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Hirai

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(54) **DELIVERY SERVER, AND TERMINAL DEVICE**

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H04W 4/06 (2009.01)

(52) **U.S. Cl.**
CPC *H04W 4/06* (2013.01)

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CPC H04L 12/2498; H04L 41/509; H04L 12/2424; H04L 12/2462; H04W 4/005; H04W 28/0215; A63F 2300/405; G01S 5/0289
USPC 370/254–258, 270, 310, 388–389, 396, 370/412, 420, 428–429, 913; 455/41, 59, 455/419, 420, 421, 422, 422.1, 456.3, 555
See application file for complete search history.

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Primary Examiner — Charles C Jiang
Assistant Examiner — Mohamed Kamara
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(57) **ABSTRACT**

A content delivery system which comprises a delivery server and multiple terminal devices, the delivery server delivering content, the multiple terminal devices receiving delivery of the content, in the content delivery system connection between the delivery server and the terminal devices and connection between the terminal devices being made by radio, in the content delivery system the terminal devices being connected in multiple stages, wherein the delivery server instructs a terminal device which has received delivery of the content and which is connected to an other terminal device at the next stage to deliver content possessed by a self terminal device to the other terminal device, and wherein the instructed terminal device delivers content possessed by the self terminal device to the other terminal device and notifies the delivery result to the delivery server.

17 Claims, 7 Drawing Sheets

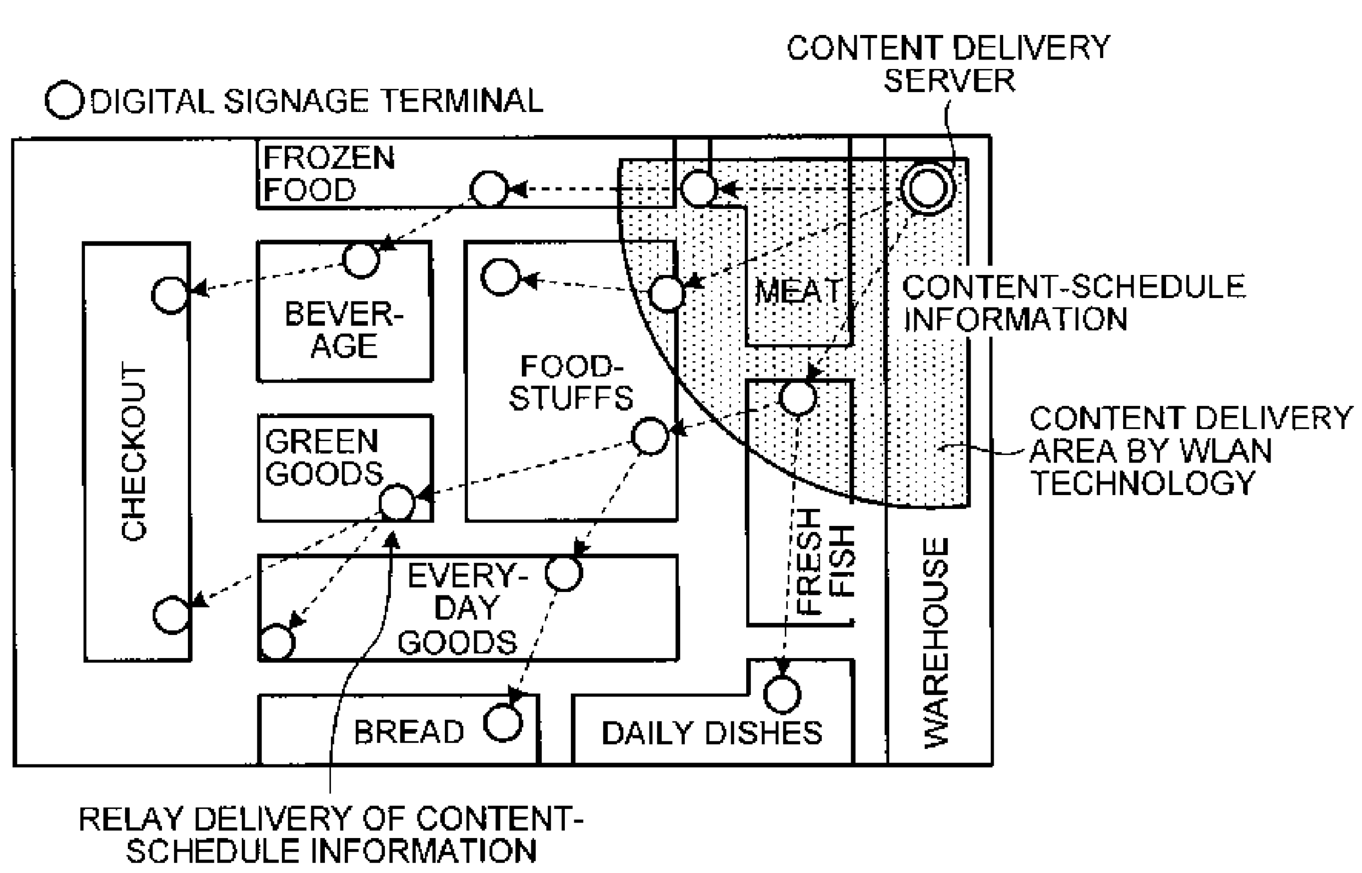

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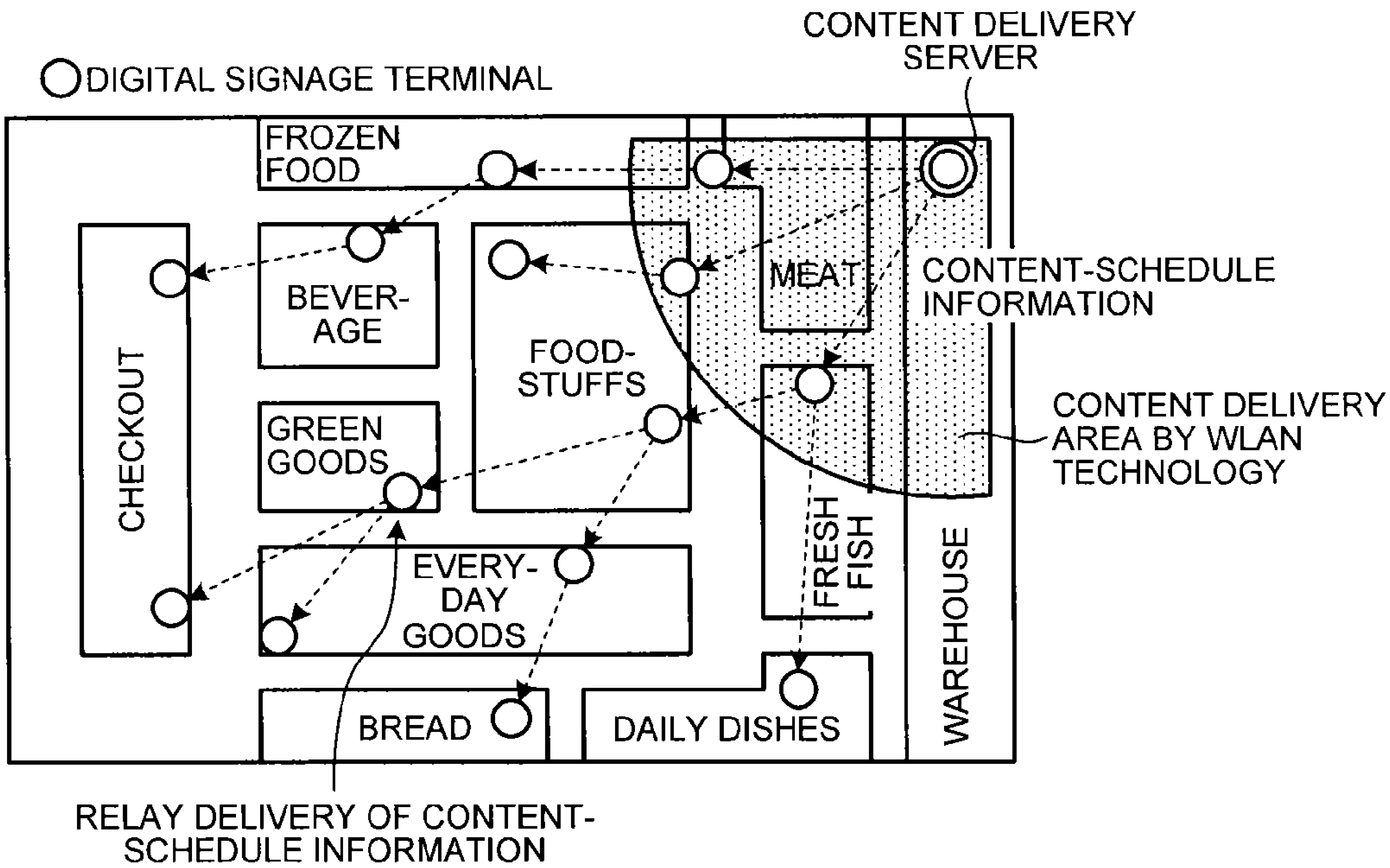
FIG.1



DIGITAL SIGNAGE TERMINAL
CONTENT DELIVERY SERVER
FROZEN FOOD
BEVER-AGE
CHECKOUT
GREEN GOODS
FOOD-STUFFS
MEAT
CONTENT-SCHEDULE INFORMATION
CONTENT DELIVERY AREA BY WLAN TECHNOLOGY
EVERY-DAY GOODS
FRESH FISH
WAREHOUSE
BREAD
DAILY DISHES
RELAY DELIVERY OF CONTENT-SCHEDULE INFORMATION

