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ASPECTS FOR TELECOMMUNICATION SYSTEMS

Man-machine language – Human-machine interfaces for
the management of telecommunications networks

**Graphic information for telecommunication
management objects**

ITU-T Recommendation Z.371

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ITU-T Recommendation Z.371

Graphic Information for telecommunication management objects

Summary

This Recommendation provides information about the way in which telecommunications resources are displayed at end-user workstations. In particular, it deals with graphical user interfaces and the information requirements for displaying telecommunications objects such as links and nodes.

Source

ITU-T Recommendation Z.371 was approved on 13 April 2005 by ITU-T Study Group 4 (2005-2008) under the ITU-T Recommendation A.8 procedure.

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Keywords

Graphic objects, human computer interface, human machine interface, user interface.

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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Introduction

Telecommunications networks operators manage their infrastructure and services via user interfaces (UIs) to operating systems (OSs) and management applications. In the ITU-T M.3000 series Recommendations, this user interface is identified as the "G" interface. Work on standardizing various aspects of this vital interface has been undertaken by various standards bodies. Examples include ANSI T1.232, ISO 9241, and ITU-T Rec. Z.361. The "G" interface is critically important in the management of modern telecommunications networks. It is the primary view of the system available to the operator and the organization. Improper or inadequate design at this interface can result in significant problems in the network in terms of reliability and operational efficiency. This interface is referred to as a Human Machine Interface (HMI).

As telecommunications network technology becomes increasingly diverse, management issues have become more complex. This complexity requires improved and standardized network management system interfaces to increase the quality of service and reduce response times to customers.

This Recommendation provides information about the way in which real telecommunications network management objects are represented to the user on workstation screens, and the information that is made available to the operators.

ITU-T Recommendation Z.371

Graphic information for telecommunication management objects

1 Scope

This Recommendation describes requirements for the "G" interface of the telecom operations environment. This "G" interface, identified in the ITU-T M.3000 series of requirements, specifically ITU-T Rec. M.3010 defines the interface between the user and the workstation often referred to as a Human Machine Interface (HMI). ITU-T Rec. M.3100, the Generic Information Model, specifies the objects and object classes that are relevant to information exchanged across standard interfaces in the architecture. In the model, objects at the "F" interface are translated into user management objects, and it is this subset that is relevant at the "G" interface. The objects in this Recommendation are the subset of M.3100 objects that are likely to be presented graphically on operators work station screens.

These HMI requirements are based on standard available information technology. They strive to maximize usability and interoperability of applications or products from different vendors.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [1] ITU-T Recommendation M.3100 (2005), *Generic network information model*.
- [2] ITU-T Recommendation M.3010 (2000), *Principles for a telecommunications management network*.
- [3] ITU-T Recommendation M.3300 (1998), *TMN F interface requirements*.
- [4] ITU-T Recommendation G.805 (2000), *Generic functional architecture of transport networks*.
- [5] ITU-T Recommendation G.7042/Y.1305 (2004), *Link capacity adjustment scheme (LCAS) for virtual concatenated signals*.
- [6] ISO/IEC 10164-2:1993, *Information technology – Open Systems Interconnection – Systems Management: State Management Function*.

3 Definitions

The following definitions are imported from other ITU-T Recommendations.

3.1 link (ITU-T Rec. G.7042/Y.1305 (2004)): A link can also be described as an entity that defines a topological relationship including available transport capacity between two nodes in different subnetworks. In a graphic screen picture, these links show up as the connections between nodes or network elements.

3.2 network element/managed element (ITU-T Rec. M.3100 (2005)): In this Recommendation, the term "Network Element" is used in a generic sense to represent managed elements.

3.3 trail (ITU-T Rec. G.805 (2000))

The following definitions are particular to this Recommendation.

3.4 domain: An administrative domain is a collection of managed entities grouped for administrative reasons.

3.5 management system: An entity that manages a set of managed systems, which can be either NEs, subnetworks, or other management systems.

3.6 visual presentation: Visual presentation includes the visual attributes: fill colour, pattern, shape, font, border colour and style, and drawing order.

3.7 alarm collection: Includes an indication of highest severity unacknowledged alarms and other alarms either acknowledged or of lesser severity. An alarm collection should be visible with no user action, or accessible by secondary mouse click and menu selection.

3.8 zoom: The increase or decrease of a geographic or network view while maintaining the same data context. In a network view, the user might be presented with a view of the network that expands to show more nodes across a larger area. Each step does not change the context of the data presented.

3.9 drill-down (expand, collapse): The change of levels of data and change in the data context. A graphical display changing from a province map, to a city view, to a building, a floor, an aisle, rack, and then the NE itself, is an example of a drill-down. Each step changes the context of the data presented. Double clicking an object is a form of drilling down.

4 Abbreviations

This Recommendation uses the following abbreviations:

2D	Two Dimensional
3D	Three Dimensional
ADM	Add, Drop Multiplexer
GUI	Graphical User Interface
HCI	Human Computer Interface
HMI	Human Machine Interface
ID	Identifier
LED	Light Emitting Diode
OC	Optical Connection
PVC	Permanent Virtual Connection
SVC	Shared Virtual Connection
TMF	Telemanagement Forum
UI	User Interface

5 Conventions

This Recommendation uses two specific markers which designate requirements and optionality.

(R) Designates those aspects which must be present if the application is to be considered compliant with this Recommendation.

(O) Designates optional aspects of this Recommendation. However, it should be noted that where appropriate, given the context, it is desirable for the HMI to use these aspects as well. Also note that there are cases where a component or area of a template may be optional, but if it is included, then there are required aspects to the included component.

6 HMI architecture

The "G" interface can be divided into the conceptual components shown in Figure 1. This architectural description provides an improved means of specifying and understanding the complex relationship between the system and the user. Figure 1 shows three different classes of user interface presentation elements, namely, task managers, generic elements, and telecommunications elements.

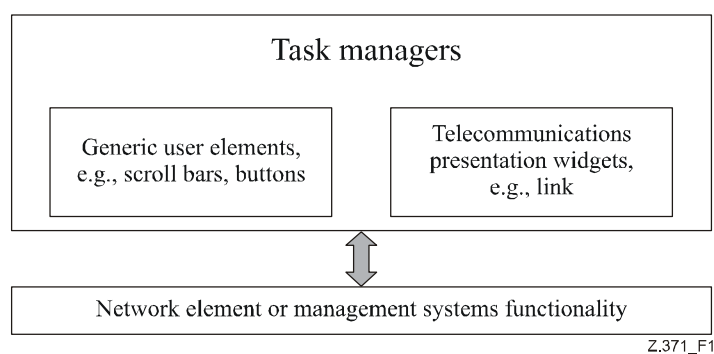


Figure 1/Z.371 – HMI components illustration

This Recommendation provides requirements for the telecommunications presentation elements in Figure 1. Task managers are created when user interface designers and system developers assemble the various data displays and controls required for the management of a particular piece of technology such as a SONET ring. These are very specific to the technology and are where many companies see competitive advantage. However, the presentation of telecommunications objects should have a degree of standardization in order that operators quickly and accurately recognize the nature of the resource, its state or condition, and its relationship to other resources.

6.1 Network element and service management system

The network element and service management component represent the software that makes up the management system and also the data about the network elements and their interconnection. This data is typically specified in the underlying information models, for example, ITU-T Rec. M.3000, *Overview of TMN Recommendations*.

6.2 Generic user interface objects

These are a set of elements such as buttons, windows, and scroll bars. These are defined by the specific user interface style or toolkit supported at the workstation (OSF Motif, Windows, JAVA Swing, etc.) and are aptly described in style guides provided by the manufacturer. These HMI elements are stable and common across the range of systems or products currently available in the

market place. This Recommendation is not a style guide and provides no information about these generic elements.

