

DESCRIPTION

ESTIMATION APPARATUS AND WIRELESS SYSTEM

5 Field

[0001] The present invention relates to an estimation apparatus connected to a wireless concentrator, which configures a wireless mesh network, and a wireless system including the estimation apparatus.

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Background

[0002] In a wireless mesh (ad hoc) network that enables communication between wireless communication apparatus without using an existing network infrastructure, a variety of routing protocols (ad hoc routing protocols) are proposed (see Non Patent Literatures 1 and 2). In wireless systems in which the wireless mesh (ad hoc) network is used disclosed in Non Patent Literatures 1 and 2, to determine whether the wireless mesh (ad hoc) network is stably constructed and whether the system is stably operable, management of connection relations (topology) between wireless terminals was necessary. Therefore, in the wireless system disclosed in Non Patent Literature 1, all wireless terminals periodically perform transmission to one another, and thus all the wireless terminals realize sharing of information concerning connection relations.

[0003] In the wireless system disclosed in Non Patent Literature 1, a reduction in a memory size necessary for the wireless terminals is realized by using only a gate way as a terminal that finally manages the connection relation.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent Application
Laid-Open No. 2008-118351

Non Patent Literature

5 [0005] Non Patent Literature 1: T. Clausen, other three,
"The Optimized Link State Routing Protocol Version 2" IETF
RFC 7181.

Non Patent Literature 2: T. Winter, other nine,
"IPv6 Routing Protocol for Low-Power and Lossy Networks"
10 IETF RFC 6550

Summary

Technical Problem

[0006] When a wireless system configured by a wireless
15 mesh network is introduced into a building or a condominium,
it is necessary to investigate beforehand whether the
wireless mesh network is stably operable. In the wireless
system configured by the wireless mesh network disclosed in
Patent Literature 1 and Non Patent Literature 1, to
20 determine whether the wireless mesh network is stably
operable, it is necessary to collect connection relations
between all the wireless terminals. In the wireless system
configured by the wireless mesh network disclosed in Patent
Literature 1 and Non Patent Literature 1, it takes time to
25 collect the connection relations between all the wireless
terminals. It is likely that a long time is required to
determine whether the wireless mesh network is stably
operable.

[0007] The present invention has been achieved in view
30 of the above, and an object of the present invention is to
obtain an estimation apparatus that can reduce a time
required for determining whether a wireless system is
stably operable.

Solution to Problem

[0008] To solve the problems and achieve the object, according to an aspect of the present invention, there is
5 provided an estimation apparatus that acquires a connection relation of a wireless mesh in a wireless system in which the wireless mesh is configured by a plurality of wireless terminal units arranged along a row direction and a column direction and a wireless concentrator, the estimation
10 apparatus including: an information storing unit that stores disposition information of the plurality of wireless terminal units; an investigating unit that investigates inter-concentrator-terminal connection relations between some of the plurality of wireless terminal units and the
15 wireless concentrator and inter-terminal unit connection relations between some of the wireless terminal units; an investigation-result storing unit that stores, as an investigation result, the inter-concentrator-terminal connection relations and the inter-terminal unit connection
20 relations investigated by the investigating unit; and an estimating unit that estimates, on the basis of the investigation result and the disposition information, connection relations between uninvestigated wireless terminal units of the wireless terminal units, the inter-
25 terminal unit connection relations of which cannot be investigated, from the inter-terminal unit connection relations of the wireless terminal units, the investigation result of which is present, among the wireless terminal units having same disposition relations as disposition
30 relations of the uninvestigated wireless terminal units.

Advantageous Effects of Invention

[0009] The estimation apparatus according to the present

invention achieves an effect that it is possible to reduce a time necessary for determining whether a wireless system is stably operable.

5 Brief Description of Drawings

[0010] FIG. 1 is a diagram showing a configuration example of a wireless system including a host apparatus according to the present invention.

10 FIG. 2 is a functional block diagram showing the configuration of the host apparatus shown in FIG. 1.

FIG. 3 is a configuration diagram showing the configuration of the host apparatus shown in FIG. 1.

FIG. 4 is a functional block diagram showing the configuration of a wireless concentrator shown in FIG. 1.

15 FIG. 5 is a configuration diagram showing the configuration of the wireless concentrator showing in FIG. 1.

FIG. 6 is a functional block diagram showing the configuration of a wireless terminal unit shown in FIG. 1.

20 FIG. 7 is a configuration diagram showing the configuration of the wireless terminal unit shown in FIG. 1.

FIG. 8 is a diagram showing an example of a table stored by an uplink-routing storing unit of the wireless concentrator shown in FIG. 4.

25 FIG. 9 is a diagram showing an example of disposition information of a structure in which the wireless system shown in FIG. 1 is set.

FIG. 10 is a schematic diagram showing a configuration example of a wireless mesh network of the wireless system shown in FIG. 1.

30 FIG. 11 is an explanatory diagram showing a state in which the host apparatus shown in FIG. 1 transmits an investigation message to a wireless terminal unit in a room

No. 302.

FIG. 12 is an explanatory diagram showing a state in which the wireless terminal unit in the room No. 302 shown in FIG. 11 transmits a peripheral search message.

5 FIG. 13 is an explanatory diagram showing a state in which wireless terminal units in rooms around the room No. 302 shown in FIG. 12 transmit search response messages.

FIG. 14 is an explanatory diagram showing a state in which the wireless terminal unit in the room No. 302 shown
10 in FIG. 13 transmits a result message to the wireless concentrator.

FIG. 15 is a diagram showing an example of a time chart showing a method in which the host apparatus shown in FIG. 1 investigates connection relations between the
15 wireless terminal unit in the room No. 302 and other wireless terminal units.

FIG. 16 is a diagram showing an example of a message format of the investigation message transmitted to the wireless concentrator by the host apparatus shown in FIG.
20 11.

FIG. 17 is a diagram showing an example of a message format of the investigation message transmitted to the wireless terminal units by the wireless concentrator shown in FIG. 11.

25 FIG. 18 is a diagram showing an example of a message format of the peripheral search message shown in FIG. 12.

FIG. 19 is a diagram showing an example of a message format of the search response message shown in FIG. 13.

FIG. 20 is a diagram showing an example of a message
30 format of the result message transmitted to the wireless concentrator by the wireless terminal unit in the room No. 302 shown in FIG. 14.

FIG. 21 is a diagram showing an example of a message

format of the result message transmitted to the host apparatus by the wireless concentrator shown in FIG. 14.

FIG. 22 is a diagram showing the wireless terminal units capable of performing wireless communication with the wireless terminal unit in the room No. 302 based on the
5 result message shown in FIG. 14.

FIG. 23 is a diagram showing an investigation result of the wireless terminal unit in the room No. 302 stored in an investigation-result storing unit on the basis of the
10 result message shown in FIG. 14.

FIG. 24 is a flowchart for the host apparatus of the wireless system shown in FIG. 1 to determine possibility of construction of a wireless mesh in the wireless system.

FIG. 25 is a diagram showing a result obtained by
15 investigating connection relations between the wireless concentrator and the wireless terminal units at step ST101 shown in FIG. 24.

FIG. 26 is a diagram showing connection relations between the wireless concentrator and the wireless terminal
20 units stored by the investigation-result storing unit of the host apparatus at step ST101 shown in FIG. 24.

FIG. 27 is a flowchart for the host apparatus to carry out an investigation of connection relations between the wireless terminal units at step ST102 shown in FIG. 24.

FIG. 28 is a diagram showing a result obtained by
25 investigating connection relations between a closest wireless terminal unit, which is the wireless terminal unit closest to the wireless concentrator, and the other wireless terminal units at step ST201 shown in FIG. 27.

FIG. 29 is a diagram showing connection relations
30 between the closest wireless terminal unit and the other wireless terminal units stored by the investigation-result storing unit of the host apparatus at step ST203 shown in

FIG. 27.

FIG. 30 is a diagram showing a result obtained by investigating connection relations between a closest wireless terminal unit between the wireless terminal units that have responded at step ST202 and the other wireless terminal units at step ST204 shown in FIG. 27.

FIG. 31 is a diagram showing the investigation result shown in FIG 30 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1.

FIG. 32 is a diagram showing an investigation result of connection relations between an investigation target wireless terminal unit and the other wireless terminal units at step ST205 shown in FIG. 27.

FIG. 33 is a diagram showing the investigation result of FIG. 32 stored by the investigation-result storing unit of the host apparatus showing in FIG. 1.

FIG. 34 is a flowchart for the host apparatus to estimate connection relations between uninvestigated wireless terminal units, connection relations of which are unknown, and the other wireless terminal units at step ST103 shown in FIG. 24.

FIG. 35 is a diagram showing a result obtained by estimating connection relations between a wireless terminal unit in a room No. 101 and the other wireless terminal units at step ST301 shown in FIG. 34.

FIG. 36 is a diagram showing the estimation result shown in FIG. 35 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1.

FIG. 37 is a diagram showing a result obtained by estimating connection relations between a wireless terminal unit in a room No. 103 and the other wireless terminal units at step ST301 shown in FIG. 34.

FIG. 38 is a diagram showing the estimation result

shown in FIG. 37 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1.

FIG. 39 is a diagram showing a result obtained by estimating connection relations between wireless terminal
5 units in the room No. 103 and a room No. 201 and the other wireless terminal units at step ST301 shown in FIG. 34.

FIG. 40 is a diagram showing the estimation result shown in FIG. 39 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1.

10 FIG. 41 is a diagram showing a result obtained by estimating connection relations between uninvestigated wireless terminal units at step ST301 shown in FIG. 34.

FIG. 42 is a diagram showing the estimation result shown in FIG. 41 stored by the investigation-result storing
15 unit of the host apparatus shown in FIG. 1.

FIG. 43 is a diagram showing an investigation result of connection relations of a host-apparatus processing unit of a host apparatus of a wireless system in a second embodiment.

20 FIG. 44 is a diagram showing the investigation result shown in FIG. 43 stored by an investigation-result storing unit of the host apparatus shown in FIG. 43.

FIG. 45 is a diagram showing an investigation result at the time when a wireless terminal unit in a room No. 205
25 of the wireless system shown in FIG. 43 is set as an additional investigation target.

FIG. 46 is a diagram showing the investigation result shown in FIG. 45 stored by the investigation-result storing unit of the host apparatus shown in FIG. 43.

30 FIG. 47 is a diagram showing an estimation result of connection relations of wireless terminal units, connection relations of which are unknown, based on the investigation result shown in FIG. 45.

FIG. 48 is a diagram showing the investigation result shown in FIG. 47 stored by the investigation-result storing unit of the host apparatus shown in FIG. 43.

FIG. 49 is a diagram showing disposition information
5 stored by a disposition-information storing unit of a host apparatus of a wireless system in a third embodiment.

Description of Embodiments

[0011] Host apparatuses, which are estimation
10 apparatuses, and wireless systems according to embodiments of the present invention are explained below in detail with reference to the drawings. Note that the present invention is not limited by the embodiments.

[0012] First Embodiment.