FIG.2

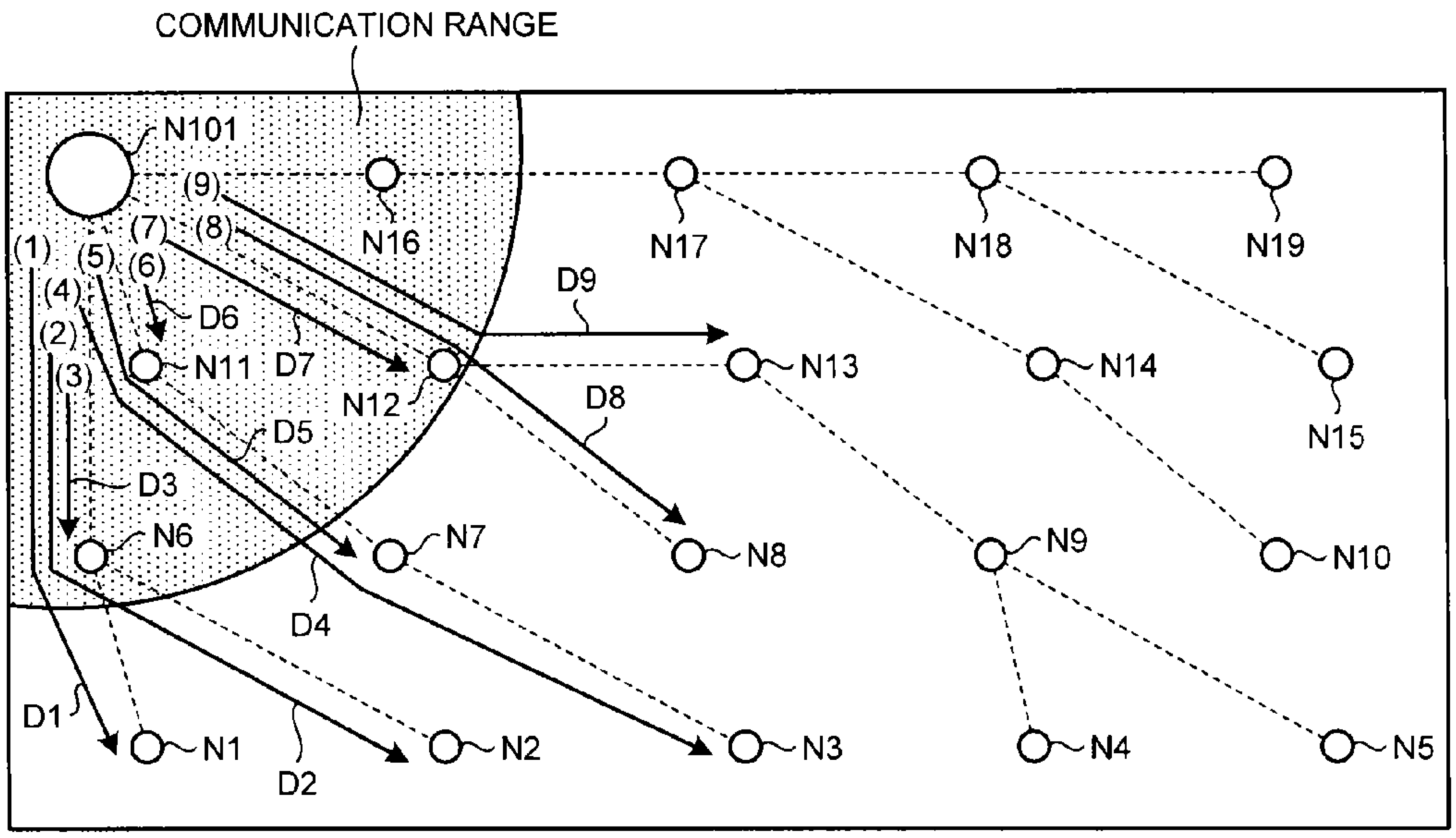
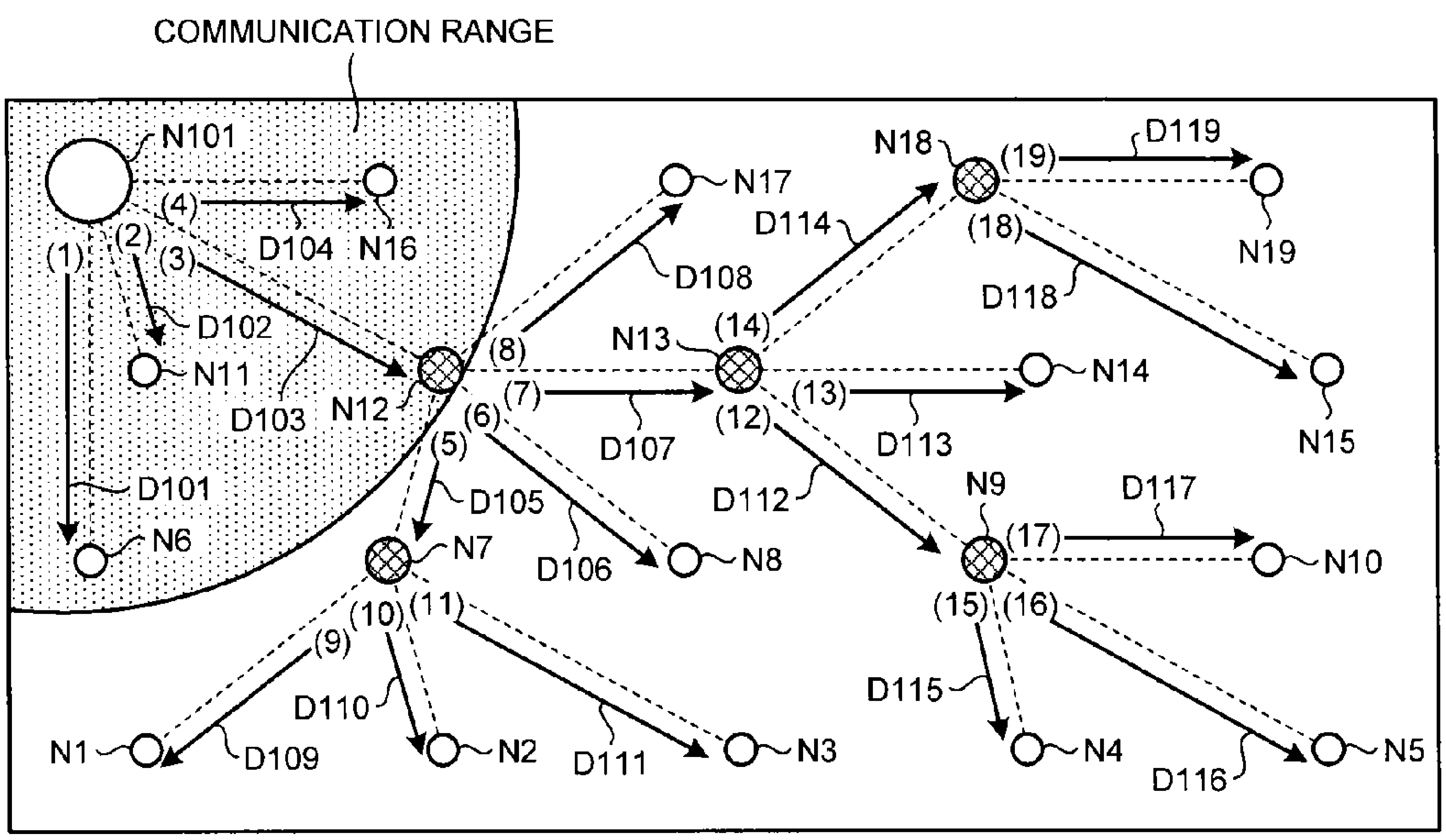

COMMUNICATION RANGE
N101
N16
N17
N18
N19
N11
N12
N13
N14
N15
N6
N7
N8
N9
N10
N1
N2
N3
N4
N5
D1
D2
D3
D4
D5
D6
D7
D8
D9
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)

FIG.3


COMMUNICATION RANGE
N101
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N17
N18
N19
N11
N12
N13
N14
N15
N6
N7
N8
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N10
N1
N2
N3
N4
N5
D101
D102
D103
D104
D105
D106
D107
D108
D109
D110
D111
D112
D113
D114
D115
D116
D117
D118
D119
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
(15)
(16)
(17)
(18)
(19)

