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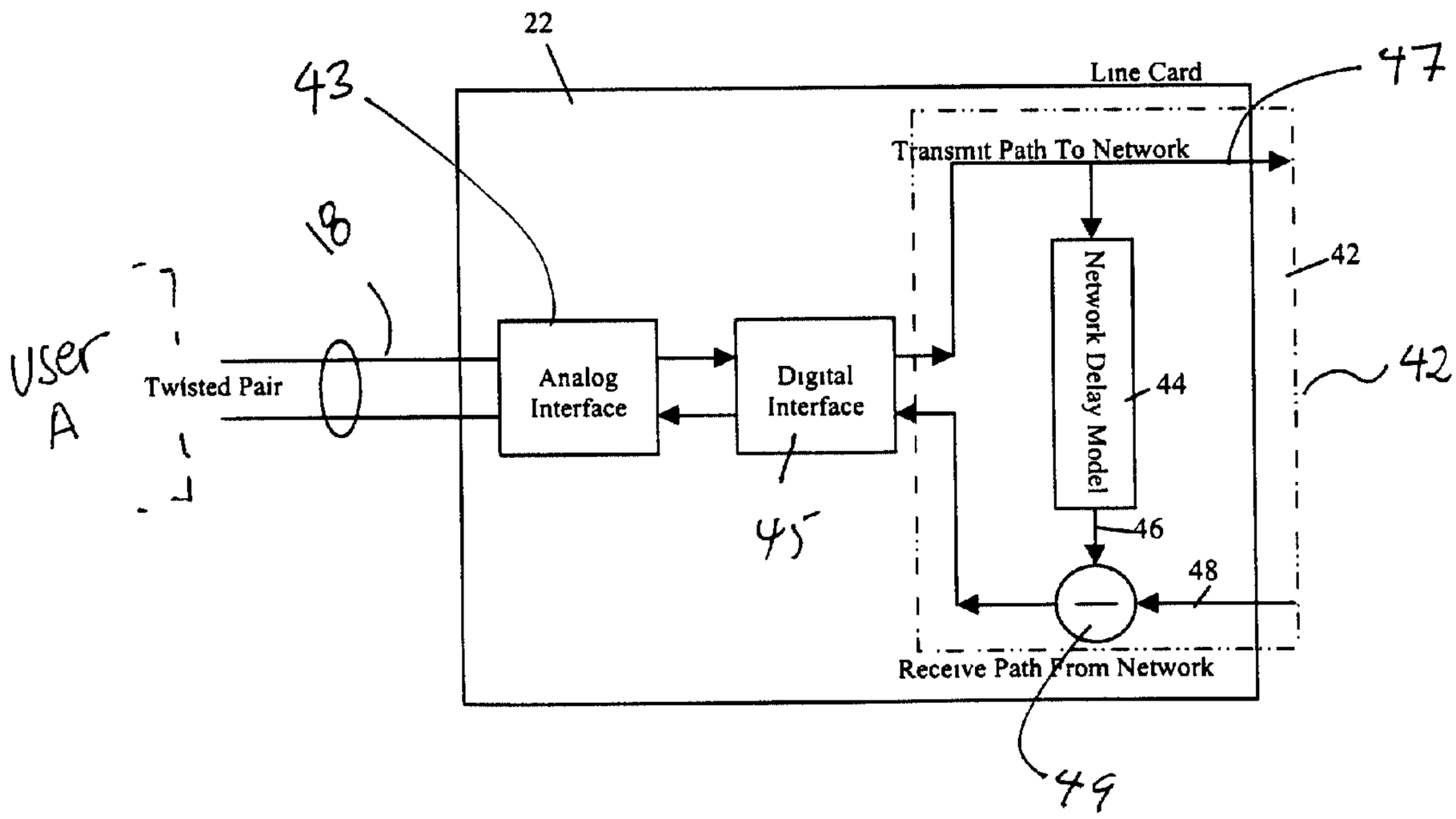
(54) **SYSTEME ET METHODE DE SUPPRESSION D'ECHO**

(54) **A SYSTEM AND METHOD FOR ECHO CANCELLATION**



(57) A line card for coupling a subscriber line to a switching network the line card comprising an echo canceling circuit for reducing an echo signal received from the network and perceived at a user instrument coupled to the subscriber line. The network echo cancellation circuit utilizes a network model to predict an echo replica signal which is then subtracted either from the transmit or receive signals to the network The line card may include a far end echo cancellation circuit, a near end echo cancellation circuit or a combination of both.

ABSTRACT

A line card for coupling a subscriber line to a switching network the line card comprising an echo canceling circuit for reducing an echo signal received from the network and perceived at a user instrument coupled to the subscriber line. The network echo cancellation circuit utilizes a network model to predict an echo replica signal which is then subtracted either from the transmit or receive signals to the network The line card may include a far end echo cancellation circuit, a near end echo cancellation circuit or a combination of both.

