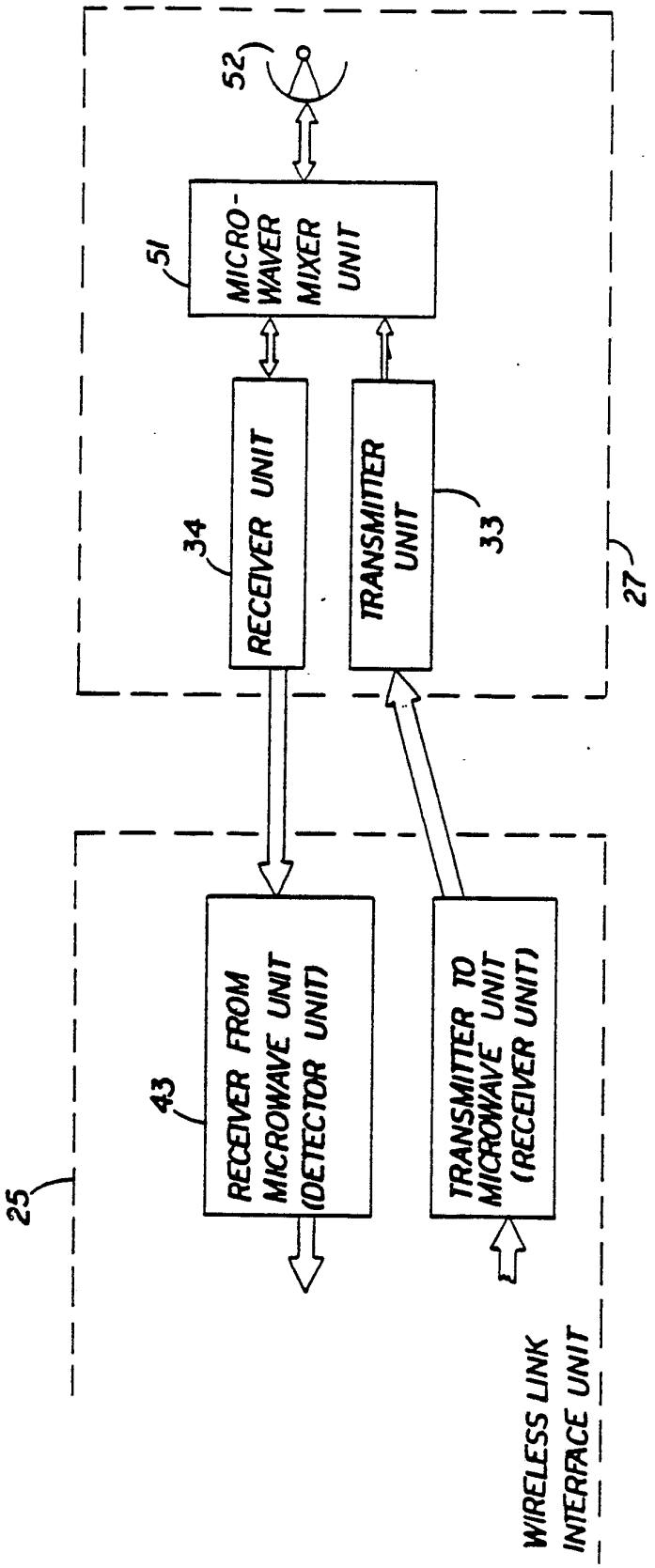
52
51
MICRO-WAVER MIXER UNIT
34
RECEIVER UNIT
TRANSMITTER UNIT
33
27
25
43
RECEIVER FROM MICROWAVE UNIT (DETECTOR UNIT)
TRANSMITTER TO MICROWAVE UNIT (RECEIVER UNIT)
WIRELESS LINK INTERFACE UNIT

FIG 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 88/00894

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: H 04 L 11/16

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	H 04 L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [9]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	Data Communications, vol. 14, no. 3, March 1984 (New York, US), J.H. Hart: "Bridges smooth troubled waters for wide-area networking", pages 213-216,219,220, see page 209, right-hand column, lines 5-7; page 214, right-hand column, lines 14-25; page 215, left-hand column, lines 30-39; page 220, right-hand column, lines 32-34; figures 2,3	1,4-7,15
A		9,19
	--	
Y	Proceedings of the COMPCON 84 FALL, 16-20 September 1984, Arlington, IEEE (New York, US), F. Akashi et al.: "Efficient local area network interconnection using a bridge", pages 333-340, see page 333, left-hand column, lines 9-19; page 333, right-hand column, lines 19-22; page 335, right-hand column, lines 26-31; page 336, right-hand column, lines 11-37; figure 3	1,4-7,15
A		8,10-13,16,19

* Special categories of cited documents: [10]

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"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.

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11th August 1988	02 SEP 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

International Application No. PCT/US 88/00894

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4535450 (TAN) 13 August 1985, see column 5, lines 19-29; figure 2 ----	1-13,15,20

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 8800894 SA 22807

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 30/08/88
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4535450	13-08-85	JP-A- 58075351	07-05-83