

DATA COMMUNICATIONS SYSTEM**BACKGROUND OF THE INVENTION****Field of the Invention**

The present invention relates to a data communications system for transmitting data packets over a system which extends over at least one or more telephone networks in accordance with an independent telephone number plan and a connectionless mode telephone network.

Background

A large-scale communications system in which a plurality of client terminals, such as computers, and various servers are connected, has been constructed due to the wide-spread diffusion of the Internet and intranets (enterprise network). In the large-scale communication systems, various information is held in common, collected and delivered. First, the Internet is frequently accessed by individual users who use dial-up connecting from wired telephone (PSTN/ISDN) which are laid into the home, to connect to a commercial provider. In this way, it is possible to collect various information from many WWW (World Wide Web) servers. In addition, the electronic mail service is also extensively used as a communication means which does not demand real-time characteristics.

On the other hand, business users carry out rendering of various information for common use, as well as the collection and delivery of the various information, by connecting the servers and the client terminals to an intranet. In the intranet system, a communication device, such as a modem or a portable telephone, is connected to the client terminal. That is, by dial-up connection to an intranet from outside the office via a communication device, wired telephone or a wireless telephone, so-called "mobile computing" in which one client terminal transmits and receives data from both within and outside the office has been put into practical use.

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In the Internet and the intranet, the IP (Internet Protocol) is used as the communication protocol of the network layer. In this communication protocol, as a general rule, a characteristic IP address is assigned to each data transmission/receiving apparatus, and data communication is carried out by data packet routing using the IP addresses. In general, the data transmission/receiving apparatus is connected to a network (which has the same network address or the same sub-network address) having the Internet and an intranet. However, there may be times when connection to other networks is desired. For example, data communications may be carried out by connecting to a network in the office, or may be carried out by connecting to other networks during a business trip. In this case, the mobility of the data transmission/receiving apparatus must be taken into consideration.

Next, three forms will be considered for guaranteeing the mobility of the data transmission/receiving apparatus.

- (1) moving at the level of the network layer
- (2) moving at the level of the data link layer
- (3) moving at the level of the physical layer

Mobile IP and Virtual IP are well known as techniques for⁺ guaranteeing mobility according to the form noted in (1) above. In Mobile IP and Virtual IP, the mobility of the data transmission/receiving apparatus in the network layer is guaranteed by carrying out a mapping (address^{re} solution) in which a correspondence is created between the existing IP address and each of addresses for Mobile IP and Virtual IP, respectively.

Next, in the case where guaranteeing mobility according to (2) noted above, it is necessary to carry out the address^{re} solution of the IP address which is used in the network layer and MAC^{address} (Media Access Control) which is used in the data link layer. In the Internet and the intranet, the address^{re} solution is general^{ly} carried out using ARP (Address Resolution Protocol).

Furthermore, mobility in (3) is guaranteed by achieving conformity in the physical interface, such as shape of connector.

When the above-mentioned mobile computing is carried out via a telephone network, it is necessary to at least guarantee mobility at the level of the data link. The MAC addresses

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in a given telephone network are telephone numbers which are in accordance with the telephone number plan of the telephone network. For this reason, a network connecting apparatus, such as a dial-up router, which connects the Internet or intranet and the telephone network has a correspondence table (AMT: Address Mapping Table) for IP addresses and telephone numbers, so that address^{re} solution which guarantees the mobility in the telephone network can be carried out. When sending data packets from the Internet or an intranet to a data transmission/receiving apparatus under the subordination of the telephone network, data communication is carried out by establishing a data link with the data transmission/receiving apparatus by means of a telephone number corresponding to the IP address of the data transmission/receiving apparatus. As a result, the movement of the data transmission/receiving apparatus in the telephone network is guaranteed.

However, when the data transmission/receiving apparatus moves in the telephone network, or moves from a telephone network to other telephone networks, the telephone number of the data transmission/receiving apparatus changes. In this case, it is necessary to rewrite the IP address-telephone number correspondence table, which is provided in the above-mentioned network connecting apparatus, in order to route data packets from the Internet or the intranet to the data transmission/receiving apparatus under the subordination of the telephone network.

