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(54) **OPERATION ARRANGEMENT SUPPORT SYSTEM AND METHOD THEREOF**

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(57) **ABSTRACT**

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An operation arrangement work is accelerated by improving efficiency of not only process of generating an operation arrangement proposal but also process of confirming whether the operation arrangement proposal is good or not by a user. An operation support system has an operation arrangement proposal generation part (1110) which executes automatic generation of an operation arrangement proposal, a diagram prediction part which executes simulation of train operation in the future, a diagram display part (1120) which displays an operation schedule and the operation arrangement proposal as a diagram, and a user input part which receives input of a parameter from the user. The system has a snapshot restoration part (1130) which restores snapshots of the operation arrangement proposal in an automatic generation process on the basis of a diagram change history outputted by the operation arrangement proposal generation part (1110), and a snapshot display input part (1140) which displays to the user a snapshot according to input from the user.

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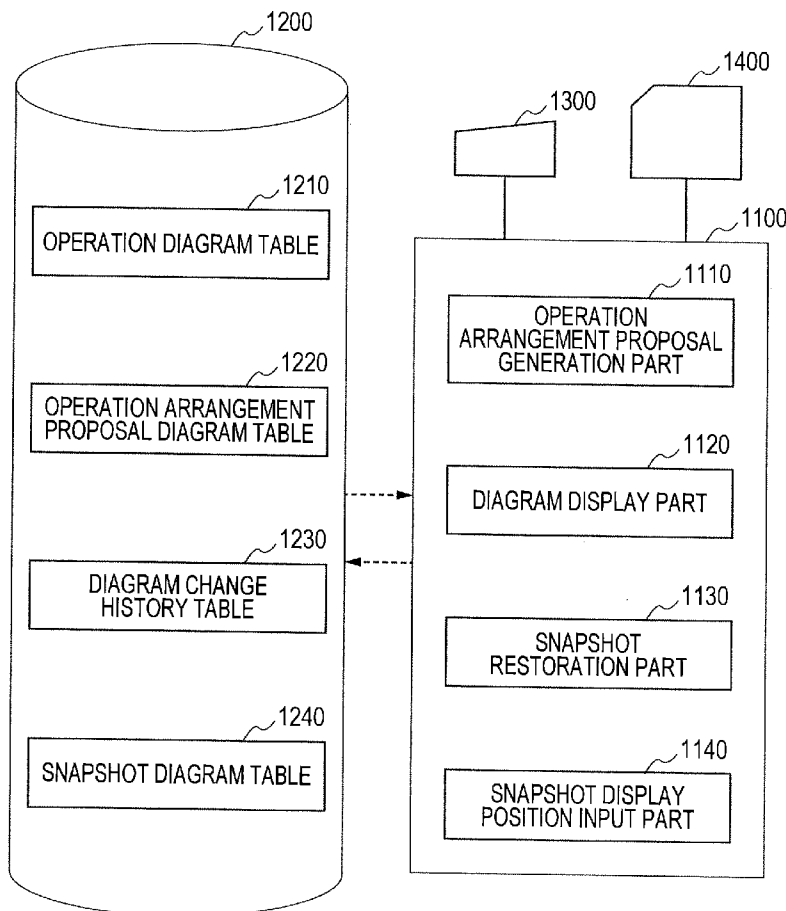