6.3 Telecommunications presentation objects

These are the set of telecommunications-specific objects such as network element symbols, link or connection graphics, and shelf level graphics. This Recommendation deals with the required information elements of these objects. There is a mapping between the system objects and the objects presented to the user. ITU-T Rec. M.3300 describes these objects as User Management Objects (UMOs) which are created in the workstation and which are then represented to the user via the "G" interface.

It is the role of the Presentation object to change the management objects and models into user objects and models suited to the people who have to operate the network. Users will require access to the complete set of information available about a network object that may be made accessible via an operating system or application. There will be a relationship, or binding, between the graphic object which appears on the screen, the UMO, and the managed object.

This Recommendation deals with the minimum subset of the information that is generic. This subset should be displayed on the screen when any particular object is visible. For example, when an operator views a network with a number of regions with different vendors' equipment, the regions should have a standard set of attributes and behaviours. Further when the region is opened, the contained network elements should appear with a standard set of information. In human factors terms, the user benefits are:

- Easy to learn and remember.
- Less likely to produce errors.
- More efficient in accomplishing goals.
- More pleasing to use.

These are universal objectives for user interface designers and are at the root of the justification for this Recommendation.

7 Telecom presentation views

7.1 Background

All network management systems rely on some level of human intervention, whether for difficult fault isolation and repair, or for complex configuration tasks. The types of displays that are appropriate to bring the information to the network operator are of various sorts. For instance, regular entry forms and table-based displays are common, though they are not specific to the telecommunications industry. On the other hand, network management applications will require network representations, interactions and navigation paradigms that are very specific to the industry. The definitions of those displays, or views, as well as the various types of objects that populate those displays are the concern of the following clauses.

A view is a rectangular space on a computer screen reserved for a coherent set of user interactions. In the old days, computer screens could only display a single, full screen view. However, with the advent of graphical user interfaces, the concept of an application window has been introduced, and one can generally conceive that a window contains a view. It is also possible to define several views coexisting inside a single window. For instance, one could imagine a window with an entry form to the left and a table to the right.

For the sake of clarity, we are hereby defining the various types of views that will be commonly found in the telecommunications industry, namely:

- Generic entry forms;
- Table-based views;
- Tree-browser views;
- Chart-based views;
- Geographical or logical network views;
- Equipment views.

Bringing the information to the network operator can be seen as a generic translation task depending on the view type. The real objects and data are provided by a network management system to a visualization layer that computes the appropriate graphic representation. In other words, the real business objects must be translated into graphic objects to enable the network operator to understand and interact with the network. Various graphic objects, according to the view type, user's preferences or role and application type, may represent a given real object.

The following clauses will describe, according to each kind of view, how the managed object should be represented, and will detail some interaction concepts that are common to every kind of view:

- Browsing the objects (like next, back, zoom, drill-down);
- Arranging the objects (like sorting, filtering, layout);
- Editing of the objects (creation, modification, copy, cut & paste, undo, redo).

7.2 Generic entry forms

These are entry forms that are common to many data-driven applications, both inside and outside the telecommunications industry. These forms contain generic graphic objects, such as menus, buttons, text fields, combo boxes, drop-down boxes, etc. These objects are common to all GUI platforms used for network management applications, from UNIX to Windows to Java. Though we do not need to re-specify these objects, it must be pointed out that these objects and their behaviour are now an expected part of any application.

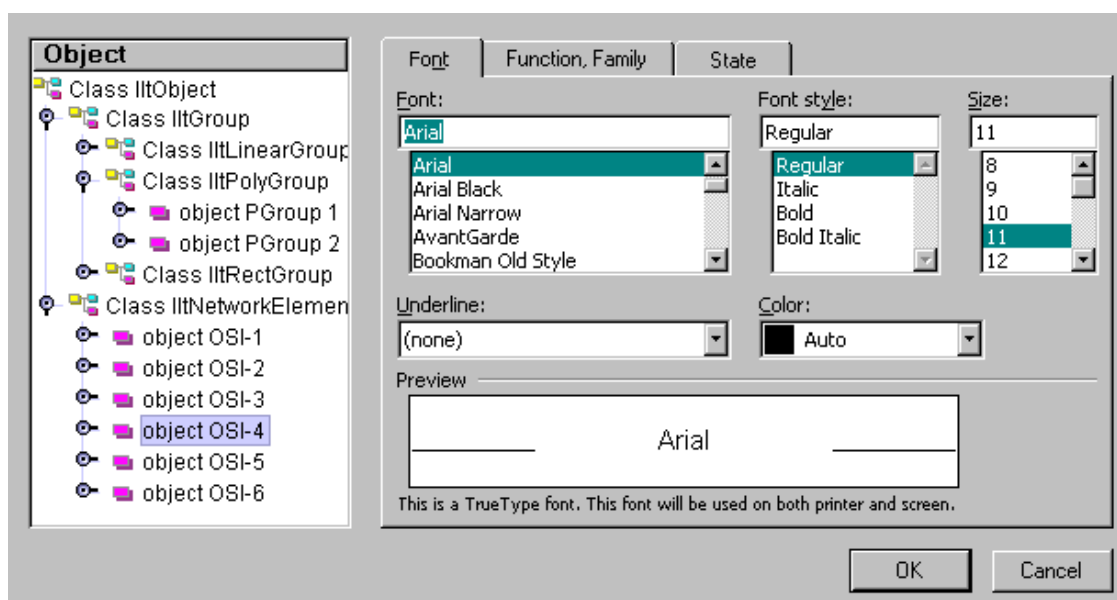
7.2.1 Graphic representation of the managed objects

One form generally represents one object from the network management system or a set of objects having common properties. A form consists of a panel including a set of graphic widgets on which the object's properties are mapped. The mapping depends on the property type. For example, a Boolean property can be mapped to a checkbox or a combo box. A string property can be mapped to a text field.

7.2.2 Browsing the objects

When the represented object has a lot of properties, the form can be arranged as a set of tabbed panes to group the object properties by domain or semantic. Thus, one way of browsing the properties of an object is to switch the visible pane. When creating user interfaces, care should be taken to not arrange properties in tabs reflecting the software architecture, but in tabs corresponding to end-users' view of the structure of the managed objects or related to the user's task.

Additionally, when the same kind of form can represent many objects, the first widget of the form could be a drop-down list of objects that allows easy switching from one object to the other. If the objects are arranged as a hierarchy, the form view can be associated with a tree view presenting all the visible objects. Thus, another way to browse objects is to select one/many objects in the tree view to display its/their properties in the form view.



(This figure is not intended to imply any particular platform or toolkit)

Figure 2/Z.371 – Illustration for a form view, with an object tree browser

7.2.3 Arranging the objects

Filtering can be used in form views, for example by showing only some of the object properties according to the operator's role/access rights, or by showing only some of the objects.

7.2.4 Editing of the objects

Form views can be used for inspection only, or for editing the objects. According to the user's role, the task being performed and the property types, only some of the fields, or all of them can be made editable. Standard graphic gadgets used in forms like the text fields, choice lists or buttons can always be enabled or disabled so it is very easy to display editable or non-editable properties.

The form views are the most appropriate and most powerful views for editing the objects.

7.2.5 Form behaviour

Forms are generic widgets and manifest what is now considered standard behaviour.

7.3 Table-based views

Table-based views are spreadsheet-like displays that are used to list large amounts of data. They are very useful in the network management area, for instance, to display lists of network elements, alarms or events. In the field of network management applications, the table-based views must be presented to the user with the following capabilities. (The GUI builder typically provides these capabilities.)

