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(71) Applicant *(for all designated States except US)*: **TRACE-TRACKER INNOVATION ASA** [NO/NO]; Christian Krohgs Gate 32A, N-0186 Oslo (NO).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **KONESTABO, Bjorn** [NO/NO]; Helgesensgate 76b, N-0563 Oslo (NO). **BJASTAD, Havard** [NO/NO]; Bringebarasen 12, N-1412 Sofiemyr (NO). **FREMME, Steinar** [NO/NO]; Perniletoppen 10, N-2072 Dal, Norway (NO). **KJAERNSROD, Steinar** [NO/NO]; Voksenkollv. 134 C, N-0790 Oslo (NO). **CORNELIUSSEN, Rolf, Arne** [NO/NO]; Ekrekroken 43, N-1356 Bekkestua (NO). **HANCKE, Rolf** [NO/NO]; Industrigata 6OA, N-0357 Oslo (NO). **OYSTEIN ARISLAND, Kjell** [NO/NO]; Hoelveien 4, N-1400 Ski (NO).

(74) Agent: **J.K. THORSENS PATENTBUREAU A/S**; P.O. Box 9276 Grønland, N-0134 Oslo (NO).

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(54) Title: GRAPHICAL USER INTERFACE FOR TRACEABILITY INFORMATION

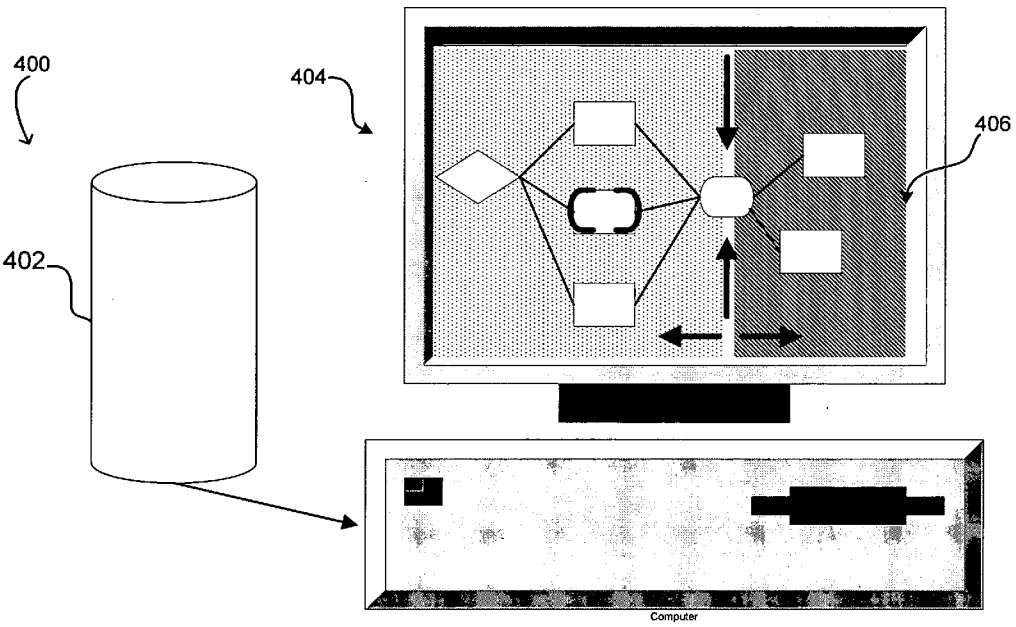

FIG. 4

(57) Abstract: A presentation method for viewing and manipulating data in a database of information collected from product value chains by interactively selecting objects representing vertices and other elements in a graph. The presentation method combines several functions that are especially useful for interactively tracing and/or tracking in product value chains in order to allow faster pinpointing of problems and problem consequences in cases of dangerous products such as contaminated food and feed.

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GRAPHICAL USER INTERFACE FOR TRACEABILITY INFORMATION

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates generally to analyzing events in a production chain and more specifically to representation of the traceability information as graphs allowing users to interactively perform tracing and/or tracking in product value chains to efficiently detect problems, identify problem origins and evaluate problem consequences.

2. Discussion of Related Art

It is becoming increasingly important to record thoroughly information about where food and feed and other products are coming from, what they contain, how they are produced, processed and handled, and where they are going. Such product history information is called traceability information. When a problem with food or feed arises, it is in some cases a matter of life and death to be able to access quickly such records of traceability information about the origins and distribution of possibly dangerous substances.

In a world of global value chains of increasing complexity, the importance of having the traceability information readily accessible also increases. Systems for handling the raw information in terms of databases and communication across the Internet partly exist and are partly being built and refined.

BRIEF SUMMARY OF THE INVENTION

Embodiments of the present invention provide a method for presenting in a graphical user interface traceability information on a production chain, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the vertices, and the vertices representing objects and the edges representing object dependencies. The method comprises receiving user input identifying a base object and presenting in the graphical user interface a graphical representation of at least a

portion of the graph, the portion having a plurality of displayed objects the plurality of objects comprising the base object and ancestor objects and successor objects of the base object in the production chain. The method also comprises receiving user input identifying an object of the plurality of displayed objects as a focus object, and in response to the user input identifying the focus object, providing information about the focus object.

In another aspect of the invention, a computer-readable medium encoded with computer-executable instructions for performing a method for presenting traceability information on a production chain in a graphical user interface, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the vertices, and the vertices representing objects and the edges representing object dependencies, is provided. The computer-executable instructions, when executed, perform a method comprising receiving user input identifying a base object of the graph, selecting a plurality of objects of the graph to be displayed in the graphical user interface based on a dependency relationship between identified base object selected objects, displaying in the graphical user interface a graphical representation of at least a portion of the selected objects, receiving user input identifying an object of the displayed portion as a focus object, and providing information about the focus object.

In yet another aspect of the invention, a method is provided for presenting traceability information on a production chain in a graphical user interface, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the vertices, and the vertices representing objects and the edges representing object dependencies, the method comprising presenting a hierarchical structure of the object visualized as collections of objects that can be shown in exploded form or in the form of single objects representing each collection, wherein the hierarchy can include two ore more levels, in which elements can be exploded or collections imploded into an icon representation independently.