However, because conventional communication systems disregard the fact that the data transmission/receiving apparatus moves from one telephone network to another telephone network, automatic rewriting of the correspondence table is not carried out. Therefore, the mobility of the data transmission/receiving apparatus cannot be guaranteed.

Furthermore, as one form of data communications, for example, a user may carry out data communications using the PHS (Personal Handy-phone System), in which case data packets are transmitted from the PHS network via an ISDN network. When data is transmitted via different telephone networks in this way, then a protocol conversion is required if information for rewriting the correspondence table is transmitted using control information attached to the data transmission.

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SUMMARY OF THE INVENTION

The present invention was conceived in consideration of the above-described circumstances, and has as its objective the provision of a data communications system in which the contents of the correspondence table are rewritten automatically, and data communications are carried out from a connectionless mode network independent of the type of the telephone network.

In order to resolve the above-described problems, the present invention provides for a data communications system comprising a connectionless mode network for transmitting data; at least one telephone network for assigning a telephone number to each communication apparatus according to an independent numbering plan; a connection apparatus for connecting between the connectionless mode network and the telephone network; a communication terminal for communicating to the connected communication apparatus through the telephone network, and for notifying its own packet address and the telephone number of the connected communication apparatus to the connection apparatus; and a storage apparatus for storing the telephone number of the connected communication apparatus and the packet address of the communication terminal correspondingly; wherein, the connection apparatus consists of a recording means which applies a correspondence to the telephone number of the connected communication apparatus that is transmitted from the communication terminal and the packet address of the communication terminal, and records the telephone number ^{and packet address} in the storage apparatus.

The above-described communication terminal is provided with a detecting means for detecting that the terminal is connected to another communication apparatus, wherein this communication terminal notifies the connected ^{connection} communication apparatus of its own packet address and the telephone number of a connected communication apparatus, based on the results detected by the detecting means.

Furthermore, in order to resolve the above-described problems, the present invention provides a data communications system comprising a connectionless mode network for transmitting data; a plurality of telephone networks for assigning a telephone number to each

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communication apparatus according to an independent numbering plan; a connection apparatus for connecting between the connectionless mode network and the plurality of telephone networks; a communication terminal for communicating to a connected communication apparatus through the telephone network, and for notifying its own packet address and the telephone number of the connected communication apparatus to the connection apparatus when it is detected that one of the aforementioned telephone networks changes to another telephone network; and a storage apparatus for storing a correspondence relationship between the telephone number of the connected communication apparatus and the packet address of the communication terminal; wherein the connection apparatus consists of a recording means which applies a correspondence to the telephone number of the connected communication apparatus that is transmitted from the communication terminal and the packet address of the communication terminal, and stores the telephone number and packet address in the storage apparatus.

The above-described communication terminal notifies the packet address and the telephone number to the connection apparatus after a data link is established between the connection apparatus and itself.

Accordingly, the present invention provides a ^{data communications system} frame synchronization circuit in which it is possible to rewrite the contents of the correspondence ^{table} automatically, and to carry out the data communications from the connectionless mode network independent of the type of telephone network.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a data communications system according to the embodiment of the present invention.

FIG. 2 is a block diagram showing the structure of a data communication terminal according to the embodiment.

FIG. 3 is a conceptual diagram showing the renewal operation of the data communication terminal according to the embodiment.

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FIG. 4 is a sequence diagram showing an example of the operation in the data communications system according to the embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The best mode for carrying out the present invention will now be described with reference to the drawings. In this embodiment, LAN (Local Area Network) will be described as an example of the connectionless mode network, such as the Internet.