FIG. 1

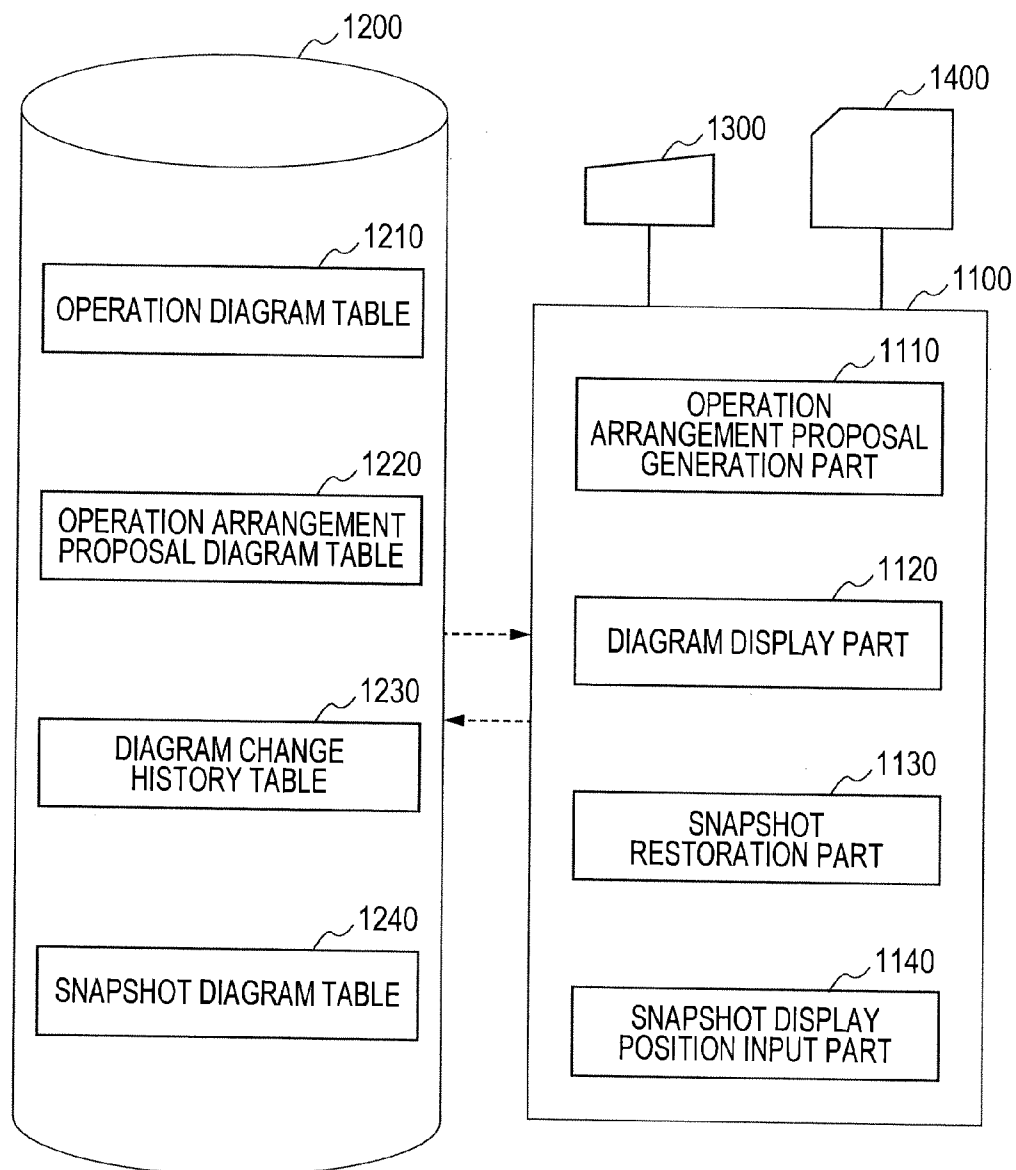


FIG. 2

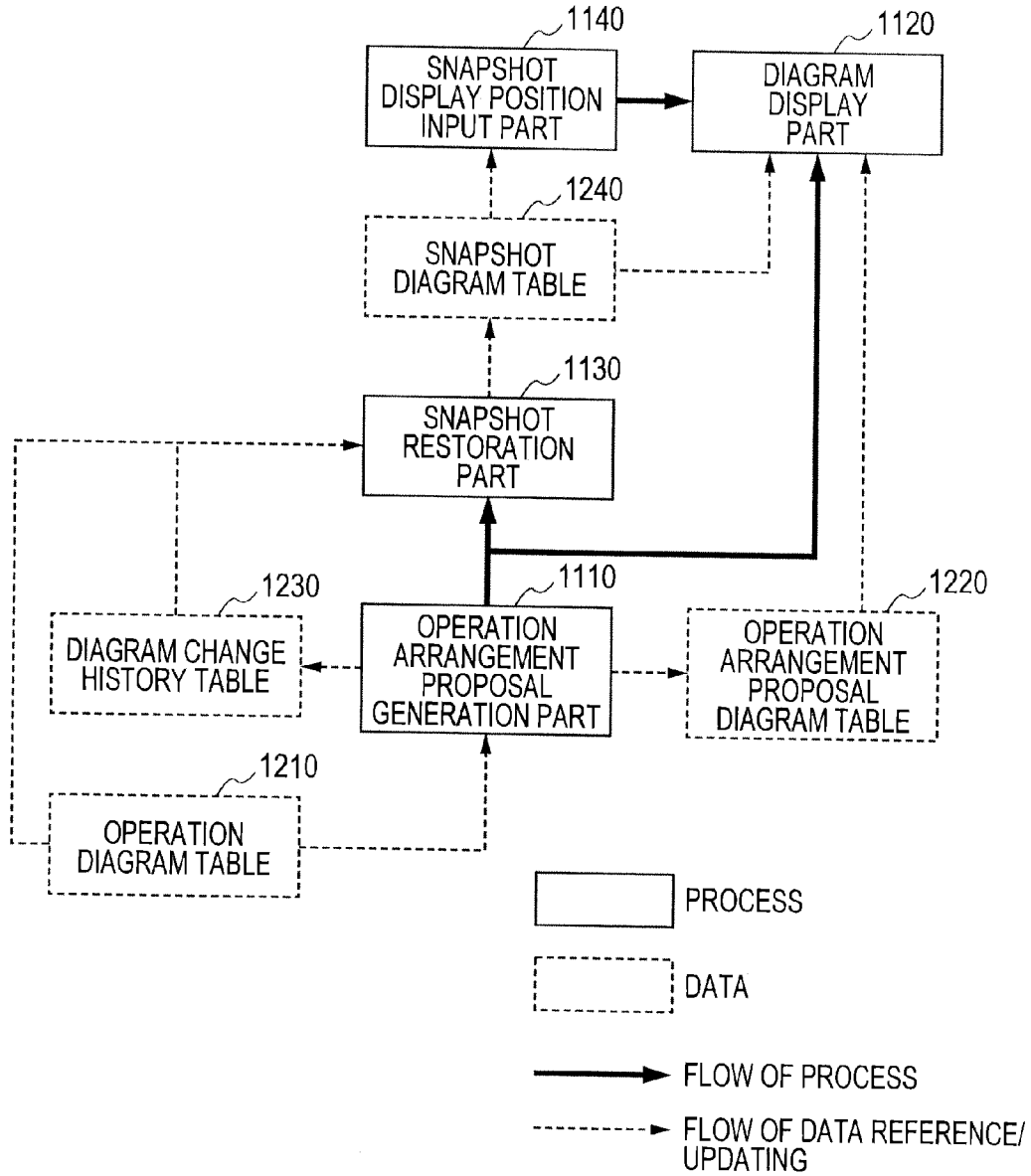


