

NetView Version 2 Release 3 Graphic Monitor Facility: Network management graphics support for the 1990s

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The NetView® Version 2 Release 3 Graphic Monitor Facility provides an Operating System/2® (OS/2®) workstation-based graphics user interface for NetView that permits an operator to view graphically and control via generic commands both Systems Network Architecture (SNA) and non-SNA networks. This paper describes the major new capabilities of the NetView V2R3 Graphic Monitor Facility, discusses its structure at a high level, and describes in some detail the new support in this release for graphic views of various types of networks, simplified commands for controlling these networks, and the manner in which non-SNA networks are supported.

The goal of the NetView* product since its first release has been to allow users to manage complex networks consisting both of resources defined in terms of the Systems Network Architecture (hereafter called SNA resources) and resources that are not defined in terms of SNA (hereafter called non-SNA resources). A good exposition of the basic structure and facilities of NetView appeared in a previous paper by Kanyuh.¹

As NetView has developed over the years, new functions have been clustered into two major groupings: those that facilitate operator ease of use and those that facilitate automation of operator tasks so that they can be performed by NetView routines rather than by human beings.

Since the time that the Kanyuh paper was written, NetView Version 1 Release 3 has added high-level language support to NetView, allowing automation routines to be written in PL/I and C, and NetView Version 2 Release 1 added the Graphic Monitor Facility (GMF), a set of functions that are distributed between NetView in the host and Operating System/2* (OS/2*) workstations and that allow users to monitor SNA networks graphically.² Thus, the theme of NetView V1R3 was automation, while that of NetView V2R1 was enhanced user interface.

NetView v2R2, which contains functions to further enhance the user's ability to automate network operations, is described in the paper by Irlbeck in this issue.³

NetView Version 2 Release 3 contains major new enhancements for both automation and usability. The major automation enhancement in NetView V2R3 is the Resource Object Data Manager, an object-oriented data cache that serves as an op-

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erational repository for real-time resource topology and status information. For a description of Resource Object Data Manager, see the paper by Finkel in this issue.⁴ The major user interface enhancement in NetView V2R3 is the extension of GMF to support non-SNA as well as SNA networks, providing the operator with a seamless graphics view of the topology of both types of networks, and the addition of command support, allowing the operator to control the status of resources in the network and obtain information about these resources via a generic "point-and-shoot" interface. This paper describes these enhancements to GMF.

From its inception, a major goal of NetView has been to present a seamless user interface allowing users to view and control their networks with a simple set of user interfaces. This goal, which is implicit in the name of the product itself, is difficult to achieve, since a data processing network typically consists of a heterogeneous collection of protocols and equipment. Earlier papers by Gottschalk⁵ and by Percival and Johnson⁶ document the usability process and usability testing which were devised to improve the usability of this product. NetView Version 2 Release 3 represents a major step forward toward IBM's goal of presenting the user with a simplified user interface that gives a unified, standardized set of views of the components of the network and their topology, as well as a powerful set of generic commands that can be used to control the states of multiple types of networking equipment running under multiple protocols. NetView V2R3 GMF greatly facilitates the management of heterogeneous networks, satisfying many of the requirements set forth in this issue in the paper by Stevenson on managing multivendor networks.⁷

Product overview

This section presents an overview of the functions and components of NetView V2R3 GMF.

NetView V2R3 GMF provides a seamless operator interface for monitoring and managing networks and associated resources. By *seamless operator interface* we mean that the operator uses the same standard set of graphics views and pull-down commands to monitor and control many different types of devices, even though the devices themselves may be under the control of device managers that use different status and commands.

NetView V2R3 GMF masks this complexity from the operator.

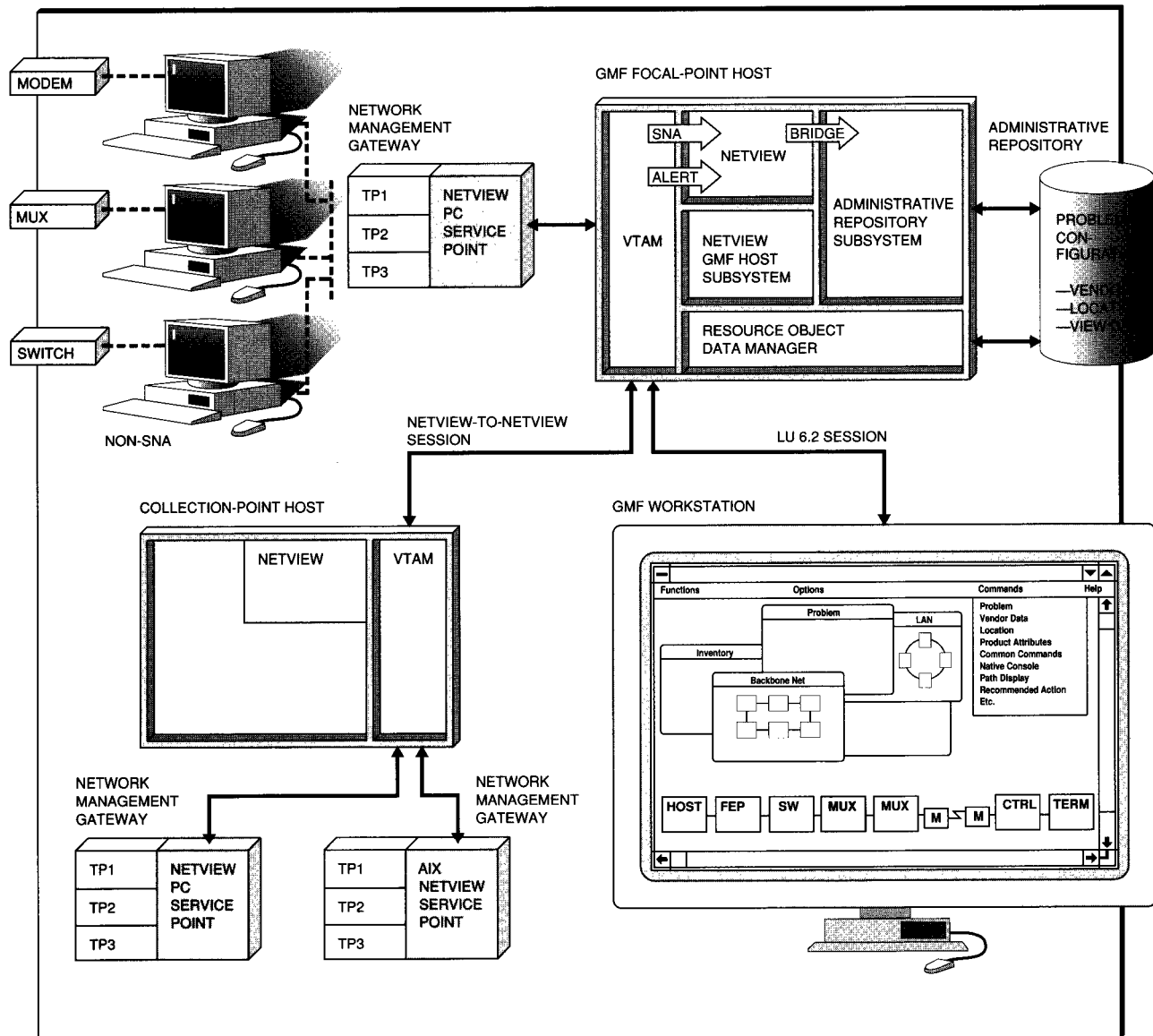
NetView V2R3 GMF presents multiple graphic views of systems and networks, including views of SNA backbone and boundary networks, non-SNA networks interfacing with an SNA backbone network by means of a service point, and specialized views such as high-level geographic views and views showing the "path to the owner" for a certain resource. Graphic views are important in network management because they allow an operator or help-desk person to see where a particular failing resource is located in a network relative to other resources, and to make inferences based on these relationships. For example, if a terminal turns red in a graphics view, indicating that it is in an unsatisfactory state, the operator can determine visually whether the controller or link to which the terminal is attached is also red, and thereby prioritize the order in which to focus on resources in doing problem determination and resolution.

NetView V2R3 GMF generates views of non-SNA networks dynamically from an operational repository of configuration and status information located on the host. The configuration information in this repository, which may be dynamically refreshed without bringing down any part of NetView Version 2 Release 3, is available to user-written automation routines as well as to the operator.

Integrated command support (point-and-shoot capability) is provided for all views, so that the user may select a resource in a view and issue commands against it via menu selection. The integrated command support provides support for an extensive set of predefined commands for both SNA and non-SNA resources. In addition, NetView V2R3 GMF allows the user and third-party vendors to add their own commands to the graphics interface; when a user selects one of these commands, the command is passed to a user-specified application residing on the host or workstation for execution. Thus, with NetView V2R3 GMF, an operator may directly affect the status of resources in a graphical view by selecting them with a mouse and then selecting a generic command, such as Activate or Inactivate, from a pull-down menu.

NetView V2R3 GMF is tightly integrated with NetView, avoiding duplication of function and

Figure 1 NetView V2R3 GMF overview



fully exploiting NetView facilities with respect to command support, span of control, and workstation "look and feel."

In the remainder of this paper we describe major functions and components of NewView V2R3 GMF.⁸

Major components of NetView V2R3 GMF. Figure 1 provides an overview of NetView V2R3 GMF and related components and subsystems, showing a

GMF Focal-Point Host, a Collection-Point Host, a GMF Workstation, Network Management Gateways, an administrative repository subsystem, and an administrative repository.

The *GMF Focal-Point Host* is a Multiple Virtual Storage (MVS) host that serves as a focal point for configuration and status information. It receives status information for SNA and non-SNA resources dynamically from Collection-Point Hosts, and

sends views and status information dynamically to the GMF Workstation.

Major subsystems shown in the GMF Focal-Point Host are as follows:

- VTAM* (Virtual Telecommunications Access Method)—an SNA telecommunications access method provided by IBM
- NetView—IBM's network management system for MVS, virtual machine (VM), and Virtual Storage Extended (VSE) hosts
- Resource Object Data Manager—a new object-oriented data cache manager shipped as part of the NetView V2R3 release
- NetView GMF Host Subsystem—a new subsystem for managing non-SNA resources that is shipped as part of NetView V2R3
- Administrative repository subsystem—a program that manages the user's inventory, problem, and configuration data; an example of an IBM-provided administrative repository subsystem is the Information/Management product

The five subsystems in the GMF Focal-Point Host all run in their own address spaces under MVS.

A *Collection-Point Host* is an MVS, VM, or VSE host running NetView V2R3 that collects status information for SNA and non-SNA resources and sends it via a NetView-to-NetView session to the NetView component in the GMF Focal-Point Host. Status for SNA resources (physical units [PUs] and logical units [LUs]⁹) is provided to NetView by VTAM. Status for non-SNA resources is provided to NetView by Network Management Gateways, which interface with non-SNA networks and convert status events for resources in these networks into SNA alerts;¹⁰ these alerts are then sent from the Network Management Gateway to a Collection-Point Host, and are forwarded to NetView residing in the GMF Focal-Point Host. The GMF Focal-Point Host itself serves as a collection point for "local" SNA and non-SNA resources that are associated with it.

The *GMF Workstation* is an OS/2 workstation that serves as the means by which operators and help-desk people interact with the network being managed. The GMF Workstation comes in two versions, the GMF Server Workstation and the GMF Client Workstation.

The *GMF Server Workstation* is an OS/2 workstation that stores static and customized views, com-

municates with the GMF Focal-Point Host to receive dynamic views and status information for resources, and sends static and dynamic views upon demand, and status information when it is received, to GMF Client Workstations. The GMF Server Workstation communicates with the GMF Focal-Point Host via an SNA LU 6.2 session, sending operator commands to the GMF Focal-Point Host and receiving back views, resource status information, and command responses.

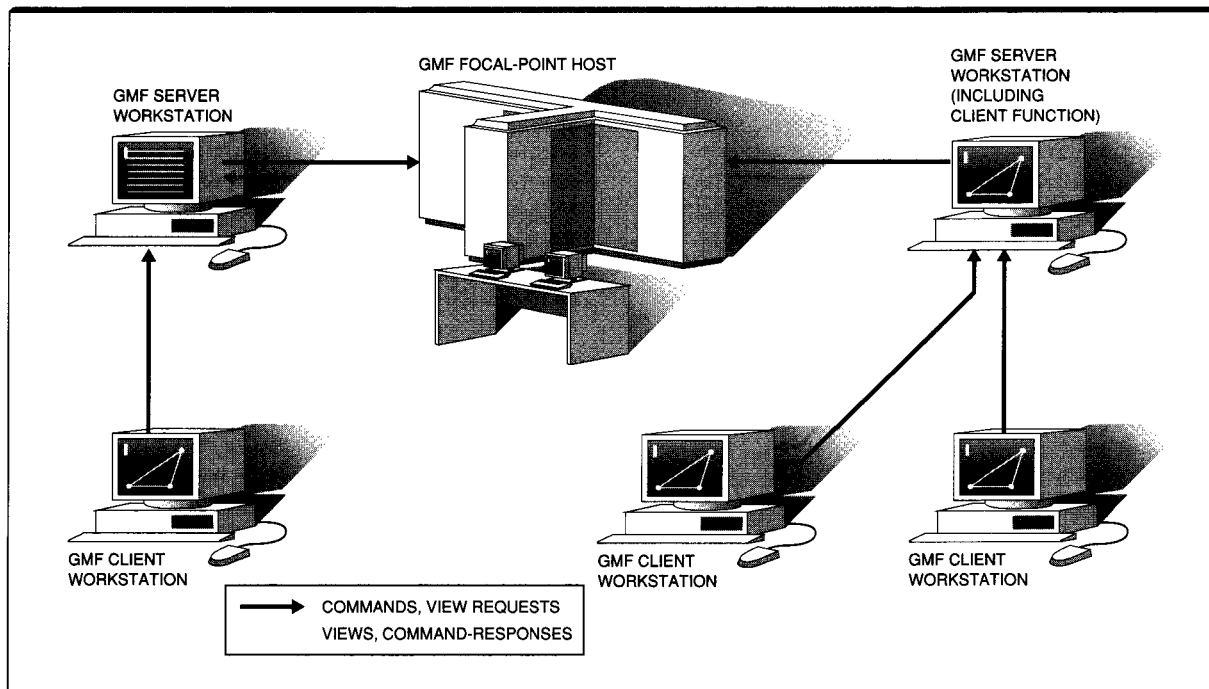
The *GMF Client Workstation* interfaces directly with the operator or help-desk person. It presents graphics views showing resource relationships and statuses to the user upon demand and also presents command menus allowing the user to issue commands against resources shown in the graphics views. The GMF Client Workstation sends operator view requests and commands to the GMF Server Workstation and receives back views and command responses, which it presents to the user.