Primary Controller ▾			Backup Controller		
		Activity			Activity
	203.111.112.129	Unknown	<input type="checkbox"/>	<none>	n/a
	203.115.28.1	Active		OPC004PP/203.113.:	Inactive
	203.115.108.27	Busy	<input checked="" type="checkbox"/>	<none>	n/a
	203.113.22.128	Active	<input type="checkbox"/>	<none>	n/a
	OPC002PP/203.113.2	Inactive	<input type="checkbox"/>	<none>	n/a
	OPC003PP/203.113.2	Active	<input type="checkbox"/>	<none>	n/a

(This figure is not intended to imply any particular platform or toolkit)

Figure 3/Z.371 – Illustration of a table view

7.3.1 Graphic representation of the managed objects

A table is used to represent sets of objects.

(R) An object from the network management system is represented graphically as a row in the table.

(R) The properties of the objects are represented at the columns of the table.

(R) The table view maps graphically the value of a given property for a given object in each of its cells. The mapping depends on the property type. For example, a Boolean property can be mapped to a checked cell, a state can be mapped to a cell containing an icon, an alarm severity can be mapped to the background colour of the entire row.

7.3.2 Browsing the objects

(R) Browsing the objects presented by a table can be done using scroll bars.

(R) Additionally, the columns and rows can be moved, resized, or hidden to show more or less information.

(O) When objects are organized as a hierarchy, table views can be associated with tree views where the tree represents categories of objects and the table represents the objects themselves (for example, this is widely used in file browsers).

7.3.3 Arranging the objects

(R) The order of the table columns can be modified. The user can reorder the columns according to the property of the objects he wants to focus on.

(O) The rows of the tables can be sorted in ascending or descending order using the values in any column.

(O) Multiple-column sorting should also be available. For instance, in a table presenting some network events, the events could be sorted both by date and then by severity.

(O) The visibility of the columns can be modified individually.

(O) A table can be filtered using patterns on the cell values. Filtering patterns may be user-defined via a text field, or predetermined and selected, for example, by a drop-down list. The filtering pattern can be applied to a single column or to multiple columns. For instance, in a table presenting some network events, the events can be filtered by their source, displaying only those produced by a given object.

7.3.4 Editing of the objects

Table views can be used for inspection only, or for editing the objects. According to the user's role, the task being performed and the property types, none, some or all of the cells may be editable.

(R) Cells are selected by a primary click.

(O) In-place cell editing is started using a double click.

When the in-place cell editing is not possible, an editable text field near the table generally represents the selected cell value.

7.3.5 Table behaviour

Tables are generic widgets and manifest what is now considered standard behaviour.

7.4 Tree-based views

Tree-based views are widely used to represent hierarchies of objects in a very compact way. The main information directly visible to the user is the hierarchy. However, some other information may be visible in a tree-based view. Generally, each tree node is represented with an icon that reflects the object type or class and a label, which is generally the name or ID of the object. Some graphic clues are also used to provide richer information to the user. For example, icon modifiers added to the object icons to represent the values of some useful properties.

7.4.1 Graphic representation of the managed objects

A tree is used to represent sets of objects. An object from the network management system is represented graphically as a tree node or as a tree leaf in the tree. The properties of the objects are not represented directly in the tree. However, some properties can be represented using graphic clues like font sizes, colours, icons, and icon modifiers.

(R) The tree view will map the name (or ID) of the object to the label of the tree node.

(R) The view will map the type (or class) of the object to an icon.

(R) The tree must also contain particular icons in the tree structure that allow the user to expand or collapse the containment hierarchy via one mouse click.

(O) The subtype or any other attribute can be represented using icon modifiers, or by using foreground or background colours for the label.

As the tree view provides very compact representation for the objects, it is not supposed to display all the properties of an object. If representing all the properties of an object is mandatory, the tree may be associated with a table view or to a form view, which is more suited to represent a large number of objects properties.

7.4.2 Browsing the objects

(R) Browsing the objects presented by a tree can be done using scroll bars.

(R) Objects can be selected by a mouse click or using the arrow keys.

(R) As the tree represents a containment hierarchy, it is possible to drill down in the container with a primary click on the special expand/collapse icon in the tree structure, or with a double click on the node itself or;

(O) Pressing the enter key may also expand the container.

7.4.3 Arranging the objects

In a tree view, the ordering of the items mainly depends on their hierarchical relations.

(O) For each containment level, the items can be sorted alphabetically.

(O) A tree can be filtered using patterns on the tree nodes properties. Filtering patterns may be user-defined via a text field, or predetermined and selected, for example, by a drop-down list.

7.4.4 Editing of the objects

As tree views are used to represent information or hierarchies in a very compact way, they should not be used to edit objects or objects properties directly.

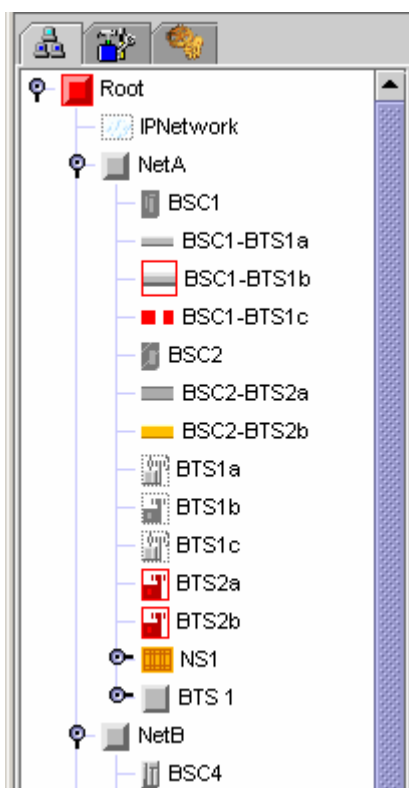
(O) When editing is mandatory, a tree view may be associated to a table view or to a form view that is more suited to editing of objects properties.

However, in some cases, it could be useful to edit the hierarchical structure of the tree.

(O) In such a situation, it may be possible to add, remove or move objects in the tree using drag and drop.

7.4.5 Tree behaviour

Trees are generic widgets and manifest what is now considered standard behaviour.



(This figure is not intended to imply any particular platform or toolkit)

Figure 4/Z.371 – Tree view

7.5 Chart-based views

Chart-based views are views that display information in the form of a chart or set of charts. These can be bar charts, pie charts, etc. Many network management applications will necessitate displaying information through charts, in particular, all testing and performance monitoring applications. The chart widgets provided by the standard GUI platforms are considered sufficient to display all types of charts specific to the telecommunications industry.

7.5.1 Graphic representation of the managed objects

A chart view is used to represent either one object or a set of objects. When only one object is represented, the chart displays one or more of the numeric properties for this object. For example, a

chart representing only one object may monitor a router by displaying its total bandwidth and the bandwidth for each of its ports. When a set of objects is represented, the chart displays the numeric value of a given property for each object. For example, a chart representing a set of objects may display a one-hour report of the bandwidth of a set of switches. Charts can display values over time, either in real-time or in reporting mode. As the chart is mainly used to represent numeric values, the objects themselves are not directly represented. The properties are the actual data displayed.

Colours, pattern and line style are widely used when mapping numeric values to a chart. They can be used to differentiate properties or to emphasize some values. The colour, pattern and line style of the chart may change when a numeric values reaches a threshold.

(R) If four or more colours are used, a legend must be provided.

7.5.2 Browsing the objects

(R) If the chart is representing values in real time, it must be possible to temporarily freeze the chart to be able to print or read the values.

(O) Browsing the objects presented by a chart view can be done using scroll bars.

(O) If the chart is reporting values over time, it should be possible to zoom in and out to display different time scale and to use scroll bars to view the history of the values.

(O) A chart view can be associated with a tree view to select which objects or which object properties the chart represents.

7.5.3 Arranging the objects

Sorting features are not always applicable to chart views. However, it could sometimes be useful especially when the chart represents a set of objects.