FIG. 3

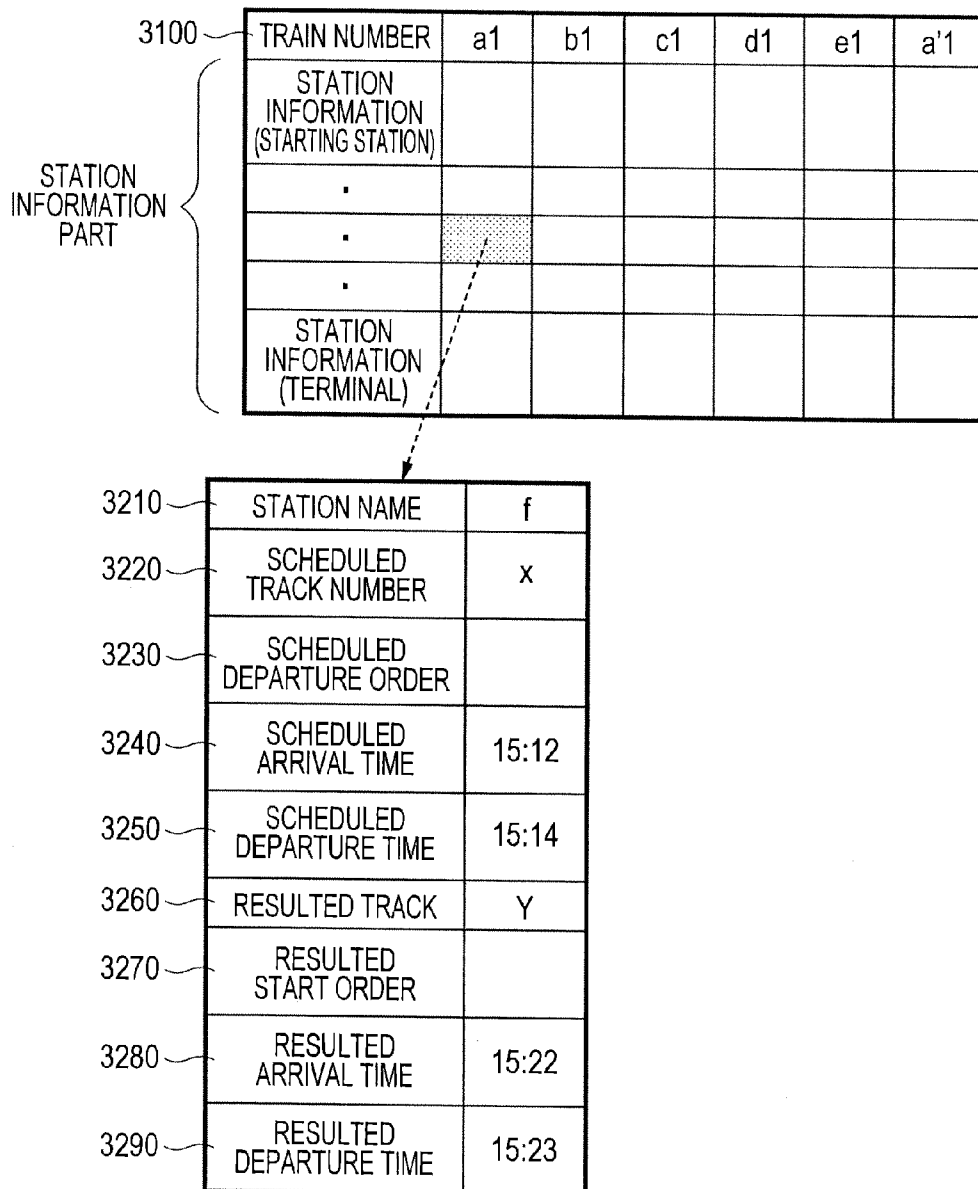
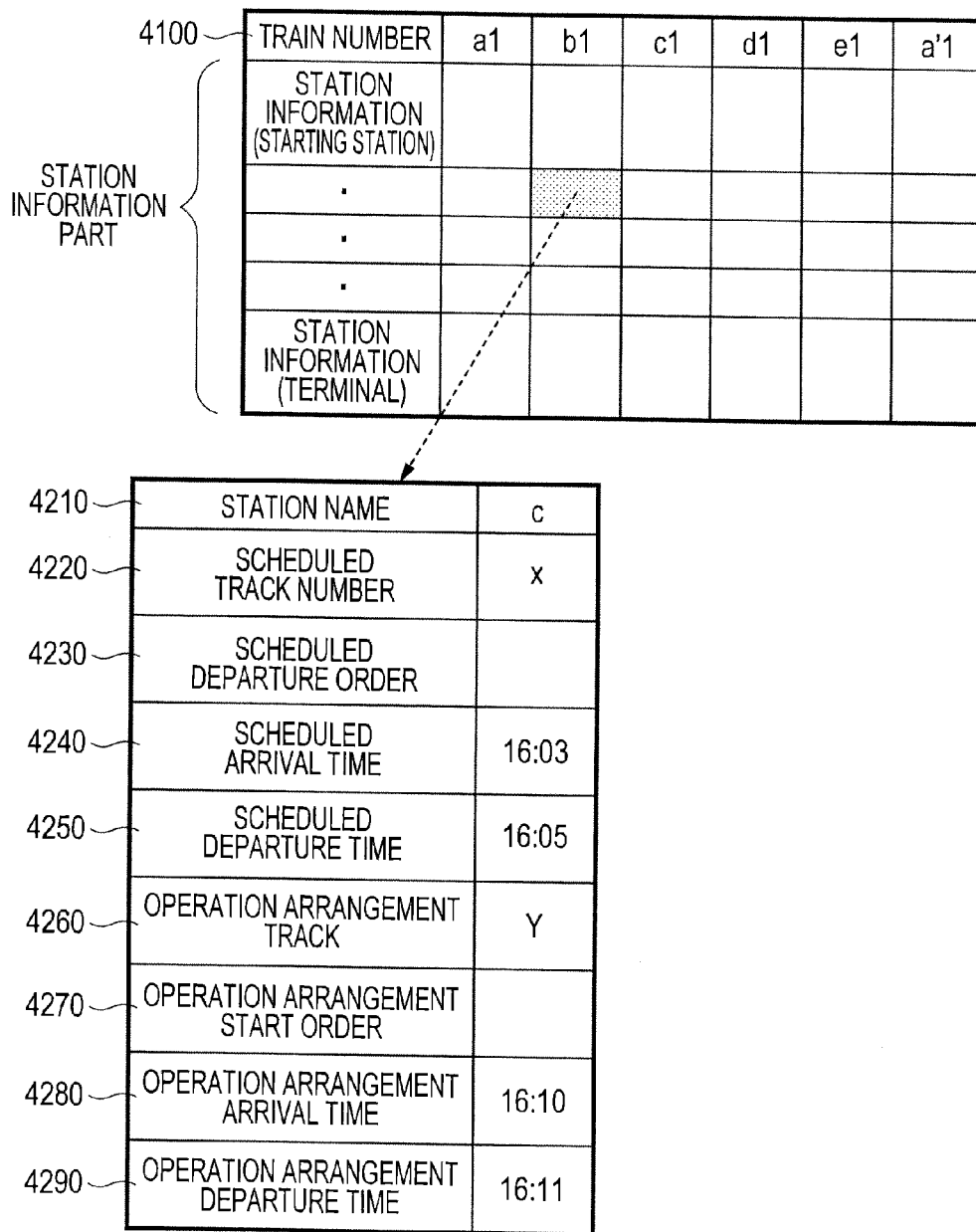