Views are shown at the GMF Client Workstation using the graphics facilities provided by the GraphicsView/2 product, while commands and responses are presented using the facilities of the OS/2 Presentation Manager*.

The GMF Server Workstation may also be used as a GMF Client Workstation; in this case, it is still called a GMF Server Workstation. Figure 2 illustrates the different types of GMF Workstations. All communications between GMF Client and GMF Server Workstations, and between GMF Server Workstations and the GMF Focal-Point Host, are via SNA LU 6.2 sessions.¹¹

The *Network Management Gateway* is an interface between the SNA network in which NetView resides and one or more non-SNA networks. Examples of Network Management Gateways are the NetView/PC* service point¹² and the AIX* NetView service point. A Network Management Gateway contains one or more transaction programs (TPs) that manage non-SNA networks. For example, a NetView/PC service point might contain one transaction program that manages a network of non-SNA minicomputers, and another transaction program that manages a T1 network. An AIX NetView service point might contain AIX NetView/6000 as a transaction program to manage single network management protocol (SNMP)

Figure 2 GMF Workstation types



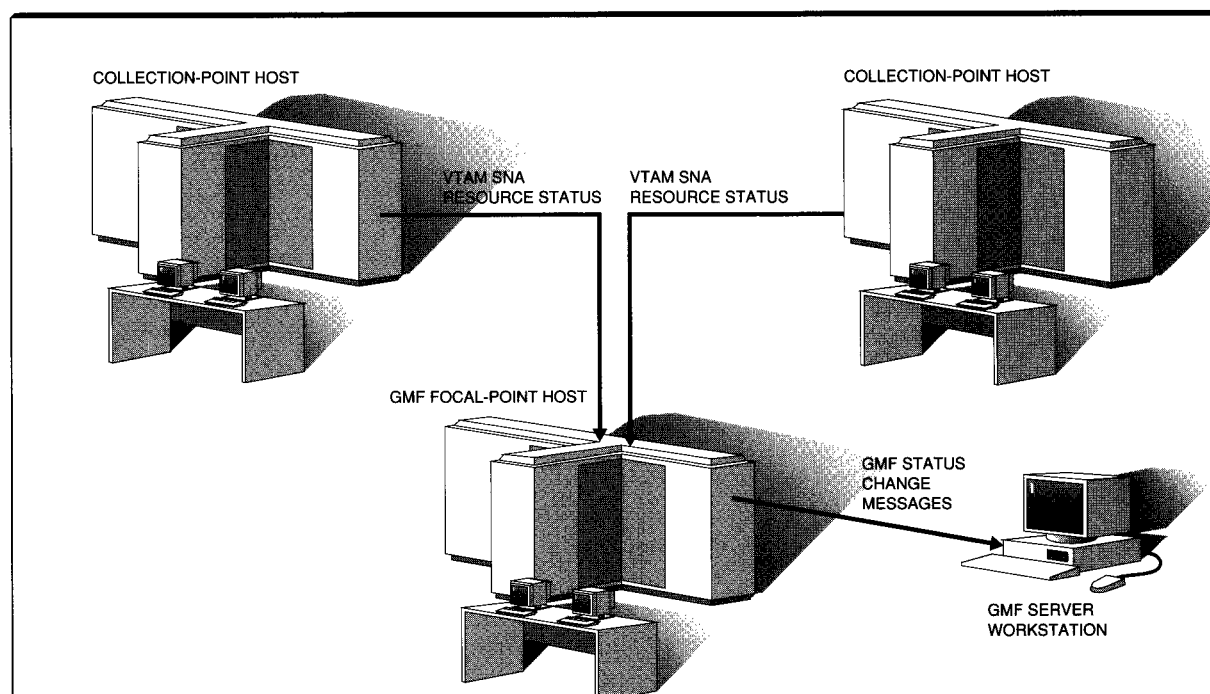
networks.¹³ Transaction programs translate commands and event notifications between the format required by the native network being managed and the format required by the SNA network in which NetView resides. They are provided by users, IBM Business Partners, companies that provide network management services for non-SNA networks, and IBM itself. (Examples of IBM-provided transaction programs are the IBM LAN Network Manager and AIX NetView/6000.)

The *administrative repository subsystem* accesses the *administrative repository*, which is a database containing configuration, inventory, and problem information. NetView V2R3 GMF is primed with configuration information for non-SNA resources from the administrative repository, and also accesses the administrative repository to receive problem and inventory data that are displayed at the workstation. NetView V2R3 GMF does not provide its own administrative repository subsystem or administrative repository, but provides published interfaces allowing users to connect NetView V2R3 GMF to their own subsystem and administrative repository. Users who have IBM's Information/Management

product may use this product as the administrative repository subsystem and the Information/Family database as the administrative repository.¹⁴ IBM provides a program called Network Configuration Application/ MVS to facilitate the definition of network configurations for NetView V2R3 GMF via the Information/Management¹⁵ product. For more information on the administrative repository subsystem and administrative repository, see the section on administrative and operational repositories, later in this paper.

Status monitoring via NetView V2R3 GMF. As may be seen in Figure 1, the GMF Focal-Point Host contains two monitoring components: NetView and NetView GMF Host Subsystem. NetView is responsible for monitoring SNA resources, while NetView and NetView GMF Host Subsystem together are responsible for monitoring non-SNA resources. SNA resources are nodes and links that communicate via protocols defined by IBM's Systems Network Architecture, or SNA, while non-SNA resources are network nodes and links that communicate via other protocols, such as TCP/IP (Transmission Control Protocol/Internet

Figure 3 GMF status flows for SNA resources



Protocol), T1, etc. Examples of SNA resources are 3090 hosts running VTAM (PU Type 5, in SNA terms) and personal computers running OS/2 (which may appear as PU Type 2.1 resources, in SNA terms). Examples of non-SNA network resources are T1 data transmission facilities, minicomputers communicating via the TCP/IP protocol, and user applications running on an MVS host. As can be seen by these examples, networks may contain a large variety of different resource types communicating via many different protocols. NetView V2R3 GMF presents the user with standardized graphic views that show these resources, their current states or statuses, and the relationships among them, thereby allowing the operator to quickly determine the location of problems and their scope.

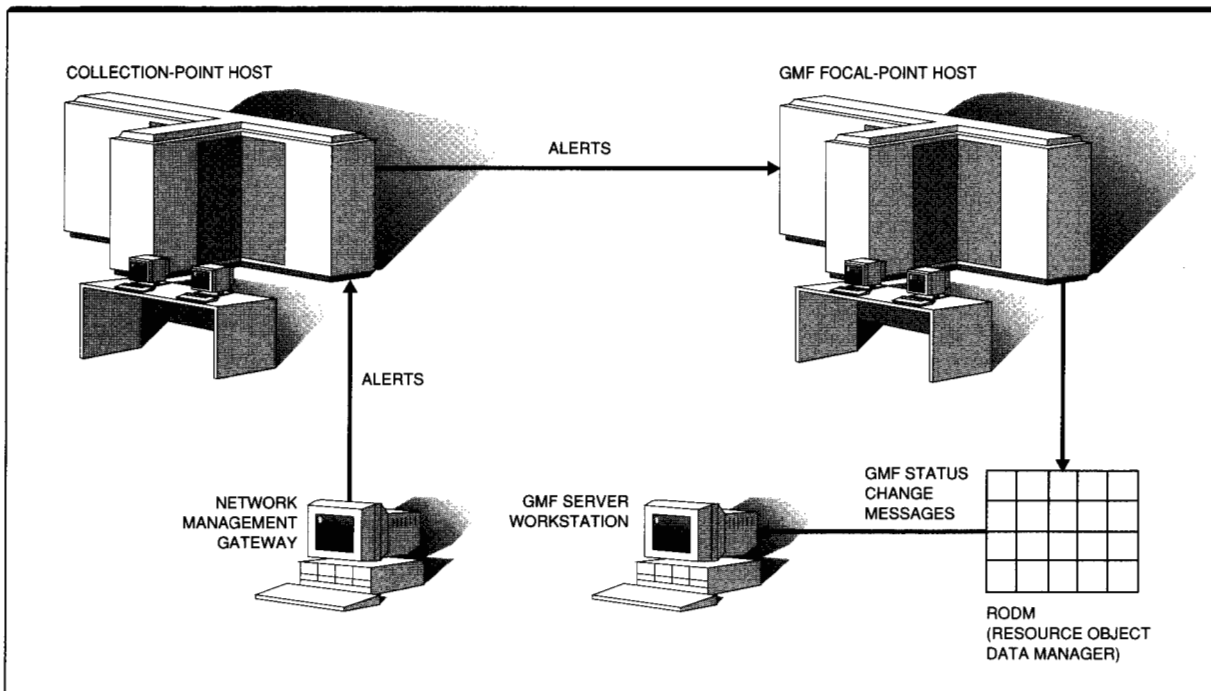
In Figure 1, NetView code in the GMF Focal-Point Host communicates with NetView code in Collection-Point Hosts to obtain status for SNA resources. NetView on each host receives its SNA status from the VTAM subsystem running on that host. NetView on the Focal-Point Host sends SNA status notifications as soon as it receives them to all GMF Server Workstations. These workstations

in turn distribute the status to GMF Client Workstations, where they cause the colors indicating statuses of monitored resources to change. Figure 3 illustrates the flow of status notifications for SNA resources.

Whereas status information for SNA resources is provided by VTAM, status information for non-SNA resources is provided by transaction programs in Network Management Gateways in the form of SNA alerts.¹⁰

Alerts are sent from Network Management Gateways to Collection-Point Hosts, and from Collection-Point Hosts to the GMF Focal-Point Host. At each host, VTAM receives alerts and passes them to NetView. NetView residing in the Collection-Point Host forwards alerts to NetView in the GMF Focal-Point Host, which passes them in turn to NetView GMF Host Subsystem. The GMF Focal-Point Host can itself serve as a collection point; that is, Network Management Gateways may be attached directly to the GMF Focal-Point Host. NetView GMF Host Subsystem interprets alerts and changes the status of the appropriate non-SNA

Figure 4 GMF status flows for non-SNA resources



resources in Resource Object Data Manager. Changing of the status in Resource Object Data Manager causes a message to be sent down to the GMF Server Workstation, which passes the message along to appropriate GMF Client Workstations, so that the color of the affected resources will change to reflect the new status. This processing is illustrated in Figure 4.

NetView code in the host communicates with GMF code in the workstation by means of an SNA LU 6.2 session. NetView GMF Host Subsystem host code will communicate with host NetView code using the NetView program-to-program interface (PPI), passing commands and views back and forth between NetView and NetView GMF Host Subsystem.

NetView V2R3 GMF operator interface overview.

As can be seen from Figure 1, NetView V2R3 GMF provides many types of network views. In addition to the SNA cluster, backbone, and peripheral views provided in the GMF component of NetView Version 2 Release 1, NetView V2R3 GMF

provides equivalent non-SNA views via the functions of NetView GMF Host Subsystem. In addition, NetView V2R3 GMF provides dynamically-constructed configuration views for SNA, non-SNA, and combinations of SNA and non-SNA resources. GMF SNA resource support includes peripheral logical units and host VTAM applications, as well as PU5, PU4, PU2, PU1, SDLC link (synchronous data link control), and transmission group resources.

At the bottom of the screen shown in Figure 1 is an example of a configuration view that contains both SNA and non-SNA resources. The configuration for the resources in this view is defined by the user and included in the Resource Object Data Manager loader file used to prime Resource Object Data Manager; the view itself is constructed dynamically via NetView GMF Host Subsystem upon command from the operator, with NetView providing the status for the SNA resources included in the view and NetView GMF Host Subsystem providing the status for the non-SNA resources.

With the command support provided by NetView V2R3 GMF, the operator is able to take action to correct problems, as well as to monitor networks to determine when problems occur. With NetView V2R3 GMF, the following common categories of commands are available via menus:

- *Resource-related commands*—to do such things as display resource information, retrieve status history information, and adjust aggregation parameters
- *Dynamic view-building commands*—for dynamically constructing views showing such things as resources that are parents of the selected resources, failing resources that contributed to the failure of this resource, physical and/or logical connectivity, and peer relationships
- *Point-and-shoot commands*—to do such things as change resource status, provide a native command line, create and retrieve problem reports, and retrieve inventory information

These commands are invoked by the operator, who selects a resource in one of the views, and then selects a command from a pull-down menu. These commands are supported by a combination of GMF and NetView GMF Host Subsystem functions.

