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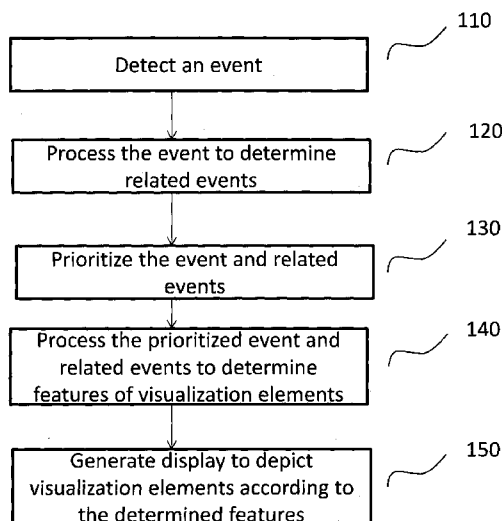
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(54) Title: A METHOD AND AN APPARATUS FOR EVENT MANAGEMENT IN A PLANT AUTOMATION SYSTEM



100

Figure 1

(57) **Abstract:** The invention relates to a method for event/alarm management in a plant automation system and more specifically a method to gather and process information from field devices in a process plant along with structural, historical and expert information to create a human machine interface for effective event/alarm management in a plant automation system. The method comprises the steps of detecting an event in the plant automation to produce event information that is then processed with a cause and effect analyzer to determine one or more related events information. The event information and one or more related events information are prioritized with a priority engine to obtain prioritized event and related events information. Further, the prioritized event and related events information are processed with a visualization engine to determine features of one or more visualization elements for the human machine interface and then the visual elements according to the determined features of one or more visualization elements are generated to have the human machine interface to manage events in the plant automation system. An apparatus based on the method is also provided.

A METHOD AND AN APPARATUS FOR EVENT MANAGEMENT IN A PLANT AUTOMATION SYSTEM

FIELD OF INVENTION

The invention relates to a method for event/alarm management in a plant automation system and more specifically a method to gather and process information from field devices in a process plant along with structural, historical and expert information to create a human machine interface for effective event/alarm management in a plant automation system.

BACKGROUND OF THE INVENTION

Identifying critical event/alarm is important for a plant operator to carry out the function of managing the plant effectively. The plant (process) automation system provides for a suitable human machine interface (HMI) for the operator to recognize events and alarms and act accordingly. A modern process automation system may also provide for situation aware guidance to the operator in this regard.

Typically, process automation system gather process information from the field, transmitted to it with the help of the field devices and accumulated in a database server. The process information is analyzed and the event information (eg alarms) that needs to be made known to the operator is prioritized. The event along with its priority is presented in a textual manner to the operator. The operator identifies critical event/alarm by scrolling the event/alarm list or using filter functionality. The present system of alarm management is thereby highly dependent on operator skills to recognize and process critical event/alarm. This task becomes much more complex, when there are multiple alarms occurring simultaneously, making response/prioritization of response difficult. Thus, there is a need to develop an event/alarm management system that would help reduce cognitive load and thereby increase the efficiency of identification of critical task and providing response.

SUMMARY OF THE INVENTION

As one aspect of the invention, a method for event management with a human machine interface in a plant automation system is provided. The method comprises the steps of detecting an event in the plant automation to produce event information that is then processed with a cause and effect analyzer to determine one or more related events information. The event information and one or more related events information are prioritized with a priority engine to obtain prioritized event and related events information. As a next step, the prioritized event and related events information are processed with a visualization engine to determine features of one or more visualization elements for the human machine interface and then the visual elements according to the determined features of one or more visualization elements are generated to have the human machine interface to manage events in the plant automation system.

As one embodiment, the method for the event management system is used for alarm management in the plant automation system.

As another embodiment, the step of processing the event information to determine one or more related events information is carried out using historical data and/or using pre-configured relationship information event.

As another embodiment, the step of processing the event information to determine one or more related events information is carried out using the structural or architectural information.

As yet another embodiment, the step of processing the event information to determine one or more related events includes determining strength of relationship between the events.

As yet another embodiment, the step of processing the prioritized event and related events information to determine features of visualization elements includes determination of features of visualization based on available screen space and configured shape, size and color for visualization elements.