FIG.4

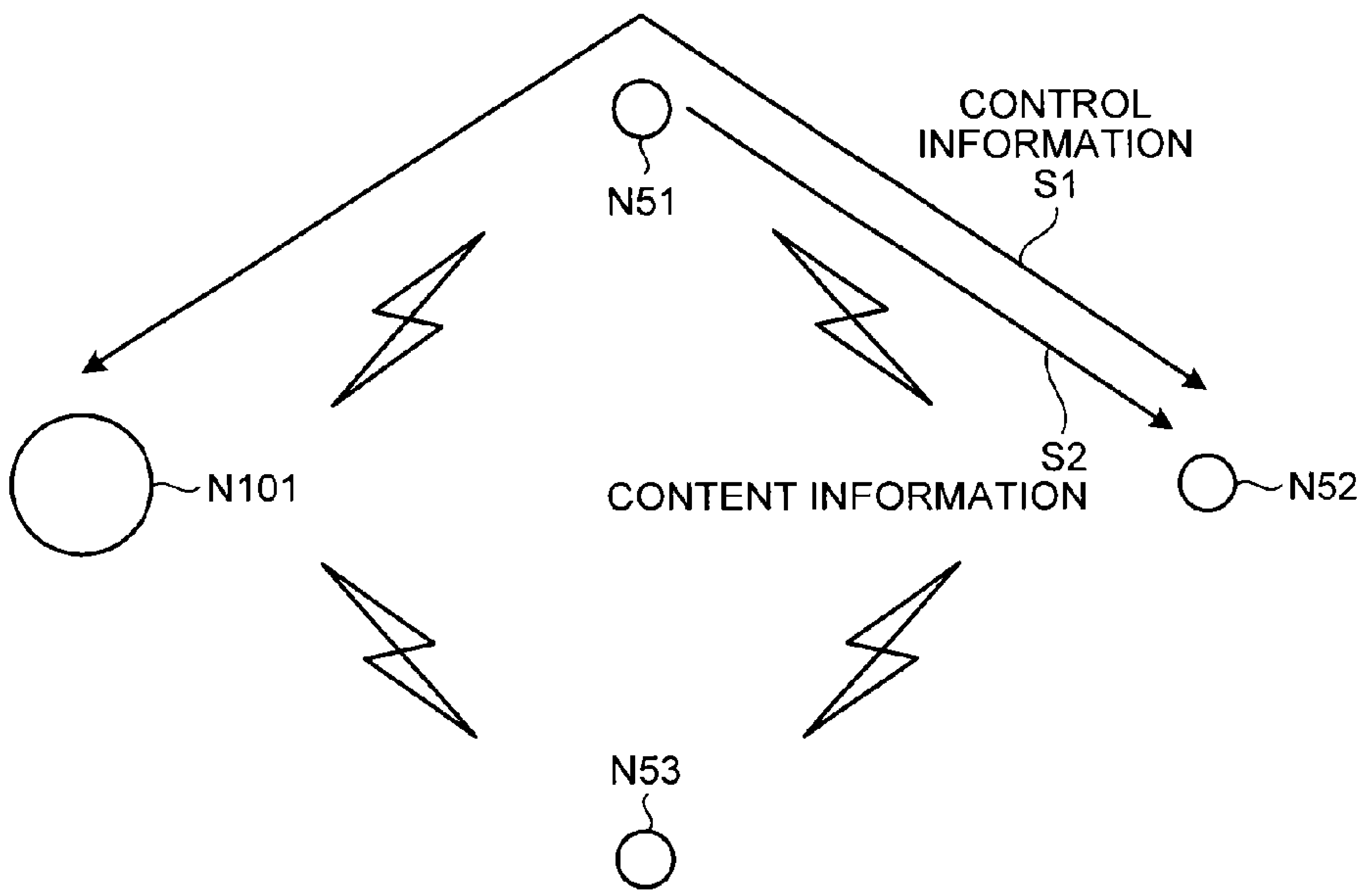

CONTROL
INFORMATION
S1
N51
S2
CONTENT INFORMATION
N101
N52
N53

FIG.5

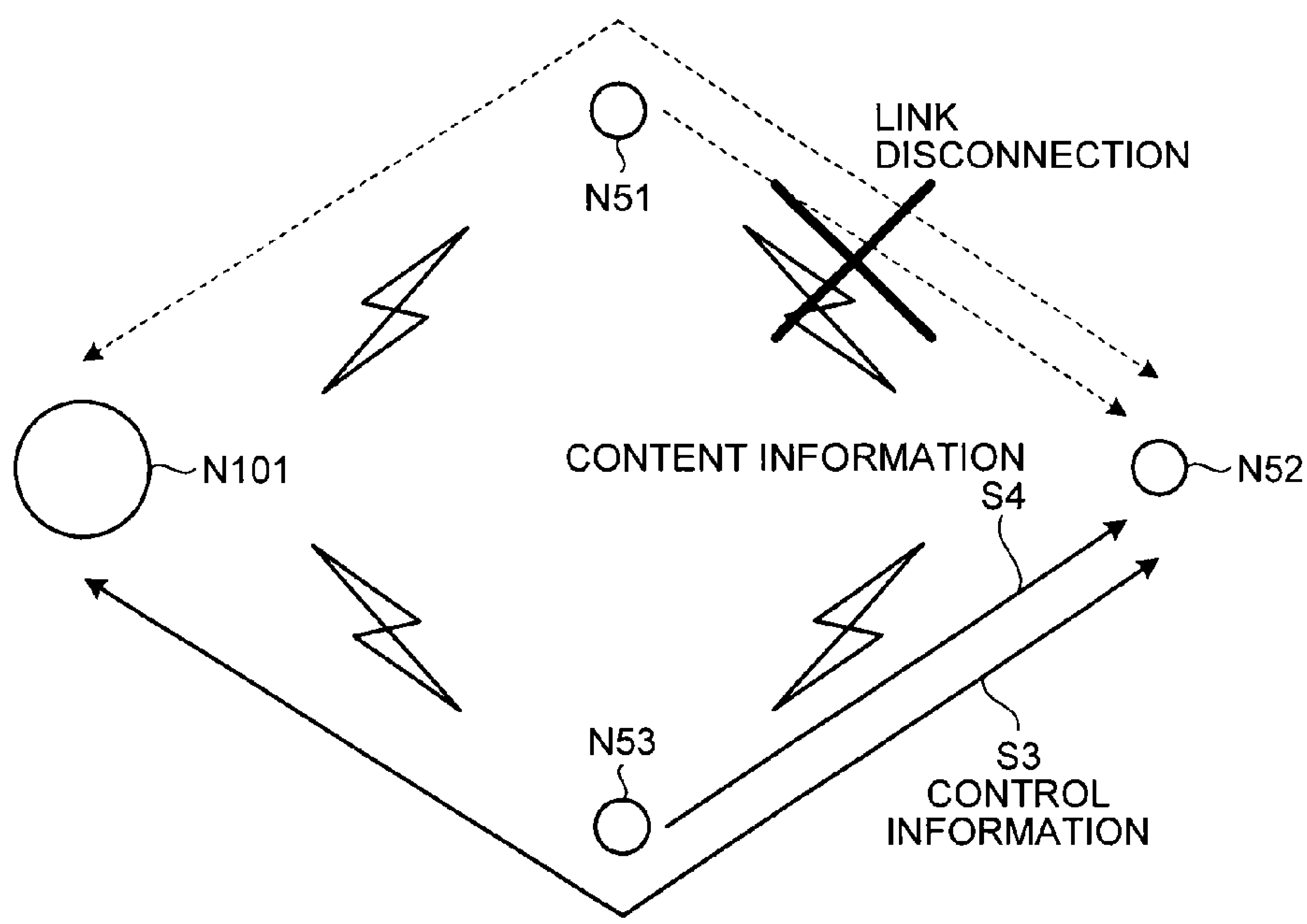

LINK
DISCONNECTION
N51
CONTENT INFORMATION
S4
N101
N52
N53
S3
CONTROL
INFORMATION

FIG.6

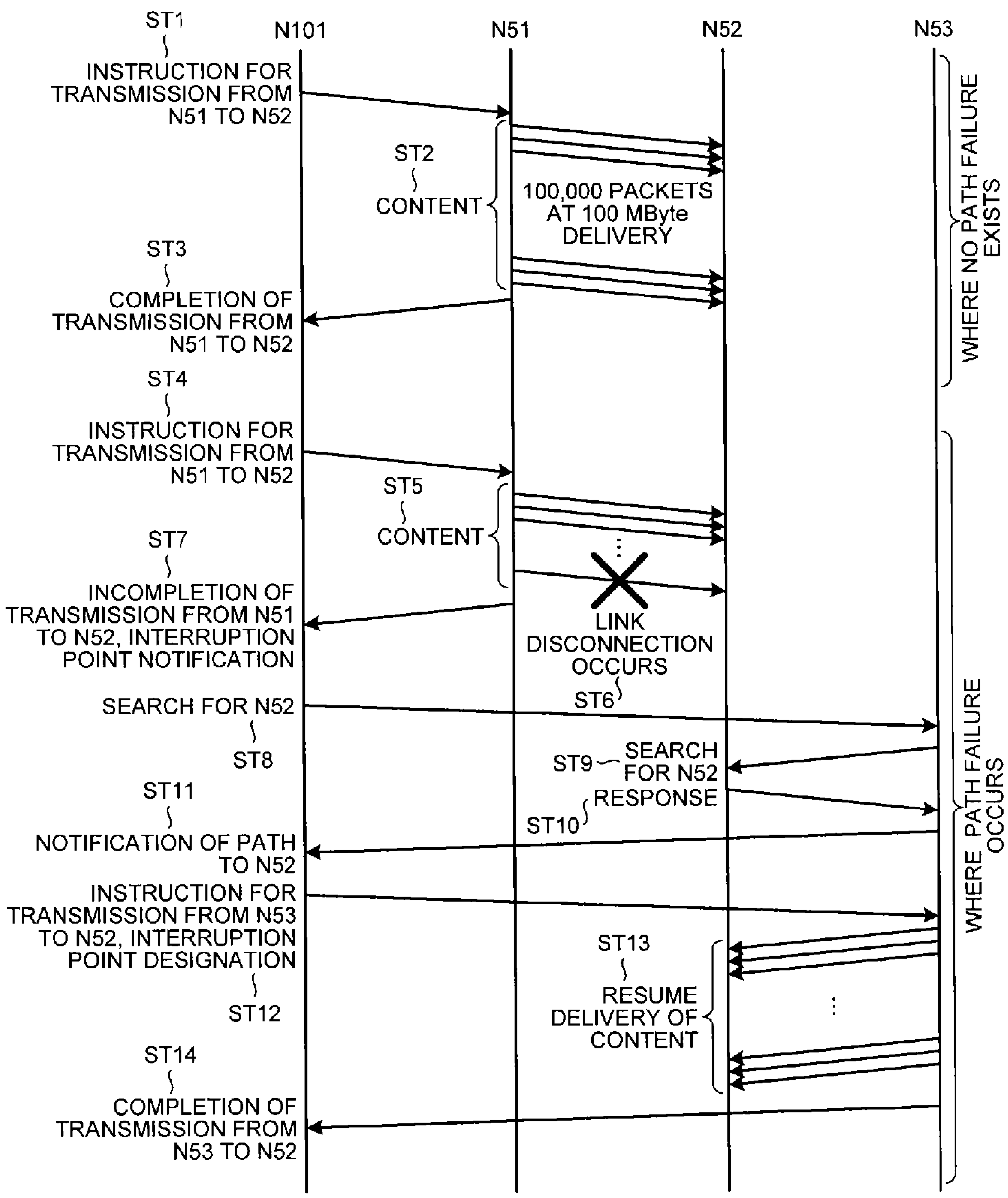

N101
N51
N52
N53
ST1
INSTRUCTION FOR TRANSMISSION FROM N51 TO N52
ST2
CONTENT
100,000 PACKETS AT 100 MByte DELIVERY
ST3
COMPLETION OF TRANSMISSION FROM N51 TO N52
WHERE NO PATH FAILURE EXISTS
ST4
INSTRUCTION FOR TRANSMISSION FROM N51 TO N52
ST5
CONTENT
ST7
INCOMPLETION OF TRANSMISSION FROM N51 TO N52, INTERRUPTION POINT NOTIFICATION
LINK DISCONNECTION OCCURS
ST6
SEARCH FOR N52
ST8
ST9
SEARCH FOR N52
RESPONSE
ST10
ST11
NOTIFICATION OF PATH TO N52
INSTRUCTION FOR TRANSMISSION FROM N53 TO N52, INTERRUPTION POINT DESIGNATION
ST12
ST13
RESUME DELIVERY OF CONTENT
ST14
COMPLETION OF TRANSMISSION FROM N53 TO N52
WHERE PATH FAILURE OCCURS