For more information on these commands, see the section on NetView V2R3 GMF command support considerations, appearing later in this paper.

Administrative and operational repositories. Figure 1 shows an administrative repository containing configuration, problem, change, and inventory information. For NetView V2R3 GMF, a Resource Object Data Manager loader file format is published for the configuration information needed in Resource Object Data Manager. Users and vendors must write conversion routines that will convert the configuration information in their current administrative repository into the published Resource Object Data Manager loader file format. A Resource Object Data Manager loader to dynamically load Resource Object Data Manager from the Resource Object Data Manager loader file is provided as part of NetView V2R3 GMF. Additionally, when a new Resource Object Data Manager loader file is created for a particular configuration, NetView GMF Host Subsystem supports a command allowing the configuration information in Resource Object Data

Manager to be refreshed from the new Resource Object Data Manager loader file. Resource Object Data Manager can be refreshed on a domain-by-domain basis.

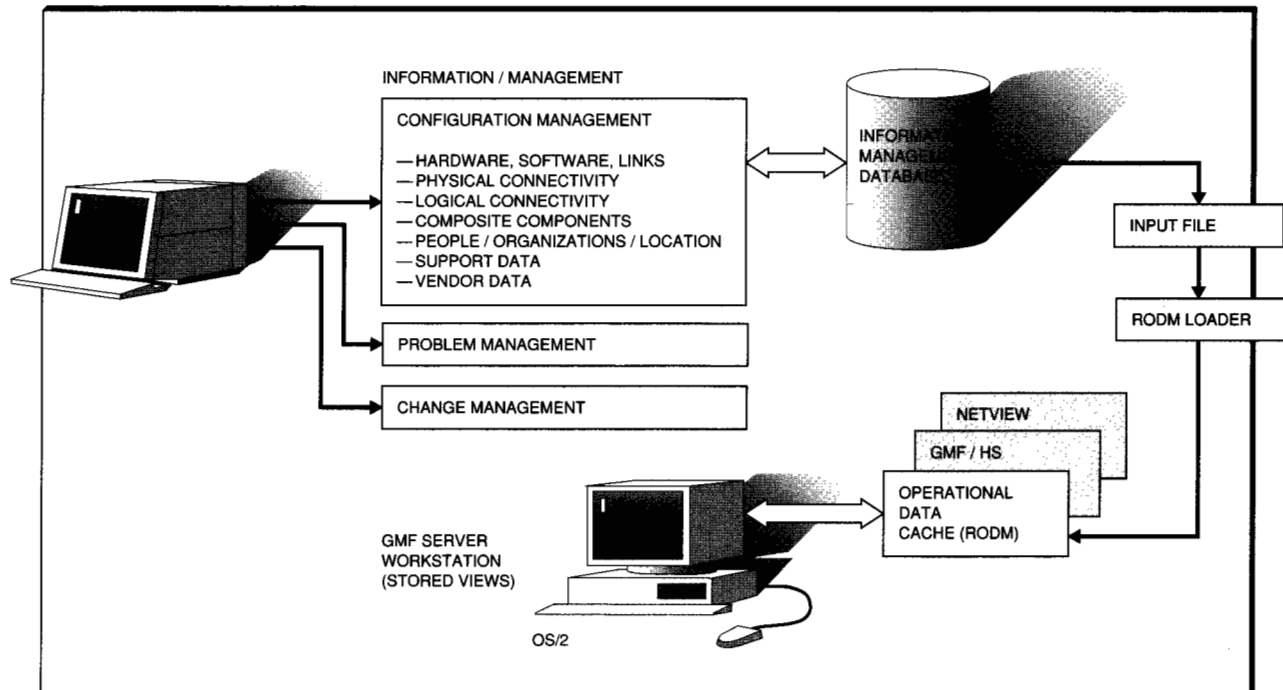
The Information/Management component of the Information/System family of products may be used as the administrative repository. In conjunction with NetView V2R3, a program offering called Network Configuration Application/MVS provides for the Information/Management product new functions that allow the Information/Management database to be used as the administrative repository for NetView V2R3 GMF. Although Network Configuration Application/MVS is associated with the NetView V2R3 GMF product, it is not part of NetView V2R3 GMF itself. It is meant to facilitate the definition of NetView V2R3 GMF configurations by users who wish to use Information/Management as their administrative repository.

The Information/Management database contains problem and inventory information that may be presented to the operator at the graphics workstation. NetView V2R3 GMF includes code to access the Information/Management database for this purpose. The Information/Management product contains a NetView Information/Management Bridge Adapter that works with the NetView Bridge to access information on inventory and problems stored in the Information/Management database, based on commands received from the GMF Client Workstation.

Figure 5 illustrates the relationship of the Information/Management product components to the GMF components. As can be seen from Figure 5, the Resource Object Data Manager input file is the interface point for priming Resource Object Data Manager from the Information/Management database. The format of this file is available to users, so that they may interface NetView V2R3 GMF to other administrative repositories for priming Resource Object Data Manager by writing an application that converts from their own administrative repository format to the format required by Resource Object Data Manager and GMF.

We have already briefly described Resource Object Data Manager in this paper, and it is described in detail in the paper by Finkel in this issue.⁴ Figure 6 illustrates the interfaces between Resource Object Data Manager and other net-

Figure 5 Relationship of Information/Management to NetView V2R3 GMF



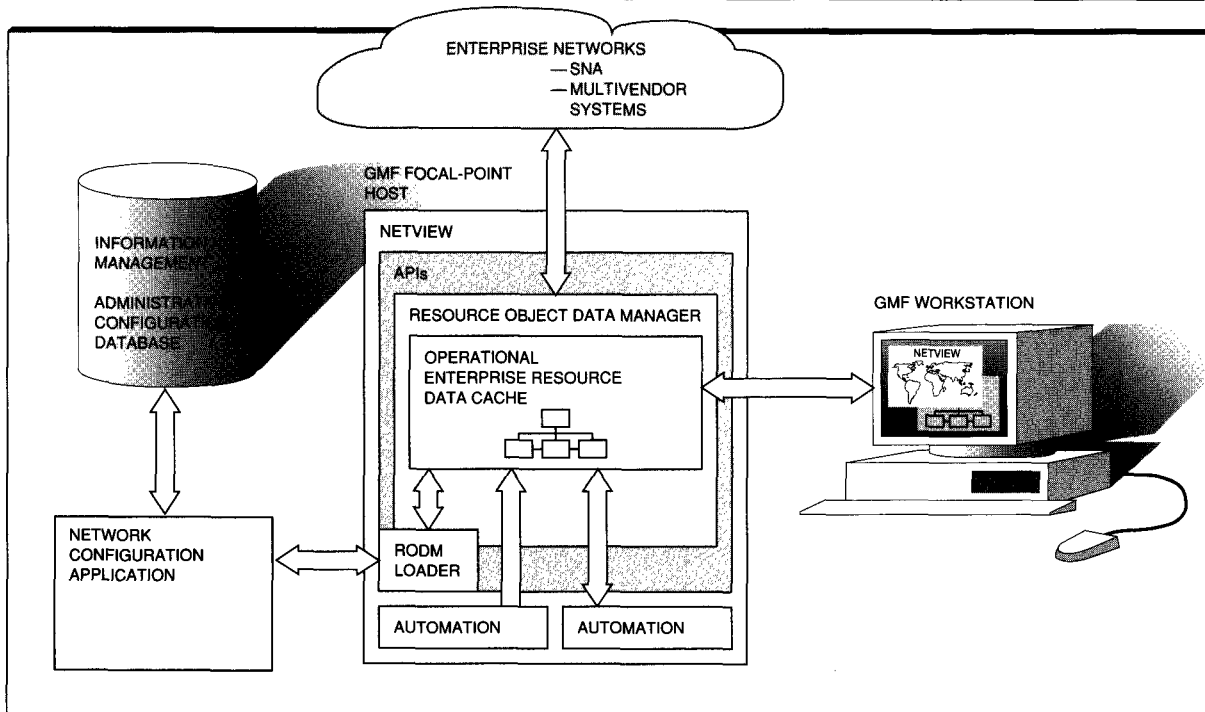
work management components. In addition to the interface with the Information/Management administrative repository, Figure 6 shows that Resource Object Data Manager has an interface with the network being managed, with the GMF Workstation, and with user-written automation routines. The interface with the network involves incoming alerts for resource status changes being processed by the NetView GMF Host Subsystem and used to change the status attribute of nodes and links maintained in Resource Object Data Manager. The interface with the workstation results from Resource Object Data Manager subroutines called *methods* that are triggered automatically whenever status attributes are updated for objects in Resource Object Data Manager, and which cause messages to be sent to the GMF Workstation to change the status of these objects in views at the workstation. Resource Object Data Manager also provides a published application programming interface that allows customer-written automation routines that reside either in NetView or in their own address spaces to access the configuration and status information stored in Resource Object Data Manager. This should

greatly enhance the ability of automation routines to perform such tasks as determining the cause of a problem when an alert comes in for a network resource. Automation applications may also register with Resource Object Data Manager so that they will be invoked automatically when attributes of objects in Resource Object Data Manager change their values.

A data model is shipped with NetView V2R3 GMF that contains objects and attributes describing non-SNA resources and their connections. The user instantiates this model by providing definitions for the resources in the network and their connectivity. The data model is quite flexible, allowing the user to define over 200 different object types and several types of connectivity, including physical, logical, peer, and parent-child. The user is provided with a means of defining additional object types within the model, so that the user is not limited to the specific resource types provided by IBM.

The presence of resource status and connectivity information in Resource Object Data Manager al-

Figure 6 Resource Object Data Manager interfaces



allows the user or others to write powerful event-correlation routines that exploit this information. The data model is documented and shipped in source format so that users can understand its structure when writing automation routines. Users can also add classes and attributes to the data model to facilitate automation, provided that they do not alter the classes and attributes already provided by IBM.

NetView V2R3 GMF view considerations

This section describes the views that operators will see using the NetView V2R3 GMF version of NetView GMF.

Static vs dynamic views. In NetView V2R1, the operator sees only static views created by the View Preprocessor, provided by GMF, which creates predefined views for SNA networks by processing VTAM definition files; these static views are stored at the GMF Server Workstation. Though the user may customize these views, the user will not see a view of components that was not originally created by View Preprocessor. Although the View

Preprocessor is a powerful facility for creating views from VTAM definition information automatically, it is not dynamic, and therefore fails to pick up changes in configuration to the network that occur between runs of View Preprocessor. Another disadvantage of the static approach is that all resources and views are stored at every GMF Server Workstation, and the number of resources that can be managed is thus limited by workstation storage constraints.

Ideally, views would be created dynamically from configuration information and stored in the GMF Server Workstation only when a user was monitoring them. This would allow dynamic changes in configuration to be picked up, and would also greatly increase the number of resources in the network that could be monitored from one GMF Server Workstation, since only the "working set" of resources that someone is actually monitoring would reside in GMF Server Workstation at any one time. Of course, even in the ideal situation the user would want to customize some views and keep them around locally and would be given the opportunity to do so if desired.

NetView V2R3 GMF is a step toward this ideal. For NetView V2R3 GMF, SNA monitoring support is extended to include LU views, which are built dynamically by GMF upon request from the user and are stored in GMF Server Workstation only while someone is monitoring them. Although dynamic reconfiguration of LUs will not be picked up by NetView V2R3 GMF because GMF still depends on the Status Monitor facility of NetView for status and that facility does not accommodate dynamic reconfiguration, at least only a working subset of LUs will be present at the GMF Server Workstation, rather than all the LUs in the network. This greatly increases the number of LUs that are capable of being monitored, when compared to the static scheme described above.

The NetView GMF Host Subsystem portion of NetView V2R3 GMF, which is used to monitor non-SNA resources, does not depend upon the View Preprocessor for its views. Instead, views are constructed dynamically based on configuration information residing in Resource Object Data Manager, and configurations can be refreshed dynamically via the Resource Object Data Manager loader. Hence, if changes to the NetView GMF Host Subsystem configuration are placed in Resource Object Data Manager, they will be reflected in future views built by NetView GMF Host Subsystem. For non-SNA resources, NetView V2R3 GMF therefore achieves both of the benefits of view dynamics—configuration changes are automatically reflected in subsequent views, and only the working set of non-SNA resources is kept in the GMF Server Workstation tables.

Placement of resources in dynamically built views is governed by automated layout algorithms provided by the GraphicsView/2 product. Several different layout algorithms are provided; the layout algorithm to be used for a dynamic view is specified in the view format. Dynamic views are laid out dynamically at the workstation as part of the view installation procedure.

When a network configuration in Resource Object Data Manager changes, NetView GMF Host Subsystem sends a notification of this fact to all GMF Server Workstations, which forward this message to all GMF Client Workstations currently logged on, and to new clients as they log on. Operators may then refresh their views to reflect the new configuration information in Resource Object Data Manager. Active views and customized

views are not automatically updated with configuration information by NetView V2R3 GMF.