In yet another aspect of the invention, a computer system is provided comprising at least one processor programmed to implement a method for presenting in a graphical user interface traceability information on a production chain, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the vertices, and the vertices representing objects and the edges representing object dependencies. The method comprises receiving user input identifying a base object and presenting in the graphical user interface a graphical representation of at least a portion of the graph, the portion having a plurality of displayed objects the plurality of objects comprising the base object and ancestor objects and successor objects of the base object in the production chain. The method also comprises receiving user input identifying an object of the plurality of displayed objects as a focus object, and in response to the user input identifying the focus object, providing information about the focus object.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are not intended to be drawn to scale. In the drawings, each identical or nearly identical component that is illustrated in various figures is represented by a like numeral. For purposes of clarity, not every component may be labeled in every drawing. In the drawings:

FIG. 1 is a sketch of an example of a graphical representation of a generic value chain according to an embodiment of the invention;

FIG. 2 is a sketch of another example of a graphical representation of a generic value chain according to an embodiment of the invention;

FIG. 3 is a sketch of an example of a graphical representation of a generic value chain with more than one base object identified according to an embodiment of the invention; and

FIG. 4 is a simplified sketch of a system with a graphical user interface presenting traceability information on a product value chain according to some embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The inventors have appreciated that, even when traceability information has been diligently recorded and is readily accessible for scrutiny, tracing a problem back to its cause and determining all other affected products may be a difficult and time consuming task. One reason for this is that database tables and lists of predecessors and successors of some product, raw material or intermediate product are not well suited for allowing people to handle the complexity of dependencies of two or more links in a possibly long value chain.

Previously existing systems for tracing and tracking of products in product value chains rely mainly on forms for searching for and listing products by identifiers such as lot numbers.

In contrast, embodiments of the invention provide methods of visual presentation and procedures for interacting with a functional model of traceability information from databases. These visual and interactive methods and procedures make it simple, quick and accurate to trace and track product dependencies in huge databases of possibly long and complex value chains, thus increasing the chances of saving lives and costs when dangerous or destructive elements are introduced into food, feed or other products.

Graphs in the mathematical sense, meaning a structure of edges and vertices, exist in many types, shapes and sizes, and are used for modeling various relations and dependencies found both in nature and in man-made structures. Various types of graphs have strict mathematical definitions, such as trees and directed acyclic graphs (DAGs). Graphs are much used to understand and keep track of information about relative dependencies between objects.

An example graph given by nature is the so-called family tree, used for tracing the ancestry of people or animals. From a mathematical point of view,

family trees are not necessarily trees, since ancestors who are related to each other, however distantly, by definition will share some of their ancestors, making these ancestors occur more than once in the family tree. However, all family trees are DAGs, like all graphs for which each directly ascending relationship of objects can be mapped sequentially on a timeline.

A man made example of a graph is the ancestry of the ingredients in products sold to consumers. Called value chains, these chains can usually be modeled as DAGs, even though local loops of recycling may occur and make it hard to separate constituents in time.

Such a DAG model of a value chain, based on a database of information collected from the value chain production processes, can be used for tracing and tracking ingredients, parameters of the production and the production process itself of food products, animal feed, chemical products, pharmaceutical products and any other production process for which traceability may be of importance. The ingredients may include live animals, vaccine, feed, produce, chemicals etc, and the parameters of production and the production itself may be the physical details of mixing, heating, annealing, vaccination, harvesting, slaughtering, distillation etc.

Graph traceability models convey useful information. To preserve the integrity of such information, exact records of the dependencies and the properties of the objects may be used, and when such records exist, it may be possible to trace and track the production of goods to find out both where, for example, poisonous material is going, and what ingredients were used in some product that turned out to contain potentially destructive biological material such as bacteria.

Visualization of graphs is very useful because it allows tracing and tracking interdependent objects in graphs interactively. If it is desired to look up dependencies one by one, this may become very tedious and error-prone since the human mind does not easily remember long sequences of data. The part of the human brain processing visual information, however, is highly effective in

conveying associations such as dependencies, making visualization a valuable tool.

In visualizing graphs, the following elements may be used: visual representation of objects (vertices), including separating any different types; visual representation of dependencies (edges), including separating any different types; conventions for dependency directions; conventions for the use of dimensions; and conventions for time and sequence.

For a visualization to be useful, it is usually desired to provide means for extraction of detailed information related to specific parts of the graph. This may require tools for indicating and marking such specific parts.

When a number of objects in a graph grows large, some problems may ensue. For example, a display area, whether static, like a paper print, or interactively dynamic, like a computer screen, is usually limited. This means some limit must be placed on how large a graph can be displayed at a time. Problems may also occur when dependencies may become complex and the display area correspondingly cluttered and confusing.

Graphs lend themselves very well to modeling in computer programs. Furthermore, visualization on computer screens in combination with the inherently interactive nature of graphical user interfaces (GUIs) is a very functional environment for creating useful methods for extracting information from graph models.

Embodiments of the present invention provide a set of visual elements and methods for interactively manipulating these elements to extract information from a model of a directed acyclic graph of high complexity or a large number of elements or both. The combination of elements and methods associated with them may make it fast and easy to find and extract information and combinations of information that might otherwise take a lot of time to find or might even totally escape detection. While visualization of graphs on a computer screen or printout is not new, applying it to a DAG model of product value chains has yielded insights and methods for useful visualization of the product value chains.

The visual elements and methods may include all or some of the following functionality and features described below. Objects (graph vertices) may be shown as icons of various types, but of roughly the same size, both in terms of width and height and their ratio. To separate them from other elements of the GUI, no other type of element may be allowed to be shown in the same size and form. Alternatively, other methods of indicating that certain elements of the graph are objects may be used, such as coloring, distinct background etc.

Dependencies (graph edges) may be shown as visual relationship indicators, e.g., distinct lines or arrows running from some point on the right hand side of a first object and to the left hand side of a second object, indicating that the first object is a predecessor upstream in the value chain of the second object. An arrow point on the connecting line may or may not be present to indicate the direction. The lines indicating dependencies may be straight, curved, broken, sectioned or have any other form usable for the purpose of indicating a connection.

One object in the graph may be identified as a base, also known as the root of the graph, meaning that all dependencies shown are related to this object, either upstream or downstream. The base object may be identified interactively or prior to presenting the graph in a graphical user interface.

The object that is the base, aka root, of the graph may be indicated by one or more means such as, for example, arrows, separating the entire left hand side, representing the upstream part of the graph from the right hand side, representing the downstream part of the graph, with the base object in between them, by means of different coloring, area hatchings or other.

In embodiments of the invention, a user input identifying a base object may comprise a user input identifying a suspect event associated with the base object. An object may comprise one of an ingredient, product, product batch, parameter of a production process and/or a production process in the production chain and the suspect event may comprise an event relating to production processing and/or transportation of one of the ingredient, product, product batch, parameter of a production process and/or a production process

of the base object. The suspect event may be, for example, contamination of one of the ingredient, product and product batch. Other suitable objects and events may be substituted.

Some object in the graph may be identified as a focus of attention, e.g., for examining details about the object.

In some embodiments, the object that is the focus of attention is clearly indicated by arrows, target aiming sights, background, graying, coloring or other means.

In some embodiments, the indication methods used for the base aka root object are distinct from the indication methods used for the focus of attention object.