FIG.7

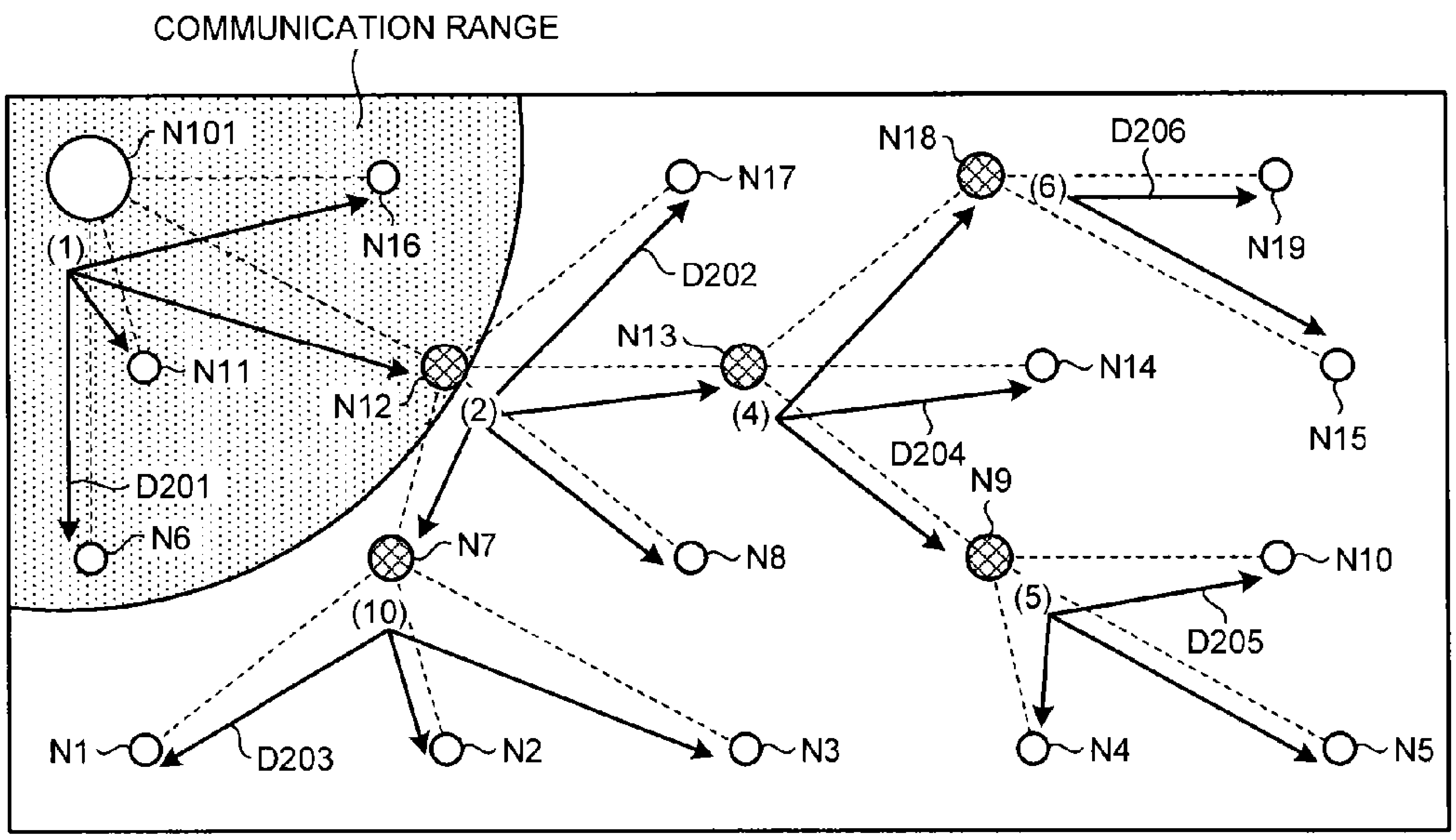

COMMUNICATION RANGE
N101
N16
(1)
N11
N12
D201
N6
N17
D202
N13
(2)
(4)
N14
N18
D206
(6)
N19
N15
D204
N9
N8
N7
N10
(5)
(10)
D205
N1
D203
N2
N3
N4
N5

FIG.8

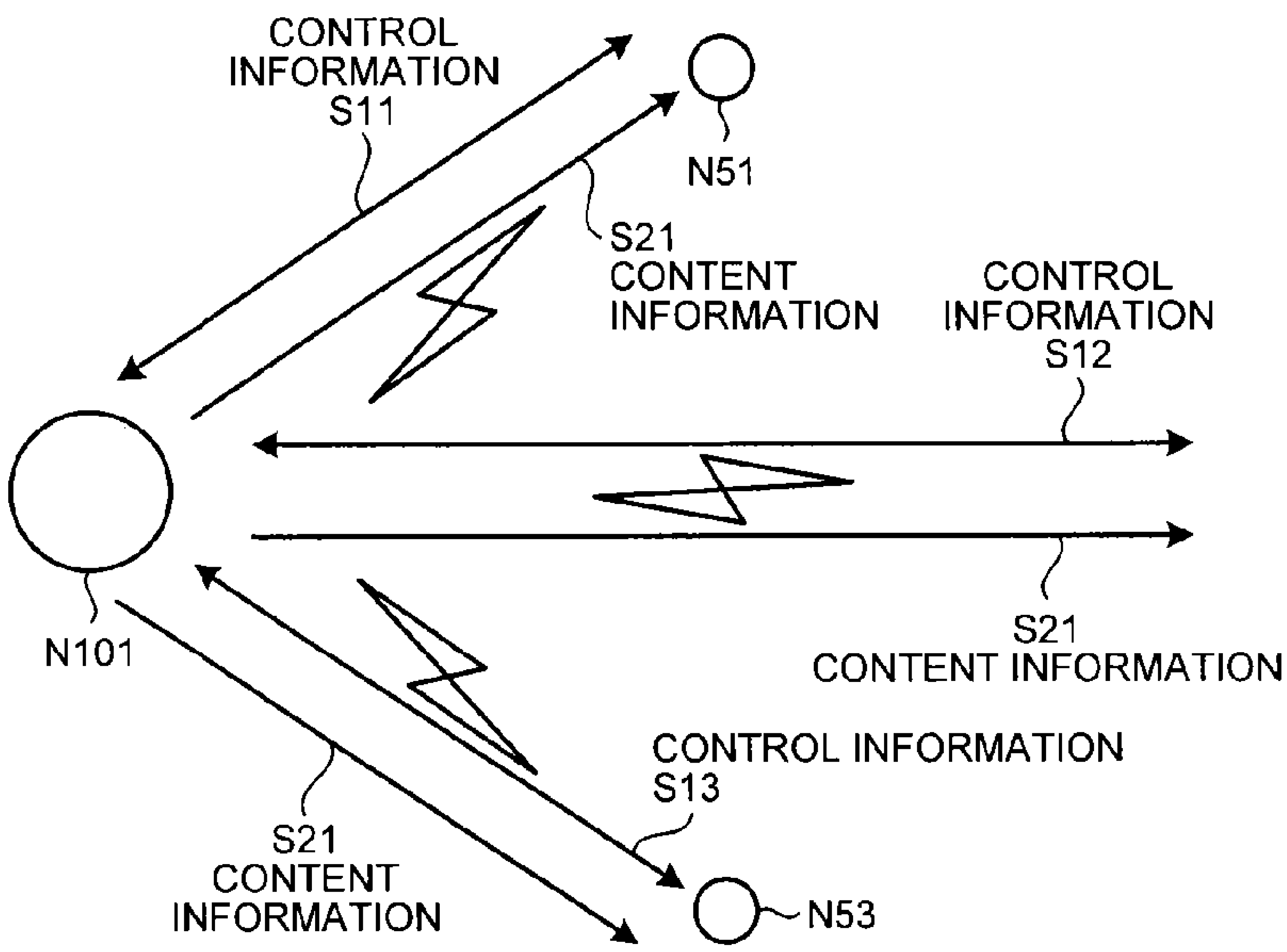

CONTROL
INFORMATION
S11
N51
S21
CONTENT
INFORMATION
CONTROL
INFORMATION
S12
N52
N101
S21
CONTENT INFORMATION
CONTROL INFORMATION
S13
S21
CONTENT
INFORMATION
N53

FIG.9

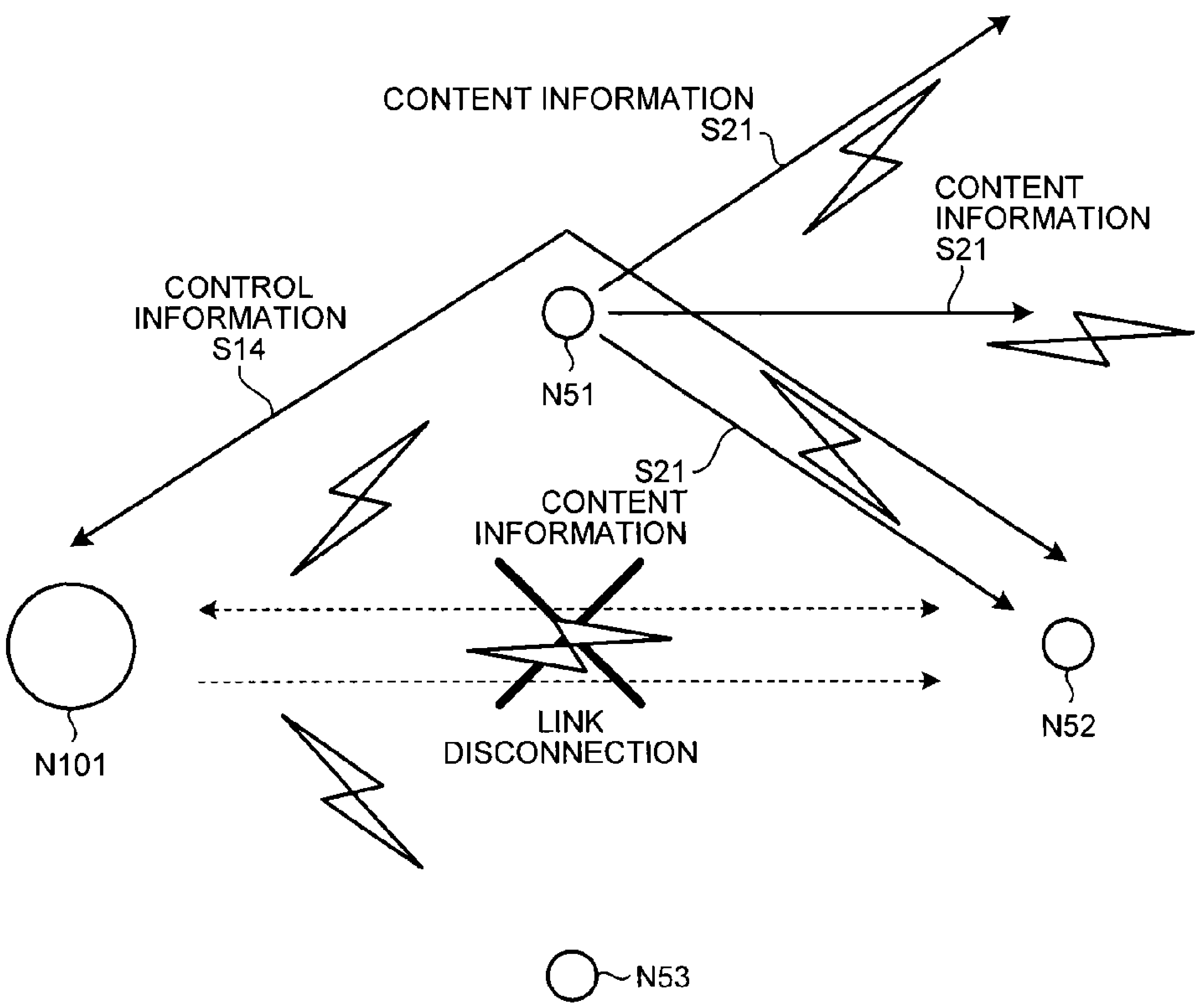
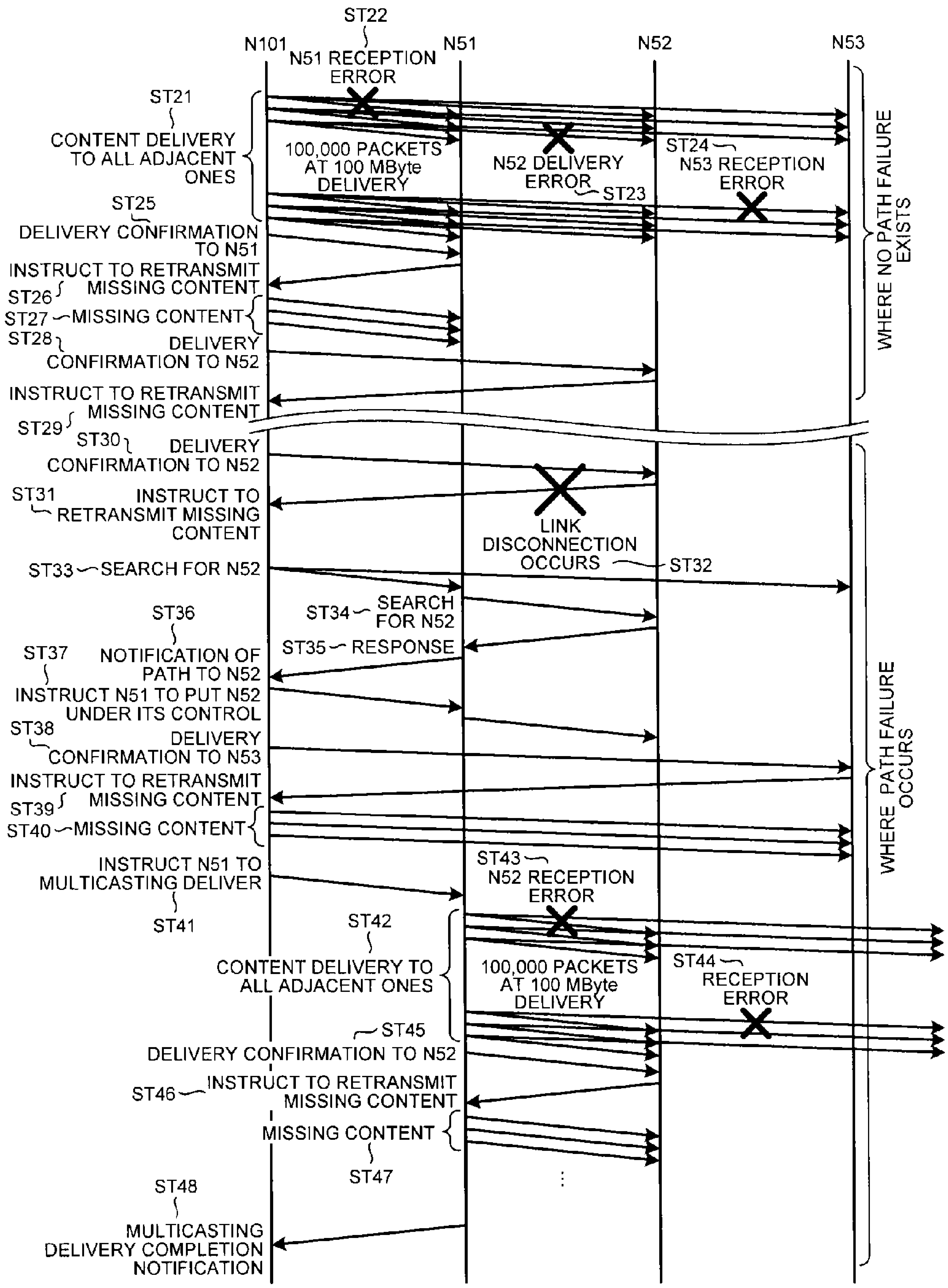