As yet another embodiment, the step of processing the prioritized event and related events information to determine features of visualization elements includes determination of features based on the strength of relationship and/or severity levels.

As still another embodiment, the step of processing the prioritized event and related events information to determine features of visualization elements includes determination of temporal information associated with the prioritized event and related events.

As still another embodiment, the step of processing the prioritized event and related events information to determine features of visualization elements includes determination of connection information associated between the prioritized event and related events.

As another aspect, an apparatus for human machine interface in a plant automation system based on the method is provided. The apparatus comprises a cause and effect analyzer module to process an event information arising in the plant automation system to determine one or more related events information; a priority engine module to process the event information and one or more related events information to determine prioritized event and related events information; a visualization engine module to process prioritized event and related events information to determine features of visualization elements; and a display to depict visualization elements according to the determined features of visualization elements.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

Figure 1 provides a method for processing event information for HMI in a plant automation system;

Figure 2 provides an exemplary representation of events/alarm in a plant automation system;

Figure 3 provides exemplary representation of critical events along with associated events.

DETAILED DESCRIPTION

This invention is about a method to create an HMI using a graphical representation (hyperbolic representation used as an example) that highlights critical events and alarm to help operator make decision to resolve the serious fault in minimal time. The hyperbolic view graphically represents critical event/alarm as a bigger bubble with associated small bubbles and their child

bubbles with relatively smaller to indicate the cascading effect. In this type of a view user can easily recognize important event/alarm that must be tackled first rather than spending time analyzing or filtering of event/alarm to identify important event/alarms.

To enable easier visualization of event/alarm, the plant automation system has additionally modules for cause and effect analysis and visualization engine. The cause and effect analysis module may further use historical data for analysis or expert data based on pre-set configuration or rules or timeline/trend (temporal) analysis or any other statistical or syntactical or artificial intelligence based analysis for determining cause and effect. Further, the analysis of information for representation may also include past events (historical data) and possible/future events (forecast) along with present events.

The steps of the method 100 are first introduced as in Figure 1 along with an illustration with an exemplary case for event visualization related with a power network management for a plant automation system. The illustration begins with a signal generated (step 110) in a power network due to a fault or event related to breaker, eg in the event of breaker tripping (particular signal). The signal is evaluated and transmitted to database and gets analyzed through a cause and effect analyzer (CEA) that analyzes what kind of signal is produced and what other signals are likely to be produced as a result of the signal produced in the system (step 120). The other signals that are likely to be produced are estimated based on the following ways:

- 1) CEA does analysis on the historical data to find out what signal had occurred when a particular signal was trigger in the plant.
- 2) CEA scans the expert system that is setup based on knowledge of the setup with regard to what signals can be caused due to a particular signal i.e. information about relationship and magnitude of effect of the signal.
- 3) CEA traverses through the path (architectural or structural), eg communication network path, information path etc., where signal has be generate and find out what other signal have being generated in same path.
- 4) CEA does time based analysis on what other signal have occur immediately after the particular signal.

- 5) CEA would decide the relationship and strength of relationship between the signals generated. The strength of relationship is decided based on the what is possibility of signal occurring as a result of particular signal and how much damage the signal can cause (Severity).

The results from the cause and effect analyzer is used by the priority engine that sets priorities for the signal and other identified signals (event and related event), shown as step 130 in Figure 1. The information (signals and priority) are then sent to visualization engine. The visualization engine (VE) works out a suitable representation for the events in the plant automation system. The visualization engine helps to visualize root cause, effects, prediction and priorities through suitable representation for the event (past, present and the future) based on the configuration (device and process/event representation) for the plant automation system. Thus features of visualization elements are determined (step 140).

The visualization engine analyzes a suitable visualization based on the what kind of device is used for representation.

- 1) VE decide based on amount of screen space available for representation
- 2) VE decides what visualization element (Square, Circle, Bubble, Rectangle etc) has to be selected based on configuration
- 3) VE decides on what visualization elements size to use based on the CEA decision on severity level
- 4) VE decides on what visualization elements need to be selected for showing the relationship based on the strength of relationship decided by CEA

A event representation is created according to the determined features of visualization elements. The method 100 is now illustrated with an event representation as per the invention for events from power networks. The relay fault (RF) in the network (circuit breaker trip) is detected by the system. This signal has to be aptly visualized to the users and is done so with the method described in the invention.