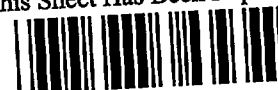
1. STRUCTURE OF EMBODIMENT

Fig. 1 is a block diagram showing the structure of a communication system of an embodiment in this invention. In Fig. 1, PDA1, PDA2, ... are data communication terminals, for example, each data communication terminal being composed of a notebook-type personal computer. IP addresses IP1, IP2, ... which are used at the network layer according to the (common ^{Internet addressing} telephone numbering) plan are assigned to data communication terminals PDA1, PDA2, When data transmission is carried out, each of ^{the} data communication terminals PDA1, PDA2, ... is identified by IP addresses IP1, IP2,....

Next, the internal structure of data communication terminal PDA1 is shown in Fig. 2. However, other data communication terminals PDA2, ... have the same internal construction as that of data communication terminal PDA1, so that an explanation of the internal structure of data communication terminals PDA2, ... is omitted. As shown in Fig. 2, data communication terminal PDA1 consists of CPU10, ROM11, RAM12, interface portion 13, hard disk 14 and display portion 15. CPU10 controls each portion of the terminal. ROM11 stores control programs which are used by CPU10. RAM12 is used as work area for CPU10. Interface portion 13 interfaces between the internal circuit and an outer device. Hard disk 14 stores the communication programs and data. Display portion 15 displays characters, symbols or icons.

Interface portion 13 is able to use various protocols which are used in the telephone network to which data communication terminal PDA1 is connected, and is constructed to

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transmit/receive data and control signals. In this case, interface portion 13 may be constructed by various interface cards for example. Furthermore, the interface card may be replaced according to the type of communication apparatus, such as a portable telephone which communicates between the cellular network, or a PHS terminal which communicates between a PHS network.

Here, the communication program supports TCP/IP (Transmission Control Protocol/Internet Protocol), for example. Addition, IP address IP1 of data communication terminal PDA1 are stored in hard disk 14 as part of the communication program.

According to the above-mentioned construction, CPU10 carries out the transmitting/receiving of control signals to/from the communication terminal, which is connected via interface portion 13 when the communication program is run. As a result, CPU 10 recognizes whether not or the communication apparatus which is connected at present has changed from the previous apparatus. A method for this recognition may be employed, with one example thereof described below.

First, in a case where data communication terminal PDA1 moves from a telephone network (for example, the cellular network) to another telephone network (for example, PHS network), the type of control signal becomes different because the communication protocol is different. As a result, CPU10 recognizes that the communication apparatus has changed, based on the control signals. That is to say, CPU10 recognizes that the communication apparatus is connected to a different telephone network. In this case, CPU 10 receives the telephone number of the communication apparatus via interface portion 13, and stores the telephone number in hard disk 14.

Next, when CPU 10 recognizes that the communication apparatus is connected to the same telephone network, then CPU 10 reads out the telephone number used with the previous data communication, and compares the read-out telephone number with the present telephone number received via interface portion 13. When both telephone numbers do not correspond, CPU 10 recognizes that data communication terminal PDA1 has connected to a different communication apparatus.

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As described above, when CPU 10 recognizes that data communication terminal PDA1 has connected to a different communication apparatus, CPU 10 controls each portion to notify the combination of IP address IP1 and the new telephone number to the (telephone apparatus network.) That is, data communication terminal PDA1 consists of a detecting means for detecting that another communication apparatus, different from the previous apparatus, is connected thereto, and a notifying means for notifying IP address IP1 (packet address of itself) and the telephone number of the communication apparatus which is connected thereto.

Next, in Fig. 1, 1 is a cellular network in which a plurality of portable telephones 101, 102, ... are connected thereto. 2 is a PHS network in which a plurality of PHS terminals 201, 202, ... are connected. Furthermore, 3 is a wired telephone network, such as PSDN or ISDN, in which data communication terminals PDA1, PDA2, ... are connected thereto via a plurality of communication modems 301, 302,

Next, 4 is a network connection apparatus, network connection apparatus 4 connecting cellular network 1, PHS network 2 and wired telephone network 3 to local area network LAN. Network connection apparatus 4 consists of interface portion 41, route control portion 42 and calling control portion 43. First, interface portion 41 transmits/receives data to/from a local area network LAN. Next, route control portion 42 controls the communication route of the data packets, when data packets are transmitted from local area network LAN or each of the telephone networks 1-3. Calling control portion 43 controls calling of each telephone network 1-3. By the above-mentioned construction, network connection apparatus 4 has a function for carrying out the establishment of data links by means of PPP (Point to Point Protocol) between the data communication terminals which exist under each telephone network.