CONTENT INFORMATION
S21
CONTENT
INFORMATION
S21
CONTROL
INFORMATION
S14
N51
S21
CONTENT
INFORMATION
N101
LINK
DISCONNECTION
N52
N53

FIG.10


N101
N51
N52
N53
ST22
N51 RECEPTION ERROR
ST21
CONTENT DELIVERY TO ALL ADJACENT ONES
100,000 PACKETS AT 100 MByte DELIVERY
N52 DELIVERY ERROR
ST23
ST24
N53 RECEPTION ERROR
ST25
DELIVERY CONFIRMATION TO N51
INSTRUCT TO RETRANSMIT MISSING CONTENT
ST26
ST27
MISSING CONTENT
ST28
DELIVERY CONFIRMATION TO N52
INSTRUCT TO RETRANSMIT MISSING CONTENT
ST29
WHERE NO PATH FAILURE EXISTS
ST30
DELIVERY CONFIRMATION TO N52
ST31
INSTRUCT TO RETRANSMIT MISSING CONTENT
LINK DISCONNECTION OCCURS
ST32
ST33
SEARCH FOR N52
ST34
SEARCH FOR N52
ST35
RESPONSE
ST36
NOTIFICATION OF PATH TO N52
ST37
INSTRUCT N51 TO PUT N52 UNDER ITS CONTROL
ST38
DELIVERY CONFIRMATION TO N53
INSTRUCT TO RETRANSMIT MISSING CONTENT
ST39
ST40
MISSING CONTENT
INSTRUCT N51 TO MULTICASTING DELIVER
ST41
ST43
N52 RECEPTION ERROR
ST42
CONTENT DELIVERY TO ALL ADJACENT ONES
100,000 PACKETS AT 100 MByte DELIVERY
ST44
RECEPTION ERROR
ST45
DELIVERY CONFIRMATION TO N52
ST46
INSTRUCT TO RETRANSMIT MISSING CONTENT
MISSING CONTENT
ST47
ST48
MULTICASTING DELIVERY COMPLETION NOTIFICATION
WHERE PATH FAILURE OCCURS

DELIVERY SERVER, AND TERMINAL DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a content delivery system that delivers content.

2. Description of the Related Art

Conventionally, techniques such as signboards, posters, bulletin boards, showcases, and the distribution of handbills or pamphlets have been used as methods of displaying information to the general public. However, where substances such as printed literature or exhibits are involved, it has been difficult to achieve a change to content in a short time. In order to solve this problem, it has been proposed to change signboards, posters, or bulletin boards throughout town for display apparatuses to display according to the advertisement technique used in broadcasting, and in these years a market which is collectively referred to by the term “digital signage” is beginning to be formed. By means of the digital signage, information display can be effectively performed in the form of a product advertisement, a notice, a news report, information delivery, publicity, or so on in commercial facilities, downtown, public institutions, or so on, where many and unspecified people are expected to come and go.

As to the way to update content, while with some products, content is rewritten manually with use of a USB memory or an SD card, products which can deal with delivery via a network for the purpose of labor saving and instant updating are coming out. Further, products have come out which utilize radio such as WiMAX or WLAN in order to reduce the cost of laying network lines or relocating a network when changing layout (Non Patent Literature 1: Digital Signage White Paper 2011 by Digital Signage Consortium, Jun. 8, 2011, First Edition). Meanwhile, as to the radio technology, as a technology for extending communication distance to improve usability, multi-hop communication technology wherein terminals themselves perform relay, represented by ZigBee (registered trademark) or the like, has been being put into practical use.

For example, where digital signage terminals are installed in sales space in retail stores to perform advertisement, in order to use WLAN technology wherein terminals directly connect to a content delivery server that is an access point, digital signage terminals need to be installed within the communication range of the content delivery server. Accordingly, by combining it with the multi-hop communication technology, installation in places where direct connection cannot be made is enabled, and merits such as communication continuation due to path redundancy or the like can be enjoyed. By using this connection configuration to deliver content and schedule to be displayed to each digital signage terminal, the simplification of installation can be achieved.

SUMMARY OF THE INVENTION

However, according to the aforementioned conventional art, the content delivery server needs to deliver to digital signage terminals one by one sequentially. Hence, there is the problem that even without overhead such as a re-connection process due to radio communication disconnection at all, it takes a long delivery time to deliver a large amount of content. For example, if the method that delivers content after store hours is used, power supply cannot be turned off for that period, thus hindering saving energy and also taking personnel costs wastefully.

The present invention was made in view of the above facts, and an object thereof is to provide a content delivery system which can deliver content highly efficiently to a large number of digital signage terminals.

There is provided a content delivery system which comprises a delivery server and multiple terminal devices, the delivery server delivering content, the multiple terminal devices receiving delivery of the content, in the content delivery system connection between the delivery server and the terminal devices and connection between the terminal devices being made by radio, in the content delivery system the terminal devices being connected in multiple stages, wherein the delivery server instructs a terminal device which has received delivery of the content and which is connected to an other terminal device at the next stage to deliver content possessed by a self terminal device to the other terminal device, and wherein the instructed terminal device delivers content possessed by the self terminal device to the other terminal device and notifies the delivery result to the delivery server.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing a digital signage system which is a combination of WLAN technology with multi-hop communication technology.

FIG. **2** is a diagram showing the way to deliver content to each digital signage terminal.

FIG. **3** is a diagram showing communication paths in the content delivery system according to Embodiment 1.

FIG. **4** is a diagram showing delivery operation in normal case according to Embodiment 1.

FIG. **5** is a diagram showing delivery operation in a case of a link failure according to Embodiment 1.

FIG. **6** is a sequence diagram showing relay delivery operation according to Embodiment 1.

FIG. **7** is a diagram showing communication paths in the content delivery system according to Embodiment 2.

FIG. **8** is a diagram showing delivery operation in normal case according to Embodiment 2.

FIG. **9** is a diagram showing delivery operation in a case of a link failure according to Embodiment 2.

FIG. **10** is a sequence diagram showing relay delivery operation according to Embodiment 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the content delivery system according to the present invention will be described in detail below with reference to the drawings. Note that the embodiments are not intended to limit the present invention.

Embodiment 1

First, a digital signage system which is a combination of conventional WLAN technology with multi-hop communication technology will be described briefly. FIG. **1** is a diagram showing a digital signage system which is a combination of WLAN technology with multi-hop communication technology. FIG. **1** is an image where digital signage terminals are installed in sales space in a retail store to perform advertisement, and shows that where digital signage terminals use WLAN technology, wherein terminals directly connect to an access point (a content delivery server in FIG. **1**), digital signage terminals need to be installed within a fan-shaped range. By combining with multi-hop communication technology, installation in places where direct connection cannot be made is enabled, and merits such as communication continuation due to path redundancy or the like can be enjoyed. By using this connection configuration to deliver content and schedule to be displayed to each digital signage terminal, the simplification of installation can be achieved.

FIG. **2** is a diagram showing the way to deliver content to each digital signage terminal. A system is formed of a delivery server (hereinafter called a server) N**101** to deliver content and schedule and digital signage terminals (hereinafter called terminals) N**1** to N**19** that are terminal devices to receive delivery. In FIG. **2**, dotted lines indicate relations of connection by radio, and FIG. **2** shows, for example, that communication between the server N**101** and the terminal N**1** goes through the terminal N**6**.