The user may change the base of the graph to another object, and this may cause a change in the graph itself if the underlying dependency data is different for the old and new base.

The user may change the focus of attention object by indicating another object, and this may cause fetching of information about the new focus of attention.

The physical or procedural methods that the user executes to select a new focus of attention object may be different from the methods of selecting a new base object.

In some embodiments, it may be possible to suppress visibility of some objects, whether for reasons of access control, for enhancing general visibility, or for other reasons.

In some embodiments, objects representing groups of objects may be shown, with all the combined dependencies of the included objects indicated as coming in and going out of the group object. The user may interactively group or ungroup objects. Further, collections of objects may be indicated by special marking. Collections may also be collapsed into single objects by grouping.

A viewing area of the viewing device may be limited to showing only part of the graph, and it may be possible to zoom, pan and rotate to view any part desired. A user input may be provided to interactively perform these actions. A

user input may also be provided to interactively stretch or compress any portion of the graph in any direction. Further, a portion of the graph shown in the viewing area may be selected to include only the base object and ancestor objects and successor objects of the base object in the production chain.

Parts of a graph for which the objects represent products originating from the same production facility, company or other unit such as, for example, geographical, may be shown as a group. Grouping may have different visual representation depending on the zoom level chosen.

In some embodiments, two or more windows of the same graph with different zoom levels may be shown. One of the graphs may be shown linked to a selection in the other graph.

Changes in the database for which the DAG is a representation may happen at any time, and may be shown on the screen asynchronously with user input.

Grouping, ungrouping, collection, insertion and deletion of such groups, collections or similar object sets may happen at any time, and may be shown on the screen asynchronously with user input.

In some embodiment, it may be possible to specify whether objects shall be included in the presentation or shall be suppressed, either individually, by object properties, grouping, or other selection means. Such suppression of objects representing graph vertices has the consequence that all graph vertices that are neighbors, meaning vertices sharing an edge, of suppressed vertices become neighbors of each other. If this is done interactively, the visual representation of the corresponding elements on the screen is updated accordingly.

The following describes an example of an embodiment of the invention. The invention is not limited to the following detailed description, but may be implemented in many variations.

According to this embodiment, a graphical user interface (GUI) for presenting a DAG representing a computer model of a value chain of products is presented. The model allows the user to interactively manipulate the elements of

the GUI representation to extract information from the DAG model of a product value chain of high complexity or a large number of elements or both.

This description uses a product value chain as an example of the information which the DAG represents, but the DAG itself and the elements and functionality described are generic in nature. It should be appreciated that other suitable information may be presented as the DAG.

In a food traceability system, a database may contain information about a full value chain of the production of food to consumers, "from farm to fork," as it is popularly expressed. The database itself may be a single system, or a combination of many systems. Any suitable database may be used to collect and store information on production chains.

In the database, information may be stored about, for example, each crop of grain received from each farmer, each batch of flour produced from each crop, each batch of bread produced from the flour by each bakery, similar information of all other ingredients used in the bread, and to which supermarket each delivery of bread goes.

Each batch, product or intermediate product at each level is registered in the database, and associated information can be retrieved from the database on demand.

A sketch of an example of a graphical representation of a generic value chain according to an embodiment of the invention is shown in Fig. 1. It should be appreciated that the black and white drawing in Fig. 1 is not an example of a real GUI screen, but only an example of contents of such screen.

In Fig. 1, there are a number of objects of various shapes (1), and they are all connected by lines (2). The objects (1) represent products, product batches or ingredients, and the different shapes and markings indicate that the objects are of different types. The lines (2) represent relations between the objects, such as, for example, (i) one object being converted into another e.g. by some processing being applied to it, (ii) two or more objects being mixed to produce a third, or (iii) a single object being split into two or more objects. The three cases (i), (ii) and (iii) are only different in the number of objects at each end of the relation. It

should be apperceived that other suitable relations between objects may be presented.

In the example illustrated, surrounding all of the objects is a bounding box (3), which has an easily recognizable form. The form in this example is a rectangle with regularly spaced, square-edged indentations, but it could be any distinctively recognizable shape.

The internal part of the bounding box (3) is divided into two areas (4 and 5), both rectangular, both indicated by diagonal hatchings, and separated by a vertical dividing space (6) with two vertical arrows (7) opposing each other and pointing towards an object (8) crossing or inside the dividing space (6).

The word "Base" is placed above the vertical arrow (7) pointing to the object (8). Is some embodiments, the word “Origin” or other suitable word may be substituted. The two words "Upstream" and "Downstream" are placed above the lower edge of the bounding box (3) on the left and right hand side respectively of the dividing space (6) and arrows (7), with arrows (9) pointing outwards towards each side. It should be appreciated that the textual elements above used for enhancing a visual distinction between the upstream and downstream parts are optional and other textual elements or no elements may be substituted.

An object (11) is framed by extra bold marks (10) indicating the corners of an invisible area. The marks (10) are intended to single out the object (11) as the focus of attention by the most intuitive means available. By "intuitive means" in this context is meant some function well known by most users as a convention having a specific meaning or interpretation. In this example, the marks (10) are similar to the focusing or light-measuring field indications used in the viewfinders of photographic cameras or the targeting indications in military aiming systems such as, for example, those used in fighter planes.

The two areas (4 and 5), separated by the space (6), arrows (7) and indicated by the arrows (9) are meant to clearly and recognizably separate the upstream part of the DAG from the downstream part of the DAG, only connected through the single object (8). The upstream part of the DAG consists

of all objects (ancestors) that somehow go into making of the product or intermediary product represented by the object (8), and the downstream part of the DAG consists of all objects (descendants) that contain some part of the object (8) or has in some way been influenced by the object (8). This division into two visually separate parts underlines the special relation of the object (8) to the rest of the graph in that it is the base of all the relationships shown, or root if the DAG is a tree.

In some embodiments, an object, referred to as a first object, from the objects in a graph may be defined as an ancestor object of another object, referred to as a second object, of the displayed objects if the second object comprises at least one ingredient from the first object and the first object precedes the second object in a production chain. Accordingly, a second object may be defined as a successor of the first object in the production chain. It should be appreciated that the objects are referred to as a "first" and "second" for purposes of description only and not to identify any specific objects. Any suitable objects having this relationship may be substituted.

The target marking (10) of the object (11) indicates that the object is the "focus," meaning the center of attention for inspecting properties of the object itself. Like the special treatment of the base, the focus is meant to be strongly visually emphasized. These two objects are the two most emphasized objects of the graph. The reason for using different methods of visual emphasis is that the objects are emphasized for different reasons. The base is emphasized because of its consequences for the graph itself, and the focus is emphasized to indicate where the information we seek shall come or has come from. Different physical actions with an input device may be required as a user input to identify the base and focus objects.