FIG. 4



*FIG. 5*

ID	DIAGRAM CHANGE DETAILS
0020	CHANGE DEPARTURE ORDER OF b1 TO PLACE BEFORE a1 AT STATION C
0021	CHANGE TRACK OF b1 FROM x-TH TO y-TH AT STATION C
0022	CHANGE ORDER OF c1 TO DEPART BEFORE f1 AT STATION E
.	
0128	CHANGE ORDER OF p1 TO DEPART BEFORE q1 AT STATION Z

FIG. 6

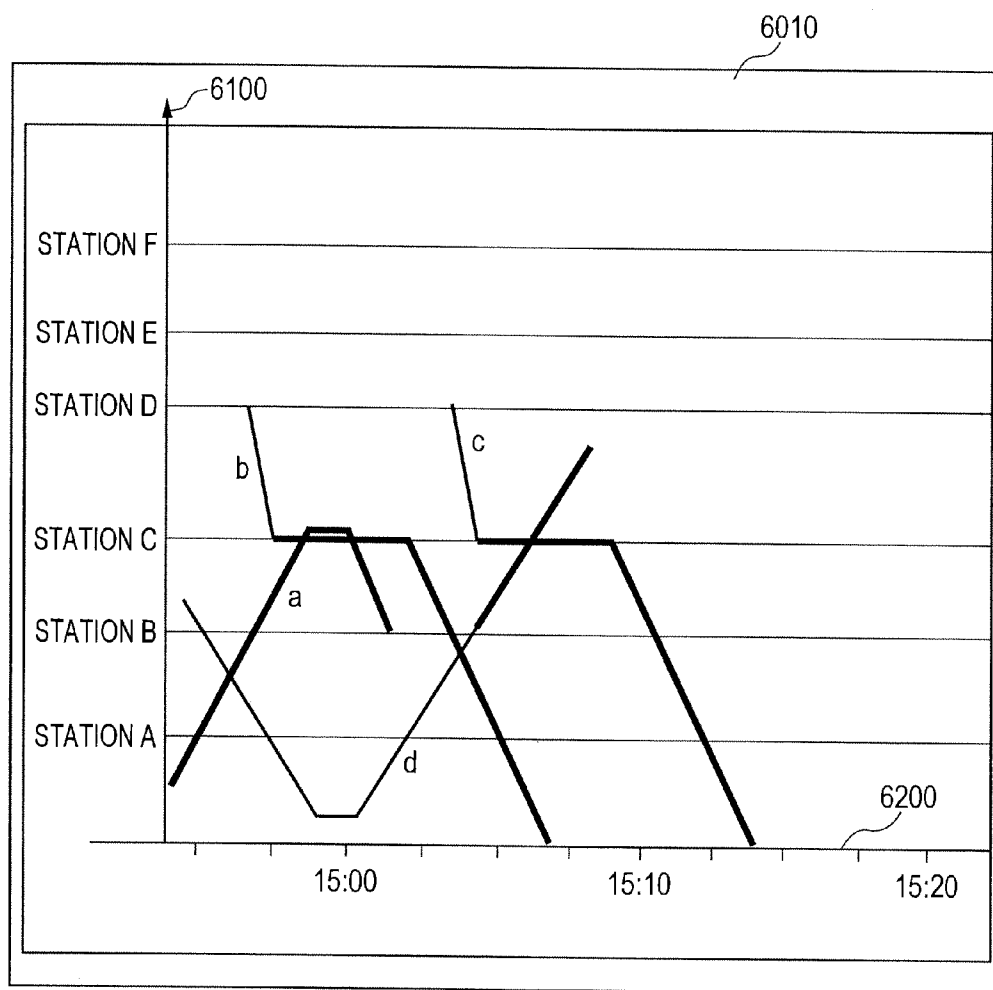


FIG. 7

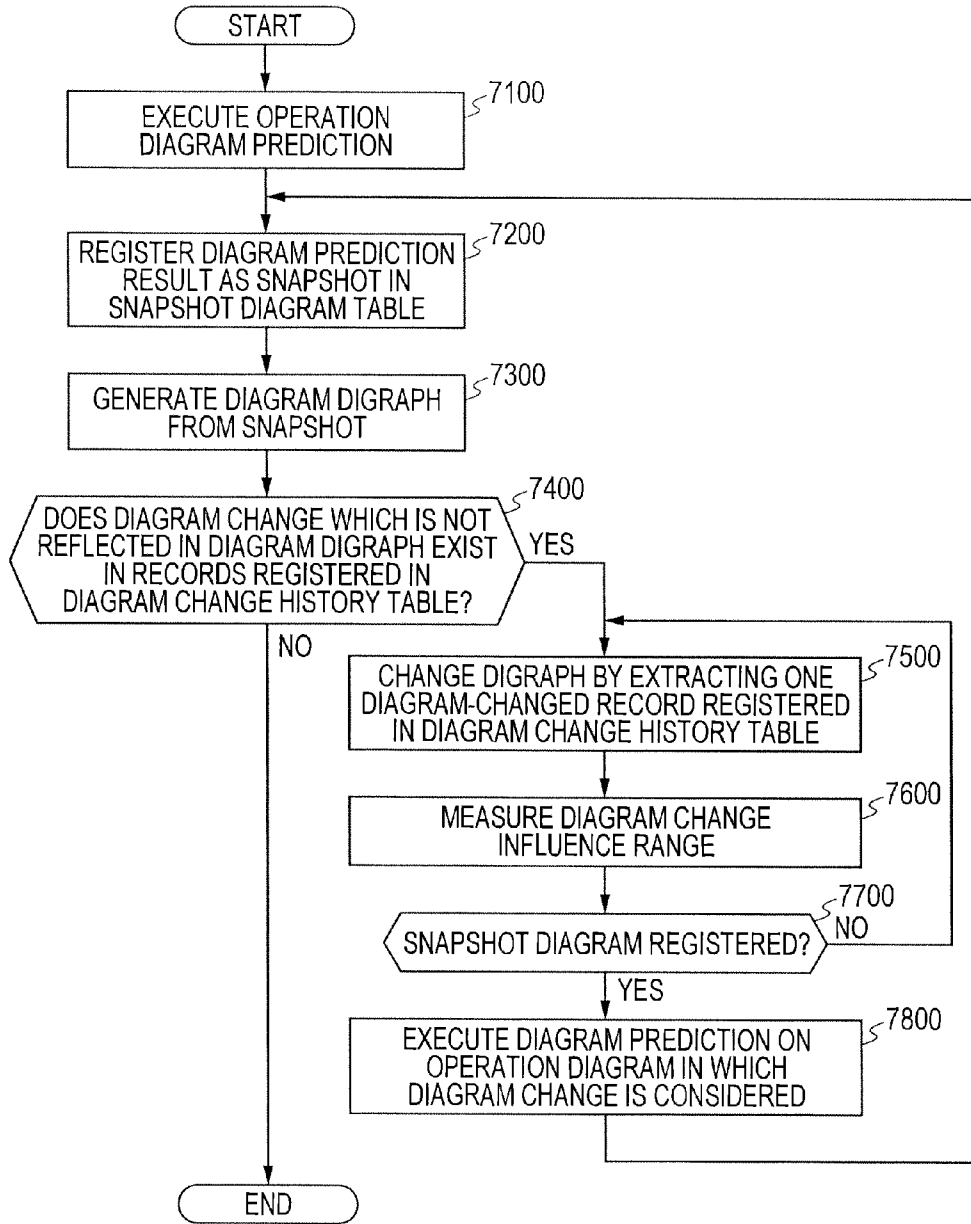




FIG. 8

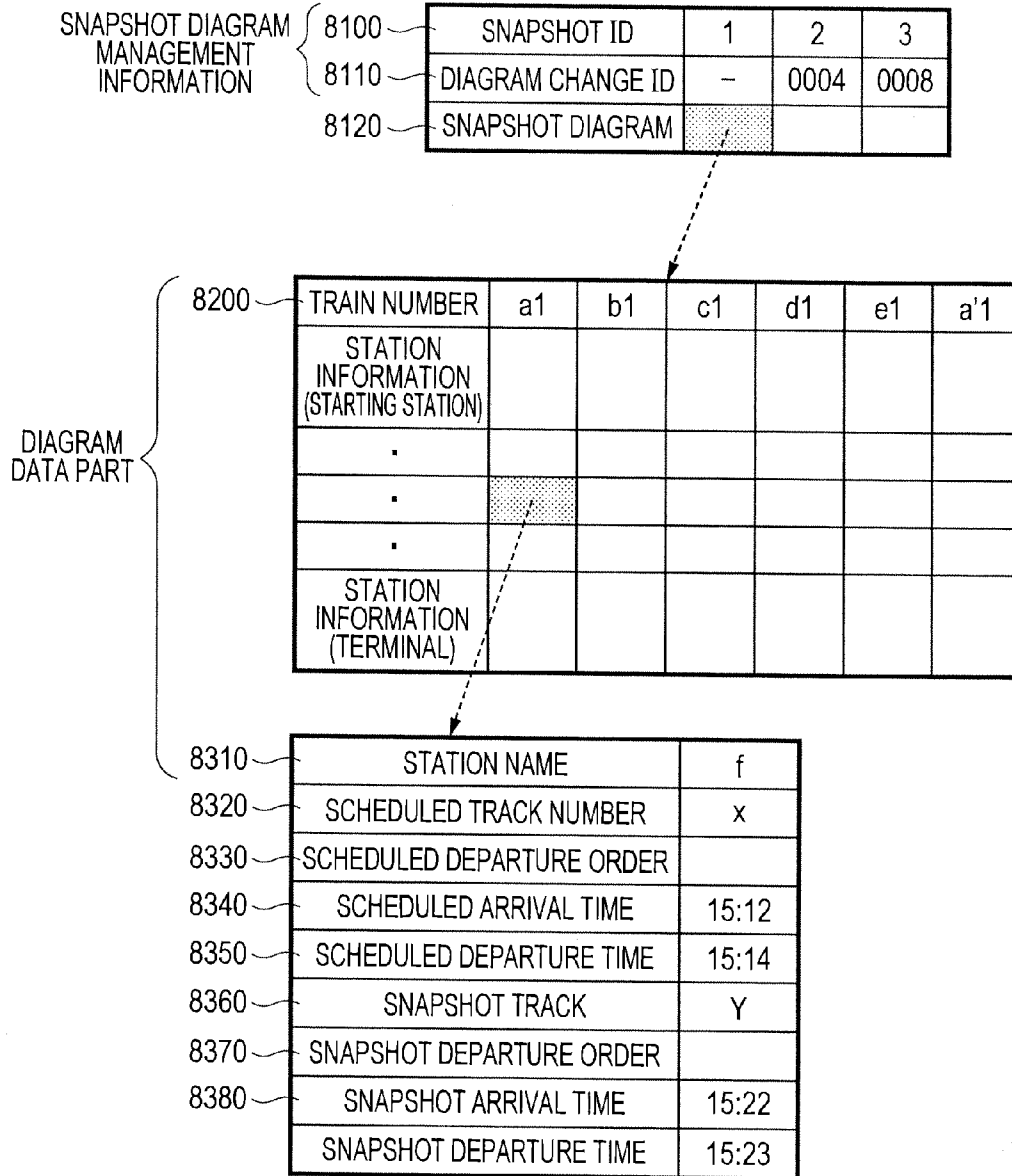


FIG. 9