15 FIG. 1 is a diagram showing a configuration example of a wireless system including a host apparatus according to the present invention. FIG. 2 is a functional block diagram showing the configuration of the host apparatus shown in FIG. 1. FIG. 3 is a configuration diagram showing
20 the configuration of the host apparatus shown in FIG. 1. FIG. 4 is a functional block diagram showing the configuration of a wireless concentrator shown in FIG. 1. FIG. 5 is a configuration diagram showing the configuration of the wireless concentrator shown in FIG. 1. FIG. 6 is
25 a functional block diagram showing the configuration of a wireless terminal unit shown in FIG. 1. FIG. 7 is a configuration diagram showing the configuration of the wireless terminal unit shown in FIG. 1. FIG. 8 is a diagram showing an example of a table stored by an uplink-
30 routing storing unit of the wireless concentrator shown in FIG. 4. FIG. 9 is a diagram showing an example of disposition information of a structure in which the wireless system shown in FIG. 1 is set. FIG. 10 is a

schematic diagram showing a configuration example of a wireless mesh network of the wireless system shown in FIG. 1.

[0013] As shown in FIG. 1, a wireless system 1 in this
5 embodiment is a system that is set in a structure 100
serving as a sensing target, an example of which is shown
in FIG. 9, and collects and stores a detection result
detected by sensors 14 respectively set in rooms 102 of the
structure 100. The structure 100 shown in FIG. 9 includes
10 one control room 101 and a plurality of rooms 102. The
control room 101 is disposed in any position in, for
example, a first floor of the structure 100. However, the
position of the control room 101 is not limited. In the
first embodiment, the rooms 102 are arranged along an X-
15 axis direction, which is a row direction parallel to the
horizontal direction, and a Y-axis direction, which is a
column direction parallel to the vertical direction and
orthogonal to the X-axis direction. In the first
embodiment, five rooms 102 are arranged in the X-axis
20 direction and five rooms 102 are arranged in the Y-axis
direction. The number of the rooms 102 is not limited.
The number of the rooms 102 in the X-axis direction and the
number of the rooms 102 in the Y-axis direction can be
different.

25 [0014] The structure 100 in the first embodiment is a
five-story structure. In the following description, the
rooms 102 in the first floor are referred to as rooms No.
101 to No. 105 in order from the room No. 101 and the rooms
102 in the second floor are referred to as rooms No. 201 to
30 No. 205 in order from the room No. 201. The structure 100
includes the rooms 102 of the room No. 101 to the room No.
505. Note that, in the following description, in this
specification, among components of the wireless system 1, a

component set in the room 102, a number of which is clear, is indicated by a sign of a wireless terminal unit, which is the component, and a room number and a component set in the room 102, a number of which is unclear, is indicated by
5 only a sign of a wireless terminal unit, which is the component.

[0015] The wireless system 1 set in the structure 100 includes, as shown in FIG. 1, sensors 14 disposed in the rooms 102, a plurality of wireless terminal units 13
10 arranged along the X-axis direction and the Y-axis direction, a wireless concentrator 12 that is disposed in the control room 101, performs wireless communication with the wireless terminal units 13, and collects and stores detection results of the sensors 14, and a host apparatus
15 11, which is an estimation apparatus that is connected to the wireless concentrator 12 and acquires a connection relation of a wireless mesh M in the wireless system 1. In the wireless system 1, as shown in FIG. 10, the wireless mesh M is configured by wireless links 2 that connect the
20 wireless terminal units 13 and the wireless concentrator 12 and wireless links 2 that connect the wireless terminal units 13. That is, in the wireless system 1, the wireless mesh M is configured by the wireless terminal units 13 and the wireless concentrator 12.

[0016] The sensors 14 disposed in the rooms 102 detect at least one of temperature, humidity, and air pressure in the rooms 102 and transmit detection results to the wireless terminal units 13. The sensors 14 can detect at least one of electric power and quantities of water used in
30 the rooms 102 and transmit detection results to the wireless terminal units 13.

[0017] The wireless terminal units 13 are disposed in the rooms 102. The wireless terminal unit 13 transmits the

detection result of the sensor 14 to the wireless concentrator 12 and wirelessly transmits a message received from the wireless concentrator 12 to the other wireless terminal units 13. The wireless terminal unit 13 specifically includes, as shown in FIG. 6, a wireless communication unit 1301 and an antenna 1302 for wirelessly communicating with the wireless concentrator 12 and the other wireless terminal units 13, a terminal processing unit 1303 that controls the wireless communication and acquires data from the sensor 14, and a routing storing unit 1304 that stores a route to the wireless concentrator 12.

[0018] The wireless communication unit 1301 transmits and receives a radio signal between the wireless communication unit 1301 and the wireless concentrator 12 and the other wireless terminal units 13 via an antenna 1302. The terminal processing unit 1303 controls the wireless communication of the wireless communication unit 1301. The terminal processing unit 1303 determines on the basis of a message received by the wireless communication unit 1301 whether the wireless terminal unit 13 is designated as a via-destination of the message. When determining that the wireless terminal unit 13 is designated as the via-destination of the message, the terminal processing unit 1303 transmits the message to the wireless communication unit 1301 of the wireless terminal unit 13, which is the next via-destination.

[0019] In the first embodiment, in the wireless system 1, as shown in FIG. 10, the wireless terminal units 13 are connected by the wireless links 2. In the first embodiment, in some case, the terminal processing unit 1303 of the wireless terminal unit 13-102 disposed in the room No. 102 is designated as a via-destination of the message and it is

determined that a transmission destination is the wireless terminal unit 13-302. Then, the terminal processing unit 1303 of the wireless terminal unit 13-102 transmits the message to the wireless terminal unit 13-302, which is the transmission destination.

[0020] The routing storing unit 1304 of the wireless terminal unit 13 manages a communication route to the wireless concentrator 12. The routing storing unit 1304 of the wireless terminal unit 13 stores via-destinations for causing the message to reach the wireless concentrator 12. Specifically, the routing storing unit 1304 stores the wireless terminal units 13, via which the message is transmitted, to cause the message to reach the wireless concentrator 12 through the wireless link 2 shown in FIG. 10.

[0021] In the first embodiment, when the wireless terminal unit 13-104 communicates with the wireless concentrator 12, the wireless terminal unit 13-104 refers to the routing storing unit 1304 and extracts the wireless terminal unit 13-103, which is a via-destination of the message. The terminal processing unit 1303 of the wireless terminal unit 13-104 transmits the message to the wireless terminal unit 13-103. Similarly, the wireless terminal unit 13-103 refers to the routing storing unit 1304 and transmits the message to the wireless concentrator 12.

[0022] The wireless terminal unit 13 is configured by, as shown in FIG. 7, a wireless transceiver 1305 that is connected to the antenna 1302 and performs wireless communication, a CPU (Central Processing Unit) 1306 that executes a control program, a ROM (Read Only Memory) 1307 that stores the control program, a RAM (Random Access Memory) 1308 used as a work area of the CPU 1306, and a nonvolatile memory 1309 in which data indicating a

detection result of the sensor 14 is written by the CPU 1306.

[0023] The wireless communication unit 1301 is realized by the wireless transceiver 1305. The wireless transceiver 5 1305 transmits, through the antenna 1302, data received from the CPU 1306 and the antenna 1302 transfers the received data to the CPU 1306, whereby the function of the wireless communication unit 1301 is realized. The terminal processing unit 1303 is realized by the CPU 1306, the RAM 10 1308, and the ROM 1307. The CPU 1306 reads the control program stored in the ROM 1307 and executes the control program in the work area of the RAM 1308, whereby the function of the terminal processing unit 1303 is realized. The routing storing unit 1304 is realized by the ROM 1307. 15 The ROM 1307 stores the wireless terminal units 13, via which data is transmitted to the wireless concentrator 12, whereby the function of the routing storing unit 1304 is realized. A plurality of processing circuits can cooperate to realize the functions of the wireless communication unit 20 1301, the terminal processing unit 1303, and the routing storing unit 1304.

[0024] The wireless concentrator 12 is disposed in the control room 101 of the structure 100. Only one wireless concentrator 12 is provided in the structure 100. The 25 wireless concentrator 12 includes, as shown in FIG. 4, a communication unit 1201 for communicating with the host apparatus 11, a concentrator processing unit 1202 that performs processing for configuring the wireless system 1, a wireless communication unit 1203 and an antenna 1204 for 30 performing wireless communication with the wireless terminal units 13, an uplink-routing-table storing unit 1205 that retains communication routes from the wireless concentrator 12 to the wireless terminal units 13, and a

sensor-data storing unit 1206 that stores a detection result of the sensor 14 received from the wireless terminal units 13.

[0025] The communication unit 1201 is connected to the host apparatus 11 by wire. The wireless communication unit 1203 transmits and receives radio signals between the wireless communication unit 1203 and the wireless terminal unit 13 via the antenna 1204. The concentrator processing unit 1202 controls wireless communication of the wireless communication unit 1203. The uplink-routing-table storing unit 1205 manages communication routes to the wireless terminal units 13. The uplink-routing-table storing unit 1205 stores a table indicating the wireless terminal units 13 functioning as via-destinations such that the wireless concentrator 12 wirelessly communicates with the wireless terminal units 13. Specifically, the uplink-routing-table storing unit 1205 stores connection relations between the wireless terminal units 13 by the wireless link 2 shown in FIG. 10. As shown in FIG 8, the table stored in the uplink-routing-table storing unit 1205 associates the wireless terminal units 13 and the wireless terminal units 13 functioning as the via-destinations. The table shown in FIG. 8 indicates that, when the wireless concentrator 12 wirelessly communicates with the wireless terminal unit 13-502, the wireless terminal unit 13-102 and the wireless terminal unit 13-302 are set as via-destinations.

[0026] In the first embodiment, when communicating with the wireless terminal unit 13-502, the wireless concentrator 12 refers to the uplink-routing-table storing unit 1205 and extracts the wireless terminal unit 13-102 and the wireless terminal unit 13-302 as via-destinations. The concentrator processing unit 1202 of the wireless concentrator 12 designates the wireless terminal unit 13-

102 and the wireless terminal unit 13-302 as via-destinations and transmits a message to the wireless terminal unit 13-102.

[0027] The wireless concentrator 12 is configured by, as
5 shown in FIG. 5, an IF (Interface) 1207 for communication,
a wireless transceiver 1208 that is connected to the
antenna 1204 and performs wireless communication, a CPU
(Central Processing Unit) 1209 that executes a control
program, a ROM (Read Only Memory) 1210 that stores the
10 control program, a RAM (Random Access Memory) 1211 used as
a work area of the CPU 1209, and a nonvolatile memory 1212
in which data indicating a detection result of the sensor
14 is written by the CPU 1209.

[0028] The communication unit 1201 is realized by the IF
15 1207. The IF 1207 communicates with the host apparatus 11,
whereby the function of the communication unit 1201 is
realized. The wireless communication unit 1203 is realized
by the wireless transceiver 1208. The wireless transceiver
1208 transmits data received from the CPU 1209 through the
20 antenna 1204 and the antenna 1204 transfers the received
data to the CPU 1209, whereby the function of the wireless
communication unit 1203 is realized. The concentrator
processing unit 1202 is realized by the CPU 1209, the RAM
1211, and the ROM 1210. The CPU 1209 reads the control
25 program stored in the ROM 1210 and executes the control
program in the work area of the RAM 1211, whereby the
function of the concentrator processing unit 1202 is
realized. The uplink-routing-table storing unit 1205 is
realized by the ROM 1210. The ROM 1210 stores the table
30 shown in FIG. 8, whereby the function of the uplink-
routing-table storing unit 1205 is realized. The sensor-
data storing unit 1206 is realized by the nonvolatile
memory 1212. The data indicating the detection result of

the sensor 14 is written in the memory 1212 by the CPU 1209, whereby the function of the sensor-data storing unit 1206 is realized. A plurality of processing circuits can cooperate to realize the functions of the communication unit 1201, the concentrator processing unit 1202, the wireless communication unit 1203, the uplink-routing-table storing unit 1205, and the sensor-data storing unit 1206.