A SYSTEM AND METHOD FOR ECHO CANCELLATION

The present invention relates to a system and method for implementing echo cancellation in a communication network, and more particularly to a system for echo cancellation in a voice-over-data telephone network.

BACKGROUND OF THE INVENTION

The convergence of voice and data networks is now a reality. Every day more and more companies are recognizing the value of transporting voice over data packet networks in order to reduce telephone charges and also as a prerequisite to the implementation of advanced multimedia applications.

Voice over data communication utilizes existing data lines such as ISDN (Integrated Services Digital Network) in order to transport digitized voice signals along with data on a common communication line. The analog voice signals are digitized using coding such as PCM (Pulse Code Modulation).

One of the problems associated with high-speed digital transmission of voice signals is the generation of echo. In general, a user's telephone equipment is connected via a line card and a twisted pair telephone line to a Public Switching Telephone Network (PSTN). The twisted pair circuit is normally a two wire circuit, while sections between a PSTN is a four wire circuit.

Because of mismatches in the line and network caused, for example by imperfect hybrids, a portion of a signal transmitted from one user is received by that user after a delay of a predetermined time period. This delayed signal is normally perceived by the initiator, or talker, as an echo. The echo becomes more significant as signal propagation time becomes longer.

Thus, the delay inherent with voice over data technology (such as digital transport over a twisted pair loop) may increase the perceptibility of echo and may lead to unacceptable voice quality. Furthermore, the delays inherent with protocols such as ATM cell assembly and disassembly can create increase the perceptibility of echo.

Figure 1 shows a schematic diagram of a typical telephone network configuration 10. A network echo path 12 is described from the perspective of one of the telephone users, referred to as "user A" 14.

As may be seen, the user A is connected via a twisted pair to line card A, which, in turn, is connected to the telephone network. Similarly, a user B is connected via a twisted pair and a line card B to the network. The echo signal received at user A (or B) may be seen as the contribution of signals from various echo paths.

In the present context, the user A is referred to as the "near end talker", or simply "near end" while the user B is referred to as the "far end talker" or simply "far end". The near end echo is comprised of signals received from the near end line card, the network, and the far end line card.

Unfortunately, when voice over data communication is implemented, a further echo is introduced. This echo is due to several reasons, including those described below. Voice over data systems typically attempt to transfer more information over a twisted pair wire than voice only systems. Therefore defects on the wire will have an increased effect on the quality of the voice over data signal, increasing the perceptibility of echo. Further, voice over data systems typically include the higher frequency spectrum of a signal for transporting information. Therefore, the crosstalk on the twisted pair wire becomes more significant, increasing the perceptibility of echo.

Various techniques have been implemented to cancel or reduce the echo signal received at the near end. Such devices are known as echo canceller and attempt to minimize the echo signal. For example, U.S. Patent Number 5,859,907 describes an echo canceller and echo path estimation method which may be used with cellular telephone networks.

When voice over data communication is used, such as voice over DSL, the echo cancellation equipment needs to be adapted to provide echo cancellation over the twisted pair wire, since the superposition of voice with data in DSL systems normally occurs at the line card. Because the echo cancellation equipment is contained within the network, the equipment to be provisioned for each new voice over data connection. Changes to the equipment is labour intensive and, therefore, expensive. The type of equipment available may also limit the number of changes thereby limiting the number of voice over data users.

Therefore, there is a need for a method for canceling the line echo without burdening the network. Such a method would greatly enhance the deployment of the

voice over data service, without the need to coordinate the availability of the service on specific subscriber lines with centralized network equipment.

Furthermore, with the number of telephone lines already in existence it is important that the existing technology can be easily retrofit.

It is an object of the present invention to obviate or mitigate at least some of the above disadvantages.

SUMMARY OF THE INVENTION

The present invention seeks to solve the problem of providing new echo cancellation equipment in a switching network whenever new voice over data services are added to the network.

According to the present invention, there is provided a line card for coupling a subscriber line to a switching network the line card comprising:

an echo canceling circuit for reducing an echo signal received from said network and perceived at a user instrument coupled to said subscriber line.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will now be described by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a typical network connection showing a connection path between a pair of subscribers;

Figure 2 is a schematic diagram of a line card for far end network echo cancellation;

Figure 3 is a schematic diagram of a line card for near end network echo cancellation; and

Figure 4 is a schematic diagram of a line card with near end network echo cancellation and balance filtering.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

For convenience in the following description, like numerals refer to like structures in the drawings.