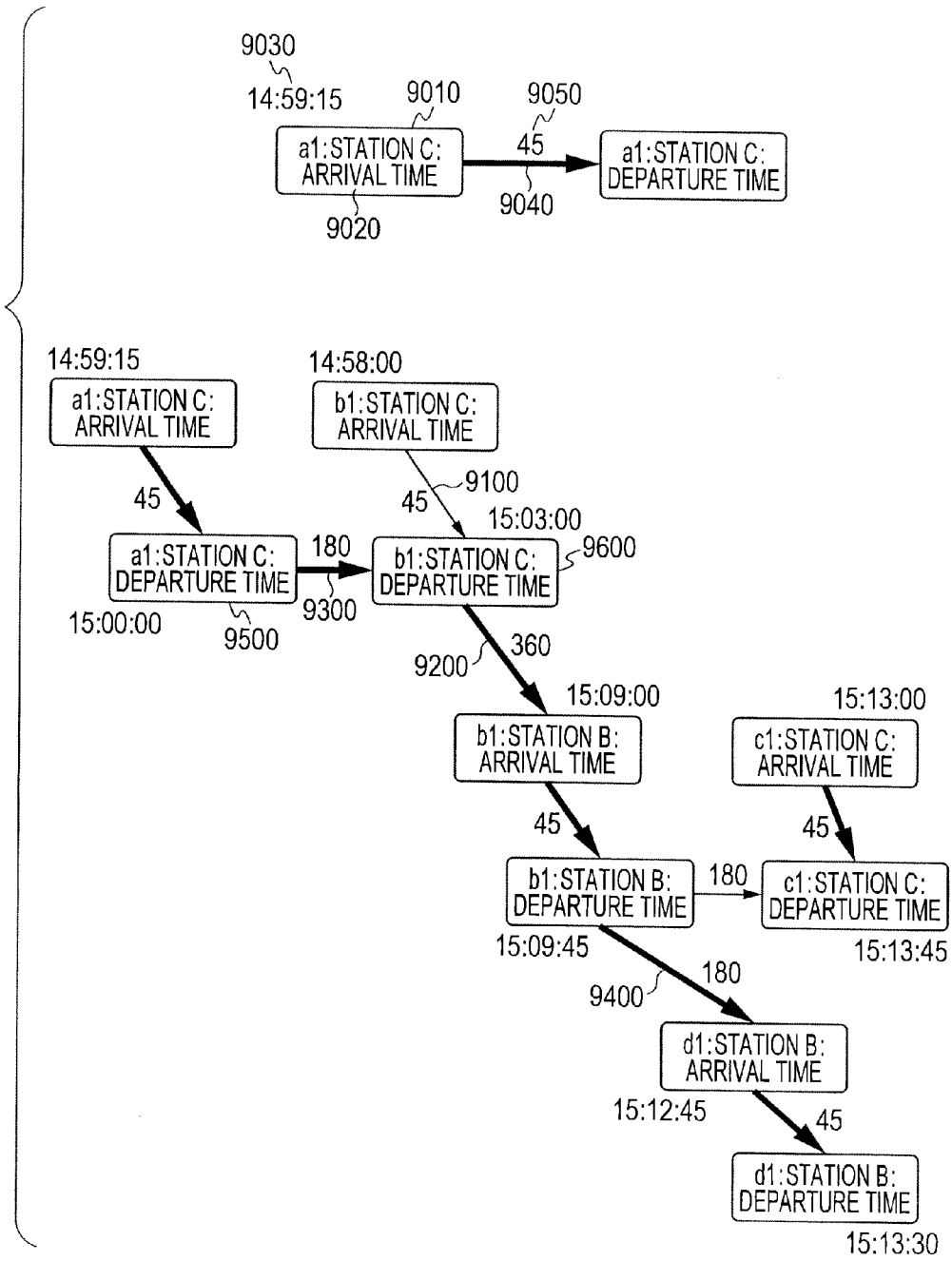


FIG. 10

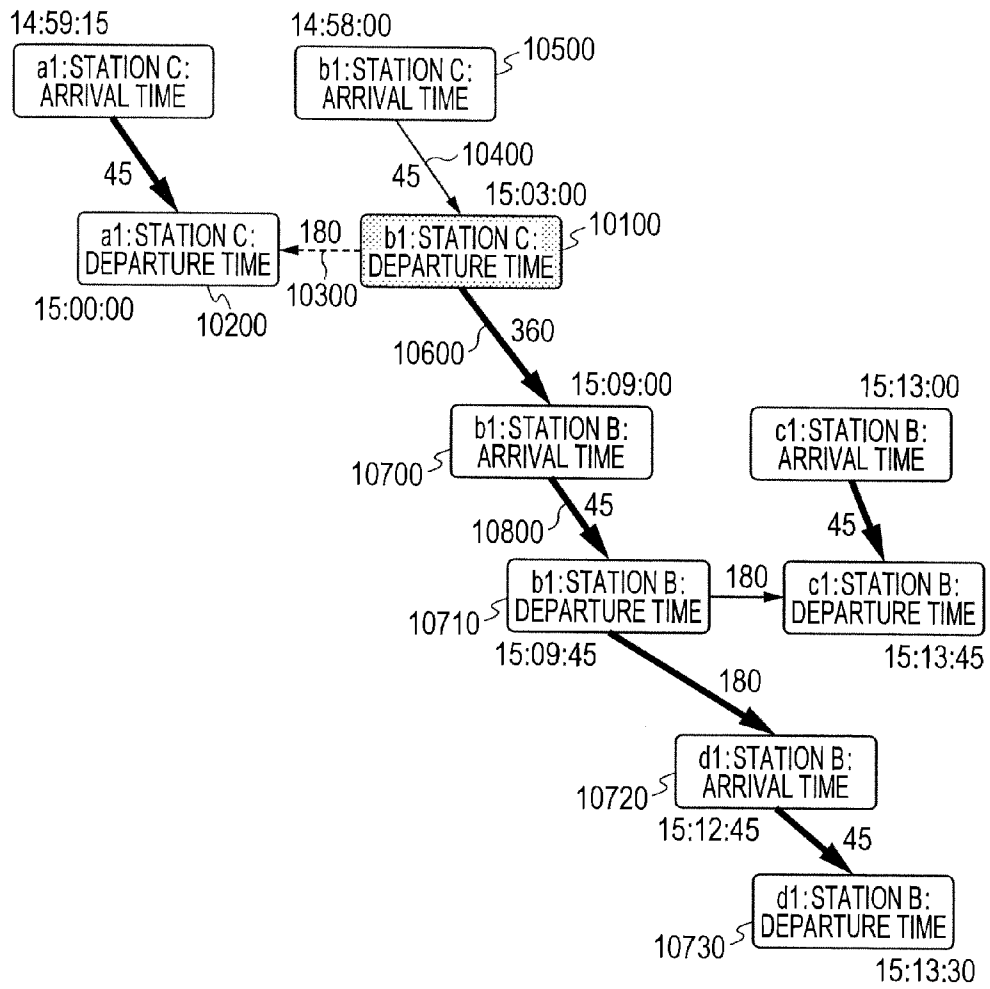


FIG. 11

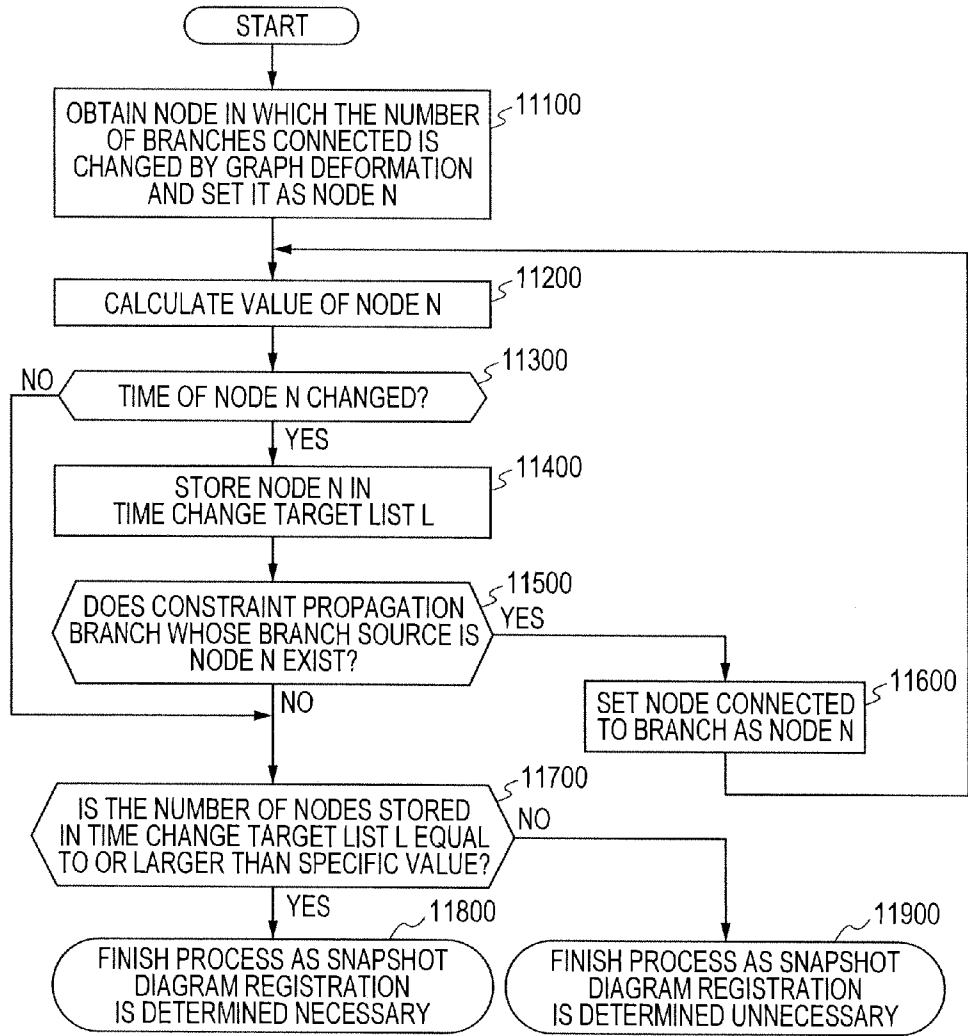
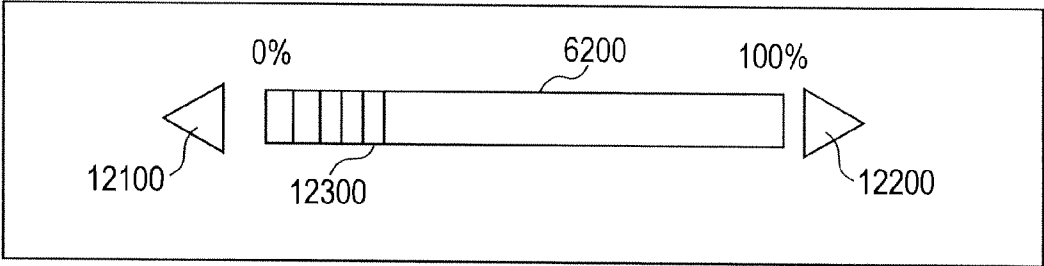


FIG. 12



**OPERATION ARRANGEMENT SUPPORT SYSTEM AND METHOD THEREOF**

TECHNICAL FIELD

[0001] The present invention relates to an operation arrangement support system for executing automatic generation of an arrangement proposal for restoring operation disruption in operation arrangement work.