(O) The bars in a chart may be sorted by value, alphabetically by name or by server location.

(O) Sorting criteria may be user defined via a text field or predetermined and selected, for example, by a drop-down list.

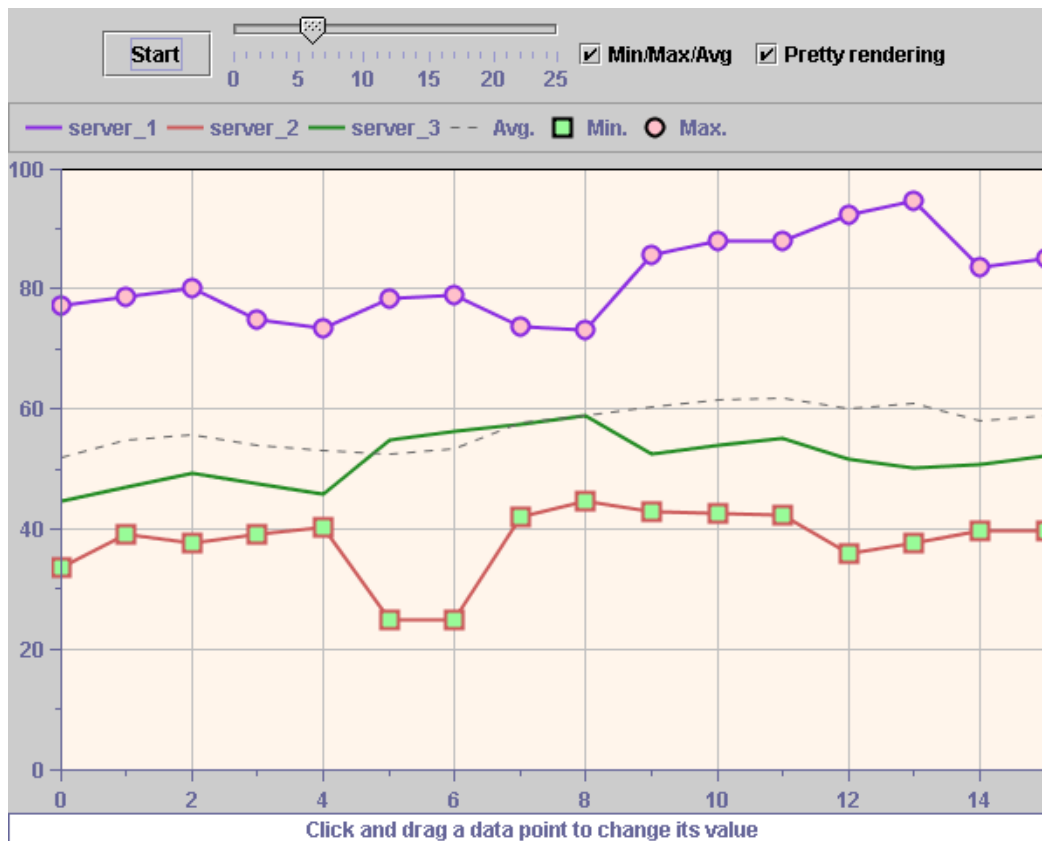
(O) A chart view can be filtered using patterns on the object, on the properties or using thresholds on the property values.

(O) Filtering patterns or thresholds may be user-defined via a text field, or predetermined and selected, for example, by a drop-down list.

7.5.4 Editing of the objects

As chart views are generally used to represent real numeric values, editing is meaningless in most cases. For example, when a chart is used to report the bandwidth of a network element over a given period of time, modifying any numeric value of the chart is inappropriate.

However, in cases like network provisioning or simulation, a chart may be used as a simulation tool. In such cases, editing is useful. Selection should be available via a single click on a chart and editing via a double click. When in editing mode, graphic clues, like anchors, should be visible. The user can then move anchors with the mouse to modify the numeric values of the chart.



(This figure is not intended to imply any particular platform or toolkit)

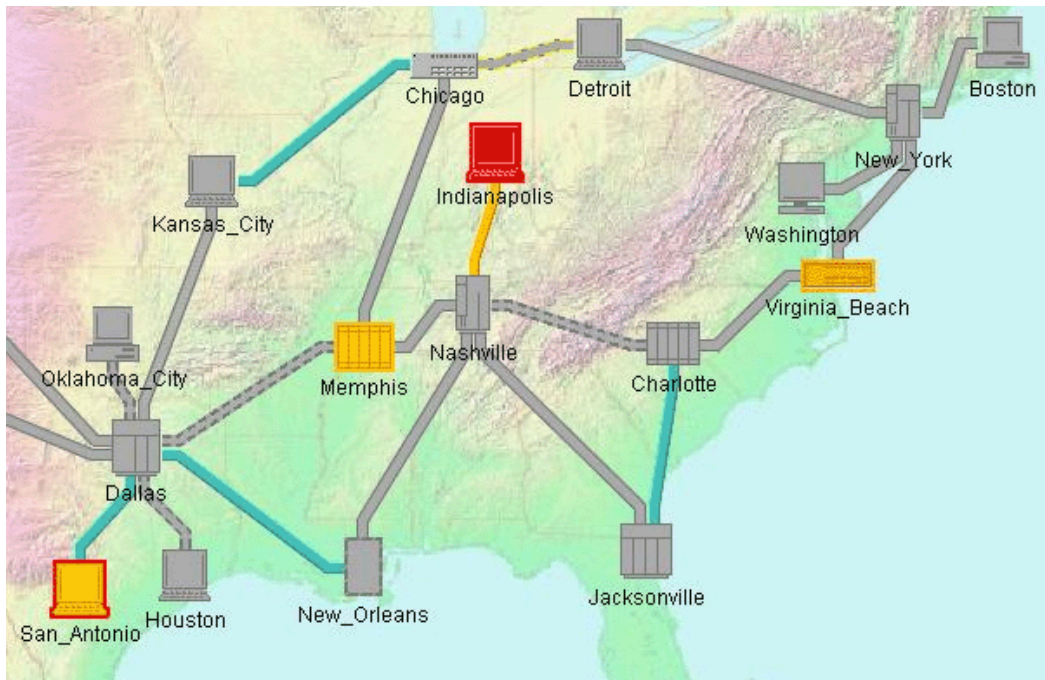
Figure 5/Z.371 – Illustration of a chart view

7.5.5 View behaviour

Chart views are generic widgets and manifest what is now considered standard behaviour.

7.6 Geographical or logical network views

These types of views are much more specific to the industry than the preceding ones. They provide the ability to monitor a network by visualizing a 2D or 3D image of the network, and by representing the devices that comprise this network in an intuitive and informative way. This type of view forces us to define new types of graphical objects which are specific to the industry and which were not mentioned in the former types of views (see clause 8). Examples include graphical representations of nodes, links, geographic maps, etc.



(This figure is not intended to imply any particular platform or toolkit)

Figure 6/Z.371 – Illustration of a geographic network view

7.6.1 Graphic representation of the managed objects

A geographical or logical network view is used to represent objects from the network management system. These objects can be either real managed objects from a network, or logical objects (like virtual private networks or regions).

(R) Geographic network views must support background maps in formats such as bitmaps or vector-based.

(R) In geographical network views, managed objects are represented using icons located geographically relative to their actual physical position.

(R) In logical network views, managed objects are represented using icons located to give the easiest understanding of the network topology (see the "Arranging the objects" 7.6.3).

(R) In both geographical and logical network view, colours, patterns or modifier icons represent the properties of these objects graphically.

(R) Network connections like electrical or fiber links are represented graphically as lines between nodes.

(R) Links can be straight, spline or polygonal lines.

(R) The link properties are represented graphically using colours, line styles or modifier icons. (See clause 8.)