Here, assuming conditions that the link speed of each radio communication is evenly at 5 Mbps and that the same content of 100 Mbytes in size is transmitted to each terminal, the delivery time will be calculated. With the conventional technology, if delivery is performed for the terminals N**1** to N**19** one by one sequentially through communication paths as indicated by D**1** to D**9**, which go halfway in the figure, it takes a delivery time of about 2 hours and 8 minutes as shown by the following equation (1) to finish delivering data to 19 terminals even without overhead such as a re-connection process due to radio communication disconnection at all.

$$48\ (\text{links})\times 100\ (\text{Mbytes})\times 8\ (\text{bits})\div 5\ (\text{Mbps})\div 3{,}600\ (\text{sec})\approx 2.133\ (\text{hours})\approx 2\ \text{hours and 8 minutes} \quad (1)$$

While there is a case where some contents are displayed only at a particular terminal depending on the type of the content, there is another case where the same content such as an advertisement of the retail store itself is displayed at multiple terminals. In a case where the time required for delivery is long as shown by the above equation (1), that is, where communication efficiency is low, for example, if the method that delivers content after store hours is used, power supply cannot be turned off for that period, thus hindering saving energy and taking personnel costs wastefully.

Further, with radio multi-hop communication, another problem caused by the low efficiency concerns path construction and maintenance. In the subject system, when a large amount of content, e.g., content of 100 Mbytes in size as assumed above is delivered, and 1,000 bytes are sent in one radio frame, the number of frames is calculated to be 100,000 from the equation (2) below. It is supposed that during the communication time required for as many as 100,000 frames, radio communication characteristics vary with each link due to fading or the like or that an obstacle gets in between terminals.

$$100\ (\text{Mbytes})\div 1{,}000\ (\text{bytes/frame})=100{,}000\ (\text{frames}) \quad (2)$$

In this case, the tasks are that the communication path needs to be reconstructed and that for a new path, with transmitted data being managed, communication needs to be continued from halfway.

Next, a system that highly efficiently delivers and relays content according to the present embodiment will be described. FIG. **3** is a diagram showing communication paths in the content delivery system according to the present embodiment. The reference numerals and arrangement of the server N**101** and the terminals N**1** to N**19** are the same as in FIG. **2** for making comparison with the conventional art easier.

The server N**101** to deliver content and schedule has a means that delivers content and schedule information, and a function that manages the presence of the terminals N**1** to N**19** to deliver to and information on paths through radio sections according to a routing protocol in advance of information delivery of content and schedule. Note that the type of the routing protocol does not matter.

The terminals N**1** to N**19** have a storage that stores content and schedule information, a mechanism and a function to respectively reproduce and display content according to the schedule information, a means that receives content and schedule by radio communication, and a function that relay-redelivers content and schedule information held in the storage in response to the reception of an instruction to relay.

The server N**101** performs delivery through communication paths D**101**, D**102**, D**103**, and D**104** for the terminals N**6**, N**11**, N**12**, and N**16** with which it can directly communicate. Then, the server N**101** instructs the terminal N**12** to deliver to the terminals N**7**, N**8**, N**13**, N**17** which can be communicated via the terminal N**12** through the communication paths D**105**, D**106**, D**107**, D**108** and performs delivery confirmation. The terminal N**12** delivers content and schedule stored in itself, but the server N**101** performs control associated with the communication as in a conventional delivery mechanism. Thus, the server N**101** can perform management to realize the terminals to which delivery has finished and to realize progress, if halfway through delivery, as in the conventional art.

Next, the operation of delivery and relay of content and the like in the content delivery system according to the present embodiment will be described. The server N**101** determines the order in which to deliver, for example, to deliver in the order of terminals N**6**, N**11**, N**12**, N**16**, N**7**, N**8**, . . . , N**15**, N**19** (the order indicated by numbers in open circles) as shown in FIG. **3**. The delivery order is an ascending order of from an adjacent one with a smallest number of hops, and in the case of the same number of hops, the terminal N**7** may transmit to the terminals N**1** to N**3** at one time, or the delivery order may be such a mixed order that, e.g., after the terminal N**7** transmits to the terminal N**1**, the terminal N**13** transmits to the terminal N**18**.

Here, the operation in the case where a link failure occurs during relay delivery because radio communication characteristics vary with each link due to fading or the like, or an obstacle gets in between terminals, or so on will be described using FIGS. **4** to **6**. FIG. **4** is a diagram showing delivery operation in normal case according to the present embodiment. FIG. **5** is a diagram showing delivery operation in the case of a link failure according to the present embodiment. FIG. **6** is a sequence diagram showing relay delivery operation according to the present embodiment.

In FIG. **4**, description will be made letting the server N**101** represent what serves as a server delivering content and schedule as above and using three terminals N**51**, N**52**, N**53** as digital signage terminals. The positional relation is that the server N**101** directly connects to the terminals N**51**, N**53** by radio and can connect to the terminal N**52** via the terminal N**51** or N**53**.

Further, in FIG. **4**, control information S**1** represents the contents of content information for the server N**101** to deliver to the terminal N**52**, an instruction to transmit, delivery confirmation, and a response. Content information S**2** represents specific information to be delivered to the terminal N**52** out of content and schedule information held in the storage of the terminal N**51**.

After finishing direct delivery of content and schedule to the terminals N**51**, N**53**, the server N**101** instructs the terminal N**51** to deliver content and schedule stored in the terminal N**51** to the terminal N**52**. This operation is shown in the upper part of FIG. **6** that is the case where no path failure exists.

Note that the arrows in FIG. **6** indicate a direction meaningful as information and that delivery confirmation in radio sections is omitted from the figure.

First, the server **N101** issues to the terminal **N51** an instruction that specifies the contents to be transmitted (step ST**1**). The instruction that specifies the contents to be transmitted may include a file name designation, frame numbers for dividing and managing content, and, e.g., a hash value obtained through a hash function to make management information be of a particular fixed length. The control information and the content information may be common across the system or encrypted on a per link basis.

The terminal **N51** relay-redelivers content and schedule information held in the storage (only the content is shown in FIG. **6**; hereinafter the same is true) to the terminal **N52** according to the transmission instruction (step ST**2**). Then, the terminal **N51** returns to the server **N101** the result of delivery to the terminal **N52** (here transmission completion) (step ST**3**). By this means, the server **N101** can manage the delivery status of the terminal **N52**.

Next, the case where an interruption (a path failure) occurs during relay redelivery from the terminal **N51** to the terminal **N52** is shown in FIG. **5** and the lower part of FIG. **6**. The server **N101** instructs the terminal **N51** to transmit (step ST**4**). While the terminal **N51** is relay-redelivering content and schedule information held in its storage to the terminal **N52** according to the transmission instruction (step ST**5**), a link disconnection occurs between the terminal **N51** and the terminal **N52** (step ST**6**). The terminal **N51** returns to the server **N101** a transmission incompletion notification and an interruption point notification instead of a transmission completion notification (step ST**7**). The interruption point designation in the interruption point notification may include a completely transmitted file name and an incompletely transmitted file name, frame numbers, a pointer position in the total size, or the like, by which the interruption point is identifiable.

In FIG. **5**, control information S**3** represents new-path information, the contents of content information for the terminal **N53** to deliver to the terminal **N52** and a transmission instruction, delivery confirmation, and a response. Content information S**4** is specific information to be delivered to the terminal **N52** out of content and schedule information held in the storage of the terminal **N53**.

The server **N101** searches for the terminal **N52** based on the incompletion notification (step ST**8**). FIGS. **5** and **6** show the case where the terminal **N53** responds that it can relay. In this case, the terminal **N53** searches for the terminal **N52** (step ST**9**); the terminal **N52** gives a response to the terminal **N53** (step ST**10**); and the terminal **N53** notifies the server **N101** of a path to the terminal **N52** (step ST**11**).

The server **N101** notifies the terminal **N53** of an instruction to deliver content subsequent to the interruption location, which the terminal **N52** does not possess (step ST**12**). The terminal **N53** relay-delivers missing content to the terminal **N52** (step ST**13**), and when completed, notifies the server **N101** of transmission completion (step ST**14**). In the above, after a link disconnection occurs between terminals, the server **N101** searches for an alternative path, but the present invention is not limited to this. If an alternative path is known beforehand, the server **N101** may try to communicate over the alternative path to see whether it is possible.

Although with FIGS. **4** to **6** description has been made with the server **N101** as a nucleus, the terminal **N12** relay-delivering and the terminals **N7**, **N13** and so on relaying in FIG. **3** operate likewise. For example, the terminal **N12** delivers according to a transmission instruction from the server **N101**, and if delivery is interrupted, returns the delivery result to the server **N101**. Then, the server **N101** searches for a new path, and a terminal instructed to relay-deliver over the new path, delivers the missing content out of content and schedule information held in its own storage for completion.

Here, when comparing the numbers of links involved in content delivery in the content delivery systems according to the conventional art and according to the present embodiment, there are 48 links for the conventional art (FIG. **2**), whereas the number of links is reduced to 19 links by omitting redundant paths for the present embodiment (FIG. **3**). Thus, as shown in the following equation (3), the delivery time can be reduced to about 51 minutes (about two fifths of that of the conventional art), which can be expected to lead to energy saving as well as efficient use of radio resources.

$$19\ (\text{links})\times 100\ (\text{Mbytes})\times 8\ (\text{bits})\div 5\ (\text{Mbps})\div 3{,}600\ (\text{sec})\approx 0.8444\ (\text{hour})\approx 51\ \text{minutes} \tag{3}$$

As described above, according to the present embodiment, in the content delivery system which performs a push type of multi-hop communication by radio, a digital signage terminal which has received content and the like delivered from the delivery server, relay-delivers content and the like held in itself to digital signage terminals at the next stage. The digital signage terminal which has relay-delivered notifies the delivery server of the delivery result, and thus the delivery server can realize the delivery status of each digital signage terminal. Hence, if relay delivery of content and the like is uncompleted due to the occurrence of a link disconnection during relay delivery between digital signage terminals, or so on, the delivery server instructs another digital signage terminal on an alternative path to relay-deliver anew. By this means, redundant links involved in content delivery can be reduced in number, thus realizing high efficient delivery. Further, taking into account overhead that occurs when a communication path is reconstructed because of the influence of radio communication characteristics of an individual link, by arranging for redundancy in delivery not to occur even in this case, high efficient delivery can be realized.

Embodiment 2

In this embodiment, a server and terminals perform multicasting delivery. The differences from Embodiment 1 will be described.

FIG. **7** is a diagram showing communication paths in the content delivery system according to the present embodiment. A server **N101** and terminals **N1** to **N19** have a transmit-receive function for multicasting communication. The type of multicasting communication may be communication simply using multicast addresses or communication wherein error correction by which the reception side can correct a frame error from multiple frames is carried out.

In the present embodiment, the server **N101** and terminals **N1** to **N19** use multicasting delivery for a range where they can simultaneously transmit and receive by radio communication. At the time of multicasting delivery, the server **N101** and terminals **N1** to **N19** set communication speed to match a terminal whose environment is the worst in order to select a common communication speed, and combine an error correction function for correcting bit errors in frames and an over-multi-frame error correction function which can correct even if frame loss occurs, and so on. Note that the server **N101** performs control related to communication as in Embodiment 1.