[0029] When the wireless system 1 is introduced into the structure 100, the host apparatus 11 investigates an inter-concentrator-terminal connection relation between the wireless terminal units 13 and the wireless concentrator 12 and an inter-terminal unit connection relation between the wireless terminal units 13 and determines possibility of construction of the wireless mesh M from the inter-concentrator-terminal connection relation and the inter-terminal unit connection relation. The host apparatus 11 includes, as shown in FIG. 2, a communication unit 1101 for communicating with the wireless concentrator 12 and a disposition-information storing unit 1103, which is an information storing unit that stores disposition information of the wireless terminal units 13. The host apparatus 11 includes, as shown in FIG. 2, a host-apparatus processing unit 1102, which is an investigating unit that investigates, on the basis of the disposition information of the wireless terminal units 13 stored by the disposition-information storing unit 1103, inter-concentrator-terminal connection relations between some of the wireless terminal units 13 and the wireless concentrator 12 and inter-terminal unit connection relations between some of the wireless terminal units 13 in order from a closest wireless terminal unit 13, which is the wireless terminal unit 13 closest to the wireless concentrator 12 among the wireless terminal units 13, and

an investigation-result storing unit 1104, which is an investigation-result storing unit that stores, as an investigation result, the inter-concentrator-terminal connection relations between some of the wireless terminal units 13 investigated by the host-apparatus processing unit 1102 and the inter-terminal unit connection relations between some of the wireless terminal units 13. Note that the closest wireless terminal unit 13, which is the wireless terminal unit 13 closest to the wireless concentrator 12, is the wireless terminal unit 13 provided at the shortest distance to the wireless concentrator 12. In the present invention, the closest wireless terminal unit 13, which is the wireless terminal unit 13 closest to the wireless concentrator 12, can be the wireless terminal unit 13 having the strongest electric field intensity at the time when the wireless concentrator 12 performs wireless communication with the wireless terminal units 13.

[0030] The communication unit 1101 is connected to the wireless concentrator 12 by wire and connects the wireless concentrator 12 and the host-apparatus processing unit 1102. The disposition-information storing unit 1103 stores coordinates in the X-axis direction and the Y-axis direction of the wireless concentrator 12 set in the control room 101 of the structure 100 and coordinates in the X-axis direction and the Y-axis direction of the wireless terminal units 13 set in the rooms 102. In the first embodiment, as shown in FIG. 9, the wireless-information storing unit 1103 allocates the wireless concentrator 12 and the wireless terminal units 13 using the coordinates in the X-axis direction and the coordinates in the Y-axis direction in such a way as to allocate the wireless concentrator 12 disposed in the control room 101 to a coordinate (1, 0), allocate the wireless terminal unit

13-101 in the room No. 101 to a coordinate (0, 1), and allocate the wireless terminal unit 13-102 in the room No. 102 to a coordinate (1, 1).

[0031] The host-apparatus processing unit 1102 of the
5 host apparatus 11 serves as an estimating unit that estimates, on the basis of the investigation result stored in the investigation-result storing unit 1104 and the disposition information of the wireless terminal units 13 stored by the disposition-information storing unit 1103,
10 connection relations between uninvestigated wireless terminal units 13, the inter-terminal unit connection relations of which cannot be investigated, and serves as a determining unit that determines possibility of construction of the wireless mesh M from the inter-
15 concentrator-terminal connection relations between some of the wireless terminal units 13 and the wireless concentrator 12 and the inter-terminal unit connection relations between the wireless terminal units 13, the inter-concentrator-terminal connection relation and the
20 inter-terminal unit connection relation being obtained from the investigation result stored in the investigation-result storing unit 1104 and the estimation result obtained by estimating connection relations between the uninvestigated wireless terminal units 13. Note that, in this embodiment,
25 connection relations between the wireless concentrator 12 and the wireless terminal units 13 indicate whether the wireless concentrator 12 and the wireless terminal units 13 are wirelessly communicable. Connection relations between the wireless terminal units 13 indicate whether the
30 wireless terminal units 13 are wirelessly communicable. In the first embodiment, the host-apparatus processing unit 1102 sets the wireless concentrator 12 and the wireless terminal units 13 wirelessly communicable when electric

field intensity between the wireless concentrator 12 and the wireless terminal units 13 and electric field intensity between the wireless terminal units 13 exceed a threshold for wireless communicability and sets the wireless concentrator 12 and the wireless terminal units 13 wirelessly incommunicable when the electric field intensities are smaller than the threshold.

[0032] When investigating the inter-concentrator-terminal connection relations between some of the wireless terminal units 13 and the wireless concentrator 12 and the inter-terminal unit connection relation between some of the wireless terminal units 13, the host-apparatus processing unit 1102 investigates connection relations between all same-row wireless terminal units 13 arranged in the same row in the X-axis direction with respect to the closest wireless terminal unit 13, which is the wireless terminal unit 13 closest to the wireless concentrator 12, and the other wireless terminal units 13. The host-apparatus processing unit 1102 investigates connection relations between a same-column-adjacent-row wireless terminal unit 13 further apart from the wireless concentrator 12 by one wireless terminal unit 13 in the Y-axis direction than an inter-terminal unit-most-distant wireless terminal unit 13 most away from the wireless concentrator 12 in the Y-axis direction among the other wireless terminal units 13 connected to all same-row wireless terminal units 13 arranged in the same row in the X-axis direction with respect to the closest wireless terminal unit 13 closest to the wireless concentrator 12 and still other wireless terminal units 13. The host-apparatus processing unit 1102 investigates connection relations between the wireless terminal units 13 present on the same Y-axis direction as the same-column-adjacent-row wireless terminal unit 13 and

arranged in a direction away from the wireless concentrator 12 in the Y-axis direction and still other wireless terminal units 13 in order from the same-column-adjacent-row wireless terminal unit 13 apart from the wireless concentrator 12 by one wireless terminal unit 13 in the Y-axis direction until one of the still other wireless terminal units 13 corresponds to the wireless terminal unit 13 most apart from the wireless concentrator 12 in the Y-axis direction. The host-apparatus processing unit 1102 estimates connection relations between the uninvestigated wireless terminal units 13 of the wireless terminal units 13, inter-terminal unit connection relations of which cannot be investigated, from the inter-terminal unit connection relations, an investigation result of which is present, among the wireless terminal units 13 having the same disposition relation as disposition relations in the X-axis direction and the Y-axis direction of the uninvestigated wireless terminal units 13. Specifically, when estimating connection relations between the uninvestigated wireless terminal units 13, the host-apparatus processing unit 1102 estimates connection relations between the wireless terminal units 13, connection relations of which with the other wireless terminal units 13 are unknown, arranged in either one of the X-axis direction and the Y-axis direction from connection relations between the wireless terminal units 13, connection relations of which have already been investigated, arranged in the other of the X-axis direction and the Y-axis direction side by side with the wireless terminal units 13, connection relations of which are unknown.

[0033] The host apparatus 11 is configured by, as shown in FIG. 3, an IF (Interface) 1104 for communication, a CPU

(Central Processing Unit) 1105 that executes a control program, a ROM (Read Only Memory) 1106 that stores the control program, a RAM (Random Access Memory) 1107 used as a work area of the CPU 1105, and a nonvolatile memory 1108 in which data indicating an investigation result is written by the CPU 1105.

[0034] The communication unit 1101 is realized by the IF 1104. The IF 1104 communicates with the wireless concentrator 12, whereby the function of the communication unit 1101 is realized. The host-apparatus processing unit 1102 is realized by the CPU 1105, the RAM 1107, and the ROM 1106. The CPU 1105 reads the control program stored in the ROM 1106 and executes the control program in the work area of the RAM 1107, whereby the function of the host-apparatus processing unit 1102 is realized. The disposition-information storing unit 1103 is realized by the ROM 1106. The ROM 1106 stores disposition information, whereby the function of the disposition-information storing unit 1103 is realized. The investigation-result storing unit 1104 is realized by the nonvolatile memory 1108. Data indicating an investigation result is written in the nonvolatile memory 1108 by the CPU 1105, whereby the function of the investigation-result storing unit 1104 is realized. A plurality of processing circuits can cooperate to realize the functions of the communication unit 1101, the host-apparatus processing unit 1102, the disposition-information storing unit 1103, and the investigation-result storing unit 1104.

[0035] A method in which the host-apparatus processing unit 1102 of the host apparatus 11 of the wireless system 1 in the first embodiment investigates connection relations between the wireless terminal units 13 when determining possibility of introduction of the wireless system 1 is

described with reference to, as an example, a method of investigating connection relations between the wireless terminal unit 13-302 and the other wireless terminal units 13.

5 [0036] FIG. 11 is an explanatory diagram showing a state in which the host apparatus shown in FIG. 1 transmits an investigation message M2 to the wireless terminal unit in the room No. 302. FIG. 12 is an explanatory diagram showing a state in which the wireless terminal unit in the
10 room No. 302 shown in FIG. 11 transmits a peripheral search message M3. FIG. 13 is an explanatory diagram showing a state in which wireless terminal units in rooms around the room No. 302 shown in FIG. 12 transmit search response messages M4. FIG. 14 is an explanatory diagram showing a
15 state in which the wireless terminal unit in the room No. 302 shown in FIG. 13 transmits a result message M6 to the wireless concentrator. FIG. 15 is a diagram showing an example of a time chart showing a method in which the host apparatus shown in FIG. 1 investigates connection relations
20 between the wireless terminal unit in the room No. 302 and the other wireless terminal units. FIG. 16 is a diagram showing an example of a message format of the investigation message M2 transmitted to the wireless concentrator by the host apparatus shown in FIG. 11. FIG. 17 is a diagram
25 showing an example of a message format of the investigation message M2 shown in FIG. 11. FIG. 18 is a diagram showing an example of a message format of the peripheral search message M3 shown in FIG. 12. FIG. 19 is a diagram showing an example of a message format of the search response
30 message M4 shown in FIG. 13. FIG. 20 is a diagram showing an example of a message format of the result message M6 transmitted to the wireless concentrator by the wireless terminal unit in the room No. 302 shown in FIG. 14. FIG.

21 is a diagram showing an example of a message format of the result message M6 transmitted to the host apparatus by the wireless concentrator shown in FIG. 14.

[0037] First, the host-apparatus processing unit 1102 of the host apparatus 11 requests, through the communication unit 1101 shown in FIG. 2, the wireless concentrator 12 to transmit an investigation message M1 to the wireless terminal unit 13 as shown in FIG. 11 and FIG. 15 (step ST11). The investigation message M1 includes, as shown in FIG. 16, a header section and a data section. The header section includes an address of the host apparatus 11, which is a transmission source, and an address of the wireless concentrator 12, which is a transmission destination. The data section includes a message body indicating that connection relations are investigated and an address of an investigation target wireless terminal unit 13-302.