(O) When objects cover large areas, like regions, they may be represented by polygonal shapes approximating the geographic coverage of the objects.

7.6.2 Browsing the objects

(R) Browsing the objects presented by a geographic or logical network view can be done using scroll bars.

(R) When objects are organized as a hierarchy, it must be possible to drill down.

(R) Containers can be opened either by expanding the objects (like regions or link bundles) either in the same view or in a new frame.

(O) It should be possible to zoom in and out to focus on a set of objects.

(O) An overview should be available to allow the user to have the whole picture of the network in mind.

7.6.3 Arranging the objects

(R) In a geographical network view, the objects must be located relative to their actual physical location.

(O) In logical network views, objects are located using node layouts that allow an easier understanding of the network structure. The better node layout depends on the actual network structure. For example, when the network connections follow a tree structure, the network should be laid out as a tree. If the network is a ring, a circular layout should be used to set the nodes positions. The shape of the links can be calculated by a link layout. For example, orthogonal or straight links are better when representing tree structures, whereas spline links are better when representing rings.

(O) A geographical or logical network view can be filtered using patterns on the object properties.

(O) Filtering patterns may be user-defined via a text field, or predetermined and selected, for example, by a drop-down list.

(O) The filtering can be either explicit, by using a filtering pattern like a geographic location, an object type, the severity of the alarms or a property threshold, or implicit using a visibility threshold associated to the zoom level.

(O) Filtering objects, according to the zoom level, is very useful to avoid views cluttered by large amount of objects.

7.6.4 Editing of the objects

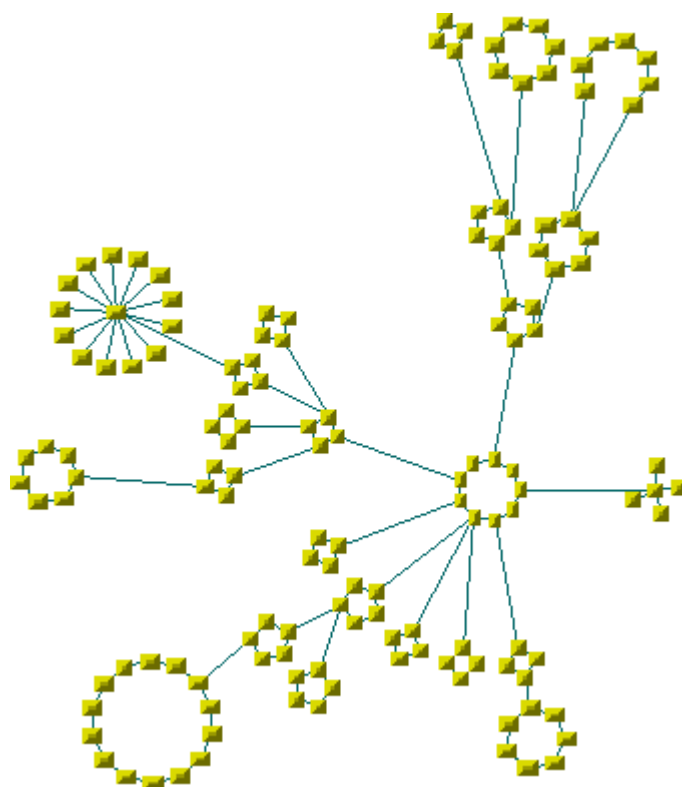
Geographical or logical network views can be used for inspection only, or for editing the objects. According to the user's role, the task being performed and the property types, none, some or all of the objects may be editable.

(R) In a provisioning application it must be possible to create or remove, edit or move any object (nodes or links) graphically using the mouse.

(R) A primary click on an object should always select the given object.

(R) Multiple selection is available either using a specific interaction or with a primary click and a keyboard modifier.

(O) As the double click is associated with the drill-down action, editing should be available via either a global editing mode (vs. a view-only mode) or via popup menus.



(This figure is not intended to imply any particular platform or toolkit)

Figure 7/Z.371 – Illustration of a logical network view

7.6.5 View behaviour

Logical views are generic widgets and manifest what is now considered standard behaviour.

7.7 Equipment views

The views that are used to describe the equipment are particular types of graphical views. They have the following properties:

- The ability to display vector-based or image-based backgrounds;
- The ability to display equipment cards, shelves and equipment racks;
- The ability to scroll, with the help of scrollbars or arrow keys.

The equipment views are important for the telecom industry. They provide the ability to monitor, configure or manage telecommunications equipment in a very generic way by visualizing a 2D or 3D image of the actual hardware equipment. Depending on the type of application, the detail level of the equipment view can vary from the entire rack to the shelves and cards, down to the ports and LEDs level. This type of view forces us to define new types of graphical objects, which are specific to the industry and were not mentioned in the former types of views. (See the graphical representations of equipment racks, shelves, circuit packs in clause 8.)

7.7.1 Graphic representation of the managed objects

(R) The equipment views must support background images in various formats like bitmaps or vector-based to represent the equipment itself, or the rack. In equipment views, managed objects are represented using rectangles or icons located on a background image according to their actual position on the hardware piece of equipment.

(R) If the equipment graphic shows LEDs, then the correct state must be indicated.

(R) The correct placement and complement of cards must be shown.

(R) In equipment views, the properties of the objects are represented graphically by colours, patterns or modifier icons.

(R) When state information is displayed, it must be accurate and correspond with the current real object state.

(O) There is no need for the graphics to be photo-realistic but they should allow the user to recognize the look and positions of the real managed objects. In fact, some degree of abstraction is preferred to photographs. This relates to the user interface principle of minimizing unnecessary or irrelevant information.

7.7.2 Browsing the objects

(R) Browsing the objects presented by an equipment view can be done using scroll bars.

(R) Where large numbers of objects are present, it must be possible to drill down to focus on a subset of objects.

(R) When focused on a given card or cards, its LEDs must be visible and must represent the current condition of the card.

(O) An overview should be available to allow the user to have the whole picture of the equipment in mind.

(O) As objects are organized as a hierarchy (racks contain shelves which contain cards which contain ports and LEDs), a tree view may be associated with the equipment view to inform the user of the equipment structure.

(O) It may also be possible to hide or show some of the objects according to their containment level or to the zoom level. For example, when displaying an entire rack, it may be useful to hide the LEDs.

7.7.3 Arranging the objects

The equipment view represents the objects arranged with a layout that is similar to their actual position on the hardware piece of equipment. There is no need for the graphics to be photo-realistic but the graphics must allow the user to recognize the look, controls, and positions of the real managed objects.

(O) An equipment view can be filtered using patterns on the object properties.

(O) Filtering patterns may be user-defined via a text field or predetermined and selected, for example, by a drop-down list. The filtering can be either explicit by using a filtering pattern like an object type, the severity of the alarms or a property threshold, or implicit using a visibility threshold associated to the zoom level.

(O) Filtering objects according to the zoom level is very useful to avoid views cluttered by large amount of objects.