The RF signal goes to Cause and Effect Analysis (CEA). CEA will find out which others signal can be generated due to RF signal. For example an medium level protection trip deactivates (PTD) and frame leakage (FL) could be generated. This information is provided to the visualization engine that determines the representation. The exemplary representation maybe as depicted by the numeral 202 in Figure 2. The RF1 signal (210) is shown as bigger visual element (Bubble, square etc.) and medium level signals (220, 230) are shown as small visual elements. Now consider that possibility of PTD (220) happening is less and that of FL (230) is more. The connection between the RF1 and PTD (240) will be shown by the visual element that requires less visual attention than the connection between the RF1 and FL (250).

In the prior-art system, the same example is likely to provided as a text information having list of alarms that are generated within a second (recent event/fault on top of the list), which may be difficult for an operator:

- Frame Leakage Not Operated -- medium
- Protection Trip Deactivate -- medium
- Relay1 fault detected ----- Critical -----

The exemplary situation is further illustrated to represent dynamic developments in the power network. The events say further develops because of RF1 and other medium signal events to cause a large problem of Transformer Fault, the representation gets developed as depicted in 204 of Figure 2. The large fault 260 gets represented and visualized as bigger visual element and connections with the causing event is provided.

For the above example, the prior-art system would generate list of alarms in a text form (recent event/fault on top of the list)

- Transformer1 Differential Protection Pickup --- Critical
- Frame Leakage Not Operated -- medium
- Protection Trip Deactivate -- medium

- Relay1 fault detected ----- Critical -----

The example of power network is used further to demonstrate the effectiveness of the method described in the invention to represent event and information in an effective manner for increased complexity. The situation is that many alarms have occurred because of the fault (relay fault) in the prime area of the system. Because of this fault many other devices/parameters get affected which are related to the primary fault (relay fault). In a typical automated system the effect of cause will reach to the interconnected devices in relatively short time. Because of this a flood of alarms, could be hundreds or thousands of alarm are generated. The end-user who is looking into the alarm list will not be able to see the cause (primary fault) easily. So the end-user will look into the latest alarm first and then he will scroll down to see the cause in the prior-art system.

For example, in the prior-art system the list of alarms that are generated may be as below (recent event on the top of the list):

- Breaker material fault – medium
- Breaker Frame leakage – medium
- Breaker lock out indication
- Breaker Open ----- Critical ----- Effect
- Master trip operated ----- Critical
- Relay material fault – medium
- Relay Frame leakage – medium
- Relay lock out indication – medium
- Relay General Trip -- medium
- R Phase Trip ----- Critical
- R Phase Pickup --- medium

- Transformer1 Differential Protection Pickup --- Critical
- Relay1 material fault – medium
- Relay1 Frame leakage – medium
- Reverse Power Not Operated -- medium
- Cable Insulation Frame Relay Not Operated -- medium
- Frame Leakage Not Operated -- medium
- Inter Trip Deactive -- medium
- Over Current Trip Not Operated -- medium
- Protection Trip Deactivate -- medium
- Relay1 fault detected ----- Critical -----

Example for representation for the above scenario having multiple faults and temporal attributes is shown in Figure 3 to depict the functioning of CEA and VE. The CEA will find out all the possible signal that can occur due to RF signal detected and then the visualization based on the method of the invention. The root cause for the series of event is RF1 (Relay Fault), 210, represented as a bubble with orange color that appears instantly after the detection of signal and processing by VE. Subsequently T1 (Transformer), 260 and B1 (Breaker), 310 also appears on screen as transparent bubbles (not shown in the figure) to indicate possible fault scenarios as shown in Figure 3 by numeral 302. The breaker fault, 310 is shown as dotted bubble to indicate transparency (a feature of visualization elements). The transparent bubble may disappear if the main root cause is resolved quickly. If the root cause is not resolved within a reasonable time frame, the transparent bubbles will become solid (distinct). The associated faults/events with a critical or important events are represented as smaller bubbles connected with the critical/important events as shown with numeral 320 in Figure 3. This association is formed based on the connection information determined by the CEA.