Referring to figure 1, a schematic diagram of a telecommunications network is shown generally by numeral 10. The network 10 connects at least a pair of subscribers 14 and 15. The network 10 is generally comprised of line card 22 connecting a digital switching network 17 (which may be comprised of more than one network) of a central office (CO) exchange to a plurality of subscriber lines 18. These subscriber lines are typically twisted pair Tip and Ring copper lines that connect subscriber instruments, (such as a telephone, fax, data modem, and such like) located at the subscriber location remote, to the CO. A line card 22 may be comprised of a plurality of POTS subscriber line interface circuits (SLIC) and CODECS. The SLIC connects a balanced two-wire transmission path (the path to and from the subscriber telephone handset) with an unbalanced four-wire transmission path (the path to and from the telephone central station). SLICs perform various functions, including battery feed, overvoltage protection, ringing, signaling, hybrid, and timing. The line card may also include for voice over data transmissions an xDSL transceiver or integrated POTS/xDSL circuit such as for example described in the applicants co-pending Canadian Patent Application No. 2,277,534.

For ease of explanation in the following embodiment, a forward communication path 18 is shown schematically in figure 1, from a first user A 14 to a second user B 15. Furthermore, an echo path 20 is defined between user A 14 and user B 15. From the point of view of user A, the echo signal is perceived as a contribution of at least four echo signals each due to segments of the echo path 20 between user A and user B, each segment is labeled e1, e2, e3, and e4 in the drawing of figure 1.

The present invention is based on the recognition that the line card 22 is the first circuit card to which a subscriber's twisted pair telephone line is coupled. It is the first point of access for either digital or analog communication over the twisted pair. Therefore, by implementing echo cancellation at the line card makes it possible to account for transport delays across the twisted pair loop to the subscriber set, without burdening the rest of the network with a requirement to perform echo cancellation.

Accordingly referring to figure 2, a Line Card A for reducing the echo returned to user A from path segments e2, e3 or e4, according to an embodiment of the invention is shown generally by numeral 22. This form of echo cancellation is referred to as "far

end" echo cancellation. That is, the term "far end" refers to the path direction with the greater physical distance from user A.

Conversely, referring to figure 3 a schematic block diagram of A Line Card B 24 for reducing the echo returned to user A 14 from path segment 4 only is shown generally by numeral 25. This form of echo cancellation is referred to a "near end" echo cancellation. That is, the term "near end" refers to the path direction with the lesser physical distance to user A.

If the communication path 18 was to be defined from user B to user A, the terms applied to the type of echo cancellation performed by each line card 22 and 24 would be reversed.

Furthermore, when a data modem transports the voice signal across the twisted pair loop 18, network echo cancellation on the line card enhances the quality of the voice connection. Similar to the situation described above, implementation of echo cancellation on the line card eliminates the need to burden the rest of the network with knowledge about the delays introduced by the transportation of the voice signal. In addition, having the echo cancellation performed on the line card makes the technology easy to retrofit since all that is required to upgrade the system is the replacement of the line card.

Referring back to Figure 2 a block diagram of a line card for "far end" network echo is indicated generally by numeral 22. The line card 22 couples at one end to the subscriber line 18 and at the other end to the network 17 and includes an echo cancellation circuit 42 which couples at one end to the network 17, an analog interface circuit 43 for connecting at one end to a twisted pair subscriber line 18, a digital interface transceiver 45 for processing analog signals coupled from the analog interface and passing it via the echo cancellation circuit 42 to the network 17. Both the analog interface circuits 43 and digital interface circuits 45 are well known in the art.

The echo cancellation circuit 42 comprises transmit and receive paths 47 and 48 respectively, a network delay model circuit 44 coupled to receive an input signal from the transmit path 47 and outputs a signal 46 to a subtractor 49. The subtractor subtracts the signal received along the receive path 48 from the output 46 of the delay model circuit 44 to produce a receive signal to the digital interface 45.

The network delay model circuit 44 uses a digital circuit such as a FIR filter, IR filter, or other adaptive filter and is based on modeling the network delay. The model 44 uses the signal transmitted to the network as its input and predicts the echo to be returned. These type of echo cancellation circuits are well known in the art.

The echo Canceller may also include a fax or modem detection circuit for disabling echo cancellation which may be used for communications other than voice; a speech activity detection for detecting the presence of a voice signal to activate the echo cancellor; and a center clippers or some other non-linear processors for removing residual echo.

In operation then, he output 46 of the network delay model 44 is subtracted from the signal received 48 from the network. Matching the magnitude, and phase of the echo signal returned with the predicted echo 46 allows the output 46 of the network delay model 44 to cancel the echo returned from the network and provide a voice transmission that is virtually free of echo.

Referring to Figure 3 a block diagram of a line card having a near end network echo cancellation circuit 52 is shown generally by numeral 24. The near end Network Echo Canceller 52 on the Line Card operates in a similar way to the far end echo canceller 42 in that it also uses a digital circuit such as a FIR filter, IR filter, or other adaptive filter as its model 53. This model 53, however, uses the signal received 54 from the network 17 as its input and predicts the echo 56 to be returned.