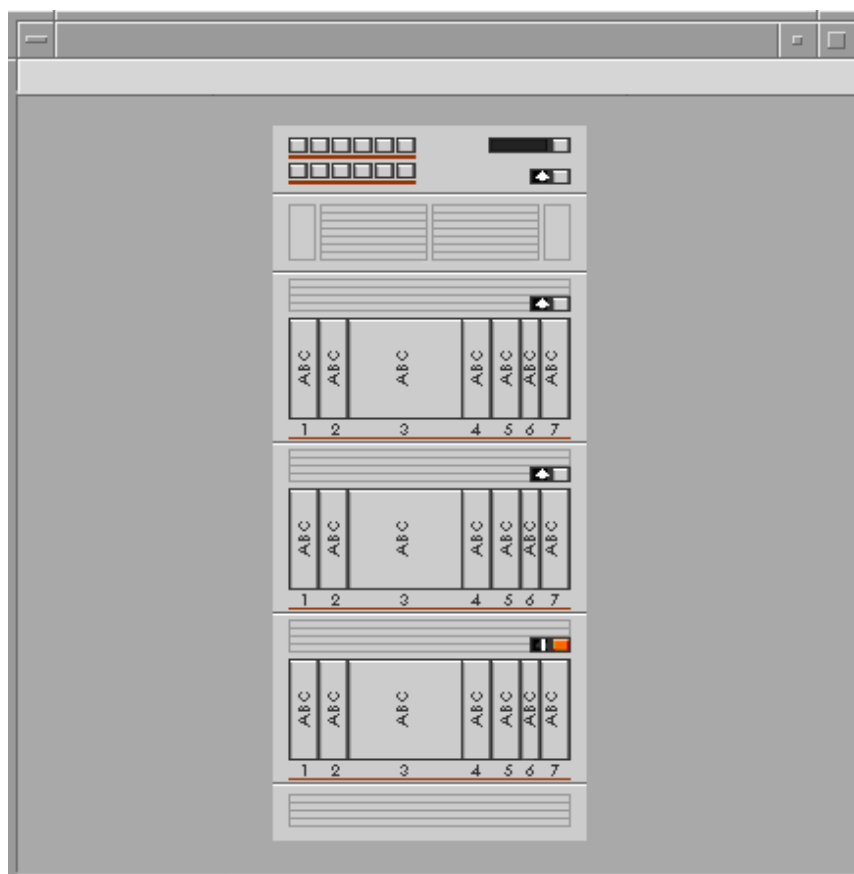
7.7.4 Editing of the objects

Equipment views can be used for inspection only or for editing the objects. According to the user's role, the task being performed and the property types, none, some or all of the objects may be editable.

(R) A primary click on an object should always select the given object.

(R) Multiple selection must be available either using a specific interaction, or with a primary click and a keyboard modifier.

(O) In an inventory application it should be possible to create or remove, edit, move or resize any object (racks, shelves, cards, ports) graphically using the mouse.



(This figure is not intended to imply any particular platform or toolkit)

Figure 8/Z.371 – Illustration of an equipment view

8 Telecom presentation objects

The real objects that are monitored by a network management system are often displayed on a network operator' workstation in order to permit management actions to be taken. The types of views described in clause 7 will be sufficient to describe virtually all types of situations encountered in network management. The objects that are necessary to build presentation views of the first three kinds (forms, tables and charts) are generic items that have already become *de facto* standards provided across the board within the various GUI platforms available on the market. The following clause lists objects and the attributes that must be graphically represented in order to create an efficient and effective human-machine interface within the telecommunications domain. It is the intent of this Recommendation to state requirements for the graphic representation of these objects in order to stabilize and normalize the presentation of the telecommunications network object to users.

The following graphical objects are described:

- **containers:** examples are regions, sites, networks, customers...
- **network node:** examples are switches, ADMs, crossconnects, routers.
- **links:** examples are physical (Fiber, electrical...), logical (OCnn, PVC, SVC...).
- **trails;**
- **equipment;**
- **off-page connectors.**

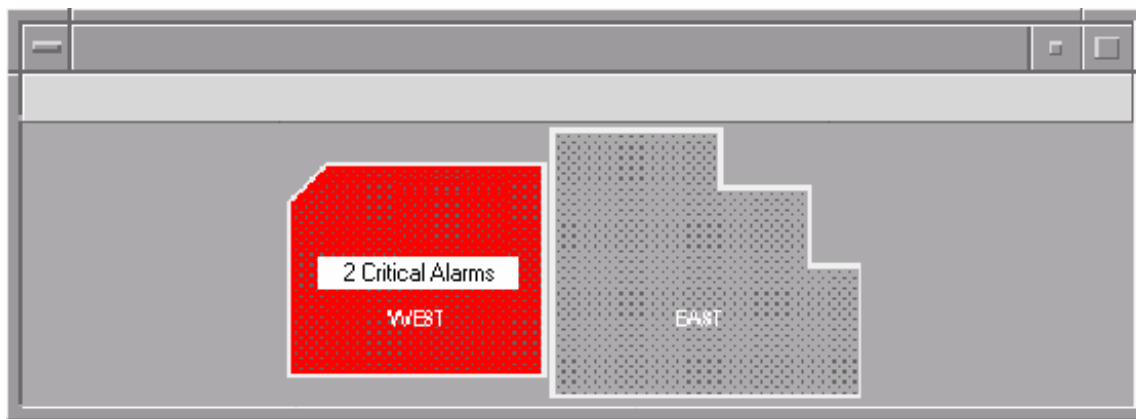
In the following clauses, the illustrations are not intended to suggest or recommend any particular toolkit or platform technology.

The reference to Administrative, operational, and usage state attributes is based on the International Organization for Standardization (ISO) State Model defined in ISO/IEC 10164-2.

8.1 Container

8.1.1 Description of the object

A container is a graphic object representing a number of other objects. It is used to reduce screen clutter and to organize regions of networks dependent on areas of work responsibility, geography, technology or for other administrative reasons.



(This figure is not intended to imply any particular platform or toolkit)

Figure 9/Z.371 – Illustration showing two containers, east and west

8.1.2 Graphic object attributes

- (R) Container ID: Text indicating the name of the container.
- (R) Alarm collection: Includes alarm propagation of contained objects.
- (R) Visual presentation: A graphic, which allows the user to double click to open the container.
- (O) Information box: Text providing additional information.
- (O) Container graphic: A graphic symbol, which indicates that this object is a container and can be opened.

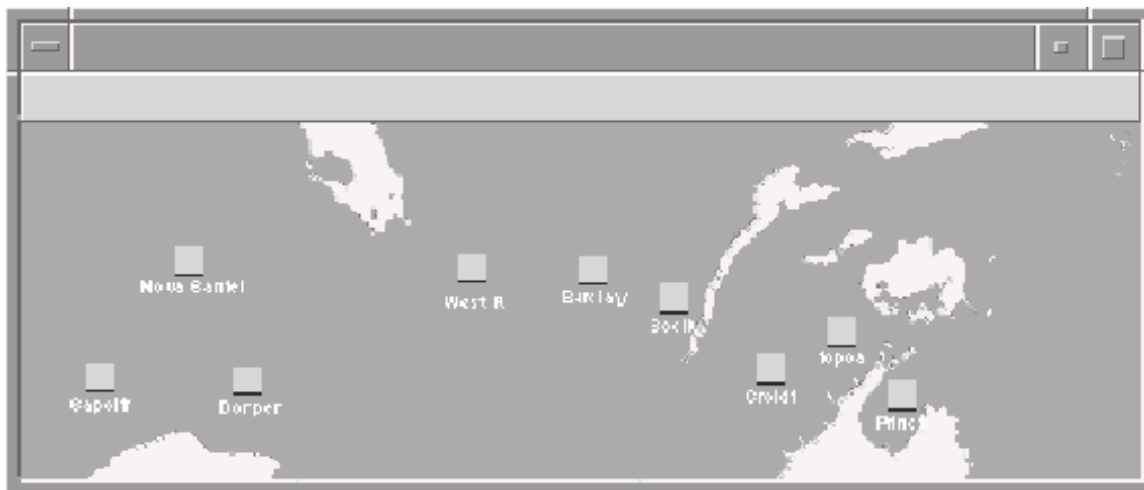
8.1.3 Generic container behaviour

- (R) Containers can be opened with a double primary mouse click.
- (R) Containers can be closed.
- (R) Containers support the most critical alarm or indication propagated up from a managed object or objects in the container.
- (O) Containers can be, moved, reshaped and resized.
- (O) Graphic Objects, including other containers, can be added to a container.
- (O) Graphic Objects, including other containers, can be removed from a container.
- (O) Containers can support secondary state information or summary information that is propagated up from a managed object or objects in the container.
- (O) Containers can have information boxes attached to them.
- (O) Containers can support menus, which are activated by a secondary mouse click.