[0002] Operation arrangement work for restoring an operation schedule when disruption occurs in train operation due to bad weather, vehicle failure, or the like is very complicated planning work requiring not only determination of physical conditions such as train travel speeds, shelter facility in stations, and the like but also all-aspects and broad-viewpoint determination in which the entire transport system including operation ratios of vehicles and occupants and services is considered. Consequently, a technique on automatization of operation arrangement for reducing burden on commanders who control the work and promoting advancement of technique has been developed (refer to patent document 1).

PRIOR ART DOCUMENT

Patent Document

[0003] Patent document 1: Japanese Unexamined Patent Application Publication 2004-224113

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0004] However, in the technique disclosed in the patent document 1, the user can see only a final result of an operation arrangement proposal which is automatically generated. The user can confirm whether the operation arrangement proposal is good or not by an evaluation index indicative of good or bad of a general operation arrangement proposal such as passenger dissatisfaction. It is however difficult for the user to confirm whether or not each of diagram changes accumulated for creating an operation arrangement proposal is good. In the case where a number of diagram changes are made at the time of serious disruption or the like, time required to confirm each of the diagram changes also increases.

[0005] An object of the present invention is to provide a system and method of realizing increase in speed of operation arrangement work by improving efficiency of not only process of creating an operation arrangement proposal but also process of confirming whether an operation arrangement proposal made by the user is right or not.

[0006] The present invention is characterized in that an operation arrangement support system having: an operation arrangement proposal generation part which executes automatic generation of an operation arrangement proposal; a diagram prediction part which executes a simulation of train operation in the future; a diagram display part which displays an operation schedule and the operation arrangement proposal as a diagram; and a user input part which receives input of a parameter from a user is provided with: a snapshot restoration part which restores snapshots of an operation arrangement proposal in an automatic generation process on the basis of a diagram change history outputted by the opera-

tion arrangement proposal generation part; and a snapshot display input part which displays to the user a snapshot according to a user input.

Effect of the Invention

[0007] According to the present invention, by improving efficiency of a process of confirming an operation arrangement proposal which is automatically generated by a computer, time required to apply the operation arrangement proposal to actual operation can be shortened.

[BRIEF DESCRIPTION OF DRAWINGS]

[0008] [FIG. 1] A system configuration diagram of an operation arrangement support system.

[0009] [FIG. 2] A diagram showing a process flow of the operation arrangement support system.

[0010] [FIG. 3] A diagram showing a table configuration of an operation diagram table 1210.

[0011] [FIG. 4] A diagram showing a table configuration of an operation arrangement proposal diagram table 1220.

[0012] [FIG. 5] A diagram showing a table configuration of a diagram change history table 1230.

[0013] [FIG. 6] A diagram.

[0014] [FIG. 7] A diagram showing a process flow of a snapshot restoration part 1130.

[0015] [FIG. 8] A diagram showing a table configuration of a snapshot diagram table 1240.

[0016] [FIG. 9] A diagram showing a diagram digraph.

[0017] [FIG. 10] A diagram showing a diagram digraph.

[0018] [FIG. 11] A diagram showing a process flow of partial diagram change influence range measurement of the process of the snapshot restoration part 1130.

[0019] [FIG. 12] A snapshot display position input part 1140.

MODE FOR CARRYING OUT THE INVENTION

[0020] An embodiment according to the present invention will be described below with reference to FIGS. 1 to 12. The embodiment will be described on assumption that an operation arrangement support system in a railroad operation system is an object to which the invention is applied.

[0021] First, the system configuration of the operation arrangement support system according to an embodiment of the present invention will be described with reference to FIG. 1.

[0022] FIG. 1 is a system configuration diagram of the operation arrangement support system according to the embodiment of the invention. The operation arrangement system of the embodiment has a configuration of a computer system and includes a central processing unit 1100 for executing a program, a database 1200 for storing data, an input unit 1300 for accepting an input from the user, and a GUI display unit 1400 for displaying various GUIs such as a diagram. The database 1200 is constructed on a storage device such as a hard disk.

[0023] The central processing unit 1100 executes, as programs, an operation arrangement proposal generation part 1110 for automatically generating an operation arrangement proposal for restoring a disruption in a train diagram, a diagram display part 1120 for graphically displaying a train diagram, a snapshot restoration part 1130 for restoring a snapshot of the operation arrangement proposal in an operation arrangement proposal automatic generation process per-

formed by the operation arrangement proposal generation part 1110, and a snapshot display position input part 1140 for accepting a designation input of a snapshot which is displayed as a diagram in the diagram display part 1120.

[0024] The database 1200 has an operation diagram table 1210 which stores diagram data of an operation schedule obtained by reflecting past travel record in an operation diagram according to plan, an operation arrangement proposal diagram table 1220 which stores diagram data of an operation arrangement proposal generated by the operation arrangement proposal generation part 1110, a diagram change history table 1230 which stores diagram change history executed in the operation arrangement proposal generation, and a snapshot diagram table 1240 which stores diagram data of a snapshot restored by the snapshot restoration part 1130.

[0025] The input unit 1300 is an input device for a general computer, such as a mouse or a keyboard.

[0026] The display unit 1400 is an output device used in a computer, such as a display.

[0027] Next, the flow of processes in the operation arrangement support system will be described. On receipt of an operation arrangement proposal automatic generation request from the user, the operation arrangement proposal generation part 1110 automatically generates an operation arrangement proposal on the basis of diagram data stored in the operation diagram table 1210, stores the generated operation arrangement proposal to the operation arrangement proposal diagram table 1220, and stores a diagram change executed in the operation arrangement proposal generation to the diagram change history table 1230.

[0028] FIG. 3 is a diagram showing the table configuration of the operation diagram table 1210. The operation diagram table 1210 manages one train as one record and stores a station information part having items on, as items in a record, train number 3100 indicative of unique ID of a train, names of stations the train travels, and departure and arrival time. The station information part manages information of one station (hereinbelow, station information) as one block and has the station information in travel order. Therefore, the station information at the beginning of the station information part is station information on the starting station, and the station information at the end is station information on the terminal station. The station information has items of station name 3210 indicative of the name of the station, a scheduled track number 3220, scheduled departure order 3230, scheduled arrival time 3240, and scheduled departure time 3250 showing a track to be used at the time of planning, departure order, departure time, and arrival time, and resulted track 3260, resulted start order 3270, resulted arrival time 3280, and resulted departure time 3290 showing a track used in an operation record, departure order, departure time, and arrival time.

[0029] FIG. 4 is a diagram showing the table configuration of the operation arrangement proposal diagram table 1220. The operation arrangement proposal diagram table 1220 manages one train as one record like the operation diagram table 1210 of FIG. 1 and stores station information such as train number 4100 indicative of unique ID of a train as items in a record. Like the operation diagram table 1210, the station information includes items of station name 4210, a scheduled track number 4220, scheduled departure order 4230, scheduled arrival time 4240, and scheduled departure time 4250 and has, as items unique to the operation arrangement proposal diagram table, operation arrangement track 4260 and

operation arrangement start order 4270 showing a track and departure order in an operation arrangement proposal, and operation arrangement arrival time 4280 and operation arrangement departure time 4290 showing arrival time and departure time of a diagram prediction result for the operation arrangement proposal.

[0030] FIG. 5 is a diagram showing the table configuration of the diagram change history table 1230. The diagram change history table 1230 is a table having details of a diagram change which is made to generate the operation arrangement proposal by the operation arrangement proposal generation part 1110 of FIG. 1, and has items of ID 5100 showing peculiar ID on the details of the diagram change, and diagram change details 5200 showing the details of a diagram change.

[0031] Referring again to FIG. 2, the description of the process will be continued. On completion of automatic generation of the operation arrangement proposal in the operation arrangement proposal generation part 1110, display of the operation arrangement proposal and snapshot restoration of the operation arrangement proposal in the automatic generation process are executed by the diagram display part 1120 and the snapshot restoration part 1130, respectively.