In the embodiment illustrated, the described GUI has three main functions. First, by allowing a user to specify an object of interest, the GUI can visualize the graph of the value chain that the object is a part of. The object

specified is the base of the graph shown. Second, by allowing a user to identify another object in the graph, e.g., by pointing to it with a pointing device such as, for example, a mouse, detailed information about the object may be shown. When this is done, the focus indication is displayed around the object identified while the detailed information is shown. This function may be repeated to inspect any object in the graph without changing the graph.

The third function allows a user to perform another type of indication, such as right-clicking on a mouse, or first focusing and then selecting a menu-item or button, by which another object in a graph may be selected to become the base. If this is done, the graph itself may change, since another object may not share all the same ancestors and descendants as the first object, even if each is part of the graph of the other, indicating they are both part of the other's value chain.

In embodiments of the invention, one or more objects in a graphical representation of a production chain may be suppressed. A user may also provide to the graphical representation a user input to visualize the suppressed object(s). Fig. 2 is a sketch of an example of a graphical representation of a generic value chain where some parts of the information may be suppressed, according to an embodiment of the invention. Fig. 2 shows how the DAG representing a value chain can be depicted to stretch across different production units such as factories or companies. In such cases it can be advantageous to suppress part of the information from the complete chain of each local unit, and only show some objects of each chain. To maintain the integrity and usefulness of the system, the dependencies and the completeness of the dependencies are maintained. This is possible even if only a selection of objects is visualized.

Different types of elements of Fig. 1 are also present in Fig. 2, with the exceptions that all of the objects are shown identically and the object (11) is omitted. The omission of the base object (11) only means that it is not visible in this DAG presentation, but there are always one or more such bases for any value chain.

Also, in Fig. 2, the size of the bounding box (3) of Fig. 1 is reduced in size (20), and four rectangular boxes with rounded edges (21-24) indicate the boundaries of each company, with all of each company's objects located inside its own bounding boxes. It should be appreciated that bounding boxes in the graphical representation may be of any suitable format. Graph edges indicating relationships of objects in two different companies cross the boundaries, indicating, for example, sales of products between companies or transportation between factories. It should be appreciated that other suitable relationships between companies, factories and other unites may be shown.

In some embodiments, a graphical representation of a DAG representing a production chain may include groups of objects. When at least two objects are grouped, these objects may be suppressed and a single group object representing these grouped objects may replace them in the graphical representation. More than one group object may also be formed and presented when at least two objects are grouped. Furthermore, different grouping of objects (vertices) and their collective relations (edges) may be indicated as visually distinct from each other. A user of a graphical user interface may be able to interactively group and ungroup objects in the graphical representation.

In some embodiments, more than one base object may be identified and presented in the same visualization. Fig. 3 illustrates an example of a graphical representation in a graphical user interface of traceability information on a production chain as a graph (300) where two base objects are identified.

In the example illustrated, the graphical representation includes base objects (325) and (326). The graph (300) is divided into an upstream part (302) and a downstream part (304) based on the base objects (325) and (326). The vertical arrows (332) and horizontal arrows (334) enhance the visualization of the separation of the graph (300) into the upstream (302) and downstream (304) parts. The upstream (302) and downstream (304) parts are presented with different backgrounds to make them visually distinct. It should be appreciated that other suitable formats may be used to make the upstream and downstream parts of the graph visually distinct.

As discussed above, embodiments of the invention provide a method of presenting objects in a graphical representation in any suitable visually distinct format. In Fig. 3, the upstream part (302) of the graph (300) encompasses objects of two different types. Objects (306 -316) are shown as having an oval shape and objects (318-324) are rectangular. In the downstream part (304), objects (328) and (330) are of yet another shape of elongated ovals. The base objects (325) and (326) are shown as visually distinct from each other and from other objects of the graph (300).

It should be appreciated that, in embodiments of the invention, any suitable formats, including different shapes, colors and sizes, may be used to differentiate among objects. Different visual representations may reflect different properties of an object, such as, for example, its type, location, company, etc. Different bounding boxes may also be used to present objects in visually different formats. In some embodiments, a user may be enabled to define new visual elements to represent object and groups. Furthermore, some embodiments provide a method of receiving user input to indicate visually which parts of a graph are related to which object and/or which parts of the graph are related to more than one object. Parts of the graph may also be collapsed and unfolded to allow viewing, for example, of very large graphs in a relatively small space of a computer screen.

Fig. 4 is a simplified sketch of a system (400) with a graphical user interface for presenting traceability information on a product value chain and on which a method according to some embodiments of the invention may be implemented. A database (402) stores traceability information. The database (402) may be any suitable database and may comprise one or more databases. The traceability information may be provided to the database (402) as is known in the art or using any other suitable method. For example, users may access the database (402) via the Internet and enter some traceability information (e.g., information related to their role in the product value chain).

The method for presenting in graphical user interface traceability information on a product value chain according to some embodiments of the

invention may be implemented in a computer system (404) which may provide on its display screen the graphical user interface (406) to present a graphical representation of the product value chain defined as a graph. In the embodiments described above, the graph is a DAG. However, it should be appreciated that other graph representations may be used to define the traceability information.

In some embodiments, the upstream part of a portion of a graph representing in graphical user interface traceability information may be displayed spatially separated from the downstream part of the portion of the graph in the graphical user interface. The spatial separation may be indicated by placement of the upstream portion of the graph and the downstream portion of the graph in diametrically opposing parts of the display area containing the graph.

In some embodiments, a production chain may be defined in a graphical user interface as a graph modeled as a three-dimensional collection of objects and vertices and the spatial separation between the upstream portion and the downstream portion of the graph may be represented as a vector distance in the three-dimensional space between the average position of the objects in the two portions and the vector distance is larger than the distances between the objects within each portion. A user input may be received by the graphical user interface to interactively view from varying viewpoints, rotate, pan and zoom in and out the three-dimensional collection of objects and vertices. A user input may also be received by the graphical user interface to interactively stretch or compress in any spatial direction the three-dimensional collection of objects and vertices representing the graph.

Having thus described several aspects of at least one embodiment of this invention, it is to be appreciated that various alterations, modifications, and improvements will readily occur to those skilled in the art.

In particular, features of a system and method according to embodiments of the invention have been described. In other embodiments of the invention, those features may be present either alone or in any combination.

Such alterations, modifications, and improvements are intended to be part of this disclosure, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description and drawings are by way of example only.

The above-described embodiments of the present invention can be implemented in any of numerous ways. For example, the embodiments may be implemented using hardware, software or a combination thereof. When implemented in software, the software code can be executed on any suitable processor or collection of processors, whether provided in a single computer or distributed among multiple computers.