Types of view provided. For NetView V2R3 GMF, three types of views are provided:

- SNA views, containing only SNA resources and aggregates of such resources
- Non-SNA views, containing only non-SNA resources and aggregates of such resources
- Mixed views, containing a mixture of SNA and non-SNA resources

Non-SNA views and mixed views are generated dynamically by NetView GMF Host Subsystem and Resource Object Data Manager methods from configuration information contained in Resource Object Data Manager, whereas SNA views are generated ahead of time from VTAM definition statements (except for LU views, which are built dynamically by NetView).

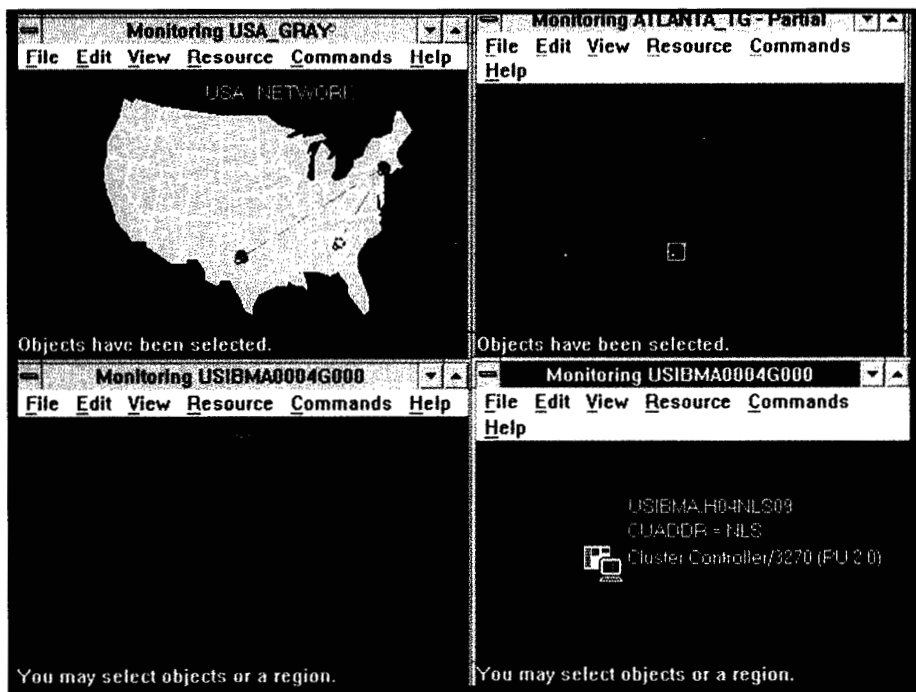
Types of SNA views. NetView V2R3 GMF supports the following types of SNA views:

- *Cluster views*—in which each node consists of a group of backbone resources and may represent a site or data center
- *Backbone views*—representing the resources in SNA backbone networks, such as hosts and NCPs
- *Boundary views*—representing a host or NCP and the SNA resources of PU Type 1, 2.0, or 2.1 associated with it
- *Peripheral LU views*—representing a PU 1, 2.0, or 2.1 and the LUs associated with it⁹

All of the above views except for the peripheral LU views are built by the View Preprocessor via analysis of VTAM definition information, and stored at the GMF Server Workstation; peripheral LU views are built dynamically upon request by the operator. Host applications running as VTAM subsystems are shown as part of the peripheral views constructed by the GMF View Preprocessor for host backbone resources. Dynamically built LU views are of two types:

1. A view showing all the LUs associated with a particular peripheral PU. This view is constructed dynamically when the user selects a peripheral PU and asks for more detail from the appropriate menu.

Figure 7 SNA views created by View Preprocessor



2. A configuration view that is constructed when the user selects an appropriate command and types in the name of the LU. This view shows the LU, the PU with which it is associated, the link to the communications controller to which the PU is attached, the communications controller itself, and the host owning the LU; it does not show intermediate backbone resources between the communications controller to which the PU is attached and the host. This view also shows the status of the link attaching the communications controller to the PU. This view is analogous to the configuration view described later in the discussion of NetView GMF Host Subsystem views.

In addition to the above views, the More Detail and Fast Path to Failing Resource facilities described in the next section are also available for SNA views; however, for GMF SNA support these are not separate view types but merely a means of navigating among views of the types described above.

Figure 7 is a screen showing in separate windows four SNA views created by View Preprocessor.¹⁶ In the upper left-hand corner is a cluster view, showing several sites against a backdrop of the U.S.A. When the user selects a site and asks for more detail, the user sees the view in the upper right-hand corner of the figure, which is a backbone view illustrating that part of the SNA backbone network assigned to the site. If the user selects a backbone resource and asks for more detail, the user gets the view shown in the lower left-hand part of Figure 7, illustrating a group of boundary resources. If the user zooms in on part of a view, more detail will be seen, as is illustrated in the bottom right-hand part of the figure. GraphicsView/2 allows the user to see an appropriate level of detail depending on how much room there is in a window; when there is room, each node is accompanied by a graphic icon and up to four lines of text information. In Figure 7, nodes in the upper right-hand and lower left-hand views are arranged automatically using a radial layout algorithm supplied by GraphicsView/2.

Figure 17, shown later, shows a peripheral view of an SNA host and associated SNA boundary resources. This view, which is superimposed on a customized view, was created dynamically and laid out automatically using a GraphicsView/2 radial layout algorithm.

Types of non-SNA and mixed views. The types of non-SNA and mixed views supported by NetView V2R3 GMF are as follows:

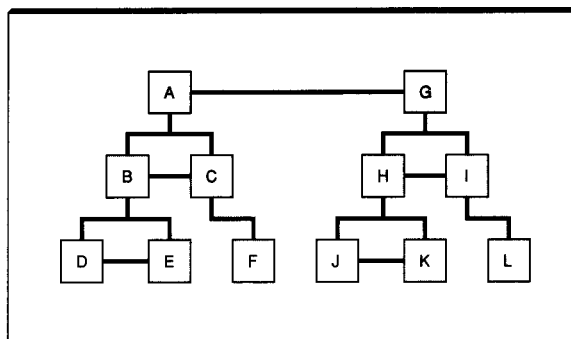
- *Network view*—used to show, among other things, a group of resources at the same level, such as sites or backbone network resources
- *Configuration view*—shows connectivity paths among resources
- *More Detail view*—a user selects a resource in a view and asks for another view that provides more detail for the selected resource
- *Fast Path to Failing Resource view*—a user selects an aggregate resource in a high-level view and asks for another view containing the real resources that contributed to the degradation in display status of the aggregate resource

All of these views are shown in the section containing an example scenario, appearing later in this paper.

The network view is built dynamically from the configuration information in Resource Object Data Manager, rather than being built by the user via customization facilities. In the Resource Object Data Manager loader file used to put configuration information in Resource Object Data Manager, the user will specify explicitly what resources the user wants to have in a network view. The user will define a name for the view and a list of the resources to go in the view. When the operator asks for this view, NetView GMF Host Subsystem will retrieve the view information and build a view containing the specified resources and their connections for presentation at the workstation, and may also specify a layout algorithm to be used to lay out the view. Network view definitions are stored in Resource Object Data Manager.

A configuration is specified in Resource Object Data Manager loader file by defining resources, their connections, their siblings (brothers and sisters), and their parents and children. Figure 8 illustrates an example generic configuration.

Figure 8 Example generic configuration



In Figure 8, there is a single generic configuration which could be composed of SNA or non-SNA resources, or a combination of both. Resources A and G are at the highest level of the configuration; they might be user sites and correspond to GMF clusters in the cluster view. Resources B, C, H, and I are at the intermediate level of the configuration; they might be NCP aggregates in an SNA view or T1 nodes in a non-SNA view, and correspond to the GMF host and NCP aggregates in the backbone view. Resources D, E, F, J, K, and L are at the lowest level; they might be PUs in an SNA view or terminals in a non-SNA view.

The horizontal layers in the configuration illustrated correspond to peer views. The vertical paths (for example that from D, to B, to A) correspond to a type of configuration view called the "configuration parent" view. In NetView V2R3 GMF, NetView GMF Host Subsystem builds both types of views dynamically using information in the configuration. For example, if a request comes for a configuration view for resource D, NetView GMF Host Subsystem will build it and send it to the workstation for display.

Since in NetView V2R3, the status of SNA resources is not kept in Resource Object Data Manager, if the configuration shown in Figure 8 was in Resource Object Data Manager and contained both SNA and non-SNA resources, the status of only the non-SNA real resources would be reflected in aggregate resources in this configuration.

Types of resources shown in views. NetView V2R3 GMF views show non-SNA resources as well as

SNA resources. Each resource has associated with it a unique geometric shape and icon, and these appear on the legend. There are potentially thousands of types of non-SNA resources that could be shown. Obviously, it is not feasible to come up with thousands of geometric shapes and to aggregate based on thousands of resource types. For one thing, the operator would not be able to remember all of the different shapes, and they would be very difficult to distinguish when they were small because the view contained many resources.

For these reasons, we have chosen to group both SNA and non-SNA resources into higher-level classes for NetView V2R3 GMF. Each real and aggregate resource has associated with it a *class* and a *type*. When showing the view, the Graphics-View/2 (GV/2) Graphic Facility will display a geometric shape associated with the class of resource, and an icon associated with the type of resource. Each resource type may have its own icon, or may use an icon associated with the class of resource. The resource type will appear in the appropriate text slot associated with each resource in the view. Aggregation parameters can be changed by the end user based on resource type.

For NetView V2R3 GMF, resource classes are as follows:

- Cluster (for sites, business groups, etc.)
- Host
- Application
- Node
- Link
- Terminal
- Transceiver (for modems, multiplexers, etc.)

Both real and aggregate resources may belong to the same class. For NetView V2R3 GMF, aggregate resources are distinguished by a visual means from real resources when they are being viewed.

For NetView V2R3 GMF, a legend available from each view will show classes but not types of resources. A toolkit provides the user with the means of adding icons and of substituting the user's own icons for icons shipped with the product. This must be done on each client workstation.

We believe that the above approach best achieves the goals of preserving a standard look and feel

across SNA and non-SNA views (via the resource classes) while simultaneously giving the user as much information as possible about the resources the user is actually monitoring (via the icons and text fields).

Resource statuses in views. For NetView V2R3 GMF, statuses for SNA resources are provided by NetView and VTAM, and statuses for non-SNA resources are provided by NetView GMF Host Subsystem. Status changes are sent automatically from the GMF Focal-Point Host to the GMF Server Workstations and from the GMF Server Workstations to the GMF Client Workstations, where they cause resources being displayed to change color.

For NetView V2R3 GMF, the statuses shown in the views are generic; that is, they are generally applicable across SNA and non-SNA resources. SNA resource statuses are converted into these generic display statuses by GMF Server Workstation. Non-SNA resource statuses are converted into these generic display statuses by NetView GMF Host Subsystem at the host.

NetView GMF Host Subsystem statuses are sent down from the host only for non-SNA resources that are currently in open views. Status flows from NetView GMF Host Subsystem are managed via commands from GMF Server Workstation.

The generic display statuses for real resources are as follows:

- Satisfactory (green), indicating that the resource is currently operating in an acceptable manner, or within specifications
- Unsatisfactory (red), indicating that the resource is currently not operating in an acceptable manner or within specifications
- Intermediate (white), indicating that the real resource is in a state intermediate between satisfactory and unsatisfactory
- Unknown (gray), indicating that the current status of the resource is not known

Generic display statuses for aggregate resources are as follows:

- Satisfactory, indicating that most or all of the underlying real resources have a status of satisfactory
- Degraded (yellow), indicating that many of the underlying resources have unsatisfactory sta-

tuses, or that at least one critical underlying real resource is in an unsatisfactory status

- Severely degraded (pink), indicating that most but not all of the underlying real resources have an unsatisfactory status
- Unsatisfactory, indicating that all or almost all of the underlying real resources have an unsatisfactory status
- Unknown, indicating that the statuses of a large number of the underlying real resources are unknown

Satisfactory statuses for SNA resources are Active, Connectible, and Never Active. Unsatisfactory statuses for SNA resources are Inactive, Pending Inactive, Pending Active, and Routable. Intermediate statuses cause the resource to be ignored by the status calculator when calculating statuses for aggregate resources. Intermediate SNA statuses are Reset and Released. Unknown status is aggregated up for real resources once an "unknown threshold" is reached. The SNA status "unknown" is mapped to this generic status.

With NetView GMF Host Subsystem, the user is provided with host tables to convert alerts to generic event reports. Users can supply their own versions of these tables to define mappings for alerts reporting on non-SNA resources. The NetView GMF Host Subsystem will support the new architected Resolve network management vector.

GMF provides the end user with a means of remapping SNA resource statuses to generic resource statuses. The exact meaning of each of the aggregate resource statuses depends on user-specifiable thresholds and aggregation priorities, as explained below in the section on the NetView V2R3 GMF aggregation algorithm.

The user is able to define SNA and non-SNA resources in the network configuration in Resource Object Data Manager. When the user does so and a view containing both types of resources is displayed, NetView supplies statuses for the SNA resources, while NetView GMF Host Subsystem supplies statuses for the non-SNA resources. By astutely defining the relationships in the configuration, the user can cause a non-SNA resource to be visually associated with a corresponding SNA resource in a view; this facilitates correlation of SNA and non-SNA statuses.

For example, by properly setting up Resource Object Data Manager loader file relationships, the user is able to show the relationship between an SNA PU Type 4 and its underlying 37X5 Communications Controller, between an SNA link and its underlying physical components, and between an X.25 virtual circuit and the LU that represents it when the NCP X.25 NPSI support is used.