[0032] FIG. 6 is a diagram showing a screen layout which is displayed to the user by the diagram display part 1120. In the diagram displaying a diagram in a diagram display area 6010 which displays a diagram, stations along which a train travels are indicated on the vertical axis 6100, and time is indicated on the horizontal axis 6200. A train diagram is displayed as a two-dimensional graph. A portion displayed by an oblique line on the graph shows that a train is traveling between stations, and a portion indicated by a horizontal line means that a train is stopping at a station. A thick line in the diagram shows that a train is being delayed.

[0033] FIG. 7 is a diagram showing a process flow of the snapshot restoration part 1130. In step 7100, prediction for an operation diagram is executed, and predicted arrival/departure time in a future part in which an operation record does not exist is calculated. In step 7200, the diagram prediction result is registered in the snapshot diagram table 1240 in FIG. 1.

[0034] FIG. 8 is a diagram showing the table configuration of the snapshot diagram table 1240. The snapshot diagram table 1240 is divided in a snapshot management information part and a diagram data part. The snapshot management information part has items of snapshot ID 8100 showing peculiar ID of snapshot diagram data, and a diagram change ID 8110 indicative of the ID of a diagram change reflected in a snapshot, in diagram changes stored in the diagram change history table 1230 in FIG. 1. Like the operation diagram table 1210 in FIG. 1 and the operation arrangement proposal diagram table 1220, the diagram data part manages one train as one record and stores, as items in a record, station information such as train number 8200 indicative of unique ID of a train. Like the operation diagram table 1210 and the like, the station information has items of station name 8310, a scheduled track number 8320, scheduled departure order 8330, scheduled arrival time 8340, and scheduled departure time 8350, and has, as items unique to the snapshot diagram table, snapshot track 8360 and snapshot departure order 8370 indicative of a track which is used and departure order in a snapshot of an operation arrangement proposal, and snapshot arrival time 8380 and snapshot departure time 8390 indicative of arrival time and departure time of a diagram prediction result for a snapshot. A snapshot registered first is operation diagram data

itself in which no diagram change is reflected. Consequently, 1 is registered as the snapshot ID **8100**, an invalid value is registered as the diagram change ID **8110**, and a diagram prediction result for the operation diagram is registered as snapshot diagram data.

[0035] Referring again to FIG. 7, the description of the process flow of the snapshot restoration part **1130** will be continued. In step **7300**, a diagram digraph expressing diagram data registered in the snapshot diagram table **1240** and its prediction result is generated.

[0036] FIG. 9 is a diagram illustrating a diagram digraph. The diagram digraph is a digraph expressing diagram data showing departure time and arrival time of diagram data as nodes, departure/arrival times in a diagram prediction result as values of the nodes, a constraint condition related to time calculation existing between nodes as a branch, a label of the branch as a time difference to be assured between times of the nodes coupled to each other via the branch, and a direction from an earlier node to a later node as the direction of the branch. A quadrangle frame in the diagram expresses a node **9010**, characters written in the quadrangle frame expresses an attribute **9020** of the node, time written on the outside of the quadrangle is value **9030** of the node, an arrow indicates a branch **9040**, and numeral written on the side of the arrow expresses label **9050**. The branches include a train stop time constraint branch **9100** extended between nodes indicative of departure/arrival times of the same train in the same station, an inter-station travel time constraint branch **9200** extended between the departure time node of the same train and an arrival time node of the next station in the travel direction, a departure interval constraint branch **9300** extended between departure time nodes of trains departing successively from the same station, and a track competition constraint branch **9400** extended between the arrival time node and the departure time node of two trains using the same track. Although not shown, there are also an arriving-train interval branch extended between arrival time nodes of two trains arriving at the same station in the same direction, an intersection hindrance constraint branch extended between arrival/departure time nodes of two trains traveling at a level intersection, and a shuttle time constraint branch extended between a last arrival time node and a first departing time node of two shuttle trains. The branches have values of different labels. For example, the label of the train stop time constraint branch **9100** is 45 indicative of the minimum stop time, and the label of the inter-station travel time constraint branch **9200** is 360 indicative of the minimum travel time. A branch having a value obtained by adding the value of a node from which the branch extends and the label of the branch, the value being the same as the value of a node to which the branch is coupled is set as a constraint propagation branch, and the branch is expressed by a thick line in the diagram like the branch **9200**.

[0037] Referring again to FIG. 7, the description of the process flow of the snapshot restoration part **1130** will be continued. In step **7400**, whether or not a diagram change which is not reflected in the diagram digraph exists in diagram changes registered in the diagram change history table **1230** shown in FIG. 1 is determined. When all of diagram changes are reflected, the process of the snapshot restoration part **1130** is finished. When there is a diagram change which is not reflected, the process advances to step **7500**. In step **7500**, a diagram change described in the diagram change history, of one record is extracted in accordance with the order of operation arrangement generating processes, and the diagram

digraph is deformed on the basis of the diagram change. In the following description, it is assumed that, as an example, the diagram change of “change of departure order of **b1** to order before **a1** at station C” indicated by record **5310** in FIG. 5 is extracted in step **7500**.

[0038] FIG. 10 is a diagram showing a diagram digraph deformed on the basis of the process of step **7500**. The diagram digraph before the deformation is as shown in FIG. 9, and the diagram change as the base of the deformation is the above-described “change of departure order of **b1** to order before **a1** at station C”. In FIG. 9 as the diagram digraph before the deformation, the departure interval constraint branch **9300** indicative of the departing order constraint of **a1** and **b1**, which is extended from the node **9500** showing the departure time of **a1** at station C and coupled to the node **9600** showing the departure time of **b1** at station C, is deformed. In FIG. 10 as the diagram digraph after the deformation, the direction of a branch **10300** indicative of the departure order constraint of **a1** and **b1** is reversed so that a node **10100** showing the departure time of **b1** at station C becomes a node from which the branch is extended, and a node **10200** showing the departure time of **a1** at station C becomes a node to which the branch is coupled. At the time point of step **7500** in FIG. 7, only a branch is deformed, and the value of a node is not changed. Consequently, a state where inconsistency occurs in the relation between the branch indicative of the constraint and the node value is temporarily maintained.

[0039] Referring again to FIG. 7, the description of the process flow of the snapshot restoration part **1130** will be continued. In step **7600**, the range of the influence exerted by the diagram change is measured by the number of nodes in which a value is changed by the change in the diagram digraph in step **7500**.

[0040] FIG. 11 is a diagram showing a process flow of the diagram change influence range measurement. In step **11100**, a node in which the number of branches connected as branches from which the node extends decreases as compared with the deformation is obtained by the graph deformation executed in step **7500** in FIG. 7, and is set as a node N to be processed. In FIG. 10, the number of branches extended to the node **10100** changes from two in FIG. 9 before deformation of the graph to one, so that the node **10100** is set as the node N. In step **11200**, the value of the node N is calculated. The value of the node N is calculated by the following mathematical formula (a).

$$\text{Value(NodeN)} = \text{Max}(\forall b: \text{label}(b) + \text{Value}(\text{Node}(b, \text{Base}))) \tag{a}$$

- \*Value(NodeN): the value of the node N
- \*Max(∀i:f(i)): the maximum value of f(i) when f(i) is executed on all of i that apply
- \*b: branches to which the node N is connected
- \*label(b): label of branch
- \*Node(b,Base): node from which the branch b is extended

[0041] In the diagram digraph of FIG. 10, the branch extended to the node **10100** as the node N is only the branch **10400**, so that the value of the node N is calculated as 14:58:45 obtained by adding the label value 45 (seconds) of the branch **10400** and the value (14:58:00) of the node (**10500**) as the branch source.

[0042] Referring again to FIG. 11, the description of the process flow of the diagram change influence range measurement will be continued. In step **11300**, the value of the node calculated in step **11200** is compared with the value of the node before calculation. When there is a change in the value



of the node, the program advances to step **11400**. When there is no change, the program advances to step **11700**. In the embodiment, the value before calculation of the node N is 15:03:00 in FIG. **10** and the value calculated in step **11200** is 14:58:45, so that there is a change in the value of the node N, and the program advances to step **11400**.