[0038] The wireless concentrator 12 refers to the table shown in FIG. 8 stored in the uplink-routing-table storing unit 1205 shown in FIG. 3 and extracts the wireless terminal unit 13-102 via which the a message is transmitted to the wireless terminal unit 13-302. As shown in FIG. 11, the wireless concentrator 12 transmits, via the wireless terminal unit 13-102, the investigation message M2 indicating that connection relations of the wireless terminal unit 13-302 are investigated to the wireless terminal unit 13-302 (step ST12 and step ST13). The investigation message M2 includes, as shown in FIG. 17, a header section and a data section. The header section includes an address of the wireless concentrator 12, which is a transmission source, and an address of the wireless terminal unit 13-302, which is a transmission destination. The data section includes an address of the wireless terminal unit 13-102, which is a via-destination, an

address of the wireless terminal unit 13-302, a message body indicating that connection relations are investigated, and an address of the investigation target wireless terminal unit 13-302.

5 [0039] As shown in FIG. 12, the wireless terminal unit 13-302, which receives the investigation message M2, transmits the peripheral search message M3 by broadcast (step ST14) and waits for the search response message M4 from the wireless terminal units 13 around the wireless
10 terminal unit 13-302 for a fixed period. The peripheral search message M3 includes, as shown in FIG. 18, a header section and a data section. The header section includes an address of the wireless terminal unit 13-302, which is the transmission source, and information indicating broadcast,
15 which is a transmission destination. The data section includes a message body indicating that a search response is transmitted.

[0040] After a random waiting time elapses, as shown in FIG. 13, the wireless terminal units 13, which receive the
20 peripheral search message M3, transmit the search response messages M4 to the wireless terminal unit 13-302, which is the transmission source of the peripheral search message M3 (step ST15). In the first embodiment, the wireless terminal unit 13-102, the wireless terminal unit 13-202,
25 the wireless terminal unit 13-301, the wireless terminal unit 13-303, the wireless terminal unit 13-401, the wireless terminal unit 13-402, and the wireless terminal unit 13-502 transmit the search response messages M4 to the wireless terminal unit 13-302. The search response message
30 M4 includes, as shown in FIG. 19, a header section and a data section. The header section includes addresses of the wireless terminal unit 13-102, the wireless terminal unit 13-202, the wireless terminal unit 13-301, the wireless

terminal unit 13-303, the wireless terminal unit 13-401, the wireless terminal unit 13-402, and the wireless terminal unit 13-502, which are transmission sources and transmit the search response messages M4, and an address of the wireless terminal unit 13-302, which is a transmission destination. The data section includes a message body indicating the search response message M4. The wireless terminal unit 13-302, which receives the search response messages M4, stores electric field intensity at the time when the search response messages M4 are received and the addresses of the wireless terminal units 13, which transmit the search response messages M4, in the nonvolatile memory 1309 in association with each other.

[0041] When the fixed period for waiting for the search response messages M4 elapses, as shown in FIG. 14, the wireless terminal unit 13-302 transmits the result message M5, in which the electric field intensity at the time when the search response messages M4 are received and the address of the wireless terminal units 13 that transmit the search response messages M4 are associated, to the wireless concentrator 12 via the wireless terminal unit 13-102 (step ST16 and step ST17). The result message M5 includes, as shown in FIG. 20, the header section and the data section. The header section includes an address of the wireless terminal unit 13-302, which is the transmission source and transmits the search response message M4, and an address of the wireless concentrator 12, which is the transmission destination. The data section is information in which a message body indicating the result message M5, the address of the investigation target wireless terminal unit 13-302, and addresses and electric field intensities of the wireless terminal units 13, which transmit the search response messages M4, are associated. In the result

message M6 in the first embodiment, an address and electric field intensity of the wireless terminal unit 13-102 are associated, an address and electric field intensity of the wireless terminal unit 13-202 are associated, an address and electric field intensity of the wireless terminal unit 13-301 are associated, an address and electric field intensity of the wireless terminal unit 13-303 are associated, an address and electric field intensity of the wireless terminal unit 13-401 are associated, an address and electric field intensity of the wireless terminal unit 13-402 are associated, and an address and electric field intensity of the wireless terminal unit 13-502 are associated.

[0042] When receiving the result message M5 from the wireless terminal unit 13-302 via the wireless terminal unit 13-102, as shown in FIG. 14, the wireless concentrator 12 transfers the result message M6 to the host apparatus 11 (step ST18). The result message M6 transferred to the host apparatus 11 by the wireless concentrator 12 includes, as shown in FIG. 21, a header section and a data section. The header section includes an address of the wireless concentrator 12, which is a transmission source, and an address of the host apparatus 11, which is a transmission destination. As in the result message M5 shown in FIG. 20, the data section is information in which a message body indicating the result message M6, the address of the investigation target wireless terminal unit 13-302, and the addresses and the electric field intensities of the wireless terminal units 13, which transmit the search response messages M4, are associated.

[0043] The host-apparatus processing unit 1102 of the host apparatus 11 stores, in the investigation-result storing unit 1104, only an address of the wireless terminal

unit 13, a value of electric field intensity of which included in the received result message M6 exceeds a threshold of wireless communicability. In the first embodiment, a value of electric field intensity of the wireless terminal unit 13-302 at the time when the wireless terminal unit 13-302 receives the search response messages M4 from the wireless terminal unit 13-102, the wireless terminal unit 13-202, the wireless terminal unit 13-301, the wireless terminal unit 13-303, the wireless terminal unit 13-402, and the wireless terminal unit 13-502 exceeds the threshold. In the first embodiment, a value of electric field intensity of the wireless terminal unit 13-302 at the time when the wireless terminal unit 13-302 receives the search response message M4 from the wireless terminal unit 13-40 is equal to or smaller than the threshold.

[0044] Note that FIG. 22 is a diagram showing the wireless terminal units capable of performing wireless communication with the wireless terminal unit in the room No. 302 based on the result message M6 shown in FIG. 14. FIG. 23 is a diagram showing an investigation result of the wireless terminal unit in the room No. 302 stored in the investigation-result storing unit on the basis of the result message M6 shown in FIG. 14. FIG. 23 indicates that the wireless terminal units 13 in the right field and the wireless terminal units 13 in the left field are wirelessly communicable. The investigation-result storing unit 1104 of the host apparatus 11 stores, as shown in FIG. 22 and FIG. 23, addresses of the wireless terminal units 13-102, the wireless terminal unit 13-202, the wireless terminal unit 13-301, the wireless terminal unit 13-303, the wireless terminal unit 13-402, and the wireless terminal unit 13-502 with which the wireless terminal unit 13-302 is

wirelessly communicable. As shown in the center field of FIG. 23, the investigation-result storing unit 1104 of the host apparatus 11 stores the wireless terminal unit 13-302, for which investigation of connection relations are carried out, as "investigated" and stores the wireless terminal unit 13-302 is investigated as "responded".

[0045] As shown in FIG. 23, the investigation-result storing unit 1104 of the host apparatus 11 stores the investigated wireless terminal unit 13-302 and the wireless terminal unit 13-102, the wireless terminal unit 13-202, the wireless terminal unit 13-301, the wireless terminal unit 13-303, the wireless terminal unit 13-402, and the wireless terminal unit 13-502 wirelessly communicable with the wireless terminal unit 13-302 in association with each other.

[0046] As shown in FIG. 22 and FIG. 23, among the wireless terminal units 13 from which the wireless terminal unit 13-302 receives the search response messages M4, a value of electric field intensity at the time when the search response message M4 is received from the wireless terminal unit 13-401 is equal to or smaller than the threshold. Therefore, the investigation-result storing unit 1104 does not store an address of the wireless terminal unit 13-401. In this way, the host-apparatus processing unit 1102 of the host apparatus 11 investigates connection relations between the wireless terminal unit 13 and the other wireless terminal units 13. The investigation-result storing unit 1104 of the host apparatus 11 stores the connection relations between the wireless terminal unit 13 and the other wireless terminal units 13. Wireless addresses shown in FIG. 22 and FIG. 23 indicate addresses of the wireless concentrator 12 and the

wireless terminal units 13. The wireless addresses shown in FIG. 22 and FIG. 23 are "concentrator" in the wireless concentrator 12 and are "room number" in the wireless terminal units 13.

5 [0047] A method in which the host-apparatus processing unit 1102 of the host apparatus 11 of the wireless system 1 in the first embodiment determines possibility of construction of the wireless mesh M in the wireless system 1 is described. FIG. 24 is a flowchart for the host
10 apparatus of the wireless system shown in FIG. 1 to determine possibility of construction of a wireless mesh in the wireless system. FIG. 25 is a diagram showing a result obtained by investigating connection relations between the wireless concentrator and the wireless terminal units at
15 step ST101 shown in FIG. 24. FIG. 26 is a diagram showing the connection relations between the wireless concentrator and the wireless terminal units stored by the investigation-result storing unit of the host apparatus at step ST101 shown in FIG. 24.

20 [0048] The host-apparatus processing unit 1102 of the host apparatus 11 investigates connection relations between the wireless concentrator 12 and the wireless terminal units 13 (step ST101). Specifically, the host-apparatus processing unit 1102 of the host apparatus 11 transmits the
25 investigation message M2 to the wireless concentrator 12 and causes the wireless concentrator 12 to transmit the peripheral search message M3. The host-apparatus processing unit 1102 of the host apparatus 11 receives the result message M6 from the wireless concentrator 12 and
30 determines whether the wireless terminal units 13 are wirelessly communicable with the wireless concentrator 12 as shown in FIG. 25. As shown in FIG. 26, the investigation-result storing unit 1104 of the host

apparatus 11 stores addresses of the wireless terminal units 13 wirelessly communicable with the wireless concentrator 12, which are a search result of inter-concentrator-terminal connection relations. Note that, in an example shown in FIG. 25 in the first embodiment, the wireless terminal units 13 wirelessly communicable with the wireless concentrator 12 are the wireless terminal unit 13-101, the wireless terminal unit 13-102, and the wireless terminal unit 13-103.

10 [0049] The host-apparatus processing unit 1102 of the host apparatus 11 refers to the disposition information stored in the disposition-information storing unit 1103, determines the wireless terminal units 13 as the wireless terminal units 13 serving as investigation targets, and
15 investigates connection relations of the determined wireless terminal units 13 (step ST102).

[0050] FIG. 27 shows a flowchart for the host apparatus to carry out investigation of connection relations between the wireless terminal units at step ST102 shown in FIG. 24.
20 FIG. 28 is a diagram showing a result obtained by investigating connection relations between a closest wireless terminal unit, which is the wireless terminal unit closest to the wireless concentrator, and the other wireless terminal units at step ST201 shown in FIG. 27.

25 FIG. 29 is a diagram showing the connection relations between the closest wireless terminal unit and the other wireless terminal units stored by the investigation-result storing unit of the host apparatus at step ST203 shown in FIG. 27. FIG. 30 is a diagram showing a result obtained by
30 investigating connection relations between a closest wireless terminal unit among the wireless terminal units that have responded at step ST202 and the other wireless terminal units at step ST204 shown in FIG. 27. FIG. 31 is

a diagram showing the investigation result shown in FIG 30 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1. FIG. 32 is a diagram showing an investigation result of connection relations between an investigation target wireless terminal unit and the other wireless terminal units at step ST205 shown in FIG. 27. FIG. 33 is a diagram showing the investigation result of FIG. 32 stored by the investigation-result storing unit of the host apparatus showing in FIG. 1.