8.2 Network node

8.2.1 Description of the object

A network node is a graphic object that represents some network equipment or a network element. Examples include intelligent and non-intelligent devices, switches, transport add-drop multiplexers, routers, application servers, and repeaters.



(This figure is not intended to imply any particular platform or toolkit)

Figure 10/Z.371 – Illustration of a managed element

8.2.2 Graphic object attributes

(R) Node ID: Text indicating the ID of the network node.

(R) Node type: A graphic symbol that indicates to the user what type of network element is represented. Symbol shapes for several key equipment classes are provided in ANSI T1.232.

(R) Visual presentation.

(R) Alarm collection.

(O) Administrative, operational, and usage state.

(O) Information box (Tool tip or dialog).

8.2.3 Generic object behaviours

(O) If the network node is also a container, it can be opened with a double primary mouse click.

(O) Network nodes can be moved when on geographical maps.

(O) Network nodes may have menus associated with them, which can be accessed by a secondary mouse click.

(O) Network nodes can be indicated as selected by a left mouse click.

(R) Network nodes support an alarm indication and will be propagated up from subclass objects of the managed element when it is a container.

(O) Network nodes can support secondary state information that is propagated up from subclass objects of the managed element when it is a container.

8.3 Links

8.3.1 Description of the object

An entity that defines a topological relationship, including available transport capacity, between two nodes. Multiple links may exist between a pair of nodes or sub-networks. A sub-network contains multiple links and nodes.

NOTE – A Link can be the same as the Pipe object class in ITU-T Rec. M.3300.



(This figure is not intended to imply any particular platform or toolkit)

Figure 11/Z.371 – Illustration of a link

8.3.2 Graphic object attributes

- (R) Link ID: Text indicating the ID of the link.
- (R) Status.
- (O) Link type: Symbol indicating transport media.
- (O) Administrative, operational and usage state.
- (O) Direction.
- (O) Status of redundant or protection capacity.
- (O) Alarm collection.
- (O) Information box (Tool tips or dialogs).

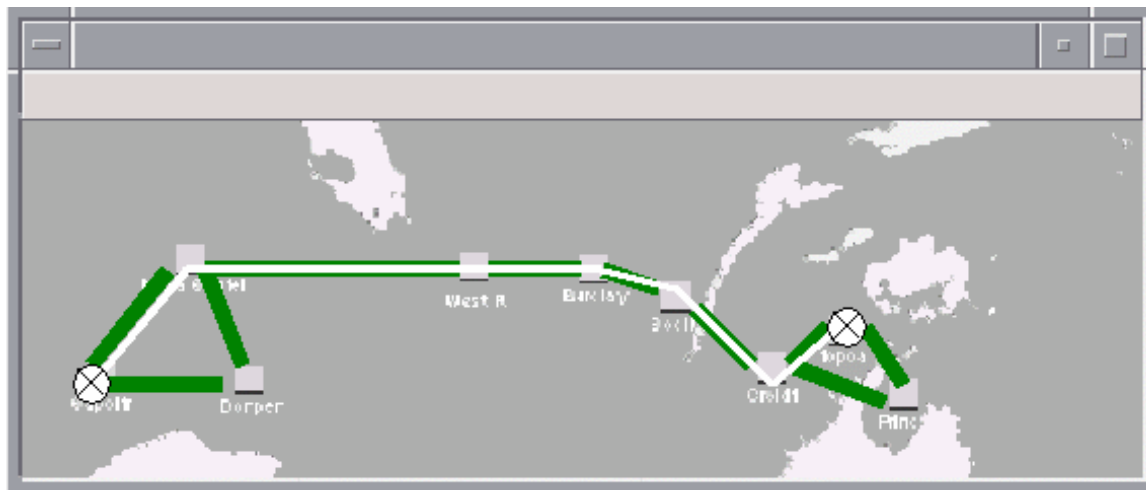
8.3.3 Generic object behaviours

- (R) If the network nodes can be moved, the ends of links remain connected to the nodes when those nodes are moved.
- (O) Links can be selected with a primary mouse click.
- (O) If a link is a container, it can be opened with a double primary mouse click.
- (O) Links can support object menus that are activated by a secondary mouse click.
- (O) Links can support an alarm.
- (O) Links can support secondary state information.

8.4 Trail

8.4.1 Description of the object

A trail is an entity that transfers information provided by a client layer network between access points in a service layer network. The transported information is monitored at the termination points.



(This figure is not intended to imply any particular platform or toolkit)

Figure 12/Z.371 – Illustration of a trail

8.4.2 Graphic object attributes

- (R) Trail ID: Text indicating the ID of the trail.
- (R) Status.
- (R) Termination end points.
- (O) Customer name.
- (O) Layer/Capacity.
- (O) Directionality.
- (O) Priority.
- (O) Channel.
- (O) Utilization.
- (O) Alarm collection.
- (O) Administrative, operational and usage state.

8.4.3 Generic object behaviours

- (R) Trails can be added or deleted or modified.
- (R) Trails can be viewed.
- (R) Trail end points are shown.
- (O) Trails can support object menus.
- (O) Trails can support an alarm.
- (O) Trails can support secondary state information.

8.5 Equipment

8.5.1 Description of the class

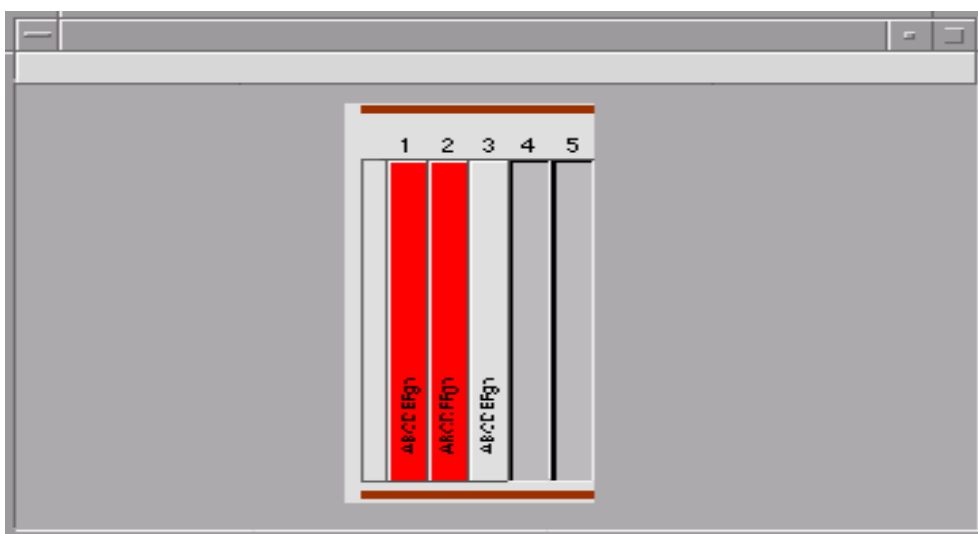
Equipment is an example of a managed element. This class shares the same graphic attributes as the managed element. Equipment typically contains hardware such as Circuit pack, Shelf, Equipment Rack.

Note that the view of a pack, shelf, or rack must be accurate, representing the complement and condition or state of the object as it is in real time.

8.6 Circuit pack

8.6.1 Description of the object

A circuit pack is a managed component in the network and it may be a container if the pack has multiple ports. Examples include ports, line cards, memory modules, and processor cards.



(This figure is not intended to imply any particular platform or toolkit)

Figure 13/Z.371 – Illustration of a circuit pack

8.6.2 Graphic object attributes

(R) Pack ID: Text indicating the ID of the pack.