Further, the user may navigate through the events by causing the graphical structure to rotate and/or centered on the event of interest as depicted in figure by the numeral 304. The color and transparency level of the bubble and connections may be coded to indicate technical, structural

(eg. related to system architecture) or temporal (past, present and future possibilities) aspects related to events in the plant automation system. For example, the color of bubble is shown to change dynamically to represent temporal factors and to draw attention as indicated for RF1 event 330 in comparison with the RF1 representation 210 before having the cascaded events.

While only certain features of the invention have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

WE CLAIM:

1. A method for event management with a human machine interface in a plant automation system comprising the steps of:
 - a) Detecting an event in the plant automation to produce an event information;
 - b) Processing the event information with an cause and effect analyzer to determine one or more related events information;
 - c) Prioritizing the event information and one or more related events information to obtain prioritized event and related events information;
 - d) Processing the prioritized event and related events information with an visualization engine to determine features of one or more visualization elements for the human machine interface; and
 - e) Generating visual elements according to the determined features of one or more visualization elements to have the human machine interface to manage events in the plant automation system.
2. The method as claimed in Claim 1 wherein the event management system is for alarm management in the plant automation system.
3. The method as claimed in Claim 1 wherein the processing the event information to determine one or more related events information is carried out using historical data and/or using pre-configured relationship information event.
4. The method as claimed in Claim 1 wherein the processing the event information to determine one or more related events information is carried out using the structural or architectural information.
5. The method as claimed in Claim 1 wherein the processing the event information to determine one or more related events includes determining strength of relationship between the events.

6. The method as claimed in Claim 1 wherein the processing the prioritized event and related events information to determine features of visualization elements includes determination of features of visualization based on available screen space and configured shape, size and color for visualization elements.
7. The method as claimed in Claim 1 wherein the processing the prioritized event and related events information to determine features of visualization elements includes determination of features based on the strength of relationship and/or severity levels.
8. The method as claimed in Claim 1 wherein the processing the prioritized event and related events information to determine features of visualization elements includes determination of temporal information associated with the prioritized event and related events.
9. The method as claimed in Claim 1 wherein the processing the prioritized event and related events information to determine features of visualization elements includes determination of connection information associated between the prioritized event and related events.
10. An apparatus for human machine interface in a plant automation system comprising:
 - a) A cause and effect analyzer module to process an event information arising in the plant automation system to determine one or more related events information;
 - b) A priority engine module to process the event information and one or more related events information to determine prioritized event and related events information;
 - c) A visualization engine module to process prioritized event and related events information to determine features of visualization elements; and
 - d) A display to depict visualization elements according to the determined features of visualization elements.