To see the real status that causes a generic status to appear for a real resource, the user may select the Resource Status History entry for SNA resources, or the Alert History entry for non-SNA resources, from the appropriate pulldown; the history entries will show the real SNA or non-SNA statuses from which generic statuses are derived.

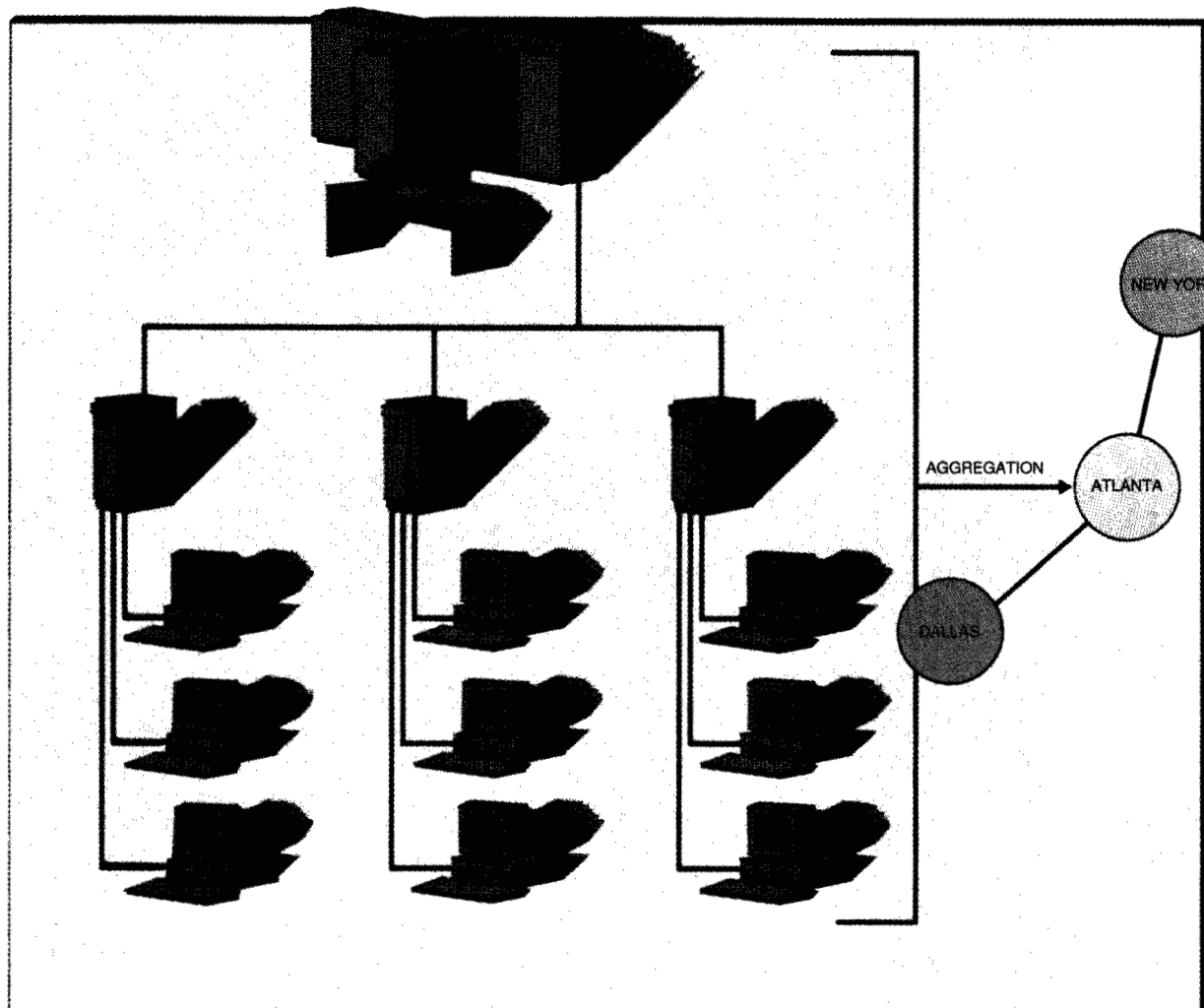
NetView V2R3 GMF aggregation algorithm. *Aggregation* refers to the calculation of status for a network node or link which represents a collection of underlying nodes and links. NetView does not receive status change notification over the network for aggregate resources, but must calculate a status for each aggregate resource based on the statuses of the real resources it contains.

Figure 9 illustrates the relationship of real-to-aggregate resources. In this figure, the aggregate resource Atlanta contains one host and several communications controllers, to each of which is attached several Personal System/2* (PS/2*) workstations. Some of these real resources are in a satisfactory status, while others are in an unsatisfactory status (indicated by a red color). The aggregate resource which contains these real resources is named Atlanta. Atlanta is yellow, indicating that some of the resources for which it is the aggregate are in an unsatisfactory state, while others are in a satisfactory state.

NetView V2R3 GMF provides a new aggregation algorithm. This section contains a high-level description of the new algorithm, which is applied by NetView GMF Host Subsystem to the non-SNA resources it is monitoring, and by code in the GMF Server Workstation to the SNA resources it is monitoring.

Aggregation overview. In the following discussion, the status calculator mentioned is a GMF Server Workstation in the case of SNA resources, and a Resource Object Data Manager method provided by NetView GMF Host Subsystem in the case of non-SNA resources.

Figure 9 Example of real and aggregate resources

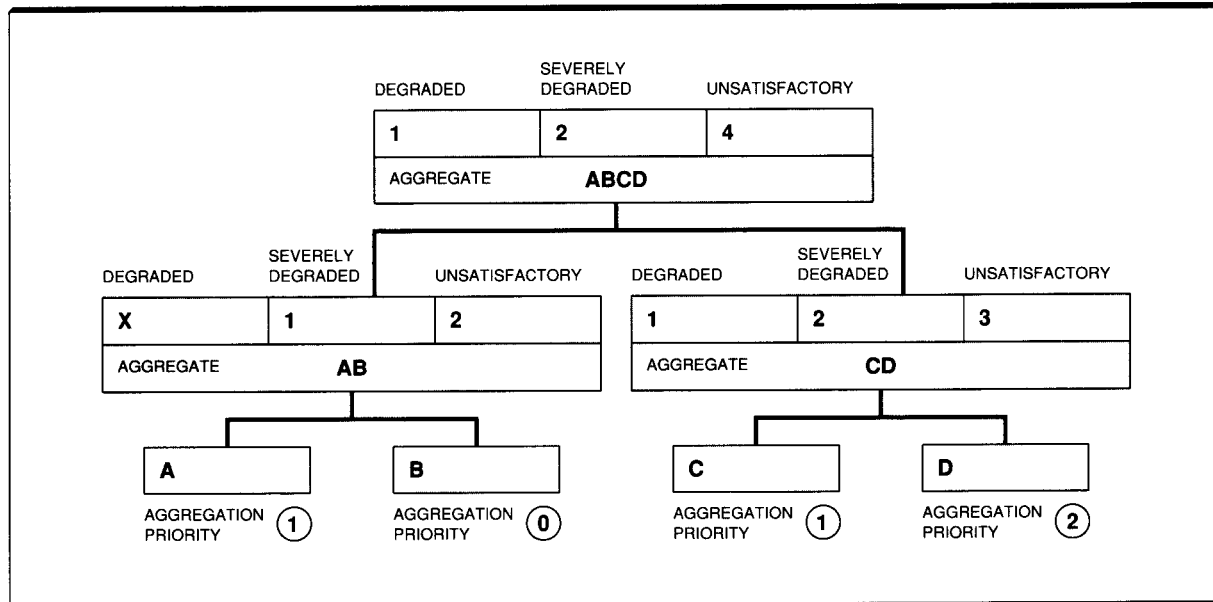


Each aggregate resource has associated with it three thresholds. The first of these indicates the number of underlying resource nodes and links that must be in an unsatisfactory state before the status calculator changes the status of the resource from satisfactory to degraded. The second of these indicates the number of underlying resource nodes and links that must be in an unsatisfactory state before the status calculator changes the status of the aggregate resource from degraded to severely degraded, while the third represents the threshold for changing the aggregate from severely degraded to unsatisfactory. Note that the status calculator performs the status calculation based upon the statuses of the real resources being monitored,

which are descendents of the aggregate, rather than on the statuses of child aggregates.

Each real node or link has associated with it an *aggregation priority* indicating how much it should affect the status of higher-level aggregates for which it is a child. The aggregation priority is a number from 0 to the highest number of layers in the network, indicating how far up in the hierarchy tree to turn an ancestor aggregate of the resource to the status of degraded. For example, if an SNA resource in a peripheral view had an aggregation priority of 0, it would not affect an aggregate node that was its parent in a backbone view (except via the threshold scheme discussed

Figure 10 NetView V2R3 GMF status aggregation in a simple case



above). If it had an aggregation priority of 1 and it went into an unsatisfactory state, its parent in a backbone view would go into a degraded state unless it was already in a degraded or worse state. If it had an aggregation priority of 2 and it went into an unsatisfactory state, its parent in the backbone view and its grandparent in the cluster view would both go into a degraded state unless they were already in a degraded or worse state.

In assigning a new status to an aggregate resource, the status calculator looks at the status of the real resources that are descendents of the aggregate and determines a status based upon the thresholds associated with the aggregate. It also looks at the aggregation priority of the real resources that are descendents of the aggregate and currently in an unsatisfactory state. The status calculator then assigns the aggregate resource the worst of the two calculated statuses. The status calculator ignores the class of the resource when making its calculations.

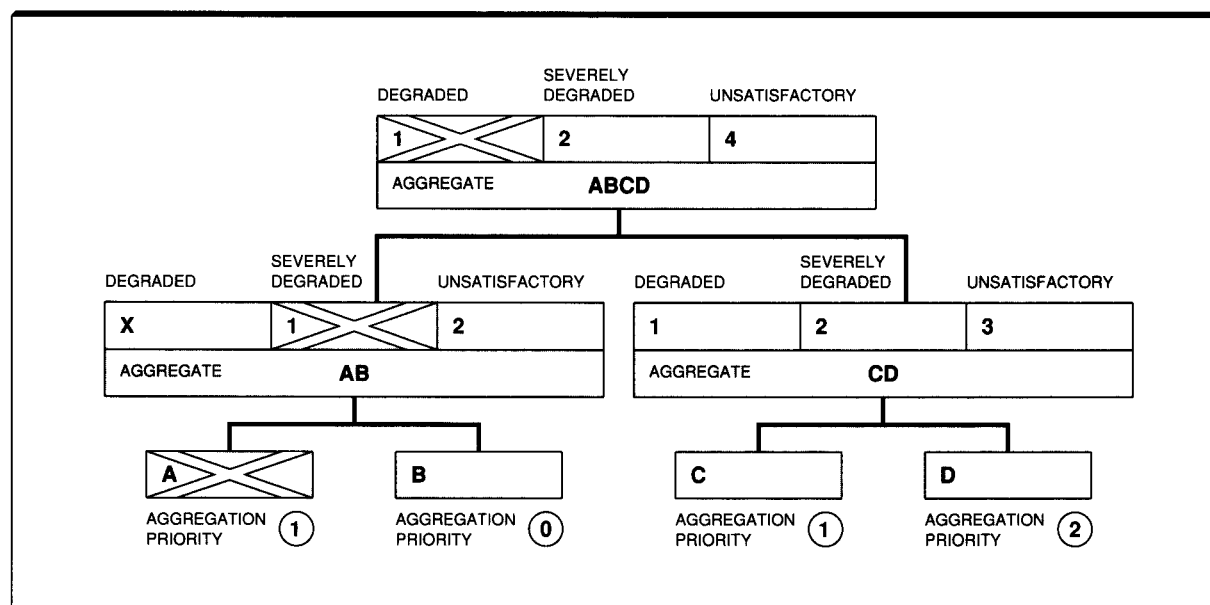
Figure 10 is used to illustrate the new status scheme. The figure illustrates an arbitrary status hierarchy that could apply to both SNA and non-SNA resources. In the figure, resources A, B, C, and D are real resources whose statuses are being

monitored by GMF or by NetView GMF Host Subsystem.

Suppose all four are in a satisfactory state and resource A goes into an unsatisfactory state. Figure 11 illustrates what happens in this case. GMF Server Workstation code (for SNA resources) or a Resource Object Data Manager method supplied by NetView GMF Host Subsystem (for non-SNA resources) first looks at the thresholds for aggregate resource AB, which is the parent of resource A. The first threshold is set to X, indicating that the aggregate resource is not to be put into the degraded state. The second threshold is 1, indicating that the aggregate resource AB is to be put into the severely degraded state if at least one underlying real resource is in an unsatisfactory state. The third threshold is 2, indicating that the aggregate resource AB is to be put into the unsatisfactory state if at least two underlying real resources are in an unsatisfactory state. Based on this information, aggregate resource AB is tentatively assigned a status of severely degraded.

The status calculator then looks at the aggregation priority for resource A. The aggregation priority is 1, indicating that based on aggregation

Figure 11 NetView V2R3 GMF resource A in the unsatisfactory state



priority, aggregate status AB should be assigned a status of degraded. Since severely degraded is worse than degraded, the status calculator assigns aggregate resource AB a status of severely degraded.