(R) Alarm collection.

(R) Visual presentation.

(O) Administrative, operational, and usage state.

(O) Information box.

8.6.3 Generic object behaviours

(R) Circuit pack objects reflect the state and status of the real object, for example, the condition of any alarm LEDs on the packs.

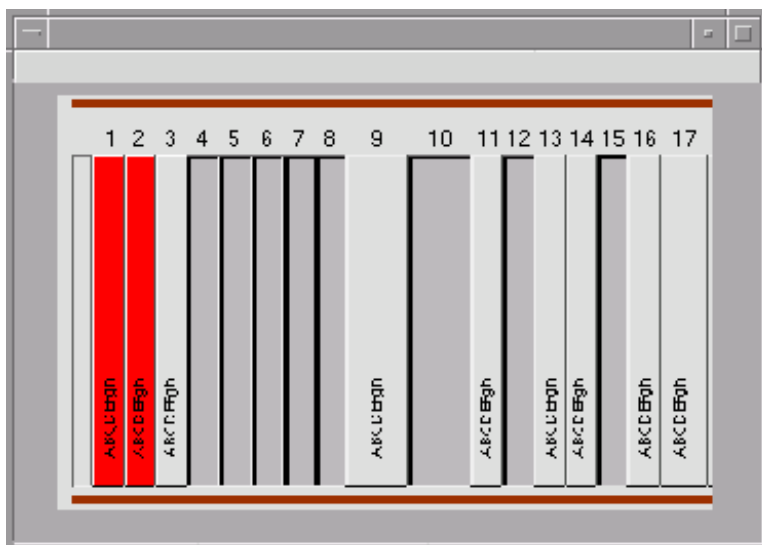
(R) Circuit packs can support an alarm indication propagated up from a managed element it holds or from itself.

(O) Circuit packs can have information boxes attached. Note that this assumes that a shelf graphic is being presented; see Figure 14.

8.7 Shelf

8.7.1 Description of the object

A shelf is a kind of container. It contains circuit packs and possibly other modules such as power supplies or fan units.



(This figure is not intended to imply any particular platform or toolkit)

Figure 14/Z.371 – Illustration of a shelf

8.7.2 Graphic object attributes

(R) Shelf ID: Text indicating the ID of the shelf.

(R) Alarm collection.

(R) Visual presentation.

(O) Information box.

8.7.3 Generic object behaviours

(R) Shelves can be opened with a double primary mouse click.

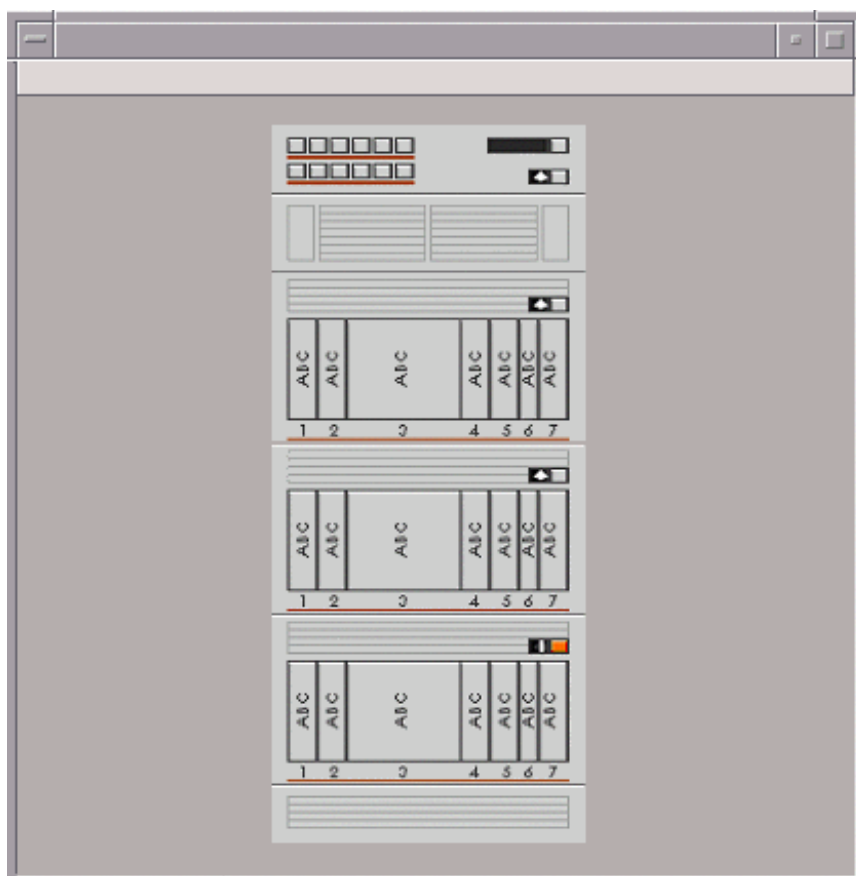
(R) Shelves can be closed.

(O) Shelf objects can support an alarm collection.

8.8 Equipment rack

8.8.1 Description of the object

An equipment rack is a type of container. It contains shelves.



(This figure is not intended to imply any particular platform or toolkit)

Figure 15/Z.371 – Illustration of an equipment rack

8.8.2 Graphic object attributes

(R) Rack ID" text indicating the ID of the rack.

(R) Alarm collection.

(R) Visual presentation.

(O) Information box.

8.8.3 Generic object behaviours

(R) Racks can be opened with a double primary mouse click.

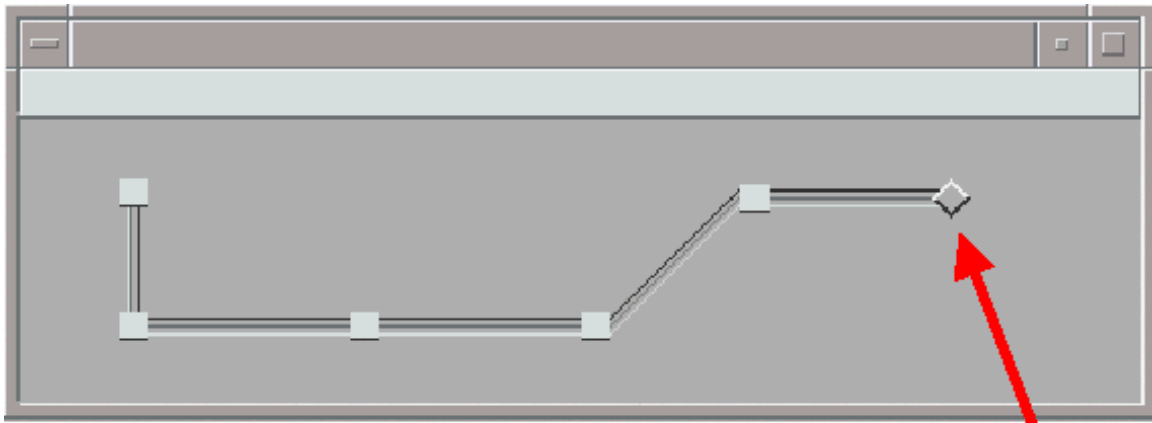
(R) Racks can be closed.

(O) Rack objects can support an alarm collection.

8.9 Off-page connector

8.9.1 Description of the object

Off-page connectors allow users to navigate between managed elements, which are displayed in separate windows.



(This figure is not intended to imply any particular platform or toolkit)

Figure 16/Z.371 – Illustration of operational software outside the hardware

8.9.2 Graphic object attributes

(R) Off-page connectors must indicate the destination element.

(R) After the transition to the new element view, the entry point must be highlighted.

8.9.3 Generic object behaviours

(R) Double primary mouse click will open a view containing the off-page connector.

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