In the near end echo cancellor 52, the output of the network delay model is subtracted from the signal transmitted 57 to the network 17. Matching the magnitude and phase of the actual echo signal with the predicted echo allows the output of the network delay model 53 to cancel the echo returned from the twisted pair 58 and provide a voice transmission that is virtually free of echo.

The near end echo cancellation aids in implementing echo cancellation on the line card. It is this function that allows the delays inherent in voice over data technology to be accounted for, thereby improving the quality of voice transmissions for DSL communication.

The near end network echo cancellation 24 as described with reference to figure 3 may also include a balance circuit which is provided in typical voice CODECS.

Referring to figure 4 a line card having near end echo cancellation and a balance function circuit is shown generally by numeral 60. The line card 60 includes a balance function circuit 62 for coupling to the subscriber line 58 and an echo cancellation circuit 52 for coupling the balance function circuit to the network 17. The echo cancellation circuit 52 provides some echo cancellation for voice communication, however it may only cancel delays in the order of microseconds and is a compromise for a range of actual loops. Since the duration of the echo is typically in the order of 1 ms, the balance function handles a signal that is large compared with the delay.

In comparison, the network echo canceller cancels delays in the order of milliseconds. Therefore, the duration of the echo is relatively small compared to the delay. The echo canceller 52 provides cancellation that enhances the performance of the balance function 62 and can take into account components of the system that are between the balance function 62, and the network echo canceller 52.

Furthermore, it may be required that Line Card A 22 is required to perform both far and near end echo cancellation. It is possible to implement both types of echo cancellation as previously described, on one line card, further integrating and simplifying the architecture of the system. Both the delay model circuit and the balance function circuits are well known in the art.

Although the invention has been described with reference to certain specific embodiments, various modifications thereof will be apparent to those skilled in the art without departing from the spirit and scope of the invention as outlined in the claims appended hereto.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A line card for coupling a subscriber line to a switching network the line card comprising:

an echo canceling circuit for reducing an echo signal received from said network and perceived at a user instrument coupled to said subscriber line.

2. A line card as defined in claim 1, wherein said echo canceling circuit cancels echo occurring between a transmitter and said line card.

3. A line car d as defined in claim 2, wherein said echo occurs across a twisted pair wire coupling said transmitter to said line card.

4. A line card as defined in claim 1, wherein said echo canceling circuit cancels echo occurring between a receiver and said line card.

5. A line card as defined in claim 4, wherein said echo occurs across a network and a twisted pair wire coupling said line card to said receiver.

6. A line card as defined in claim 1, wherein said line card includes a second echo canceling circuit for reducing the echo of a transmitted signal from a further sender, said echo occurring along said twisted pair wire.

7. A line card as defined in claim 1, wherein said echo canceling circuit includes an adaptive filter.

8. A system as defined in claim 7, wherein said adaptive filter is a IIR (Infinite Impulse Response) filter.

9. A system as defined in claim 7, wherein said adaptive filter is a FIR (Finite Impulse Response) filter.

10. A line card for coupling a subscriber line to a switching network the line card comprising:
an analog interface circuit for coupling to a subscriber line;
a digital interface circuit coupled to said analog interface circuit;
an echo cancellation circuit coupled to said digital interface circuit including a subtractor for subtracting an echo replica supplied by a finite length impulse response (FIR) filter unit from a receive signal received from said network to output a residual signal to a said digital interface circuit.

11. A line card for coupling a subscriber line to a switching network the line card comprising:
an analog interface circuit for coupling to a subscriber line;
a digital interface circuit coupled to said analog interface circuit;
an echo cancellation circuit coupled to said digital interface circuit including a subtractor for subtracting an echo replica supplied by a finite length impulse response (FIR) filter unit from a transmitted signal to said network to output a residual signal to said network.