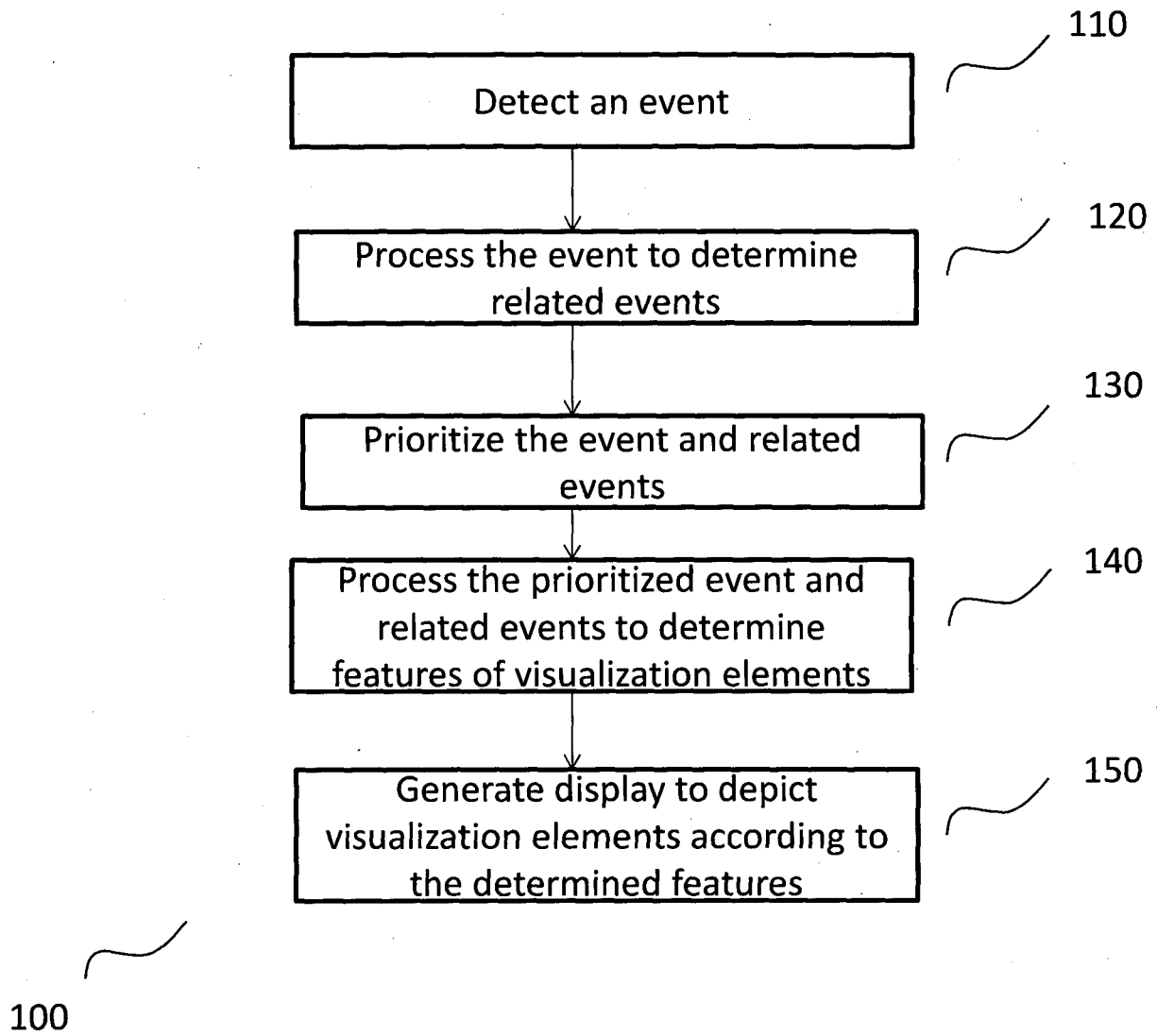


Figure 1

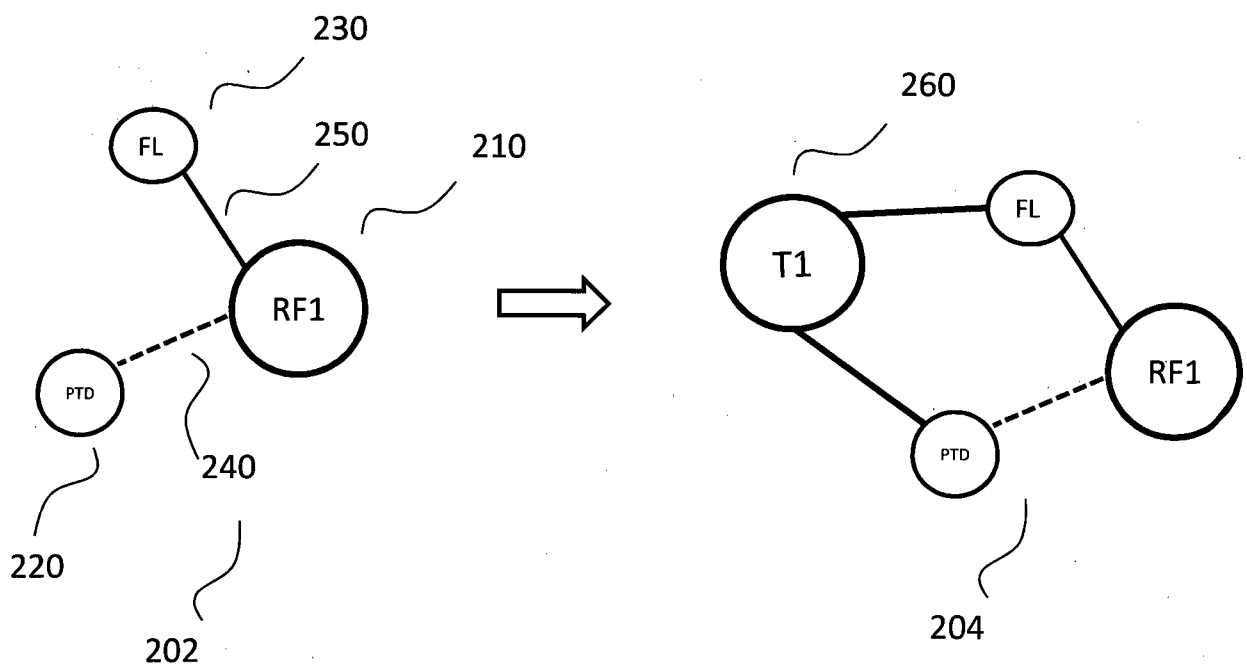