10 [0051] The host-apparatus processing unit 1102 of the host apparatus 11 refers to the disposition information stored in the disposition-information storing unit 1103 and the investigation result of the wireless concentrator 12 shown in FIG. 26 and determines, as an investigation target, the closest wireless terminal unit 13, which is the wireless terminal unit 13 closest to the wireless concentrator 12 among the wireless terminal units 13 wirelessly communicable with the wireless concentrator 12 (step ST201). Specifically, the host-apparatus processing unit 1102 determines, as an investigation target, the wireless terminal unit 13 at the shortest distance from the wireless concentrator 12 from the disposition information among the wireless terminal units 13 wirelessly communicable with the wireless concentrator 12. In the first embodiment, the host-apparatus processing unit 1102 determines the wireless terminal unit 13-102, which is the closest wireless terminal unit 13, as an investigation target. The host-apparatus processing unit 1102 of the host apparatus 11 refers to the table shown in FIG. 8 stored in the uplink-routing-table storing unit 1205, transmits the investigation message M2 to the wireless terminal unit 13-102 determined at step ST201 via the wireless concentrator 12, and causes the wireless terminal

unit 13-102 to transmit the peripheral search message M3 (step ST202). The host-apparatus processing unit 1102 of the host apparatus 11 receives the result message M6 from the wireless terminal unit 13-102 and determines whether
5 the wireless terminal units 13 are wirelessly communicable with the wireless terminal unit 13-102 as shown in FIG. 28. As shown in FIG. 29, the investigation-result storing unit 1104 of the host apparatus 11 stores addresses of the wireless terminal units 13 wirelessly communicable with the
10 wireless terminal unit 13-102 (step ST203). Note that, in the first embodiment, the wireless concentrator 12, the wireless terminal unit 13-101, the wireless terminal unit 13-103, the wireless terminal unit 13-202, and the wireless terminal unit 13-302 are wirelessly communicable with the
15 wireless terminal unit 13-102. In this way, the host-apparatus processing unit 1102 investigates connection relations between the wireless terminal unit 13-102, which is the closest wireless terminal unit 13, and the other wireless terminal units 13.

20 [0052] The host-apparatus processing unit 1102 of the host apparatus 11 determines whether the wireless terminal units 13, connection relations of which are not investigated, among the wireless terminal unit 13-101, the wireless terminal unit 13-103, the wireless terminal unit
25 13-104, and the wireless terminal unit 13-105 arranged in the X-axis direction side by side with the wireless terminal unit 13-102, which is the investigation target at step ST201, is present (step ST204). Note that the wireless terminal units 13, connection relations of which
30 are not investigated, refer to the wireless terminal units 13, connection relations of which are not investigated and which are not determined as wirelessly communicable in investigation of connection relations of the other wireless

terminal units 13. In the first embodiment, because the wireless terminal unit 13-104 and the wireless terminal unit 13-105 do not transmit the search response message M4 yet, the host-apparatus processing unit 1102 of the host apparatus 11 determines that the uninvestigated wireless terminal units 13 are present.

[0053] When determining that the uninvestigated wireless terminal units 13 are present (YES at step ST204), the host-apparatus processing unit 1102 of the host apparatus 11 refers to the investigation result stored in the investigation-result storing unit 1104 and the disposition information stored in the disposition-information storing unit 1103, sets, as an investigation target, the wireless terminal unit 13 closest to, in the X-axis direction, the wireless terminal unit 13 wirelessly communicable with the wireless terminal unit 13-102 among the uninvestigated wireless terminal units 13 (step ST205) and returns to step ST202. In the first embodiment, the host-apparatus processing unit 1102 of the host apparatus 11 determines the wireless terminal unit 13-104 as an investigation target, refers to the uplink-routing-table storing unit 1205, and transmits the investigation message M2 to the wireless terminal unit 13-104 via the wireless terminal unit 13-103 (step ST202). The host-apparatus processing unit 1102 of the host apparatus 11 receives the result message M6 from the wireless terminal unit 13-104 and determines whether the wireless terminal units 13 are the wireless terminal units 13 wirelessly communicable with the wireless terminal unit 13-104 as shown in FIG. 30. As shown in FIG. 31, the investigation-result storing unit 1104 of the host apparatus 11 stores addresses of the wireless terminal units 13 wirelessly communicable with the wireless terminal unit 13-104 (step ST203). In the first

embodiment, the wireless terminal unit 13-105 is wirelessly communicable with the wireless terminal unit 13-104. In this way, the host-apparatus processing unit 1102 investigates connection relations between the wireless
5 terminal unit 13-102, which is the closest wireless terminal unit 13, and the wireless terminal unit 13-101, the wireless terminal unit 13-102, the wireless terminal unit 13-103, the wireless terminal unit 13-104, and the wireless terminal unit 13-105, which are all the same-row
10 wireless terminal units 13 arranged in the same row in the X-axis direction with respect to the wireless terminal unit 13-102.

[0054] Then, all the wireless terminal units 13 arranged in the X-axis direction with respect to the wireless
15 terminal unit 13-102 change to "investigated" or "responded". In this state, the host-apparatus processing unit 1102 of the host apparatus 11 determines that the uninvestigated wireless terminal units 13 are absent (NO at step ST204). The host-apparatus processing unit 1102 of
20 the host apparatus 11 determines that the uninvestigated wireless terminal units 13 are absent (NO at step ST204) to thereby investigate connection relations between all the wireless terminal units 13 arranged in the X-axis direction with respect to the wireless terminal unit 13-102 closest
25 to the wireless concentrator 12 and the other wireless terminal units 13. When determining that the uninvestigated wireless terminal units 13 are absent (NO at step ST204), the host-apparatus processing unit 1102 of the host apparatus 11 determines whether connection relations
30 of which of the wireless terminal units 13 most away from the wireless concentrator 12 in the Y-axis direction are investigated (step ST206).

[0055] In the first embodiment, connection relations of

the wireless terminal unit 13-401 to the wireless terminal unit 13-505 are not investigated yet. When determining that connection relations of any one of the wireless terminal units 13 most away from the wireless concentrator 12 in the Y-axis direction are not investigated (NO at step ST206), the host-apparatus processing unit 1102 of the host apparatus 11 refers to the investigation result stored by the investigation-result storing unit 1104 and the disposition information stored by the disposition-information storing unit 1103 and extracts the wireless terminal units 13 most away from the wireless concentrator 12 in the Y-axis direction among the that wireless terminal units 13 that have already responded. In the first embodiment, the host-apparatus processing unit 1102 of the host apparatus 11 extracts the wireless terminal unit 13-302 and the wireless terminal unit 13-304 as the wireless terminal units 13 most away from the wireless concentrator 12 in the Y-axis direction among the wireless terminal units 13 that have already responded. In this way, the host-apparatus processing unit 1102 extracts the wireless terminal unit 13-302 and the wireless terminal unit 13-304, which are inter-terminal unit-most-distant wireless terminal units 13 most away from the wireless concentrator 12 in the Y-axis direction among the wireless terminal unit 13-102, which is the closest wireless terminal unit 13, and the other wireless terminal units 13 connected to the wireless terminal unit 13-101, the wireless terminal unit 13-102, the wireless terminal unit 13-103, the wireless terminal unit 13-104, and the wireless terminal unit 13-105, which are the same-row wireless terminal units 13.

[0056] The host-apparatus processing unit 1102 of the host apparatus 11 extracts the wireless terminal unit 13 most way from the wireless concentrator 12 in the Y-axis

direction among the wireless terminal units 13 that have already responded, sets, as an investigation target, the wireless terminal unit 13 further away from the wireless concentrator 12 by one wireless terminal unit 13 in the Y-axis direction than the extracted wireless terminal unit 13 (step ST207), and returns to step ST202. In the first embodiment, because the wireless terminal unit 13-302 is the wireless terminal unit 13 most away from the wireless concentrator 12 in the Y-axis direction among the wireless terminal units 13 that have already responded, the host-apparatus processing unit 1102 of the host apparatus 11 sets, as an investigation target, the wireless terminal unit 13-402 further away from the wireless concentrator 12 by one wireless terminal unit 13 in the Y-axis direction than the wireless terminal unit 13-302. Because the wireless terminal unit 13-304 is the wireless terminal unit 13 most away from the wireless concentrator 12 in the Y-axis direction among the wireless terminal units 13 that have already responded, the host-apparatus processing unit 1102 of the host apparatus 11 sets, as an investigation target, the wireless terminal unit 13-404 further away from the wireless concentrator 12 by one wireless terminal unit 13 in the Y-axis direction than the wireless terminal unit 13-304. The host-apparatus processing unit 1102 of the host apparatus 11 transmits the investigation message M2 to the wireless terminal unit 13-402 and the wireless terminal unit 13-404, which are the investigation targets (step ST202). The host-apparatus processing unit 1102 of the host apparatus 11 receives the result messages M6 from the wireless terminal unit 13-402 and the wireless terminal unit 13-404 and determines whether the wireless terminal units 13 are the wireless terminal units 13 wirelessly communicable with the wireless terminal unit 13-402 and the

wireless terminal unit 13-404 as shown in FIG. 32. As shown in FIG 33, the investigation-result storing unit 1104 of the host apparatus 11 stores addresses of the wireless terminal units 13 wirelessly communicable with the wireless terminal unit 13-402 and the wireless terminal unit 13-404 (step ST203). In the first embodiment, the wireless terminal unit 13-502 is wirelessly communicable with the wireless terminal unit 13-402 and the wireless terminal unit 13-504 is wirelessly communicable with the wireless terminal unit 13-404. In this way, the host-apparatus processing unit 1102 investigates connection relations between the wireless terminal unit 13-402 and the wireless terminal unit 13-404, which are same-column-adjacent-row wireless terminal units 13, further away from the wireless concentrator 12 by one wireless terminal unit 13 in the Y-axis direction than the wireless terminal unit 13-302 and the wireless terminal unit 13-304, which are inter-terminal unit-most-distant wireless terminal units 13, and still other wireless terminal units 13. The wireless terminal unit 13-502 and the wireless terminal unit 13-504 most away from the wireless concentrator 12 in the Y-axis direction change to "responded" and are connected to the wireless concentrator 12. Then, the host-apparatus processing unit 1102 of the host apparatus 11 determines that any one of the wireless terminal units 13 most away from the wireless concentrator 12 in the Y-axis direction has already been investigated (YES at step ST206) and ends the processing of the flowchart shown in FIG. 27.