Next, the operation of delivery and relay of content and the like in the content delivery system according to the present embodiment will be described. The server **N101** performs a first delivery to the terminals **N6**, **N11**, **N12**, **N16** by multicasting communication as shown in FIG. **7**. After the completion of the first delivery from the server **N101**, the terminal **N12** performs delivery to the terminals **N7**, **N8**, **N13**, **N17** by multicasting communication. Then, the server **N101** determines the order in which to deliver, for example, such an order that, e.g., the terminal **N7** performs delivery to the terminals **N1**, **N2**, **N3** by multicasting communication, that the terminal **N13** performs delivery to the terminals **N9**, **N14**, **N18** by multicasting communication, and that finally the terminal **N18** performs delivery to the terminals **N15**, **N19** by multicasting communication. The order in which to deliver is an ascending order of from an adjacent one with a smallest number of hops.

Here, the operation in the case where a link failure occurs during relay delivery because radio communication characteristics vary with each link due to fading or the like or an obstacle gets in between terminals will be described using FIGS. **8** to **10**. FIG. **8** is a diagram showing delivery operation in normal case according to the present embodiment. FIG. **9** is a diagram showing delivery operation in the case of a link failure according to the present embodiment. FIG. **10** is a sequence diagram showing relay delivery operation according to the present embodiment.

In FIG. **8**, description will be made, letting the server **N101** represent as a server delivering content and schedule as above, and using three terminals **N51**, **N52**, **N53** as digital signage terminals. The present embodiment differs from Embodiment 1 in that they each can multicasting-communicate. The positional relation is that the server **N101** directly connects to the terminals **N51**, **N52**, **N53** by radio and can connect to the terminal **N52** via the terminal **N51** as well.

Further, in FIG. **8**, control information **S11** to **S13** represent the contents of content information for the server **N101** to deliver to the terminals **N51** to **N53** respectively, delivery confirmation, and retransmission control of missing frames. Content information **S21** represents information to be delivered by multicasting delivery out of content and schedule information held in the storage of the server **N101**.

The operation in the case where no path failure exists is shown in the upper part of FIG. **10**. Note that the arrows in FIG. **10** indicate a direction meaningful as information and that delivery confirmation in unicast communication in radio sections is omitted from the figure.

First, the server **N101** multicasting-delivers content and schedule information (only the content is shown in FIG. **10**; hereinafter the same is true) directly to the terminals **N51**, **N52**, **N53** (step ST**21**). Because the communication environment differs, the incorrect frame is different between the terminals **N51**, **N52**, **N53** (steps ST**22**, ST**23**, ST**24**). After the completion of content delivery to all the adjacent terminals, the server **N101** performs delivery confirmation sequentially on the terminals **N51**, **N52**, **N53**. If missing frames exist, the server **N101** performs retransmission individually to them, thereby completing delivery to all the adjacent terminals.

Specifically, the server **N101** performs delivery confirmation on the terminal **N51** (step ST**25**); the terminal **N51** instructs the server **N101** to retransmit missing content (step ST**26**); and the server **N101** retransmits the missing content to the terminal **N51** (step ST**27**). Likewise, the server **N101** performs delivery confirmation on the terminal **N52** (step ST**28**); the terminal **N52** instructs the server **N101** to retransmit missing content (step ST**29**); and the server **N101** retransmits the missing content to the terminal **N52** (not shown). Although not shown, the server **N101** performs the same process with the terminal **N53**. In the individual retransmission process, only an inquiry for missing frames may be made, and combined information of their missing frames may be multicasting-delivered again.

Next, the case where an interruption (a path failure) occurs during relay redelivery from the terminal **N51** to the terminal **N52** is shown in FIG. **9** and the lower part of FIG. **10**. The method of determining whether a path failure has occurred is, for example, to check whether there is no response to delivery confirmation, but the present invention is not limited to this.

The server **N101** searches for the terminal **N52** based on the fact that delivery confirmation is not obtained or an incompletion notification. In FIG. **10**, the server **N101** performs delivery confirmation on the terminal **N52** (step ST**30**), and the terminal **N52** instructs the server **N101** to retransmit missing content (step ST**31**). If the server **N101** fails to receive the instruction to retransmit missing content from the terminal **N52** because of the occurrence of a link disconnection (step ST**32**), the server **N101** searches for the terminal **N52** through the terminals **N51**, **N53** (step ST**33**).

In FIGS. **9** and **10**, the terminal **N51** responds that it can relay. The terminal **N51** searches for the terminal **N52** (step ST**34**); the terminal **N52** gives a response to the terminal **N51** (step ST**35**); and the terminal **N51** notifies the server **N101** of a path to the terminal **N52** (step ST**36**). Then, the server **N101** notifies the terminal **N51** of an instruction to put the terminal **N52** under the control for management (step ST**37**). The terminal **N51** notifies the same to the terminal **N52**.

Then, the server **N101** performs delivery confirmation on the terminal **N53** (step ST**38**); the terminal **N53** instructs the server **N101** to retransmit missing content (step ST**39**); and the server **N101** retransmits the missing content to the terminal **N53** (step ST**40**). After the completion of delivery to all the adjacent terminals, the server **N101** instructs the terminal **N51** having the terminal **N52** under its control to relay-multicasting deliver (step ST**41**).

The terminal **N51** multicasting-delivers content and schedule directly to the terminal **N52** and terminals not shown (step ST**42**). Because the communication environment differs, the incorrect frame is different between the terminal **N52** and the not-shown terminals (steps ST**43**, ST**44**). After the completion of content delivery to all the adjacent terminals, the terminal **N51** performs delivery confirmation sequentially on the terminal **N52** and the not-shown terminals. If missing frames exist, the terminal **N51** performs retransmission individually to them, thereby completing delivery to all the adjacent terminals.

Specifically, the terminal **N51** performs delivery confirmation on the terminal **N51** (step ST**45**); the terminal **N52** instructs the terminal **N51** to retransmit missing content (step ST**46**); and the terminal **N51** retransmits the missing content to the terminal **N52** (step ST**47**). Further, the terminal **N51** performs the same process with the not-shown terminals. Then, after retransmission of the missing content finishes, the terminal **N51** notifies the server **N101** of the completion of multicasting delivery (step ST**48**). As in Embodiment 1, in the individual retransmission process, only an inquiry for missing frames may be made, and combined information of their missing frames may be multicasting-delivered again.

Although with FIGS. **8** to **10** description has been made with the server **N101** as a nucleus, the terminal **N12** relay-delivering and the terminals **N7**, **N13** and so on relaying in FIG. **7** also operate likewise to deliver according to a transmission instruction from the server **N101** and, if a failure in the link with a terminal that should be under its control is detected, to give the delivery result to the server **N101** and thus to relay-deliver missing content out of content and schedule information held in their storage via a new path.

Here, when comparing the numbers of links involved in content delivery in the content delivery systems according to the conventional art and according to the present embodiment, there are 48 links for the conventional art (FIG. **2**), whereas the number of links is reduced to six times of multicasting delivery by omitting redundant paths for the present embodiment (FIG. **7**). Thus, as shown in the following equation (4), the delivery time can be reduced to about 24 minutes (about one fifth of that of the conventional art), which can be expected to lead to energy saving as well as efficient use of radio resources. Note that as to redundancy for multicasting delivery, calculation is made assuming overhead of 50% to occur because of the presence of the over-multi-frame error correction and control for individual retransmissions.

$$6\text{ (links)}\times1.5\text{ (redundancy)}\times100\text{ (Mbytes)}\times8\text{ (bits)}\div5\text{ (Mbps)}\div3{,}600\text{ (sec)}\approx0.4\text{ (hour)}=24\text{ minutes} \quad (4)$$

As described above, according to the present embodiment, in the content delivery system which performs a push type of multi-hop communication by radio, a delivery server and a digital signage terminal multicasting-deliver content and the like to digital signage terminals within a range where they can simultaneously transmit and receive by radio communication. By this means, redundant links involved in content delivery can be further reduced in number, thus realizing high efficient delivery as compared with Embodiment 1.

Embodiment 3

In this embodiment, multiple terminals perform delivery processes at the same time. The differences from Embodiments 1, 2 will be described.

In Embodiments 1, 2, the server N**101** manages terminals which perform delivery by radio communication such that one terminal delivers at a time, thus preventing interference by radio. However, if the space is known beforehand to be broad enough that radio waves do not interfere in the respective areas of, e.g., terminals N**7** and N**18** in FIG. **3**, two or more terminals may perform delivery processes in parallel at the same time.

The server N**101** finds out the amount of interference between the terminals in the network as well as managing network topology according to a routing protocol in advance of information delivery of content and schedule. When calculating the amount of interference, the server N**101** may automatically generate a test signal or allow a user to enter manually. Further, the server N**101** may perform calculation of received power using map information, or so on.

In FIG. **3**, if it is realized that the terminals N**7** and N**18** can simultaneously transmit/receive data without an adverse influence, the server N**101** performs a process to delay transmission to the terminal N**7** until transmission to the terminal N**18** as well as delivering in an ascending order of from an adjacent one with a smallest number of hops.

As described above, according to the present embodiment, in the content delivery system which performs a push type of multi-hop communication by radio, if it is known beforehand that radio waves do not interfere in the respective areas of terminals, two or more terminals perform delivery processes in parallel at the same time. This means can be expected to lead to further energy saving as well as further efficient use of radio resources as compared with Embodiments 1, 2.

Embodiment 4

In this embodiment, retransmission of missing content is performed depending on whether or not a relay delivery process is performed. The differences from Embodiment 2 will be described.

In Embodiment 2, at the time of relay redelivery, one terminal delivering finds out missing frames in terminals under the control of and managed by the one terminal and performs a redelivery process, and after the delivery process of all the content finish, one terminal delivering at the next stage performs the same process. Specifically, in FIG. **3**, after finishing deliver to terminals N**6**, N**11**, N**12**, N**16**, the server N**101** instructs the terminal N**12** to deliver to terminals N**7**, N**8**, N**13**, N**17** under its control. The server N**101** waits for a notification from the terminal N**12** that delivery to all the terminals has finished, and then instructs the terminal N**7** to deliver to terminals N**1**, N**2**, N**3** under its control.

In the present embodiment, the server N**101** or the terminals relay-redelivering, dissolve missing content for terminals having at least one terminal under their control and relaying, but delay dissolving missing content for terminals not relaying. For example, in a case where the server N**101** delivers, the terminals not relaying are terminals N**6**, N**11**, N**16**, and so on. Since there is a possibility that the terminals N**6**, N**11**, N**16** can receive radio signals from the terminals N**7**, N**12** relaying, they can utilize radio signals from the terminals N**7**, N**12** for missing content.

After the server N**101** and the terminals N**12**, N**7**, N**13**, N**9**, N**18** perform multicasting delivery in turn, the server N**101** performs delivery confirmation and the recovery of missing content individually on the terminals N**6**, N**11**, N**16**. Then, the server N**101** has the terminal N**12** perform delivery confirmation and the recovery of missing content individually on the terminals N**8**, N**17**.