Figure 2

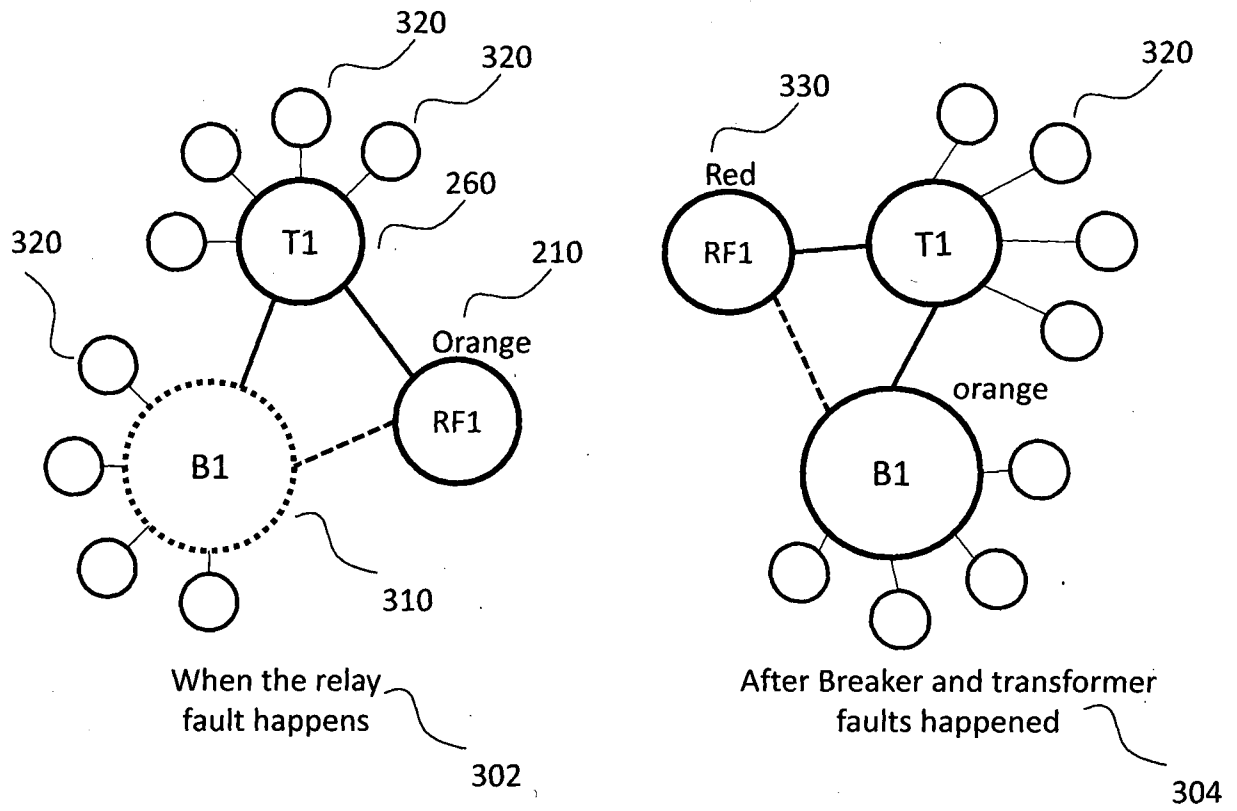


Figure 3