[0057] The host-apparatus processing unit 1102 executes the processing of the flowchart shown in FIG. 27 to investigate, on the basis of the disposition information of the wireless terminal units 13 stored by the disposition-information storing unit 1103, inter-concentrator-terminal

connection relations between some of the wireless terminal units 13 and the wireless concentrator 12 and inter-terminal unit connection relations between some of the wireless terminal units 13 in order from the wireless terminal unit 13-102, which is the closest wireless terminal unit 13 closest to the wireless concentrator 12 among the wireless terminal units 13. The host-apparatus processing unit 1102 of the host apparatus 11 executes the processing at step ST201 to step ST203 of the flowchart shown in FIG. 27 to investigate connection relations between the wireless terminal unit 13-102, which is the closest wireless terminal unit 13 closest to the wireless concentrator 12, and the other wireless terminal units 13. The host-apparatus processing unit 1102 of the host apparatus 11 repeatedly executes the processing at step ST202 to step ST205 of the flowchart shown in FIG. 27 until the determination at step ST204 changes to YES to investigate connection relations between the wireless terminal unit 13-102, which is the closest wireless terminal unit 13 closest to the wireless concentrator 12, and the wireless terminal unit 13-101, the wireless terminal unit 13-103, the wireless terminal unit 13-104, and the wireless terminal unit 13-105, which are all the same-row wireless terminal units 13 arranged in the same row in the X-axis direction with respect to the wireless terminal unit 13-102.

[0058] The host-apparatus processing unit 1102 of the host apparatus 11 executes the processing at step ST207 when the determination at step ST206 of the flowchart shown in FIG. 27 is NO to extract the wireless terminal unit 13-302 and the wireless terminal unit 13-304, which are the inter-terminal unit-most-distant wireless terminal units 13 most away from the wireless concentrator 12 in the Y-axis

direction among the wireless terminal unit 13-102, which is the closest wireless terminal unit 13 closest to the wireless concentrator 12 and the wireless terminal unit 13-202, the wireless terminal unit 13-204, the wireless terminal unit 13-302, and the wireless terminal unit 13-304, which are the other wireless terminal units 13 connected to the wireless terminal unit 13-101, the wireless terminal unit 13-103, the wireless terminal unit 13-104, and the wireless terminal unit 13-105, which are all the same-row wireless terminal units 13. The host-apparatus processing unit 1102 of the host apparatus 11 executes the processing at step ST207 when the determination at step ST206 of the flowchart shown in FIG. 27 is NO and returns to step ST202 to thereby investigate connection relations between the wireless terminal unit 13-402 and the wireless terminal unit 13-404, which are the same-column-adjacent-row wireless terminal units 13 further way from the wireless concentrator 12 by one wireless terminal unit 13 in the Y-axis direction than the wireless terminal unit 13-302 and the wireless terminal unit 13-304, which are the extracted inter-terminal unit-most-distant wireless terminal units 13, and still other wireless terminal units 13. The host-apparatus processing unit 1102 of the host apparatus 11 executes the flowchart shown in FIG. 27 until the determination at step ST206 changes YES to thereby respectively investigate connection relations between the wireless terminal units 13 present on the same Y-axis direction as the wireless terminal unit 13-402 and the wireless terminal unit 13-404, which are the same-column-adjacent-row wireless terminal units 13, and arranged in a direction away from the wireless concentrator 12 and still other wireless terminal units 13 in the Y-axis direction in order from the wireless terminal unit 13-402 and the

wireless terminal unit 13-404, which are the same-column-adjacent-row wireless terminal units 13, until the still other wireless terminal units 13 become the wireless terminal unit 13-502 and the wireless terminal unit 13-504 most away from the wireless concentrator 12 in the Y-axis direction among all the wireless terminal units 13.

[0059] Step ST103 shown in FIG. 20 is described. The host-apparatus processing unit 1102 of the host apparatus 11 refers to the results at step ST101 and step ST102, that is, the investigation results at step ST101 and step ST102 stored in the investigation-result storing unit 1104 and estimates connection relations between the remaining uninvestigated wireless terminal units 13, connection relations of which are unknown (step ST103).

[0060] FIG. 34 is a flowchart for the host apparatus to estimate connection relations between uninvestigated wireless terminal units, connection relations of which are unknown, and the other wireless terminal units at step ST103 shown in FIG. 24. FIG. 35 is a diagram showing a result obtained by estimating connection relations between the wireless terminal unit in the room No. 101 and the other wireless terminal units at step ST301 shown in FIG. 34. FIG. 36 is a diagram showing the estimation result shown in FIG. 35 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1. FIG. 37 is a diagram showing a result obtained by estimating connection relations between the wireless terminal unit in the room No. 103 and the other wireless terminal units at step ST301 shown in FIG. 34. FIG. 38 is a diagram showing the estimation result shown in FIG. 37 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1. FIG. 39 is a diagram showing a result obtained by estimating connection relations between the

wireless terminal units in the room No. 103 and the room No. 201 and the other wireless terminal units at step ST301 shown in FIG. 34. FIG. 40 is a diagram showing the estimation result shown in FIG. 39 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1. FIG. 41 is a diagram showing a result obtained by estimating connection relations between uninvestigated wireless terminal units at step ST301 shown in FIG. 34. FIG. 42 is a diagram showing the estimation result shown in FIG. 41 stored by the investigation-result storing unit of the host apparatus shown in FIG. 1.

[0061] The host-apparatus processing unit 1102 of the host apparatus 11 refers to the investigation result stored in the investigation-result storing unit 1104 and sets the wireless terminal units 13 not responding yet and the wireless terminal units 13, connection relations of which are uninvestigated, as uninvestigated wireless terminal units 13, inter-terminal unit connection relations of which cannot be investigated and connection relations of which are unclear. The host-apparatus processing unit 1102 of the host apparatus 11 sets the wireless terminal units 13 not responding yet and the wireless terminal units 13, connection relations of which are uninvestigated, as estimation target uninvestigated wireless terminal units 13 (step ST301). Specifically, the host-apparatus processing unit 1102 of the host apparatus 11 sets, as estimation targets, the wireless terminal units 13, connection relations of which with the other wireless terminal units 13 are unknown, arranged in either one of the X-axis direction and the Y-axis direction among the wireless terminal units 13. In the first embodiment, because connection relations of the wireless terminal unit 13-101 with the other wireless terminal units 13 arranged in the

Y-axis direction are unknown, the host-apparatus processing unit 1102 of the host apparatus 11 refers to the investigation result stored in the investigation-result storing unit 1104 and the disposition information stored in the disposition-information storing unit 1103 and sets the wireless terminal unit 13-101 as an estimation target. Similarly, the host-apparatus processing unit 1102 of the host apparatus 11 sets the wireless terminal unit 13-103, the wireless terminal unit 13-105, the wireless terminal unit 13-201, the wireless terminal unit 13-202, the wireless terminal unit 13-203, the wireless terminal unit 13-204, the wireless terminal unit 13-205, the wireless terminal unit 13-301, the wireless terminal unit 13-302, the wireless terminal unit 13-303, the wireless terminal unit 13-304, the wireless terminal unit 13-305, the wireless terminal unit 13-401, the wireless terminal unit 13-403, the wireless terminal unit 13-405, the wireless terminal unit 13-501, the wireless terminal unit 13-502, the wireless terminal unit 13-503, the wireless terminal unit 13-504, and the wireless terminal unit 13-505 as estimation targets.

[0062] The host-apparatus processing unit 1102 of the host apparatus 11 determines whether estimation target uninvestigated wireless terminal units 13 are present (step ST302). When determining that estimation target uninvestigated wireless terminal units 13 are present (YES at step ST302), the host-apparatus processing unit 1102 of the host apparatus 11 estimates connection relations of the estimation target uninvestigated wireless terminal units 13 from inter-terminal unit connection relations of the wireless terminal units 13, investigation results of which are present, among the wireless terminal units 13 in the same arrangement relation as an arrangement relation of the

uninvestigated wireless terminal units 13 (step ST303), stores an estimation result in the investigation-result storing unit 1104, and returns to step ST302. Specifically, the host-apparatus processing unit 1102 of the host apparatus 11 estimates connection relations of the estimation target wireless terminal units 13 from connection relations between the estimation target wireless terminal units 13, connection relations of which in one of the X-axis direction or the Y-axis direction are unknown, and the wireless terminal units 13, connection relations of which have already been investigated, arranged in the other of the X-axis direction and the Y-axis direction.

[0063] In the first embodiment, when estimating connection relations in the Y-axis direction of the wireless terminal unit 13-101, the host-apparatus processing unit 1102 of the host apparatus 11 refers to an investigation result of the investigated wireless terminal unit 13-102 arranged in the X-axis direction with respect to the wireless terminal unit 13-101 and in the same disposition relation as the wireless terminal unit 13-101. Because the wireless terminal unit 13-102 is wirelessly communicable with the wireless terminal unit 13-202 and the wireless terminal unit 13-302, as shown in FIG. 35, the host-apparatus processing unit 1102 of the host apparatus 11 estimates that the wireless terminal unit 13-101 is wirelessly communicable with the wireless terminal unit 13-201 and the wireless terminal unit 13-301. As shown in FIG. 36, the investigation-result storing unit 1104 of the host apparatus 11 stores addresses of the wireless terminal unit 13-201 and the wireless terminal unit 13-301 estimated as being wirelessly communicable with the wireless terminal unit 13-101.

[0064] When estimating connection relations in the Y-

axis direction of the wireless terminal unit 13-103, the host-apparatus processing unit 1102 of the host apparatus 11 refers to overlapping investigation results of the investigated wireless terminal unit 13-102 and the

5 investigated wireless terminal unit 13-104 arranged in the X-axis direction with respect to the wireless terminal unit 13-103 and in the same arrangement relation as the wireless terminal unit 13-103. In the first embodiment, the wireless terminal unit 13-102 is wirelessly communicable

10 with the wireless terminal unit 13-202 and the wireless terminal unit 13-302. The wireless terminal unit 13-104 is wirelessly communicable with the wireless terminal unit 13-204 and the wireless terminal unit 13-304. Therefore, as shown in FIG. 37, the host-apparatus processing unit 1102

15 of the host apparatus 11 estimates that the wireless terminal unit 13-103 is wirelessly communicable with the wireless terminal unit 13-203 and the wireless terminal unit 13-303. As shown in FIG. 38, the investigation-result storing unit 1104 of the host apparatus 11 stores addresses

20 of the wireless terminal unit 13-203 and the wireless terminal unit 13-303 estimated as being wirelessly communicable with the wireless terminal unit 13-103.

[0065] When estimating connection relations in the X-axis direction and the Y-axis direction of the wireless

25 terminal unit 13-201, the host-apparatus processing unit 1102 of the host apparatus 11 refers to a connection relation of the wireless terminal unit 13-101 and a connection relation of the wireless terminal unit 13-202 having the same disposition relation as the wireless

30 terminal unit 13-201. As shown in FIG. 39, the host-apparatus processing unit 1102 of the host apparatus 11 estimates that the wireless terminal unit 13-201 is wirelessly communicable with the wireless terminal unit 13-

101, the wireless terminal unit 13-202, and the wireless terminal unit 13-401. As shown in FIG. 40, the investigation-result storing unit 1104 of the host apparatus 11 stores addresses of the wireless terminal unit 13-101, the wireless terminal unit 13-202, and the wireless terminal unit 13-401 estimated as being wirelessly communicable with the wireless terminal unit 13-201.