Next, 5 is a correspondence table which is connected to network connection apparatus 4, in which the relations of IP addresses IP1, IP2, ... and the telephone numbers which are used by each of data communication terminals PDA1, PDA2, ... at present are stored. Therefore, it is possible to specify the telephone number of the object of communication by referring to correspondence table 5 based on the IP address of the object

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of communication. Route control portion 42 refers to correspondence table 5 when it carries out the routing of an IP packet.

2. OPERATION OF EMBODIMENT

Next, an explanation will be made of the operation of this embodiment with reference to the figures. Fig. 3 is a conceptual diagram showing the state for renewing correspondence table 5. Fig. 4 is a sequence diagram showing an example of the renewal.

In this example, it is assumed that, as the initial state, data communication terminal PDA1 having IP address IP1 exists under the subordination of cellular network 1, and is connected to portable telephone 101 of the telephone number IDa. At this point the telephone number IDa is stored in correspondence table 5 by applying a correspondence to IP address IP1 as shown 5a of Fig. 3.

If data communication terminal PDAx which is connected to local area network LAN, indicates IP address IP1 and has transmitted IP packet, then route control portion 42 of network connection apparatus 4 detects IP address IP1 in IP packet. Route control portion 42 then searches correspondence table 5 based on IP address IP1, and obtains the corresponding telephone number IDa. Afterward, ^{calling} (route control portion 43) of network connection apparatus 4 makes a telephone call to portable telephone 101 using the telephone number IDa, and carries out the routing of IP packet after establishing the data link to data communication terminal PDA1.

Next, it is assumed that data communication terminal PDA1 moves from cellular network 1 to PHS network 2, and is connected to PHS terminal 201 to which the telephone number IDb is assigned. In this case, CPU 10 of data communication terminal PDA1 transmits/receives control signals to/from PHS terminal 201 via interface portion 13, and recognizes that the type of communication network what data communication terminal PDA1 is dependent on, has changed. At this time, data communication terminal PDA1 obtains the telephone number IDb of PHS terminal 201 which is connected thereto, and stores the telephone number IDb into RAM 12 and hard disk 14.

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Next, an explanation will be made of the sequence in which data communication terminal PDA1 transmits IP packets to other data communication terminals with reference to Fig. 4. In Fig. 4, first, when a link establishment request (connection request) is transmitted from data communication terminal PDA1 to network connection apparatus 4 via a telephone network (in this case, PHS network 2) (S1, S2), network connection apparatus 4 detects the link establishment request. Afterward, network connection apparatus 4 sends back a link establishment confirm (connection confirm) to data communication terminal PDA1 (S3, S4). As a result, data communication terminal PDA1 can recognize that the link is established between data communication terminal PDA1 and network connection apparatus 4.

Next, data communication terminal PDA1 expands an optional region of the frame in the link control protocol LCP which is used with the link establishment phase. As a result, a new ^{option} (frame type) is defined. In this case, data communication terminal PDA1 generates a ^{option} (frame) into the optional region of which IP address IP1 and the telephone number IDa are written, and transmits the frame to network connection apparatus 4 (S5).

When network connection apparatus 4 receives the frame, and detects IP address IP1 and the telephone number IDb which are written into the optional region of the frame, network connection apparatus 4 accesses correspondence table 5 (S6). At this time, network connection apparatus 4 searches correspondence table 5 based on the received IP address (in this case, IP1), and then obtains the corresponding telephone number. Afterward, network connection apparatus 4 compares the telephone number which is obtained from correspondence table 5 and the received telephone number, and carries out the following operations based on the result of the comparison.