Next, the status calculator calculates the status of aggregate resource ABCD. Since only one real resource is in an unsatisfactory state, based on the threshold settings for aggregate resource ABCD the status calculator tentatively assigns it a status of degraded. Since the worst status it could have based on aggregation priority is degraded, the status collector leaves it with a degraded status.

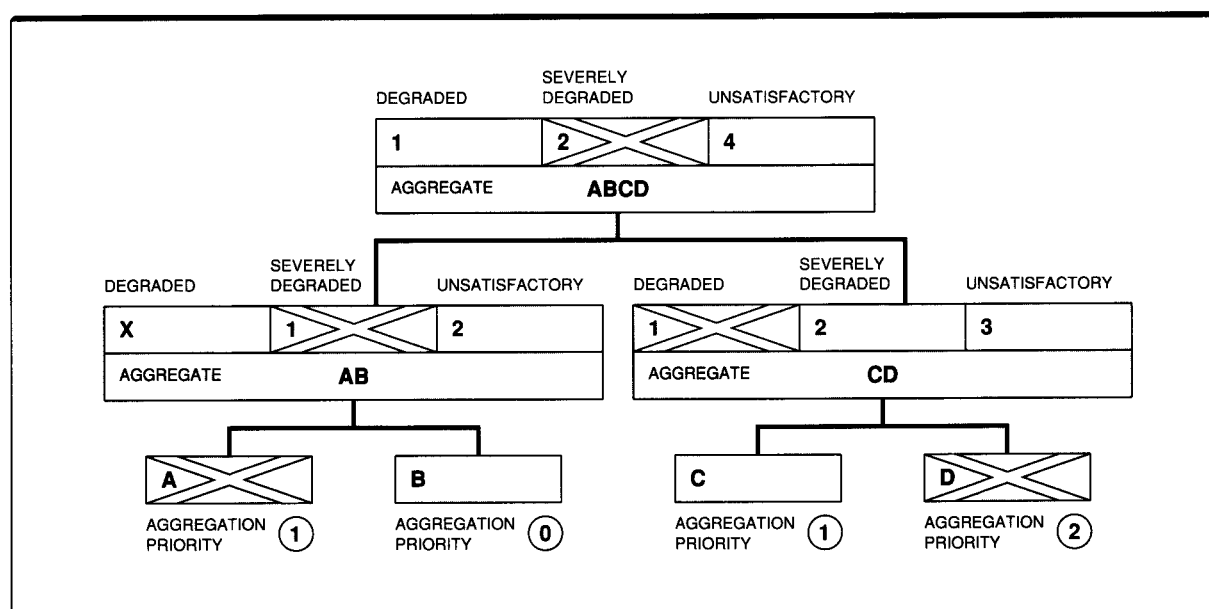
Now assume that resource D goes into an unsatisfactory state. Figure 12 illustrates what happens in this case. Based on the logic given above, aggregate resource CD is given a status of degraded. The status calculator then looks at the thresholds for aggregate ABCD and assigns it a status of severely degraded since two descendent real resources of ABCD are in an unsatisfactory state (namely, A and D). Since the worst state an aggregate resource can be assigned because of aggregation priority is degraded, and since a status of severely degraded has already been calculated

for ABCD, the aggregate resource ABCD is left in the severely degraded state.

Now assume that resource A goes into a satisfactory status. The status calculator first sets aggregate resource AB to satisfactory, since all underlying real resources are in a satisfactory state. The status calculator then sets aggregate resource ABCD to degraded since only one real resource (resource D) under aggregate ABCD is in an unsatisfactory state, and ABCD's degraded threshold is one.

Setting of thresholds and aggregation priorities. For SNA resources, aggregation priorities are set initially by View Preprocessor. View Preprocessor defines keywords allowing the customer to specify these parameters, and assigns appropriate defaults. Default thresholds are assigned by GMF. For non-SNA resources, thresholds and aggregation priorities are assigned to resources by NetView GMF Host Subsystem based upon parameters specified by the user in the file used to initialize Resource Object Data Manager. NetView GMF Host Subsystem assigns appropriate default priorities.

Figure 12 NetView V2R3 GMF resources A and D in the unsatisfactory state



GMF allows the user monitoring the network to reset thresholds and aggregation priorities for resources and types of resources. Resetting values for a type of resource results in the new values being applied to all resources of that type until resource values are subsequently changed on a resource-by-resource basis. For SNA resources, the GMF Server Workstation is modified with the new values. For non-SNA resources, the modifications are sent up to NetView GMF Host Subsystem code on the host, which modifies the appropriate resources in the Resource Object Data Manager to reflect the new thresholds and aggregation priorities.

The user is also able to reclassify real resource statuses into the satisfactory, unsatisfactory, and intermediate categories by specifying an appropriate parameter in GMF for SNA resources, and by specifying an appropriate alert translation table for NetView GMF Host Subsystem resources.

Unknown threshold for aggregate resources. A percentage is used to determine when an aggregate should show the unknown status. If the status of 40 percent of the aggregate statuses children are unknown, the aggregate itself is assigned the unknown status. For NetView V2R3 GMF, this percentage is modifiable by the user via a GMF

user interface option, and will be specified only for aggregate resources to indicate a percentage of underlying real resources. For example, if 40 percent of the real-resource descendents of an aggregate resource have a status of unknown and the threshold is 40 percent, the aggregate will be assigned the status of unknown.

Taking a resource out of the status calculations. In certain situations, it is desirable to take a resource out of future calculations of status once its condition is known. If a critical resource is known to be unavailable, one may wish to remove it from calculations of future status so that other network problems will not be drowned out by this resource's status. Thus when a critical resource becomes unavailable, it might turn an aggregate node to degraded status. It may be desirable to turn the aggregate back to "active" once the problem has been detected but before it is fixed, so that if another critical resource under the same aggregate resource becomes unavailable, it also may be detected. For this purpose, a command called Suspend/Resume Aggregation is provided by GMF that allows the user to remove the resource from further status calculations as long as its status remains unsatisfactory; this command also allows the resource to be returned to consideration during resource calculations; option-

ally, the resource can be automatically returned to status calculations once it regains a satisfactory status. A command is also provided to allow the user to list resources that currently have aggregation suspended for them.

A special backfill is used to denote resources for which aggregation has been suspended.

Aggregation exception. SNA LU status is not aggregated upward in NetView V2R3 GMF.

Fast Path to Failing Resources. With the aggregation scheme described above, it is possible for GMF Server Workstation and NetView GMF Host Subsystem to quickly determine which views contain real resources that contributed to a status change at a higher level. For NetView V2R3 GMF, when the user selects an aggregate resource in a high-level SNA view and asks for a fast path, the user is presented with a list of views containing real resources that contributed to the aggregate resource's degradation. The user is then able to select a view from this list and open it immediately. If there are only one or two views that contain resources causing the problem, they are opened automatically without the user having to select them.

In Figure 12, for example, if aggregate resource ABCD became severely degraded because resources A and D went to an unsatisfactory state, the user could select ABCD and ask for a Fast Path to the Failing Resources. If resources A and D were in two separate views, or in the same view, the view or views would be opened immediately. The user would no longer have to navigate through the level containing composite resources AB and CD to see the views containing resources A and D.

For NetView GMF Host Subsystem resources, if a user selects Fast Path to Failing Resource, NetView GMF Host Subsystem code constructs a view consisting of all real resources contributing to the failure and sends it to GMF Server Workstation. If all resources will not fit in one view, NetView GMF Host Subsystem constructs more than one. These views are assigned arbitrary names indicating they are "fast-path" views from NetView GMF Host Subsystem. They are listed by GMF along with any views at the server workstation that contain resources contributing to the failure.

The user may specify that a non-SNA or mixed view provides more detail for an aggregate resource in an SNA view. GMF Server Workstation knows about this association. If the operator selects an SNA aggregate resource that has a non-SNA or mixed view providing more detail for it and asks for Fast Path to Failing Resource, GMF Server Workstation sends a message to NetView GMF Host Subsystem, and NetView GMF Host Subsystem either returns a view containing resources that may have contributed to the unsatisfactory state of the SNA resource, or indicates that it has no such view. If a view is returned, it is added to the list of SNA views.

View selection for NetView V2R3 GMF. With NetView V2R3 GMF, views may be selected in three ways:

1. Explicitly, by selecting a view from a view list provided by GMF
2. Implicitly, by selecting a resource in a view and asking for More Detail or for a configuration view or Fast Path to Failing Resource from the GMF command menu at the GMF Client Workstation
3. Implicitly, by typing in the name of a resource and then selecting Configuration as a view type from a GMF command menu

Integrating SNA views with non-SNA and mixed views via navigation. NetView GMF Host Subsystem sends to GMF Server Workstation a list of non-SNA and mixed network views that is displayed when the user is selecting the views the user wants to monitor. The user is given a means via Resource Object Data Manager loader file to specify what these views are. In addition, the user is given a means via Resource Object Data Manager loader file to specify that a non-SNA or mixed view provide more detail for a specified resource in an SNA view, such as a cluster or aggregate NCP node. This information is also provided to GMF Server Workstation by NetView GMF Host Subsystem. When the user selects the specified SNA resource in an SNA view and asks for More Detail, the non-SNA or mixed view is included along with any eligible SNA views in the list of eligible views. If the user picks the non-SNA or mixed view, it will be shown.

GMF Server Workstation will not aggregate status for non-SNA resources; all such aggregation must be done by NetView GMF Host Subsystem. If a

user picks a resource in a non-SNA or mixed view and asks for More Detail, GMF Server Workstation sends a message to NetView GMF Host Subsystem indicating the command and the resource selected. NetView GMF Host Subsystem returns either the appropriate view or a response indicating that there is no such view.

Other than the navigation facility¹⁷ described in this section, there is no navigation between SNA views managed by GMF code at the GMF Server Workstation and views built by NetView GMF Host Subsystem from configuration information in Resource Object Data Manager.

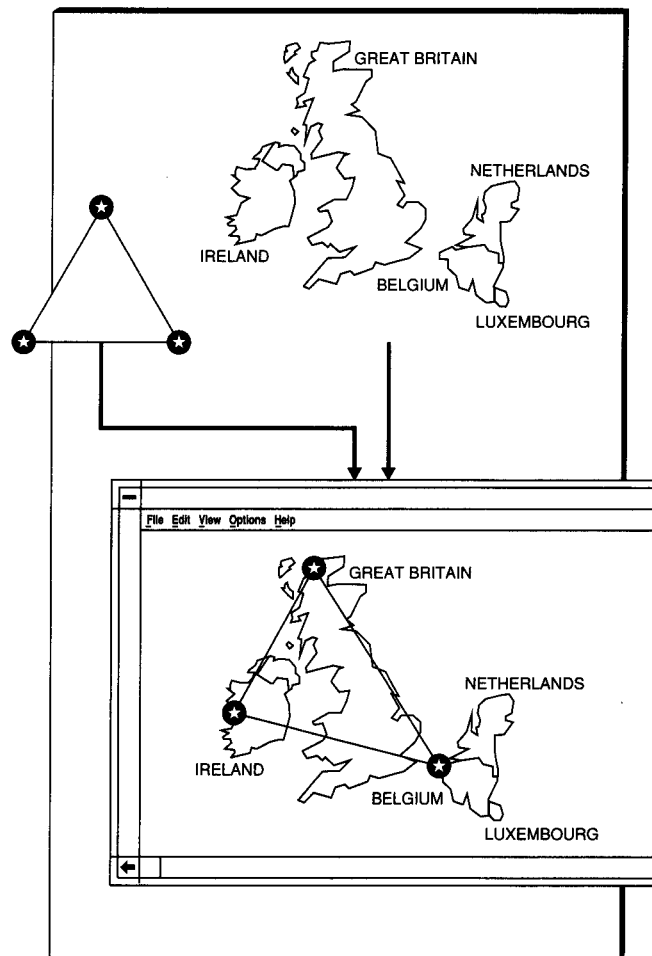
Customizing views. Although NetView V2R3 GMF makes use of powerful layout algorithms provided by GraphicsView/2 for automatically placing nodes and links in views, there are cases when the user wishes to override the layout algorithm and place resources according to the user's own wishes. GMF provides graphical editing facilities allowing the user to customize network views generated out of Resource Object Data Manager and all SNA views created by the View Preprocessor. The user does this by specifying a backdrop, specifying that a view be overlaid on that backdrop, and then moving the nodes and the links around in the view by "grabbing" them with the mouse and moving them to where the user wants them. The operator then saves the customized view.

Figure 13 illustrates this procedure. In this example, a network view laid out via an automated layout algorithm is superimposed on a map. The user then moves the nodes in the view to the places on the map where they are wanted, using the mouse. The result is a customized view.

When the network configuration changes, customization is preserved for customized views, as explained in the next section.

A set of backdrops containing various maps will be shipped with NetView V2R3. In addition, users may use available OS/2-based drawing applications to draw their own backdrops. GMF will accept any figure as a backdrop that conforms to the OS/2 metafile format. Figure 14 shows a customized view consisting of user sites overlaid on a backdrop created by means of a drawing tool running on OS/2.