[0066] As shown in FIG. 41, the host-apparatus processing unit 1102 of the host apparatus 11 estimates, in the same manner, connection relations of the wireless terminal unit 13-202, the wireless terminal unit 13-203, the wireless terminal unit 13-204, the wireless terminal unit 13-205, the wireless terminal unit 13-301, the wireless terminal unit 13-302, the wireless terminal unit 13-303, the wireless terminal unit 13-304, the wireless terminal unit 13-305, the wireless terminal unit 13-401, the wireless terminal unit 13-403, the wireless terminal unit 13-405, the wireless terminal unit 13-501, the wireless terminal unit 13-502, the wireless terminal unit 13-503, the wireless terminal unit 13-504, and the wireless terminal unit 13-505. As shown in FIG. 42, the investigation-result storing unit 1104 of the host apparatus 11 stores the estimated connection relations of the wireless terminal unit 13-202, the wireless terminal unit 13-203, the wireless terminal unit 13-204, the wireless terminal unit 13-205, the wireless terminal unit 13-301, the wireless terminal unit 13-302, the wireless terminal unit 13-303, the wireless terminal unit 13-304, the wireless terminal unit 13-305, the wireless terminal unit 13-401, the wireless terminal unit 13-403, the wireless terminal unit 13-405, the wireless terminal unit 13-501, the wireless terminal unit 13-502, the wireless terminal unit 13-503, the wireless terminal unit 13-504,

and the wireless terminal unit 13-505. When determining that estimation target wireless terminal units 13 are absent (NO at step ST302), the host-apparatus processing unit 1102 of the host apparatus 11 ends the processing of the flowchart shown in FIG. 34.

[0067] When estimating connection relations between the remaining wireless terminal units 13 by executing the processing of the flowchart shown in FIG. 34, the host-apparatus processing unit 1102 estimates connection

relations of the wireless terminal units 13, connection relations of which with the other wireless terminal units 13 are unknown, arranged in either one of the X-axis direction and the Y-axis direction from connection relations between the wireless terminal units 13,

connection relations of which are unknown, and the wireless terminal units 13, connection relations of which have already been investigated, arranged in the other of the X-axis direction and the Y-axis direction.

[0068] The host-apparatus processing unit 1102 of the host apparatus 11 determines possibility of construction of the wireless mesh M in the wireless system 1 from the inter-concentrator-terminal connection relations and the inter-terminal unit connection relations obtained from the investigation result and the estimation result stored by the investigation-result storing unit 1104 (step ST104).

Specifically, when there are a plurality of un-overlapping wirelessly communicable routes, via which a message is transmitted, between all the wireless terminal units 13 and the wireless concentrator 12, the host-apparatus processing unit 1102 of the host apparatus 11 determines that the wireless mesh M in the wireless system 1 can be constructed. When there is only one wirelessly communicable route, via which a message is transmitted, between any one of the

wireless terminal units 13 and the wireless concentrator 12, the host-apparatus processing unit 1102 of the host apparatus 11 determines that the wireless mesh M in the wireless system 1 cannot be constructed.

5 [0069] In the first embodiment, the disposition-information storing unit 1103 of the host apparatus 11 stores the disposition information of the wireless concentrator 12 and the wireless terminal units 13. The host-apparatus processing unit 1102 of the host apparatus
10 11 investigates, on the basis of the disposition information stored by the disposition-information storing unit 1103, connection relations of some of the wireless terminal units 13 in order from the closest wireless terminal unit 13, which is the wireless terminal unit 13
15 closest to the wireless concentrator 12. For this reason, the host apparatus 11 can limit the wireless terminal units 13 to which the investigation message M2 is transmitted. Therefore, the wireless system 1 of the host apparatus 11 can further reduce a time required for determining
20 possibility of construction of the wireless mesh M in the wireless system 1 than transmitting the investigation message M2 to all of the wireless terminal units 13 and investigating connection relations. As a result, the host apparatus 11 and the wireless system 1 can reduce a time
25 required for determining whether the wireless system 1 can be stably operated and can reduce power consumption required for determining whether the wireless system 1 can be stably operated and achieve a reduction in energy consumption.

30 [0070] In the first embodiment, when investigating inter-concentrator-terminal connection relations between some of the wireless terminal units 13 and the wireless concentrator 12 and inter-terminal unit connection

relations between some of the wireless terminal units 13, the host-apparatus processing unit 1102 of the host apparatus 11 investigates connection relations between the closest wireless terminal unit 13, which is the wireless terminal unit 13 closest to the wireless concentrator 12, and all the same-row wireless terminal units 13 arranged in the same row in the X-axis direction with respect to the closest wireless terminal unit 13 and the other wireless terminal units 13. The host-apparatus processing unit 1102 of the host apparatus 11 investigates connection relations between the same-column-adjacent-row wireless terminal unit 13 away in the Y-axis direction by one wireless terminal unit 13 from the inter-terminal unit-most-distant wireless terminal unit 13 most away from the wireless concentrator 12 in the Y-axis direction among the other wireless terminal units 13 connected to the closest wireless terminal unit 13, which is the wireless terminal unit 13 closest to the wireless concentrator 12, and all the same-row wireless terminal units 13 arranged in the same row in the X-axis direction with respect to the closest wireless terminal unit 13 and the other wireless terminal units 13 until the wireless concentrator 12 is connected to the wireless terminal unit 13 most away from the wireless concentrator 12 in the Y-axis direction. Further, when estimating connection relations between the uninvestigated wireless terminal units 13, the host-apparatus processing unit 1102 of the host apparatus 11 estimates connection relations of the wireless terminal units 13, connection relations of which with the other wireless terminal units 13 are unknown, arranged in either one of the X-axis direction and the Y-axis direction from connection relations of the wireless terminal units 13, connection relations of which have been investigated, arranged in the

other of the X-axis direction and the Y-axis direction side by side with and in the same disposition relation as the wireless terminal units 13, connection relations of which are unknown.

5 [0071] Therefore, the host apparatus 11 does not need to transmit the investigation message M2 to all of the wireless terminal units 13. Even if the host apparatus 11 transmits the investigation message M2 to some of the wireless terminal units 13, the host apparatus 11 can
10 investigate connection relations of the entire wireless system 1. Therefore, the host apparatus 11 and the wireless system 1 can reduce a time required for determining whether the wireless system 1 can be stably operated.

15 [0072] Second Embodiment.

When investigating connection relations according to the flowchart shown in FIG. 24, the host-apparatus processing unit 1102 of the host apparatus 11 in a second embodiment does not obtain connection relations in either
20 one of the X-axis direction and the Y-axis direction of some of the wireless terminal units 13. When connection relations of the uninvestigated wireless terminal units 13 cannot be estimated, the host-apparatus processing unit 1102 of the host apparatus 11 in the second embodiment
25 additionally executes investigation of a part insufficient for performing estimation. Note that the wireless system 1 and the host apparatus 11 of the second embodiment have the same apparatus configuration as the first embodiment except disposition of the wireless terminal units 13.

30 [0073] FIG. 43 is a diagram showing an investigation result of connection relations of a host-apparatus processing unit of a host apparatus of a wireless system in the second embodiment. FIG. 44 is a diagram showing the

investigation result shown in FIG. 43 stored by an investigation-result storing unit of the host apparatus shown in FIG. 43. FIG. 45 is a diagram showing an investigation result at the time when a wireless terminal unit in a room No. 205 of the wireless system shown in FIG. 43 is set as an additional investigation target. FIG. 46 is a diagram showing the investigation result shown in FIG. 45 stored by the investigation-result storing unit of the host apparatus shown in FIG. 43. FIG. 47 is a diagram showing an estimation result of connection relations of wireless terminal units, connection relations of which are unknown, based on the investigation result shown in FIG. 45. FIG. 48 is a diagram showing the investigation result shown in FIG. 47 stored by the investigation-result storing unit of the host apparatus shown in FIG. 43.

[0074] In the second embodiment, in the wireless system 1, as shown in FIG. 43 and FIG. 44, the wireless terminal unit 13-106 and the wireless terminal unit 13-105 adjacent in the X-axis direction are not wirelessly communicable. Therefore, in the second embodiment, when determining possibility of construction of the wireless mesh M in the wireless system 1 on the basis of an investigation result stored by the investigation-result storing unit 1104, the host-apparatus processing unit 1102 of the host apparatus 11 determines that the wireless mesh M in the wireless system 1 cannot be constructed.

[0075] Even if the host-apparatus processing unit 1102 of the host apparatus 11 executes the processing of the flowchart shown in FIG. 34 in the first embodiment, the host-apparatus processing unit 1102 of the host apparatus 11 cannot estimate connection relations in the X-axis direction of the wireless terminal unit 13-206 and the wireless terminal unit 13-306. In the second embodiment,

the host-apparatus processing unit 1102 of the host apparatus 11 sets, as additional investigation targets, the wireless terminal unit 13-206, connection relations of which cannot be estimated, and the wireless terminal unit 13-205, connection relations of which are unknown, adjacent in the X-axis direction. Specifically, the host-apparatus processing unit 1102 determines presence or absence of the wireless terminal units 13, the number of routes of the wireless mesh M from which to the wireless concentrator 12 is smaller than a predetermined number, from inter-concentrator-terminal connection relations and inter-terminal-unit connection relations obtained from the investigation-result storing unit 1104 and an estimation result. When determining that the wireless terminal units 13 are present, the host-apparatus processing unit 1102 determines that additional investigation is necessary. In the second embodiment, the host-apparatus processing unit 1102 sets the predetermined number for determining necessity of the additional investigation to three. However, the predetermined number is not limited to this number. In the host-apparatus processing unit 1102, the predetermined number for determining necessity of the additional investigation is a number with which connection relations of the uninvestigated wireless terminal units 13 cannot be estimated even if the processing of the flowchart shown in FIG. 34 is executed and a number that cannot be estimated from inter-terminal unit connection relations of the wireless terminal units 13 having the same arrangement relation as arrangement relations of the uninvestigated wireless terminal units 13 and having an investigation result.

[0076] The host-apparatus processing unit 1102 of the host apparatus 11 refers to the table stored in the uplink-

routing-table storing unit 1205 and transmits the investigation message M2 to the wireless terminal unit 13-205 via the wireless terminal unit 13-103, the wireless terminal unit 13-104, and the wireless terminal unit 13-105.

5 The host-apparatus processing unit 1102 of the host apparatus 11 receives the result message M6 from the wireless terminal unit 13-205 and determines whether the wireless terminal units 13 are the wireless terminal units 13 wirelessly communicable with the wireless terminal unit 13-205 as shown in FIG. 45. As shown in FIG. 46, the investigation-result storing unit 1104 of the host apparatus 11 stores the addresses of the wireless terminal units 13 wirelessly communicable with the wireless terminal unit 13-205. In the second embodiment, the wireless terminal unit 13-205 is determined as being wirelessly communicable with the wireless terminal unit 13-105, the wireless terminal unit 13-204, the wireless terminal unit 13-206, and the wireless terminal unit 13-405. In this way, when determining that there are the wireless terminal unit 13, the number of routes of the wireless mesh M from which to the wireless concentrator 12 is smaller than the predetermined number, from the inter-concentrator-terminal connection relations and the inter-terminal unit connection relations obtained from the investigation-result storing unit 1104 and the estimation result, the host-apparatus processing unit 1102 of the host apparatus 11 investigates connection relations between the wireless terminal unit 13-205, which is the wireless terminal unit 13, an inter-terminal unit connection relation of which in either one of the X-axis direction and the Y-axis direction is unknown, and the other wireless terminal units 13.