First, when the telephone number which is obtained from correspondence table 5 is not the same as the received telephone number, network connection apparatus 4 renews the telephone number which is stored in correspondence table 5 to the received telephone number. However, when the telephone number, which corresponds to the IP address, is not stored in correspondence table 5, it is determined that the telephone numbers do not coincide, since there is no object for comparison. In this case, the received telephone number is related to the IP address and stored in correspondence table 5. On the other hand,

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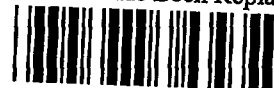
when the telephone number, which is obtained from correspondence table 5, is the same as the received telephone number, network connection apparatus 4 does not renew correspondence table 5, and proceeds with the procedure.

In this example, prior to renewal of correspondence table 5, the telephone number IDa is stored in correspondence table 5 after a correspondence to IP address IP1 has been applied, as shown in 5a of Fig. 3. As a result, network connection apparatus 4 obtains the telephone number IDa from correspondence table 5, and receives the telephone number IDb from data communication terminal PDA1. Therefore, since both do not coincide, the content of correspondence table 5 is renewed as shown in 5b of Fig. 3.

After correspondence table 5 is renewed as described above, network connection apparatus 4 sends back a LCP registration confirm to data communication terminal PDA1 (S7). When data communication terminal PDA1 receives LCP registration confirm, data communication terminal PDA1 transmits data to the other side after shifting to the data phase (S8). Data communication terminal PDA1 then transmits PPP termination request to network connection apparatus 4 when data transmission is finished (S9). As a result, network connection apparatus 4 can detect that data communication terminal PDA1 requests the termination of PPP by the completion of data transmission, etc. When network connection apparatus 4 terminates PPP based on the detected result, it transmits a PPP termination confirm to data communication terminal PDA1 (S10). Afterward, the disconnect request and the disconnect confirm are transmitted/received between data communication terminal PDA1 and network connection apparatus 4, and the communication is then finished (S11-S14).

Next, it is assumed that data communication terminal PDA1 moves to wired telephone network 3, and carried out communication by connecting to communication modem 301 to which the telephone number IDc is assigned. In this case, in the same manner as when data communication terminal PDA1 moves from cellular network 1 to PHS network 2, correspondence table 5 is renewed. Therefore, the content of correspondence table 5 is changed from that shown in 5b of Fig. 3 to that shown in 5c of Fig. 3.

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As described above, according to this embodiment, even if each of data communication terminal PDA1, PDA2,... moves through various telephone networks, the telephone number of the communication apparatus which is connected to data communication terminal PDA can be constantly renewed to the most recent data. This is because, in this embodiment, data communication terminal PDA can recognize that it is connected to the different telephone network, and correspondence table 5 is renewed by transmitting the new telephone number and IP address to network connection apparatus 4. As a result, it is possible to carry out the routing of IP packets for other data communication terminal PDAs independent of the type of the telephone network.

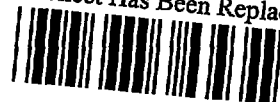
Furthermore, in this example, after the data link is established between data communication terminal PDA1 and network connection apparatus 4, the IP address and the new telephone number are then transmitted. For this reason, the renewal information necessary for renewing correspondence table 5 is not transmitted by using the control information which is attached to the data transmission. Therefore, for example, in a case where data communication terminal PDA is connected from the PHS network to network connection apparatus 4 via an ISDN network, it is not necessary to transmit the renewal information which is written into the control information after converting the control protocol which is determined for each telephone network. In addition, it is possible to simplify the architecture of the network with respect to the transmission of the renewal information.

3. MODIFICATIONS

This invention is not limited to the above-mentioned embodiments, however. Rather, it is possible to provide various modifications as follows, for example.

- I. In the above-mentioned embodiment, LAN is used as an example of the connectionless mode network. But, this invention is not limited thereto. Rather, the connectionless mode network may be the Internet or an intranet.
- II. In the above-mentioned embodiment, TCP/IP is used as the communication protocol. But, other network protocols, for example, IPX/SPX or Appletalk etc., may be used.