Further, it should be appreciated that a computer may be embodied in any of a number of forms, such as a rack-mounted computer, a desktop computer, a laptop computer, or a tablet computer. Additionally, a computer may be embedded in a device not generally regarded as a computer but with suitable processing capabilities, including a Personal Digital Assistant (PDA), a smart phone or any other suitable portable or fixed electronic device.

Also, a computer may have one or more input and output devices. These devices can be used, among other things, to present a user interface. Examples of output devices that can be used to provide a user interface include printers or display screens for visual presentation of output and speakers or other sound generating devices for audible presentation of output. Examples of input devices that can be used for a user interface include keyboards, and pointing devices, such as mice, touch pads, and digitizing tablets. As another example, a computer may receive input information through speech recognition or in other audible format.

Such computers may be interconnected by one or more networks in any suitable form, including as a local area network or a wide area network, such as an enterprise network or the Internet. Such networks may be based on any suitable technology and may operate according to any suitable protocol and may include wireless networks, wired networks or fiber optic networks.

Also, the various methods or processes outlined herein may be coded as software that is executable on one or more processors that employ any one of a variety of operating systems or platforms. Additionally, such software may be written using any of a number of suitable programming languages and/or conventional programming or scripting tools, and also may be compiled as executable machine language code or intermediate code that is executed on a framework or virtual machine.

In this respect, the invention may be embodied as a computer readable medium (or multiple computer readable media) (e.g., a computer memory, one or more floppy discs, compact discs, optical discs, magnetic tapes, flash memories, circuit configurations in Field Programmable Gate Arrays or other semiconductor devices, or other tangible computer storage medium.) encoded with one or more programs that, when executed on one or more computers or other processors, perform methods that implement the various embodiments of the invention discussed above. The computer readable medium or media can be transportable, such that the program or programs stored thereon can be loaded onto one or more different computers or other processors to implement various aspects of the present invention as discussed above.

The terms "program" or "software" are used herein in a generic sense to refer to any type of computer code or set of computer-executable instructions that can be employed to program a computer or other processor to implement various aspects of the present invention as discussed above. Additionally, it should be appreciated that according to one aspect of this embodiment, one or more computer programs that when executed perform methods of the present invention need not reside on a single computer or processor, but may be distributed in a modular fashion amongst a number of different computers or processors to implement various aspects of the present invention.

Computer-executable instructions may be in many forms, such as program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract

data types. Typically the functionality of the program modules may be combined or distributed as desired in various embodiments.

Various aspects of the present invention may be used alone, in combination, or in a variety of arrangements not specifically discussed in the embodiments described in the foregoing and is therefore not limited in its application to the details and arrangement of components set forth in the foregoing description or illustrated in the drawings. For example, aspects described in one embodiment may be combined in any manner with aspects described in other embodiments.

Use of ordinal terms such as "first," "second," "third," etc., in the claims to modify a claim element does not by itself connote any priority, precedence, or order of one claim element over another or the temporal order in which acts of a method are performed, but are used merely as labels to distinguish one claim element having a certain name from another element having a same name (but for use of the ordinal term) to distinguish the claim elements.

Also, the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having," "containing," "involving," and variations thereof herein, is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

What is claimed is:

CLAIMS

1. A method for presenting in a graphical user interface traceability information on a production chain, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the vertices, and the vertices representing objects and the edges representing object dependencies, the method comprising:

receiving user input identifying a base object;

presenting in the graphical user interface a graphical representation of at least a portion of the graph, the portion having a plurality of displayed objects the plurality of objects comprising the base object and ancestor objects and successor objects of the base object in the production chain;

receiving user input identifying an object of the plurality of displayed objects as a focus object; and

in response to the user input identifying the focus object, providing information about the focus object.

2. The method of claim 1, further comprising, in résponse to the user input identifying the base object, selecting the portion of the graph to include only the base object and ancestor objects and successor objects of the base object in the production chain.

3. The method of claim 1, wherein the base object comprises a first base object and the portion of the graph comprises a first portion, the method further comprising:

receiving user input identifying a second base object;

selecting a second portion of the graph to include the second base object and second ancestor objects and second successor objects of the second base object in the production chain; and

changing the graphical user interface to present a graphical representation of the second portion of the graph.

4. The method of claim 1, wherein receiving user input identifying the base object comprises receiving input in response to a first physical action with an input device by a user and receiving user input identifying the focus object comprises receiving input in response to a second physical action with an input device by the user, the first action being different than the second action.

5. The method of claim 1, wherein presenting in the graphical user interface the graphical representation of the portion of the graph further comprises presenting the base object and the focus object in visually distinct formats, wherein the visually distinct formats are different in at least one of color, size and shape.

6. The method of claim 1, wherein presenting in the graphical user interface comprises displaying the ancestor objects visually separate from the successor objects, with the only dependency between the ancestor objects and successor objects depicted in the graphical user interface passing through the base object.

7. The method of claim 6, wherein presenting in the graphical user interface the graphical representation of the portion of the graph further comprises presenting the ancestor objects in an upstream part of the portion of the graph and presenting the successor objects in a downstream part of the portion of the graph.

8. The method of claim 7, wherein the upstream part of the portion of the graph is displayed spatially separated from the downstream part of the portion of the graph in the graphical user interface.

9. The method of claim 8, wherein the spatial separation is indicated by placement of the upstream portion of the graph and the downstream portion of

the graph in diametrically opposing parts of the display area containing the graph.

10. The method of claim 9, further comprising receiving user input to interactively rotate, pan and zoom the graph.

11. The method of claim 9, further comprising receiving user input to interactively stretch or compress any portion of the graph in any direction.

12. The method of claim 8, wherein the graph is modeled as a three-dimensional collection of objects and vertices and the spatial separation between the upstream portion and the downstream portion of the graph is represented as a vector distance in the three-dimensional space between the average position of the objects in the two portions and the vector distance is larger than the distances between the objects within each portion.

13. The method of claim 12, further comprising receiving user input to interactively view from varying viewpoints, rotate, pan and zoom in and out the three-dimensional collection of objects and vertices.

14. The method of claim 12, further comprising receiving user input to interactively stretch or compress in any spatial direction the three-dimensional collection of objects and vertices representing the graph.

15. The method of claim 7, wherein presenting in the graphical user interface comprises presenting the upstream part of the portion of the graph and the downstream part of the portion of the graph in visually distinct formats, wherein the visually distinct formats are different in at least one of color, size and shape.

16. The method of claim 15, wherein presenting the upstream part of the portion of the graph and the downstream part of the portion of the graph

comprises presenting textual elements enhancing a visual distinction between the upstream and downstream parts.

17. The method of claim 1, wherein providing information about the focus object comprises providing information about the focus object in addition to information provided by the graphical representation for the plurality of displayed objects.