[0077] Then, in the second embodiment, the host-apparatus processing unit 1102 of the host apparatus 11

executes the processing of the flowchart shown in FIG. 34 in the first embodiment and estimates connection relations in the X-axis direction of the wireless terminal unit 13-306. When estimating connection relations in the X-axis direction of the wireless terminal unit 13-306, the host-apparatus processing unit 1102 of the host apparatus 11 refers to an overlapping investigation result of the investigated wireless terminal unit 13-206 and the investigated wireless terminal unit 13-406 arranged in the Y-axis direction with respect to the wireless terminal unit 13-306. Because the wireless terminal unit 13-206 is wirelessly communicable with the wireless terminal unit 13-205 and the wireless terminal unit 13-406 is wirelessly communicable with the wireless terminal unit 13-405, the host-apparatus processing unit 1102 of the host apparatus 11 estimates that the wireless terminal unit 13-306 is wirelessly communicable with the wireless terminal unit 13-305, as shown in FIG. 47. As shown in FIG. 48, the investigation-result storing unit 1104 of the host apparatus 11 stores the wireless terminal unit 13-305 estimated as being wirelessly communicable with the wireless terminal unit 13-306.

[0078] Then, when determining possibility of construction of the wireless mesh M in the wireless system 1 on the basis of the investigation result stored by the investigation-result storing unit 1104, the host-apparatus processing unit 1102 of the host apparatus 11 in the second embodiment determines that the wireless mesh M in the wireless system 1 can be constructed because there are a plurality of un-overlapping wirelessly communicable routes, via which a message is transmitted, between all the wireless terminal units 13 and the wireless concentrator 12.

[0079] In the second embodiment, when determining on the

basis of the investigation result and the estimation result stored in the investigation-result storing unit 1104 that there is the wireless terminal unit 13, the number of routes of which in the wireless mesh M to the wireless concentrator 12 is smaller than the predetermined number, and determining that the wireless mesh M in the wireless in the wireless system 1 cannot be constructed, the host-apparatus processing unit 1102 of the host apparatus 11 investigates connection relations between the wireless terminal unit 13, an inter-terminal unit connection relation of which in either one of the X-axis direction and the Y-axis direction is unknown, and the other wireless terminal units 13. In the second embodiment, the host-apparatus processing unit 1102 of the host apparatus 11 investigates connection relations of the wireless terminal unit 13, an inter-terminal unit connection relation of which in either one of the X-axis direction and the Y-axis direction is unknown, and estimates connection relations on the basis of an investigation result to be capable of determining that the wireless mesh M in the wireless system 1 can be constructed.

[0080] Third Embodiment.

The disposition-information storing unit 1103 of the host apparatus 11 in a third embodiment stores disposition information shown in FIG. 49. The disposition information shown in FIG. 49 is position information indicating relative positions in the X-axis direction and the Y-axis direction of the wireless terminal units 13 based on the wireless concentrator 12. FIG. 49 is a diagram showing disposition information stored by a disposition-information storing unit of a host apparatus of a wireless system in the third embodiment.

[0081] In the disposition information shown in FIG. 49,

the wireless concentrator 12 is set as the origin in the X-axis direction and the Y-axis direction. In the disposition information shown in FIG. 49, position information of the room No. 101 is a distance DX-101 in the X direction and a distance DY-101 in the Y-axis direction from the wireless concentrator 12. In the disposition information shown in FIG. 49, position information of the room No. 102 is a distance DX-102 in the X-axis direction and the distance DY-102 in the Y-axis direction from the wireless concentrator 12. In the disposition information shown in FIG. 49, position information of the room No. 103 is a distance DX-103 in the X-axis direction and the distance DY-103 in the Y-axis direction from the wireless concentrator 12. In the disposition information shown in FIG. 49, position information of the room No. 504 is a distance DX-504 in the X-axis direction and the distance DY-504 in the Y-axis direction from the wireless concentrator 12. In the disposition information shown in FIG. 49, position information of the room No. 505 is a distance DX-505 in the X-axis direction and the distance DY-505 in the Y-axis direction from the wireless concentrator 12.

[0082] The wireless system 1 and the host apparatus 11 in the third embodiment can use the position information of the wireless terminal units 13 based on the wireless concentrator 12. Therefore, it is possible to accurately investigate connection relations of the wireless terminal units 13 and accurately determine possibility of introduction of the wireless system 1.

[0083] In the first embodiment and the second embodiment, the disposition-information storing unit 1103 stores the coordinates in the X-axis direction and the Y-axis direction of the rooms shown in FIG. 9. In the present

invention, the disposition-information storing unit 1103 can store coordinates in the X-axis direction, the Y-axis direction, and a Z-axis direction of the rooms. Note that the Z-axis direction is a direction orthogonal to both of the X-axis direction and the Y-axis direction.

5 [0084] In the structure 100, in general, the structures of the rooms 102 in the X-axis direction are sometimes different. However, the structures of the rooms 102 in the Y-axis direction are often the same. Therefore, in the third embodiment, the host-apparatus processing unit 1102 of the host apparatus 11 can investigate connection relations of the wireless terminal units 13 arranged in the X-axis direction in any one of a plurality of floors and estimate connection relations of the wireless terminal units 13 in the other floors on the basis of an investigation result.

15 [0085] Further, in the third embodiment, when structures are different in an upper part and a lower part of the structure 100, the host-apparatus processing unit 1102 of the host apparatus 11 can investigate and estimate connection relations of the wireless terminal units 13 independently in the upper part and the lower part of the structure 100.

20 [0086] In the present invention, when investigating connection relations between some of the wireless terminal units 13 and the wireless concentrator 12 and connection relations between some of the wireless terminal units 13, the host apparatus 11 does not always have to investigate the connection relations in order from the wireless terminal unit 13 closest to the wireless concentrator 12. In the present invention, when investigating connection relations between some of the wireless terminal units 13 and the wireless concentrator 12 and connection relations

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between some of the wireless terminal units 13, the host apparatus 11 can investigate connection relations between some of the wireless terminal units 13 in any order among all the wireless terminal units 13.

5 [0087] The configurations explained in the embodiments above indicate examples of the contents of the present invention. The configurations can be combined with other publicly-known techniques. A part of the configurations can be omitted or changed in a range not departing from the
10 spirit of the present invention.

Reference Signs List

[0088] 1 wireless system
11 host apparatus (estimation apparatus)
15 1102 host-apparatus processing unit (investigating unit, estimating unit, and determining unit)
1103 disposition-information storing unit
(information storing unit)
1104 investigation-result storing unit
20 (investigation-result storing unit)
12 wireless concentrator
13 wireless terminal unit.

CLAIMS

1. An estimation apparatus that acquires a connection relation of a wireless mesh in a wireless system in which the wireless mesh is configured by a plurality of wireless terminal units arranged along a row direction and a column direction and a wireless concentrator, the estimation apparatus comprising:

an information storing unit that stores disposition information of the plurality of wireless terminal units;

an investigating unit that investigates inter-concentrator-terminal connection relations between some of the plurality of wireless terminal units and the wireless concentrator and inter-terminal unit connection relations between some of the plurality of wireless terminal units;

an investigation-result storing unit that stores, as an investigation result, the inter-concentrator-terminal connection relations and the inter-terminal unit connection relations investigated by the investigating unit; and

an estimating unit that estimates, on the basis of the investigation result and the disposition information, connection relations between uninvestigated wireless terminal units of the wireless terminal units, the inter-terminal unit connection relations of which cannot be investigated, from the inter-terminal unit connection relations of the wireless terminal units, the investigation result of which is present, among the wireless terminal units having same disposition relations as disposition relations of the uninvestigated wireless terminal units.

2. The estimation apparatus according to claim 1, wherein, when investigating the inter-concentrator-terminal connection relations and the inter-terminal unit connection relations, the investigating unit performs the

investigation on the basis of the disposition information stored by the information storing unit.

3. The estimation apparatus according to claim 2, wherein,
5 when investigating the inter-concentrator-terminal connection relations and the inter-terminal unit connection relations, the investigating unit performs the investigation in order from a closest wireless terminal unit among the wireless terminal units, the closest
10 wireless terminal unit being the wireless terminal unit closest to the wireless concentrator.

4. The estimation apparatus according to claim 3, wherein,
when investigating the inter-concentrator-terminal
15 connection relations and the inter-terminal unit connection relations, the investigating unit executes, until one of still other wireless terminal units corresponds to the wireless terminal unit most away from the wireless concentrator in the row direction,

20 investigating connection relations between the closest wireless terminal unit and the other wireless terminal units,

 investigating connection relations between the closest wireless terminal unit and all same-row wireless terminal
25 units arranged in a same row in the row direction with respect to the closest wireless terminal unit,

 extracting an inter-terminal unit-most-distant wireless terminal unit most away from the wireless concentrator in the column direction among the other
30 wireless terminal units connected to the closest wireless terminal unit and all the same-row wireless terminal units,

 investigating connection relations between a same-column-adjacent-row wireless terminal unit further away

from wireless concentrator by one wireless terminal unit in the column direction than the inter-terminal unit-most-distant wireless terminal unit and the still other wireless terminal units, and

5 respectively investigating connection relations between the wireless terminal units present in a same column as the same-column-adjacent-row wireless terminal unit and arranged in a direction away from the wireless concentrator and the still other wireless terminal units in
10 the column direction in order from the same-column-adjacent-row wireless terminal unit.

5. The estimation apparatus according to claim 1, further comprising a determining unit, wherein

15 the determining unit determines presence or absence of the wireless terminal unit, a number of routes in the wireless mesh from which to the wireless concentrator is smaller than a predetermined number, from the inter-concentrator-terminal connection relations and the inter-
20 terminal unit connection relations obtained from the investigation-result storing unit and the estimating unit.

6. The estimation apparatus according to claim 5, wherein, when the determining unit determines that there is the
25 wireless terminal unit, the number of routes of which is smaller than the predetermined number, the investigating unit investigates connection relations between the wireless concentrator, the inter-terminal unit connection relation of which in either one of the row direction and the column
30 direction is unknown, and the other wireless terminal units.

7. The estimation apparatus according to any one of claims 1 to 6, wherein the disposition information stored

by the information storing unit is position information of the wireless terminal units based on the wireless concentrator.

5 8. A wireless system comprising:

a plurality of wireless terminal units arranged along a row direction and a column direction;

a wireless concentrator configuring a wireless mesh in conjunction with the plurality of wireless terminal units;

10 an information storing unit that stores disposition information of the plurality of wireless terminal units;

an investigating unit that investigates inter-concentrator-terminal connection relations between some of the wireless terminal units and the wireless concentrator
15 and inter-terminal unit connection relations between some of the wireless terminal units;

an investigation-result storing unit that stores the inter-concentrator-terminal connection relations and the inter-terminal unit connection relations investigated by
20 the investigating unit;

an estimating unit that estimates, on the basis of an investigation result stored by the investigation-result storing unit and the disposition information, connection relations between uninvestigated wireless terminal units of
25 the wireless terminal units, the inter-terminal unit connection relations of which cannot be investigated, from the inter-terminal unit connection relations of the wireless terminal units, the investigation result of which is present, among the wireless terminal units having same
30 disposition relations as the disposition relations of the uninvestigated wireless terminal units; and

a determining unit that determines possibility of construction of the wireless mesh from the inter-

concentrator-terminal connection relations and the inter-terminal unit connection relations obtained from the investigation-result storing unit and the estimating unit.