As described above, according to the present embodiment, the server N**101** or the terminals relay-redelivering, dissolve missing content for terminals having at least one terminal under their control and relaying, but delay dissolving missing content for terminals not relaying. This means leads to further reducing overhead associated with content delivery and can be expected to lead to energy saving as well as efficient use of radio resources.

Embodiment 5

In Embodiments 1 to 4, description has been made of the case where common information is delivered to all the terminals. In the present embodiment, description will be made of the case where content necessary intrinsically for a particular terminal, content necessary intrinsically for multiple terminals categorized or grouped, or the like is delivered. The differences from Embodiments 1 to 4 will be described.

For example, in FIG. **3**, letting Ck(N(k)) be one of contents necessary for terminal Nk and C[Nk] be all the contents necessary (Ck(N(k)) ∊ C[Nk]), the contents necessary for terminal N1 are expressed as C[N1]{≡C**1**(**1**), C**1**(**2**), C**1**(**3**), . . . C**1**(**1**(*k*))}; the contents necessary for terminal N**2** are C[N**2**]≡{C**2**(**1**), C**2**(**2**), C**2** (**3**), . . . C**2**(**2**(*k*))}; and so on. In practice, it may happen that C**1**(**1**)=C**2**(**1**) as a content common to terminals N**1**, N**2**.

Further, letting C[Nk]<all the contents> denote all the contents possessed by terminal Nk, since terminal N**7** has a relay function, the contents which terminal N**7** possesses are the sum of the contents necessary for terminals N**1**, N**2**, N**3**, N**7**, that is, C[N**7**]<all the contents>=C[N**1**]∪ C[N**2**]∪ C[N**3**]∪ C[N**7**]. As such, the sum of the contents is possessed on the near-headstream side of the formed network, but by performing control where content to be delivered is reduced as going downstream, the effect of shortening the delivery time is obtained.

Content and the like is relay-delivered to the terminal N**7** from the terminal N**12**, but if a link failure occurs because radio communication characteristics vary with each link due to fading or the like or an obstacle gets in between terminals, the terminal **N7** receives deliver of content from the terminal **N6** or **N11** or so on as an alternative path in its neighborhood. Hence, the terminals **N6** and **N11** hold as much content for terminals not under their control which they can receive as possible. Specifically, if the terminal **N7** changes the path from the terminal **N12** to the terminal **N11**, with content to be held in the terminal **N11** being C[**N11**]<all the contents>=C [**N1**]∪ C[**N2**]∪ C[**N3**]∪ C[**N7**] ∪ C[**N11**], the server **N101** delivers the difference from what it was before the path change.

As described above, according to the present embodiment, when content necessary is different for each terminal, terminals relay-delivering possess the sum of the contents necessary for the terminals to deliver to. This means can be expected to reduce the time required for delivering content throughout the system by the effect of reducing the delivery time for unnecessary content and lead to energy saving as well as efficient use of radio resources.

According to the present invention, the effect of being able to deliver content highly efficiently to a large number of digital signage terminals is produced.

What is claimed is:

1. A delivery server in a content delivery system,

wherein the content delivery system uses a multi-hop communication technology to deliver content from the delivery server via a radio communication network to multiple terminal devices,

wherein the multiple terminal devices are located downstream from the delivery server on the radio communication network and connected in multiple stages,

wherein each of the multiple terminal devices comprises a storage configured to store the delivered content, and

wherein the multiple terminal devices include:

a first terminal device configured to receive the content from upstream in the radio communication network and store the received content in the storage device of the first terminal device; and

a second terminal device located one hop downstream from the first terminal device in the radio communication network,

wherein the delivery server is configured to:

instruct the first terminal device to deliver the content stored in the storage of the first terminal device to the second terminal device; and

manage a status of delivery of the content, based on information that is reported from the first terminal device and indicates a result of delivery of the content from the first terminal device to the second terminal device.

2. The delivery server according to claim **1**,

wherein when the delivery of the content from the first terminal device to the second terminal device is interrupted, the first terminal device reports, to the delivery server, the information indicating a delivery interruption and an interruption location in the content, and

wherein the delivery server is further configured to:

search for a new communication path to the second terminal device, in response to the information indicating the delivery interruption, and

instruct a third terminal device of the multiple terminal devices, which is located one hop upstream from the second terminal device on the new communication path, to deliver, to the second terminal device, a remaining part of the content following the interruption location and stored in the storage of the third terminal device.

3. The delivery server according to claim **1**,

wherein when the delivery of the content from the first terminal device to the second terminal device is interrupted, the first terminal device reports, to the delivery server, the information indicating a delivery interruption and an interruption location in the content, and

wherein the delivery server is further configured to:

hold an alternative communication path to the second terminal device; and

instruct, in response to the information indicating the delivery interruption, a third terminal device of the multiple terminal devices, which is located one hop upstream from the second terminal device on the alternative communication path, to deliver, to the second terminal device, a remaining part of the content following the interruption location and stored in the storage of the third terminal device.

4. The delivery server according to claim **1**,

wherein the delivery server is further configured to create radio connection relations between the delivery server and the multiple terminal devices and between the multiple terminal devices, by using at least one of a positional relation between the delivery server and the multiple terminal devices and a radio communication environment relation between the delivery server and the multiple terminal devices.

5. The delivery server according to claim **4**,

wherein the delivery server is further configured to use at least one of the positional relation and the radio communication environment relation to instruct two or more terminal devices of the multiple terminal devices to concurrently deliver the content stored in the respective storages of the two or more terminal devices.

6. The delivery server according to claim **1**,

wherein the delivery server is further configured to give priority to such a terminal device of the multiple terminal devices that is located upstream from another terminal device in the radio communication network, in regard to an order of delivering the content.

7. The delivery server according to claim **1**,

wherein the delivery server and each of the multiple terminal devices are configured to deliver the content by multicasting communication.

8. The delivery server according to claim **7**,

wherein the delivery server is further configured to perform delivery confirmation of the content after delivering the content to fourth terminal devices of the multiple terminal devices by the multicasting communication, and

wherein if some content is missing in any of the fourth terminal devices, the delivery server is further configured to redeliver the missing content to the any fourth terminal device.

9. The delivery server according to claim **7**,

wherein the delivery server is further configured to perform delivery confirmation of the content after delivering the content to fourth terminal devices of the multiple terminal devices by the multicasting communication, and

wherein if there is no response from any of the fourth terminal device, the delivery server is further configured to:

search for a new communication path to the any fourth terminal device; and

instruct a fifth terminal device of the multiple terminal devices, which is located one hop upstream from the any fourth terminal device on the new communication path, to deliver, by the multicasting communication, the content stored in the storage of the fifth terminal device to the any fourth terminal device.

10. The delivery server according to claim **7**,

wherein the first terminal device performs delivery confirmation of the content after delivering the content to the second terminal device by the multicasting communication,

wherein if the first terminal device reports, to the delivery server, the information indicating that there is no response from the second terminal device, the delivery server is further configured to:

search for a new communication path to the second terminal device; and

instruct a third terminal device of the multiple terminal devices, which is located one hop upstream from the second terminal device on the new communication path, to deliver, by the multicasting communication; the content stored in the storage of the third terminal device to the second terminal device.

11. A terminal device in a content delivery system,

wherein the content delivery system uses a multi-hop communication technology- to deliver content from a delivery server via a radio communication network to multiple terminal devices,

wherein the multiple terminal devices are located downstream from the delivery server on the radio communication network and connected in multiple stages,

wherein each of the multiple terminal devices comprises a storage configured to store the delivered content, and

wherein the multiple terminal devices include:

a first terminal device; as the terminal device, configured to receive the content from upstream in the radio communication network and store the received content in the storage device of the first terminal device; and

a second terminal device located one hop downstream from the first terminal device in the radio communication network,

wherein the terminal device as the first terminal device is further configured to:

receive a first instruction from the delivery server, the first instruction instructing the terminal device to deliver the content stored in the storage of the terminal device to the second terminal device;

deliver, in response to the first instruction; the content stored in the storage of the terminal device to the second terminal device; and

report, to the delivery server, information indicating a result of delivery of the content from the terminal device to the second terminal device.

12. The terminal device according to claim **11**,

wherein if the delivery of the content from the terminal device to the second terminal device is interrupted, the terminal device is further configured to report, to the delivery server, the information indicating a delivery interruption and an interruption location in the content,

wherein the delivery server searches for a new communication path to the second terminal device, in response to the information indicating the delivery interruption,

wherein the delivery server instructs a third terminal device of the multiple terminal devices, which is located one hop upstream from the second terminal device on the new communication path, to deliver, to the second terminal device, a remaining part of the content following the interruption location and stored in the storage of the third terminal device, and

wherein the third terminal device is configured to deliver, to the second terminal device, the remaining part of the content following the interruption location and stored in the storage of the third terminal device.

13. The terminal device according to claim **11**,

wherein if the delivery of the content from the terminal device to the second terminal device is interrupted, the terminal device is further configured to report, to the delivery server, the information indicating a delivery interruption and an interruption location in the content,

wherein the delivery server holds an alternative communication path to the second terminal device,

wherein the delivery server instructs, in response to the information indicating the delivery interruption, a third terminal device of the multiple terminal devices, which is located one hop upstream from the second terminal device on the alternative communication path, to deliver, to the second terminal device, a remaining part of the content following the interruption location and stored in the storage of the third terminal device, and

wherein the third terminal device is configured to deliver, to the second terminal device, the remaining part of the content following the interruption location and stored in the storage of the third terminal device.

14. The terminal device according to claim **11**,

wherein the first terminal device requires a first content including the content,

the second terminal device requires a second content including the content, and

the terminal device is further configured to store the first content and the second content in the storage.

15. The terminal device according to claim **11**,

wherein the delivery server and each of the multiple terminal devices are configured to deliver the content by multicasting communication.

16. The terminal device according to claim **15**,

wherein the terminal device is further configured to perform delivery confirmation of the content after delivering the content to the second terminal device by the multicasting communication; and

wherein if some content is missing in the second terminal device, the terminal device is further configured to redeliver the missing content to the second terminal device.

17. The terminal device according to claim **15**,

wherein the terminal device is further configured to perform delivery confirmation of the content after delivering the content to the second terminal device by the multicasting communication,

wherein if there is no response from the second terminal device, the terminal device is further configured to report, to the delivery server, the information indicating that there is no response from the second terminal device,

wherein the delivery server searches for a new communication path to the second terminal device,

wherein the delivery server instructs a third terminal device of the multiple terminal devices, which is located one hop upstream from the second terminal device on the new communication path, to deliver, by the multicasting communication, the content stored in the storage of the third terminal device to the second terminal device, and wherein the third terminal device is configured to deliver, by the multicasting communication, the content stored in the storage of the third terminal device to the second terminal device.

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