**[0043]** In step **11400**, the node N is stored as a node influenced by the diagram change into a time change target list L. In step **11500**, whether a constraint propagation branch whose branch source is node N exists or not is determined. When there is a constraint propagation branch, the program advances to step **11600**. When there is no such branch, the program advances to step **11700**. In the embodiment, the branch **10600** whose branch source is the node **10100** is the constraint propagation branch shown by a thick line in FIG. **10**. Consequently, it is determined in step **11500** that there is a constraint propagation branch, and the program advances to step **11600** in FIG. **11**. In step **11600**, the node to which the constraint propagation branch whose existence is confirmed in step **11500** is connected is set as the node N. After that, the program returns to the process in step **11200**. In the embodiment, the node **10700** in FIG. **10** is set as the node N, and the program advances to step **11200** in FIG. **11**. Hereinafter, as the process advances, nodes **10710**, **10720**, and **10730** in FIG. **10** become nodes N which are stored in the time change target list L in step **11400** in FIG. **11**, the process in step **11500** on the node **10730** is executed and, after that, the program advances to step **11700**. In step **11700**, whether the number of nodes stored in the time change target list L is equal to or larger than a specific value is determined. When the number of nodes is equal to or larger than the specific value, the program advances to step **11800**. When the number of nodes is less than the specific value, the program advances to step **11900**. The specific value is a value which can be arbitrarily set by the user. In step **11800**, it is determined that snapshot registration is necessary, and the diagram change influence range measuring process is finished. In step **11900**, it is determined that the snapshot registration is unnecessary, and the process is finished.

**[0044]** Referring again to FIG. **7**, the description of the process flow of the snapshot restoration part **1130** will be continued. In step **7700**, whether the snapshot registration becomes necessary in the process of step **7600** or not is determined. When the snapshot registration becomes necessary, the program advances to step **7800**. When the snapshot registration becomes unnecessary, the program advances to step **7500**. In step **7800**, diagram prediction is executed on the operation diagram to which the diagram change extracted in step **7500** is added. After that, the program advances to step **7200**. In the embodiment, the diagram prediction is executed on the diagram data obtained by reflecting the diagram change in the record **5310** in FIG. **5** in the operation diagram. In the case where the snapshot registration is unnecessary, the program advances to step **7500**. In step **7500**, the diagram change shown in a record **5320** in FIG. **5** is extracted, and the digraph in which the diagram change in the record **5310** is reflected is deformed by adding the diagram change in the record **5320**. After that, the program advances to step **7600**.

**[0045]** Referring again to FIG. **2**, the description of the process will be continued. When the user executes an operation of inputting data to the snapshot display position input unit **1120**, a snapshot according to the input data is displayed as a diagram on the diagram display part **1120**.

**[0046]** FIG. **12** is a diagram showing a GUI in the snapshot display position input part **1140**. The GUI has a review button **12100** instructing display of a snapshot in the past direction from a snapshot being displayed, a fast-forward button **12200** instructing display of a snapshot in the future direction, and a progress bar **12300** instructing a snapshot to be displayed by designation of the percentage when the number of all of snapshots is 100. Diagram data of a snapshot having snapshot ID to be displayed is obtained from snapshot data stored in the snapshot diagram table **1240** in FIG. **1** on the basis of the ID of the snapshot being displayed and input data, and a snapshot is displayed in the diagram display part **1120** in FIG. **1**.

**[0047]** By the above process, the flow of the series of processes in the embodiment is finished.

DESCRIPTION OF REFERENCE NUMERALS

- [0048]** **1100** . . . Central processing unit
- [0049]** **1200** . . . Database
- [0050]** **1300** . . . Input unit
- [0051]** **1400** . . . Display unit
- [0052]** **1110** . . . Operation arrangement proposal generation part
- [0053]** **1120** . . . Diagram display part
- [0054]** **1130** . . . Snapshot restoration part
- [0055]** **1140** . . . Snapshot display position input part
- [0056]** **1210** . . . Operation diagram table
- [0057]** **1220** . . . Operation arrangement proposal diagram table
- [0058]** **1230** . . . Diagram change history table
- [0059]** **1240** . . . Snapshot diagram table

What is claimed is:

1. An operation arrangement support system having: an operation arrangement proposal generation part which executes automatic generation of an operation arrangement proposal; a diagram prediction part which executes a simulation of train operation in the future; a diagram display part which displays an operation schedule and the operation arrangement proposal as a diagram; and a user input part which receives input of a parameter from a user, the system comprising:

- a snapshot restoration part which restores snapshots of the operation arrangement proposal in an automatic generation process on the basis of a diagram change history outputted by the operation arrangement proposal generation part; and

- a snapshot display input part which displays to the user a snapshot according to an input from the user.

2. The operation arrangement support system according to claim 1, wherein the snapshot restoration part expresses diagram data by a digraph in which departure time and arrival time are set as nodes, departure/arrival times in a diagram prediction result are set as node values, a constraint condition related to time calculation and existing between nodes is set as a branch, a difference between node values to be assured between nodes coupled to each other via a branch is set as a label of the branch, and a direction from an earlier node to a later node is set as the direction of the branch, extracts a diagram change described in a diagram change history in accordance with an order of an automatic generation process of the operation arrangement proposal, executes deformation of the digraph on the basis of the diagram change and calculation of the number of nodes influenced by deformation of the digraph and, when the number of nodes influenced becomes equal to or larger than a specific value, stores, as a

snapshot to be restored, a snapshot of an operation arrangement proposal in which the diagram change used for the deformation of the digraph is reflected in an operation schedule.

3. The operation arrangement support system according to claim 2, wherein the snapshot restoration part calculates, using a node in which the number of branches connected to the node decreases due to deformation of the digraph as a base node, a total value of a value of a node connected as a branch source and a value of a label of a branch on all of branches extended from the base node, compares the value of the base node with a maximum value in total values calculated on the value of the base node and each of the branches, when the maximum value changes with respect to the value of the base node, updates the value of the base node with the maximum value, counts the node as an influenced node, extracts a node having a value equal to a total value of a value before updating of the base node and a value of the label of the branch from branches from which the base node extends, and when the node exists, repeatedly executes the process using the node as a new base node.

4. An operation arrangement supporting method executed by an operation arrangement support system having: an operation arrangement proposal generation part which executes automatic generation of an operation arrangement proposal; a diagram prediction part which executes a simulation of train operation in the future; a diagram display part which displays an operation schedule and the operation arrangement proposal as a diagram; and a user input part which receives input of a parameter from a user, comprising the steps of:

restoring snapshots of the operation arrangement proposal in an automatic generation process on the basis of a diagram change history outputted by the operation arrangement proposal generation part; and

displaying the user a snapshot according to an input from the user.

5. The operation arrangement supporting method according to claim 4, further comprising the steps of, in the case of

restoring the snapshot, expressing diagram data by a digraph in which departure time and arrival time are set as nodes, departure/arrival times in a diagram prediction result are set as node values, a constraint condition related to time calculation and existing between nodes is set as a branch, a difference between node values to be assured between nodes coupled to each other via a branch is set as a label of the branch, and a direction from an earlier node to a later node is set as the direction of the branch, extracting a diagram change described in a diagram change history in accordance with an order of an automatic generation process of the operation arrangement proposal, executing deformation of the digraph on the basis of the diagram change and calculation of the number of nodes influenced by deformation of the digraph and, when the number of nodes influenced becomes equal to or larger than a specific value, storing, as a snapshot to be restored, a snapshot of an operation arrangement proposal in which the diagram change used for the deformation of the digraph is reflected in an operation schedule.

6. The operation arrangement supporting method according to claim 5, wherein in the case of restoring the snapshot, using a node in which the number of branches connected decreases due to deformation of the digraph as a base node, a total value of a value of a node connected as a branch source and a value of a label of a branch is calculated on all of branches extended from the base node, the value of the base node is compared with a maximum value in total values calculated on the value of the base node and each of the branches, when the maximum value changes with respect to the value of the base node, the value of the base node is updated with the maximum value, the node is counted as an influenced node, a node having a value equal to a total value of a value before updating of the base node and a value of the label of the branch is extracted from branches from which the base node extends, and when the node exists, the process is repeatedly executed using the node as a new base node.

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