12. A line card as defined in claim 11, including a balance function circuit coupled to said echo cancellation circuit.

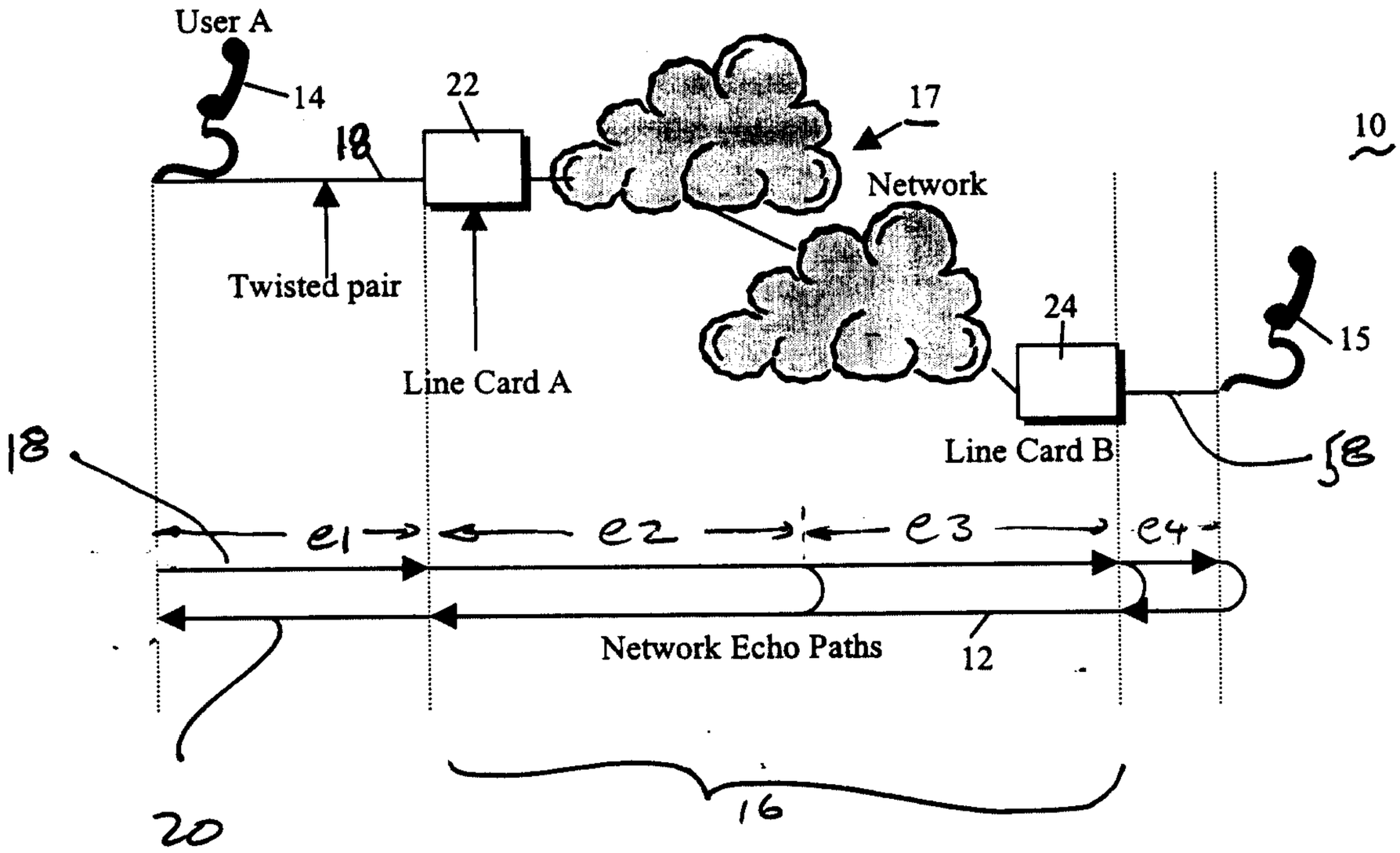


Figure 1

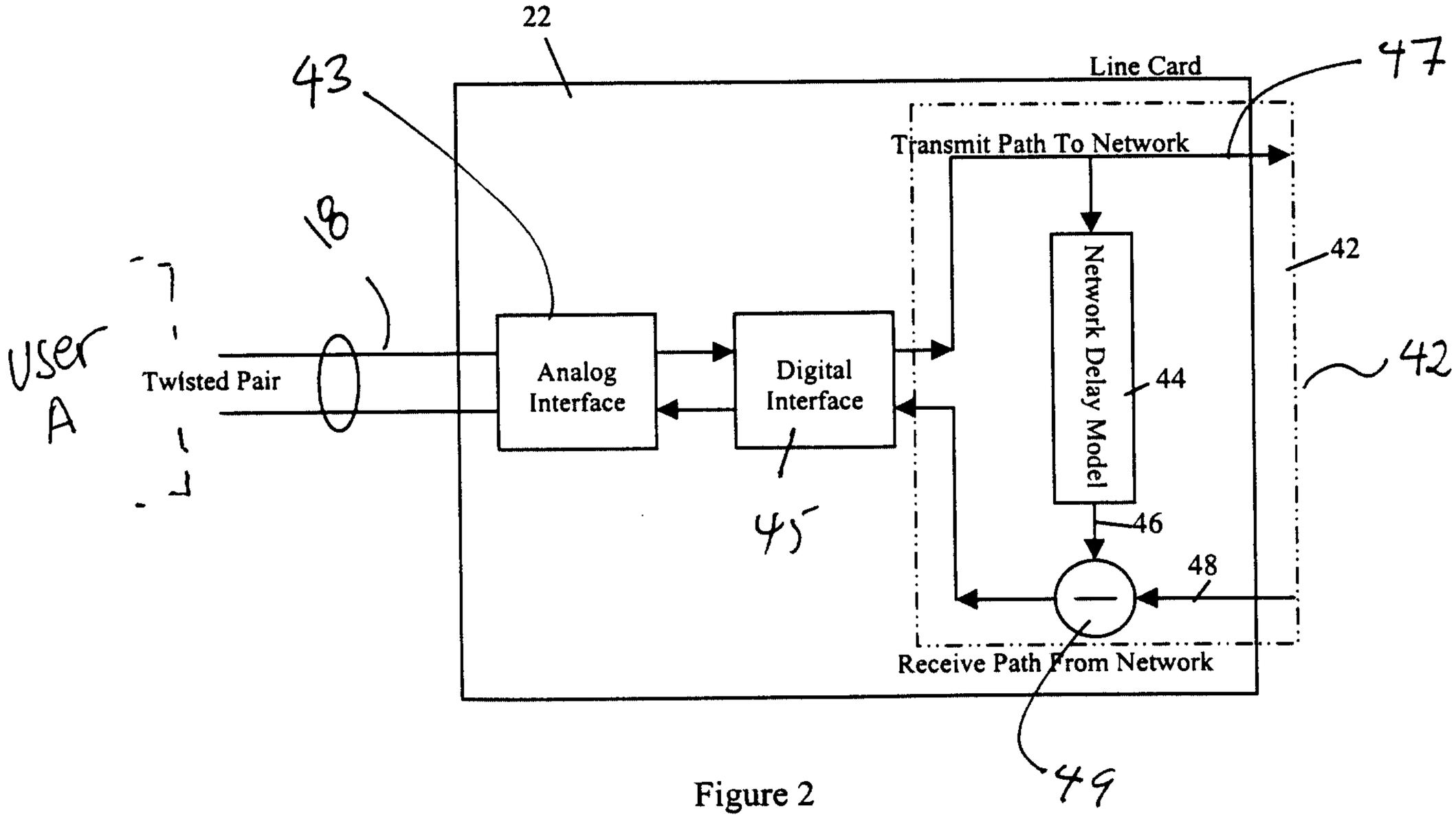


Figure 2

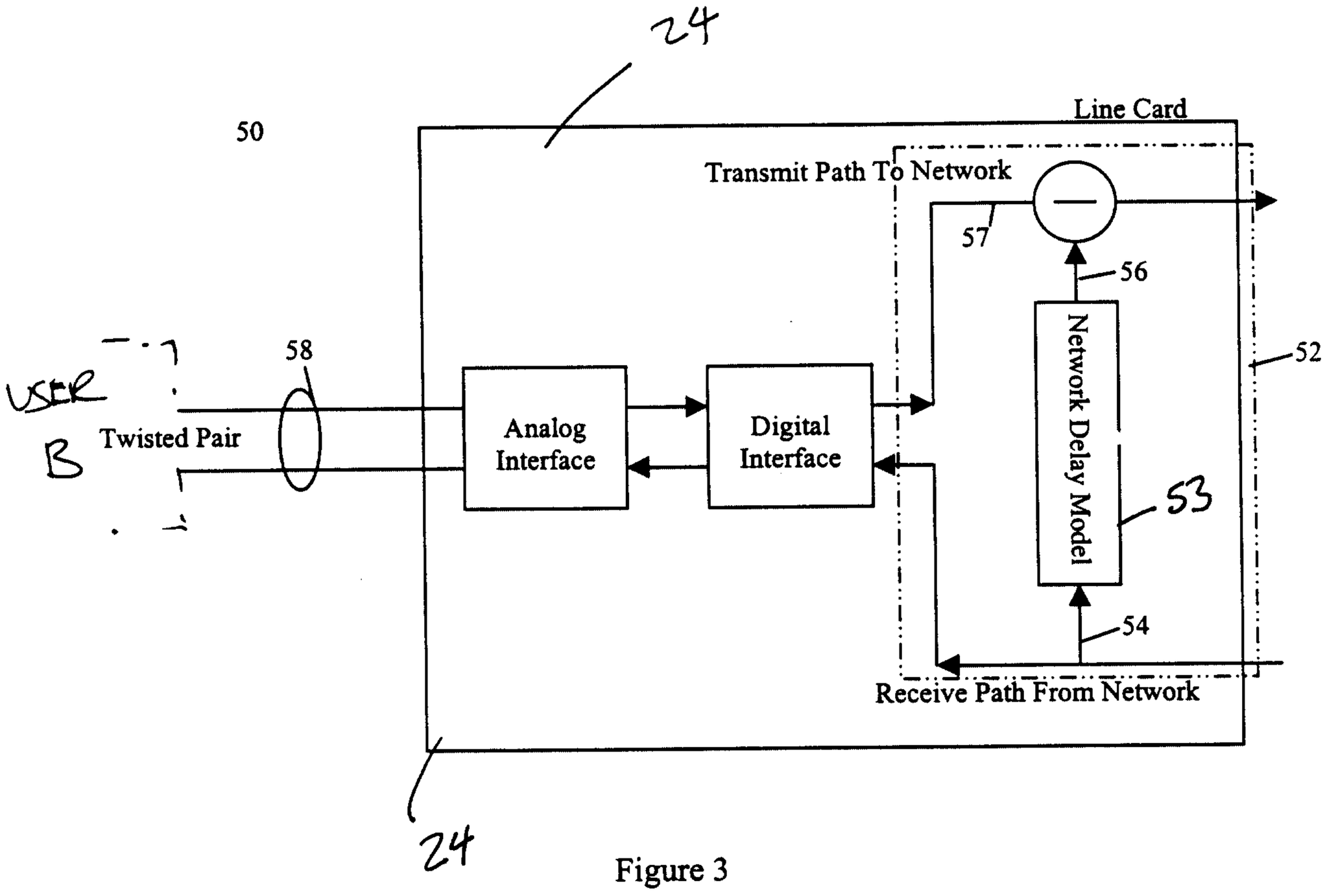