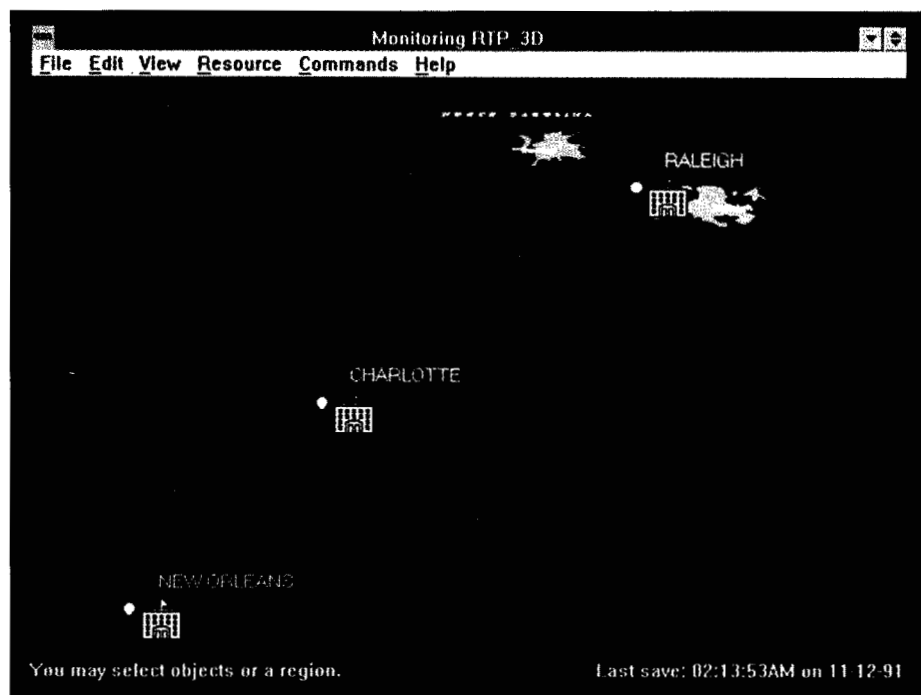
Figure 13 NetView V2R3 GMF example of view editing



Managing configuration changes. When the Resource Object Data Manager loader updates all or part of Resource Object Data Manager, NetView GMF Host Subsystem sends each GMF Server Workstation a message indicating this. The GMF Server Workstation notifies each GMF Client Workstation attached to it of the configuration change, causing each GMF Client Workstation to display a message indicating the configuration has changed. This message remains until the user specifies that it be removed, or until the Remap command (described later) has been executed.

When the Resource Object Data Manager configuration is updated, a command allows users at the GMF Server Workstation to retrieve from Re-

Figure 14 Example customized view with user-supplied backdrop



source Object Data Manager all network views in the new network view list that have the same names as customized network views. A remap facility is run against the new view copies so as to preserve customization, and the views are then stored once again on GMF Server Workstation.

Once the views have been restored, the "configuration has changed" message is no longer displayed by GMF Workstations.

Customization of views for SNA views created by the View Preprocessor is preserved in a similar fashion. When a new set of SNA views is downloaded from the host, the remap utility is run to preserve the locations of resources in customized views.

NetView V2R3 GMF command support considerations

This section provides a high-level description of the command support that is provided with NetView V2R3 GMF.

The approach for NetView V2R3 GMF command support is to keep commands generic as much as possible, in order to minimize operator confusion. (Figure 16, shown later, illustrates a typical command menu.) To issue a command, the user first selects one or more network resources against which the command is to be issued, then selects the command from the pull-down menu. As a result, the command is sent up to the GMF Focal-Point Host and issued against all selected objects. NetView and NetView GMF Host Subsystem take care of translating the generic command into the appropriate character string for the resource and routing it to the appropriate application for execution.

NetView V2R3 GMF command categories. For NetView V2R3 GMF, there are two major categories of commands, those applying to resources and those applying to views.

Commands applying to resources generally alter the state of or show information about a selected

resource in the network, while commands applying to views allow the user to solicit and manipulate views consisting of multiple resources.

Resource-oriented commands. Commands applying to resources are generic; that is, they appear the same to the user regardless of the type of resource. When necessary, NetView V2R3 GMF translates the generic command seen by the user into its nongeneric equivalent before sending it to the appropriate component for execution.

The following are some of the major resource-oriented commands supported by NetView V2R3 GMF. In general, they apply to both SNA and non-SNA real resources.

- **Activate/Inactivate:** Activate or inactivate this resource or group of resources. Applies to real resources only.
- **Recycle:** Recycle this resource. Applies to real resources only.
- **Native Network Command Line:** Let me enter a native command and send it to the element manager for this resource. Applies to non-SNA real resources only.
- **Inventory:** Give me inventory information for this resource from the administrative repository. Applies to real resources only.
- **Problem Report:** Let me work with the administrative repository's problem-management facility. Applies to real resources only.
- **Resource Information:** Show the contents of four text slots plus status information. Applies to both real and aggregate resources.
- **Status History:** Show list of time-stamped status changes for this real SNA resource.
- **Alert History:** Show list of recent alerts received for this resource. Applies to real non-SNA resources only.
- **More Detail:** Show view or list of views containing more detail for the selected resource. Applies to both real and aggregate resources.
- **Set Marker/Clear Marker:** Change the backfill for the selected resource symbol to indicate whether it is marked. Applies to both real and aggregate resources.
- **Suspend/Resume Status Reception:** Either do not show or show status for this resource. Applies to both real and aggregate resources.
- **Find Resource:** Find the named resource in this view and center the viewport on it. Applies to both real and aggregate resources.

- **Fast Path to Failing Resource:** Show me a view or list of views that contain real resources that contributed to the failure of the selected resource. Applies to aggregate resources.
- **Suspend/Resume Aggregation:** Either stop or start counting this real resource when doing aggregation. Applies to real resources only. Special backfill indicates that aggregation has been suspended for a resource.
- **Adjust Aggregate Resource:** Adjust the aggregation thresholds associated with this resource. Applies to aggregate resources only.
- **Adjust Real Resource:** Adjust the aggregation priority associated with this resource. Applies to real resources only.

The Suspend/Resume Aggregation command allows the operator to cause a real resource to be excluded from aggregation calculations until either the Resume Aggregation command is issued against it or (optionally) the resource against which it is issued returns to a satisfactory state. This command is needed so that problems with other resources in an aggregate may be noted once a problem with a particular resource has been detected.

The Activate, Inactivate, and Recycle commands, if issued for SNA resources, are routed by GMF Server Workstation to exits that take them up to NetView via the LU 6.2 pipe for execution. If issued for non-SNA resources, these commands are routed by GMF Server Workstation via the LU 6.2 pipe to NetView GMF Host Subsystem code in the GMF Focal-Point Host to be executed. NetView GMF Host Subsystem code at the GMF Focal Point makes command-string substitutions as specified by the customer and sends the command to a customer-specified transaction program in a Network Management Gateway for execution. These transaction programs are not part of NetView V2R3 GMF, but must be provided by the user.

The Native Network Command Line command results in a command line appearing over the GV/2 Graphic Facility view; the user may type in a command that is routed to the appropriate program for handling the command.

The Inventory and Problem Report commands are routed to a command exit in the workstation for execution. If the Information/Management product is the administrative repository, then this

exit opens a dialog to solicit further information, and then sends the commands up to a NetView task in the Focal-Point Host. The NetView task interacts with Information/Management via the NetView Bridge to execute the command, and then returns data to the exit code in the workstation. NetView's GMF interface code will work with little or no customization with an administrative repository built by IBM's Information/Management product using the Network Configuration Application/MVS. If a product other than Information/Management is used as an administrative repository, the user would code the user's own command exit for Inventory and Problem Report commands and perform whatever programming is required to interface these commands to the appropriate product and present results to the user.

The Inventory and Problem Report commands are applicable to both SNA and non-SNA resources.

View-oriented commands. The following are some of the major view-oriented commands supported by NetView V2R3 GMF.

- **Select View:** Allows the user to select predefined views by name from a list. Among the views that can be selected in this way are cluster, backbone, and peripheral views built by the View Preprocessor, network views built by NetView GMF Host Subsystem, and customized views stored at the GMF Server Workstation. Views may be selected for monitoring, browsing, customization, or deletion.
- **Fast Path to Failing Resource:** Give me a list of views that contain real resources that contributed to the current unsatisfactory status for this aggregate resource. Applies to aggregate resources only.
- **Configuration View:** Construct a view that shows connectivity information for the selected resource. Applies to real and aggregate NetView GMF Host Subsystem resources, and to peripheral LUs only for GMF resources.
- **Locate Resource:** Provide a list of views containing an operator-specified resource.
- **Zoom In, Zoom Out, Undo Zoom, Zoom to Fit:** Commands for magnifying portions of a view and alternating among multiple perspectives of a view.
- **Display Labels:** Lets end user specify which view labels and icons the user wishes to see at

any given level of magnification. Applies to both real and aggregate resources.

- **Subnet:** Draw a new view consisting of all resources within a specified number of hops of the selected resource. Applies to both real and aggregate resources.
- **Hide:** Hide the selected resource or resources. Applies to both real and aggregate resources.
- **Show Only:** Show only the selected resources. Applies to both real and aggregate resources.
- **Show All:** Show all resources in the view. Applies to both real and aggregate resources.

User command support. The user is able to add commands to the list of choices on the Commands pull-down menu. User command installation exits are passed the resource name and type of resource against which the command is being issued, so that they can perform different actions for NetView GMF Host Subsystem resources and for GMF resources, if required. User command installation exits may be written in C or REXX. A toolkit with appropriate header files and other support tools is provided with NetView V2R3 GMF to aid users in writing their own command support.

Example scenario

This section is meant to pull together some of the concepts discussed in this paper and to give the reader a sense of how NetView V2R3 GMF actually looks and feels to an operator using it. Here we present a scenario involving the use of NetView V2R3 GMF to diagnose a problem in a network. The figures in this section are actual views generated using a prototype of the GMF Client Workstation support.

Figure 15 illustrates a user view of the data centers in the user's network. Each site represents a cluster of resources. The view is an example of a customized view, where resources taken from Resource Object Data Manager or generated by the View Preprocessor are presented against a backdrop with their locations specified by the operator, who moved the resources where they were wanted with a mouse.

In Figure 15, the three sites, Atlanta, Dallas, and New York, are aggregate resources, with multiple real resources underneath them. Their status colors are determined by an aggregation algorithm, as described previously. Whereas Dallas and