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- III. Furthermore, in the above-mentioned embodiment, the IP address and the telephone number are notified in the link establishment phase of PPP which is the link control protocol. But, the IP address and the telephone number may be notified in the network layer protocol phase ^A(NCP: Network Control Protocol) which carries out the protocol control in a different network layer. The most important thing is to renew correspondence table 5 at anytime from the start of the communication to the finish of the communication. However, when the number of access events per unit time with respect to correspondence table 5 is ^{are} many, then the renewal time of correspondence table 5 may become longer, causing the connection time to become longer. For this reason, the IP address and the telephone number which ^{are} received are stored into a supplementary memory, and correspondence table 5 may be renewed after the communication is finished.
- IV. Furthermore, the above-mentioned embodiment may be applied to a case where the communication is carried out via different networks, for example, such as a PHS network or an ISDN network. In this case, the communications system is constructed to establish and end-end data link. Therefore, it is possible to obtain the same effects as the above-mentioned embodiment because the renewal of correspondence table 5 is carried out automatically.
- V. Furthermore, the above-mentioned embodiment may be applied to a case where the data communication terminal PDAs belong to the same network, and the connected apparatus is changed. In this case, the telephone number is changed, so that data communication terminal PDA may detect the new telephone number, and may transmit the IP address and new telephone number to network connection apparatus 4.
- VI. When the power switches of portable telephones 101, 102,... or PHS terminals 201, 202, ... are turned from the OFF state to the ON state, conventionally familiar position registration is carried out. But, when the position registration is carried out, cellular network 1 or PHS network 2 may notify the IP address and the telephone number to network connection apparatus 4, and the correspondence table 5 may be renewed. In this case, even if the IP packet is not transmitted from data communication terminals PDA1, PDA2, ..., it is possible to renew correspondence table 5. As a result, data

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communication terminals PDA1, PDA2, ... move from cellular network 1 to PHS network 2, such that, even before data transmission, for example, it is possible to receive an IP packet from the other data communications terminal.

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WHAT IS CLAIMED IS:

1. A data communications system comprising:
 - a connectionless mode network for transmitting data;
 - at least one telephone network for assigning a telephone number to each communication apparatus according to an independent numbering plan;
 - a connection apparatus for connecting said connectionless mode network and said telephone network;
 - a communication terminal for communicating to a connected communication apparatus through said telephone network, and for notifying its own packet address and said telephone number of said connected communication apparatus to said connection apparatus; and
 - a storage apparatus for storing said telephone number of said connected communication apparatus and said packet address of said communication terminal correspondingly;wherein said connection apparatus consists of a recording means which records said telephone number of said connected communication apparatus that is transmitted from said communication terminal, ^{and} corresponding to said packet address of said communication terminal into said storage apparatus.
2. A data communications system according to claim 1, wherein said communication terminal consists of a detecting means for detecting that this terminal is connected to another communication apparatus, and notifies its own packet address and a telephone number of a connected communication apparatus based on a detected result of said detecting means.
3. A data communications system comprising:
 - a connectionless mode network for transmitting data;
 - a plurality of telephone networks for assigning a telephone number to each communication apparatus according to an independent numbering plan;



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a connection apparatus for connecting said connectionless mode network and said plurality of telephone networks;

a communication terminal for communicating to a connected communication apparatus through said telephone network, and for notifying its own packet address and said telephone number of said connected communication apparatus to said connection apparatus, when a telephone network that is used with the communication changes to another telephone network; and

a storage apparatus for storing a correspondence relation between said telephone number of said connected communication apparatus and said packet address of said communication terminal;

wherein said connection apparatus consists of a recording means which records said telephone number of said connected communication apparatus that is transmitted from said communication terminal, ^{and} corresponding to said packet address of said communication terminal into said storage apparatus.

4. A data communications system according to claim 1, 2 or 3 either, wherein said communication terminal notifies said packet address and said telephone number to said connection apparatus after a data link is established between said connection apparatus and itself.



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