18. The method of claim 1, further comprising altering the appearance of the graphical representation of the portion of the graph by zooming and panning the portion in response to user input.

19. The method of claim 1, wherein presenting in the graphical user interface the graphical representation of the portion of the graph comprises presenting the focus object in a format visually distinct from the representation of others of the plurality of displayed objects.

20. The method of claim 1, further comprising receiving user input identifying the base object as a focus object.

21. The method of claim 1, wherein the graphical user interface is first presented with a base object automatically selected as a focus object.

22. The method of claim 1, wherein the focus object comprises a first focus object, and the method further comprises:

receiving user input identifying an object of the plurality of displayed objects as a second focus object; and

in response to the user input identifying the second focus object:

suppressing the information about the first focus object; and

providing information about the second focus object.

23. The method of claim 1, further comprising:

receiving user input identifying at least two objects of the plurality of displayed objects to form and display in the graphical user interface a graphical representation of at least one group object; and

replacing the at least two objects and their object dependencies in the graphical representation with the at least one group object.

24. The method of claim 23, wherein the at least two objects are grouped into the at least one group object based on at least one property of the at least two objects.

25. The method of claim 23, further comprising:

receiving user input instructing to ungroup the at least one group object; and

replacing the graphical representation of the at least one group object with a graphical representation of the at least two objects and their object dependencies in the graphical representation.

26. The method of claim 24, wherein the at least one property of the at least two objects comprises one of production facility, company, and geographical location.

27. The method of claim 23, further comprising receiving user input instructing to suppress the at least one group object in the graphical representation, wherein objects of the plurality of displayed objects that are connected by an edge to the at least one group object are displayed as connected to each other by an edge.

28. The method of claim 1, wherein receiving user input identifying a base object comprises receiving user input identifying a suspect event associated with the base object.

29. The method of claim 28, wherein the object comprises one of an ingredient, product, product batch, parameter of a production process and/or a production process in the production chain and the suspect event comprises an event relating to production processing and/or transportation of one of the ingredient, product, product batch, parameter of a production process and/or a production process of the base object.

30. The method of claim 29, wherein the suspect event comprises contamination of one of the ingredient, product and product batch.

31. The method of claim 1, wherein an object comprises one of an ingredient, product, product batch, parameter of a production process and/or a production process, and an object dependency comprises production processing and transportation between locations of one of the ingredient, product, product batch, parameter of a production process and/or a production process, respectively.

32. The method of claim 1, wherein an object dependency specifies flow of ingredients, products and/or product batches from one object of the plurality of displayed objects to another.

33. The method of claim 3, wherein receiving user input identifying the second base object comprises receiving user input identifying a base object from the ancestor objects or the successor objects of the base object to trace and/or track traceability information on ingredients, products, product batches, parameters of one or more production processes and/or one or more production processes connected via the production chain with the first object, wherein a suspect event is associated with the first object.

34. The method of claim 1, wherein a first object of the plurality of displayed objects is an ancestor object of a second object of the plurality of displayed objects if the second object comprises at least one ingredient from the first object and the first object precedes the second object in a production chain.

35. The method of claim 1, wherein a first object of the plurality of displayed objects is a successor object of a second object of the plurality of displayed objects if the first object comprises at least one ingredient from the second object and the second object precedes the first object in a production chain.

36. The method of claim 1, wherein the graph is a directed acyclic graph.

37. The method of claim 1, further comprising receiving user input to make the base object not visible in the graphical representation.

38. The method of claim 1, further comprising receiving user input identifying a base object prior to presenting the graphical user interface.

39. The method of claim 1, wherein the base object comprises a first base object, further comprising:

receiving user input identifying a second base object from the plurality of displayed objects;

selecting a second portion of the graph to include the second base object and second ancestor objects and second successor objects of the second base object in the production chain; and

changing the graphical user interface to present a graphical representation of the second portion of the graph simultaneously with presenting the graphical representation of the first portion of the graph.

40. The method of claim 1, further comprising presenting objects of different types of the plurality of displayed objects in visually different formats, wherein the different formats comprise different graphical and/or textual elements.

41. The method of claim 40, further comprising presenting the objects of different types of the plurality of displayed objects using different icons.

42. The method of claim 1, further comprising presenting object dependencies identifying direction of the dependencies in the production chain.

43. The method of claim 1, further comprising reflecting in the graphical representation changes in the traceability information asynchronously with receiving the user input identifying the base object and receiving the user input identifying the focus object.

44. The method of claim 1, further comprising:

receiving user input identifying an object of the plurality of displayed objects to be suppressed in the graphical user interface, wherein objects of the plurality of displayed objects that are connected by an edge to the object identified to be suppressed become connected to each other by an edge; and

changing the graphical user interface to present a graphical representation wherein the object identified to be suppressed is suppressed.

45. The method of claim 44, further comprising receiving user input instructing to visualize the suppressed object.

46. The method of claim 1, further comprising receiving user input identifying objects to be presented in the graphical user interface.

47. A computer-readable medium encoded with computer-executable instructions for performing a method for presenting traceability information on a

production chain in a graphical user interface, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the vertices, and the vertices representing objects and the edges representing object dependencies, the computer-executable instructions, when executed, performing a method comprising:

receiving user input identifying a base object of the graph;

selecting a plurality of objects of the graph to be displayed in the graphical user interface based on a dependency relationship between identified base object selected objects;

displaying in the graphical user interface a graphical representation of at least a portion of the selected objects;

receiving user input identifying an object of the displayed portion as a focus object; and

providing information about the focus object.

48. A method for presenting traceability information on a production chain in a graphical user interface, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the vertices, and the vertices representing objects and the edges representing object dependencies, the method comprising presenting a hierarchical structure of the object visualized as collections of objects that can be shown in exploded form or in the form of single objects representing each collection, wherein the hierarchy can include two ore more levels, in which elements can be exploded or collections imploded into an icon representation independently.

49. A computer system comprising:

at least one processor programmed to implement a method for presenting in a graphical user interface traceability information on a production chain, the production chain being defined as a graph, the graph comprising a set of vertices and edges, each one of the edges connecting at least two of the

vertices, and the vertices representing objects and the edges representing object dependencies, the method comprising:

receiving user input identifying a base object;

presenting in the graphical user interface a graphical representation of at least a portion of the graph, the portion having a plurality of displayed objects the plurality of objects comprising the base object and ancestor objects and successor objects of the base object in the production chain;

receiving user input identifying an object of the plurality of displayed objects as a focus object; and

in response to the user input identifying the focus object, providing information about the focus object.