Figure 15 Customized view of user network

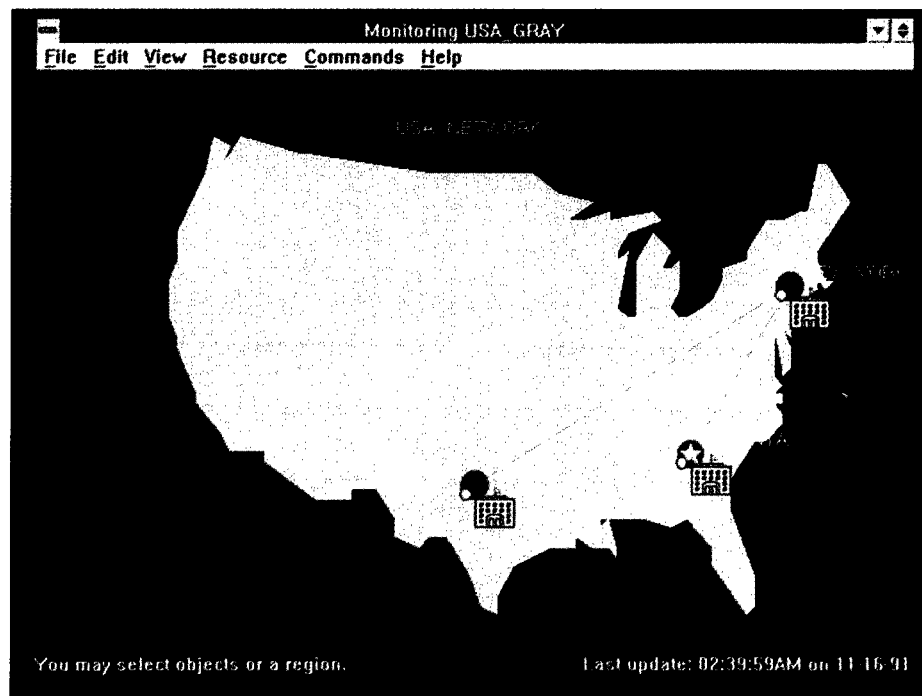


Figure 16 Peripheral view showing command menu

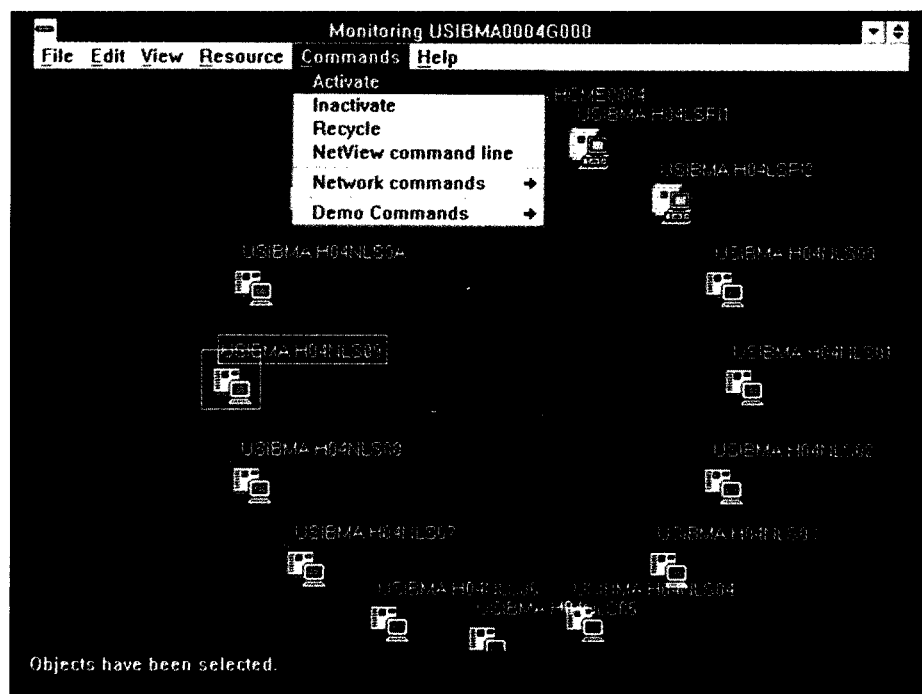


Figure 17 Customized view and peripheral view

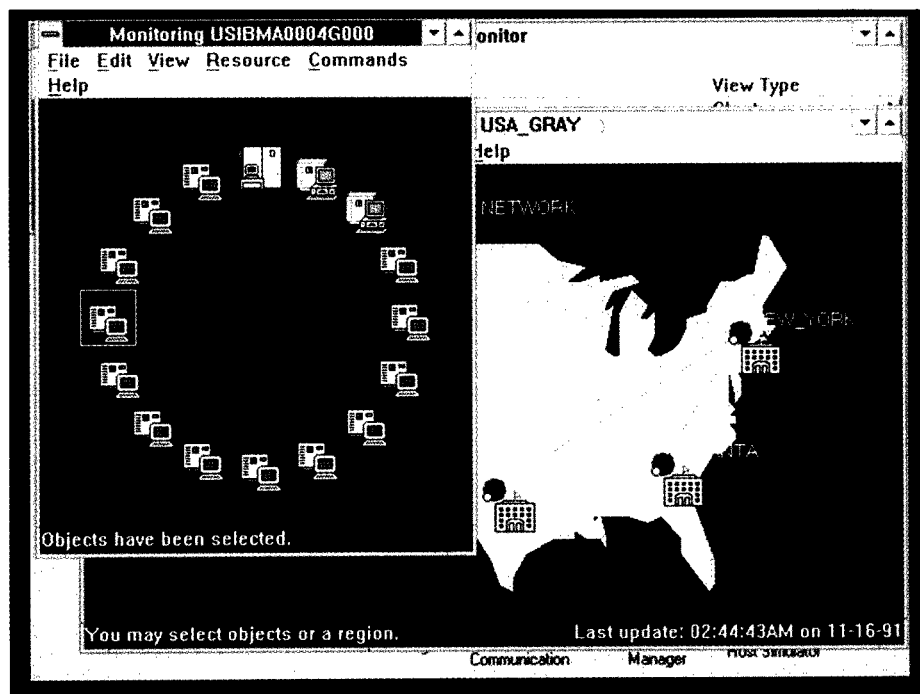


Figure 18 SNA configuration view

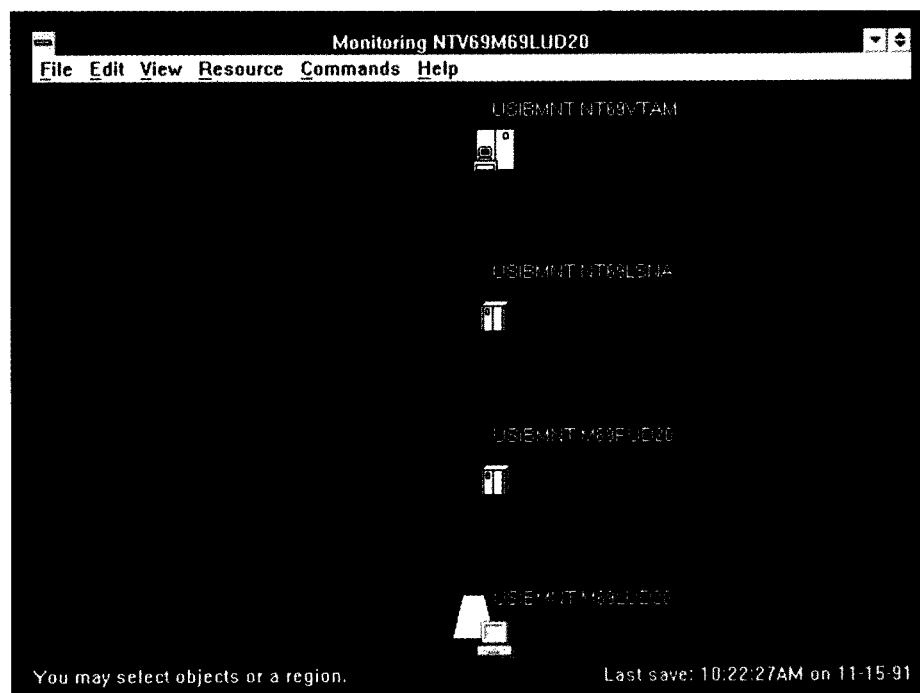


Figure 19 Mixed SNA and non-SNA configuration view

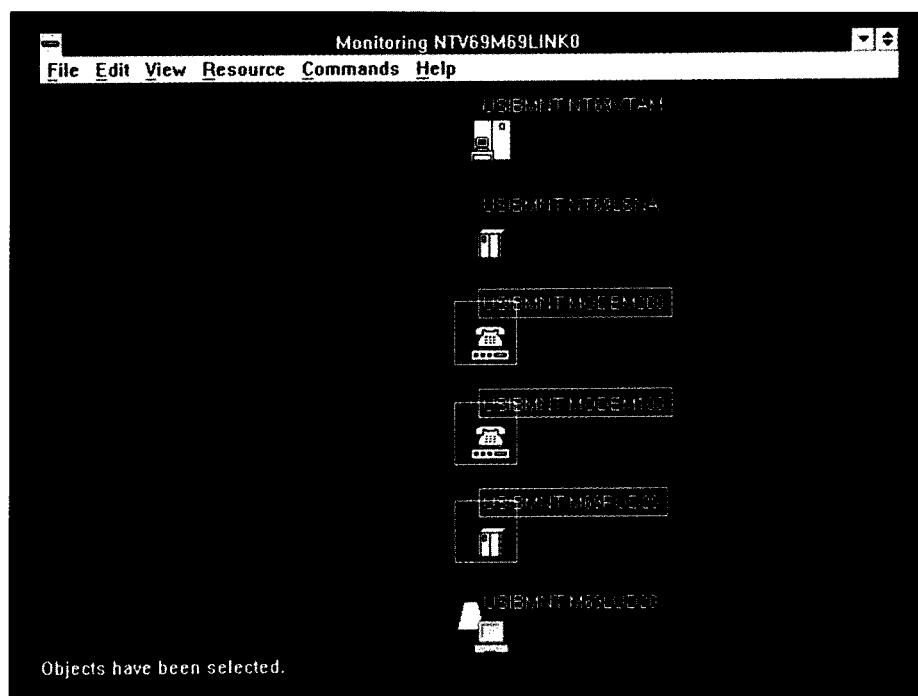
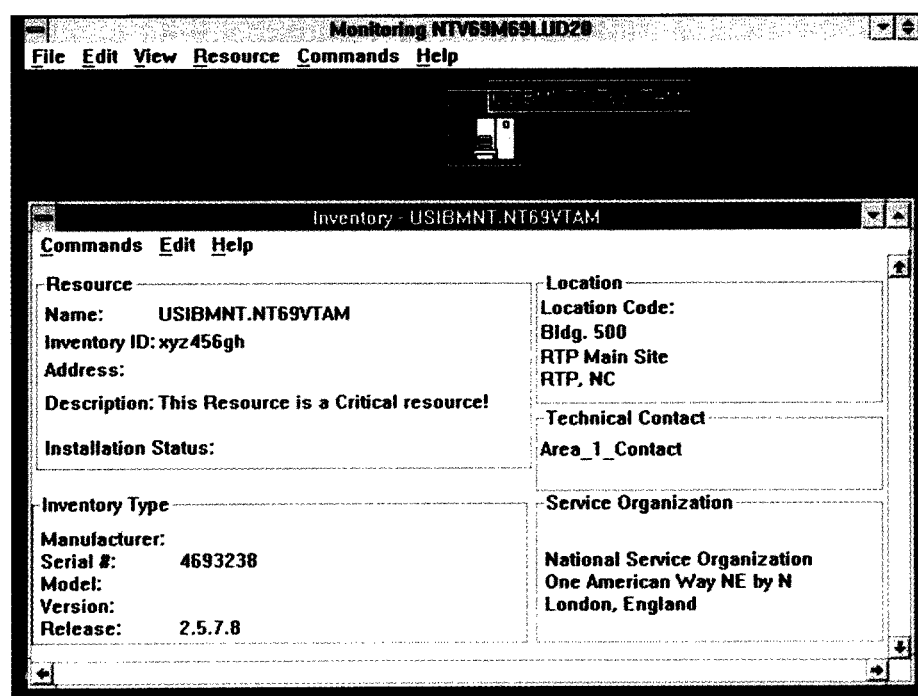


Figure 20 Example of GMF inventory information



New York are green, Atlanta is yellow, indicating that some resources contained in Atlanta are in an unsatisfactory status. Since Figure 15 is an SNA view originally generated by the View Preprocessor, the underlying unsatisfactory resources are SNA resources.

To determine what has gone awry at Atlanta, the operator selects it with the mouse by moving the cursor over Atlanta and pressing the left mouse button. The operator then double clicks with the right mouse button; this double click is an implicit Fast Path to Failing Resource command. As a result of this command, the operator brings up the view shown in Figure 16.

Figure 16 was generated by the View Preprocessor and laid out automatically using one of the GraphicsView/2 layout algorithms. It consists of an SNA VM host with many PS/2 workstations attached to it. (These are represented as SNA PU Type 2.1 resources.) In the view, the operator has selected the failing SNA resource and invoked the Commands menu and selected the Activate command. When the operator clicks on the Activate command, the appropriate command will be generated for the resource and sent up to the GMF Focal-Point Host for execution.

If all goes well, the result will be that illustrated in Figure 17. Here the failing resource has turned green, indicating that it is now in a satisfactory status, and Atlanta has also turned green, indicating that all resources in Atlanta are now in a satisfactory status.

If the operator wishes to see the logical units associated with the PU selected in Figure 17, the operator may issue a More Detail command to do so. The operator may then issue a Configuration Parent command against an LU to see the LU, its owning PU, the NCP to which the PU is attached, if any, and the owning host. This is an SNA view, and an example is shown in Figure 18.

The user may also select a resource and ask for a configuration view consisting of both logical and physical resources, such as that illustrated in Figure 19. This view is generated out of Resource Object Data Manager; it is similar to the previous view but shows some modems between two of the SNA resources. Note that the operator has selected the three unsatisfactory resources and is preparing

to issue Activate commands against them by selecting Activate from the Commands menu. The Activate commands generated by NetView for the modems will look very different from the Activate command generated for the SNA resource, but the operator need not be aware of these differences; the operator just selects the generic command.

The operator may also select a Resource and ask for inventory and problem information, as is illustrated in Figure 20 for the Inventory selection.¹⁵ The information shown is retrieved from the Information/Management database across the NetView Bridge. The user can customize this panel to show different types of information, and may also interface GMF to a different administrative repository than that provided by Information/Management.

Conclusion

As can be seen from this overview of its functions, NetView V2R3 GMF provides significant new functions in the areas of graphics network management, and integrated support for heterogeneous networks positions NetView as the "manager of managers" for system and network management. The combination of non-SNA support, command support, and dynamic view support helps position NetView as "best of breed" in the system and network management arena. In addition, by putting non-SNA configuration information into Resource Object Data Manager, NetView V2R3 GMF enables powerful automation routines to be written that can access the configuration and status information in Resource Object Data Manager and use it to perform automated diagnosis and fault correlation for multivendor networks.

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8. Because this paper was written before NetView V2R3 was shipped, functions, terminology, and command and view details may differ somewhat between this paper and the shipped product.
9. A *physical unit* or PU is an SNA component that manages and monitors resources (such as attached links) associated with a node. A *logical unit* or LU is an SNA component that enables end users to communicate with each other and gain access to network resources.
10. An *alert* is an SNA-architected notification sent by a transaction program or element manager to the owning host to indicate a problem or impending problem. NetView V2R3 GMF also uses alerts to indicate that a problem has been resolved. For a paper on the use of alerts in managing heterogeneous networks, see R. E. Moore, "Utilizing the SNA Alert in the Management of Multivendor Networks," *IBM Systems Journal* 27, No. 1, 15-31 (1988).
11. An LU 6.2 session is a type of SNA session between resources that supports general communication between programs in a distributed processing environment. LU 6.2 is characterized by: (1) a peer relationship between session partners, (2) efficient utilization of a session for multiple transactions, (3) comprehensive end-to-end error processing, and (4) a generic application program interface consisting of structured verbs that are mapped into a product implementation.
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14. For information on the Information/Family and Information/Management products, see the publication *Introducing the Information/Family*, GC34-3035, IBM Corporation; available through IBM branch offices.
15. The Information/Management product is optional; appropriate interface information is available as part of the NetView V2R3 GMF documentation so that customers may interface NetView V2R3 GMF to administrative subsystems other than Information/Management.
16. The GMF views shown in this paper are taken from a prototype of the product; details may change in the final version of the product.
17. The navigation facility described in this section is for More Detail only.

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