Figure 3

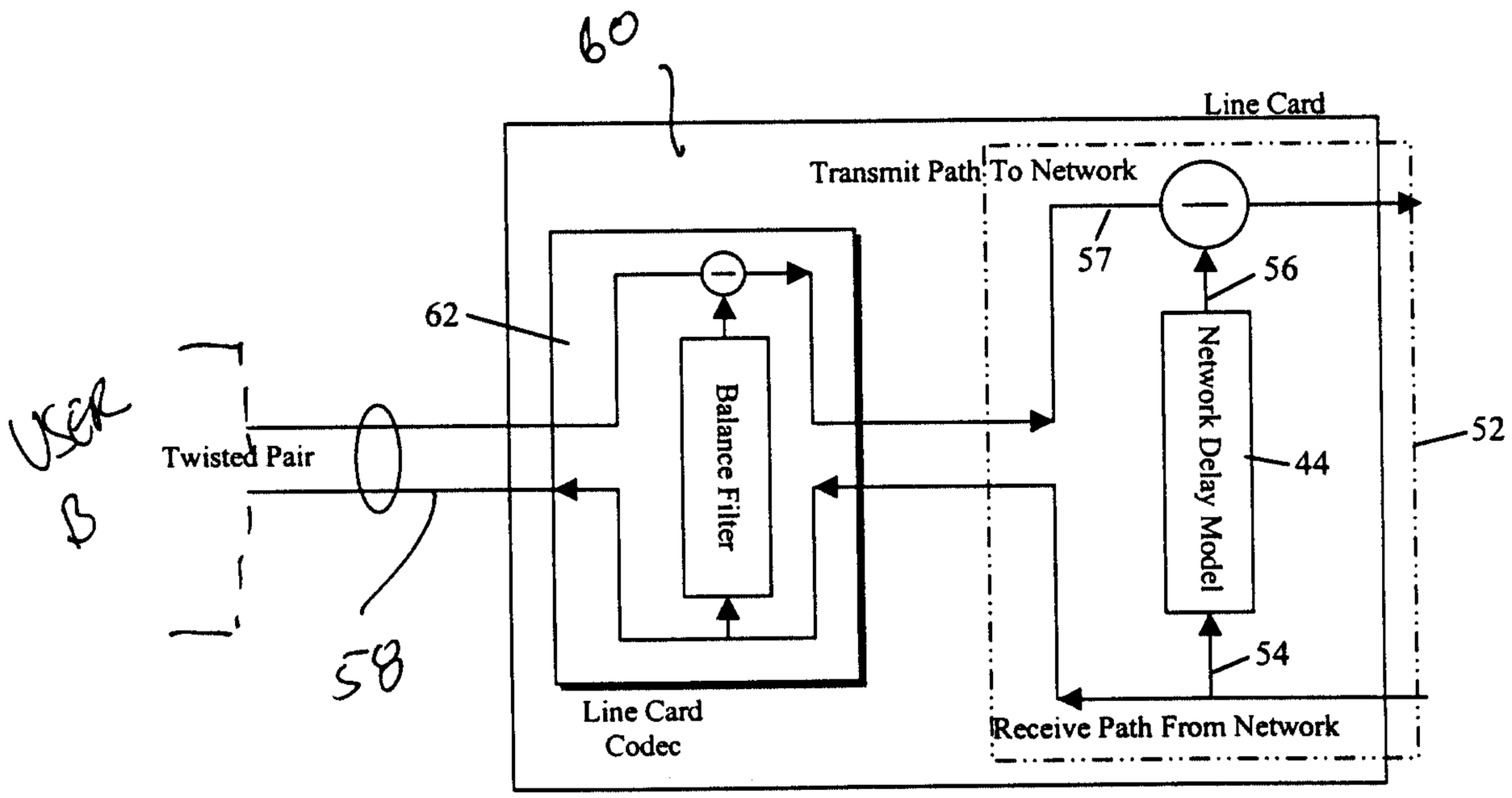
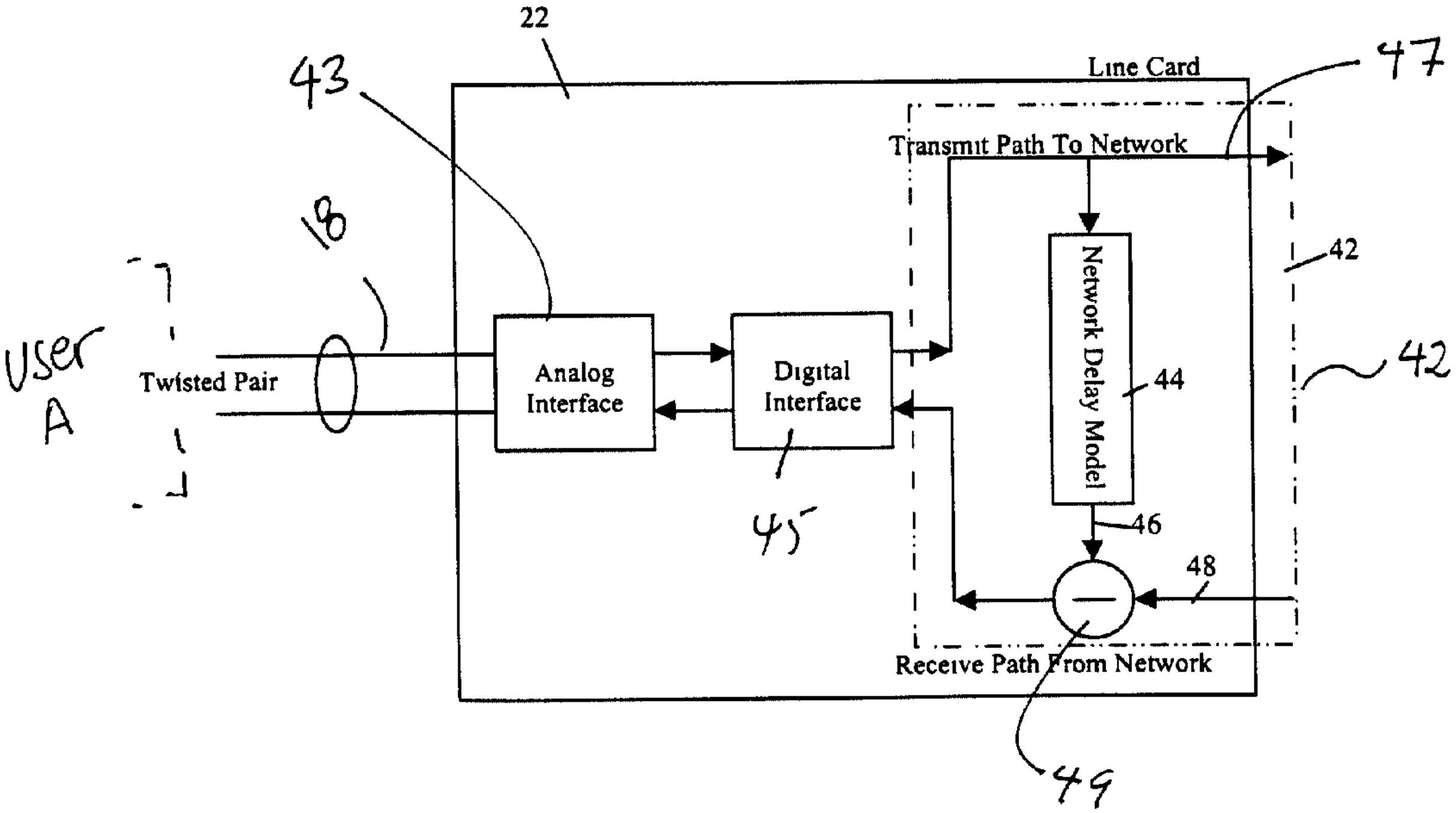


Figure 4


22
43
Line Card
47
Transmit Path To Network
18
User A
Twisted Pair
Analog Interface
Digital Interface
Network Delay Model
42
44
42
45
46
48
Receive Path From Network
49