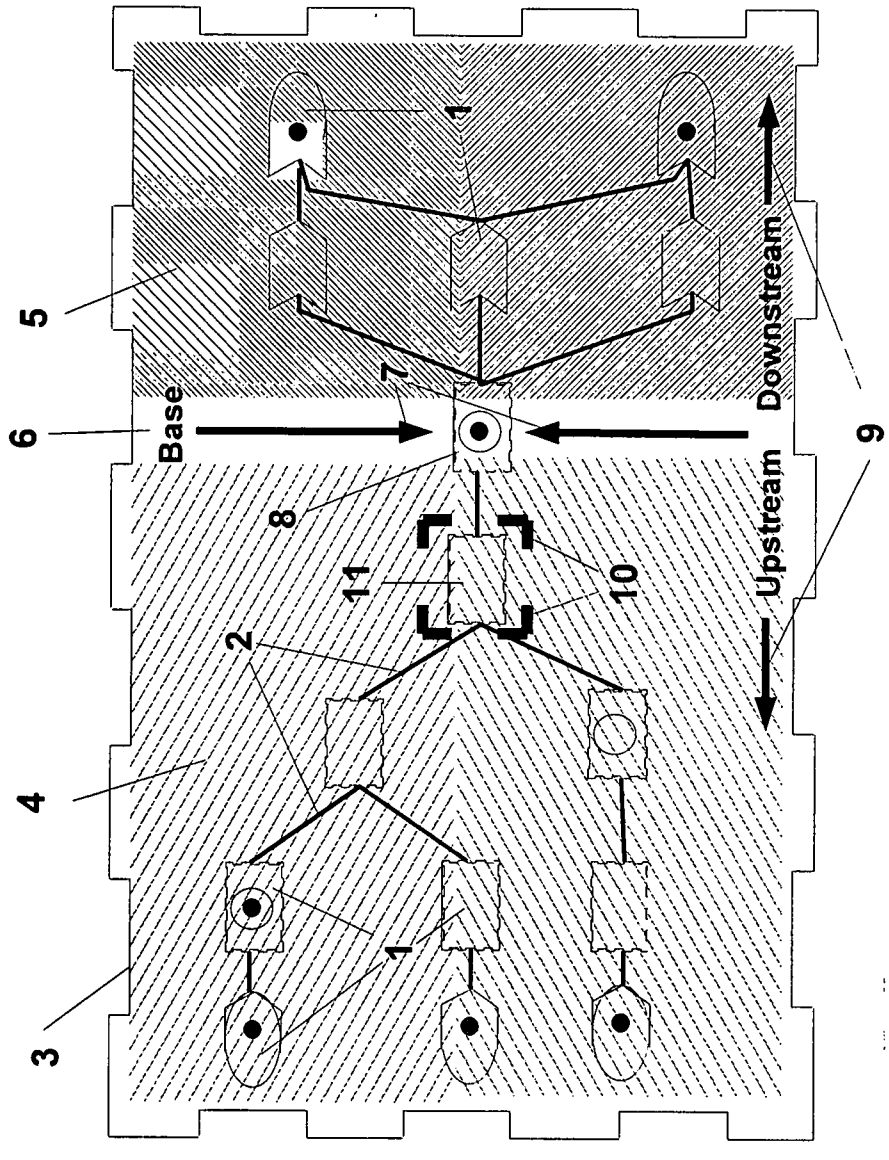

FIG. 1

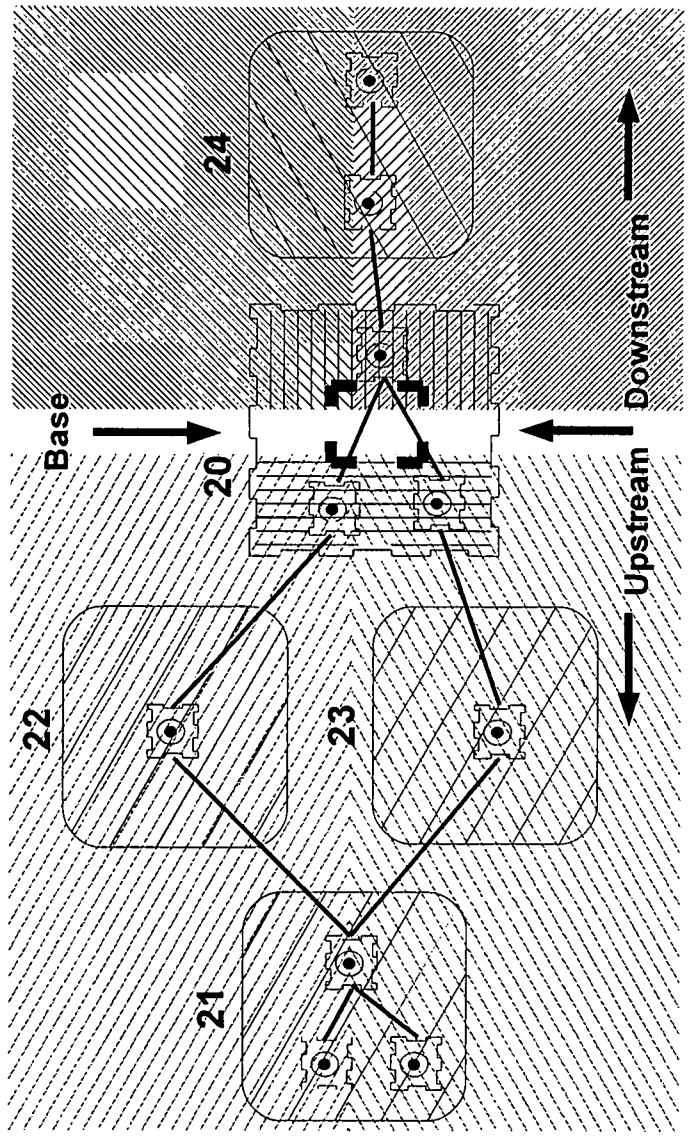

FIG. 2

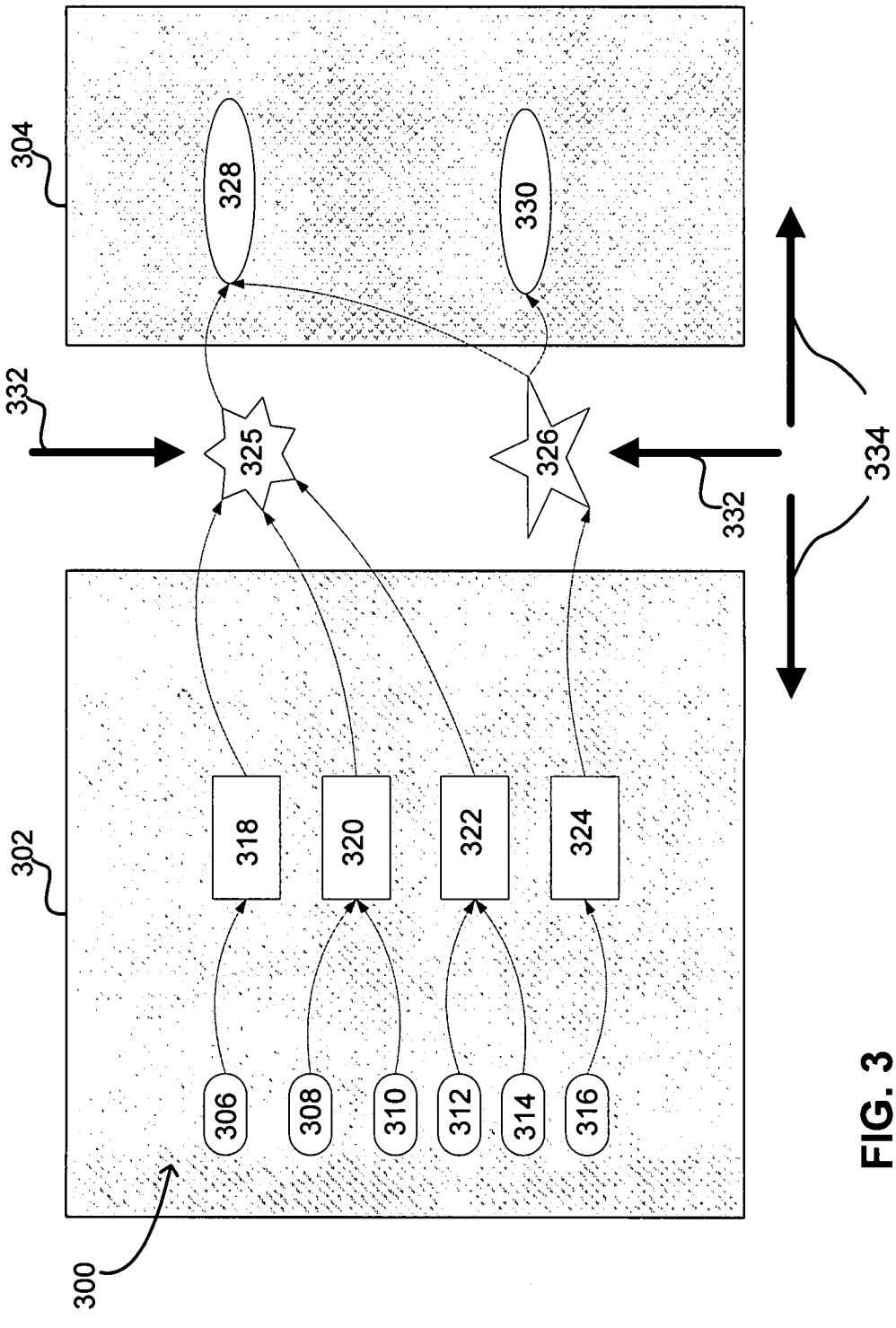
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FIG. 3

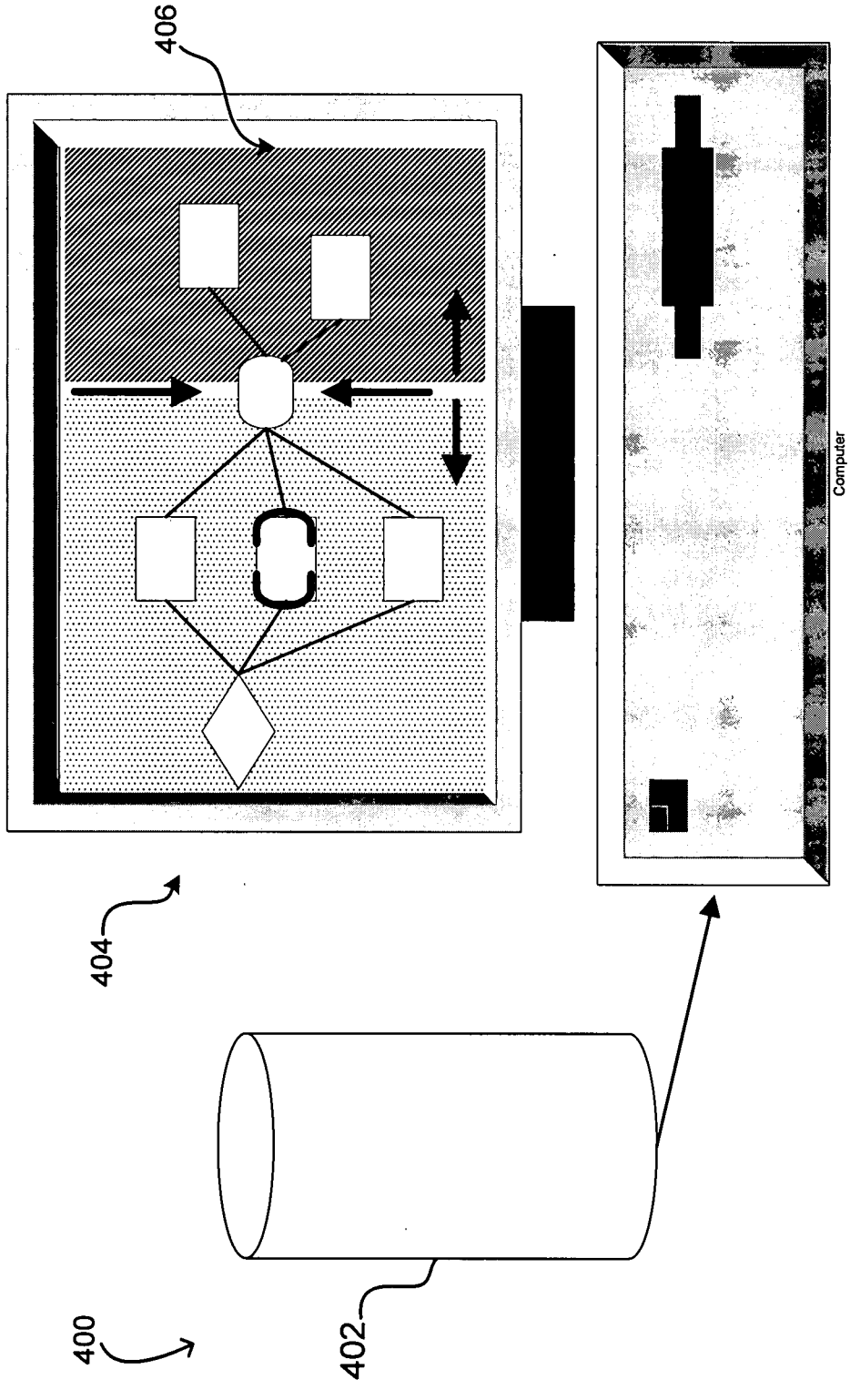

FIG. 4